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December 1977

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Cincinnati, Ohio 45268

MUNICIPAL WATER POLLUTION CONTROL ABSTRACTS:

November 1976 - October 1977

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MUNICIPAL WATER POLLUTION CONTROL ABSTRACTS
November 1976 - October 1977

by

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OFFICE OF RESEARCH AND DEVELOPMENT
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CINCINNATI, OHIO 45268

ABSTRACT

The Franklin Institute Research Laboratories, Science Information Services Department, prepared for the Environmental Protection Agency Volume 4 of the *Municipal Technology Bulletin*, a current awareness abstracting bulletin covering methods of municipal waste water treatment, problems of water quality, and water pollution control. Volume 4 of the *Bulletin* contained abstracts of technologically significant literature appearing in print during 1976 and 1977. Under the same grant the Science Information Services Department, as a center of competence on municipal waste water, provided 1320 abstracts, including those appearing in the *Bulletin*, to the Water Resources Scientific Information Center (WRSIC). The *Municipal Technology Bulletin* informs researchers, consultants, engineers, and government officials of current developments described in more than 4000 English and non-English language scientific and technical publications. Topics covered in the *Bulletin* and in the abstracts submitted to WRSIC include: analytical techniques for water quality measurements; biological, chemical, and physical methods of waste water treatment, disposal, and recycling; construction and equipment for pollution control; mathematical, statistical, and simulation model studies; storm runoff; tunnelling technology and sewer systems; and treatment plant operation and automation. This report is a compilation of the 1320 abstracts arranged consecutively by accession number within subject categories. A list is provided of the abstracts that appeared in the *Municipal Technology Bulletin*. The report is completed by a journal list and subject and author indices.

Municipal Water Pollution Control Abstracts: November 1976-October 1977 is submitted in fulfillment of grant number R 804922-01 by the Franklin Institute Research Laboratories under the sponsorship of the Environmental Protection Agency. Work on this project was completed as of October 31, 1977.

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INTRODUCTION

For the purpose of providing ready access to the large body of current literature on municipal waste water collection, treatment, and disposal, the Science Information Services Department of the Franklin Institute Research Laboratories has abstracted, categorized, and indexed pertinent literature appearing in print during 1976 and 1977. This service was made possible through a grant from the Environmental Protection Agency's Office of Research and Development. Abstracts of technologically significant articles were printed in Volume 4 of the *Municipal Technology Bulletin*, a monthly current awareness abstracting publication. A total of 1320 abstracts, including the 273 appearing in Volume 4, were submitted to the Water Resources Scientific Information Center (WRSIC), Office of Water Research and Technology, Department of the Interior. The present report is a fully indexed compilation of these 1320 abstracts and serves as a specialized yearly bibliography on municipal waste water control.

The *Municiapal Technology Bulletin*, Volume 4, is the outgrowth of several preceding publications which were prepared by the Franklin Institute for the EPA: *Selected Storm Water Runoff Abstracts*, 1970-1972, and the *Municipal Technology Bulletin*, Volumes 1, 2 and 3, 1973 to 1976. These publications were designed to meet the information needs of officials, researchers, and engineers regarding recent developments in the field while allowing them to spend a minimum amount of time in personally scanning the literature. The abstracts in the *Municipal Technology Bulletin* provide a basis for further exploration of the relevant water resources literature.

Material for the *Municipal Technology Bulletin* was selected by the regular scanning of over 4000 English and non-English language publications, including technical journals, government reports, industrial reports, newsletters, patent gazettes, design manuals, conference proceedings, recent dissertations, and textbooks. The material was screened at the Franklin Institute Library and several other Philadelphia libraries. Additional screening was performed at the Franklin Institute's facilities in Munich, Germany, and Tokyo, Japan. Each month, 25 to 30 documents pertaining to the latest waste water technology were selected for inclusion in the *Municipal Technology Bulletin*. Specific subjects covered were: (1) waste water treatment methods relating to facilities, land application, utilization of sludge, waste water reuse, legislation, plant automation, mechanical and chemical devices; (2) sampling and instrumentation for biological, chemical, and physical analytical techniques; (3) storm water runoff, including urban runoff, runoff forecasting, flood routing, rainfall-runoff relationships, catchment basins, and surface runoff; (4) tunneling technology and sewer systems, including combined, separated, outfall and interceptor sewers, storm drains, infiltration-inflow, materials

and equipment; (5) patents for methods and equipment pertaining to waste water treatment, reuse and disposal; (6) mathematical, statistical, and simulation model studies; and (7) hydrologic aspects involving parametric hydrology, sewer hydraulics, and drainage.

In 1976 and 1977, the *Municipal Technology Bulletin* was distributed free of charge on a monthly basis to 660 selected recipients whose names were supplied by the EPA Project Officer, or were added to the mailing list as a result of their direct request to the Franklin Institute.

Through this EPA grant, the Franklin Institute served as a center of competence for municipal waste water pollution control. Thirteen hundred and twenty abstracts on municipal waste water treatment methods were provided to WRSIC. These were published in *Selected Water Resources Abstracts*, WRSIC's semi-monthly abstracting journal. They were also entered into the WRSIC computerized data base. Literature was chosen for input to WRSIC using essentially the same criteria and screening procedures as for the *Municipal Technology Bulletin*.

This report includes all the abstracts prepared for the *Municipal Technology Bulletin* and WRSIC. So that this publication may be easily used as a specialized bibliography, an in-depth subject index is provided in a hierarchical, computer-generated form. A complete author index and a journal list complement the subject index. The abstracts are ordered by consecutive accession number within each subject area. Topic headings are: Storm Runoff, Sewer Systems, Patents, Treatment Methods, Analytical Techniques, Model Studies, Hydrologic Aspects, and Miscellaneous. The format of each abstract is displayed on the following page.

ABSTRACT FORMAT

FIRL ACCESSION NUMBER

TITLE OF ARTICLE

NAME OF AUTHOR(S)

AFFILIATION OF PRIMARY AUTHOR

BIBLIOGRAPHIC DATA: Journal Title (source), Volume, Issue number, Pagination, Date, Figures, Tables, References.

ABSTRACT

DESCRIPTORS: Those terms found in the *Water Resources Thesaurus* which best describe the concepts and content of the article. Asterisks denote the more relevant terms.

IDENTIFIERS: Those terms not contained in the *Water Resources Thesaurus* which also closely describe the article's content.

MUNICIPAL TECHNOLOGY BULLETIN ABSTRACT LIST

ACCESSION NUMBERS

A001
A006
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A021
A027-028
A032-034
A036

B003-008
B013-017
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F063-066
F070
F074-079
F083
F088-092
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H003-007
H013
H015
H017

J107
J122
J130
J139

MUNICIPAL WATER POLLUTION CONTROL ABSTRACTS

STORM RUNOFF

A001
STORMWATER MANAGEMENT LOOKS TO NATURAL DRAINAGE,

The American City and County, Vol. 91, No. 10, p 51-53, October, 1976. 2 tab.

New trends in stormwater management are discussed, with particular emphasis on detention, long-term equalization, and natural drainage. The objective of these solutions is to attenuate both peak and total short-term runoff and to reduce major facilities investments required for protecting against flood hazards in the lower portion of an urban drainage basin. The initial planning for a residential subdivision should begin with a study of the total drainage area, with the major components of the system (streams, large depressions, lakes, and ponds) being located for an assessment of their stormwater management potential. During this phase, existing plans for stormwater management should be assessed both in terms of the effect of the subdivision drainage on basin-wide drainage and vice versa. Temporary storage can be achieved using rooftop and parking lot ponding; while ponds, reservoirs, and stream channels provide permanent storage. Street design in residential areas should take into account the functions of streets as part of the stormwater management system. Maximum use should be made of natural drainage. The installation of stormwater inlets should be delayed as long as possible because as soon as the runoff enters the pipe system it is carried rapidly downstream and may pose flood hazards in the lower part of the drainage basin.

*Water management (applied), *Storm water, *Storm runoff, *Urban runoff, *Drainage systems, Flood control, Drainage area, Drainage practices, Detention reservoirs, Storage

A002
STORMWATER TUNNEL CUTS DRAINAGE COSTS,

The American City and County, Vol. 91, No. 10, p 54, October, 1976.

A stormwater system for the city of Indianapolis, Indiana which is designed to handle periodic flooding and divert overflow from existing combined sewers for treatment is described. The system includes a 22-block-long storm drainage pipe, a treatment facility, and a huge outfall conduit. Stormwater will be collected, channeled north to the treatment facility for solids separation and chlorination, and then pumped into the White River. The design includes an underground sedimentation and contact tank sized to provide slightly more than 15 min contact time at a flow rate of 100 million gallons/day, equivalent to the treatment of 0.5 in of rainfall/hr with a runoff factor of 40%. After storms, the solids and sludge which have been collected in the detention tank will be flushed into a sump and pumped into an existing 42-inch sanitary sewer for further treatment at the city's waste water treatment plant. The sewer system conveying stormwater to the treatment facility will consist of almost 2.5 mi of reinforced concrete pipe, most of which will be installed by tunnel construction down to a depth of 40 ft. Total cost of the project is $5.5 million.

*Storm water, *Runoff, *Sewers, *Urban runoff, *Drainage systems, Treatment facilities, Cities, Conduits, Conveyance structures, Hydraulic structures, Construction, Design criteria, Storm runoff, Concrete pipes, Tunneling, Materials, Separation techniques, Chlorination, Costs

Indianapolis

A003
ON THE RUN-OFF CHARACTERISTICS IN THE NIGORI RIVER AND OHORA RIVER BASINS CONSIDERED BY THE SURFACE RUN-OFF (Hyomer ryushutsu o kangaeta nigori gawa oyobi ohora gawa ryuiki ni okeru shusui tokusei ni tsuite),

Takase, N., and Ujibashi, Y.

Kanazawa Daigaku Kogakubu Kiyo, Vol. 10, No. 1, p 17-24, 1976. 9 fig, 1 tab, 7 ref.

The runoff mechanism in river basins is very complicated due to many factors involved. Despite studies, many problems are still unsolved. Several methods for runoff analysi have been introduced, including the runoff function method, unitgraph method, storage function method, and characteristic curve method. However, the runoff phenomena are not entirely clear, as no method of runoff analysis is completely satisfactory. A universal analysis method is desirable. The relationship between variations in river basin characteristics and surface runoff area were studied in the Nigori river basin and Ohora river basin of the Hida river tributary of the Kiso river system, all in Japan. The characteristic curve analysis method was used to analyze runoff. Some unusual data were obtained.

*Runoff, *Analytical techniques, *Surface runoff, *River basins, *Analysis, *Graphical analysis, River systems, Rivers, Tributaries

*Japan

A004
THEORY OF STORAGE AND TREATMENT-PLANT OVERFLOWS,

Howard, C. D. D.

Journal of the Environmental Engineering Division-ASCE, Vol. 102, No. EE4, p 709-722, August, 1976. 5 fig, 5 ref, 1 append.

A theoretical description is presented of the volume of pollution spilled into receiving water during storms. The theory may be used as a basis for selecting alternatives for more detailed analysis and engineering design. The theory begins with the probabilistic aspects of the climate as determined from analysis of local records. It develops the statistics of untreated discharge through mathematically derived probability functions. Economic analysis is included. The theory has the potential for greatly simplifying the analysis of storage treatment plant combinations and application to the effects of storage in urban drainage systems. It is useful for extrapolating results of detailed computer simulations. Its theoretical limitations stem from the approximation to the true density function for storm volumes.

*Storm runoff, *Waste water treatment, *Analytical techniques, *Treatment facilities, *Storage, *Overflow, Volume, Storms, Design, Water pollution sources, Analytical techniques

A005
PHOSPHORUS AVAILABILITY IN PARTICULATE MATERIALS TRANSPORTED BY URBAN RUNOFF,

Cowen, W. F., and Lee, G. F.

Wisconsin University
Madison,
Water Chemistry Program.

Journal Water Pollution Control Federation, Vol. 48, No. 3, p 580-591, March, 1976.
4 fig, 5 tab, 19 ref.

A study was undertaken to provide estimates of the availability of runoff particulate phosphorus forms collected from a variety of urban land uses. Grab samples of urban runoff were collected from low, medium, and high density residential areas; a university campus; the central commercial district; and areas of urban construction activity in Madison, Wisconsin, during 12 precipitation or snowmelt events. The following P forms were determined by chemical analysis: dissolved reactive; total soluble; particulate; total; and particulate inorganic extracted by acid, base, and anion exchange resin. The sorption of soluble inorganic P by runoff particles was investigated by adding monobasic potassium phosphate standard solutions to aliquots of runoff and comparing the resin-extractable dissolved reactive P concentrations with the expected values. Particulate P of 0.45 micron pore size or larger showed group mean values of acid extractable particulate inorganic P that ranged from 33 to 46% of particulate P. Corresponding ranges were 22 to 27% for base-extractable particulate inorganic P and 13 to 17% for anion exchange resin-extractable particulate inorganic P. The relatively narrow ranges of group mean values for a given type of chemical extraction indicated that the particulate P forms transported by surface runoff from different land uses were similar. Possibly the dominant type of particulate P was derived from a common source. Dark incubations of runoff particulate P or unfiltered runoff itself with anion exchange resin indicated that physical-chemical processes were more important in the release of inorganic P to solution than was microbial mineralization of particulate P.

*Analytical techniques, *Pollutant identification, *Phosphorus, *Urban runoff, *Land use, Water sampling, Construction, Wisconsin

A006
STORMWATER STUDIES AND ALTERNATIVES IN ATLANTA,

Holbrook, R. F., Perez, A. I., Turner, B. G., and Miller, H. I.

Jordan, Jones and Goulding, Incorporated,
Atlanta, Georgia.

Journal of the Environmental Engineering Division-ASCE, Vol. 102, No. EE6,
p 1263-1277, December, 1976. 2 fig, 10 tab, 14 ref.

The U. S. Army Corps of Engineers quantified and evaluated sewer overflows and stormwater runoff in Atlanta, Georgia. Field sampling and data from previous studies of the area were combined. For the present study, four suburban watersheds were selected for analysis of BOD5, COD, suspended solids (SS), lead, phosphorus, oil and grease, ammonia nitrogen, Kjeldahl nitrogen, nitrate nitrogen, and fecal coliform. Results indicated that annual combined sewer overflows and urban runoff produced about 45% of the BOD load and 95% of the SS load in area streams. Computer simulations used indicated that proposed receiving stream DO standards were frequently violated in the metropolitan area by nonpoint sources. The urban runoff nutrient loads were found to be excessive of levels which result in accelerated eutrophication. Abatement alternatives proposed included storage basin construction and possible stormwater treatment for urban runoff. Methods for controlling sewer overflows were suggested and included sewer separation, screening, storage, sedimentation, air flotation, chlorination and off-peak discharge to existing treatment facilities. Cost estimates for all proposed abatement systems were evaluated.

*Waste water treatment, *Pollutant identification, *Sewerage, *Biochemical oxygen demand, *Chemical oxygen demand, Treatment facilities, Storm water, Overflow

A007
SIMPLIFIED METHODS OF COMPUTING THE QUANTITY OF
URBAN RUNOFF,

Shubinski, R. P.

Water Resources Engineers,
Springfield, Virginia.

In: Short Course Proceedings: Applications of Stormwater Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 200-213.
7 fig, 4 tab, 2 ref.

Regional flood-frequency relations were developed for 40 non-urban watersheds in the San Francisco Bay area by means of multiple regression. The regression equations were developed for basins larger than 5 sq mi under essentially non-urban conditions, and increasing urbanization will tend to change the coefficients and exponents. The rational method is based on the equation setting the maximum runoff rate equal to the product of a runoff coefficient representing the effects of rainfall losses, the average intensity of rainfall for the travel time, and the drainage area. The method's two principal assumptions are that the maximum runoff rate occurs when the entire area is contributing flow and the maximum rate of rainfall occurs during the time of concentration and the design rainfall depth during the time of concentration can be converted to an average rainfall intensity. The unit hydrograph (UH) is based on the assumption that the ordinates of a direct runoff hydrograph are proportional to the ordinate of the UH times the rainfall excess in a given time interval. Using the UH involves derivation of the UH for specified duration and application to a given rainfall event to determine the corresponding hydrograph of direct runoff. Computation of rainfall excess is based on known rainfall rates and estimates of losses. The UH can be used in comprehensive watershed simulation to evaluate the hydrologic effects of urbanization and costs of required drainage facilities.

*Analytical techniques, *Rainfall intensity, *Runoff, *Urban runoff, *Peak discharge, Storm runoff, Storm water, Drainage systems

Peak storm flow

A008
IMPACT OF STORMWATER RUNOFF ON RECEIVING WATER QUALITY,

Roesner, L. A.

Water Resources Engineers,
Walnut Creek, California.

In: Short Course Proceedings: Applications of Stormwater Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 159-176.
9 fig, 5 tab, 10 ref.

Currently, every United States city ultimately disposes of much of its storm runoff in natural surface watercourses. The impact of this disposal on receiving water quality depends principally on the quality and quantity of the discharge or discharges, the type of body of water into which the storm water is discharged, and outfall location. The pollution potential of storm water is shown, and some examples are presented of the impact on receiving waters. Considerations that are involved in assessing storm water discharge impact on the quality of receiving water are discussed.

*Water quality, *Runoff, *Urban runoff, *Storm water, *Storm runoff, *United States, Cities, Waste water disposal, Natural streams

A009
QUALITY ASPECTS OF URBAN STORMWATER RUNOFF,

Roesner, L. A.

Water Resources Engineers,
Walnut Creek, California.

In: Short Course Proceedings: Applications of Stormwater Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 138-158. 7 fig, 6 tab, 7 ref.

The biochemical oxygen demand (BOD) and solids loads in urban runoff are significantly higher than those in combined sewer overflows. Pollutant loads are introduced into urban runoff from three sources: the land surface itself, catch basins, and the sewers in combined systems. The pollutant types found in greatest quantity are chemical oxygen demand (COD), BOD, and solids; nitrogen and phosphorus are also significant. The amount of runoff, and hence the pollution loads, contributed from pervious surfaces in urban areas is small compared to that coming from the impervious areas. An equation gives the rate of dust and dirt buildup for a given land use on urban watersheds. The amount of pollutant remaining on the watershed decays exponentially for a constant runoff rate. Depending on the travel time in the transport system and the time to peak for the individual pollutographs, the resultant pollutograph at the outfall may have a high peak due to individual peaks arriving simultaneously or a lower peak and broader base if the travel time in the sewer system is long compared to travel time on the individual watersheds. Changing a park to a multiple residence area would increase imperviousness and produce a seven-fold increase in peak-runoff. Since the major contribution to urban runoff pollution comes from the land surface itself, control of the pollution problem should start there.

*Sewerage, *Analytical techniques, *Biochemical oxygen demand, *Chemical oxygen demand, *Combined sewers, Water quality, Runoff, Urban runoff

Peak storm flow

A010
QUANTITY ASPECTS OF URBAN STORMWATER RUNOFF,

Espey, W. H., and Winslow, D. E.

Espey, Huston, and Associates, Incorporated
Austin, Texas.

In: Short Course Proceedings: Applications of Stormwater Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 83-137. 13 fig, 7 tab, 73 ref.

Considerations must be given in designing urban drainage facilities to the required design to storm rainfall, the rainfall-runoff relationships as affected by the surface, and geometric characteristics of the watershed. The system must adequately dispose of all surface runoff from the design storm without serious damage to physical facilities or serious interruption of normal traffic. Runoff from storms exceeding the design storm must be disposed of with minimum damage to physical facilities and traffic interruption. The system must have maximum reliability of operation. The concept of rainfall excess, methods for determining rainfall excess, overland flow analysis, runoff hydrographs, urban drainage systems, open channel flow, and methods of routing are discussed. Many urban design techniques consist of a combination of empirical, statistical, and theoretical methods. Urban hydrology literature is categorized as empirical/statistical formulas, flood frequency analysis, and simulation methods. Empirical formulas are generally based on some form of hydrologic hypothesis; resulting relationships are developed by empirical derivation of equations and/or coefficients. Flood frequency equations have been developed which predict the peak flow for urban basins for selected recurrence intervals. Simulation methods generally attempt to describe in a somewhat analytical fashion the various physical processes involved in the generation of runoff.

*Analytical techniques, *Runoff, *Urban runoff, *Peak discharge, *Storm runoff, Storm water, Design, Drainage systems

Peak storm flow

A011
CONDUCTING A SEWER INFILTRATION/INFLOW SURVEY TO ELIMINATE 20 MGD,

Karanik, J. M., and Johnson, P. C.

Onondaga County Department of
Drainage and Sanitation,
Syracuse, New York.

Public Works, Vol. 107, No. 12, p 49-52, December, 1976. 1 fig.

A Phase II infiltration/inflow evaluation survey identifies specific infiltration/inflow sources, determines their effect on treatment capacity, verifies cost-effective levels for elimination, and determines a program for sewer rehabilitation. Such a survey was undertaken of the tributary areas of the Metropolitan Syracuse Sewage Treatment Plant. The study area has a 300,000 population and contains 369 miles of separate sanitary sewers and 287 miles of combined stormwater and sanitary sewers. The plant is being expanded to an 80 mgd tertiary facility and the combined system overflows are evaluated for recommendations to control and abate stormwater/sanitary overflows. The study was in three parts separate system evaluation survey, combined system evaluation survey, and combined sewer overflow monitoring and abatement program. The second part of this program was described in detail. Four major service areas were defined, divided into smaller subservice areas, and the data were combined to complete an overall data base. Manholes and sewer lines were assigned identification codes. Flow depth monitors were placed in key manholes and this data plus pipe sizes, slopes and sewer invert depth measurements were input into a computer. The computer was used to calculate flows for specific sections of sewer line, as well as general system flows. Groundwater and precipitation data were collected to determine their relationship to infiltration. A physical inspection program was conducted of manholes, the trunk sewer, and connecting branch sewers. Following a television inspection of sewers, a final cost-effective analysis will be performed to determine which points of infiltration and continuous inflow will be removed.

*Infiltration, *Inflow, On-site investigations, Sewers, Manholes, Sewage districts, Groundwater, Economics

Phase II infiltration inflow evaluation survey, Metropolitan Syracuse Sewage Treatment Plant, Precipitation data

A012
A STOCHASTIC APPROACH TO SNOWMELT RUNOFF FORECASTING,

Kim, K.

Dissertation Abstracts International B, Vol. 37, No. 6, p 2729, December, 1976.

A study was undertaken to develop models using air temperature and precipitation data to determine the range and probability of snowmelt floods during spring periods. The Minnesota River Basin was used to develop stochastic simulation models. The transformation function chosen was the Streamflow Synthesis and Reservoir Regulation (SSARR) model. Temperature at one station could be modeled. It was transformed to determine constant variance, then divided into deterministic and stochastic components. The first was represented by a second degree regression line and the latter was shown as a first order autoregressive, first order moving average model. With a network of stations, air temperature was modeled like that for a single station except for the modeling of white noise. Transformation coefficients were obtained at all stations to determine transformation temperature. Deterministic and stochastic portions were represented by a second order regression line and an ARMA model for each station. Precipitation for a single station was represented by a first order Markov chain model and a gamma distribution with the proper parameter values. Wet day precipitation at each station was independently described by gamma distribution since the amounts of precipitation at all study stations was assumed to be independent. A 500-year data sequence was generated by the proposed models for each station. This data was divided into four groups by possible contribution to snowmelt runoff. One temperature or precipitation sequence was input to the SSARR model from each group for simulation of floods. Major and minor floods, similar to past floods, were generated.

*Model studies, *Hydraulic models, *Runoff forecasting, *Snowmelt, Temperature, Simulation analysis, Stochastic processes, Markov processes, Streamflow forecasting, Precipitation (atmospheric)

Minnesota River Basin, Streamflow Synthesis and Reservoir Regulation (SSARR) model, Precipitation data

A013
ON-LINE ADAPTIVE CONTROL FOR COMBINED SEWER SYSTEMS,

Trotta, P. D.

Dissertation Abstracts International B, Vol. 37, No. 7, p 3538, January, 1977.

A new approach to the problem of urban storm water management was proposed. On-line computer control of the mechanical features of a combined sewer system was investigated. These controls would aid sewer systems effectively to contain combined flows during storms. A model was developed for a system divided into subbasins. Controls for each subbasin are derived separately using a stochastic dynamic programming formulation. An upper limit for releases is determined by a master control problem, which combines the separate basin situations and determines individual interceptor and treatment capacities. An autoregressive-transfer function model is used to forecast inflows, and can respond to new information on the storm event. A part of the proposed system for San Francisco was used as a test case. Results indicated that controls based on stochastic models were superior to deterministic forecasts. The model provided a superior distribution of overflows when such overflows were unavoidable. A reactive model which was tested was able to minimize total overflows to an even higher degree.

*Model studies, *Storm water, *Computer models, *Storm runoff, *Combined sewers, Interceptor sewers, Waste water treatment, Overflow, Planning, Automatic control

Stochastic dynamic programming

A014
LONDON'S STORMWATER PROBLEM,

Horner, R. W., Wood, L. B., and Wroe, L. R.

Journal Water Pollution Control Federation, Vol. 49, No. 1, p 103-110, January, 1977. 1 fig, 2 tab, 3 ref.

London's storm water problem and methods utilized to cope with it were reviewed. Six districts (central London, north-western, northern, north-eastern, south-eastern, and south-western) were described by characteristics of population, storm water conditions, and sewerage/drainage systems. A "standard storm" was selected to estimate storm water quantities discharged to rivers and streams for comparison of districts on a common basis. Instruments have been added at pumping stations, discharge mains, and culverts for water quality sampling. Basic principles used in controlling storm water were rapid removal of storm water from the area affected and storage for dispersal over a period greater than that of the storm at a rate close to the normal receiving stream flow. Studies indicated several effects of storm water on the Thames and its tributaries in the Greater London area. These include the depletion of dissolved oxygen in river water, where oxygen levels are dependent upon previous waterway conditions, flow quantity, and quality, and the spreading of pollution effects over a larger area when a storm occurs at rising tide. Possible control methods which were suggested included operating the sewerage system so as to contain as much of the dry weather flow within the system as possible; increasing intercepting sewer capacity to allow more storage and greater carrying capacity for storm water removal to treatment plants, storm tanks, or other areas; providing short term sedimentation or other treatment for pollution reduction; and aerating the river water to counter oxygen depletion. It was concluded that the major problem within the Greater London area was the control of storm water discharges.

*Storm water, *Storm runoff, *Drainage systems, *Floods, Urban drainage, Storm drains, Intercepter sewers, Combined sewers, Water quality, Analysis, Monitoring, Water quality

London (England)

A015
SEDIMENTS AND WATER QUALITY OF URBAN STORM WATER,

Ellis, J. B.

Middlesex Polytechnic,
Hendon, England.

Water Services, Vol. 80, No. 970, p 730-734, December, 1976. 4 fig, 10 ref.

The Silk Stream catchment, a tributary of the River Brent, in North London, was studied to gather information on the relationship between sediments and water quality of urban storm water. Storm water runoff contains a substantial quantity of pollutants which can present a more serious problem than municipal wastes. Typical components of storm water are organic compounds, fecal bacteria, heavy metals, and suspended solids. Oils, phenols, detergents, and greases are other pollutants. Hydrologic and other characteristics of the area were studied. Storm water sediment composition is dominated by inorganic mineral fractions (45-70%) from roof, pavement, and street surfaces; also included are brick, glass, concrete, ash, bitumen, rubber-coated particles, minor amounts of plastics, aggregate, and metallic particles. These sediments are well sorted, spherical, and concentrated in the 0.1-0.5 millimeter range. Accumulated discharge of huge amounts of sediment in the receiving channels produces a very thick gelatinous benthal sludge. When these sludges are oil, grease, and detergent, flocs bubble to the surface. This bubbling and flotation are signs of decomposition, just as depressed pH and dissolved oxygen values indicate. Benthal sludges have a high ionic absorptive capacity, mainly from inorganic matter in the sediment. Organic components increase the potential by decomposing to release complex, toxic compounds into surrounding sediments or by solutional release into the stream. There is a strong likelihood of co-precipitation of trace metals with these substances as well as with free iron oxides, rubber, and bitumen components. The use of sediment loads to upgrade nutrient rich waters, to take chemical species from the solution phase, or to remove these species, heavy metals, and organic compounds from the stream are all feasible water quality goals.

*Storm runoff, *Urban runoff, *Water pollution sources, Heavy metals, Sediments, Oxygen demand, Surface runoff, Hydrology, Hydrogen ion concentration, Storm water, Water quality

Silk Stream (London, England)

A016
TIME-DISTRIBUTION OF STORM RAINFALL IN PENNSYLVANIA,

Kerr, R. L., Rachford, T. M., Reich, B. M., Lee, B. H., and
Plummer, K. H.

Pennsylvania State University,
University Park,
The Institute for Research on Land and Water Resources.

June, 1974. 173 p, 33 fig, 33 tab, 27 ref, 3 append. Technical Report PB 244 251.

A sample of 1623 storms obtained from the rainfall charts of 46 recording rain gage stations throughout Pennsylvania were analyzed. Each storm was large enough to have produced a flood, given the proper antecedent conditions. Percentage rainfall occurring in successive 5%, 10%, 25%, and 33.3% time intervals of storm duration were calculated for each storm. Ten percent of duration was best for noticing possible trends. Techniques used to identify storms with similar patterns included calculating a median mass curve for storms in each group, calculating limit curves including 80% of the data points around this median line, and calculating statistics for the percentage rainfall in each interval of 10% duration. A sample of 405 antecedent precipitation events associated with flood-producing storms in Pennsylvania was also analyzed. Antecedent rainfalls associated with each storm were listed for seven sequential 24 hr periods immediately before the start of the storm. Antecedent precipitation distributions were somewhat different during the growing and dormant seasons. Regional variations across Pennsylvania were insignificant. The occurrences of antecedent rainfalls were nearly independent statistically from the ensuing flood-producing storms.

*Time, *Storm water, *Storms, *Rainfall, *Pennsylvania, Rain gages, Floods, Antecedent precipitation

A017
QUALITY ASPECTS OF URBAN STORM WATER RUNOFF,

Roesner, L. A.

Water Resources Engineers,
Walnut Creek, California.

In: Short Course Proceedings: Applications of Storm Water Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 138-158. 7 fig, 6 tab, 7 ref. Technical Report NTIS PB 247-163.

The quality of urban storm water runoff was considered in light of recent recognition of storm water runoff as a pollution source. Pollutant loads are introduced into urban runoff from the land surface (primarily impervious surfaces), catch basins, and combined sewer systems. Street litter, waste water from sewers, and pollutants from catch basins affect storm water quality. Practically all urban runoff pollutants are associated with dust and dirt components of street litter COD, BOD, solids (suspended and settleables), nitrogen and phosphorus. These are found in significant quantities. Others include pesticides, herbicides, fertilizers, chemical additives, heavy metals and other unknown pollutants. Methods are presented for calculating the rate of pollutant buildup on urban watersheds and determining urban runoff pollution loads. Effects of land use changes on storm runoff characteristics were studied. For example, the change from a park area to a residential area increased the impervious area of the subcatchment and generated a dry weather sanitary flow from the area. BOD remained relatively the same under these conditions, although suspended solids increased after the change to multiple residences. Suggested solutions included draining impervious areas to pervious areas and providing means for runoff to infiltrate without contaminating groundwaters. Alternatives were to store storm water for treatment between storms or to initiate a combination of the two methods.

*Storm runoff, *Water quality, *Water pollution sources, Groundwater, Waste water, Chemical oxygen demand, Biochemical oxygen demand, Solid wastes, Nitrogen, Phosphorus, Urban hydrology, Pollution abatement, Watersheds, Combined sewers

A018
IMPACT OF STORM WATER RUNOFF ON RECEIVING WATER QUALITY,

Roesner, L. A.

Water Resources Engineers,
Walnut Creek, California.

In: Short Course Proceedings: Applications of Storm Water Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 159-176. 9 fig, 5 tab, 10 ref. Technical Report NTIS PB 247-163.

The effect of storm water runoff on receiving stream quality depends upon the quantity and quality of the storm water discharges; the type of water body into which the runoff is discharged; and the location of the outfalls. Components of storm water having pollution potential are suspended solids, COD, BOD, nitrogen, phosphorus, and metals. Whether the receiving stream is relatively enclosed, as a marina, or open to greater flow and tidal effects, as a stream or an ocean, makes a great difference in the type of resultant pollution. Tidal influence (mixing and dispersion) affects water quality as does a coastal or enclosed outfall location. Control measures must allow consideration of the use of the receiving stream: for drinking water, recreational purposes, or the propagation of aquatic life. Computation analyses should be carried out to determine effects with time and spatial detail. Value judgment is then used to carry the assessment beyond present computational technology. One such evaluation system is the EPA Storm Water Management Model which simulates quality effects of BOD, dissolved oxygen, and suspended solids. Another useful model is the EPA River Basins Modeling Projects program.

*Storm runoff, *Water quality, Analysis, Storm water, Water types, Model studies, Evaluation, Water pollution sources, Suspended solids, Chemical oxygen demand, Biochemical oxygen demand, Nitrogen, Phosphorus, Metals

A019
NONPOINT SOURCES AND PLANNING FOR WATER POLLUTION CONTROL,

Whipple, W., Jr., and Hunter, J. V.

Rutgers University,
New Brunswick, New Jersey,
Water Resources Research Institute.

Journal Water Pollution Control Federation, Vol. 49, No. 1, p 15-23, January, 1977.
6 fig, 3 tab, 23 ref.

Nonpoint sources and urban runoff were considered in the planning of water pollution control. In general, constructing facilities for treating storm water pollution has been neglected since federal programs do not aid urban runoff pollution control on a regular basis. On-site detention facilities now exist primarily for groundwater recharge or flood retardation. The treatment of urban runoff and combined sewer overflows combined with detention storage still has problems relative to BOD and suspended solids. The problems of heavy metals and other pollutants are also unsolved. Section 208 studies will help to include these items in the planning process. These studies require development of optimal techniques for handling nonpoint and point sources combined. Water quality control in urban areas requires treatment of runoff and costs are expected to be high if plans are not well designed. More definitive planning will follow when better data collection is available and technology is further developed.

*Urban runoff, *Combined sewers, *Planning, Water pollution sources, Pollution abatement, Water quality control, Biochemical oxygen demand, Suspended solids, Water purification, Waste water treatment

A020
DESIGN AND OPERATION OF RAIN SPILLWAYS AND RAIN OVERFLOW CATCHMENT
(Entwurf und Betrieb von Regenuberlaufen (Ru) und Regenuberlaufbecken (RUB)),

Pfeiff, S.

Berichte der Abwassertechnischen Vereinigung e.V., No. 29, p 127-146, 1976. 11 fig.

Detailed description is given of the design and operation of rain spillways and rain overflow catchment basins. Feed canals should have triangular or half-cup cross-sections to prevent sludge sedimentation from back-water. The overflow dam should be at least 25 cm above the feed canal sole, and it should be as long as possible.

*Storm runoff, *Watersheds (basins), *Spillways, *Design criteria, *Operations, Overflow, Canal construction, Precipitation (atmospheric), Water storage, Dam construction

A021
URBAN RUNOFF POLLUTION CONTROL--TECHNOLOGY OVERVIEW,

Field, R., Tafuri, A. N., and Masters, H. E.

Storm and Combined Sewer Section,
Waste Water Research Division,
Municipal Environmental Research Laboratory,
Edison, New Jersey.

1977. 103 p, 23 fig, 17 tab, 273 ref. Technical Report EPA-600/2-77-047.

An overview was presented of methods for handling and treating urban runoff and the pollution problems which result from it. Discharge types considered were combined sewer overflows, storm drainage in separate systems, and overflows from infiltrated sanitary sewers. The report describes completed work, ongoing work, and future work needed to combat wet-weather flow pollution. Various study areas included user assistance tools (instrumentation and computers), management alternatives, collection system control, and storage and treatment. Highlights were presented from more than 150 research projects. Capital cost comparisons were provided for storm and combined sewer control and treatment. In-line storage in Seattle was used to demonstrate a cost-effective solution for urban runoff pollution control. Cost-effective control alternatives for Des Moines were also considered in comparison with the costs of frequent violations of dissolved oxygen standards.

*Urban runoff, *Overflows, *Combined sewers, Water quality, Pollution abatement, Sewage treatment, Waste treatment, Costs, Cost comparisons, Water management (applied), Waste water treatment

A022
STORM WATER MANAGEMENT MODEL: LEVEL I--COMPARATIVE EVALUATION OF STORAGE-TREATMENT AND OTHER MANAGEMENT PRACTICES,

Heaney, J. P., and Nix, S. J.

Florida University,
Gainesville,
Department of Environmental Engineering Science.

1977. 105 p, 24 fig, 13 tab, 18 ref, 2 append. Technical Report EPA-600/2-77-083.

A simplified method was presented for the evaluation of management practices in conjunction with storage-treatment means of storm water pollution control. Section 208 planning requires procedures which are simpler than the EPA Storm Water Management Model (SWMM), and four levels of management models were developed. A procedure for the comparison of selected alternative control techniques was presented in this report. Control options included storage and treatment, street sweeping, sewer flushing, and catch-basin cleaning. The graphical solution technique described could evaluate these factors in series and/or in parallel with one another. A reference area, Anytown, U.S.A., with a population of 1,000,000 was incorporated in this evaluation. Final conclusions were based on a control cost function for the study area that presented the optimal means of achieving a desired level of control. Application of the technique to the hypothetical community indicated the mix of treatment, storage, street sweeping, and sewer flushing needed.

*Storm water, *Water management (applied), Drainage systems, Pollution abatement, Analysis, Cost comparisons, Urban runoff, Storage requirements, Water treatment, Evaluation

A023
URBAN STORM WATER POLLUTANT LOADINGS: A STATISTICAL SUMMARY THROUGH 1972,

Bradford, W. L.

URS Corporation
San Mateo, California.

Journal Water Pollution Control Federation, Vol. 49, No. 4, p 613-622, April, 1977.
5 tab, 18 ref.

A statistical study was undertaken to develop methods and information to aid prediction of various pollutants in urban storm water. After a search of the literature, a list of dependent and independent parameters was compiled. Data on dust and dirt loading rates on street surfaces, and on pollutant counts in these solids, were analyzed according to the chosen parameters. Several observations were noted. Few loadings and parameter concentrations showed a consistent relationship to daily traffic patterns. No relationship between pollutants and land use was found. It was concluded that the data were insufficient or that such a pattern does not exist. The development of more sophisticated methods was suggested.

*Pollutant identification, *Storm water, *Urban runoff, Analytical techniques, Sampling, Watersheds (basins), Nutrients, Trace metals, Suspended solids, Coliforms, Water pollution sources, Waste water treatment

A024
DEMONSTRATION OF VOID SPACE STORAGE WITH TREATMENT AND FLOW REGULATION,

1976. 114 p, 30 fig, 11 tab, 22 ref, 4 append. EPA Technical Report EPA-600/2-76-272.

Void space storage was presented as a means of regulation and containment for combined sewer overflows. The result was a reduction of pollution loads discharged to receiving streams. A two-year study considered system design, construction, and performance. The prototype system was built in Akron, Ohio. A combined sewer drainage area of 188.5 acres was provided. A one million gallon void space retention tank received excess flows. The excavated tank was lined with an impermeable membrane and filled with inert matter. The waste water was stored in the void space of the media. After the storm, stored water was gravity fed into interceptor sewers for further treatment. The facility's top could be used as a park or recreational grounds. Other functions of the tank include chlorination. The project cost $750,000 and projected costs for other facilities were $0.30 to $0.35 per gallon. No detectable foul odors or flammable gases were produced during the study period. Slime and algal growth in the media was non-existent and there was no evidence of rodent or insect infestations. The facility was not operated in an automatic mode. Some design changes were recommended, but the concept could provide a practical and economical solution to pollution problems associated with combined sewer overflows.

*Combined sewers, *Overflows, *Storage, Design, Performance, Operation, Construction, Treatment facilities, Storm water, Costs, Economics, Water pollution control, Waste water treatment, Flow control

Void space storage

A025
PROCEEDINGS OF WORKSHOP ON MICROORGANISMS IN URBAN STORMWATER,

Field, R., Olivieri, V. P., Davis, E. M., Smith, J. E.,
and Tifft, E. C., Jr.

Municipal Environmental Research Laboratory (Cincinnati),
Edison, New Jersey.

1976. 128 p, 28 fig, 42 tab, 47 ref. EPA Technical Report EPA-600/2-76-244.

The proceedings of a workshop on microorganisms in urban storm water were reported. The major objective was to exchange EPA data on such microorganisms, in order to understand their behavior and occurrence in urban storm runoff and combined sewer overflow. Assay procedures for pathogenic microorganisms were reviewed. Studies were conducted on the relationship between pathogenic and coliform microorganisms. Disinfection and aftergrowth of microorganisms were investigated and viruses in storm water were studied.

*Pollutant identification, *Microorganisms, *Storm water, *Urban runoff, *Bioassay, Bacteria, Viruses, Disinfection, Analytical techniques, Water pollution control, Waste water treatment, Pathogenic bacteria

A026
MICROORGANISMS IN URBAN STORMWATER — A U.S. ENVIRONMENTAL
PROTECTION AGENCY PROGRAM OVERVIEW,

Field, R.

Municipal Environmental Research Laboratory (Cincinnati),
Edison, New Jersey.

IN: Proceedings of Workshop on Microorganisms in Urban Stormwaters, 1976.
p 1-7, 6 ref. Technical Report EPA-600/2-76-244.

The analysis and disinfection of microorganisms in storm water is discussed. The highly variable flow, temperature, pollutant load, and hydraulic quality of storm water discharge makes the analysis and disinfection of microorganisms difficult. The direct adoption of waste water analysis methods which utilize total coliform, fecal coliform, and fecal streptococcus methods can produce misleading conclusions. On-site disinfectant generation by raw materials' batching and electrolysis is necessary to economically provide the highly unpredictable quantities of disinfectant which are required. High-rate disinfection means and disinfection facility designs to accommodate the variable character of storm water should be developed.

*Microorganisms, *Storm water, *Pollutant identification, *Urban runoff, Analytical techniques, Flow, Temperature, Loads (forces), Bioindicators, Biological properties, Physical properties, Chemical properties, Disinfection, Treatment facilities, Economics, Waste water treatment, Pathogenic bacteria

A027
STORM MANAGEMENT PROGRAM IS MODEL FOR OTHERS,

Debo, T. B., and Ulrich, B. O.

Georgia Institute of Technology,
Atlanta,
Department of City Planning.

Public Works, Vol. 108, No. 7, p 60-62, July, 1977. 3 fig.

Urbanization and changes in land use have substantially altered the natural drainage and vegetation patterns in the area of Columbus, Georgia. Construction in previously undeveloped areas has led to increased surface runoff, sedimentation, stream-flow, and stream bank erosion. The Columbus Storm Water Management Program (CSWMP) was designed to establish guidelines and procedures to alleviate flooding, erosion, and sedimentation and to protect existing natural areas. New computer techniques are used to augment traditional methods. The first phase of the three phase program included a comprehensive soils inventory and analysis to supplement existing data. The goal of the second phase was to conduct hydrologic studies and to develop a comprehensive erosion and sediment control program. The third phase of the program includes implementation of a two-part urban flood simulation model. The first component of the model generates flood hydrographs and frequency estimates, while the second component evaluates alternative flood mitigation measures using local physical characteristics and economic data.

*Storm runoff, *Stream bank erosion, *Surface runoff, *Streamflow, *Flood routing, Sedimentation, Erosion control, Planning, Model studies, Hydrologic models, Storm water, Urbanization, Urban drainage

Columbus (GA), Columbus Storm Water Management Program (CSWMP)

A028
URBAN RUNOFF AND COMBINED SEWER OVERFLOW,

Field, R., Bowden, R., and Rozgonyi, K.

Environmental Protection Agency,
Wastewater Research Division,
Edison, New Jersey.

Journal Water Pollution Control Federation, Vol. 49, No. 6, p 1095-1104, June, 1977. 116 ref.

A literature review is presented of the various aspects related to the control and treatment of storm water discharges and combined waste water overflows from urban areas. Various methods for determining the quantity and quality of urban runoff are discussed, including descriptions of field and laboratory studies. Hydrologic studies and mathematical models for simulation of storm and combined sewer systems are considered for urban watershed management. The use of infiltration-flow analysis and flow meters is outlined for sewer system management and evaluation. Previous studies of construction costs for combined sewer overflow treatment plants and erosion control programs are described.

*Storm runoff, *Storm drains, *Combined sewers, *Urban runoff, *Infiltration, Mathematical models, Hydrologic studies, Overflow, Flow control, Flow measurement, Runoff, Urban runoff, Urban hydrology, Waste water treatment, Water Pollution Control Federation

A029
METHODOLOGY FOR EVALUATING THE COST OF URBAN STORMWATER QUALITY MANAGEMENT,

Heaney, J. P., and Hasan, S. H.

Florida University,
Gainesville,
Department of Environmental Engineering Sciences.

In: Applications of Stormwater Management Models 1976, 1977. p 15-33, 3 fig, 2 tab, 14 ref. Technical Report EPA-600/2-77-065.

Procedures used during an EPA-sponsored study to estimate the nationwide cost of treating combined sewer overflows and storm water runoff are described. The EPA Storm Water Management Model (SWMM) was used to simulate a single storm event for a single catchment area for each of five cities in the U. S. The HEC STORM model was used to estimate hourly precipitation, runoff, and discharge rates for projections of the total volume of storm water treated for a specified size of storage unit and treatment rate. Results were used to derive storage-treatment isoquants. Mathematical derivations and procedures for adjustment according to treatment efficiency are given for the calculated isoquants. Formulas are given for the estimation of costs for storm water management based on quality control. Potential savings due to multipurpose planning and the integration of wet- and dry-weather treatment are considered.

*Costs, *Forecasting, *Storm water, *Combined sewers, *Model studies, Urban runoff, Mathematical models, Mathematical studies, Cost comparisons, Storm runoff, Water quality, Waste water treatment

Storage-treatment isoquants, STORM, SWMM

A030
SHORT COURSE PROCEEDINGS - APPLICATIONS OF STORMWATER MANAGEMENT MODELS, 1976,

1977. 434 p, 80 fig, 41 tab, 176 ref. Technical Report EPA-600/2-77-065.

This short course, held in Chicago, Illinois on July 18-23, 1976, focused on the role of mathematical models and simulations in storm water management. The U. S. EPA Storm Water Management Model (SWMM) is discussed in detail. Applications of other models, including FILTH, STORM, and USLE, are also considered. Topics discussed in the eleven papers presented include cost assessments for storm water management planning programs; a description of program blocks, data requirements, and capabilities of SWMM; various criteria for the selection of storm water management models; methods for proper collection of field data for model input; and sample applications of model use.

*Mathematical models, *Federal Water Pollution Control Act, *Storm water, Model studies, Water management (applied), Storm runoff, Planning, Management, Urban runoff, Legislation, Cities, Waste water treatment

Storm water management, SWMM, STORM, FILTH, USLE

A031
THE SWIRL CONCENTRATOR FOR EROSION RUNOFF TREATMENT,

Sullivan, R. H., Cohn, M. M., Ure, J. E., Parkinson, F. E.,
and Zielinski, P. E.

1976. 74 p, 46 fig, 5 tab, 6 ref, 1 append. Technical Report EPA-600/2-76-271.

The applicability of the swirl solids-liquid separator has been examined for the removal of suspended solids from storm water erosion flows. The swirl concentrator consists of a circular flat-bottomed basin which contains an internally-supported overflow weir, flow spoilers, a concentrate discharge take-off, and a baffled inlet. A cattle watering tank is suggested as a possible swirl concentrator basin. In a series of 62 performance tests, the swirl concentrator reduced the volume of grit-containing waste water by 14-50%. The desilted or clarified effluent could be discharged directly to receiving waters provided erosion solids met existing standards, while the concentrated grit-containing portion could be directed to settling ponds for later disposal. Further studies and possible design modifications on the prototype are suggested to establish standards for future use of the swirl concentrator in the treatment of erosion runoff waters.

*Separation techniques, *Erosion control, *Storm runoff, *Suspended solids, Silting, Soil erosion, Surface runoff, Flow rates, Overflow, Waste water treatment, Storm water, Equipment, Design, Research and development, Model studies

*Swirl concentrator, Erosion runoff

A032
ENHANCEMENT OF HIGH-RATE DISINFECTION BY SEQUENTIAL ADDITION
OF CHLORINE AND CHLORINE DIOXIDE,

Tifft, E. C., Moffa, P. E., Richardson, S. L., and
Field, R. I.

O'Brien and Gere Engineers, Incorporated,
Syracuse, New York.

Journal Water Pollution Control Federation, Vol. 49, No. 7, p 1652-1658, July, 1977.
2 fig, 9 tab, 10 ref.

Combined waste water overflows due to use of interceptor sewer systems for both normal waste waters and storm water runoff are a major source of microbial contamination of surface waters. Several methods for the high-rate point source treatment of microbial contamination have been investigated. As the cost, availability, and possible carcinogenicity of chlorine may restrict future disinfection by chlorine alone, the use of ClO_2 in combination with Cl_2 has been considered. In laboratory studies to determine the approximate dosages of Cl_2 and ClO_2 necessary to adequately reduce the microbial count, Cl_2 and ClO_2 were applied individually and sequentially during single- and two-stage studies on a simulated combined waste overflow. The treatment method included fine-mesh screening prior to disinfection. Two full-scale facilities were used to verify findings. Studies concluded that ClO_2 at 12 mg/liter had the same bacterial and viral killing capacities as Cl_2 at 25 mg/liter in two minutes contact time. In a two-stage addition treatment, Cl_2 at 8 mg/liter followed by ClO_2 at 2 mg/liter also accomplished the same disinfection as Cl_2 at 25 mg/liter. Although the effects of the chlorite ion as a byproduct of disinfection with ClO_2 are not known, it is suggested that the use of ClO_2 in conjunction with Cl_2 to enhance disinfection may significantly reduce treatment costs.

*Disinfection, *Chlorination, *Combined sewers, *Overflow, Storm water, Bactericides, Waste water treatment, Water Pollution Control Federation, Model studies

*Chlorine dioxide

A033
PLANNING FOR URBAN STORMWATER CONTROL,

Fell, W. J.

Fell Brusso Bruton and Knowles, Incorporated,
Engineers, Architects, Planners,
Tulsa, Oklahoma.

Public Works, Vol. 108, No. 8, p 81-85, August, 1977. 4 fig, 2 tab.

The elements of hydrograph construction and the use of hydrographs are discussed with respect to storm water management and the Soil Conservation Service (SCS) unit hydrograph. Hydrographs are graphical presentations of storm flow or discharge rates with respect to storm duration, with the unit hydrograph representing the flow from one inch of rainfall over the entire catchment area. The Soil Conservation Service (SCS) unit hydrograph relates ratios of discharge and time, the shape of the curve being determined by field observations from actual watershed flows. Applications of the unit graph in constructing discharge hydrographs for actual storms are discussed. A series of equations relating rainfall, peak discharge, time to peak, and runoff is presented. An area of 160 acres in Tulsa, Oklahoma is used in a numerical example for hydrograph construction.

*Unit hydrographs, *Rainfall-runoff relationships, *Watersheds (basins), *Storm water, *Hydrologic data, Duration curves, Discharge (water), Hydrograph analysis, Mathematical models, Runoff, Precipitation (atmospheric), Storms, Water management (applied), Waste water treatment

Tulsa (OK)

A034
THE INVESTIGATION OF SEWER NETWORKS BY COMPUTER,

Cook, L. A., and Lockwood, B.

Proceedings of the Institution of Civil Engineers, Part 2, Vol. 63, p 481-494, June, 1977. 4 fig, 5 ref.

Computer-based algorithms have been used by the London Borough of Hammersmith to examine the area's sewer system. The Sewcheck suite of programs and the Transport and Road Research Laboratory (TRRL) method of hydrographic analysis were the major components of the evaluation program. TRRL as used in Hammersmith was modified to produce hydraulic gradients, provide line-printer output, characterize surcharge, allow for pipes with oval and circular cross-sections, accept input data in a more compact form than the original version, and minimize cost in operating the program. A series of flow charts is provided to illustrate program logic. Calculated individual and cumulative surcharge figures may be high because of program limitations on relaxation of pipes and storage of storm water. Dry weather flow velocity should be checked for all new additions to the sewer network. Recommendations for weir placement, pipe size, and pipe gradient based on peak flow are presented. The size and other characteristics of the network control operating costs for the hydrograph program, with a system of 110 pipes requiring 105,000 octal words of storage per run using a CDC 6600.

*Algorithms, *Computer programs, *Sewerage, *Storm runoff, *Hydrograph analysis, Hydrographs, Analytical techniques, Storm drains, Sewers, Urban hydrology, Design criteria, Water management (applied), Sewers, Drainage systems, Pipes, Mathematical models, Waste water treatment

Borough of Hammersmith, London, England, TRRL

A035
POTENTIAL VALUE OF TREATMENT OF URBAN STORMWATER,

Cordery, I.

New South Wales University,
Australia,
School of Civil Engineering.

The Institution of Engineers, Australia, Vol. CE 18, No. 2, p 60-63, 1976. 2 fig, 4 tab, 9 ref.

Storm water quality was examined for two sites in Sydney, Australia, to examine the feasibility of storm water treatment. Flow rate, suspended solids, BOD, phosphate, and ammonia were measured for approximately 100 water samples collected from 13 floods within a catchment area. Analyses indicated that pollutant loads were highest during the "first flush" of the storm and also tended to be higher during morning storms than afternoon storms. Laboratory studies on settling for from 4 minutes to 24 hours as a treatment method for storm water showed that suspended solids could be reduced by as much as 87% with a settling time of only 15 minutes. A comparison of estimated annual loads indicated that settling of urban runoff could produce effluent qualities similar to those produced by tertiary treatment but at a much lower cost.

*Urban runoff, *Storm water, *Water quality, *Tertiary treatment, *Settling basins, Suspended solids, Biochemical oxygen demand, Surface runoff, Water pollution sources, Model studies, Waste water treatment

Storm water treatment

A036
WATER-QUALITY EFFECTS FROM URBAN RUNOFF,

Pitt, R., and Field, R.

Woodward-Clyde Consultants,
San Francisco, California.

Journal of the American Water Works Association, Vol. 69, No. 8, p 432-436, August, 1977. 3 fig, 6 tab, 13 ref.

A hypothetical example was used to demonstrate potential problems and possible solutions for urban storm water runoff. Hypothetical inputs, loading, worst-case storm predictions, quality-quantity hydrographs, a comparison of storm water quality and sanitary waste water effluent quality, effects on receiving waters, and costs of required treatment were included in the example case study for a hypothetical city of 100,000 people. Total solids concentration curves were calculated for receiving waters using various storms simulated in the study. Oxygen sag curves were calculated to show oxygen depletion in receiving waters caused by secondary treated sewage and untreated urban runoff. Costs for treatment processes in use at various locations within the United States are compared. Total waste discharge analysis, water quality management planning, and more research on the long-term toxic effects of storm flow were suggested to help solve urban runoff problems.

*Urban runoff, *Storm water, *Model studies, *Urban hydrology, *Water management (applied), Cities, Oxygen sag, Water quality, Costs, Forecasting, Runoff forecasting, Precipitation (atmospheric), Hydrographs, Sewage treatment, Waste water treatment

A037
QUALITY OF URBAN FREEWAY STORM WATER,

Jodie, J. B.

In: Water Quality, Conduits, and Geometrics. Transportation Research Record 556, p 1-5, 2 fig, 2 tab, 9 ref.

The quality of storm-water runoff from urban freeways was monitored during a year-long sampling and testing program in Milwaukee County, Wisconsin. Sodium chloride, calcium chloride, total solids, volatile total solids, suspended solids, volatile suspended solids, 5-day BOD, total nitrogen, pH, total phosphorus, ammonia, fecal coliforms, lead, dissolved oxygen, nitrates, and nitrites were measured for two storm water outfall locations. Analyses indicated that parameter concentrations were higher during the first hour of a rainstorm and tended to be very high during snowstorms. High salt concentrations were observed during winter and spring. No significant differences in storm water quality were observed between the two sampling stations. Total solids, suspended solids, and BOD were higher in storm water than in treatment plant effluent. Parameter concentrations for the Milwaukee study and for other cities are listed. Additional research into contamination by and treatment of urban runoff is suggested.

*Urban runoff, *Storm water, *Surface runoff, *Water pollution, *Model studies, Data collections, Monitoring, Salts, Snow, Storms, Storm runoff, Cities

Milwaukee (WI)

A038
COUNTERMEASURES FOR POLLUTION FROM OVERFLOWS;
THE STATE OF THE ART,

Field, R., and Lager, J. A.

Storm and Combined Sewer Section (Edison, New Jersey),
Advanced Waste Treatment Research Laboratory,
National Environmental Research Center,
Cincinnati, Ohio.

1974. 38 p, 4 fig, 2 tab, 28 ref. Technical Report EPA-670/2-74-090.

A state-of-the-art review of treatment and control of storm water runoff and combined sewer overflow is presented. Management alternatives including source controls, collection system controls, storage, and treatment are discussed. Methods of abatement for urban runoff include retention, physical treatment, biological treatment, physical-chemical treatment, disinfection, and integrated processes. Storage costs and cost comparisons for different treatment alternatives are provided for various cities in the United States. Legislation which supports the development of countermeasures against the environmental impacts of urban runoff is examined, including the Federal Water Pollution Control Act (FWPCA), 1972 amendments to the FWPCA, and state and local requirements. Considerations in characterizing and evaluating storm water include simulation models, nationwide assessment of urban runoff impacts, combined sewage sludge, uniform procedures for analysis and evaluation of storm flow characteristics and treatability, flow measurement, consideration of trace pollutants, and pathogen detection. Methods of storm water treatment discussed include new sewer design, upstream impoundment, catch basins, runoff attenuation by porous pavement, dual use facilities, swirl and helical separators, and screening devices.

*Urban runoff, *Storm water, *Combined sewers, *Overflow, *Storm drains, Storage tanks, Hydraulics, Mathematical models, Reviews, Sewage treatment, Water pollution control, Costs, Cost comparisons, Waste water treatment, Water management (applied)

Storm water management

A039
URBAN RUNOFF CHARACTERISTICS: VOLUME I ANALYTICAL STUDIES,

Pruel, H. C., and Papadakis, C. N.

Cincinnati University,
Ohio,
Department of Civil and Environmental Engineering.

1976. 338 p, 44 fig, 28 tab, 100 ref, 5 append. Technical Report EPA-600/2-76-217a.

Analysis and development of storm water management models are examined in the first part of a two-volume series on analytical studies and field investigations for the characterization of urban runoff and combined sewer overflows. Design storm hydrographs were developed for use in mathematical models which simulate urban runoff for design and analysis of sewer systems. Precipitation duration and intensity for a Cincinnati, Ohio, watershed were used to calculate synthetic storm patterns for seven selected design frequencies. Infiltration capacity curves for runoff prediction are derived. The University of Cincinnati Urban Runoff Model (UCUR), which contains submodels for infiltration, surface retention, overland flow, gutter flow, and sewer routing, is described. A general description, verification, and testing of the EPA Storm Water Management Model (SWMM) on the Bloody Run catchment area in Cincinnati, Ohio, are provided. Various methods for determining urban storm water runoff were tested and compared: empirical methods, the Los Angeles Hydrograph method, Izzard's method, the Chicago Hydrograph method, the Inlet method, the Unit Hydrograph method, the RRL method, the UCUR model, and the SWMM model. Appendices include data card preparation, testing data, typical input and output for SWMM, and a copy of the program for the UCUR model.

*Urban runoff, *Storm water, *Water management (applied), *Hydrologic data, *Forecasting, *Rainfall-runoff relationships, Hydrograph analysis, Mathematical models, Computer models, Combined sewers, Sewerage, Overflow, Storm runoff, Urban hydrology, Water pollution sources

Storm water management models, SWMM, UCUR, Cincinnati (OH)

A040
URBAN RUNOFF CHARACTERISTICS: VOLUME II - FIELD INVESTIGATIONS,

Preul, H. C., and Papadakis, C. N.

Cincinnati University,
Ohio,
Department of Civil and Environmental Engineering.

1976. 769 p, 424 fig, 314 tab. Technical Report EPA-600/2-76-217b.

Field investigations on urban runoff in Cincinnati are described in the second part of a two-volume series on characterization of urban runoff and combined sewer overflows. The Bloody Run Sewer System encompasses approximately 2,380 acres of a combined sewer watershed. Data on the physical characteristics of the watershed are provided. The watershed was divided into 37 subareas for study purposes according to topography, zoning, land use, and sewer network. Manhole locations and the size, slope, and length of sewer pipes are listed for each of the 37 subareas. Five storm and six dry weather flow stations were set up to collect flow quantity and quality data. Storm runoff samples were collected at the five monitoring stations from October 29, 1970 to June 28, 1972. Laboratory analyses were carried out for total solids, suspended solids, volatile suspended solids, biochemical oxygen demand, chemical oxygen demand, chlorides, and pH. Runoff quality and quantity data are provided for individual storms during the study period. Information collected was used to evaluate storm water management models developed by EPA and the University of Cincinnati.

*On-site investigations, *On-site data collections, *Urban runoff, *Storm water, *Storm runoff, Water pollution sources, Water quality, Combined sewers, Sewerage, Watersheds (basins), Cities, Watershed management, Monitoring, Precipitation (atmospheric), Model studies, Overflow, Sampling, Hydrologic data, Waste water treatment

SEWER SYSTEMS

B001
TANKS OF PANEL CONSTRUCTION,

Water and Waste Treatment, Vol. 19, No. 7, p 26, July, 1976.

A Diapac sewage treatment unit constructed of modular tank panels is described. The Diapac unit consists of two tanks, each designed for both aeration and clarification. Since tank construction is based on the use of modular tank panels which are prefabricated and produced in standard size, erection of the tanks consists of a simple bolting up and sealing operation. The tanks can also be taken down and installed at another site with relative ease.

*Sewage treatment, *Aeration, *Equipment, *Construction, *Materials, Materials engineering, Waste water treatment

Clarification tanks, Aeration tanks

B002
CONSTRUCTION OF GOSCOTE SEWAGE PUMPING STATION,

Cooper, M. L.

Proceedings of the Institution of Civil Engineers, Vol. 60, Part 1, p 345-365, August, 1976. 16 fig, 3 tab, 8 ref.

The construction of a substructure for a raw sewage pumping station in Great Britain is described. The substructure consisted of a circular cofferdam (38 m in diameter and 15 m deep). The notable feature of the substructure was the employment for the first time at such a large scale of a precast concrete bolted segmental lining. Although the circular cofferdam had the disadvantage of requiring a relatively large amount of over-excavation and backfilling, it had the overwhelming advantage of providing an unobstructed working space. Specific details of the design and construction of the cofferdam are presented.

*Sewage treatment, *Pumping plants, *Construction, *Structural design, *Concrete structures, Design criteria, Treatment facilities, Materials

B003
AUSTIN'S 11 MILE SEWER TUNNEL REFLECTS SOUND ECONOMIC, ENVIRONMENTAL ALTERNATIVES,

Eldridge, A. M.

City of Austin,
Austin, Texas,
Construction Management Department.

Civil Engineering-ASCE, Vol. 46, No. 8, p 52-55, August, 1976. 1 fig.

An 11-mile, $20 million continuous sewer tunnel which extends across the city of Austin, Texas is described. The sewer tunnel is designed to serve as a sanitary sewer and obviates about 98,000 ft of relief sewer construction work. Anticipating a maximum flow rate of 131 million gallons/day for the year 2020 and an allowable slope of about 0.00066, the lower end of the tunnel is sized for a finished diameter of 96 in. Maximum velocity is expected to be about 4.6 ft/sec at the maximum future flow rate. The tunnel is fitted in places with removable cunnette inserts which provide the hydraulic characteristics of a 24-inch pipe for low flow conditions. Measures being taken to prevent hydrogen sulfide buildup in the tunnel along with the usually associated problems of odors and corrosion include: the provision of air-excluder gates at each inlet shaft and the use of specially designed inlet vortex chambers, T-lock polyvinyl chloride lining, and limestone coarse aggregate for the 12-inch concrete lining of the tunnel. In addition to relieving many existing sewers from periodic overflows, the all-gravity flow design of the crosstown interceptor reflects substantial long-range savings over the more conventional cut and cover alternative.

*Sewers, *Tunnels, *Interceptor sewers, *Municipal wastes, *Construction, Tunnel design, Tunnel construction, Hydraulics, Sewage treatment, Hydrogen sulfide, Odor, Corrosion, Design criteria, Tunnel linings, Materials, Flow, Liquid wastes, Cities, Texas

B004
THURROCK BEATS PEAT WITH PILED PIPES,

Appleton, B.

New Civil Engineer, Vol. 19, No. 207, p 24, August, 1976.

The installation of new sewers supported by piles in an area where old sewers were adversely affected by peat layers up to 11 meters deep which overlay weathered chalk is described. Piling was decided upon since any form of conventional bedding would eventually settle unevenly as the peat alternately swelled and shrank with movements in the water table. Construction was simplified by selecting just two pile spacings (5 m and 10 m), two pipe diameters (300 mm and 450 mm), and a constant beam depth (1 m). Beam widths were 600 mm for the smaller pipe diameter and 750 mm for the larger pipes. The problem of supporting the pipe inside a reinforcement cage during concreting was solved by using a Williams form tie fastened at one end to a circular clamp around the pipe and at the other end to a worm thread adjuster clamped to a modified horizontal Acrow prop. Spaced at 1.2 m centers, the brackets allowed any deflection of the pipe to be corrected during concreting.

*Sewers, *Construction, *Design criteria, *Peat, *Piles (foundation), Hydraulic structures, Conveyance structures, Foundation failure, Foundations, Pipes, Geology, Conduits

B005
MODEL FOR LAYOUT AND DESIGN OF SEWER SYSTEMS,

Mays, L. W., Wenzel, H. G., Jr., and
Liebman, J. C.

Texas University,
Austin,
Department of Civil Engineering.

Journal of the Water Resources Planning and Management Division-ASCE, Vol. 102, No. WR2, p 385-405, November, 1976. 7 fig, 1 tab, 24 ref.

A heuristic optimization model for simultaneously determining minimum cost layouts and designs of sewer systems is described. The heuristic optimization model is developed as a screening model consisting of two conjunctive phases: a combined layout and design model and a design model for given layouts. The combined layout and design model is an optimization procedure which uses a connectivity model for selecting the least-cost network configuration from a finite set of alternatives for each stage. The model for given layouts is used to compute the optimal design of the layouts generated in the combined model. The screening model can be efficiently used for large-scale sewer systems and can be extended for storm sewer design to include risk considerations. Computer storage requirements for large-scale systems are relatively small so that slow core memory is not needed. Approximately 268k bytes of storage are required for a system of 200 manholes.

*Mathematical models, *Sewers, *Cost-benefit analysis, *Model studies, *Drainage systems, Hydraulic structures, Conveyance structures, Computer models, Computer programs, Optimization

B006
TEST NEW SEWERS WITH LOW-PRESSURE AIR,

Foster, W. S.

American City and County, Vol. 91, No. 10, p 102, October, 1976.

A low-pressure air test for determining the integrity of newly constructed sewers is described. Under the test procedure, the sewer line should be flushed and cleaned with the interior walls moist. The line should be plugged, including the laterals and outlets. Air under pressure is then introduced to a point where the pressure at the test line registers 4.0 pounds/sq in and is then allowed to stabilize until it reaches a figure of 3.5 pounds/sq in or slightly above. The pressure drop over a specified test period is then recorded; if the pressure drops more than 1 pound/sq in, the line has failed. The specified test period is determined by the following equation: test time equals (0.085 times the nominal inside pipe diameter)/permissible air loss per sq ft of internal pipe surface. The test time is established on an allowable air loss of 0.003 cu ft/min per sq ft of internal pipe surface with the following restrictions: minimum significant air loss is 2.0 cu ft/min and maximum total allowable air loss is 3.5 cu ft/min. Sewers should be air tested before and after backfill in order to assess the integrity of the installed material and the construction procedures.

*Sewers, *Construction, *Testing procedures, *Pressure, *Hydraulic structures, Conduits, Conveyance structures, Pipes

B007
EMERGENCY REPAIR OF A DEEP STORM SEWER LINE,

Weis, D. M.

Assistant Village Manager's Office,
Whitefish Bay, Wisconsin.

Public Works, Vol. 107, No. 9, p 76-77, September, 1976. 3 fig.

The emergency repair of a 60-inch monolithic concrete storm sewer in imminent danger of collapse is described. The sewer discharges into Lake Michigan, emerging from a bluff in a head wall a short distance from the shore line. A slippage had occurred along the face of the bluff about 110 ft inland from the head wall and extended laterally about 600 ft. This resulted in a shear failure in the sewer along the apparent fault line of the slippage. The existence of the fault was unsuspected until the face of the 90-foot high bluff suddenly dropped a total of 2 ft at the rate of 3-6 in/day. Temporary repair of the sewer with a 48-inch diameter, 3/8 in steel liner plate was performed. Sections of the liner were assembled on the outfall apron, attached to a cable extending through 287 ft of sewer and up to a manhole where a crane could pull the completed pipe or liner into place at the point of the break. A gap of about 1.5 in at the joint of the dropped section was closed by welding. A concrete transition section was poured to anchor the liner, and the front 20 ft was grouted with mortar. A bulkhead was made at the lake end to hold the pea gravel. The remaining annular space was filled with pea gravel or torpedo sand.

*Sewers, *Repairing, *Storm water, *Concrete structures, *Hydraulic structures, Materials, Linings

B008
PRECAST SEGMENTS SPEED INSTALLATION OF THUNDER BAY SEWER,

Engineering and Contract Record, Vol. 89, No. 10, p 22-23, October, 1976.

The use of non-reinforced precast concrete segments for an 85-inch diameter section of the Neebing-McIntyre sanitary trunk sewer in Thunder Bay, Ontario is reported. The main advantage of the system is that both the primary lining and secondary poured concrete section usually used in soft ground are replaced by a one-step installation of segments. One tunnel ring consists of four segments, each 4.33 in thick, 39.3 in long, and weighing 1000 pounds. They are erected by a mechanical arm attached to a 97-inch mole. The rate of advance is as much as 50 ft of finished tunnel per 8-hour shift. Materials handling is essentially the same as in conventional tunneling systems. One major difference is that the segments are considerably larger, and it is thus necessary to exercise greater care to ensure that they do not obstruct the tunnel passageway or foul the conveyor support assembly.

*Sewers, *Tunneling, *Construction, *Concrete pipes, *Hydraulic structures, Municipal wastes, Conveyance structures, Materials

B009
THE DESIGN AND CONSTRUCTION OF A SCREENING AND PUMPING STATION AND AN OUTFALL FOR THE DISPOSAL OF SEWAGE FROM BRIGHTON AND HOVE,

Osorio, J. D. C.

The Public Health Engineer, Vol. 4, No. 5, p 131-137, September, 1976. 4 fig, 6 ref.

Design and construction details of a screening and pumping station and an outfall for the disposal of sewage from Brighton and Hove (Great Britain) are described. The general scheme involves: an outfall long enough to ensure that sewage cannot reach the beach areas of the above communities until dilution and action of the sea water on sewage bacteria have reduced pollution to an acceptable level, pumps to allow the intercepting sewer to discharge freely at all times, and screens and ancillary equipment for the removal of sewage solids. The pumping and screening plant is designed for a 4000-liters/sec flow, and the outfall and diffuser system is designed to accept 6800 liters/sec, six times the anticipated average dry-weather flow. The screening plant should be capable of handling 2500 kg of dry solids/day. Screening is removed from the fine screens by water jets, and grit removal from tanks is by chain and bucket scrapers. The outfall tunnel is 2.3 meters in internal diameter and 1830 meters long and is lined with Kinnear Moodie Rapid smooth bore segments. Infiltration of groundwater is controlled by injecting rapid hardening cement grout through holes drilled ahead of the face.

*Pumping plants, *Screens, *Outlets, *Sewage disposal, *Treatment facilities, Equipment, Construction, Design criteria, Liquid wastes, Suspended solids, Waste water treatment, Waste disposal, Flow, Hydraulics, Municipal wastes

B010
DILUTION AND DESIGN,

Agg, A. R.

Water and Waste Treatment, Vol. 19, No. 7, p 33, July, 1976. 2 fig, 1 ref.

A method for designing outfalls for the discharge of sewage or industrial wastes to the sea is described which is based primarily on initial dilution and the transit times from the outfall to the area of concern. The design procedure assumes a demand for very high initial dilution factors if the release is close to the beach and progressively lower demand factors as the outfall is extended offshore. The design length for the outfall is given by the intersection of a curve for the dilution which can be attained with the flow of sewage and depths of water with a curve representing the demand for dilution. Calculations based on the above design procedure indicate that a system with 10 outfalls reduces the length of the outfall required by about 50%.

*Outlets, *Design criteria, *Waste water disposal, *Conveyance structures, *Hydraulic structures, Mathematical models, Sewage disposal, Industrial wastes, Liquid wastes, Waste disposal

B011
PLASTIC LINING OVERCOMES RUGGED TERRAIN,

Dainwood, J. F.

Bement-Dainwood-Sturgeon,
Civil Engineers,
San Diego, California.

Public Works, Vol. 107, No. 9, p 100-101, September, 1976.

The use of plastic lining to overcome exfiltration and infiltration problems associated with a 55-year-old, 6-inch concrete sewer line running through rocky terrain in the city of La Mesa, California is described. The repair project involved pulling heat-fused lengths of flexible polyethylene pipe (inside diameter of 4.75 in) through the old line. The pipe was supplied to the job-site in 38-foot sections and heat-fused in lengths necessary to extend from the lead-in pit to pull point. Lateral connections were made with polyethylene plastic saddles and jointed to the existing lateral with mechanical couplings. Manhole-main connections were made with a special grout and existing manholes were not damaged. The city elected to manage the work itself, contracting out only those portions of the project which their own forces could not handle. The final cost to complete the project was $40,000 for the 3400-foot sewer run.

*Sewers, *Repairing, *Plastic pipes, *Hydraulic structures, *Drainage systems, Conduits, Conveyance structures, Cities, Materials, Construction, Costs, California

La Mesa

B012
FLOW DATA COLLECTION FOR INFILTRATION-INFLOW ANALYSIS,

Maynes, J. S.

Whitman, Requardt and Associates,
Baltimore, Maryland.

Journal Water Pollution Control Federation, Vol. 48, No. 8, p 2055-2061, August, 1976.
2 fig, 4 ref.

An analysis of the cost-effectiveness of continuing to transport and treat inflow (leakage from surface run-off resulting from rainfall) and infiltration (leakage originating from the groundwater table) versus eliminating these flows through a rehabilitation program was performed for the Baltimore, Maryland area over a 20-year planning period. The amount of infiltration was determined by comparing the observed average daily flows with computed flows, and inflow was determined by comparing the observed peak flow rate resulting from rainfall with the flow rate from a twin-day comparison. The annual flow records for two treatment plants in the area revealed that infiltration composed about 30% of the average daily flow, while infiltration flows for pumping stations ranged between 1-62%. In general, it appeared to be more economical to continue to transport and treat these infiltration flows rather than to identify and correct the sources. An exception to this involved several pumping stations which required three or more repumping operations downstream before the flow arrived at the treatment plant. Inflow quantity, on the other hand, was found to equal one-half of a station's pumping capacity. It generally appeared to be more cost-effective to correct sources contributing to extraneous flows in valleys that were currently fully developed and did not have relief interceptors planned.

*Cost-benefit analysis, *Inflow, *Infiltration, *Treatment facilities, *Leakage, Surface waters, Groundwater, Flow, Cities, Urban runoff, Runoff, Pumping plants, Maryland

B013
MECHANICAL MOLE BURROWS SEWER TUNNEL,

Public Works, Vol. 107, No. 11, p 62-63, November, 1976. 1 fig.

The use of a boring machine to create a sewer tunnel in Quincy, Illinois, was evaluated. With this machine, it was possible to build a tunnel with 50 percent increased sewage outflow capacity at no additional costs. Safety margins were greater and the problems associated with blast and drill methods were avoided. The machine bored a tunnel 8 feet, 2 inches, by 5 feet, 3 inches wide as compared to an 8-foot diameter tunnel originally planned. With this method, damage to surrounding rock by blasting was avoided. The horseshoe shape of the bored tunnel allowed additional height for maintenance headroom and the smaller arch gives the tunnel greater strength and stability. Tunnel construction proceeded at rates similar to conventional drill and blast methods while overbreak and fracturing due to blasting were avoided. The operation of the machine was similar to a milling machine that shaves metal surfaces.

*Sewers, *Construction equipment, *Safety, *Tunnelling machines, *Tunnelling, Costs

B014
CONDUCTING SEWER SYSTEM EVALUATIONS FOR SMALL SYSTEMS,

Darnell, P. E.

Water and Sewage Works, Vol. 123, No. 11, p 68-71, November, 1976.

Various aspects of an Infiltration/Inflow Analysis were described. This analysis applied to sewer systems with a total installed length of lines of 200,000 ft or less. Its function was to determine system susceptibility to excessive infiltration/inflow. Detailed descriptions were given for the three phases of analysis (evaluation survey, physical survey, and data analysis). Accurate flow data was a prime prerequisite in making all determinations. Smoke testing for leaks, observation during a rainfall or a rainfall simulation, and monitoring of groundwater levels in the system were important considerations. Preliminary data analysis involved an estimation of the quantity of water needed in a line section to justify costs of cleaning, inspecting, and rehabilitating the line. Consideration was also given to the option of replacement work. This was followed by a preparatory cleaning and internal inspection of the lines. Advantages and disadvantages of cleaning systems were compared. These activities were followed by an evaluation survey and the preparation of cost estimates for needed work.

*Sewerage, *Sewers, *Infiltration, *Inflow, *Evaluation, Data processing, Analytical techniques, Monitoring, Inspection, Cleaning, Repairing, Surveys, Cost analysis, Flow

*Infiltration/inflow

B015
DUCTILE IRON PIPE SOLVES A TOUGH SEWER PROBLEM AT
JIMERSON CREEK,

Stroud, T. F.

Ductile Iron Pipe News, p 9-11, Spring-Summer, 1976.

Ductile pipe was used to replace deteriorated sewer piping at Jimerson Creek near Little Rock, Arkansas. Ductile iron pipe was chosen because of its ability to withstand harsh bedding conditions without breaking and the protection it provides against large rocks and other debris in the Creek. Permanence and low-maintenance needs were also prime considerations. Rubber-gasketed joints helped to eliminate infiltration/inflow which had been a problem with the older concrete mortar joints previously used. Completed in 1975, the ductile iron line performed much as expected.

*Sewerage, *Pipelines, *Iron, Maintenance, Waste water treatment, Infiltration, Inflow, Joints (connections), Construction materials

*Ductile iron pipe, Rubber gaskets

B016
INNOVATIONS IN SEWER DESIGN AND CONSTRUCTION,

Willis, D. L.

Edward H. Richardson Associates, Incorporated,
Consulting Engineers,
Newark, Delaware.

Public Works, Vol. 107, No. 11, p 44-47, November, 1976.

A trenchless sewer construction demonstration (E.P.A. Project No. S-800690) was described. The project's purpose was the development of construction techniques in which it would not be necessary to have a man enter a construction trench. Another design intent was the redefinition of relative factors such as manhole needs and design. Bethany Beach, Delaware, was chosen as the demonstration site. Preliminary cost studies projected as much as 25 percent savings over traditional construction methods. The machinery involved plows open an earth section and pulls in a length of polyethylene pipe. There were minor problems with pipe tension, "floating" pipes, and cold-weather brittleness of the PVC pipes. The fiscal savings and safety aspects of this construction method are expected to make it an attractive alternative to more traditional procedures.

*Sewerage, *Manholes, *Cost analysis, *Plastic pipes, *Construction equipment, Construction costs, Delaware, Pipelines, Safety factors

*Trenchless sewers

B017
PRECAUTIONS TO BE TAKEN IN THE CONSTRUCTION AND MAINTENANCE OF WATER SUPPLY AND SEWER SYSTEMS (Precautions a prendre dans la construction et l'entretien des reseaux d'aqueduc et d'egout),

Asselin, Yvan

Eau du Quebec, Vol. 9, No. 3, p 8-9, August, 1976.

A survey performed on the water treatment practices of the 155 towns in Quebec with populations of 5000 or more revealed that the levels of inspection and cleaning of water lines were generally low. Improvements in quality and service could be achieved by checking valve operation at least twice a year, checking operation of street fountains three or four times a year, cleaning the water lines at least twice a year, checking the sewage lines regularly and cleaning them at least twice a year, and seeking and eliminating leakage. Application of modern construction techniques can eliminate many potential or actual problems; these techniques include proper preparation of the pipe beds, packing a filler around the pipes, sealing the joints with rubber, providing inspection points with constrictions to maintain flow speeds, ensuring easy access to inspection sites, firmly connecting the cesspools, providing for electrical conductivity of water supply lines, selecting optimal valves, and establishing proper anchoring and drainage for street fountains. Modern devices are available for leakage and continuity detection.

*Surveys, *Inspection, *Maintenance, *Water supply, *Sewerage, Water distribution (applied), Pipelines, Valves

Fountains, Quebec, Canada

B018
INFILTRATION/INFLOW IMPROVEMENTS IN THE OYSTER BAY SEWER DISTRICT,

Albanese, R. H.

Holzmacher, McLendon and Murrell,
Melville, New York.

Water Pollution Control Federation Highlights, Vol. 13, No. 9, p D1, D6-8, September, 1976. 2 fig.

The program used by the Oyster Bay Sewer District of Long Island, New York, to correct their infiltration/inflow problem was discussed. The area is composed of a low-lying harbor and hillier areas to the east, south, and west. The original plant was replaced by a trickling filter plant in 1965. In 1966, an infiltration/inflow study was conducted revealing a structurally sound system needing partial replacement to reduce infiltration/inflow. Only 20-30% of the system and some significant leaks needed repair. A major salt water lake which discharged salt water into the system was discovered. A modified Phase I study was done in 1974 which indicated that 20-30% of the system contained 75-80% of the total infiltration/inflow. Pilot cleaning indicated that all hydraulic cleaning equipment should have a minimum flow of 227 liters per minute (60 gpm); that sewers being cleaned should be less than one quarter full; that sand traps should be used in all manholes downstream of lines being cleaned; that heavy sand deposits are best removed by bucket machines; and that "bee liners" should not be used. A pilot grouting program revealed that air testing of each joint is required in spring areas to prevent the spring from entering the sewer at an adjacent joint; that sealing joints in these areas tends to cause a buildup of ground water which appears as a leak in an adjacent manhole; and that sealing visible leaks under static groundwater conditions eliminates infiltration.

*Infiltration, *Inflow, *New York, *Sewers, *Programs, Public utility districts, Harbors, Topography

*Infiltration/inflow

B019
OUTFALL HAS UNUSUAL ADMINISTRATION,

Milgram, O.

Elson T. Killam Associates,
Millburn, New Jersey.

Water and Wastes Engineering, Vol. 13, No. 11, p 56, 58, 62-63, November, 1976.
2 fig, 1 tab.

The Monmouth County (New Jersey) regional outfall serves twelve communities and diverts treated effluent from environmentally sensitive bays to the Atlantic Ocean. The system includes an ocean section (48 in. diameter), two land sections (48 and 42 in. diameters), and two (8.0 mgd) pump stations and retention basins. Treated effluent from three regional treatment plants is received by the Outfall Authority and pumped to the ocean by a common force main. Retention basins are also used as overflows and high flow conditions are handled by using standby outfall pumps and storage capacity of the retention basins. Natural basin sedimentation helps to improve effluent quality. The ocean section is protected by exterior and interior epoxy coatings and a mortar and mesh cover. Model testing was used to determine final design location. Financing was by a combination of federal, state, and county funding. Actual project costs have exceeded projections by only 5%. The system is now automatically operated, and only routine service and maintenance are required. An automatic sampling station monitors effluent quality. The system may, in the future, be adapted to advanced waste treatment methods and reuse schemes.

*Outfall sewers, *Automatic control, *Waste water treatment, *Sewage effluent, *Sewerage, Outlets, Administration, Bays

Monmouth County, (NJ)

B020
OPTIMAL DESIGN OF MULTILEVEL BRANCHING SEWER SYSTEMS,

Mays, L. W., and Wenzel, H. G., Jr.

Texas University at Austin,
Austin,
Department of Civil Engineering.

Water Resources Research, Vol. 12, No. 5, p 913-917, October, 1976. 2 fig, 1 tab, 6 ref.

Discrete differential dynamic programming (DDDP) was used to develop a serial approach for the description of a system for determining a minimum cost design for multilevel branching sewer systems. The advantages of a serial rather than a nonserial DDDP approach were outlined and discussed. A major advantage of the serial system is that less space is required for storage. Also, there is a saving in computer time since much time is used in a nonserial system for retrieval of information. Ease of programming was proven as a third advantage because the serial system can handle all levels of branching whereas the nonserial approach is capable of handling only one level of branching from the main and increasing its capability would require a significant increase in the code size. One could divide the sewer system into smaller subsystems for minimum cost computation, but the result would not necessarily produce optimal results for the entire system. The serial approach can better handle such additions to computations as hydraulic models.

*Analytical techniques, *Design, *Sewers, *Computer programs, *Cost analysis, Storage, Time, Information retrieval

*Discrete differential dynamic programming

B021
FORCE MAIN SEWER LINE USES POLYETHYLENE PIPE,

Water and Wastes Engineering, Vol. 13, No. 12, p 16, December, 1976.

An installation of a 16,640 ft, 14-in. polyethylene sewer force main was installed in Ruston, Louisiana. It connected a treatment plant, being phased out, with a new one across town. This is part of the first of three stages in the rehabilitation of the community's waste treatment program. The high density polyethylene pipe, under pressure up to 100 psi, was chosen because it can withstand the vibration stresses resulting from three passes under railroad tracks. Variable speed pumps will minimize shock waves when line pressure is increased or decreased. Economy and safety of construction was improved since hydraulic backfilling of ditches eliminated the need for men in the ditches after pipe laying.

*Waste water treatment, *Sewage treatment, *Sewers, *Pipelines, *Plastic pipes, Sewerage, Treatment facilities, Installation

Polyethylene, Ruston (La)

B022
CHARACTERIZATION AND TREATMENT OF COMBINED SEWER OVERFLOWS,

1975. 202 p, 59 fig, 24 tab, 21 ref, 6 append. Tech. Rept. EPA-670/2-75-054, NTIS PB 241-299.

Two combined sewer outfall systems, the Selby Street and Laguna Street systems, in San Francisco, were studied. Eight storm overflows were monitored at the Selby Street outfall and two in the Laguna Street system. Monitoring included measurement of rainfall, discharge, and quality characteristics of the overflows. The bacteriological impact of overflows on receiving waters was determined by a coliform survey of a segment of the municipal marina adjacent to the Laguna Street outfall. Laboratory tests were conducted to select suitable methods to treat combined sewer overflows. The initial overflow phase is probably caused by flushing of sewage in the lower reaches of the sewerage system. Generally initial overflows have the characteristics of raw sewage. During the second phase, a systematic scouring of materials in the sewer and on the surface appears to occur, and pollutant concentrations usually increase. The concentrations then drop to the steady third phase level. Relatively unpolluted surface runoff and normal sewage flow make up third phase discharges. The discharge rate has little effect on pollutant concentrations. The time of decrease to a steady level is virtually independent of system physiography and meteorological conditions. Differences between combined sewer overflows and urban storm runoff are small. Apparently, separation of sewers would not significantly reduce pollution of receiving waters. Wet weather discharges significantly affected coliform levels in waters proximate to combined sewer outfalls. Disinfecting combined sewer overflows will be necessary for receiving waters to meet recreational water quality requirements. Dissolved air flotation is potentially feasible as a means of treating combined sewer overflows.

*Waste water treatment, *Pollutant identification, *Sewage treatment, *Sewerage, *Outfall sewers, Storm surge, Combined sewers, Storm drains

B023
PLAIN END PIPE MEANS PRODUCTION EFFICIENCY,

Jeffers, P. E.

Brick and Clay Record, p 17-18, November, 1976. 6 fig, 1 tab.

The advantages of manufacturing plain end pipe are many. Forming is faster and easier, dryer and kiln space is reduced, jointing is simplified, and shipping is streamlined by permitting more compact packaging. The pipe is manufactured from a combination of shale and fireclay. It is formed by extrusion, and a special press manufactures curves, elbows, and traps. Branching is accomplished manually. After forming, the pipe is dried with hot air for 16 hr to 7 days. After drying, the pipe is fired. Two types of jointing systems are used. A plain end coupling made from rubber, silicon bronze, stainless steel, and plastic is available in several sizes. Another coupling, used with automatic equipment, consists of a urethane ring cast on each end of the pipe and coupled together with a sleeve.

*Clay pipes, *Efficiencies, *Joints (connections), *Shales, *Clays, Curves, Drying, Rubber, Bronze, Stainless steel, Plastics

B024
EQUALIZATION OF FLOW VARIATIONS IN COMBINED SEWERS,

Janson, L-E., Bendixen, S., and Harlaut, A.

Royal Institute of Technology,
Stockholm, Sweden,
Department of Water Supply and Sewerage Engineering.

Journal of the Environmental Engineering Division-ASCE, Vol. 102, No. EE6, p 1139-1149, December, 1976. 8 fig, 1 tab, 13 ref, 2 append.

During heavy rainstorms the main collecting sewers in combined systems are overloaded and, to avoid flooding of low areas, it has been necessary to discharge the peak amounts of combined untreated waste water to adjacent watercourses. The pollution problems in the receiving watercourses can be serious. Treatment plants are usually not capable of producing satisfactory purification at such peak flows. A method is presented of using normally unutilized volumes in main sewers as temporary storage for excess flow during rainstorms by installing flow regulators in main sewers. The flow regulators are helical plates mounted in the pipes. A basic sewage flow is always discharged through a basic opening in the regulator. This opening's size is calculated to obtain the most favorable use of the upstream storage volume and maintain the pipe self-cleaning at dry-weather flow. Only the basic flow is discharged through the regulator, while the inflow excess up to the center of the pipe is stored in the sewer upstream from the regulator. For higher water levels, discharge starts over four triangular outlets in the regulator. This discharge increases with water level. At full flow the entire inflowing sewage is discharged over the four outlets, and the total discharge through the flow regulator is practically the same as the pipe capacity without a flow regulator. At decreasing flow the storage upstream from the regulator is slowly emptied through all five openings. Friction losses at full flow are small. Construction cost is lower than for other regulators; operation cost is negligible. The risk of clogging is eliminated. Flow regulators can be used in pipes 0.8 m or more in diameter. The flow regulators have been tested during nearly 2 yr and have fulfilled all requirements.

*Waste water treatment, *Sewerage, *Treatment facilities, *Flow control, *Flow rates, Combined sewers, Storms, Rainfall intensity

B025
SIMULATED FIELD STUDY FOR I/I ANALYSIS,

Stilley, S. H.

Public Works, Vol. 108, No. 1, p 50-53, January, 1977. 1 fig, 1 tab.

A simulated field study was presented as a guide to infiltration/inflow analysis. Significant factors are: monitoring of significant bypasses and overflow from surcharged manholes, use of weirs to measure gravity sewer flows and recorders for logging flows of an extended period, logging of frequency and duration of each pump operation, monitoring to determine amount of time a bypass operates at a set level, obtaining daily rainfall readings, correlating groundwater levels to flows during wet and dry weather, and analyzing flow data with respect to water consumption, treatment plant flows, rainfall and groundwater levels. Dry weather infiltration is primarily due to high groundwater levels, expressed as the difference between dry weather average flow and calculated waste water flow. Wet weather infiltration and inflow are usually extraneous flows entering the system during and after wet weather rainfall, expressed as all flows above average dry weather flow. After determining flows and calculating the I/I, a comparison of alternatives is made to determine the excess I/I and to select a cost-effective plan of improvement. In cost comparison, hydraulic capacities of transmission and treatment facilities are based on capacities necessary to accommodate flows met in the present system, but applied to an expanded system. Not included is a reserve capacity for future growth or I/I greater than that encountered during study period.

*Waste water treatment, *Analytical techniques, *Treatment facilities, *Infiltration, *Inflow, Sewerage, Hydraulic condictivity, Analysis

*Infiltration/inflow

B026
TUNNELS AND TUNNELLING PRACTICE,

Water Services, Vol. 80, No. 969, p 688-689, November, 1976.

The piping system of the Milton Keynes, England, city sewerage scheme was described. Consulting engineers made recommendations as to the general requirements and approximate routes for trunk sewers. Separate sewerage systems are provided for foul and surface water sewage. Trunk sewers were built along the lines of grid roads to avoid interference with development areas and the two sets of sewers were built in twin parallel trenches where possible. The necessity for a single trench was small. The foul trunk sewer was made of bolted ring, smooth bore ring, and reinforced flexibly jointed pipe layed in open cut. The other system used reinforced concrete pipes and internal segmental tunnel with associated segmental shafts, manholes and outfall bays for foul and surface water drainage. The central contract was for reinforced concrete pipe in open cut at depths up to 7 meters. Construction involved pipes in open trench, pipe-jacking, heading, segmental tunnelling and box culvert. Manholes were constructed in precast concrete rings, segmental concrete rings, and in-situ concrete. Close-piled coffer dam construction and well-point dewatering were often used. Where river crossing was involved, tunnel, pipe jack, coffer dam, and open cut methods were employed. Ground conditions varied from hard rock to running sand and silt, and the major soil is Oxford Clay. Special trench supporting boxes were designed for use in open cut construction.

*Sewerage, *Tunnels, *Piping systems (mechanical), Pipes, Separated sewers, Tunneling, Tunnel design, Soil types

Milton Keynes, England

B027
SET SEWER RATES THAT REFLECT USE,

Ghosh, M. M., and Hall, M. W.

Missouri University,
Columbia,
Department of Civil Engineering.

The American City and County, Vol. 91, No. 12, p 49-50, December, 1976. 1 tab.

The problems of equitable distribution of water treatment costs which reflect usage were considered. The dominant question is providing reasonable means of charging industrial users for a fair share of municipal costs involved in waste water treatment. Previously, this cost was negotiated between municipalities and their largest users with taxation used to offset any differences. It is recommended that a new system involving accurate determination of the quantity and quality of influent from these customers be used to determine the load on the municipal system and costs determined from this consideration. The most common rate structures used are: Ad valorem tax, based on dollar value of property or a levy on corporate revenue; percentage of water bill, varied from 50% to 150%; special assessment charges; volume of sewage; or volume of sewage plus surcharge for suspended solids, oil and grease, BOD, chlorine demand or some other parameter. The practices of Dover, New Hampshire, were used for an example. Both collection and operating costs are charged to direct users. Annual revenue for maintenance and operation was proportioned on the basis of percentage-of-use.

*Water rates, *Waste water treatment, *Sewerage, *Biochemical oxygen demand, Economics, Cost sharing, Capital costs, Operating costs

Dover (NH)

B028
SEWER CLEANING SYSTEM COMBINES VERSATILITY, LOW INITIAL COST,

Twitty, B. A., Jr.

Water and Sewer Maintenance,
Monroe, North Carolina.

Public Works, Vol. 108, No. 1, p 47-48, January, 1977.

The city of Monroe, North Carolina, has tested a new sewer cleaning system. The power operated units, Sewer Jet and Jet-Vac, provide low initial cost, and better versatility and efficiency than mechanical sewer cleaners previously used. One advantage is that solids can be removed from sewer systems with the Jet-Vac. The procedure involves a high velocity jet nozzle fed through a manhole and thrust up the sewer through clogs by water at 2000 psi. Solids are flushed back and removed by the intake tube of the trailer system. Liquids and solids are simultaneously removed and solids are separated while the liquid returns, under pressure, through a discharge hose into the sewer line downstream. Economic advantages have not been documented, but time involved for projects has been reduced from a matter of days to hours. Field tests indicated a cleaning capacity for 2000 feet of 8-inch diameter pipe of 1.5 hours with the use of 1000 gallons of water. This equipment can operate at temperatures as low as minus 40 F. The vacuum trailer system can operate all day without the necessity of dumping the sludge from the sealed tank. Maintenance and cleaning is a simple operation. The Jet-Vac can also be left to remove liquids and solids as the Sewer Jet moves on to clean other lines. There are various features for operator safety and noise suppression.

*Cleaning, *Initial costs, *Cities, *North Carolina, *Efficiencies, Sewers, Sewage effluents, Clogging

Monroe (NC), Sewer Jet, Jet-Vac

B029
CALIFORNIA CITIES LAUNCH $2 BILLION IN SEWERAGE JOBS,

Engineering News-Record, Vol. 197, No. 26, p 27, December, 1976.

The cities of San Francisco and Los Angeles, California, have embarked on programs to upgrade their waste water handling capabilities. San Francisco plans a $1.5 billion program which includes building collector sewers, storm water storage, a 114-mgd pumping station, and the consolidation of outfalls on the city's east side. The project is expected to be completed in twelve years. The $500 million Los Angeles project involves improvements to the Hyperion plant at Playa del Rey, its major treatment facility, to upgrade it to secondary treatment in five years. Upon completion, the plant will handle its own 160 tons per day of sludge, as well as sludge from another small waste water plant and two reclamation plants. The sludge will be disposed in sanitary landfills. Ocean discharge will be discontinued by the early 1980s.

*Sewerage, *Cities, Waste water treatment, Sludge treatment, Ultimate disposal, Landfills, Treatment facilities, Pumping stations, Sludge disposal, Storm water, California

San Francisco (Calif), Los Angeles (Calif)

B030
NO SEWERS--NO GROWTH!,

Boyles, E. H.

DE Journal, Vol. 228, No. 5, p 56-59, 77, November, 1976. 6 tab.

The spread and impact of sewer moratoriums as a means of restricting community growth was investigated. One major effect of this program is an adverse effect on the recovery of the American housing industry. One plumbing industry spokesman suggested that moratoriums result in housing shortages; unemployment in the construction industry; depressed business for builders, subcontractors, and their suppliers; and contribute to rising costs. Sewer moratoriums result when a sanitary district or municipality outgrows its sewerage system or cannot maintain established treatment standards. The moratorium usually involves a combination of the following factors: a freeze on new sewer authorizations, a freeze on new sewer connections, a freeze on new building permits or a class of building permits, a freeze on subdivision requests or re-zoning and zoning to higher than developed densities, and a slowing down or quota system for any or all of the above. Suggested solutions consisted of developing untapped water sources, building additional sewage treatment facilities, or instituting an area-wide water conservation program. One facet of the latter category is water saving fixtures and fittings. Various items, suggested by the plumbing industry, were evaluated.

*Water conservation, Domestic water, Domestic wastes, Treatment facilities, Plumbing

Sewer moratorium, Housing industry

B031
EPOXY MORTAR AND COATING PROVIDE NEW LIFE FOR INVERT,

Water and Sewage Works, Vol. 123, No. 12, p 74, December, 1976.

A 14,000 square foot box culvert invert beneath Santa Rosa, California, uses a combination of a rock-hard epoxy mortar and an erosion-resistant epoxy coating to provide long-term protection. The culvert is one of three which aid flood and high water run-off. It is constructed of a foot-thick reinforced concrete slab which has a full-length wall on one side and a 4-foot wall on the other side. During the past 12 years, erosion has occurred from flooding, abrasive debris, sulfates and lignins. Overlays of portland cement concrete or asphaltic concrete were rejected because they could not ensure corrosion resistance. The epoxy coating is designed to protect portland cement concrete from moisture, abrasion, wear and many corrosive chemicals. No signs of wear were found after 10 months of use.

*Conduits, *Culverts, *Corrosion control, *Coatings, *Concrete construction, Concrete structures, Reinforced concrete, Asphaltic concrete, Corrosion, Chemical degradation, Sewerage, Construction materials

Epoxy mortar, Santa Rosa (Calif)

B032
FLAME SPRAYING REDUCES PUMP LEAKAGE AT WASTE WATER TREATMENT PLANT,

Welding Journal, Vol. 55, No. 11, p 968, November, 1976. 2 fig.

A ceramic coating on packing sleeves was used by the Metropolitan Sewer District of greater Cincinnati to reduce pump leakage. A titanium dioxide ceramic was applied to pump sleeves by flame spraying. The process produces molten particles by feeding the titanium dioxide powder into the flame spraying gun. The coating, thus produced, is more resistant to abrasive/sewage sludge than the original metal. In five years of usage, there has been no failure. When the pumps in the system (stainless, bronze, or mild steel) develop excessive leakage, they are stripped down and the sleeves are rebuilt with the ceramic coating. This process has proven more economical than any other repair or replacement scheme. Proof of the effectiveness of the ceramic coating was shown a few years ago. Raw sludge-draw off pumps were installed to move solids from the settling tanks to the digesters. The new pump shaft sleeves began to wear excessively before the system was completed. The solution was the substitution of a water type lubricant for the pumps and rebuilding worn sleeves with the ceramic.

*Pumps, Sludge, Waste water treatment, Hydraulic machinery, Treatment facilities, Economics, Solid wastes, Leakage, Sewerage, Mechanical equipment

Flame spraying, Titanium dioxide, Pump sleeve ceramic coatings

B033
SUCCESS IN GRP MOULDINGS THROUGH PRODUCT AND PROCESS DIVERSIFICATION,

European Plastics News, Vol. 3, No. 7 and 8, p 38-39, July/August, 1976.

The use of GRP molding at sludge handling facilities in Great Britain is described. Plastic materials are used in the production of tanks and silos as well as high pressure pump housings. Silo tanks for sewage farms are of the non-pressurized type and are produced in two semicircular section halves by the hand/spray lay-up technique using GRP molds. After molding, the two halves are bonded together and fitted with manhole covers, valves, and pipework. GRP is used in the form of hot press molded DMC to make the heavy section suction chamber and stator housing of high pressure, positive displacement pumps which are designed to handle liquids containing a high proportion of solids or fibrous materials.

*Sludge treatment, *Treatment facilities, *Pumps, *Sewage, *Materials, Equipment, Waste water treatment, Manholes, Plastics

GRP molding

B034
DESIGN SEWERS TO BE SELF-CLEANING,

Paintal, A. S.

Water and Wastes Engineering, Vol. 14, No. 1, p 32, 44-45, January, 1977. 6 fig, 9 ref.

Hydrogen sulfide control and a self-cleaning capability can be designed into sewer systems. Design considerations include: flow characteristics, solids characteristics, BOD, sulfate contents, principles of fluid mechanics, sediment transport, and biochemical decomposition of solids. The self-cleaning aspects of sewers are dependent on tractive force generated by sewage flow on the sewer boundary. Hydrogen sulfide generation is important where microorganism activity is increased, as in warm climates. Sulfide generation depends upon sewage temperature and BOD, called effective BOD (EBOD) Hydrogen sulfide generation and buildup depend on the amount of sulfide reducing bacteria present. These bacteria breed in slime growth on the sewer boundary. Various equations and formulae are provided for making necessary design calculations with the above-mentioned criteria. Applicable design conditions evolved indicated the following: sanitary sewers should be essentially straight and circular in cross-section; flow should be uniform and describable by Manning's Formula; critical boundary shear stress should be the minimum which keeps sewage solids moving to reduce slime growth (0.08 pounds/square foot) and, at minimum flow, the mean value should be considered equal to the assumed critical shear stress. Pameroy's Z criteria can be used in sulfide control calculations. The slope necessary for self-cleaning sewers and sulfide control was calculated to be 0.00305 for a 2-foot diameter sewer.

*Sewerage, *Sanitary engineering, *Design criteria, *Design data, *Fluid mechanics, Solid wastes, Flow characteristics, Bacteria, Microorganisms, Biochemical oxygen demand, Temperature, Environmental control

Self-cleaning sewers, Effective BOD, Boundary shear stress

B035
CANWEL CAN DO?,

Leich, H. H.

Compost Science, Vol. 17, No. 5, p 21, Winter, 1976.

The Ontario Research Foundation has spent fifteen years developing the Canwel system of sewerless sanitation. The approach was developed under the assumption that central treatment plants cannot produce effluents which are nonhazardous to the environment and are not able to keep up with increasing demands upon them. Several avenues were investigated. Cleaning waste water to two levels, one good enough for recirculation to toilets, washing cars, and sprinkling lawns, and one pure enough for cooking and drinking, was the first step. Others were ozonation rather than chlorination for purification and incineration of sewage sludge and kitchen garbage. The heat produced was used for hot water needs. Advantages of this system would be the elimination of sewer lines and central treatment facilities, lessening of home water requirements, meeting of hot water demand without added energy input, lowered costs for refuse collection, and significant increases in the quality of effluents released to ground or surface waters. A combination of physical, biological, and chemical processes would be used to run the system. Filtration and reverse osmosis techniques would reduce contaminant levels and increase water quality. Brine concentrates from this process could be incinerated with sludge and garbage. A prototype installation has been successful and the next step will be testing of the entire system in an apartment building.

*Waste water treatment, *Domestic wastes, *Water quality, *Treatment facilities, Water reuse, Environmental control, Sanitary engineering, Sewage treatment, Biological treatment, Chemical treatment

Ontario Research Foundation (Canada), Canwel sewerless sanitation system

B036
TESTING AND GROUTING LEAKING JOINTS,

Herndon, J.

Halliburton Services,
Environmental Control Department,
Duncan, Oklahoma.

Water and Sewage Works, Vol. 124, No. 1, p 76, January, 1977. 1 fig.

A three-element packer was designed to alleviate the problem of sewer infiltration through faulty joints. This instrument tests, grouts and retests joints. The packer contains a liquid-filled center portion connected to a direct reading, Bourbon tube pressure gauge which is viewed by television during air testing or grouting. The packer is usually pulled through the sewer line from the downstream manhole. The air test is performed by applying air to the center void until test pressure is attained; the pressure is released from the line and stays trapped in the void around the joint. Void pressure decrease indicates a leak. PWG chemical grout is mixed and pumped in two streams to the packer and, as the grout is injected, the two streams mix to begin a reaction which forms a high-strength gelled material that squeezes around the center element and fills the void between the flows into the leaking joint. This prevents further leakage. If necessary, retesting of the joint can be performed by deinflating and reinflating the end elements of the packer. The system is efficient and can be controlled by one operator. It is also economical since a minimum amount of grout is wasted and no excess is used.

*Grouting, *Chemical grouting, *Leakage, *Equipment, Sealants, Seepage, Sewerage, Infiltration, Testing, Repairing

B037
SEWERAGE FOR A RURAL RESORT AREA,

Sullivan, J. A.

Alexandria Lake Area Sanitary District,
Alexandria, Minnesota.

Public Works, Vol. 108, No. 2, p 56-57, February, 1977. 1 fig.

A tertiary waste water treatment plant, 75 miles of sanitary sewers and 48 major lift stations are being constructed to provide sewerage for a 50 square mile area in rural Minnesota. Fifteen lakes and the groundwater in the area began to show signs of pollution during the late 1960's. This project was instituted to preserve the water resources of the area. A secondary treatment plant was completed in 1971, phasing out the two plant system previously employed. A comprehensive program including an activated sludge process, followed by alum coagulation and polymer filtration, chlorination, and final aeration in ponds was accepted by government agencies responsible for pollution control. Total costs of the project including engineering, administration, land acquisition and capitalized interest is $23 million. Fourteen million dollars was obtained as grants from state and federal agencies. Operational costs are expected to be about $1.1 million annually. All properties gaining lateral sewer benefit from the system will be assessed by special levy. The treatment plant and interceptor system have a design capacity of 2.5 and 3.2 mgd, respectively. Staff is expected to total 14 full-time employees and 2 part-time employees by 1978.

*Sewerage, *Treatment facilities, *Interceptor sewers, Engineering structures, Tertiary treatment, Waste water treatment, Construction, Costs, Financing, Planning

Alexandria Lake Area Sanitary District (Minn)

B038
CHICAGO DRIVES LARGE BORES TO CONTROL COMBINED
SEWAGE FLOW,

Engineering News-Record, Vol. 198, No. 5, p 20, February, 1977. 1 fig.

Chicago has begun work on a program to control storm and sanitary sewage runoff by utilizing underground storage caverns. With pilot bores for testing tunneling and sealing completed, work on the remaining hardrock tunnels has proceeded. The two systems will contain 125 miles when completed in 10 years. Combined sewer overflow has been an irritant, creating problems of waterway pollution and disease. Sewer overflow has accounted for nearly 45% of the metropolitan area water pollution. The tunnel and reservoir plan provides for three reservoirs (118,000 acre/foot of combined sewage) which will pump stored water to surface plants for off-peak treatment. Rochester, New York, and other cities are considering similar plans. Also included in the system are a $365 million mainstream system under downtown Chicago, a $114 million pumping station and associated structures, and tunnels, shafts, and pumping works estimated at $183 million. Machine mining without blasting is to be used for hardrock tunneling to avoid surface disturbances. Shale portions of rock must be concrete-lined, and more competent rock must be 100% grouted to prevent infiltration. Surface disturbance must be minimized when drop shafts are excavated.

*Combined sewers, *Runoff, *Overflow, *Water pollution sources, *Pollution abatement, Construction, Reservoirs, Waste treatment, Waste water treatment, Engineering structures, Underground storage, Rock excavation, Tunnel excavation, Costs

Chicago (Ill), Rochester (NY)

B039
CINCINNATI'S PREVENTIVE MAINTENANCE SEWER PROGRAM,

Water and Sewage Works, Vol. 124, No. 1, p 70-71, January, 1977.

The Greater Cincinnati Sewer Maintenance Division will soon complete a 12-year program of preventive inspection and cleaning of its 4000-mile sewer system. The goal of the project is to provide repair and cleaning services before conditions warrant complaints. A complex network of crews was formed to achieve this goal. There are three cleaning and repair-section crews and an inspection section crew. Each cleaning/repair section has two major repair crews, a minor repair crew, two major cleaning crews, a power cleaning crew, and a complaint crew. The inspection and investigation section is composed of three minor investigation crews for interceptor cleaning; three regulator crews--two routine inspection crews and one maintenance crew for welding and fabrication; and four routine inspection crews. Other divisions of the Metropolitan Sewer District are Administration, Technical Services, and Operations. The entire operation is financed by a special rate charge. Daily reports are made on trouble areas, and monthly reports are given on how much sewer line was cleaned and repaired, on the number of complaints, and on recommended solutions. Equipment is serviced regularly and purchases are based on the amount of cleaning and repair work to be done.

*Sewerage, *Repairing, *Inspection, *Cleaning, *Maintenance, *Water districts, Cities, Personnel, Water quality control, Sanitary engineering

Cincinnati Metropolitan Sewer District (OH)

B040
PREVENTIVE SEWER MAINTENANCE HELPS PRESERVE HISTORIC ANNAPOLIS,

Public Works, Vol. 108, No. 2, p 58-59, February, 1977.

The role of sewer maintenance in preserving Annapolis, Maryland, as a clean city and tourist attraction was reviewed. The program was designed to prevent blockages which could cause backups and flooding. An evaluation of equipment was conducted in 1972 and a Myers-Sherman Vactor "Jet-Rodder" was selected to bring the city's equipment level to a state of adequacy. First used full time on emergency work, the apparatus now cleans the entire system on a regular basis. Trouble spots are serviced every six months and the rest of the system is inspected annually and cleaned every two years. The former average of 370 emergency calls per year has been cut by more than 60%. Since the new machinery has been in use, there has been no severe basement flooding problem or back-up problem. Claims for blocked line damage were reduced by 50%. Economic savings have been made in maintenance and labor costs, as well as costs associated with treatment and removal of the sludge previously accumulated in the system. Lift station wet wells are now cleaned every four months and the machinery has been used to remove sand and gravel from filters. Valve boxes can now be cleared of clogging debris and other adapted uses include the removal of dead fish accumulations from the harbor.

*Sewerage, *Inspection, *Cleaning, *Equipment, *Maintenance, Water districts, Machinery, Repairing, Sanitary engineering, Water quality control

Annapolis (Md)

B041
COPPER SULFATE FIGHTS ROOT GROWTH IN SEWER SYSTEMS,

Tuwiner, S. B.

Water and Sewage Works, Vol. 124, No. 1, p 40-41, January, 1977. 1 fig.

Copper sulfate has become an effective cure for the problem of sewer and storm drain blockage by root and fungus growth. Root growth in pipes produces a mechanical obstruction causing unsanitary conditions, and an odor problem from the decomposition of detained organic matter. This obstruction deteriorates mortar pipe, joints, manholes, pipes and substructures, treatment plant units and mechanisms; it reduces the capacity of pumps, force mains and gravity lines, and it can lead to stream pollution. Copper sulfate treatment produces an immediate abatement of these conditions, but an exact usage formula has not been deduced. The only guideline is that the amount of needed copper sulfate is in ratio to the total mass of roots present. The pH-alkalinity test can be used to determine the existence of a problem as well as the results of treatment. Sewer and lateral application is by sprinkling copper sulfate along the invert of the pipe. In homes and buildings, flushing the chemical through the toilet is the prescribed procedure. About two pounds is used for home treatment. It is safe to use around trees because it results in only local killing action on the root system. It is a stable, crystalline, easily handled, mildly acidic material. Use should be planned only at low flow periods to avoid excess dilution.

*Root distribution, *Root systems, *Copper sulfate, *Sewerage, *Cleaning, Drainage, Storm drains, Combined sewers, Municipal wastes, Domestic wastes, Hydrogen ion concentration, Flow

B042
ENVIRONMENTAL IMPACT OF URBAN STORM WATER RUNOFF,

McPherson, M. B.

In: Short Course Proceedings: Applications of Storm Water Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 11-82. 4 fig, 4 tab, 198 ref. Technical Report NTIS PB 247-163.

The use of models for the analysis and development of engineering methods for flood control projects in urban catchments was evaluated. Preliminary analysis and design should employ the simplest models. These should be based on data such as temporary rainfall-runoff-quality measurements. Detailed modeling is justified only if actual field data is available, and only to delineate better the underlying processes and to develop an understanding of the simpler models used. Compatibility should be sought between tool sophistication, scale of use, and input data quality. Artificial supports, such as intensity-duration-frequency curves, should be avoided and historical storm data should be used as inputs with all model types. The rational method is the only model type which does not require computers for efficient calculation. Drainage design is important because of the great expense involved in sewer system development and construction.

*Model studies, *Design criteria, *Storm runoff, *Storm drains, Urban drainage, Urban hydrology, Analysis, Engineering, Drainage engineering, Pollution abatement

B043
SLIPFORM PAVER, STEEL FORMS SPEED LINING OF 25,000-FOOT SEWER TUNNEL,

Hancock, N.

Engineering and Contract Record, Vol. 90, No. 1, p 64-65, January, 1977. 1 fig.

A slipform paver was used to pour a 12-inch concrete lining for a 25,000-foot sewer tunnel in Montreal, Canada. Special steel forms were used for the 16-foot horseshoe-shaped arch and wall. The Miller M9000 paver can slipform up to 16 feet wide and 2 feet deep and was used to form curbs and an invert. After a very successful experience with tunnels for the Montreal subway system, modifications were instituted to make the apparatus applicable to sewer tunnel construction. Telescoping steel forms with hinged upper quarters were used on the horseshoe portion of the tunnel. When the first form is anchored and the concrete is poured, the second 40-foot form is moved ahead, anchored, and more concrete is poured. This operation is repeated until the first form is ready to be moved on the 20-foot traveler to a new position. This process completes about 1,000 feet of wall and arch per week.

*Tunnel linings, *Tunnel construction, Sewers, Engineering structures, Construction, Concrete construction, Concrete placing, Equipment, Underground structures, Construction equipment

Montreal (Canada)

B044
CONTROL SEWER CORROSION WITH H2O2,

Matthews, D. G.

Public Utilities,
Corpus Christi, Texas.

The American City and County, Vol. 92, No. 2, p 65, February, 1977.

In Corpus Christi, Texas, hydrogen peroxide was used to control odor and hydrogen sulfide-induced corrosion. The city tried, unsuccessfully, to eliminate the problem with the use of liners for its concrete sewers. No liner material proved satisfactory. Peroxide completely oxidizes hydrogen sulfide. Water and sulfur are formed in acid or neutral sewage; water and sulfates are formed in alkaline sewage. Although available in various concentrations, a 50% solution of hydrogen peroxide is the maximum concentration that can be used safely and housed easily in residential areas, although the 70% solution is the more economical. Other alternatives were suggested, but the peroxide proved efficient and more effective.

*Sewers, *Corrosion, *Corrosion control, *Odor, *Hydrogen sulfide, Waste treatment, Waste water treatment, Liners, Chemical reactions, Economics

Hydrogen peroxide, Corpus Christi (TX)

B045
CONTRACT SERVICES STRETCH SEWER MAINTENANCE BUDGET,

Anderson, D. C.

The American City and County, Vol. 92, No. 2, p 53, February, 1977.

The city of Gladstone, Missouri, has contracted its sewer maintenance work. The annual fee of $9,000 enables the city to avoid the purchase and maintenance of $100,000 worth of equipment. Personnel costs are also eliminated, as are insurance, unemployment compensation, hiring or overhead charges, and salaries. Round-the-clock service is guaranteed and the service keeps lines free of roots, leaks, and other obstructions. Flooding, odor, and pollution have all been abated as a result of this contracted service.

*Sewerage, *Maintenance, *Cleaning, Costs, Cities, Equipment, Personnel, Flood protection, Leakage, Odor, Root systems, Water pollution sources, Pollution abatement

Gladstone (MO), Contracted maintenance

B046
NEW PROGRAMS IMPROVE SENSITIVE AREAS OF WATER AND SEWER SYSTEMS,

Delaney, E. F.

Public Works, Vol. 108, No. 3, p 66-67, March, 1977.

Waltham, Massachusetts, has embarked on a program of water and sewer system improvements. The old and inaccurate metering system was first to be renovated to improve efficiency in accounting for water use. Nine thousand self-generating remote readout meters have already been installed, producing a $33,000 savings in one year, and accounting for 138 million "lost" gallons of water. These meters, which will eventually total 12,000, eliminate the need for access to homes. The specifications required a self-generating remote meter with a simplified two-wire system; a bronze maincase; non-corrosive gears and measuring chamber; a frost bottom plate for severe winters; and a hermetically sealed, easily removable register. The water program also included new municipal storage and pumping facilities, new pumping station and interceptors, and a preventive maintenance program.

*Sewerage, *Instrumentation, *Measurement, Equipment, Cities, Water use, Storage, Pumping plants, Design criteria, Interceptor sewers

Waltham (MA)

B047
THE USE OF OXYGEN TO TREAT SEWAGE IN A RISING MAIN,

Boon, A. G., Skellett, C. F., Newcombe, S., Jones, J. G.,
and Forster, C. F.

Water Research Centre,
Stevenage, England.

Water Pollution Control, Vol. 76, No. 1, p 98-112, 1977. 6 fig, 11 tab, 9 ref.

Oxygen was used as a sewage treatment in rising and slow-flowing gravity mains to correct anaerobiosis which causes organic sulfur compounds and inorganic sulfates to be reduced to sulfide by specific bacteria growing in the sewage. Sulfide can lead to odor problems, concrete corrosion, and a sewage which is more difficult to treat at the receiving works. Testing was conducted in Bath, England. Average DO and total sulfide concentrations were 5 and 0 milligrams/liter, respectively, in the main and 0 and 8 milligrams/liter at the sewage works. Poor sludge settling characteristics at the facility were thought to be caused by Leucothrix bacteria in the raw sewage. By injecting oxygen and maintaining sewage DO concentrations above 0.5 milligrams/liter, sulfur formation was prevented. The oxygen was injected at a point on the outgoing main. The theoretical maximum of oxygen needed was 1400 kilograms/day. BOD reductions were equivalent to between 70%, in winter, and 140%, in summer, of the mass of DO injected at the foot of the main. BOD in the final treatment effluent decreased from 58 to 21 milligrams/liter; suspended solids decreased from 51 to 21 milligrams/liter. Although the total weight of sludge produced at the plant was only slightly affected by this treatment, the consolidated sludge volume was reduced by nearly 10%. Treatment produced an almost total reduction of Leucothrix bacteria. During oxygen injection periods, there was an 8% increase in the daily power needed for sewage pumping because the flow rate decreased slightly. The annual cost of injecting oxygen to produce easily treatable sewage will be about 19,000 pounds. The alternative to this procedure, upgrading the biological filtration plant, would require an expenditure of 500,000 pounds.

*Oxygenation, *Sewers, *Anaerobic conditions, *Sulfur compounds, *Anaerobic bacteria, *Sulfides, Odor, Corrosion, Dissolved oxygen, Suspended solids, Biochemical oxygen demand, Physical properties, Chemical properties, Sludge treatment, Sewage treatment, Pumping plant, Treatment facilities, Filters, Waste water treatment

Oxygen injection, Rising main, Leucothrix, Bath (England)

B048
TELESCOPING FORM SYSTEM SPEEDS SEWER CONCRETING,

Water and Sewage Works, Vol. 124, No. 3, p 68, March, 1977.

A telescoping two-section concrete form system was used for sewer construction in Cleveland, Ohio. Concrete is poured around a steel form to make a 9-foot diameter tube. While the concrete sets behind one of the two-piece sections, the other is stripped from a completed sewer wall portion, threaded through the first set of forms, and placed for the next pouring. An overhead beam moves the forms which, with the hydraulic traveler, comprise a self-contained unit. The small crew needed for the system can pour 100 linear feet of concrete every two days, using the alternate days to strip, move and place the forms. The hydraulic system of the traveler is utilized for stripping and setting the form panels. The advantages realized from this system included the efficient and rapid movement of the forms, an excellent concrete finish, and a single clean-up which would not be possible by using separate systems for floor and sidewall sections.

*Sewers, *Concrete construction, *Concrete technology, *Formwork (construction), Concrete placing, Concrete structures, Equipment, Engineering structures, Tunnel construction, Interceptor sewers

Cleveland (OH)

B049
PLASTIC SEWER PIPE MATERIALS,

Journal of the Environmental Engineering Division, ASCE, Vol. 103, No. EE2, p 177-180, April, 1977.

Recent information on plastic sewer pipe materials was presented. The two types of plastics are thermosetting, which is irrevocably set into shape once molded, and thermoplastic, which may be reheated, refabricated, and reshaped. The following pipe materials are most commonly used. Acrylonitrile-Butadiene-Styrene (ABS) plastic pipe is used for gravity, nonpressure sanitary, and storm and drainage installations. This is available as composite pipe (plastic shell plus filler), and as solid plastic wall pipe. The advantages of these pipes are their light weight, long laying lengths, reduced infiltration and exfiltration, corrosion resistance, higher flow characteristics, and lower installation costs. They are, however, susceptible to ultra-violet rays which affect shape and impact strength, and they are available only in limited sizes. Continuous lateral support is necessary for structural stability. Fiberglass reinforced plastic (FRP) pipe can be used for both gravity and pressure sanitary, and storm and drainage installations. This is a Reinforced Thermosetting Resin Pipe (RTRP); various reinforcements include glass-fibers and asbestos. The thermosetting resins used are epoxy, polyester, and phenolics. Fillers, such as sand, are used in some pipes to improve stiffness and abrasion properties, but they are available for gravity service only. The FRP pipe provides high strength at a light weight, corrosion resistance, and the ability to make field connections. Polyethylene pipe has a high density and is suitable for many applications. Its life expectancy depends upon time, temperature, pressure, and wall thickness. Polyvinyl chloride (PVC) pipes are used for both gravity sewer and pressure pipe applications. It has a light weight, long laying lengths and low fraction resistance. It requires special bedding, softens at 140+ F, and is sensitive to some solvents. Specifications were listed for all the above pipe types.

*Plastic pipes, *Construction materials, *Sewers, Physical properties, Pipes, Plastics, Temperature, Flow, Corrosion control, Structural engineering

Acrylonitrile-Butadiene-Styrene (ABS), Fiberglass reinforced plastic (FRP), Polyvinyl chloride (PVC)

B050
GAS DETECTORS DETERMINE HEALTH HAZARDS IN SEWAGE TREATMENT,

Water and Sewage Works, Vol. 124, No. 3, p 60, March, 1977.

The Los Angeles City Sewer Maintenance Department has acquired portable combination H_2S and combustible gas detectors. These gases have become known safety problems in sewage and water treatment. The detectors consist of a sensor, alarms, a charger, a three and one-half inch meter, and an optional miniature sample pump. The units weigh five and one-half pounds. The instruments are very durable and easily calibrated. Detectors are preset for audible alarm at 30-35 ppm H_2S and 20% LEL for combustible gases. They are placed at three points at any entry to a pumping station. The sensor is directed to the above-ground wet well vent to monitor gas concentration in the concrete-enclosed rooms below, and operates at slightly above ambient temperature. The instrument is worn for all work in the underground pump room. The detector is placed on a metal grid walkway above the waste water flow in the wet well when the area is cleaned. H_2S is the one highly toxic gas which cannot be detected by smell at low concentrations of 100-150 ppm. Concentrations at 700 ppm can cause instant unconsciousness and death. The other gas combinations in the area of sewer maintenance are all explosive. The Los Angeles maintenance group requires that workmen immediately leave the area at first warning.

*Monitoring, *Hydrogen sulfide, *Gases, *Hazards, *Sewers, Pumping plants, Maintenance, Personnel, Safety, Toxicity

Los Angeles City Sewer Maintenance Department (CA)

B051
HOW TO DETERMINE WASTE WATER FLOW,

Foster, W. S.

The American City and County, Vol. 92, No. 3, p 61-62, March, 1977.

A discussion was presented of various aspects of the problem of waste water flow determination. The monitoring equipment should be accurate and operable in wet or dry weather, reasonably priced and easy to install and service, capable of quick and easy installation at various manhole locations, rugged and operable in an automatic mode, reasonably vandal-proof, and should not interfere with the flow in the sewers or with sewer use. Oscillating probes, bubbler tubes, various floats, ultrasonic level detectors, and capacitance measuring probes are used for monitoring purposes. Flow velocity can be measured by using salts or radioactive tracers in the waste water, or by a chemical dilution method using a fluorescent dye. Information derived by these instruments and methods can guide engineers, planners, and administrators in developing and improving collection systems.

*Flow measurement, *Pipe flow, *Monitoring, *Sewers, *Measurement, Data collection, Equipment, Flow rates, Instrumentation, Planning

B052
A NEW VACUUM SEWAGE SYSTEM BY IFO WARTSILA,

Shipbuilding and Marine Engineering International, Vol. 99, No. 1204, p 684-686, December, 1976. 1 fig.

A new marine vacuum sewage system was introduced by Swedish firms. All sanitary fittings are connected to a piping system kept under partial vacuum pressure. This pressure is generated by pumps at the outlet end of the system. Sewage is pumped to a holding tank which can be emptied at port or directly into the sea in unrestricted waters. The holding tank need not be a vacuum tank and the vacuum system may be connected to any receptacle under atmospheric pressure by a special discharge unit. The holding tank can be designed to accommodate available space or an existing facility may be used. The components of the system are more expensive than a conventional system, but the freedom of pipe routing which benefits the sewage system and other ship sub-systems, along with the retrofit installation advantages, provide many cost reductions. Only 1.2 liters of water are used per flushing, and the toilet water can be separated from other waste water. This creates water savings and produces about 10 liters of sewage per person per day, as compared to 200-300 liters for conventional gravity flow systems.

*Sewerage, *Boats, Sewage disposal, Storage, Piping, Pollution abatement, Pressure conduits, Plumbing, Economics, Waste disposal, Storage

Vacuum pressure, Marine sanitation

B053
INCREASING SEWER CAPACITY BY POLYMER DOSING,

Sellin, R. H. J.

Bristol University,
Bristol, England,
Department of Civil Engineering.

Proceedings of the Institution of Civil Engineers, Part 2, Vol. 63, p 49-67, March, 1977. 9 fig, 3 tab, 10 ref.

An evaluation was conducted to determine the various factors involved in using polymer dosing to increase sewer flow discharge capacities. An increase of about 25% could be expected with 20-50 ppm polymer additions by weight. An increase of 140% was obtained in a 150 millimeter, 30 meters long pipe with a dose of 300 ppm. No pollution or toxicity problems occurred, except in the immediate area of an accidental bulk spill, which would be naturally cleared in a short time. Comparisons with sewer construction costs indicated that polymer injection would be a cheaper alternative. There was a clear financial advantage in most cases. A minimum sewer length is necessary to make polymer addition economically viable. Other advantages of polymer treatment include its ease of use and transport in emergency situations and its ability to prolong the life of sewer systems prone to overloads during the planning and construction of new sewers. Drag reduction in large or rough pipes will be determined by future testing.

*Polymers, *Sewers, *Flow, Performance, Costs, Chemical treatment, Chemical reactions, Sewage treatment, Economics, Waste water treatment

B054
DRAINAGE--WHO PAYS?,

Davies, J., and Dixon, R. E.

Chartered Municipal Engineer, Vol. 104, No. 3, p 35-38, March, 1977. 1 fig, 4 ref.

The English 1973 Water Act places the responsibility for sewerage on various water authorities and other agencies. There is a provision in the Act stating that owners or occupiers of a property, or local authorities, can requisition sewer systems for domestic purposes. The increasing costs of sewer construction present a financing problem: who is to pay for the installations? Water authorities seem likely to have funds for only essential sewer construction in the foreseeable future, and will probably concentrate on making the best use of already existing facilities. There is no absolute duty for them to provide sewers for their areas. The requisitioning provision of the Water Act appears to be a useful instrument, since the requisitioner will guarantee the authority's income in uneconomical situations.

*Drainage, *Sewers, *Costs, *Sewer construction, Municipal wastes, Domestic wastes, Legislation, Capital costs, Water quality control, Waste water treatment

B055
STUDY OF IN-SERVICE BITUMIZED FIBER SEWER PIPE,

Brumagin, T. E., Colwell, J. A., and Skelton, W. H., Jr.

Transportation Engineering Journal of ASCE, Vol. 103, No. TE2, p 257-267, March, 1977. 10 fig, 2 tab, 2 ref.

Used bitumized fiber sewer pipes were recovered and tested to determine in-service changes which had occurred. Pipes used in the City of Tampa and Hillsborough County, Florida, were studied. Pipe strength had rapidly decreased according to time in service and the amount of water absorbed. Rotary knife cleaning, surface blisters, and root penetration also decreased pipe strength. Beam strength test results indicated that rigidity was less than one-third that of the original specifications. Wet conditions produced greater strength deterioration than dry conditions. This pipe was considered inappropriate for the Tampa or Hillsborough areas because of the rapid loss of needed pipe properties.

*Sewers, *Pipes, *Physical properties, Evaluation, Conveyance structures, Chemical reactions, Waste water treatment, Equipment, Conduits, Engineering structures

Tampa (FL), Bitumized fiber sewer pipe

B056
MOVEMENT JOINT FOR CONCRETE SEWER BRIDGE,

New Zealand Engineering, Vol. 31, No. 15, p 261, November 15, 1976. 1 fig.

Hamilton City, New Zealand, has built a concrete bridge for transporting sewage across a river for treatment. The prestressed concrete bridge has two 1.34 square meter ducts, is 165 meters between abutments, and 15 meters above river level. Flexible duct pins provide longitudinal earthquake protection. A leak-proof, elastic jointing system (Transflex Type 200A) was used for earthquake deflection, temperature movement, shrinkage, and creep shortening. The seal also resists the chemicals in raw sewage and hydraulic pressures.

*Sewerage, *Bridges, *Concrete, *Construction joints, Bridge design, Construction materials, Prestressed concrete, Sealants, Corrosion, Engineering structures, Design criteria

Hamilton City (New Zealand)

B057
INDUSTRY MONITORS COUNTY STORM SEWER WATER,

Tilsner, F.

Water and Sewage Works, Vol. 124, No. 3, p 56-57, March, 1977. 1 fig.

A storm sewer and its monitoring by a Wisconsin tractor plant and foundry operation were described. The system is completely open and susceptible to contamination by oil and other waste matter. An oil interceptor system was installed at the sewer outlet to a lake. It was divided into two units, a pump basin and a filter building. The pump basin is the primary monitoring and flow controlling station of water into the lake. Water passes over a baffle for the removal of heavy solids or debris, then through the pump house via a screened inlet so that flotable materials which passed the baffle are removed. Another baffle traps flotable oil or process liquid in the basin, while an oil skimming unit continuously removes surface oils. Water contaminated by matter which mixes with it is transferred to the filter house which has primary and secondary solids separators. It is then moved to a pre-filter tank or to the secondary separator if further solids removal is necessary. Solids and debris collected are transferred to an outside collection tank for pumping to the waste treatment plant grit chamber for ultimate disposal. An operator monitors the system's performance for possible pollution problems and controls the equipment.

*Storm drains, *Monitoring, Pumping plant, Filters, Industrial wastes, Domestic wastes, Liquid wastes, Oil wastes, Chemical wastes, Flow, Separation techniques, Water purification, Pollution abatement

Racine (WI)

B058
HANDLING SMALL AMOUNTS OF CRUDE SEWAGE,

Water and Waste Treatment, Vol. 20, No. 2, p 41, February, 1977.

An English company has marketed specialized sewage handling equipment in the Middle East. Most applications involve sewage pumping and sewage disposal. Equipment is constructed to handle flows up to 115 liters/second, especially in cases where low and constant delivery rates are necessary. Gravity filled sewage ejectors are provided, as are fully automatic sewage pumping systems. These systems are designed to handle small crude sewage flows.

*Sewers, *Equipment, *Sewage treatment, *Sewage disposal, Pumps, Automatic controls, Maintenance, Design, Performance, Waste water treatment

Middle East

B059
PIPES FOR SEWERAGE AND SURFACE WATER,

Pipes and Pipelines International, Vol. 22, No. 1, p 39, February, 1977.

Piping for an English scheme to improve sewerage and surface water facilities was described. The purpose was to accommodate new development and avoid sewer and drain damage by mine wastes. The village of Riccall is very near a coal field and mine wastes must be sewered to a treatment facility which replaced the older municipal plant. The work involved a sewage pumping main and the laying of 710 meters of 200 millimeter diameter pipe and 1,985 meters of 225 millimeter diameter pipe. The pipes, constructed with Widnes joints, were laid on a granular bed with normal cover. Pipes were laid at a depth of 3 meters in the section crossing under an aqueduct.

*Pipes, Sewage treatment, Physical properties, Sanitary engineering, Mechanical engineering, Treatment facilities, Waste water treatment, Conduits, Cities, Surface water, Industrial wastes, Mine wastes

B060
THE CONCEPTION, DESIGN, AND CONSTRUCTION OF METROPOLITAN TORONTO MID-TORONTO SEWER,

Hogarth, L. N.

James F. MacLaren Limited,
Willowdale, Ontario, Canada.

Canadian Journal of Civil Engineering, Vol. 4, No. 1, p 47-56, March, 1977. 3 fig, 3 ref.

Various factors of the planning, design, and construction of an intercepting sewer in Toronto, Canada, were discussed. Considerations of flows in the Toronto area and hydraulics of the area were prime factors of the system's design. Advantages of the deep sewer design used include the dewatering of existing intercepting sewers for inspection, repair, or restoration without raw sewage discharge to the lakefront. Surplus flows of present sewers will be discharged to the new interceptor sewer. Pumping station and trunk sewer connections will also allow continued maintenance of the present low and high level sewers and their pumping station, as well as that of the new system, without sewage loss to the lake. Dynamic operation measures flows in various sewers and, manually or automatically, diverts flow from sewer to sewer by the regulation of gates. This utilizes full sewer capacity while reducing overflows. Backflows into trunk sewers should be avoided and flow tributary to the interceptor sewer must be measured to achieve flow routing. Air trapped in sewage during the fall to the interceptor sewer is vented by a structure in a spur tunnel horizontal to the main interceptor sewer. Access shafts for maintenance and inspection of the interceptor sewer are located at 305-1219 meter intervals. A level sensing bubble is located at each shaft and hydraulic gradients can be accurately measured at these points. The shafts are located at points where the 150 centimeter diameter cross connections between high and low level interceptors meet the new interceptor systems. Construction, maintenance and operation data are being collected.

*Sewers, *Construction, *Design criteria, *Interceptor sewers, Tunneling, Automatic controls, Engineering structures, Flow, Hydraulic design, Operation and maintenance, Performance, Construction techniques, Construction materials, Waste water treatment

B061
GO AHEAD FOR DRAINAGE AND OUTFALL,

Effluent and Water Treatment Journal, Vol. 17, No. 3, p 112, March, 1977.

The Wessex Water Authority, in England, has decided to build a proposed drainage and long sea outfall system as the most effective and economical solution for the sewage problems in the Weymouth and Portland areas. A study has been undertaken to select definite siting and outfall length. Conditions in the outfall area will be monitored before and after construction to determine the necessity of pretreatment. Tests are also to be conducted with harmless bacteria to determine the time it takes for them to move from the outfall area back to land. The long sea outfall discharging macerated and screened domestic effluent into deep water is expected to relieve present marine pollution problems.

*Drainage, *Outfalls, Piping, Monitoring, Waste disposal, Sewage effluents, Bacteria, Saline water, Domestic wastes, Pollution abatement, Environmental control

Ocean disposal

B062
IMPROVEMENT AND EXPANSION OF THE DRAINAGE SYSTEM OF HAMBURG,

Kuntze, E.

Abwassentechnische Vereinigung E.V.,
Fernuf Bonn, Germany.

Journal Water Pollution Control Federation, Vol. 49, No. 3, p 499-502, March, 1977.

The City of Hamburg, West Germany, has embarked on a program to improve its drainage system. Deterioration of its waterways and the rapid growth following its devastation after World War II made improvements and expansion of drainage and water treatment systems necessary. The system was primarily a combined sewer system with separate sewers added to accommodate post-war expansion. Results of this construction, aided by geographical considerations, were increased loads of existing trunk sewers which led to frequent storm overflows, and sewers which were overloaded by the increased per capita water consumption. A study revealed that nearly 1,000 kilometers of the system were older than 50 years and needed renovation; 92% of the population was connected to the drainage system; most of the industrial firms were connected to the drainage system or had their own treatment facilities; treatment efficiency was between 50 and 94%; and about 75 million cubic meters of highly polluted storm water was discharged into smaller city streams and created extreme pollution. The proposed solutions involve stopping the direct disposal of untreated waste water into natural water resources; banning disposal of treated effluents into streams incapable of sufficient self-purification; reducing overflows from combined sewers and relocating storm overflows to more suitable areas; expanding treatment plants which discharge effluents into the Elbe; renovating the old central drainage system and improving its capacity; building new sewers in areas already built up, but not connected to the drainage system; and finding an economical treatment for storm water from separated systems before disposal. The city is applying model studies, electronic analysis, flow control investigations, and economic analysis in various investigations of the best means for solving these problems.

*Drainage systems, *Water quality control, *Public health, *Combined sewers, *Separated sewers, Urban drainage, Cities, Pollution abatement, Storm water, Treatment facilities, Overflows, Construction, Engineering structures, Waste water treatment

B063
CORROSION AVOIDANCE IN WATER AND SEWAGE PIPELINES,

Smith, T. R.

Water Services, Vol. 82, No. 973, p 143, 145, 146, March, 1977.

Current economic conditions dictate that water and sewage pipelines be chosen for the lowest overall costs. These costs not only include the pipe cost, but installation and maintenance costs. The latter depends greatly on pipe life-aging and breakage. Corrosion, which contributes greatly to aging and breakage, should be minimized. Ductile iron is generally coated with a tar or bitumen-based substance which enhances its metal corrosion resistance, and especially its oxide skin. Great reliance is placed on cement mortar linings. Sulfate resisting cement is often specified for ductile iron linings. Other lining materials include epoxy resin systems and loose polyethylene film. Better application methods are being developed for polyethylene to provide resistance to extremely corrosive environments. Prestressed concrete pipes can be used under conditions of sulfate levels exceeding 5000 ppm when a proprietary wrapping tape system is used or when the pipes are installed in limestone surroundings. The very dense structure of concrete gives it an improved corrosion resistance similar to that of prestressed concrete. When sulfates are present in soils, a sulfate resistant cement should be specified. Corrosion resistance can be improved by using a hard calcareous aggregate such as dolomite. Glass reinforced plastics (grp) or reinforced plastic mortar (rpm) pipes provide corrosion resistance at a reasonable cost. Proper installation of this pipe is necessary for obtaining the full benefits of its resistance properties. Soil analyses can aid in determining the pipe composition and the means of protection needed.

*Corrosion control, *Sewers, *Piping, *Linings, Iron, Concrete, Plastics, Costs, Maintenance costs, Construction materials, Evaluation, Prestressed concrete

Ductile iron, Polyethylene, Glass reinforced plastics, Reinforced plastic mortar

B064
STATIC CALCULATION OF DRAINAGE CHANNELS AND PIPES (Die statische Berechnung von Entwasserungskanalen und-leitungen),

Zaschke, W.

Berichte der Abwassertechnischen Vereinigung e.V., No. 29, p 107-122, 1976. 12 fig, 17 ref.

The static calculation of statically stiff and soft pipes is presented. The basic soil mechanical parameters necessary to load calculation are specific gravity, viscous flow, and modulus of deformation. The earth load is reduced by the friction forces of the wall. The traffic load is calculated on the basis of Boussinesq's theory. Various formulas for the determination of the stress concentration in stiff pipes, and the Iowa formula for statically soft pipes, are presented. The live load is nearly independent of the pipe-laying conditions; it can be assumed to be rectangular. While statically stiff pipes should be chosen on the basis of stress or load-bearing capacity calculations, the long-term and short-term deformations, and possibly the stresses, should be calculated for statically soft pipes. The maximal permissible relative change in the vertical diameter of soft pipes is 6%.

*Sewers, *Analytical techniques, *Loads (forces), Viscous flow, Specific gravity, Friction, Mechanical properties, Physical properties, Conduits, Soil mechanics, Stress analysis, Drainage

Static calculation

B065
DEMONSTRATING THE FEASIBILITY OF VACUUM AND PRESSURE SEWERS,

Clark, L. K., and Eblen, J. E.

C and G Engineering,
Salem, Oregon.

Public Works, Vol. 108, No. 4, p 81-84, April, 1977. 1 tab.

A study was conducted in Bend, Oregon, to determine the feasibility of using vacuum and pressure sewers. A concurrent study attempted to develop construction techniques other than drilling and blasting for sewers in rocky areas. The pressure sewers were designed to tap septic tank effluent lines upstream from boreholes or trench drainage systems. Multiple residential connections were also investigated. There were three residences on one unit, two on each of three units, and two residences were connected to single pumping installations. The system had a total of eleven service connections. The PVC pressure lines were buried at a depth of no less than three feet. The pumping units included a submersible centrifugal pump (25 gpm) in a 30-inch vertical culvert with a tight cover. Two head conditions were used for the six connections, 25 and 37 feet. Discharge lines had check and gate valves and gates were fitted with extension rods. An alarm system was included, but even in the event of pump failure, liquids back up into the original disposal system and householders are not inconvenienced. Monitoring was at the point of discharge into the trunk sewer. Gravity lines did not require rock excavation. A rock trencher was used to place about 25% of the pressure lines. Operation, maintenance and repair costs are being evaluated. The vacuum system also served eleven residences. The central station drew air from small diameter pipes connected to small sumps that received residential waste water. The waste water was collected by vacuum in a receiving tank and pumped through a pressure line to a force main that terminates in the main interceptor. The system was limited by elevation differences. Vacuum release valves were built into the collection system, but electrical or hydraulic valves would also work. Sumps were connected to building sewers by a line upstream from the septic tank. Costs for the vacuum system piping were about $9.75/foot and, for the pressure sewers, about $5/foot. About 50% of the excavation for the vacuum system was done with the rock trencher. These systems show promise as alternatives to gravity systems in areas requiring excessive underground work, in heavily built-up areas, in locations with high groundwater tables, or where buildings are inaccessible for gravity service.

*Sewers, *Sewer construction, Costs, Conduits, Equipment, Monitoring, Interceptor sewers, Pumping plants, Excavation, Cities

B066
PVC LINING--THE ANSWER TO CORROSIVE ATTACK BY H2S IN CONCRETE SEWERS AND STRUCTURES,

Water Services, Vol. 82, No. 973, p 161-162, March, 1977.

Polyvinyl chloride (PVC) linings were studied in Australia as a preventive measure for hydrogen sulfide corrosion in concrete sewers and structures. Factors involved in this type of corrosion are temperature, sewer design, and degree of turbulence. High temperature increases the rate of corrosive attack. Hydrogen sulfide corrosion can be broken down to four stages: sulfur compounds natural to sewage or formed by bacterial activity in anaerobic conditions provide a sulfide content; H2S gas is released into the sewer atmosphere depending on the relative humidity, the degree of turbulence, and the pH in the sewer flow; H2S is oxidized by bacteria, reducing the pH and forming sulfuric acid on the concrete; and the sulfuric acid reacts with lime and hydrated calcium silicates in cement to destroy its structure and reduce it to a putty-like paste. Any protective lining should be resistant to waste constituents and sulfuric acid. It should be suitable for sewer use, remain in place, be unaffected by bacterial actions, be formed as a continuous coating throughout the entire system, and be easily identifiable and reparable in case of accidental damage. A patented process was developed to embed PVC sheets in concrete pipes. They are placed to avoid moisture buildup between the PVC sheets and the concrete, and methods were developed to join sheets between successive pipes after laying them. A lining testing method was also developed to ensure the lining's integrity.

*Linings, *Plastics, *Corrosion control, *Concrete structures, Hydrogen sulfide, Physical properties, Chemical properties, Sewers, Sulfur compounds, Aerobic conditions, Design criteria

Polyvinyl chloride (PVC)

B067
GO AHEAD FOR LONG SEA OUTFALL,

Water Services, Vol. 82, No. 973, p 126-127, March, 1977.

After much investigation, the Wessex Water Authority, England, has decided to construct a long sea outfall as part of a drainage system to solve sewage problems in Weymouth and Portland. Further testing and study will determine the optimum location and length of the outfall. Environmental conditions are to be continuously monitored. Tests will be conducted with harmless bacteria to determine the time they take to reach land from the outfall. Sewage is an extreme problem and it is expected that a long outfall discharging into deep waters will provide the most economical solution. Inland treatment facilities would be more expensive and an outfall would be necessary in any case. Total costs for all systems involved are estimated to be about 8.8 million pounds; the outfall will cost 2.4 million pounds of this amount. Construction should begin about 1978.

*Outfall sewers, Drainage, Monitoring, Testing, Bacteria, Planning, Sewage treatment, Waste disposal, Domestic wastes, Waste water treatment

Weymouth (England), Portland (England)

B068
POLYETHYLENE SEWER FORCE MAIN TAKES VARYING PRESSURES,

Water and Sewage Works, Vol. 124, No. 4, p 108-110, April, 1977. 1 fig.

A 16,640-foot, 14-inch polyethylene sewer force main has been constructed in Ruston, Louisiana. This is part of the first of a three stage project to rehabilitate the city's treatment system. The force main is subjected to pressures of up to 100 psi. The pipe was formed by butt fusing of the joints to provide resistance to railway vibration; it is also elastic and able to withstand deflection. The Driscopipe 1000 chosen has a high molecular weight and is suited for sewer use due to its stress crack resistance, stiffness, and toughness. Variable speed pumps will be used to minimize shock wave production when pressure is increased or dropped. A pressure profile was used and pipe thicknesses were chosen to match pressure at various points along the line. This resulted in a material and cost savings of nearly 15%. Hydraulic backfilling of the ditches eliminated the need for a man in the ditch after pipe laying.

*Sewers, *Construction, *Plastics, Planning, Pipes, Physical properties, Construction materials, Pumps, Costs, Hydraulic structures

B069
SEWAGE PUMPING STATION BUILT TO HANDLE FUTURE SYSTEM DEMANDS,

Glidewell, J. D., Jr.

Water Pollution Control Department,
Topeka, Kansas.

Water and Sewage Works, Vol. 124, No. 4, p 105-106, April, 1977.

A pumping station of "concentric cylinder" design was constructed in Topeka, Kansas. The automated station, with computer monitoring, houses variable speed pump and motor combinations which are designed to meet normal growth demands. The system included a 44 foot deep, 22 foot diameter center wet well for sewage which first passes through bar screens. Two variable speed solids-handling pumps have a 21 mgd capacity, and the third has a 14 mgd rating. A 50 mgd design capacity was built into the system. The pumps have mixed-flow sewage-type closed impellers to aid handling of large solids and stringy materials.

*Pumping plants, *Pumps, *Design criteria, Planning, Engineering structures, Cities, Sewage treatment, Automatic controls, Maintenance, Performance, Operations, Waste water treatment

Topeka (KS)

B070
THE PROTECTION AND REPAIR OF UNDERGROUND PIPELINES FOR WATER AND SEWAGE,

Leng, M. S.

Water Services, Vol. 82, No. 973, p 168, 171, March, 1977.

The protection and repair of underground pipelines of ferrous metals, asbestos cement, and various concretes is very important. Metal pipes are subject to various chemical reactions, such as oxidation, which causes them to revert to their original ores, and corrosion from the elements in raw sewage. Coatings of various types and cathodic protection are used to protect ferrous metal pipes. Various polymer resins are used for cement and concrete pipes. These pipes require protection primarily from sulfuric acid, acidic water and groundwater, and chemicals from industrial sources. Special equipment is available for sealing defective joints. Pipe repairs may be needed to stop excessive infiltration, protect pipes from interior chemical attack, correct damage already done, or to strengthen pipelines. Repair is expensive, but reconstruction is much more costly.

*Pipelines, Metal pipes, Concrete pipes, Oxidation, Corrosion, Conveyance structures, Resins, Linings, Sewers, Chemical reactions, Corrosion control, Physical properties, Chemical properties, Hydraulic structures

B071
POST-TENSIONED SEWER RIVER CROSSING,

New Zealand Engineering, Vol. 32, No. 2, p 42, February, 1977.

A major part of the main sewer drainage of the Hutt Valley, New Zealand, was recently duplicated. This project included an on-grade sewer crossing of the Hutt River at Silverstream. Previous sewers crossing the river were true siphons or pumping mains, which entailed continuous operating costs and potential pollution hazards. The availability of bedrock close to the stream bed surface was confirmed. Because of a fault zone in the area, it was decided to make the 165 meter long crossing and the manholes monolithic by post tensioning. A tidy slab with a reinforced shear key was poured on the excavated rock surface. The pipe structure was post-tensioned with eighteen multistrand cables with five vertical anchors stressed to 70 t to anchor the crossing to the bedrock. Sewage flow is carried by two 1065 millimeter diameter pipes. Design capacity is 10,900 cubic meters/hour. Overflow pipes and service ducts were included in the construction, with a river level recording channel and a modified Parshall flume to monitor total sewage flows of the Upper Hutt basin.

*Sewers, *Construction, *Engineering structures, Hydraulic structures, Pipelines, Pumping plants, Equipment, Excavation, Design criteria, Flow, Monitoring

Hutt River (New Zealand)

B072
CONSTRUCTION AND MAINTENANCE COSTS OF SEWER SYSTEMS
(Bau- und Betriebskosten von Kanalisationsanlagen),

Haendel, H.

Berichte der Abwassertechnischen Vereinigung, e.V., No. 29, p 205-219, 1976. 9 tab.

Construction, operating, and maintenance costs of sewer systems are discussed. The construction costs are influenced by such factors as topographic conditions, population density, type of ground, groundwater level, weather conditions, type and price of the pipes and other installations. Charts are presented for the determination of the specific costs of earthworks and piping. The high construction costs fully justify the use of high-quality, more or less expensive pipes to increase the life of the sewer system.

*Sewers, *Construction costs, *Maintenance costs, *Operating costs, Topography, Soil types, Population, Density, Groundwater, Construction materials, Climates, Piping, Earthworks, Cost analysis

B073
PLAIN-END PIPE 'COLLARS' PROBLEM SEWER CONNECTIONS,

Foster, W. S.

The American City and County, Vol. 92, No. 4, p 76, April, 1977.

Plain-end pipe, which has a factory-applied polyvinyl chloride or fiberglass-reinforced polyester plastic collar, may permit reductions of installation costs in sewer collection systems. The collar is molded to provide a double bead and ensure an infiltration-tight seal; the spigot end is provided with a flexible molded band, generally of urethane rubber. The bells of flared-end pipes represented the most common site of breakage in the past. Trench excavation and pipe bedding had to be very carefully executed to provide safe and proper support for these pipes. Clay pipe has many desirable properties, but the cold mastic or cement mortar previously used to join them were not sufficiently resistant to movement or infiltration. Jointing systems for clay pipes are now improved. Many suppliers of bell-and-spigot type pipes expect to offer plain-end pipe in the future, and some suppliers of plain-end pipe are listed.

*Piping, *Sewers, *Joints (connections), Clay pipes, Plastics, Infiltration, Costs, Physical properties, Chemical properties, Construction materials

Plain-end pipes

B074
IDEAS APLENTY-BUT STILL SEWERS FACE CASH NEGLECT,

Surveyor, Vol. 149, No. 4425, p 14-15, April, 1977.

Proposals from Great Britain's Water Research Centre conference on Opportunities for Innovations in Sewerage are reported. The lack of progress towards innovation in the British sewerage industry was blamed not upon a lack of ideas, but on shortages in funding. British sewer systems are greatly in need of repair. A four-point plan was outlined for improvements, involving: identification of work priorities; use of existing techniques to increase sewer life; development of new technology where applicable; and increasing the efficiency and cost-effectiveness of full reconstruction techniques. The five sections of the conference focused upon planning and design, construction and records, flow measurement and control, inflow and infiltration and maintenance and renovation. New synthetic materials for sewerage were suggested as replacements for traditional ones. These plastics provide high reliability and durability in drainage systems, rising mains, and gravity and trunk sewers. It was recommended that upgrading of sewerage systems be implemented, using available and new technologies, in order to counteract the effects of years of neglect on these systems.

*Sewers, *Maintenance, *Repair, *Construction, Economics, Planning, Costs, Construction materials, Tunneling, Flow, Measurement, Polymers, Corrosion control, Cleaning, Inspection

B075
SEABED SEWERS FOR HONG KONG,

Short, A. F.

The Consulting Engineer, Vol. 41, No. 4, p 47, 50, April, 1977.

The planned system of submarine interceptor sewers for Hong Kong was described. The system was planned to replace direct discharge to the ocean, which has caused deterioration of beaches and local waters. Rapid population increases and industrial development have made the recommended waste disposal system necessary. Oxygen levels of the city's harbor had been falling below 50% saturation. The proposed scheme uses an interceptor sewer to collect wastes from the three main North West Kowloon drainage areas and convey them to a new treatment site. Treated effluents will be discharged into the harbor's main tidal stream. The interceptor sewer would be a twin circular sewer that crosses the harbor to the treatment site. Interceptor and outfall sewers to the treatment works will be gravity sewers. A main pumping station with degritting and coarse and fine screening facilities will lift sewage to ground level and on to treatment. A high rate biological filtration system with settlement and recirculation is to be employed, and a twin outfall with diffusers will be used for effluent discharge. Sludge treatment will involve heated anaerobic digestion in covered digesters for circulation and gas collection. Sludge disposal will be by ocean dumping. Investigations are continuing for development of underwater construction by tunnelling and immersed tube techniques. The treatment facility is to be constructed on reclaimed land and the entire system must be able to withstand the worst extremes of weather, such as typhoons.

*Sewers, *Construction, *Planning, Pollution abatement, Outfalls, Waste disposal, Treatment facilities, Waste water treatment, Tunneling

North West Kowloon (Hong Kong)

B076
CONCRETE BUCKET DISTRIBUTES CRUSHED BEDDING EVENLY ON SEWER JOB,

Highway and Heavy Construction, Vol. 120, No. 4, p 32-33, April, 1977.

A bottom-dump concrete bucket was used to distribute granular bedding for a sanitary sewer line. The work was done quickly and easily in otherwise inaccessible areas. Excavation of sandy, red clay soil in Dothan, Alabama, was done with an hydraulic backhoe with a 1 1/2 cubic yard bucket. Clay and PVC pipe were used for the project which required 23,000 linear feet of sewer line and 14,000 linear feet of water pipe. The terrain ranged from open prairie to wooded with a creek. An eighteen-foot deep cut was planned near the creek. A right work area was created because many old trees could not be removed. A track loader with a bucket was used to carry granular material from the stockpile to the concrete bucket. The concrete bucket was attached to the backhoe bucket and lowered into a trench after backhoe excavation. The bucket dropped an even 12 inches of crushed bedding into the trench. After pipe connections were made, backfill operation was begun. A compactor was used to consolidate the upper 12 inches of backfill to a 100% modified Proctor.

*Sewers, *Concrete construction, Construction materials, Excavation, Concrete, Conveyance structures, Conduits, Piping, Clay pipes, Plastics

Concrete bucket

B077
CHELLASTON TRUNK FOUL SEWER. SOME INTERESTING ASPECTS OF THE SCHEME,

Fisher, R. G.

Chartered Municipal Engineer, Vol. 104, No. 4, p 53-59, April, 1977. 4 fig, 2 ref.

An increase in the population served by the sewage disposal works in Derby Borough, England, and in projected increased industrial operations created a need for development of a drainage plan. This included abolishing the old system and constructing the new Chellaston trunk foul sewer scheme. The proposed scheme involved a gravity trunk foul sewer to the borough's sewage disposal works, laid to minimum falls with a self-cleaning velocity, and routed through developing areas. This would relieve the existing overloaded system and eliminate five existing pumping stations. Design criteria were chosen to satisfy needs until the year 2000. New residential development was assumed to be on a separate system with standards for domestic properties of 0.23 cubic meters per head/day with 3.5 persons per house, and a maximum discharge of six times dry weather flow allowed for 30 dwellings per hectare. Various aspects of construction were described. These included solutions to problems created by noise, ground conditions, outfall construction, excavation processes, culvert construction, river crossings, and canal construction.

*Sewers, *Sewage disposal, Analysis, Outfalls, Design criteria, Construction, Treatment, Flow, Odor, Canals

B078
CHICAGO PLAN DESIGNED FOR POLLUTION AND FLOOD CONTROL,

Water and Sewage Works, Vol. 124, No. 5, p 50-51, May, 1977.

Construction has begun on a Chicago, Illinois, tunnel and reservoir plan for pollution and flood control. Phase one comprises storm water and sewage conveyance, storage, and purification. Ninety-one miles of 9 to 35-foot diameter tunnels at 150 to 300 feet below ground will be drilled through dolomitic rock. Phase two will provide flood control. It will involve 21.2 miles of 30 and 35-foot diameter tunnels, and storage reservoirs with a volume of 127,000 acre-feet of runoff water from a tributary area of 363.8 square miles. Total costs for the project were estimated as $1,912.4 million. The present interceptors are subject to runoff volumes 15 to 30 times that of design capacities. The planned expansions will allow storage in the tunnel system and three open-pit quarries. Combined sanitary/storm water flows would be pumped from storage and treated at the present facilities during dry weather to prevent flooding of low-lying areas and the discharge of untreated sewage into waterways. Drop shafts will interrupt sewer flow for diversion into the tunnels. Portions of the system which have been completed were described.

*Tunnels, *Reservoirs, Pollution abatement, Flood control, Storm water, Water purification, Storage, Urban runoff, Conveyance structures, Tunneling, Costs

Chicago (IL)

B079
COLLECTION SYSTEMS,

In: 1977 Public Works Manual and Catalog File, Billings, C. H., Conner, S. H., and Kircher, J. R., editors, p D2-8, 1977.

The collection system is the most expensive portion of a sewage system; therefore, its design and construction are important in order to avoid future problems with maintenance and treatment plant operation. Pipe materials, such as clay, iron, concrete, and asbestos-cement were presented with various specifications for each. These included strength, fittings, installation, and testing procedures. Linings, coatings, and other methods for prevention of corrosion and proper operation were presented. Linings for concrete sewers included polyvinyl chloride and vitrified clay. Jointing materials were briefly discussed, as were various manhole designs and materials. Septic tanks and cesspools were discussed for use in small systems where sewers were not installed. The use of flow regulators in sewers was also considered.

*Sewers, *Design criteria, *Physical properties, *Chemical properties, Construction, Maintenance, Clay pipes, Concrete pipes, Metal pipes, Plastic pipes, Joints (connections), Linings, Manholes, Construction materials, Conduits

Asbestos-cement pipes

B080
DESIGN PROPOSALS FOR SUBMERSIBLE SEWAGE LIFT STATIONS,

Kelly, H. G.

Water and Sewage Works, Reference Issue, p 76-78, 80-84, 86, 88-90, April, 1977. 12 fig, 2 tab, 18 ref.

Designs were presented for submersible sewage lift stations. Submersible lift stations are economical alternatives to larger dry well/wet well stations. They can also be used to handle flows until increased flows require larger facilities. Design factors considered were construction materials, sizing, pump types, power and controls, hydraulic conditions, operation and maintenance needs, and costs. Practical design can be achieved for flows less than 1500 gpm. Centrifugal pumps are generally used, but progressive cavity pumps and pneumatic ejectors have been used in low flow-high head applications. Concrete, fiberglass, or a protected metal are the usual construction materials, depending upon specific site, design, and construction considerations. Sizing and pump selection should be based on accurate design inflow estimations. Pumps should also perform reliably and have a good service record, as well as conform to head requirements. A friction loss equation should be derived before the selection of system components, and the system head curve should reflect its optimum solution. System hardware should be selected for ease of installation, operation, maintenance, cleaning, and repair. The well must be large enough to provide pump operation times which would prevent material accumulation and septicity. The range of liquid level controls includes float and pneumatic bubbler controls, ultrasonic echo controls, and pressure sensing tubes with time delays. Pump motors should be installed with non-overloading features. Horsepower should run out a certain percentage of the pump characteristic curve past the intended operation point. Grinder pumps provided alternatives for low flow applications. They were economical and simple, and could be used for individual homes or in a station for several homes or sources. Installation and material costs can determine the type of station constructed. Individual preference may overrule cost comparison in this selection. Operation and maintenance costs should be considered, as well as the costs of downtime.

*Hydraulic design, *Hydraulic structures, *Pumps, Sewers, Construction materials, Performance, Design criteria, Operation and maintenance, Flow rates, Costs, Control systems

Submersible lift stations

B081
SEWER MAINTENANCE AND REHABILITATION,

In: 1977 Public Works Manual and Catalog File, Billings, C. H., Conner, S. H., and Kircher, J. R., editors, p D57-D62, 1977. 1 fig.

Tests for evaluating sewer systems were presented. These were needed to maintain design performance levels of treatment plants. Public Law 92-500 provided for 75% of construction costs of interceptors and treatment plants if the applicant could demonstrate that related sewer systems were not subject to excessive infiltration/inflow. The evaluation procedures consist of an infiltration/inflow analysis and a physical evaluation survey. These must be conducted before rehabilitation can proceed. The first analysis includes area topography, soil conditions and hydrology; wet and dry weather patterns and 100-year flood crest; projected population and industrial growth and growth patterns; industrial effluent characteristics; environmental aesthetic effects of treatment facilities; mapping of collector lines and manhole inspection to determine infiltration; treatment costs of extraneous water; comparison of metered water sales and returned volume for treatment; health hazards of bypass pumping into recreational waters; and a smoke and/or dye test to locate hidden infiltration sources. The second test includes evaluation of soil cavitation; potential exfiltration/infiltration areas; visual grade variance; maintenance of way and system; qualification of damage from surface forces; and soil characteristics. The effect of groundwater conditions should also be examined. Various mechanical and chemical means for clearing obstructions from sewers were described, as well as methods for rehabilitation, such as chemical grouting and sewer relining. Maintenance and safety measures and equipment were suggested.

*Sewers, *Maintenance, *Rehabilitation, Evaluation, Hydraulic structures, Conveyance structures, Monitoring, Infiltration, Inflow, Cleaning, Chemical treatment, Equipment, Repairs, Safety, Conduits

B082
PENNSYLVANIA WASTE WATER PROJECT PROGRESSES QUICKLY,

Water and Sewage Works, Vol. 124, No. 5, p 73, May, 1977.

The Valley Forge Joint Sewerage Authority has been responsible for one of the largest American sewer projects. Nine local governments, six contractors, and seventeen contracts were involved. The project consisted of an $11 million treatment plant, a new interceptor main, and hundreds of miles of sewer pipe. Construction was 40% ahead of schedule, in spite of simultaneous Bicentennial celebrations. Good planning contributed to this success. Lines across the Valley Forge National Park were completed before the summer of 1976. Sewer construction along highways coincided with low traffic periods. Excavation was accomplished by extendable-boom drills and portable compressors, with dynamite blasting in rocky areas. Community disturbances due to drilling were minimized. About 275-325 linear feet of pipe were laid daily. Project completion was expected to be earlier than the target date set for the fall of 1977.

*Sewers, *Construction, Planning, Water districts, Equipment, Excavation, Trenches, Performance, Pipes, Hydraulic structures

Valley Forge Joint Sewerage Authority (PA)

B083
CRITICAL AND BRINK DEPTHS IN ELLIPTICAL SEWERS,

Paintal, A. S.

Water and Sewage Works, Reference Issue, p 172-173, April, 1977. 3 fig.

A method for the determination of critical depth in elliptical sewers was presented. Flow estimation involved measurement of brink depth. Brink depth was the result of a subcritical sewer flow at a free overfall critical depth upstream of the overfall. The brink depth to critical depth ratio is constant and provides a method for critical depth determination. Basic elliptical geometry was combined with mathematical expressions for the determination of critical depth and brink depth. This resulted in equations which could be used to formulate functional relationships between the two depths.

*Sewers, *Non-uniform flow, *Channel flow, *Flow rates, Subcritical flow, Overfalls, Physical properties, Conveyance structures, Mathematical studies, Equations

Critical depth, Brink depth, Elliptical sewers

B084
CITY OF MINNETONKA WING LAKE TRUNK SEWER: CITY OF MINNETONKA, MINNESOTA,

Consulting Engineer, Vol. 48, No. 5, p 89, May, 1977.

Fifteen thousand feet of 6 to 24-inch sewer and force main, and a lift station were installed as part of a trunk sewer system in Minnetonka, Minnesota. The installation was to eliminate individual soil adsorption disposal systems and sewage leaching into four lakes. An 18-inch diameter gravity sewer was placed across Wing Lake. The lake was drained and cleaned for pipe installation. Clean water from the city water system was used as refill water. Environmental effects of alternative proposals were considered. Sewer construction adjacent to the lake might have destroyed trees. Excessive groundwater movement could have resulted from trench dewatering. The lake's ability to hold water was in danger of disruption due to the breakage of bottom seals by excavation. Negative effects on aquatic life were considered when lake dewatering was investigated. Public meetings were conducted, and a biological assay provided information so that final decisions could be made. Inclusion of the public in preconstruction planning avoided possible lawsuits from those disturbed about possible environmental hazards, while providing the best solution to the extreme environmental problem of maintaining an intact lake ecosystem.

*Sewers, *Sanitary engineering, Construction, Environmental control, Excavation, Dewatering, Aquatic life, Conveyance structures, Leaching, Pipes

Minnetonka (MN)

B085
NEW SEWER SYSTEM RESISTS INFILTRATION,

Public Works, Vol. 108, No. 5, p 130, May, 1977.

Caruthersville, Missouri, has completed a sanitary sewer system which resists infiltration. The city is located along the Mississippi River and has a soil which is mostly river and glacial silt. The area also possesses a high water table. Infiltration-proof piping was needed because of its installation several feet below the water table at several points. The major requirements of piping were tight joints and beam strength which would withstand probable subsurface structural movement. Chemical bonding was used to solve the jointing problems; longer pipe lengths necessitated fewer joints. The choice of a pipe which allowed connection to house lines at random levels and increment was important. About 13,500 feet of 8-inch diameter pipe, 4,000 feet of 10-inch diameter pipe, and 1,400 feet of 12-inch diameter pipe were supplied by the Armco Steel Corporation. Another 5,300 feet of 4 and 6-inch diameter extra-strength, solid wall ABS pipe were used in reconnecting house lines.

*Sewers, *Infiltration, *Flooding, Design, Pipes, Construction materials, Sanitary engineering, Joints (connections), Chemical properties, Physical properties, Design criteria, Metal pipes, Plastic pipes

Caruthersville (MO)

B086
A NOTE ON SEWER DESIGN,

Swamee, P. K., and Grewal, N. S.

Roorkee University, India, Department of Civil Engineering.

Indian Journal of Environmental Health, Vol. 19, No. 1, p 69-72, January, 1977.
1 fig, 2 ref.

A method has been devised for the design of circular sewers to handle partially full flow conditions. Determinations are made for design parameters without any trial and error procedure. Parameters of known value, such as discharge, bed slope, and Manning's roughness coefficient n, are used to determine sewer radius, average flow velocity, and flow depth. Equations and a sample solution are provided to illustrate the process.

*Sewers, *Design criteria, Hydraulic design, Conveyance structures, Structural design, Flow, Mathematical studies, Equations, Conduits, Waste water treatment

B087
HYDROGEN PEROXIDE CONTROLS ODOR, CORROSION IN COLLECTION SYSTEMS,

Matthews, D. G.

Water and Sewage Works, Vol. 124, No. 6, p 52-54, June, 1977. 1 ref.

A review was presented of efforts to control concrete sewer corrosion in Corpus Christi, Texas. Experiences were related concerning one line using pipe factory-coated with Polycor Enamel and carrying flows of nearly one-half its diameter. Corrosion was noted soon after completion, and attributed to the reduction of inorganic sulfates and organic compounds to hydrogen sulfide or the hydrosulfide ion by anaerobic bacteria. The hydrogen sulfide combined with oxygen to form water and sulfur. Thiobacillus bacteria converted the sulfur to sulfuric acid, which combined with calcium oxide in the concrete to form calcium sulfate. The resultant porosity of the structure allowed sulfuric acid penetration of the sewer pipe. Several correctives were considered. Replacement with smaller diameter clay pipe at steeper grades using lift stations was too costly and disruptive. Sliplining the pipe with a polyethylene liner and injecting air into the sewage for bacterial control were discussed. Chlorine could be added to end sulfide production or to oxidize hydrogen sulfide rapidly. High chlorine levels would be required to destrov bacterial colonies. Hydrogen peroxide, originally suggested for odor control, was chosen for testing. It was injected into the collection system well before the concrete component. Sulfides were undetectable for three miles and then reached a concentration of 1 ppm. Concentrations reached 12 ppm at the end of the line. Feed rates were increased in summer to control higher sulfide concentrations. The city found that the best solution would be hydrogen peroxide addition, unless polyethylene sliplining could be federally funded.

*Concrete pipes, *Corrosion control, *Odor, *Hydrogen sulfide, *Anaerobic bacteria, *Linings, Chlorination, Oxidation, Equipment, Conveyance structures, Sewers, Sewage treatment, Sewage effluents, Waste water treatment

Corpus Christi (TX)

B088
SUBMERSIBLE PUMPS SPEED SEWAGE FLOW,

Ransom, J. E.

The American City and County, Vol. 92, No. 6, p 70, June, 1977.

Rapid community and area growth and overloaded pumping stations created sewage handling problems in Florence, Kentucky. A modified activated sludge process package plant was constructed to support the original facility. In the mid-1960s, the three original pumping stations suffered from frequent breakdowns and flooding. These were converted to electrical submersible pumps, which were also used in the nine stations subsequently constructed. Station capacity can be increased by changing impellers or adding another pump. Equipment failure due to flooding has been eliminated because the pumps operated submerged normally. No major problems have since occurred, and maintenance and inspection have been simplified. City regulation of pumping station construction has standardized equipment and contributed to the simplification of inspection and maintenance.

*Pumping plants, *Pumps, Equipment, Sewers, Treatment facilities, Sewage effluents, Regulation, Planning, Cities, Urban areas, Performance, Maintenance, Inspection, Waste water treatment

Florence (KY)

B089
COLLECTION, TREATMENT AND REUTILIZATION OF WASTE WATERS IN ARID ZONES OF THE MIDDLE EAST,

Roberts, D. G. M., and Banks, P. A.

John Taylor and Sons,
Consulting Engineers,
London, England.

Proceedings of the Institution of Civil Engineers, Part 1, Vol. 62, p 209-219, May, 1977. 3 tab, 5 ref.

Local influences on the design and operation of Middle Eastern sewer systems were examined. Waste treatment and water reuse were also discussed. Major problems result from high temperature, low rainfall, and the predominantly sandy ground surface. The temperature in sewers can reach 35 C which quickly produces septicity, especially in rising mains. The resultant H2S can cause severe corrosion. Design features which may ease the problems were: good gradients, small capacity pumps, restricted sump sizes, and short rising mains. Highly technological solutions were avoided. Linings and coatings which have been used successfully include coal tar epoxy, pure epoxy resins, and glass reinforced plastic. The use of expensive, non-corrosive pipes was frequently justified. Provisions should be made for heavy rainfall as most areas do not have storm sewers. Ingress of groundwater into house connections should be avoided to prevent sewer system overloading. The effectiveness of various treatment systems was evaluated and recommendations made as to their applicability. Careful handling and treatment were suggested for water reuse schemes. Use as industrial process water or orchard and agricultural irrigation water was recommended to prevent public health problems. Waste disposal and the economics of sewer systems and treatment facilities were briefly reviewed.

*Sewers, *Design criteria, *Environment, *Corrosion control, *Linings, Pipes, Corrosion, Pumps, Conveyance structures, Treatment facilities, Waste disposal, Precipitation (atmospheric), Water reuse, Waste water treatment

Middle East

B090
PVC SEWER PIPE SURVIVES DEEP BURIAL,

The American City and County, Vol. 92, No. 5, p 89-90, May, 1977.

Polyvinyl chloride (PVC) sewer pipe was successfully installed by Genge/Meurer, Serafini and Meurer, Incorporated, of Denver, Colorado, in a 42-foot deep trench. Proper bedding and control of the trench width were able to minimize deflection. The achievement of a 90% Standard Proctor Compaction or better around the sides of the pipe allowed transmission of the load from the pipe to the trench wall. The bedding also had to permit water to percolate through to avoid deterioration and excessive deflection. A composite material of gravel with minimal sand and no clay was used as bedding. Washed rock was placed on the sides of the pipe and crushed rock with dirt and fine sand was used on top of the pipe. The project described used 15-inch diameter pipe in 12 1/2-foot sections. The pipe allowed easy and fast joint assembly. A Ring-Tite joint, made of a rubber ring seated in the ring groove of the pipe's bell end, was used. The joint, tight and leakproof, also allowed for deflection. The most severe deflection in the 2200-foot length of pipe was 3 1/2%.

*Pipes, *Sewers, Plastics, Construction materials, Pressure, Design criteria, Conduits, Conveyance structures, Loads (forces), Joints (connections)

B091
KEEP MAINTENANCE IN MIND WHEN DESIGNING OR USING PUMPS,

Bright, R. D.

Water and Wastes Engineering, Vol. 14, No. 5, p 62-65, May, 1977. 6 fig.

The proper choice and placement of pumps can reduce costs and increase dependability and economy of sewage handling systems. Several useful steps were recommended. Provision should be made for maintenance in the initial phases of system design. Pumping systems should be adapted to handle current volumes to maintain efficiency. Pump suction conditions should be accurately determined. The equipment should be scheduled for maximum running time. Effective maintenance programs and personnel training should also be provided.

*Pumps, *Maintenance, *Operations, *Performance, Sewers, Hydraulic equipment, Design, Optimization, Equipment, Personnel, Waste water treatment

B092
EXTENSIVE COLLECTION SYSTEM HIGHLIGHTS $30 MILLION POLLUTION CONTROL PROGRAM,

Water and Wastes Engineering, Vol. 14, No. 5, p 35-38, May, 1977.

A $30-million waste water collection and treatment project is nearing completion in Haverhill, Massachusetts. The project selected, one developed by Camp Dresser and McKee, follows an intermediate plan and will be able to handle treatment of all dry weather waste water flows. Excess flows during rainfall and snowmelt will be diverted to the Merrimack River. Other collection approaches--separation of storm water and waste water or treatment of all collected water--were rejected as too costly and disruptive. The 18 mgd capacity of the activated sludge facility will meet the needs of the city's estimated 1985 population (48,500) and also those of nearby Groveland. The plant is designed to treat wastes of paper, tannery, and textile manufacturing as well. Construction has also included two major intercepting sewers on either side of the dividing river, and three inverted river crossings conveying waste water to the south bank where a 30 mgd peak capacity pumping station is being built. Treatment processes will include screening, primary sedimentation, aeration, final sedimentation, and chlorination.

*Waste water treatment, *Municipal wastes, Sewers, Sewage systems, Industrial wastes, Interceptor sewers, Planning, Design, Costs

Haverhill (MA), Merrimack River

B093
GROUT ROUTS SEWER PROBLEMS,

Sweeney, C. G.

Metropolitan Sewer District,
St. Louis, Missouri.

Water and Wastes Engineering, Vol. 14, No. 5, p 59-60, May, 1977.

The St. Louis Metropolitan Sewer District, established in 1954, was an early experimenter with TV inspection and grouting for sewer line maintenance. The district, a consolidation of 90 municipalities, towns, and unincorporated areas, continues to show great success in the use of these techniques. The district requires efficient use of funds, equipment, and manpower for upkeep of its complex system. Two TV inspection/grouting units are now on daily operation. While they are a direct and effective approach for handling emergencies, they are largely deployed for preventive maintenance. Areas of heavy infiltration/inflow are identified for inspection by the units. Sources of inflow are pinpointed by TV inspection and dye testing. A "pump until no acceptance" formula is used, restricting to 5 or 6 gallons the maximum amount of grout--a viscous acrylamide gel--that is generally required. Costs of chemical grouting are estimated to be 1% that of repair by other methods. Inspections carried out six months after every grouting have never revealed any evidence of breakdown or deterioration.

*Municipal wastes, *Grouting, *Pipes, *Repairing, *Maintenance, Municipal wastes, Waste water treatment, Sewers, Sewer systems, Costs

Television inspection, St. Louis (MO)

B094
EPA INDEXES SHOW COSTS RISING AT QUICKER PACE,

Engineering News Record, Vol. 198, No. 25, p 120, June, 1977. 1 tab.

Compilations made by the Environmental Protection Agency (EPA) on municipal waste water treatment plants and urban sewer system construction costs have shown that costs have risen from about 1% to over 2% during the first part of 1977. Sewer construction costs were 105% higher during the first quarter of 1977 than during the five-month total for 1976, with the rate of increase for the complete urban sewer system being the greatest. Comparisons of sewage treatment plant and sewer construction cost indexes for 5 mgd municipal waste water treatment facilities in 25 cities, 50 mgd treatment facilities in 25 cities, and complete urban sewer systems are presented.

*Cost analysis, *Cost comparisons, *Construction costs, *Sewage treatment, *Waste water treatment, Sewers, Cost trends, Water costs

B095
PROGRAM HOPES TO REDUCE POLLUTION FROM SEWER OVERFLOW,

Water and Wastes Engineering, Vol. 14, No. 5, p 32, May, 1977.

A study being conducted by the Onondaga County Department of Drainage and Sanitation was originated to develop an abatement program for overflow discharges into Onondaga Lake by the city of Syracuse, New York. An examination of quantity/quality relationships, measurements, projections, and assessment of the impact of overflows on receiving waters led to the development of a four-step plan of action. This plan included the definition of major drainage areas, studies on selected overflow sites using automatic sampling and flow monitoring equipment, and verification of a model to be used for overflow and pollutant loading prediction. During an overflow, samplers are automatically activated by a relay system in the flow monitoring equipment and samples are taken at predetermined intervals. Following the overflow, samples are collected for laboratory analysis, as these overflow discharges may contain a heavy load of oxygen-demanding matter, suspended solids, bacteria, and viral organisms.

*Stormflow, *Combined sewers, *Overflow, *Drainage systems, *Sewerage, Municipal wastes, Sewage disposal, Effluents, Storm drains, Storm water, Water pollution sources, Urban drainage, Urban runoff, Waste water treatment

Syracuse (NY), Onondaga Lake (NY), O'Brien & Gere Engineers

B096
SEWERS UNDER ATTACK: THE HYDROGEN SULPHIDE PROBLEM,

Pullin, J.

Surveyor, Vol. 149, No. 4433, p 12, May 27, 1977.

Hydrogen sulfide can be produced in sewage under anaerobic conditions by the reduction of sulfate, or in sewers containing dissolved oxygen but having a layer of biological slime coating the sewer pipe wall. The hydrogen can be then oxidized in the presence of Thiobacillus concretivorus to sulfuric acid which can cause considerable damage to sewer pipes. Factors influencing the rate of H2S build-up include oxygen concentration, temperature, and concentrations of sulfate and organic matter in the sewage. Increased temperatures and decreased oxygen concentrations increase sulfide production. The resistance of various pipe materials to attack by sulfuric acid is examined. Although vitrified clay pipes are resistant to corrosion, cast iron, steel, and concrete pipes will deteriorate unless other preventive measures are taken. Use of plastic liners for sewer pipes, periodic treatment with caustic soda or lime, and application of chlorine are suggested as methods for reducing corrosion.

*Hydrogen sulfide, *Sulfur compounds, *Pipes, *Anaerobic conditions, *Corrosion, Corrosion control, Chemical degradation, Sewers, Pipe flow, Waste water treatment

B097
WASTEWATER COLLECTION,

Singh, T., and Bhutani, J. S.

H. D. Nottingham and Associates, Incorporated,
McLean, Virginia.

Journal Water Pollution Control Federation, Vol. 49, No. 6, p 1074-1078, June, 1977.
55 ref.

Various methods developed during 1976 for the collection of waste water are reviewed. An evaluation of general sewerage problems and future waste water treatment needs for New York City is given. Design criteria are described for the construction of storm retention basins, combined sewer systems, and other waste water collection and storage systems. The use of plastic pipes for highly corrosive and abrasive waste water flows is evaluated. Inspection, monitoring, and maintenance are considered for the safer, more efficient operation of waste water systems. Recent monitoring techniques for characterizing infiltration/inflow in a continuing program of sewer maintenance are evaluated. Experiences of various municipalities in the use of polyethylene pipe insertion for the correction and prevention of infiltration/inflow problems by sewer rehabilitation or new construction are related. Maintenance techniques and applications presented include television monitoring of newly installed sewer lines, chemical treatment to retard the growth of tree roots in sewers, and standardization of inflow/infiltration measurements using hydrographic analysis. A design for a waste water lift pump designed to handle larger flows is described. Sewer system rehabilitation and maintenance is mentioned as a cost-effective method of increasing treatment plant capacity.

*Combined sewers, *Infiltration, *Inflow, *Plastics, *Maintenance, Storm drains, Sewerage, Sanitary engineering, Municipal wastes, Urban runoff, Storm runoff, Maintenance costs, Waste water treatment, Rehabilitation, Replacement costs, Construction, Construction materials, New York

Tampa (FL), Grand Rapids (MI), Bossier City (LA), Montclair (NJ)

B098
HOW TO CONDUCT A WASTEWATER SURVEY, PART I - IDENTIFYING PHYSICAL CHARACTERISTICS OF SEWER SYSTEMS,

Vernick, A. S.

Burns and Roe
Industrial Services Corporation,
Paramus, New Jersey.

Plant Engineering, Vol. 31, No. 14, p 85-87, July, 1977. 5 fig.

A method for conducting a waste water survey is outlined as an important aspect in developing more efficient waste water management programs. This part of a two part series emphasizes identification of the physical characteristics of sewer systems. The first part of the survey would entail the compilation and review of a complete drawing file of all plans and schematic diagrams that relate to the plant's sewer systems and water supply. Observations should be made on the plant's sanitary sewage system, storm water collection and disposal facilities, and process drainage systems. The next part of the survey would require field investigation to confirm and augment information provided by the drawing file. Specific objectives would include: the characterization of plant design, layout, and waste sources; sampling point selection; and familarization with sewer, collection, and disposal systems. A complete identification of the physical characteristics of a sewer system aids in the preparation of updated sewer maps, flow diagrams, and individual waste stream profiles.

*Waste water treatment, *Surveys, *Waste treatment, *Sewerage, *Facilities, Waste water (pollution), Storm drains, Drainage systems, Management, On-site investigations, Basic data collections, Water quality control

B099
DUCTILE IRON PIPES TO CARRY WIMBLEBALL WATER,

Water Services, Vol. 81, No. 976, p 368, June, 1977.

The Stanton and Stavely Group of British Steel Corporation's Tubes Division is furnishing 4500 tons of ductile spun iron pipes to the Wessex Water Authority for the construction of trunk mains to the Wimbleball Reservoir. Pipe supplied includes 15,683 m of pipe in the 600 mm to 250 mm diameter range fitted with Tyton joints, and 13,789 m of 700 mm diameter pipe fitted with Stantyte joints. Construction of Wimbleball Reservoir is scheduled for completion by the end of 1977. The completed reservoir will service the Wessex and South West Water Authorities.

*Metal pipes, *Joints (connections), *Reservoir construction, *Water treatment, Reservoirs, Pipelines, Pipes, Waste water treatment

*Ductile iron pipes, *Wessex Water Authority (UK), Tyton joints, Stantyte joints

B100
NORTH EAST SEWERAGE SCHEMES, PUMP CONTRACTS,

Water Services, Vol. 81, No. 976, p 368, June, 1977.

The Northumbrian Water Authority in England has awarded two contracts to Sigmund Pulsometer Projects Ltd. for the supply and installation of pumping equipment at Browns Point, Whitley Bay and for construction of a new sewage treatment plant at Sunderland. The Browns Point pumping station will contain three Hidrostal vertical pump sets, three disintegrator pumps, a submersible pump, and a washwater booster unit. The Sunderland sewage works will be used for sewage treatment prior to ocean discharge of effluent.

*Treatment facilities, *Pumping plants, *Interceptor sewers, *Sewage treatment, *Pumps, Sewerage, Waste water treatment

*Northumbrian Water Authority (UK), Sunderland (UK), Browns Point (UK)

B101
THE USE OF BACTERIA TO REDUCE CLOGGING OF SEWER LINES BY GREASE IN MUNICIPAL SEWAGE,

Baig, N., and Grenning, E. M.

The Maryland-National Capital Park and Planning Commission, Silver Spring, Maryland.

In: Biological Control of Water Pollution (ed. Tourbier, J., and Pierson, R. W. Jr.), University of Pennsylvania Press, 1976. p 245-252, 4 tab, 5 ref.

An alternative to traditional cleaning and removal of grease from sewers by mechanical means is described. Packaged freeze-dried bacteria cultures are reactivated in water and added to sewer mains and laterals through manhole covers. Accumulated grease is consumed and organic material, removed from the sewer walls, flows to the treatment plant. After initial grease deposits are removed, low-dosage applications are used to prevent further accumulation. The use of bacteria cultures for removal is suggested as a much less costly alternative to mechanical cleaning. Cost projections for sewer cleaning in Montgomery and St. George's Counties, Maryland were placed at $4 million for traditional cleaning methods and $1.3 million for bacterial treatment. Bacterial cultures may also provide pretreatment of sewage as it flows through the collection system. Information on municipalities currently using bacterial cleaning is given, including population size, providing organization, system characteristics, and user experiences.

*Biological treatment, *Bacteria, *Cultures, *Sewerage, *Sewers, Manholes, Organic wastes, Decomposing organic matter, Maintenance costs, Treatment, Cleaning, Sewage bacteria, Sewage treatment, Municipal wastes, Microbial degradation, Drainage systems, Waste water treatment

*Sewer maintenance, Degreasers, Perry (FL), St. George County (MD), Montgomery County (MD)

B102
COST ESTIMATING MANUAL--COMBINED SEWER OVERFLOW STORAGE AND TREATMENT,

Benjes, H. H., Jr.

Culp, Wesner, Culp, El Dorado Hills, California.

1976. 133 p, 30 ref, 19 tab, 72 fig, 2 append. Technical Report EPA-600/2-76-286.

Cost estimates for various processes associated with storm water treatment have been prepared according to plant size (5-200 mgd) and storage capacity (1-240 mgd). Fourteen process functions are examined: swirl flow regulator/concentrator, horizontal shaft rotary screen, stationary screen, vertical shaft rotary screen, air flotation, chlorination, granular media filtration, storage, flocculation, sedimentation, chemical feed systems, raw sewage pumping, sludge pumping, and flow measurement. Graphical presentations relate labor, capital, operation, and maintenance costs and energy requirements to process design and capabilities. A method of projecting construction costs according to inflation rates and time of construction is presented. Examples of cost estimates for various processes are presented.

*Storm water, *Estimated costs, *Capital costs, *Cost analysis, *Energy, *Combined sewers, Costs, Overflow, Sewage treatment, Operating costs, Construction costs, Waste treatment, Sewerage, Treatment facilities, Waste water treatment

B103
SURGE ARRESTOR CONTROLS FLORIDA SEWAGE,

Water and Wastes Engineering, Vol. 14, No. 7, p 55, July, 1977.

The Boca Ciega Cross State Sewage Transmission System, servicing the St. Petersburg/ Tampa Bay area in Pinellas County, Florida, has begun using a hydro-pneumatic surge arrestor to control pressure fluctuations and prevent rupture of thin-walled sewer piping from the shock pressures of pump start-up and shutdown. The vented surge arrestor, furnished by Greer Hydraulics, Inc., is designed to limit maximum surge pressure at the Lake Seminole master lift station to 83 psig, thereby controlling shock pressures in the system's 14,000 feet of thin-walled piping.

*Sewerage, *Pipes, *Flow, *Equipment, *Pressure, Sewers, Hydraulic structures, Waste water treatment

Pinellas County (FL), St. Petersburg (FL), Tampa Bay (FL)

B104
EASING THE BURDEN ON TREATMENT WORKS,

Effluent and Water Treatment Journal, Vol. 17, No. 6, p 275, June, 1977.

Extension of sewage treatment plant facilities by modification of sewer mains has been considered by the Water Research Center, Wessex Water Authority, and British Oxygen Company, Ltd., in the United Kingdom. A large-scale application of the principle is being tested for a five-mile stretch of pumping main between Bath and Saltford. In this section, sewage became anaerobic and more difficult to treat at the already overloaded treatment plant. An oxygen injection system was used to establish aerobic conditions in the sewer main, allowing aerobic bacteria to partially digest sewage before it arrives at the sewage treatment plant.

*Treatment facilities, *Sewerage, *Anaerobic conditions, *Aerobic treatment, *Sewers, Aerobic bacteria, Sewage treatment, Pipes, Oxygenation, Aeration, Waste water treatment

Wessex Water Authority (UK), Bath (UK), Saltford (UK), Water Research Center (UK)

B105
WATER QUALITY, CONDUITS, AND GEOMETRICS,

1975. 41 fig, 9 tab, 28 ref, 1 append. (ed. Silberman, J.) Transportation Research Record 556, Technical Report PB 251 101.

These four articles dealing with urban runoff and storm water conduits were prepared for the 54th annual meeting of the Transportation Research Board. A testing program in Milwaukee, Wisconsin, for quality of storm water runoff from urban freeways is described. The use of composite construction of conduits for sewer systems is investigated. Failure analyses for an unreinforced concrete conduit are presented. A method of curve design to be used in highway construction is also described.

*Conduits, *Storm water, *Highways, *Concrete pipes, *Sewers, Structural analysis, Structural engineering, Urban runoff, Water quality, Data collections, Cities

Transportation Research Board

B106
COMPOSITE CONDUIT CONSTRUCTION FOR LOWER COST
INSTALLATIONS AND IMPROVED PERFORMANCE,

Breitfuss, T. K.

In: Water Quality, Conduits, and Geometrics. Transportation Research Record 556, p 6-19, 19 fig, 2 tab, 8 ref.

The use of conduits having a thin-shelled core surrounded by a supporting medium such as concrete or a combination of concrete and soil-cement are discussed. Prior to studies on composite construction, shear transfer capacities were examined for various bonding agents. Comparative analyses for eight composite configurations having different modes and degrees of encasement with soil-cement, dense sand, and concrete were based on calculations of moment, thrust, shear, and earth load. The allowable load and design criteria for open-topped conduits, soil-cement or unbonded concrete as a surrounding medium, and full encasement with bonded concrete were discussed. Field tests showed that thin-cored composite conduits would greatly limit vertical deflections for backfill of almost any height.

*Conduits, *Concrete pipes, *Structural engineering, *Stress analysis, *Strength of materials, Shear strength, Pipes, Engineering structures, Sewers, Model studies

Composite conduits

B107
FAILURE OF A CAST-IN-PLACE UNREINFORCED CONCRETE CONDUIT,

Chang, J. C.

In: Water Quality, Conduits, and Geometrics. Transportation Research Record 556, p 25-34, 12 fig, 5 tab, 5 ref.

A structural analysis of the failure of a 72-inch cast-in-place, unreinforced concrete conduit at the toe of a highway embankment near San Dimas, California is presented. Soil analyses of backfill were used to determine soil shear strength by triaxial compression tests. Earth pressures on the conduit due to local overburden and highway embankment load were calculated. The distribution of internal hydrostatic pressure on the water-filled conduit was examined. Analyses of moment, thrust, and shear due to internal and external loads were performed. Results indicated that failure was due to the additional lateral load from the highway embankment which caused the upper half of the conduit to be sheared off. The conduit was subsequently replaced with a class 4, double-caged, reinforced pipe.

*Conduits, *Structural analysis, *Structural engineering, *Failures, *Stress analysis, *Concrete pipes, Strength of materials, Pipes, Sewers, Concrete testing, Overburden, Soils, Shear stress

San Dimas (CA)

B108
HANDBOOK FOR SEWER SYSTEM EVALUATION AND REHABILITATION,

1975. 228 p, 47 fig, 25 tab, 17 ref, 4 append. Technical Report EPA-430/9-75-021.

A manual to assist in the preparation and review of infiltration/inflow analyses and sewer system evaluation surveys is presented. Construction grant regulations imposed by the Federal Water Pollution Control Act Amendments of 1972 are discussed with respect to sewer system evaluation and rehabilitation. A user's guide to the handbook is presented. Methodology for conducting infiltration/inflow analysis, representative data, and work sheets are provided. Aspects of a sewer system evaluation survey are described, including a physical survey, rainfall simulation, preparatory cleaning, internal inspection, and the survey report. Excavation/replacement, chemical grouting, pipe lining with polyethylene pipe, pipe lining with fiberglass-reinforced polyester mortar pipe, and pipe lining with cement mortar and epoxy mortar are examined as methods of sewer rehabilitation. Representative costs for sewer system evaluation and rehabilitation are presented.

*Infiltration, *Sewerage, *Pipes, *Inflow, *Sewers, *Evaluation, Analytical techniques, Model studies, Sewage treatment, Surveys, Rehabilitation, Costs, Waste water treatment

*Sewer system evaluation, Sewer system rehabilitation, Infiltration/inflow analysis

B109
EPA SETS RULES ON 'INELIGIBLE' SEWERS,

The American City and County, Vol. 92, No. 8, p 13, August, 1977.

The U. S. Environmental Protection Agency has limited the availability of construction funds for sewage collection systems, restricting grants to applications where the lack of such a system has serious public health implications and other methods of sewage collection and treatment are not as cost-effective. Population density criteria established in 1972 limit the allocation of EPA funds for sewage system construction to areas with a population density of more than 1.7 persons per acre. Current EPA grant application regulations require the applicant to demonstrate that a collection system is more cost-effective than septic tanks, holding tanks, "honey wagons", or aerated mounds for areas where the population density is less than 10 persons per acre.

*Sewerage, *Septic tanks, *Legislation, *Sewage treatment, *Cost-benefit analysis, Construction, Sewers, Environmental sanitation, Waste water treatment

Construction grants

B110
HEAVY RAINS, POOR SOIL FORCE INTERNAL SEWER REPAIR,

Engineering News Record, Vol. 199, No. 8, p 20, August, 1977.

A $1 million sewer repair project directed by Smith, Miller Associates (SMA) of Kingston, Pennsylvania was financed by the Federal Disaster Assistance Administration after tropical storm Eloise caused a rupture in an 800-ft-long combined sewer near Wilkes-Barre, Pennsylvania in 1975. The sewer transports 3.5-4.0 mgd of sanitary sewage from southern Wilkes-Barre to the Wyoming Valley Pumping Station and eventually to the Horton treatment plant. For an investigation of the damage to the sewer line, sewage was rerouted from the 42-inch Barney Farm sewer line through 10-inch pipes running parallel to the interceptor. After dewatering and cleaning of the sewer line, the interceptor ruptured again. A steel and concrete casing was placed around the sewer line at the site of the initial rupture and cleaning began again. Heavy rains again produced infiltration and ruptures during the fall of 1976. SMA then began using a high-velocity vacuum system to clean the sewer pipe. External grouting had to be used to stop excessive infiltration until the waters of the Susquehanna River receded enough to begin internal reinforcement of the sewer by spray application of concrete. Where infiltration could not be controlled by internal spraying, grout was pumped to the outer surface of the pipe through 1.5-inch plastic pipes. Repeated rainfall, unstable soil conditions, and high water levels resulted in a final cost for the 20-month project of $972,000.

*Sewers, *Infiltration, *Grout curtains, *Cement grouting, *Combined sewers, Interceptor sewers, Sewerage, Construction costs, Repairing, Pipes, Concrete pipes, Rehabilitation, Waste water treatment

Wilkes-Barre (PA)

B111
CATCHBASIN TECHNOLOGY OVERVIEW AND ASSESSMENT,

Lager, J. A., Smith, W. G., and Tchobanoglous, G.

Metcalf and Eddy, Incorporated,
Palo Alto, California.

1977. 129 p, 36 fig, 31 tab, 121 ref, 3 append. Technical Report EPA-600/2-77-051.

A survey of technical and economic information on catchbasins was conducted to enable more efficient planning and decision-making for urban runoff and collection systems. The report includes: a state-of-the-art review, a review of variables affecting catchbasin efficiency, hydraulic modeling analyses, an assessment of the role of catchbasins, an economic evaluation of alternative storm and combined sewer designs, and a review of recent developments and continuing program needs. The state-of-the-art survey provides background information on catchbasin design, maintenance, and use. Hydraulic modeling analyses indicate that catchbasins could effectively remove medium to very coarse sands from storm water runoff. Removal efficiency increases with increased particle size, decreasing flow velocity, and increased basin depth. Catchbasin cleaning is recommended when solids content exceeds 40-50% of the storage depth. A survey on existing catchment basins indicated that mixed performance for the 1,750,000 catchment basins in the United States is probably due to underfinanced and poorly monitored programs. Major alternatives to the use of catchment basins are sewer and street cleaning, the use of inlets and flow-attenuation devices, and separate storm water storage. Recommendations from this study include further evaluation of cost effectiveness, more accurate records of catchment performance, and field scale demonstrations of catchbasin cleaning programs.

*Storm water, *Urban runoff, *Watersheds (basins), *Operation and maintenance, *Suspended solids, Design criteria, Sewers, Combined sewers, Water pollution control, Urban drainage, Waste water treatment

PATENTS

C001
SUSPENDED SLUDGE SCRAPER FOR ARCUATE SEDIMENTATION ZONE,

Pelton, J. F.

Union Carbide Corporation,
New York, New York. (assignee)

United States Patent 3,977,974. Issued August 31, 1976. Official Gazette of the United States Patent and Trademark Office, Vol. 949, No. 5, p 2027-2028, August, 1976. 1 fig.

A patent for a waste water treatment device that allows for separation of solids from the liquid in a sedimentation zone is described. The device consists of two circular concentric walls spaced apart to form an intermediate volume. A first radial partition extends across the intermediate volume and is joined at opposite edges to the inner and outer walls, while a second radial partition is similarly located and spaced from the first partition to form an arcuate sedimentation zone. Means for introducing a liquid-solid feed in the arcuate sedimentation zone are provided to achieve a solids-depleted liquid in the upper part of the zone and a layer of settled solids in the bottom part of the zone. Means are also provided for discharging the solids-depleted liquid from the upper zone and for collecting the settled solids from the bottom part of the zone. The solids collection means include a mechanically driven bridge which moves in an arcuate path around the arcuate sedimentation zone and a scraper blade extending transversely across the sedimentation zone at the bottom thereof.

*Patents, *Waste water treatment, *Separation techniques, *Sludge, *Sedimentation, Equipment, Waste treatment, Solid wastes, Liquid wastes, Design criteria

C002
METHOD OF BIOLOGICAL PURIFICATION OF SEWAGE,

Tholander, B. K., and Krarup, S.

Akvadan A/S, Denmark. (assignee)

United States Patent 3,977,965. Issued August 31, 1976. Official Gazette of the United States Patent and Trademark Office, Vol. 949, No. 5, p 2024, August, 1976. 1 fig.

A patent for a four-phase biological sewage treatment process is described. During the first phase raw sewage is fed to the first of three tanks in series, with nitrification and denitrification occurring in the first tank during different portions of the first phase. Sewage in the second tank undergoes denitrification and sewage in the third tank is clarified. Raw sewage in a second phase is fed to the second tank for nitrification and transferred to the third tank for clarification, while sewage in the first tank (uncoupled) undergoes nitrification. The second tank is then used as the first tank in a three tank series arrangement during a third phase where nitrification and denitrification occur during different portions of the phase in the second tank. Sewage in the first tank also undergoes nitrification, while sewage in the third tank is clarified. During a fourth phase, after the uncoupling of the last arrangement, raw sewage is fed to the first tank and then transferred to the third tank for nitrification and clarification treatment in the two tanks, respectively. Sewage in the uncoupled second tank undergoes nitrification. After the fourth phase, the tanks are rearranged according to the first series arrangement, and the method is repeated.

*Patents, *Sewage treatment, *Biological treatment, *Nitrification, *Denitrification, Waste water treatment

C003
CLARIFICATION PLANT,

Kaelin, J. R.

United States Patent 3,979,294. Issued September 7, 1976. Official Gazette of the United States Patent and Trademark Office, Vol. 950, No. 1, p 265, September, 1976. 1 fig.

A patent for an activated sludge clarification plant is described which provides for recycling of the activated sludge. The plant consists of at least one gas-tight activation tank provided with a surface ventilation rotor, a reclarification tank, inlet means for supplying sewage to the activation tank, and outlet means for conducting activation sewage to the reclarification tank. A conduit with one of its ends vertically oriented in the activation tank directly below the surface ventilation rotor is connected at its other end to the reclarification tank for recycling activated sludge concentrate from the reclarification tank to the activation tank. An outlet aperture in one end of the conduit is located in the suction zone of the surface ventilation rotor such that the activated sludge in the conduit is sucked upward through the surface ventilation rotor zone. Means are also provided for supplying pure oxygen to the other end of the conduit for application to the concentrated recycled activated sludge prior to the sludge's entry into the surface ventilation rotor.

*Patents, *Activated sludge, *Biological treatment, *Sewage treatment, *Recycling, Oxygenation, Design criteria, Equipment, Waste water treatment

C004
APPARATUS FOR THE PURIFICATION OF EFFLUENT,

Boulenger, P.

L'Air Liquide, Societe Anonyme pour
l'Etude et l'Exploitation des Procedes Georges
Claude, Paris, France. (assignee)

United States Patent 3,979,293. Issued September 7, 1976. Official Gazette of the United States Patent and Trademark Office, Vol. 950, No. 1, p 265, September, 1976. 1 fig.

A patent for a waste water purification apparatus that employs oxygenation and activated sludge treatment is described. The apparatus includes: an uncovered main treatment tank which contains a suspension of biologically activated sludge in the waste liquid, an inlet receptacle which is separate from the main treatment tank and contains a waste/sludge mixture, a preliminary oxygenation chamber which ensures flow from the inlet receptacle to the main treatment tank, a means for injecting oxygen-enriched gas into the waste/sludge mixture, and a means for recycling at least a portion of non-dissolved oxygen-enriched gas which is recovered in a gas-accumulation receiver.

*Patents, *Waste water treatment, *Activated sludge, *Oxygenation, *Biological treatment, Liquid wastes, Recycling, Equipment, Design criteria, Waste treatment

C005
FREEING WASTE WATER FROM NITROGENOUS CPDS - USING PARTIALLY OXIDISED SLUDGE AS SOURCE OF ORGANIC CARBON,

South African Patent ZA 7505-682. Issued September 5, 1975. Derwent French Patents Abstracts, Vol. X, No. 37, p D2-D3, August, 1976.

A patent for a process that removes nitrogen compounds from waste water is described. The process involves mixing the waste water with active nitrifying organisms and an oxygen-containing gas to convert the nitrogenous material to the nitrate form. The nitrifying organisms and accumulated biomass are then separated from the waste water and recycled to the nitrification contacting step. A portion of the accumulated biomass is either periodically or continuously removed from the nitrifying step. The nitrified waste water is then contacted with heterotrophic denitrifying bacteria in the presence of a source of organic carbon to reduce nitrate nitrogen to elemental nitrogen. The denitrifying organisms and accumulated biomass are separated from the waste water and recycled to the denitrification step, with a portion of the accumulated biomass being either periodically or continuously removed from the denitrifying step. The process is improved by heating the biomass removed from the nitrifying and denitrifying steps in the presence of an oxygen-containing gas at 175-315 C at an oxygen partial pressure of 5-250 pounds/sq in to partially oxidize the biomass and convert the organic nitrogen to ammonia nitrogen. The solid phase is then separated from the liquid phase of the oxidized mixture; and after ammonia is removed from the liquid phase, the latter is directed to the denitrifying step as a source of carbon.

*Patents, *Waste water treatment, *Nitrogen compounds, *Nitrification, *Denitrification, Biological treatment, Oxidation, Chemical reactions, Liquid wastes, Chemical wastes, Nitrates, Nitrogen, Ammonia, Biomass, Microorganisms

C006
FLUID SAMPLER AND OXYGEN METER FOR SEWAGE PROCESSING - BIOLOGICAL OXYGEN DEMAND DETAILED CONTINUOUSLY BY REACTION VESSEL READ-OUT,

French Patent FR 2289-451. Issued August 4, 1975. Derwent French Patents Abstracts, Vol. X, No. 36, p D3-D4, May 28, 1976.

A patent for a biochemical oxygen demand metering device which can be used in activated sludge type sewage treatment installations is described. The device has a reaction vessel which constantly receives a sample from the aeration tank and through which air is caused to flow. A vent is provided to allow air leaving the liquid sewage to escape into the atmosphere. Air from the vent can be conducted to an oxygen metering instrument in a second section of the device. A third section of the reactor is provided for feeding in the liquid sample, and a fourth section takes overflow back to the aeration tank. The device provides continuous biochemical oxygen demand readings in a minimum amount of time and is protected from soiling, clogging, and corrosion.

*Patents, *Biochemical oxygen demand, *Sewage treatment, *Monitoring, *Activated sludge, Biological treatment, Aeration, Equipment, Analytical techniques, Instrumentation

C007
COMBINED FILTER AND DRYER FOR SEWAGE SLUDGE ETC. - USES BAND OF VACUUM FILTER TO CARRY CAKE THROUGH FILTER PRESS,

French Patent FR 2289-453. Issued October 30, 1975. Derwent French Patents Abstracts, Vol. X, No. 36, p D4, May 28, 1976.

A patent for a sewage sludge filter and dryer combination is described. The device combines a vacuum band filter with a filtrate expressing unit. A porous band which carries the filter cake from its passage around a partly-immersed vacuum filter drum moves horizontally into the expressing unit where it is squeezed between a porous drainage plate below the band and a fluid-pressurized, impervious membrane above the cake. The machine is programmed so that the drum rotates periodically to advance the band only when the expressing unit is inactive. The device is useful for drying sludges prior to incineration and is easily installed.

*Patents, *Sewage sludge, *Drying, *Sludge treatment, *Filters, Equipment, Waste treatment, Dewatering, Solid wastes

C008
SEWAGE SURFACE AERATOR WITHOUT AXIAL THRUST THUS REDUCING VIBRATION FROM WAVES,

German Patent DS 2120-576. Issued September 9, 1976. Derwent German Patents Abstracts, Vol. X, No. 38, p D1, October 27, 1976.

A patent for a sewage surface aerator rotor that reduces vibration from waves by avoiding axial thrust is described. The aerator rotor consists of a driven vertical shaft to which several vanes are attached by means of a circular support. The vanes lie in vertical planes containing the rotor axis or planes parallel to it which extend beyond the edge of the circular support when seen axially from above. The vanes are at least partially immersed in the water. The effective surfaces of the rotor are arranged so that they do not produce any axial force components, either individually or together. The vanes extend from the support first downwards and outwards and then parallel to the shaft in the region of immersion. The rotor is immersed in the water only to the point where in operation the support is either not subject to flow or only to flow in a direction free from axial thrust.

*Patents, *Rotors, *Aeration, *Sewage treatment, *Flow, Waste water treatment, Equipment, Design criteria, Liquid wastes

C009
ACTIVATED SLUDGE WASTE WATER TREATMENT PROCESS - USING SUCCESSION OF AEROBIC AND ANAEROBIC ZONES TO REMOVE NITROGENOUS MATERIAL,

Belgian Patent BE-840-694. Issued April 13, 1976. Derwent Belgian Patents Abstracts, Vol. X, No. 36, p D3, October 13, 1976.

A patent for an activated sludge waste water treatment process that uses a succession of aerobic and anaerobic zones to remove nitrogenous material is described. The process involves the following steps: waste water is mixed with activated sludge and a gas containing free oxygen under aerobic conditions (above 1 milligram/liter of dissolved oxygen); the liquor is then treated under anaerobic conditions (below 0.3 milligrams/liter of dissolved oxygen) to convert nitrates and/or nitrites formed in the aeration stage to nitrogen; the liquor is again treated under aerobic conditions, with part of the treated liquor being returned to the anaerobic stage; the liquor passes to a settling tank from which part of the settled activated sludge is returned to the initial aeration stage; and the purified decanted liquor is then discharged. Unlike prior art processes, the above scheme provides efficient nitrogen removal without either requiring multi liquid/solid separations or having an adverse effect on the rate of separation at the decantation stage.

*Patents, *Waste water treatment, *Activated sludge, *Nitrification, *Nitrogen compounds, Aerobic conditions, Anaerobic conditions, Biological treatment, Nitrates, Nitrites, Chemical reactions, Dissolved oxygen, Nitrogen

C010
SCREENING APPTS FOR REMOVAL OF SOLIDS - FROM SEWAGE WITH ROTATING SCREEN AND VERTICAL LIFT FOR RESIDUES,

Belgian Patent BE-841-043. Issued April 23, 1976. Derwent Belgian Patents Abstracts, Vol. X, No. 37, p D3, October 20, 1976.

A patent for a screening device that removes solids from sewage or other waste waters is described. The device includes a first cylindrical screen with a vertical axis that is provided with slits or openings through which the liquid flows, with the solids in the liquid becoming deposited thereon and thus separated from the general flow. This screen is also provided with a scraper and can be fixed or rotated by a motor. A second screen located at the side of the first screen which rises above the upper level of the liquid flow is also provided. A lifting plate is associated with this second screen and is moved up and down by a hydraulic ram. When ascending, the plate collects all of the solid matter that has accumulated on the second screen. The solid matter is then pushed by a pressure head and associated piston into a compression chamber. The walls of the latter decrease in diameter towards the outlet, and a spring-loaded articulated plate assists in compressing the solid reject. Screening is continuous and effective.

*Patents, *Screens, *Waste water treatment, *Solid wastes, *Sewage treatment, Equipment, Design criteria, Separation techniques

C011
BIOLOGICAL TREATMENT OF SEWAGE WATERS DEVICE WITH INTERNAL AERATION ZONE,

Buzovkin, M. I., Zhukov, D. D., and Ivanyukov, D. V.

Soviet Patent SU-497-245. Issued March 15, 1976. Derwent Soviet Inventions Illustrated, Vol. X, No. 38, p D3, October 27, 1976. 1 fig.

A patent for an activated sludge sewage treatment device that has an internal aeration zone is described. The device consists of a horizontal cylindrical vessel with a coaxial inner cylinder which divides the unit into an outer circular aeration zone and an internal settling zone. The aeration zone with horizontal filtration mesh packing is provided with an inlet for compressed air and an outlet for the disposal of sludge into the settling zone. A round tray for distributing the feed sewage is also provided along with a circular tray for distributing the recirculated activated sludge. The system also has a separating partition and a central collecting tray.

*Patents, *Sewage treatment, *Activated sludge, *Aeration, *Waste water treatment, Biological treatment, Equipment, Design criteria, Liquid wastes

C012
SLUDGE COLLECTOR AND LIGHT LIQUID SEPARATOR-FROM SEWAGE WITH TWO TANKS IN SINGLE HOUSING AND COVER,

Belgian Patent BE-841-045. Issued August 16, 1976. Derwent Belgian Patents Abstracts, Vol. X, No. 37, October, 1976.

A patent has been issued for a sludge collector. A unit containing this collector and separator is designed to separate settled materials and light liquids from waste water and sewage. Water flows into the unit and materials which can settle into the collector. The remaining liquid moves under the partition into the separator where materials such as oil and fats rise to the surface to be removed. Then, the water passes under a partition and out of the unit. Separate pipes are used to pump out collected sludge and light liquids. The collector and separator are washed by water after evacuation.

*Patents, *Waste water treatment, *Sewage treatment, *Sludge treatment, *Sludge disposal, Recycling, Liquid wastes, Separation techniques

Sludge collectors, Sludge separators

C013
SEWERAGE TREATMENT APPARATUS,

Edwards, R. N.

Edward Waters and Sons,
Melbourne, Australia. (assignee)

Australian Patent 475,357. Issued August 19, 1976. Official Journal of Patents, Trade Marks, and Designs, Vol. 46, No. 30, p 3029, August, 1976.

A patent has been issued for a liquid sewage and waste treatment apparatus which provides biological and chemical oxidation and sterilization, and color, taste, odor, phenol, cyanide, and phosphate reduction of the contaminants. It is characterized by a high degree of oxygen absorption and utilization. The treatment apparatus is composed of an enclosed pressurized chamber with an upper and lower section. Liquid sewage enters the lower section, and oxygen is supplied to the upper one. The liquid sewage is directed in a stream into the upper portion where it is broken into small particles which absorb the oxygen as they drop through the oxygen rich atmosphere.

*Patents, *Sewage treatment, *Waste water treatment, *Design criteria, *Equipment, Oxidation, Chemical reactions, Color, Taste, Odor, Phenols

C014
BIOLOGICAL PURIFICATION OF SEWAGE WATER-IN A MULTI-STAGE TREATMENT TANK WITH ROTATING CONTACTOR SURFACES PARTLY IMMERSED IN THE LIQUID,

German Patent DS 2407-423. Issued September 2, 1976. Derwent German Patents Abstracts, Vol. X, No. 37, p D2, October, 1976.

A patent has been issued for a process and apparatus for biological purification of sewage water which features a multi-stage treatment tank with rotating contactor surfaces partly immersed in the liquid. The treatment unit should have a treatment basin/contact element surface area ratio about 0.0049 cu m/sq m. It should never be less than this. Under normal operating conditions, obtaining the optimum effect requires little effort.

*Patents, *Sewage treatment, *Biological treatment, *Equipment, *Design criteria, Tanks, Liquid wastes, Operation, Treatment facilities, Waste water treatment

C015
COAGULATION CLARIFYING EFFLUENTS CONTAMINATED WITH COLLOID SUSPENSIONS-BY ELECTROPHORESIS AFTER MIXING IN INSOLUBLE METALLIC PARTICLES,

German Patent DS 2461-943. Issued September 9, 1976. Derwent German Patents Abstracts, Vol. X, No. 38, p D2-D3, October, 1976.

A patent has been issued for a process for coagulation clarifying effluents contaminated with colloid suspensions by electrophoresis following mixture with insoluble metallic particles. The plant for treating dirty water containing colloids by electrophoresis has a suspension, coagulation, and separation zone. An electrode pipe containing electrodes is adjacent to a treating vessel with a cone-shaped upper section and a lower suspension area which is cylindrical and has a conical lower portion. A suction pipe valve, a pipe and a suspension pump connect the interior of the treating vessel to the lower end of the electrode pipe which is connected, by a pipe at its upper end, to the upper end of the separating area. Waste water enters through the tip of the lower conical area of the suspension zone and exits through an outlet at the upper end of the separating zone.

*Patents, *Waste water treatment, *Coagulation, *Electrophoresis, *Design criteria, Colloids, Mixing, Metals, Solids removal

C016
BIOLOGICAL CONVERTER FOR FAECAL MATTER IN WATER USING ROTARY TUBES WITH FIBROUS FILLING SUPPORTING THE BACTERIAL CULTURE,

Netherlands Patent NL 7601-914. Issued August 31, 1976. Derwent Netherlands Patents Abstracts, Vol. X, No. 38, p D3, October, 1976.

A patent has been issued for a system for the conversion of fecal matter in water to harmless matter by a biological culture. The major component is a conversion tank which houses perforated tubes. The tubes are on wheels which rotate to allow submersion and complete emergence. The tubes contain a water insoluble material with a large surface area, exposable to both water and air, for bacterial growth. Water which has been purified may be either re-used or released directly into waterways. The water quality is such that it may be used in fish farming or cattle watering. With some chlorination, it may be used as potable water.

*Patents, *Biological treatment, *Sewage treatment, *Biodegradation, *Design criteria, Water purification, Tanks, Waste water treatment, Recycling, Water reuse

Fecal matter

C017
CENTRIFUGE FOR DEWATERING SEWAGE SLUDGE,

Australian Patent 475,847. Issued September 2, 1976. Official Journal of Patents, Trade Marks and Designs, Vol. 46, No. 32, p 3240-3241, September 1976.

A patent has been granted for a centrifuge which drains off sewage sludge. The equipment includes a drum which is tapered towards both ends, a hollow shaft that extends longitudinally within the drum for the passage of sewage sludge, and means to withdraw separated water at one end of the drum and dewatered sludge at the other end. A conveyor screw passes through the drum's interior, along the whole length of the drum. Additionally, a rotatable ejection wheel with blades adapted to accelerate the sludge tangentially to the direction of the wheel is arranged within the drum. Thus, with a wheel in the interior of the drum, at or adjacent to the largest cross-section of the drum, the centrifuge operates and communicates with the interior of the hollow shaft for dewatering and discharging separated sewage.

*Separation techniques, *Centrifugation, *Sewage sludge, *Dewatering, *Patents, *Waste water treatment, *Sewage treatment, *Sludge treatment, Equipment

C018
FLUIDIZED WASTE INCINERATOR AND METHOD,

Pledger, W. R., and Gwyn, J. E.

Shell Oil Company
Houston, Texas. (assignee)

United States Patent 3,994,244. Issued November 30, 1976. Official Gazette of the United States Patent Office, Vol. 952, No. 5, p 1975, November, 1976. 1 fig.

A patent has been granted for a fluidized bed incinerator for sewage sludge and similar waste liquids containing a high proportion of easily fusible salts. The equipment includes: a refractory lined vessel; means for holding dense fluidized-solids in a bed in the lower part of the vessel, with a bed supporting grate and means to force air upward through the bed; equipment to introduce a stream of feed into the fluidized bed; and effluent take-off means to communicate with the upper portion of the vessel and withdraw an effluent stream of combustion vapors and entrained solids. These take-off means have the properties of comprising a refractory-lined metal conduit which connects one end of the vessel with the other; a second conduit, communicating with the first, at about right angles; and quench water injection means adapted to spray quench water directly into the opening of the second conduit.

*Incineration, *Sewage treatment, *Sewage sludge, *Sludge disposal, *Patents, *Equipment, Waste water treatment, Joints (connections)

Combustion, Conduits, Fluidized beds

C019
MODULAR AERATOR AND SEPARATOR ASSEMBLY FOR
SEWAGE TREATMENT FACILITY,

Schmid, L. A.

United States Patent 3,975,276. Issued August 17, 1976. Official Gazette of the United States Patent Office, Vol. 949, No. 3, p 1111-1112, August, 1976.

A sewage treatment apparatus was patented. A bottom wall is adapted for holding sludge and particulate matter derived from it. A chamber directs sewage flow through the separation equipment after it enters the apparatus. A sewage inlet is located below the particulate separation equipment. Sewage flows upward through the chamber. Provision is made to induce a generally upward hydraulic suction to increase turbulence and aeration in the particulate matter and sludge and to aerate sewage entering the inlet. Baffles at least partially cover the aeration means to prevent clogging by solid material in the sewage. Provision is made for withdrawing clarified liquid emerging from the particulate separation equipment.

*Waste water treatment, *Sewage treatment, *Patents, *Sewerage, *Treatment facilities, *Aerobic treatment, *Aeration, Aerobic conditions, Separation techniques, Equipment

C020
INTEGRAL CIRCULAR WASTEWATER TREATMENT PLANT,

Australian Patent 473,063. Issued June 10, 1976. Official Journal of Patents, Trade Marks and Designs, Vol. 46, No. 20, p 1968-1969, June, 1976.

A waste water treatment apparatus was patented. It has concentric circular inner and outer walls. The radius of the inner wall is between one quarter and seven tenths the radius of the outer wall. A radial partition extends across the intermediate volume joined to the outer and inner walls, spaced from the first radial partition to form a portion of the intermediate volume bounded by segments of the outer and inner walls from 90 degrees to 330 degrees and a second portion consisting of the remainder of the intermediate volume. There is an aeration zone within the outer wall outside the first arcuate portion, enclosed by a cover. Oxygen gas is introduced in the aeration zone. Another passage introduced activated sludge and feed waste water to the aeration zone. A second aeration zone outside the first arcuate portion is also enclosed by a cover. Oxygen depleted gas discharged from the first aeration zone is introduced to the second aeration zone and mixed with the oxygen-containing gas. A gas vent discharges further oxygen depleted gas from the second aeration zone. The second oxygenated liquor is also discharged from the second aeration zone. Oxygenated liquor is uniformly distributed in the first arcuate portion around the inner wall segments for radial flow across the first arcuate portion. A trough around the upper part of the outer wall segment of the first arcuate portion discharges clarified water. Activated sludge is collected and removed from the lower part of the first portion and at least part of it is returned to the passage to the first aeration zone.

*Waste water treatment, *Patents, *Activated sludge, *Treatment facilities, *Aeration, Aerobic treatment, Aerobic conditions, Oxygen

C021
SEWAGE SLUDGE TREATMENT SYSTEM,

Kalvinskas, J. J., Pasadena, S., and Mueller, W. A.

California Institute of Technology,
Pasadena, California. (assignee)

United States Patent 3,994,804. Issued November 30, 1976. Official Gazette of the United States Patent Office, Vol. 952, No. 5, p 2160-2161, November, 1976. 1 fig.

A patented method for treating raw liquid sewage is described. The process, used when the waste includes water with dissolved organic and inorganic matter as well as suspended matter, involves mixing the raw liquid waste with activated carbon and ash, then introducing the mixture into a primary settling tank for settling the suspended matter as primary sludge. The effluent from this first tank is mixed, then fed to a secondary settling tank to permit the settlement of secondary sludge. Both the primary and secondary sludges are dewatered and sent to pyrolysis equipment. There, they are formed into activated carbon and ash, mixed with raw liquid waste and effluent. In this particular invention, the primary and secondary sludges are pyrolyzed separately to form separate quantities of activated carbon and ash. The products of pyrolysis of the primary sludge are mixed with the raw waste while the products of the pyrolysis of the secondary sludge are mixed with the effluent from the first settling tank.

*Incineration, *Sewage treatment, *Liquid wastes, *Activated carbon, *Recycling, Mixing, Sludge treatment, Sludge disposal, Settling basins, Sedimentation, Effluents

*Pyrolysis

C022
REMOVAL OF BOD AND NITROGENOUS POLLUTANTS FROM WASTEWATERS,

Casey, J. P., and Spector, M. L.

Air Products and Chemicals,
Allentown, Pennsylvania. (assignee)

United States Patent 3,994,802. Issued November 30, 1976. Official Gazette of the United States Patent Office, Vol. 952, No. 5, p 2160, November, 1976. 1 fig.

A process for purifying waste water with activated sludge has been patented. Waste water is subjected to continuous flow through several successive zones of an activated sludge system, where BOD is reduced and nitrogenous pollutants are removed. The influent waste water is mixed with activated sludge, nitrified and denitrified, and mixed with free oxygen-containing gas under aerobic conditions. This provides a mixed liquor which is passed, without separation, to further treatment under anaerobic conditions in the presence of nitrates or nitrites plus microorganisms. The liquor is then again treated with an oxygen-containing gas and is introduced into a final settling zone to separate the settled solids from the supernatant liquid. Part of the settled solids are returned as activated sludge; a portion of the microorganisms which have been oxidized are returned; and the mixed liquor is maintained with a dissolved oxygen level of one ppm and a F/M ratio of 1.5.

*Patents, *Waste water treatment, *Aerobic conditions, *Anaerobic conditions, *Nitrogen, *Biochemical oxygen demand, *Mixing, *Activated sludge, Nitrification, Denitrification, Dissolved oxygen

C023
AUTOMATIC CLARITY CONTROL OF OVERFLOW FROM SEDIMENTATION TANK-
WITH SLUDGE PUMP ACTUATED BY PHOTO-ELECTRIC CHECK OF SAMPLE LIQUID,

French Patent FR 2292-505. Issued July 30, 1976. Derwent French Patents Abstracts, Vol. X, No. 41, p J1, November, 1976.

A patent was issued for a control system and process to ensure proper clarification of overflow of a sedimentation tank. A sample stream of liquid continually passes from the tank at a level below the overflow but as high as permissible suspended particles, and falls through the beam of a photo-electric cell detector system. When particles are detected, sludge pumps are automatically activated. The sample stream is from a pipe which enters the liquid through a side wall between 0.1 and 0.2 meters below the overflow.

*Patents, *Waste water treatment, *Pollutant identification, *Overflow, *Settling basins, Sludge, Sedimentation, Automatic control

C024
SLUDGE SETTLING BASIN,

Fux, K.

Prometall Uznach AG,
Uznach, Switzerland. (assignee)

United States Patent 3,993,568. Issued November 23, 1976. Official Gazette of the United States Patent Office, Vol. 952, No. 4, p 1732, November, 1976. 1 fig.

A patent was issued for a sludge settling basin. The basin, with an essentially flat floor and vertical walls, has a fixed channel on one wall and a roller-mounted cover for movement over the basin. A siphon tube attached to the cover has a mouthpiece, extending over the entire basin floor, constructed to reduce the cross section of channels from the suction gap to the upper end of the mouthpiece. Tube portions extend up to the mouthpiece directly upward from the adjacent floor to the basin; horizontally and transversely over the basin slightly above the maximum liquid levels; and downward into the channel. There is also a controllable pump.

*Patents, *Waste water treatment, *Settling basins, *Treatment facilities, *Sludge, *Walls, Channels, Siphons

*Floor

C025
WASTE WATER DENITRIFICATION-BY PROCESS COMPRISING BIOLOGICAL DENITRIFICATION AND NITRIFICATION STEPS,

German Patent DS 2339-557. Issued September 30, 1976. Derwent German Patents Abstracts, Vol. X, No. 41, p D3, November, 1976.

A patent was issued for a waste water denitrification process. Nitrogen removal is accomplished by feeding waste water first to a further biological denitrification stage before the biological nitrification stage. The solid-separation-stage activated sludge and mixed water from the biological nitrification stage are introduced to the further denitrification stage. Oxygen-free conditions which allow anaerobic respiration without anaerobic fermentation are best for the two denitrification stages. Nitrogen removal is highly effective at low temperatures and with feed water containing great amounts of total nitrogen.

*Patents, *Denitrification, *Waste water treatment, *Biological treatment, *Activated sludge, *Nitrification, Nitrogen, Waste water (pollution)

C026
BIOLOGICAL TREATMENT OF EFFLUENT CONTAINING ACTIVATED SLUDGE-INVOLVES CONTINUOUSLY INTRODUCING OXYGEN (CONTG. GAS) AND FEEDING THE OUTLET GAS TO A BURNER,

Belgian Patent BE-839-847. Issued September 22, 1976. Derwent Belgian Patents Abstracts, Vol. X, No. 41, p D1, November, 1976.

A patent was issued for an oxygen based biological treatment for effluent that contains activated sludge. The process involves the continuous introduction of air or an oxygen-containing gas into the effluent. The apparatus involves a cylindrical tank with ejectors that receive gas through the pipe. Residual gas passes through the outlet into a burner. Effluent overflows are pumped into the ejectors as a propelling liquid. The overflow used is equal to 10-30% of the gas volume. The oxygen is stripped from the gas in a single absorption stage.

*Patents, *Waste water treatment, *Biological treatment, *Activated sludge, *Treatment facilities, Air, Sewage effluents, Oxygen

C027
WASTE WATER PURIFICATION-USING SUPER-PARAMAGNETIC DISPERSED ION-EXCHANGER IN CONSTANT MAGNETIC FIELD,

Svyadoshch, Ya. N., Alsher, G. P., and Lyubman, N. Ya.

Soviet Patent SU-497-027. Issued March 15, 1976. Soviet Inventions Illustrated, Vol. X, No. 41, p D2, November, 1976.

A patent was issued for a waste water purification process using a micro dispersed super paramagnetic ion exchanger. This allows an 8 to 10-fold increase in liquid flows. An example was provided. Eight kilograms of super-paramagnetic cation-exchanger KU-2-8f were placed in a column with an electromagnetic coil having a strength of 350 oersted. A $CaCl_2$ solution was passed upwards at 40 specific vols/hr giving a capacity of 2.85 milligrams equivalent per gram. The same capacity by non-magnetic ion-exchange methods requires a rate of 5 specific vols/hr.

*Patents, *Ion exchange, *Treatment facilities, *Water purification, *Waste water (pollution), Magnetic studies, Liquid wastes, Waste water treatment

Paramagnetism, Magnetic field

C028
SETTLED SLUDGE REMOVAL,

Australian Patent 475,862. Issued January 3, 1974. Official Journal of Patents, Trade Marks, and Designs, Vol. 46, No. 32, p 3244, September, 1976.

A patent was issued for a mechanism to remove sludge from the bottom of settling tanks. The apparatus is composed of means to concentrate settled sludge in a localized area on the tank bottom, and conduits from this area to a collection zone. There are also controls for selective operation of these conduits to control flow and range of sludge from the tank bottom to the collection area.

*Patents, *Sludge disposal, *Waste water treatment, *Treatment facilities, *Sludge, Settling basins, Mechanical equipment, Equipment, Conduits

C029
EFFLUENT WASTE TREATMENT PROCESS AND APPARATUS,

United States Patent 3,986,955. Issued October 19, 1976. Official Gazette of the United States Patent Office, Vol. 951, No. 3, p 1155, October, 1976. 1 fig.

A patent was issued for a process and apparatus for treating effluent waste. The apparatus is a self-contained unit with an internal water system. The process consists of passing waste effluent into a collection zone and various heat exchanges where water vapor from the heated effluent is converted to heat for preheating wastes and other heating needs. The solid wastes are sterilized, dried, and stored. After passing through four heat exchanges, the condensed vapor is passed to the system's water supply.

*Patents, *Treatment facilities, *Effluents, *Waste treatment, *Equipment, Water vapor, Waste water treatment, Heat exchangers

C030
SEWAGE DISPOSAL SYSTEM,

Greenleaf, J. W., Jr.

United States Patent 3,998,736. Issued December 21, 1976. Official Gazette of the United States Patent Office, Vol. 953, No. 3, p 1155, December, 1976. 1 fig.

A patent was issued for a vacuum type sewage disposal system. The system has two variable volume chambers with movable walls. The first contains a sewage accumulating sump at atmospheric pressure. A discharge conduit, with a negative pressure source, has an open intake end which is normally below the sewage surface. A flow valve is contained in the conduit and is biased to a closed position. The chamber is defined by a means for opening the valve in opposition to its closed position. A control valve is connected to the chamber on the side opposite from the sump. It is movable to a first position which vents the chamber to the atmosphere, and a second which establishes contact between the chamber and discharge conduit. The second chamber is defined by a means which connects it to the control valve to hold it in the second position due to the negative pressure therein. There is another means for returning the control valve to the first position which is responsive to atmospheric pressure in the first chamber.

*Sumps, *Atmospheric pressure, *Sewage, *Patents, Sewage disposal, Conduits, Negative pressure

C031
APPARATUS AND METHOD FOR DENITRIFICATION OF WASTE WATER,

Neff, H. P., and Graham, J. T.

United States Patent 3,994,803. Issued November 30, 1976. Official Gazette of the United States Patent Office, Vol. 952, No. 5, p 2160, November, 1976.

An improvement is patented in an apparatus for treating sewage with an aeration zone to convert nitrogen-containing compounds in sewage to nitrates, as well as a settling zone to separate a nitrate-containing liquid and sludge produced in the aeration zone, and a filter bed containing anaerobic denitrifying bacteria. The nitrate-containing liquid is charged from the settling zone to the filter. The filter bed is periodically backwashed, including forcing clean water into the bottom of the filter and upwardly through it to a level higher than the surface of the filter bed. The improvement makes it possible to conduct most of the clean water away from the filter by gravity and retain a small portion of it above the bed. This small portion also contains a portion of the colony of bacteria. The flow of clean water is discontinued after a predetermined time. The water in the filter bed can be withdrawn and the small portion of water along with the portion of bacteria released to flow by gravity onto the bed, inoculating it with the portion of the colony of bacteria. A conduit is included, through which the nitrate-containing liquid is conveyed to flush away the small amount of water and portion of the colony of bacteria.

*Patents, *Waste water treatment, *Sewage treatment, *Biological treatment, *Sewerage, Treatment facilities, Equipment, Denitrification

C032
TERTIARY FILTER FOR WASTE TREATMENT,

Australian Patent 475,789. Issued September 2, 1976. Official Journal of Patents, Trade Marks and Designs, Vol. 46, No. 32, p 3227, September, 1976.

A method for filtering liquid was patented. Two filter beds are positioned in outlets in containers. The flow of liquid being filtered is directed through one filter bed. The liquid level in each container is sensed. When the liquid level in the container holding the first filter bed exceeds a predetermined value, flow of liquid being filtered is diverted through the other filter bed. The flow of unfiltered liquid is transferred. The solid contaminant particles are removed from the first filter bed while flow of liquid is maintained through the second filter bed. Flow of liquid is directed through the first bed when the liquid level in the container holding the second filter bed exceeds a predetermined value. Liquid is transferred, and contaminant particles are removed from the second bed while liquid flows through the first.

*Patents, *Waste water treatment, *Treatment facilities, *Tertiary treatment, *Filters, Liquid wastes, Outlets, Flow, Diversion

C033
SCREENING APPTS FOR REMOVAL OF SOLIDS - FROM SEWAGE WITH
ROTATING SCREEN AND VERTICAL LIFT FOR RESIDUES,

Netherlands Patent NL 7604-312. Issued October 26, 1976. Derwent Netherlands Patents Report, Vol. X, No. 46, p D6, December, 1976.

A patent was issued for an apparatus to remove solids from sewage flow or other liquids. Solids are trapped on the face of a cylindrical screen with a vertical axis placed in the liquid flow. The screen can be fixed or rotated by a motor. At its side, there is another screen, composed of vertical rods which rise above the level of fluid flowing through the device. A lifting mechanism related to the second screen is moved up and down by a hydraulic ram. When rising, the mechanism captures solids which remain on the second screen and pushes them into a compression chamber. Screening is continuous and effective.

*Patents, *Filtration, Sewage treatment, Waste water treatment, Sewage effluents, Separation techniques, Suspended solids, Waste disposal, Liquid wastes, Screens

C034
SEWAGE SLUDGE IRRADIATION SYSTEM-APPLYING ELECTRON BEAM BEFORE
MIXING GAP BETWEEN ENDLESS BELTS MOVING AT DIFFERENTIAL SPEED,

French Patent FR 2291-946. Issued July 23, 1976. Derwent French Patents Abstracts, Vol. X, No. 39, p D3, November, 1976.

A patent was issued for a sewage sludge irradiation system. The sludge is sterilized by radiation just ahead of the gap between two endless belt conveyors, moving at different speeds. The irradiated layers are mixed with less affected lower layers in the gap. The process pasteurizes sewage sludge before its use as manure and there is no odor problem. There is no need for an additional paddle mixer. This process kills all bacteria, worms, and pathogens.

*Patents, Sludge treatment, Irradiation, Sewage treatment, Bacteria, Sterilants, Fertilizers, Odor, Pathogenic bacteria, Worms, Treatment

C035
ROTARY DRUM EVAPORATIVE DRYER ESP FOR SEWAGE SLUDGE - CONTROLS DRYING FILM THICKNESS BY ADJUSTING INCLINATION OF DRUM AXIS,

Netherlands Patent NL 7603-913. Issued November 1, 1976. Derwent Netherlands Patents Report, Vol. X, No. 46, p D5, December, 1976.

A patent was issued for a rotary sewage sludge dryer. Sludge is applied to the inside circumferential wall and evaporated by a heater inside the drum. A means is provided for removing dried residue. The hollow interior is tapered conically on a longitudinal axis and is open at the large end. The drum should be mounted on a pivot in order to adjust its axis to the horizontal. Wet sludge is fed into the drum via the large end at the bottom of its circumference. Film thickness is adjusted by tilting to make surplus sludge flow back to overflow the mouth of the drum.

*Patents, *Sludge treatment, Solid wastes, Evaporation, Drying, Overflow, Treatment, Waste water treatment, Wastes, Dehydration

C036
AEROBIC TYPE SEWAGE DIGESTION SYSTEM,

Prince, J. E., Terry, F. E., and Mullins, W. H.

United States Patent 3,997,437. Issued December 14, 1976. Official Gazette of the United States Patent Office, Vol. 953, No. 2, p 718, December, 1976. 1 fig.

A patent was issued for an aerobic sewage digestion system. The system is composed of a primary state which receives sewage from a screened headworks into a primary clarifier. After settling to the bottom of the clarifier, sludge is carried to a sludge digester. A secondary stage involves a filter which receives overflow from the primary clarifier which is then passed to another clarifier for additional treatment and discharge of separated liquids. The sludge digester contains a pump for continual sludge circulation, an aerator which discharges above the sludge level, and a means for controlling sludge additions by the aerator. There is also a supernatant overflow mechanism and a means for periodically removing digester sludge.

*Patents, *Sewage treatment, *Aerobic treatment, Waste water treatment, Pumps, Filters, Filtration, Sludge treatment, Digestion, Overflow

Supernatant

C037
ACTIVATED SLUDGE TREATMENT-PASSING ALL SEWAGE BY FORCE PUMP THROUGH ATMOSPHERIC AIR ENTRAINING ENJECTORS INTO ACTIVATION TANK,

Belgian Patent BE 843-613. Issued October 18, 1976. Derwent Belgian Patents Abstracts, Vol. X, No. 46, p D2, December, 1976.

A patent was issued for an activated sludge treatment process which ensures the introduction of maximum required oxygen into the activated sludge-effluent mixture without air compressors. The liquid-sludge mixture is circulated in a closed circuit channel, pressurized by a pump and passed through at least one injector with an inlet exposed to the atmosphere. Air is introduced to the liquid by a downward sloping jet and caused to circulate around the closed circuit. The effluent to be purified is delivered to the channel only by the pump unit and the injector or injectors.

*Patents, *Sludge treatment, Activated sludge, Oxygen, Pumps, Sewage effluents, Hydraulic machinery, Water purification, Treatment, Waste water treatment, Closed conduits

C038
STIRRING APPTS. FOR WASTE WATER PURIFICN. BY INJECTION OF GAS IN BIOLOGICAL TREATMENT TANK,

Belgian Patent BE 843-751. Issued November 3, 1976. Derwent Belgian Patents Abstracts, Vol. X, No. 47, p D2-3, January, 1977.

A patent was issued for a stirring device to be used in waste water purification. The device consists of a central cyclindrical body with a cone-shaped extension capped by an ovoid element that has an inlet from the biological tank to the device. The circular unit admits atmospheric air. The body extends downward by the conical part and a paddle-wheel, driven by the shaft, is mounted in the lower body. When immersed in a treatment tank with a biological bed, the vortex is produced and the water drawn in tends to stick to the walls of element and absorb much of the oxygen in the air entering through the inlet. The water moves down the walls and joins the vortex. Supersaturation of the water with air creates a great degree of expansion at a certain tank level, resulting in intense rising currents which bring the sludge into suspension. This promotes excellent oxygen circulation in the mass which provides excellent conditions for the biological elements.

*Patents, *Waste water treatment, *Biological treatment, Sludge, Oxygen, Water purification, Sludge treatment, Sewage treatment, Air circulation

C039
WASTE TREATMENT AND SOLIDS SEPARATING SYSTEM,

Sullins, J. K.

Canton Textile Mills, Incorporated,
Canton, Georgia. (assignee)

United States Patent 3,990,974. Issued November 9, 1976. Official Gazette of the United States Patent Office, Vol. 952, No. 2, p 762, November, 1976. 1 fig.

An aerobic system for waste treatment was patented. It includes a reservoir with an outlet. Waste liquid flows into the reservoir and outward through the outlet. An ejector in the reservoir communicates with the atmosphere. A pump interconnects with the reservoir through a conduit and with the ejector via a conduit to withdraw liquid from the reservoir and force the withdrawn liquid through the ejector in a substantially horizontal direction to impart atmospheric air to the liquid as it flows through the ejector to aerate the liquid and cause it to flow substantially horizontally. The opening in the reservoir which supplies liquid to the pump is upstream from and adjacent to the direction of liquid discharge from the ejector. A sensor senses the dissolved oxygen concentration of the liquid in the reservoir. Control means vary the speed of the pump to change the rate that the pump forces liquid through the conduit. An ejector maintains the dissolved oxygen concentration at a selected level. A wall in the reservoir's upper part accomodates flow thereunder from the ejector. A tube settler in the reservoir adjacent to the wall has several parallel juxtaposed vertical tubes. Their upper ends directly communicate with the outlet. The liquid flows upward through them and is discharged at the outlet. Settled solids fall downward through the tubes against the upward liquid flow. The tube settler is remote from the ejector's discharge end and somewhat higher.

*Patents, *Waste water treatment, *Treatment facilities, *Waste treatment, *Aerobic treatment, Outlets, Liquid wastes, Reservoirs, Air, Separation techniques

C040
SEWAGE SETTLING TANK,

McGivern, R. F.

Sybron Corporation,
Rochester, New York. (assignee)

United States Patent 3,997,444. Issued December 14, 1976. Official Gazette of the United States Patent Office, Vol. 953, No. 2, p 720, December, 1976. 1 fig.

A patent was issued for a sewage settling tank. The tank consisted of a settling chamber with an inlet for liquid to be treated and an outlet for clarified water. At least two banks of tube settlers, arranged in a horizontal plane above the chamber bottom, and a baffle from the periphery of each bank, defining a clear water area above each bank, were employed. A sludge removal siphon carried by a floating carriage removes sludge from the tank bottom and tube settlers.

*Patents, *Settling basins, *Sedimentation, *Sewage treatment, Sludge, Waste water treatment, Liquid wastes, Sewage effluents, Environmental sanitation

C041
AN APPARATUS FOR WASTE WATER TREATMENT BY OZONE
(Ozon ni yoru haisui shori sochi),

Japanese Patent No. Sho 51-5278. Issued February 13, 1976. Japanese Model Utility, p 223-235, February, 1976. 1 ref.

A patent was issued for a continuous waste water treatment apparatus utilizing ozone. A spiral tube was used for the contact between ozone and waste water to improve ozone absorption efficiency. Waste water to be treated was fed into the spiral tube under pressure and ozonized air was jetted into the tube through an injector. The flow rate of waste water in the tube was controlled by a pressure valve attached adjacent to the tube so that the water flow was slightly faster than the speed of the ozonized air moving up the tube. A degassing tank was connected to the end of the spiral tube. When waste water entered into this tank, the pressure decreased, liberating the dissolved ozone in the form of small gas bubbles which further increased the reaction between the waste water and the ozone. With the use of this spiral tube, the size of the ozone treatment apparatus could be reduced to 1/10 that of conventional ozone treatment apparatus and still provide nearly 100% ozone absorption efficiency.

*Patents, *Waste water treatment, *Equipment, *Ozone, Absorption, Chemical reactions, Optimization, Mechanical equipment, Gases

C042
APPARATUS FOR BIOLOGICAL TREATMENT OF WASTE WATER,

Thissen, C.

George A. Hormel and Company,
Austin, Minnesota. (assignee)

United States Patent 3,997,443. Issued December 14, 1976. Official Gazette of the United States Patent Office, Vol. 953, No. 2, p 720, December, 1976. 1 fig.

A patent was issued for an apparatus to biologically treat waste water. The apparatus involves a container for the waste water to be treated, several driven shafts extending transversely through and mounted on the tank with biological discs mounted thereon, and a means for rotating the discs in the same or opposite directions that alternately exposes them to the waste water and air for the growth of aerobic materials on their surfaces.

*Patents, *Waste water treatment, *Biological treatment, Aerobic treatment, Mechanical equipment, Sewage treatment, Waste treatment, Sewage effluents, Environmental sanitation

C043
METHOD AND APPARATUS FOR AEROBIC SEWAGE TREATMENT,

Traverse, C. E.

United States Patent 4,002,561. Issued January 11, 1977. Official Gazette of the United States Patent Office, Vol. 954, No. 2, p 776-777, January, 1976. 1 fig.

A patent was issued for a method and apparatus for aerobic sewage treatment in septic tanks. The system contains a means for removing a portion of the liquid from the tank and reducing floc particle size. The liquid is placed in a cylindrical treatment vessel designed to create a hydraulic turbulence in the fluid and to provide surface means to reduce floc particle size by mechanical shear forces. Oxygen is introduced to optimize size reduction and aerobic treatment. The treated liquid is returned to the septic tank.

*Patents, *Sewage treatment, *Aerobic treatment, *Septic tanks, Domestic wastes, Sewage disposal, Oxygen, Waste water treatment, Liquid wastes

C044
WASTE WATER TREATMENT PROCESS,

Joseph, J. J., and Keigher, J. R.

SCM Corporation,
New York, New York. (assignee)

United States Patent 4,001,114. Issued January 4, 1977. Official Gazette of the United States Patent Office, Vol. 954, No. 1, p 295, January, 1977. 1 fig.

A patent was issued for a treatment process for waste water containing fatty residue. Density separation is employed to remove accumulated lighter oil phase from the denser aqueous phase. The denser phase is treated with a flocculating agent and brought to a pH of at least 6. It is then subjected to dissolved air flotation to recover the stripped water product phase from the oily froth formed. The waste water is acidified to a pH of approximately 3 to 5.5 before density separation, and the oil froth is allowed to flow by gravity and mix with waste water admitted to the process.

*Patents, *Waste water treatment, *Oily water, *Lipids, Separation techniques, Flocculation, Flotation, Acidity, Hydrogen ion concentration

Density separation

C045
POLLUTED WATER PURIFICATION,

Box, E. O., Jr., and Farha, F., Jr.

Phillips Petroleum Company,
Bartlesville, Oklahoma. (assignee)

United States Patent 3,992,295. Issued November 16, 1976. Official Gazette of the United States Patent Office, Vol. 952, No. 3, p 1210, November, 1976.

A patent was issued for a process to purify aqueous streams containing organic material impurities, dissolved and/or suspended, to products substantially free of organic material. This involves mixing the contaminated stream with an oxygen-containing gas and a copper manganite catalyst under liquid phase oxidation conditions at a temperature of 350 F to 550 F. The organic materials are converted to relatively innocuous forms and the stream can be safely discarded or reused.

*Patents, *Waste water treatment, *Oxidation, Organic matter, Water purification, Oxygenation, Copper, Manganese, Water reuse

C046
PROCESS OF TREATING GELATINOUS SLUDGE AGGLOMERATIONS,

Weiland, H. J., and Black, D. W.

Environmental Improvement Systems, Incorporated,
Birmingham, Alabama. (assignee)

United States Patent 3,997,438. Issued December 14, 1976. Official Gazette of the United States Patent Office, Vol. 953, No. 2, p 718, December, 1976. 1 fig.

A patent was issued for a process to treat gelatinous sludge agglomerations containing aluminum hydroxide from the clarification of raw water with coagulants. The gelatinous sludge is reacted with lime to combine with the aluminum hydroxide to form a precipitate and produce a filterable sludge in water. This is settled in the water, and separated and passed through a filter to separate solids from the liquid.

*Patents, *Sludge treatment, *Filtration, Separation, Suspended solids, Waste water treatment, Lime, Aluminum, Chemical degradation

C047
CONVERTING SEWAGE SLUDGE INTO COMPOST,

Australian Patent 476,969. Issued October 7, 1976. Australian Official Journal of Patents, Trade Marks, and Designs, Vol. 46, No. 37, p 3718, October, 1976.

A patent was issued for a process to compost sewage sludge by biological decomposition. Sewage sludge and an organic additive are fed into the upper part of a reactor and air and additional oxygen are fed into the lower part of the reactor for biological decomposition. The sewage sludge and the gases flow countercurrent to each other and the air and oxygen are fed at a rate so that zones of different temperatures and oxygen concentrations prevail at different areas of the reactor. Highest temperatures are in the upper reactor and lowest temperatures are in the lower portion. Locations of high and low O2 concentrations are inversely located to high and low temperature areas.

*Patents, *Sludge treatment, Biological treatment, Sewage treatment, Oxygen, Temperature, Air, Gases, Organic matter

C048
SEWAGE TREATMENT DEVICES PARTICULARLY FOR MARINE APPLICATIONS,

Wray, S. W.

Hamworthy Engineering Limited,
Dorset, England. (assignee)

United States Patent 3,992,299. Issued November 16, 1976. Official Gazette of the United States Patent Office, Vol. 952, No. 3, p 1211, November, 1976. 1 fig.

A patent was issued for a two-container compartment for sewage treatment aboard marine vessels. The extended aeration activated sludge treatment process was employed. The first container had provisions for aeration, inlet, discharge, and flow directing means. Liquid is transferred from the first to the second container and sludge is returned to the first container. The second container also has means for skimming floating debris and returning it to the first container. Provisions are made for the removal of effluent from the second container and for protecting the process from ship movement.

*Patents, *Sewage treatment, *Equipment, *Activated sludge, *Aeration, *Ships, Waste water treatment, Sludge treatment, Liquid wastes, Waste disposal

C049
ELECTRON-BEAM IRRADIATION OF WASTE PRODUCTS-E.G. FOR
STERILIZATION OF SEWAGE SLUDGE AND WASTE INDUSTRIAL PRODUCTS,

French Patent FR 2298-363. Issued October 20, 1976. Derwent French Patents Abstracts, Vol. X, No. 48, p D3, January, 1977.

A patent was issued for a sterilization process for wastes which can be stirred and mixed. The process involves irradiation of materials which flow into a chamber below an electron beam of 300-800 keV. Several parallel waste flow channels which are not transversely joined form the container. They have flat floors inclined to the horizontal and are connected by pumps and pipework. The radiation source covers the entire container and is perpendicular to the flow, producing a uniformly irradiated material. No excessive radiation is needed to treat thick layers. No protection and disposal problems are faced due to the lack of a strongly radioactive source.

*Patents, *Equipment, *Sludge treatment, *Irradiation, Industrial wastes, Sewage treatment, Waste treatment, Waste water treatment, Disinfection

Sterilization

C050
SLUDGE SEPARATOR,

Australian Patent 478,919. Issued December 16, 1976. The Australian Official Journal of Patents, Trade Marks, and Designs, Vol. 46, No. 47, p 4621, December, 1976.

A patent was issued for a sludge separator apparatus to remove sinking and buoyant contaminants from sewage. The apparatus is cylindrical with a vertical axis, and separated into an upper and lower chamber by an insert which also produces a gap between the two chambers. Sewage flows into the lower chamber below the water level and sinking contaminants in the sewage influent are deposited on the vessel bottom while buoyant contaminants are captured on the insert surface facing the bottom.

*Patents, *Separation, *Sludge treatment, *Equipment, Sewage effluents, Sediments, Waste water treatment, Waste treatment, Treatment facilities

C051
OXIDATION AND OZONATION CHAMBER,

Bowen, J. H.

BDH, Incorporated,
Rome, Georgia. (assignee)

United States Patent 4,007,120. Issued February 8, 1977. Official Gazette of the United States Patent Office, Vol. 955, No. 2, p 582, February, 1977. 1 fig.

A patent was issued for an oxidation and ozonation chamber to treat liquids. The combined treatment chamber is composed of several compartments. These compartments contain a rotatable axle with a blade which creates an electrostatic charge by liquid agitation and mixes oxygen and ozone with the liquids.

*Patents, *Equipment, Oxidation, *Ozone, Oxygen, Liquid wastes, Waste treatment, Waste water treatment, Chemical treatment

Electrostatic charge

C052
HYDROCARBON PRODS MFG BY CARBONISATION OF COAL, SCRAP RUBBER OR PLASTIC OR DOMESTIC SEWAGE UNDER REDUCED PRESSURE,

French Patent FR 2300-124. Issued October 8, 1976. Derwent French Patents Abstracts, Vol. X, No. 50, p D5, January, 1977.

A patent was issued for a process to make hydrocarbon products from organic raw materials with coal or an analogous carboniferous material. The process can be applied to domestic sewage. The operation involves circulating the material through an elongated tubular element at a temperature of 425-98 C in the absence of oxygen at a reduced pressure of 50-150 mm Hg. The raw material is agitated as it enters the tube to increase surface area contacting the inner surface of the element. Reduced pressure in the process assures the removal of liquid and gaseous hydrocarbons before secondary reactions occur.

*Patents, *Organic compounds, *Equipment, *Domestic wastes, *Resources development, Waste treatment, Sewage treatment, Coal, Carbon, Natural resources, Oxygen, Chemical reactions

Hydrocarbon products

C053
SEWAGE AERATION IMPELLER-WITH AUTOMATIC DE-ICING AND ANTI-CLOGGING SYSTEM,

Tofaute, K.

Soviet Patent SU-504-472. Issued April 30, 1976. Soviet Inventions Illustrated, Vol. X, No. 51, p D5, February, 1977. 1 fig.

A patent was issued for a sewage water surface aerator employed in biological cleaning. Contamination of external surfaces is prevented by connecting tubes to these surfaces and the volume of the transport channels. The mechanism consists of a conical body with corrugated internal walls and external caps connecting the outer surface with the transporting channel volume. It is fixed to a drive shaft and, when rotated, the liquor is sucked into the transporting channel, mixed with air, and ejected by centrifugal forces. Oxygen from the air further aerates the dispersed liquor.

*Patents, *Aeration, *Equipment, *Sewage treatment, Biological treatment, Cleaning, Waste water treatment, Oxygen, Waste treatment, Sewage effluent

C054
APPARATUS FOR DISPOSAL OF EFFLUENTS,

United States Patent 4,008,155. Issued February 15, 1977. Official Gazette of the United States Patent Office, Vol. 955, No. 3, p 935, February, 1977. 1 fig.

A patent was issued for an apparatus to handle effluent disposal. The equipment is composed of two major enclosures, one within the other, and has a means for flotation on the open sea. The second chamber includes a centrally located open-bottom chamber. The second enclosure has a closed bottom for the accumulation of material separated from the treated effluent transferred to it from the first enclosure. The bottom of the second enclosure has tapered chambers arranged side-by-side with walls that diverge upward so that material which is denser than water is separated from the remainder of the waste.

*Patents, *Waste disposal, *Separation techniques, *Equipment, Surface waters, Pollutants, Water quality control, Water pollution control, Pollutants, Pollution abatement

C055
METHOD OF WASTE TREATMENT AND ALGAE RECOVERY,

Oswald, W. J.

California University,
Berkeley. (assignee)

United States Patent 4,005,546. Issued February 1, 1977. Official Gazette of the United States Patent Office, Vol. 955, No. 1, p 30, February, 1977. 1 fig.

A patent was issued for a method of waste treatment and algae recovery involving three ponds. Sewage containing algae is retained in a pond open to light and air under natural conditions for 10 to 20 days. A portion is transferred to another pond open to light and air which is agitated for 3 to 6 days. Then a portion of the water in the second pond is transferred to a third that is substantially closed to light and remains quiescent for 1 1/2 to 3 days while algae settles. Settled algae is removed from this last pond.

*Patents, *Algae, *Sewage treatment, *Ponds, *Aerobic treatment, Air, Water purification, Waste water treatment, Sewage effluent, Treatment facilities

Algae recovery

C056
OZONE OXIDATION OF WASTE WATER,

United States Patent 4,007,118. Issued February 8, 1977. Official Gazette of the United States Patent Office, Vol. 955, No. 2, p 581-582, February, 1977. 1 fig.

A patent was issued for an ozone oxidation treatment method for waste water containing organic contaminants and bacteria. Waste water is injected into a closed tank, submerging fluid-pervious bags containing powdered metal oxide catalyst (manganese trioxide, ferric oxide, nickel oxide or copper oxide); ozone is injected into the bags for exposure to the catalyst and reaction with waste water flowing through the bags. Purified and inert water is drawn from the tank and ozone is vented from the upper part of the tank.

*Patents, *Oxidation, *Ozone, *Organic matter, *Bacteria, Waste water treatment, Oxides, Equipment, Metals, Sewage treatment

C057
PROCESS FOR THE PURIFICATION OF WASTE WATERS WITH ACTIVATED CARBON,

United States Patent 4,007,116. Issued February 8, 1977. Official Gazette of the United States Patent Office, Vol. 955, No. 2 p 581, February, 1977. 1 fig.

A patent was issued for an activated carbon waste water treatment process. Waste water is passed upward through a column of activated carbon particles and distributed equally over the cross-sectional area. Total organic carbon is determined before water enters the column and simultaneously at a point between 30 and 70% of the carbon particles height in the column. Spent carbon particles are withdrawn from the column bottom at a rate which maintains a selected difference between total organic carbon content of water entering the column and at the above selected point. Fresh activated carbon or reactivated carbon is constantly introduced at the column top to compensate for the withdrawal. Purified water is recovered at the top of the column.

*Patents, *Waste water treatment, *Activated carbon, Organic carbon, Treatment facilities, Equipment, Sewage treatment, Sewage effluents, Water purification, Sanitary engineering

C058
CLARIFIER WITH OVERFLOW SCUM REMOVAL,

United States Patent 4,009,106. Issued February 22, 1977. Official Gazette of the United States Patent Office, Vol. 955, No. 4, p 1265, February, 1977. 1 fig.

A patent was issued for a sewage treatment clarifier. The clarifier has a circular outer wall with submerged feed ports, a conical bottom defining a lower sludge collection area, a sludge return line from the lowest portion of this area, and a circular overflow launder that establishes the normal liquid level in the clarifier. A circular scum trough, a frusto-conical baffle, and a scum collection zone are other features of the system.

*Patents, *Separation, Separation techniques, Waste water treatment, Sewage treatment, Equipment, Water purification, Sewage effluents, Treatment, Sludge

Clarifier, Scum removal

C059
WASTE TREATMENT PROCESS,

United States Patent 4,009,098. Issued February 22, 1977. Official Gazette of the United States Patent Office, Vol. 955, No. 4, p 1262, February, 1977. 1 fig.

A patent was issued for a waste water treatment process for BOD removal. Waste water passes through a bed of microorganisms which oxidizes BOD under aerobic conditions and allows suspended solids to pass through it. This produces an upflow fluidized bed of solid particulate carrier by passing waste water up at a flowrate of 6+ gallons/minute/square foot of bed. About 0.1 to 1.5 milligrams of oxygen per milligram of BOD removed from the waste water are provided to allow the microorganisms to reduce BOD. Specific gravity of the particles is increased by removal of excess microorganism growth from the bed to aid BOD removal. Floc produced by excess growth removal is taken from the process without any interference with operational efficiency.

*Patents, *Waste water treatment, *Biochemical oxygen demand, *Oxidation, Oxygen, Microorganisms, Suspended solids, Aerobic treatment, Aerobic conditions

C060
RENOVATION OF WASTE WATER,

Besik, F.

Ontario Research Foundation,
Sheridan Park,
Ontario, Canada. (assignee)

United States Patent 4,008,159. Issued February 15, 1977. Official Gazette of the United States Patent Office, Vol. 955, No. 3, February, 1977. 1 fig.

A patent was issued for a process to renovate waste water containing contaminants such as suspended solids, dissolved organic material, organic nitrogen-, ammoniacal nitrogen-, nitrite nitrogen-, and nitrate nitrogen-containing materials, phosphate material, odor-producing matter, and turbidity-producing material. The process subjects waste water to primary treatment for partial removal of dissolved organic matter, nitrogenous and phosphate matter, and turbidity-causing matter, followed by effluent removal to a second treatment zone where adsorption-biological treatment using activated carbon and microorganisms takes place. The effluent from this stage is treated with chemical coagulants, and then treated with ozone and oxygen. After the filtration of solids, renovated water is removed.

*Patents, *Water purification, Suspended solids, Organic matter, Inorganic compounds, Nitrogen compounds, Odor, Adsorption, Biological treatment, Chemical treatment, Filtration, Coagulation, Microorganisms, Phosphates, Waste water treatment

Waste water renovation

C061
WASTE TREATMENT APPARATUS,

Jeris, J. S.

Ecolotrol, Incorporated,
Bethpage, New York. (assignee)

United States Patent 4,009,105. Issued February 22, 1977. Official Gazette of the United States Patent Office, Vol. 955, No. 4, p 1264, February, 1977. 1 fig.

A patent was issued for a treatment apparatus to biologically remove BOD from waste water. The equipment is composed of an elongated vertical container with a manifold near the bottom for control of waste water passage through the container, and an inlet for waste water that will be treated. Above the manifold is a fluidized bed of a solid particulate carrier with a layer of cultured microorganisms for BOD oxidation. There are means for adding oxygen to the bed which is arranged to receive the waste water and biologically convert most of the BOD to be removed to carbon dioxide, water, and cellular material. The waste water and carbon dioxide are continuously removed through an outlet, and the excess cellular material is removed from the particulate carrier.

*Patents, *Equipment, *Biochemical oxygen demand, *Biological treatment, *Oxidation, Microorganisms, Filters, Oxygen, Carbon dioxide, Waste water treatment, Organic matter

C062
METHOD OF TREATING WASTE WATER WITH JET NOZZLES,

United States Patent 4,009,100. Issued February 22, 1977. Official Gazette of the United States Patent Office, Vol. 955, No. 4, p 1263, February, 1977. 1 fig.

A patent was issued for a treatment process for activated sludge systems with aerating nozzles submerged in the waste water and activated sludge contained in a reservoir. A gas stream of air or high-oxygen gas is propelled through the nozzles, near the bottom of this mixture, into a small impulse exchange tube. A directional flow is produced in a rotary motion by ascending bubbles to create a screw motion flow in the waste water/activated sludge mixture.

*Patents, *Activated sludge, *Aeration, Equipment, Gases, Air, Oxygen, Sludge treatment, Waste water treatment, Water purification, Waste treatment

C063
PROCESS FOR THE TREATMENT OF WASTE WATER BY HETEROGENEOUS PHOTOSENSITIZED OXIDATION,

Williams, J. R.

Temple University,
Philadelphia, Pennsylvania. (assignee)

United States Patent 4,008,136. Issued February 15, 1977. Official Gazette of the United States Patent Office, Vol. 955, No. 3, p 929, February, 1977.

A patent was issued for the treatment of waste water by heterogeneous photosensitized oxidation. This process is especially for waste water containing organic materials. A water insoluble polymer-based photosensitizer is added to the waste effluent in the presence of oxygen. The suspension is photolyzed by light with a wave-length between 320 and 800 nm.

*Patents, *Light, *Oxidation, *Polymers, *Liquid wastes, Sewage effluents, Oxygen, Water purification, Waste water treatment, Treatment

Photolysis

C064
DEVICE FOR SUCKING THE UPPER LAYER OF A POLLUTED WATER SURFACE,

United States Patent 4,008,156. Issued February 15, 1977. Official Gazette of the United States Patent Office, Vol. 955, No. 3, p 935, February, 1977. 1 fig.

A patent was issued for a device to collect floating pollutants from water surfaces. The mechanism has an inlet opening in the forward portion connected to a channel with extending sidewalls so that polluted water flows through the channel from the inlet opening. A collection chamber is provided with means to separate the polluting materials according to their specific gravities. A negative pressure area sucks the pollutants into the collection chamber and means are provided to remove separated water and pollutants from the collection chamber.

*Patents, *Equipment, *Separation techniques, *Specific gravity, Separation, Water pollution control, Surface waters, Pollutants, Water quality control, Pollution abatement

C065
METHOD OF APPLYING OZONE AND SONIC ENERGY TO STERILIZE AND OXIDIZE WASTE WATER,

Henderson, A. D., and Periale, J. M.

TII Corporation,
Lindenhurst, New York. (assignee)

United States Patent 4,003,832. Issued January 18, 1977. Official Gazette of the United States Patent Office, Vol. 954, No. 3, p 1203, January, 1977. 1 fig.

A patent was issued for a method employing ozone and sonic energy to sterilize and oxidize waste water. A coagulating agent is added, followed by a polyelectrolyte to form a floc. The water is passed through a lamina to remove suspended solids, and is then passed in a counter-flow through a gravity gradient stand of water. The water is pre-treated with ozone and sonic energy to cause cavitation. Further treatment by ozone and sonic energy produces additional cavitation for effective oxidation and sterilization.

*Patents, *Ozone, *Sound waves, *Cavitation, *Oxidation, Water purification, Suspended solids, Coagulation, Polyelectrolytes, Waste water treatment, Sterilants

C066
APPARATUS AND PROCESS FOR REMOVING AMMONIA NITROGEN FROM WASTE WATER,

Jeris, J. S.

Ecolotrol, Incorporated,
Bethpage, New York. (assignee)

United States Patent 4,009,099. Issued February 22, 1977. Official Gazette of the United States Patent Office, Vol. 955, No. 4, p 1262, February, 1977. 1 fig.

A patent was issued for an apparatus and biological process to remove ammonia nitrogen from waste water. The process includes a fluidized bed of a solid particulate carrier with a cultured layer of nitrifying microorganisms. Waste water continuously passes through this bed, to which oxygen is added, and retained at a controlled temperature and length of time under aerobic conditions. This biologically converts most of the ammonia nitrogen to be removed from the waste water to oxidized forms of nitrogen, water and cellular material. These oxidized nitrogen forms and the water are continuously removed from the bed, as the excess cellular material is removed from the particulate carrier.

*Patents, *Equipment, Water purification, Biological treatment, Oxygen, Ammonia, Nitrogen, Ammonia compounds, Microorganisms, Temperature, Oxidation, Waste water treatment, Aerobic conditions

Fluidized bed

C067
WASTE-WATER PROCESS,

United States Patent 4,002,565. Issued January 11, 1977. Official Gazette of the United States Patent Office, Vol. 954, No. 2, p 777-778, January, 1977. 1 fig.

A patent was issued for a process to produce recycle water and to separate ammonia and acid gas from waste water. Waste water is passed through an acid gas-ammonia stripping column, which is maintained at a bottoms temperature of 93-149 C and a pressure of 1 to 5 atmospheres absolute, to produce a recycle water stream and an effluent gas stream of acid gas, ammonia, and water vapor. The acid gas and ammonia content is less than 15% of that in the waste water. The two streams are separately withdrawn from the stripper and a liquid aqueous concentrate of ammonia and gas are produced by decreasing the temperature of the gas stream to about 55 to 110 C. The concentrate is passed into a primary acid-gas stripping column, and is maintained at superatmospheric pressure acid-gas stripping conditions to produce an effluent acid-gas stream and an aqueous bottoms stream. The acid-gas stream and the bottoms stream are separately removed from the acid-gas stripping column to produce an effluent gas stream of ammonia, and a second recycle water stream by passing the bottoms stream through an ammonia stripping column. This column is maintained at superatmospheric pressure ammonia stripping conditions. The second stream has an acid gas and ammonia content which is 15% less than that of the bottoms stream from the acid-gas stripping column.

*Patents, *Water reuse, *Ammonia, *Acids, *Gases, Waste water treatment, Separation, Temperature, Equipment, Water purification, Liquid wastes

C068
METHOD FOR ELIMINATING ORGANIC AND INORGANIC BOUND NITROGEN FROM DOMESTIC AND INDUSTRIAL WASTE WATER,

United States Patent 4,011,156. Issued March 8, 1977. Official Gazette of the United States Patent Office, Vol. 956, No. 2, p 566-567, March, 1977. 1 fig.

A patent was issued for a method to eliminate organic and inorganic bound nitrogen from domestic and industrial waste water. The process involves two stages connected in series which can directly process unclarified waste water in a biological activated sludge treatment plant. Waste water is aerated in the first stage and transferred to the settling basin where a clarified effluent is transferred into the second stage aeration tank and then to the second stage settling basin. Waste water with organic and inorganic bound nitrogen is aerated in the first stage tank and the organic bound nitrogen is ammonified. The ammonified waste water is transferred to the first settling basin and nitrates are denitrified. This effluent is transferred to the second aeration tank where an oxygen level of at least 2 milligrams/liter is provided. Ammonia is nitrified to nitrates in this section and the process is continued by recirculating a portion of the clarified effluent from the second settling basin to the first aeration tank.

*Patents, *Aeration, *Nitrogen, Organic matter, Inorganic compounds, Domestic wastes, Industrial wastes, Waste water treatment, Water purification, Denitrification

C069
MARINE SANITATION METHOD AND DEVICE,

Behrendt, G. H., and Potter, J. L.

Filteron Systems Incorporated,
Dallas, Texas. (assignee)

United States Patent 4,009,104. Issued February 22, 1977. Official Gazette of the United States Patent Office, Vol. 955, No. 4, p 1264, February, 1977. 1 fig.

A patent was issued for an automatic marine sanitation unit and sanitation method. The system incorporates two storage tanks, a sewage inlet to the first tank, and a separator for solids beyond a determined size limit. A means is provided for the circulation of salt water containing sewage from the first to the second tank while the first tank is filling. The effluent passes through an electrolytic cell during this transfer. A portion of treated effluent is returned to the first tank.

*Patents, *Equipment, Sewage treatment, Saline water, Sanitary engineering, Waste water treatment, Electrolysis, Water purification, Storage

Marine sanitation

C070
METHOD OF TREATING WASTE WATER WITH JET NOZZLES,

United States Patent, 4,009,100. Issued February 22, 1977. Official Gazette of the United States Patent Office, Vol. 955, No. 4, p 1263, February, 1977. 1 fig.

A patent was issued for a waste water treatment system using aerating nozzles. These nozzles are submerged in a body of waste water and activated sludge. A gas stream of air, or a high-oxygen gas, or parallel streams of air, are injected into the liquid. The ascending bubbles column produces a rotary motion which is superimposed on the directional flow caused by the gas impulse. A screw type flow of the waste water and activated sludge is thus created.

*Patents, *Aeration, *Air, *Oxygen, Gases, Activated sludge, Flow, Equipment, Waste water treatment, Liquid wastes

C071
WATER WASTE TREATMENT,

United States Patent 4,011,163. Issued March 8, 1977. Official Gazette of the United States Patent Office, Vol. 956, No. 2, p 569, March, 1977. 1 fig.

A patent was issued for a sewage treatment apparatus. The device consists of an outer tank enclosing a mixing chamber with a draft tube for sewage transport to the mixing chamber. An outer draft tube is positioned annularly about the first draft tube, and an inner tank, positioned annularly about the outer draft tube, is below and open to the mixing chamber and acts as a primary settling circuit. There are two annular passageways between the inner tank and the outer wall. A portion of the sewage solids from the primary and secondary settling circuits can be returned to the mixing chamber. The mixing chamber contains a pumping means for the introduction of air into the sewage. There is a digester compartment with a connective means to the primary and secondary settling circuits and a sewage treatment outlet.

*Patents, *Equipment, Sewage treatment, Sludge digestion, Suspended solids, Sedimentation, Liquid wastes, Waste water treatment, Treatment, Air

C072
INCINERATION METHOD AND SYSTEM,

United States Patent 4,013,023. Issued March 22, 1977. Official Gazette of the United States Patent Office, Vol. 956, No. 4, p 1202, March, 1977. 1 fig.

A patent was issued for a method and apparatus for sludge incineration. Dewatered sludge containing organic wastes is incinerated in a multiple hearth furnace equipped with an afterburner for receiving gases and vapors from the furnace. Wastes are pyrolyzed in a regulated oxygen-deficient atmosphere so that the products of the pyrolysis are only partially oxidized. These products are then conveyed in the gases and vapors from the furnace to the afterburner, where enough air is introduced to complete their oxidation.

*Patents, *Incineration, *Equipment, Oxidation, Gases, Oxygen, Sludge disposal, Dewatering, Air, Waste water treatment

Multiple hearth furnace, Afterburners

C073
PREFABRICATED PANELS FOR SUB-SURFACE SEWAGE EFFLUENT AND WASTE WATER DISPOSAL,

United States Patent 4,013,559. Issued March 22, 1977. Official Gazette of the United States Patent Office, Vol. 956, No. 4, p 1380, March, 1977. 1 fig.

A patent was issued for prefabricated panels to be used for underground sewage effluent and waste water disposal from septic tanks. There is at least one panel section which includes top, bottom, end, and side walls of a strong, porous cementitious material. Several elongated chambers with an upper, lower, and intermediate chamber, one above the other, are arranged within the section. These are partially separated by a web of the porous cementitious material. A pipe extends from the septic tank into the upper chamber to allow air and waste water to enter the panel section. There is also a means for overflow effluent to move through the separating webs to the lower chambers.

*Patents, *Concrete, *Underground disposal, Septic tanks, Sewage disposal, Waste water disposal, Liquid wastes, Construction materials, Ultimate disposal, Disposal

C074
COAL DISTN. WASTE LIQUOR PURIFICN. TO REMOVE PHENOLS, AMMONIA- AND HYDROGEN SULPHIDE BY 2-STAGE SOLVENT EXTN. AND DISTN.,

South African Patent ZA 7600-011. Issued November 11, 1976. Derwent French Patents Abstracts, Vol. Y, No. 4, p D4, March, 1977.

A patent was issued for a method to remove monohydric and polyhydric phenols, hydrogen sulfide, and free and combined ammonia from sewage by extracting and distilling waste water formed during degasification or gasification of coal with subsequent biological purification. Most of the monohydric phenol, part of the polyhydric phenols, and any free fatty acids present are separated by extraction. Phenols are separated by distillation. Next, a major portion of the polyhydric phenols is separated and the remainder of the monohydric phenols and free fatty acids are separated by extraction with an organic solvent. Phenols in this extract are changed to their salts which are then washed. This mixture is separated into an organic and aqueous phase. The organic phase is recycled, and free phenols are separated from the aqueous phase by surplus CO_2 and by decanting and/or extraction with the organic solvent or the sump product.

*Patents, *Separation techniques, *Phenols, *Ammonia, *Hydrogen sulfide, Distillation, Liquid wastes, Sewage treatment, Waste water treatment, Treatment

C075
OXYGEN ADDN. REGULATION IN WATER AND SEWAGE PURIFICN.--USING EJECTORS TO SECURE INTIMATE CONTACT WITH ACTIVATED SLUDGE,

Belgian Patent BE 845-103. Issued February 14, 1977. Derwent Belgian Patents Abstracts, Vol. Y, No. 6, p J3, March, 1977.

A patent was issued for oxygen addition regulation in water and sewage purification. The process is designed for plants with at least one treatment unit mounted in cascade. A gas with a 20-45% volume of oxygen is introduced in the finely divided state to produce a great agitation of the waste water. Two units in cascade are fed with water from the inlet on the suction side of the pump which also recycles partially purified water containing activated sludge. This mixture is pumped through an ejector to meet the recycled gas from a compressor. Activated sludge from the settlement tank has a flocculant structure and goes into suspension in the liquid in the first unit. Technical oxygen is introduced in a quantity dependent upon the content of biodegradable materials in the water. Oxygen in the first unit water is maintained at 1-4 milligrams/liter. A rapid transfer of oxygen to the liquid and of dissolved oxygen in the liquid to the finely divided activated sludge is assured. The amount of dissolved oxygen can be maintained at a constant value despite variations in the rate of the raw water supply.

*Patents, *Oxygenation, Treatment facilities, Oxygen, Sludge treatment, Sewage treatment, Activated sludge, Water purification, Dissolved oxygen, Gases, Waste water treatment

C076
FLOTATION TREATMENT OF WASTE WATER AND SEWAGE-USING GAS CONTG. OXYGEN IN DEEP PIT TO FLOAT THE PARTICLES,

French Patent FR 2306-745. Issued December 10, 1977. Derwent French Patents Abstracts, Vol. Y, No. 6, p J3, March, 1977.

A patent was issued for the flotation treatment of waste water and sewage. The device is composed of a tank with a pit beneath it which contains rising and descending passages separated by a partition. These passages are connected above and below the partition. The upper passage extends above the tank base and contains a means for directing flow. The rising passage opens into a flotation chamber near a separator, and the upper end of the chamber opens in a flotation tank. Gas containing oxygen is injected into the two passages. The bubbles of the gas are injected into the descent passage and move down to where the pressure is greatest and their size is reduced. Most of the bubbles are completely absorbed by the water at the lowest levels. When the water rises, the bubbles reappear and grow. Air bubbles attach to the particles which pass through the opening into the flotation chamber, and raise the solids to the surface where they are raked off and evacuated. Substantial sludge recycling is possible without sedimentation, thereby avoiding long anaerobic tank treatment. Special compression chambers or decompression systems are not necessary to achieve flotation.

*Patents, *Separation techniques, *Flotation, *Equipment, Waste water treatment, Sewage treatment, Sludge treatment, Air, Gases, Oxygen

C077
MACERATOR-STERILIZER SEWAGE TREATMENT SYSTEM,

Saigh, P. A., and Glueckert, A. J.

General American Transportation Corporation,
Chicago, Illinois. (assignee)

United States Patent 4,012,322. Issued March 15, 1977. Official Gazette of the United States Patent Office, Vol. 956, No. 3, p 958-959, March, 1977. 1 fig.

A patent was issued for a sterilizer sewage treatment system which collects, treats, and discharges toilet wastes. The system is composed of a collection tank, a sterilization tank, and a transfer pump which is connected to the collection tank and to the sterilization tank by a power-operated valve transfer mechanism. Liquid sewage is measured into the sterilization tank where the temperature is elevated to a preset level. Automatic controls and sensors operate the valves, pumping, and heating mechanisms to control effluent flow.

*Patents, *Domestic wastes, *Liquid wastes, Sewage treatment, Automatic controls, Temperature, Heat treatment, Equipment, Sewage effluents, Waste water treatment

Sterilization

C078
METHOD FOR IMPROVING THE QUALITY OF CONTAMINATED WASTE WATER,

United States Patent 4,012,320. Issued March 15, 1977. Official Gazette of the United States Patent Office, Vol. 956, No. 3, p 958, March, 1977. 1 fig.

A patent was issued for a method to improve contaminated waste water quality by removing pollutants. An aqueous solution of an alkali metal silicate and a silicate setting agent are mixed with the contaminated waste water to form an earth-like material. This material is pulverized and mixed with the waste water to react with pollutants. After a sufficient mixing time, the water is separated from the pulverized material and pollutants.

*Patents, *Adsorption, Separation techniques, Water quality, Waste water treatment, Pollution abatement, Chemical reactions, Liquid wastes, Alkalis, Water purification

C079
WASTE TREATMENT APPARATUS,

United States Patent 4,009,105. Issued February 22, 1977. Official Gazette of the United States Patent Office, Vol. 955, No. 4, p 1264, February, 1977. 1 fig.

A patent was issued for a waste treatment apparatus for BOD removal from waste water by biological treatment. A vertical container has a manifold near the bottom which controls waste water flow into the container. A fluidized bed composed of a solid particulate carrier with a layer of microorganisms for BOD oxidation lies above the manifold. Oxygen is added to this bed. BOD is oxidized to water, carbon dioxide, and cellular material. There is an outlet and a means for continually withdrawing the products of BOD oxidation.

*Patents, *Oxidation, *Biochemical oxygen demand, Equipment, Microorganisms, Oxygen, Carbon dioxide, Biological treatment, Waste water treatment, Waste treatment

C080
SEWAGE TREATMENT APPARATUS,

Snodgrass, J. D., and Pilolla, J. J.

Sloan Valve Company,
Franklin Park, Illinois. (assignee)

United States Patent 4,013,557. Issued March 22, 1977. Official Gazette of the United States Patent Office, Vol. 956, No. 4, p 1379, March, 1977. 1 fig.

A patent was issued for an apparatus providing for the electrolytic treatment of sewage. This treatment occurs in a casing with electrodes positioned between the casing inlet and a valve adjacent to the discharge outlet. A fluid is introduced to this treatment zone to provide agitation and turbulence which produces a homogeneous sewage liquid. Projections above the treatment area, and adjacent to the electrodes aid sewage reduction.

*Patents, *Electrolysis, *Electrodes, Equipment, Water purification, Waste water treatment, Liquid wastes, Waste treatment, Treatment facilities, Mechanical engineering

C081
SKIMMER APPARATUS FOR SEWAGE SETTLING TANKS AND THE LIKE,

United States Patent 4,011,164. Issued March 8, 1977. Official Gazette of the United States Patent Office, Vol. 956, No. 2, p 569, March, 1977. 1 fig.

A patent was issued for a skimmer apparatus for sewage settling tanks. The device consists of a ramp with one end below the tank liquid level and the other above this level. It is mobilized to move back and forth across the tank. A boom is attached which moves the scum towards and into a scum trough at one end of the tank.

*Patents, *Sedimentation, *Settling basins, Equipment, Water purification, Waste water treatment, Treatment facilities, Municipal wastes, Pollutants

C082
CONTROL OF AEROBIC BIOLOGICAL GROWTH IN ACTIVATED CARBON WASTE TREATMENT,

Australian Patent 480,396. Issued June 25, 1973. The Australian Official Journal of Patents, Trade Marks, and Designs, Vol. 47, No. 5, p 382, February 17, 1977.

A patent was issued for a process to remove suspended and dissolved organic matter from waste water. The waste water is pretreated for removal of suspended matter and passed through at least one activated carbon bed to remove dissolved contaminants. Oxygen is added to the bed at a rate of 0.09-0.15 pounds per pound of COD contaminants removed.

*Patents, *Activated carbon, Suspended solids, Organic matter, Filtration, Oxygen, Chemical oxygen demand, Waste water treatment, Water purification, Pollution abatement

C083
PROCESS FOR SLUDGE DISPOSAL AND CIRCULAR LANDFILL SYSTEM,

Jordan, J. L.

Dravo Corporation,
Pittsburgh, Pennsylvania. (assignee)

United States Patent 4,016,073. Issued April 5, 1977. Official Gazette of the United States Patent Office, Vol. 957, No. 1, p 266, April, 1977. 1 fig.

A patent was issued for a disposal process for waste products, including aqueous sludge, in a circular landfill. The circular disposal area has a raised central portion and a dike perimeter. Several disposal ponds are created by radial dikes from the center to the dike perimeter. Aqueous sludge is charged from a central mechanism into the first of the disposal ponds, settled, and the supernatant water is removed from a location near the perimeter dike. The settled solids are dried by evaporation and are mechanically disturbed to aerate added settled sludge solids. Solid absorbent particulate matter is deposited on the partially dried sludge solids and mixed to form a landfill material within the disposal pond. The material is compacted, which raises the level of the perimeter dike and radial dikes, and the process is repeated.

*Patents, *Sludge disposal, *Landfills, Soil disposal field, Solid wastes, Evaporation, Aeration, Drying, Waste water treatment, Sludge treatment

C084
RECIRCULATING SEWERAGE SYSTEM,

Davis, R. B.

Koehler-Dayton, Incorporated,
New Britain, Connecticut. (assignee)

United States Patent 4,017,395. Issued April 12, 1977. Official Gazette of the United States Patent Office, Vol. 957, No. 2, p 712, April, 1977. 1 fig.

A patent was issued for a recirculating sewage system and toilet. Wastes are filtered after flushing and mixed with bath water from a reservoir for this purpose. Solids remaining after filtration are washed into a solids collection area. The collected filtrate is directed back to the toilet for the next flushing.

*Patents, *Water reuse, Sewage treatment, Filtration, Sewage effluents, Liquid wastes, Equipment, Domestic wastes, Water conservation, Waste water treatment

C085
AEROBIC TREATMENT OF LIQUID WASTES--WITH OXYGEN CONC. MEASURED AND USED TO CONTROL PUMP SPEED USED TO FORCE LIQUID THROUGH VENTURIS,

Netherlands Patent NL 7608-692. Issued February 8, 1977. Derwent Netherlands Patents Abstracts, Vol. Y, No. 8, p D7, April 1, 1977.

A patent was issued for an aerobic treatment process for liquid wastes. The waste flows through a reservoir and a portion is removed and reinjected, with added air, into the reservoir. This creates a horizontal aerated liquid flow. A device, sensitive to the liquid oxygen concentration, controls the speed of the pump which forces the liquid through the ejectors to maintain a determined dissolved oxygen level. Liquid from the reservoir flows out and up through tube settlers above the level of the ejectors. The process may be applied to sanitary and industrial waste liquids. Power needs are lowered and a maximum efficiency is obtained.

*Patents, *Aerobic treatment, *Oxygen, *Pumps, Liquid wastes, Reservoirs, Dissolved oxygen, Sewage effluents, Sedimentation, Equipment, Industrial wastes, Performance, Waste water treatment

C086
MECHANICAL SURFACE AERATOR FOR EFFLUENT PURIFICN.--HAS THE LIQUID SCOOPED BY THE CURVED ELEMENTS AND EJECTED INTO THE AIR ABOVE,

Chumachenko, P. N., Papkov, G. I., and
Kostenko, V. F.

Soviet Patent SU 508-485. Issued August 6, 1976. Soviet Inventions Illustrated, Vol. Y, No. 9, p D3-D4, April 12, 1977. 1 fig.

A patent was issued for an aerator to be used in the biochemical purification of water. The device consists of a vertical shaft with curved elements mounted at angles to each other, and a mechanical drive. Inlets and outlets are placed about the rotational direction of the shaft. Rotation of the elements occurs as the liquid passes through. The liquid is then ejected into the air above the liquid level for aeration. This saturates the liquid with oxygen; additional mixing and aeration take place on the side plane of the curved element. Aeration effectiveness is very independent of level variations in the aeration tank.

*Patents, *Aeration, *Equipment, Water purification, Performance, Domestic wastes, Industrial wastes, Oxygen, Liquid wastes, Waste water treatment

C087
BREAKING DOWN SOLID AND LIQUID WASTE TO FORM A FERTILIZER--BY INOCULATION WITH SELECTED FUNGI AND FERMENTATION,

Netherlands Patent NL 7608-433. Issued February 2, 1977. Derwent Netherlands Patents Abstracts, Vol. Y, No. 8, p D5, April 1, 1977.

A patent was issued for a process to transform solid and liquid wastes, which are compressed or comminuted, into fertilizer. Ferrous metals are removed and the material is fermented at room temperature and inoculated with fungus, yeast, or mold. Milling and mixing after inoculation distributes the fungi through the material. It is then placed in a closed aerobic area. This method can be used to treat solid domestic waste and sludge from either domestic or industrial waste water treatment. Various feedstocks may be treated by this process. The resultant product is stable and has properties resembling natural manure.

*Patents, *Solid wastes, *Liquid wastes, *Fertilizers, *Fungi, *Fermentation, Metals, Aeration, Domestic wastes, Industrial wastes, Microorganisms, Recycling, Waste water treatment

C088
SLUDGE COLLECTOR AND LIGHT LIQ. SEPARATOR--FROM SEWAGE WITH TWO TANKS IN SINGLE HOUSING AND COVER,

French Patent FR 2309-677. Issued December 31, 1976. Derwent French Patents Abstracts, Vol. Y, No. 9, p D9, April, 1977.

A patent was issued for a process to collect sludge and to separate settled materials from light liquids. The apparatus is installed in a common covered housing. Contaminated water enters the inlet and settled material is placed in the collector as the liquid moves over the overflow and under a partition into the separator. Light materials float upwards and water passes under the partition. A pump evacuates buildups of separated matter. Light liquids are removed through one pipe and sludge through another. Water is recycled for jet injection to break up the floating light materials; the collector and separator are washed by water. Separated materials can be removed by a pump as needed.

*Patents, *Sludge treatment, *Liquid wastes, *Separation, *Equipment, Oil wastes, Pumps, Sewage effluents, Water reuse, Separation techniques, Waste water treatment

C089
CLEANING OF SEWAGE SLUDGE SYSTEM,

Australian Patent 480,414. Issued February 17, 1977. Australian Official Journal of Patents, Trade Marks, and Designs, Vol. 47, No. 5, p 387, February, 1977.

A patent was issued for a sludge system cleaning process. The process involves a high pressure pump connected to a sludge source, and piping from the pump to a heat exchanger, a reactor, a separator, and an oxidized sludge tank. A cold water source separated from the sludge source has a separate pipe leading to the pump. The sludge line to the pump is closed and the cold water line is opened. The cold water is directed through the heat exchanger, by-passing the reactor, to isolate the hot reactor contents from the system. Afterwards, the cold water line is closed, the sludge line is opened, and the reactor is returned to the system. Sludge blockage is removed by cold water flowing through the heat exchanger in the reverse direction of sludge flow during normal operation. The blocking material is flushed through a previously closed drain line.

*Patents, *Sludge treatment, *Cleaning, Pumps, Piping, Separation, Oxidation, Heat exchangers, Waste water treatment, Equipment

C090
SCREENING APPTS. FOR REMOVAL OF SOLIDS--FROM SEWAGE WITH ROTATING SCREEN AND VERTICAL LIFT FOR RESIDUES,

French Patent FR 2308-599. Issued December 24, 1976. Derwent French Patents Abstracts, Vol. Y, No. 8, p D5, April, 1977.

A patent was issued for a screening apparatus to remove solids from sewage. Sewage flows through a cylindrical screen with a vertical axis and solids are retained on the external face, separating them from the flow. The screen is either fixed or rotated by motor. A second screen, of vertical rods, is located to the side of the first one. The rods extend above the level of flow and a hydraulic ram moves a lifting plate up and down. This plate collects solids which remained on the second screen and pushes them into a compression chamber. The first screen has a scraper and the process is continuous.

*Patents, *Separation techniques, *Solid wastes, *Filtration, Equipment, Sewage effluents, Mechanical engineering, Sewage treatment, Waste water treatment, Waste treatment

C091
SEWAGE DISPOSAL SYSTEM,

Australian Patent 478,238. Issued November 25, 1976. The Australian Official Journal of Patents, Trade Marks, and Designs, Vol. 46, No. 44, p 4320, November, 1976.

A patent was issued for a sewage disposal system. It is composed of a main frame positioned at a selected above-ground level with at least one vertical shank secured to it that penetrates the ground to a chosen depth. An underground disposal tunnel is formed by an axially elongate foot attached to a plow at the shank's lower end. Servomechanisms vary the cross-sectional area of the tunnel during operation. A dispensing port is at the end of the flow path for sewage discharge into the tunnel.

*Patents, *Sewage disposal, Equipment, Waste treatment, Sewage treatment, Hydraulic engineering, Waste disposal, Mechanical engineering, Waste water treatment

C092
DISINFECTION SYSTEM AND METHOD,

Mandt, M. G.

Houdaille Industries, Incorporated,
Buffalo, New York. (assignee)

United States Patent 4,019,983. Issued April 26, 1977. Official Gazette of the United States Patent Office, Vol. 957, No. 4, p 1565, April, 1977. 1 fig.

A patent was issued for a sewage disinfection method and system. Sewage effluent is continuously mixed and passed to a disinfection zone, while maintaining a turbulent energy dissipation level in the mixing zone of at least 5 sec to the minus one. Thus, the fluid disinfectant and the effluent are sufficiently mixed to produce a toxic environment for organism inactivation. The process produces a treated effluent with a 99.9% bacterial kill measured by fecal coliform removal and a viral kill rate of 99% measured by f2 virus removal.

*Patents, *Disinfection, Sewage effluents, Equipment, Water purification, Bacteria, Coliforms, Viruses, Microorganisms, Waste water treatment

C093
HIGHLY EFFICIENT AERATING SYSTEM--FOR AN ACTIVATED SLUDGE EFFLUENT TREATMENT PLANT, WITH RESTRICTED LIQUID CIRCULATION IN AERATING TANK,

French Patent FR 2311-758. Issued January 1, 1977. Derwent French Patents Abstracts, Vol. Y, No. 11, p D3, April, 1977.

A patent was issued for an activated sludge treatment aeration system. Domestic or industrial waste effluents are treated by diffusing an oxygen-containing gas through aerators into an aeration tank containing bacterial sludge. The tank bottom aerators are fixed to a movable platform for continuous motion. Air lift pumps hold the settling sludge in suspension. Baffles limit the circulation of tank contents, but do not interfere with aeration. A portion of the aerated effluent is supplied by a connection with a sedimentation tank while the rest of the separated effluent can be recycled to the aeration tank for solids content regulation.

*Patents, *Aeration, *Activated sludge, Treatment facilities, Sewage effluents, Equipment, Pumps, Design, Performance, Waste water treatment

C094
WASTE WATER BIOCHEMICAL PURIFCN. CONTROL--BY AUTOMATED DETERMN. OF CARBON DIOXIDE CONCN. WITH BARIUM HYDROXIDE SOLN.,

Soviet Patent SU 517-845. Issued August 2, 1976. Soviet Inventions Illustrated, Vol. Y, No. 11, p D1, April, 1977.

A patent was issued for a method to control biochemical treatment of waste water using automated determination of carbon dioxide concentrations. The carbon dioxide monitor includes a circulating pump, respirometric flask, a vessel of barium hydroxide solution with pH meter electrodes and temperature sensor, automatic titration, and a digital analogue transducer with a register. The barium hydroxide solution is kept constant. Carbon dioxide production is monitored during biological oxidation of organic compounds in waste water. The carbon dioxide gas reacts with the barium hydroxide to create a pH change while the temperature is monitored. A reagent flows to a dispenser to keep the pH at a constant value.

*Patents, *Water purification, *Monitoring, *Equipment, *Carbon dioxide, Hydrogen ion concentration, Temperature, Automation, Oxidation, Organic compounds, Gases, Electrodes, Waste water treatment

C095
CONTINUOUS COMPOSTING OF ORGANIC W W WASTE--BY AUTOMATIC CONTROL OF FERMENTATION TEMPERATURE AND HUMIDITY OF PRODUCT AND CONTROL OF CARBON DIOXIDE OR OXYGEN IN WASTE GASES,

Kneer, F. X.

Netherlands Patent NL 7604-357. Issued March 17, 1977. Derwent Netherlands Patents Abstracts, Vol. Y, No. 13, p D1, May, 1977.

A patent was issued for a continuous composting process for organic waste water sludge. Major features of the system are automatic control of fermentation temperature, product humidity, and carbon dioxide or oxygen in the waste gases. The waste/sludge flows down through a closed aeration reactor. Reactor readings determine the amount of air contacted with the waste stream. The air bubbles flow upward through the waste. Quantity and flow rate are controlled based on comparisons of the pre-set and real values of CO_2 and O_2 in the waste air. Water is supplied as a function of humidity measurements made in the upper and lower thirds of the waste stream. Air heated to 30-50 C is supplied to the base of the waste. The process operates for long periods under optimum conditions and a minimum of labor. The compost contains a high degree of biologically active microorganisms and is free of pathogenic organisms and weed seeds.

*Patents, *Sludge disposal, Organic matter, Automatic control, Fermentation, Temperature, Humidity, Carbon dioxide, Oxygen, Equipment, Aeration, Microorganisms, Waste water treatment, Ultimate disposal

C096
BIOLOGICAL TRANSFORMATION PLANT FOR REFUSE AND SLUDGE--WITH PRE-MIXER FOR TREATMENT CHAMBER,

Kaelin, J. R.

French Patent FR 2312-474. Issued January 28, 1977. Derwent French Patents Abstracts, Vol. Y, No. 11, p D8, April, 1977.

A patent was issued for a treatment facility to process domestic wastes and/or thickened sludge for humus production. The material is mixed in the upper portion of a treatment chamber. The mixer exterior is heated by air from the biological transformation process. The material is softened during treatment. Hot, dry air enters through a pipe and humid, oxygen-depleted air is removed. The entering air may be enriched with oxygen. Blades are arranged for gas diffusion and aeration. Sludge enters by pipe, after being dried to 75% of its moisture content. It then undergoes partial aeration in a preliminary mixer. The sludge is heated and, if necessary, mixed with treated material for regulation of temperature, consistency, and biological condition. The gaseous current in the treatment chamber accelerates the heat from the biological transformation process.

*Patents, *Biological treatment, *Treatment facilities, Domestic wastes, Sludge, Humus, Heat treatment, Oxygen, Aeration, Temperature, Gases, Waste treatment, Ultimate disposal

C097
SEWAGE CLARIFIER SYSTEM,

Hughes, C. D.

United States Patent 4,024,060. Issued May 17, 1977. Official Gazette of the United States Patent Office, Vol. 958, No. 3, p 1194, May, 1977. 1 fig.

A patent was issued for a tube clarifier system to treat sewage effluent. The clarifier is connected to a main pond and to a compressed air source. A settling conduit is connected to the pond at one end, and to an outlet and air lock at the other end. The air lock structure includes a U tube chamber connected to the discharge means and to an inverted U tube chamber which has a connection with the compressed air source. Means are provided for the creation of back pressure and its release. A second air lock assembly is contained within the discharge tube.

*Patents, *Water purification, Equipment, Air, Sedimentation, Ponds, Sewage treatment, Waste water treatment, Design

C098
RADIOACTIVE TREATMENT OF SEWAGE SLUDGE--IN IRRADIATION CHAMBER SUNK IN PIT BELOW WATER TANK AS RADIATION SCREEN,

Netherlands Patent NL 7512-546. Issued March 15, 1977. Derwent Netherlands Patents Abstracts, Vol. Y, No. 13, p D1, May, 1977.

A patent was issued for an irradiation treatment system for sewage sludge. A vertical hollow cylinder is suspended in an irradiation chamber. Its annular jacket contains radioactive elements. The fluid circulates along the jacket's inner and outer walls alternately. A tank above this chamber is filled with a liquid to a level that provides protection from radiation. This tank is connected to the chamber jacket space and should form a storage sump for radioactive elements. A centrifugal pump should be used to circulate the waste fluid. Water can be used as a screen against radiation.

*Patents, *Irradiation, Sludge treatment, Equipment, Pumps, Water purification, Design, Waste water treatment

C099
MIXING CHAMBER FOR THICKENING SEWAGE SLUDGE BY MEANS OF A FLOCCULATION AGENT COMBINED WITH OVERFLOW DRAINAGE MEANS,

Heinrich, H. J.

United States Patent 4,022,691. Issued May 10, 1977. Official Gazette of the United States Patent Office, Vol. 958, No. 2, p 739, May, 1977. 1 fig.

A patent was issued for a mixing chamber to thicken sludge. There is a cylindrical housing with a cup-like bottom and a widened upper area. A mixing area is defined by an agitator in the lower part. A sewage inlet is attached at the lower end. A pipe for flocculant addition extends through the inlet. Thickening occurs in the mixing area. An annular chamber is formed at the wider upper portion by a perforated inner wall and an outer wall spaced from the inner wall. The perforated construction provides dewatering for the thickened sludge. A pipe from the dewatering area delivers thickened sludge to a drainage system. Provision is made for additional drainage or dewatering and sludge storage or conveyance.

*Patents, *Flocculation, Equipment, Overflow, Dewatering, Sewage effluents, Sludge treatment, Mechanical engineering, Waste water treatment

Sludge thickening

C100
SEWAGE TREATMENT SYSTEM,

Teller, R. E., and Zachar, S. G.

United States Patent 4,021,347. Issued May 3, 1977. Official Gazette of the United States Patent Office, Vol. 958, No. 1, p 286-287, May, 1977. 1 fig.

A patent was issued for a sewage treatment system. It is comprised of an enclosed horizontally elongated tank with inlet and outlet at opposite ends. First and second compartments are formed by a wall extending across the interior to a point slightly below the level of the lowest edge of the inlet. Two filter screens are placed in the interior and a pair of solid side walls and a bottom wall, extending to the filter screens, define a third compartment. The sewage flow is aerated in the first chamber, partially purified by gravity settling of some solids in the second chamber, and further purified by the screens in passing to the third chamber.

*Patents, *Aeration, *Filtration, Equipment, Sewage effluent, Screens, Sedimentation, Suspended solids, Liquid wastes, Water purification, Waste water treatment

C101
AERATED SEWERAGE EFFLUENT DISPOSAL SYSTEM,

Smith, A. J.

United States Patent 4,021,348. Issued May 3, 1977. Official Gazette of the United States Patent Office, Vol. 958, No. 1, p 287, May, 1977. 1 fig.

A patent was issued for a disposal system for aerated sewage effluents. The construction of the liquid sewage pool receptacle is such that it forms a submerged trench with sidewalls which taper downward. Solids collect in a narrow channel at the trench bottom. Gas is injected into the pool to form bubbles which contact the solids. The injection means is attached to a guide rail above and along the trench.

*Patents, *Waste disposal, Equipment, Gases, Suspended solids, Mechanical engineering, Sewage treatment, Sanitary engineering, Waste water treatment, Aeration

C102
METHOD FOR TREATING SEPTIC TANK EFFLUENT SEEPAGE BEDS AND THE LIKE,

Harkin, J. M.

Wisconsin Alumni Research Foundation,
Madison, Wisconsin. (assignee)

United States Patent 4,021,338. Issued May 3, 1977. Official Gazette of the United States Patent Office, Vol. 958, No. 1, p 283, May, 1977.

A patent was issued for a process to treat clogged or crusted and ponded effluent seepage beds of septic systems. The septic tank is pumped to lower the liquid below the effluent outlet level to reduce the amount of water ponded in the seepage bed. Hydrogen peroxide is applied in quantities sufficient to increase the seepage bed permeability and to enhance its functioning.

*Patents, *Septic tanks, *Seepage, *Seepage control, Liquid wastes, Waste water treatment, Leakage, Domestic wastes, Waste water treatment, Chemical treatment

Hydrogen peroxide

C103
GERMICIDAL SOLUTIONS AND METHODS FOR PRESERVING AND PURIFYING MILK, OTHER BEVERAGES, FOODS, WATER AND SEWAGE EFFLUENT,

Vinson, L. J., and Cancro, L. P.

Lever Brothers Company,
New York, New York. (assignee)

United States Patent 4,022,882. Issued May 10, 1977. Official Gazette of the United States Patent Office, Vol. 958, No. 2, p 785, May, 1977.

A patent was issued for a germicidal solution which could be applied to the treatment of water and sewage effluent. The solution was composed of hydrazine, elemental iodine, and polyvinyl pyrrolidone dissolved in water. A quantity of hydrazine was used which would dissolve the iodine and overcome its color. The amount of iodine employed was 100 grams and that of polyvinyl pyrrolidone was 20-100 grams.

*Patents, *Pesticides, *Water purification, Sterilants, Chemicals, Iodine, Waste water treatment, Aqueous solutions, Liquids

Hydrazine, Polyvinyl pyrrolidone, Germicides

C104
WASTE WATER TREATMENT,

Ramirez, E. R.

Swift and Company,
Chicago, Illinois. (assignee)

United States Patent 4,012,319. Issued March 15, 1977. Official Gazette of the United States Patent Office, Vol. 956, No. 3, p 958, March, 1977.

A patent was issued for a waste water treatment process involving the coagulation, agglomeration, and flotation of suspended and dissolved materials. Waste water flows along an electrode grid in which the current gradually diminishes in density. The greatest density is at the influent end of the flow path. This process forms microbubbles by electrolytic decomposition of waste water. A high water turbulence in the waste water is created at the influent end and maintained within and above the grid by the microbubbles.

*Patents, *Coagulation, *Flotation, *Electrolysis, Suspended solids, Electrodes, Equipment, Separation techniques, Waste water treatment

C105
SEWAGE TREATMENT AERATION SYSTEMS,

Thayer, P. M.

Water Pollution Control Corporation,
Milwaukee, Wisconsin. (assignee)

United States Patent 4,012,470. Issued March 15, 1977. Official Gazette of the United States Patent Office. Vol. 956, No. 3, p 998, March, 1977. 1 fig.

A patent was issued for an aeration treatment system. The system was composed of header means arranged in a tank with diffusers spaced at longitudinal intervals along them. The orientation of diffusers with regard to the tank can be adjusted by rotation of the header means.

*Patents, *Aeration, *Equipment, Mechanical engineering, Sewage treatment, Hydraulic equipment, Waste water treatment

C106
SEWAGE TREATMENT PROCESS,

Kreuter, J.

Ecquacon Corporation,
Matawan, New Jersey. (assignee)

United States Patent 4,013,552. Issued March 22, 1977. Official Gazette of the United States Patent Office, Vol. 956, No. 4, p 1378, March, 1977. 1 fig.

A patent was issued for a sonobioaeration process that utilizes an electroacoustic horn to treat sewage. The horn is exposed to air and the sewage, converted to a thin film, is applied to the horn. Ultrasonic energy is transmitted through the horn to atomize the film. This process reduces liquid particle size and surrounds the particles with air to provide more oxygen to the aerobic organisms. The micro-organisms are then used in a biochemical oxidation process to convert organic matter to a more stable compound.

*Patents, *Sound waves, *Biological treatment, *Microorganisms, Oxidation, Aerobic treatment, Organic matter, Oxygen, Sewage treatment, Waste water treatment

C107
OXIDATION OF REFRACTORY ORGANICS IN AQUEOUS WASTE STREAMS BY HYDROGEN PEROXIDE AND ULTRAVIOLET LIGHT,

Koubek, E.

The United States of America,
Secretary of the Navy,
Washington, D. C. (assignee)

United States Patent 4,012,321. Issued March 15, 1977. Official Gazette of the United States Patent Office, Vol. 956, No. 3, p 958, March, 1977. 1 fig.

A patent was issued for a method to lower COD in aqueous wastes by using hydrogen peroxide and ultraviolet radiation. Waste stream COD is measured and an amount of hydrogen peroxide (as grams), no less than 2.1 times the measured COD, is added. The mixture is then agitated and moved through a container where it is irradiated at a wavelength no greater than 2600 Angstroms.

*Patents, *Oxidation, *Chemicals, *Ultraviolet radiation, *Organic matter, *Chemical oxygen demand, Liquid wastes, Light, Equipment, Water purification, Effluents, Waste water treatment

Hydrogen peroxide

C108
ROTATING MULTITUBE BIOCONTACTOR FOR TREATING SEWAGE,

Kato, M., Kato, I., Kato, S., Kato, Y., and Kato, T.

United States Patent 4,022,689. Issued May 10, 1977. Official Gazette of the United States Patent Office, Vol. 958, No. 2, p 738, May, 1977. 1 fig.

A patent was issued for a rotary multi-tube biocontactor for sewage treatment. The apparatus contains an open trough which holds the liquid to be treated and a rotating rod above the liquid surface. Many tubes surround the rod and are longitudinally askew to the rod and to each other. These tubes are partially submerged in the liquid, and move in and out of it as the rod rotates.

*Patents, *Biological treatment, *Equipment, Water purification, Mechanical engineering, Sewage effluents, Liquid wastes, Waste water treatment

C109
WATER TREATMENT USING OXIDISED SLUDGE,

Australian Patent 479,408. Issued January 13, 1977. The Australian Official Journal of Patents, Trade Marks, and Designs, Vol. 46, No. 50, p 4873, January, 1977.

A patent was issued for a waste and water treatment process utilizing oxidized sludge. The process involves coagulation and separation using aluminum compounds. The resultant sludge is subjected to wet air oxidation. The sludge pH is adjusted so that the aqueous mixture resulting from the oxidation treatment will have a pH below 1.5 or above 9.0. This aqueous mixture can be directly re-used for water treatment if its pH is below 1.5 or above 10.5. For pH levels between 1.5 and 10.5, the mixture can be used after the removal of the aluminum compounds by adding acid or alkali.

*Patents, *Oxidation, *Coagulation, *Aluminum, Water purification, Sludge, Hydrogen ion concentration, Chemicals, Waste water treatment

Wet air oxidation

C110
BIOLOGICAL EFFLUENT TREATMENT PLANT WITH THREE TANKS ARRANGED FOR REVERSIBLE FLOW,

Kaelin, J. R.

German Patent DS 2459-634. Issued April 21, 1977. Derwent German Patents Abstracts, Vol. Y, No. 17, p D4, June, 1977.

A patent was issued for a biological effluent treatment plant. The plant consisted of three connected tanks. After the activated sludge concentration in the first tank is reduced to a pre-determined level, the flow is reversed. This allowed the second and third tanks to act as an activated tank. The first tank became a downstream post-clarification tank. Pure oxygen or an oxygen mixture was introduced into the aeration tank by a centrifugal pump impeller below the waste water surface. A flow rate of 30 cm/second was created above the floor of the activated tank. No mechanical sludge removal was necessary for prevention of clogging.

*Patents, *Biological treatment, *Aeration, Treatment facilities, Activated sludge, Oxygen, Flow, Water purification, Waste treatment, Waste water treatment

C111
WASTE WATER TREATMENT APPARATUS BY BIOLOGICAL ACTION,

Akae, K.

Unitika Limited,
Amagasaki, Japan. (assignee)

United States Patent 4,026,802. Issued May 31, 1977. Official Gazette of the United States Patent Office, Vol. 958, No. 5, p 2121, May, 1977. 1 fig.

A patent was issued for a small-scale biological treatment apparatus for waste water treatment. The plant contained a tank with a water outlet and overflow means. The tank was fitted with several individual biological filter beds and a central longitudinal partition. The filters were separated and provided with a means for rotation around the partition. Water was circulated around the partition by a diffuser. The filter beds can be washed while they are above the water level.

*Patents, *Treatment facilities, *Mechanical equipment, *Biological treatment, Liquid wastes, Filters, Water purification, Filtration, Separation techniques, Waste water treatment

C112
SMALL-SCALE PLANT FOR MECHANICALLY/BIOLOGICALLY PURIFYING WASTE WATER,

Netherlands Patent NL 152-516. Issued March 15, 1977. Derwent Netherlands Patents Abstracts, Vol. Y, No. 15, p D2, May, 1977.

A patent was issued for a mechanical-biological waste water purification plant. Only one immersion-dripper body was contained in the biological stage. Its worm-like form reduced manufacturing and operating costs. This feature also allowed continuous stepwise cleaning. The biological stage also included a basin with the rotating immersion-dripper body. Separate pre- and/or post-purifying tanks may be attached to the unit.

*Patents, *Treatment facilities, *Biological treatment, Water purification, Mechanical equipment, Effluents, Liquid wastes, Waste water treatment

C113
NON-BIODEGRADABLE WASTE WATER TREATMENT - BY WET OXIDN. FOLLOWED BY BIOLOGICAL AERATION IN PRESENCE OF ACTIVE CARBON,

Belgian Patent BE 846-256. Issued March 16, 1977. Derwent Belgian Patents Abstracts, Vol. Y, No. 12, p D1, April, 1977.

A patent was issued for a non-biodegradable waste water treatment. Effluents were treated by wet oxidation at 150-375 C and 150-4,000 p. s. i. g. This separated the gaseous, solid, and liquid phases and reduced COD by 30-99%. Biological oxidation followed in a tank with a suitable biomass. Powdered activated carbon was added to reduce color and odor while enhancing the oxidation process. Carbon was used up as excess biomass accumulated. The carbon and excess biomass were then moved to a second oxidation stage similar to the first. This regenerated the activated carbon and dispersed excess biomass. The expense of wet oxidation used alone was avoided. Toxic wastes can be biologically treated after wet oxidation.

*Patents, *Oxidation, Chemical oxygen demand, Biological treatment, Biomass, Activated carbon, Sewage effluents, Aeration, Odor, Color, Waste water treatment

Wet oxidation, Non-biodegradable waste water treatment

C114
MECHANICAL SEWAGE SLUDGE COMPOSTING IN MIXER WITH RECYCLED BIOGENIC MASS CHARGING REVOLVING HEATED DRUM,

German Patent DS 2517-381. Issued March 3, 1977. Derwent German Patents Abstracts, Vol. Y, No. 10, p D3, April, 1977.

A patent was issued for a mechanical sludge composting process for sewage sludge and other semi-solid wastes. The sludge to be composted is premixed with recycled sludge compost according to a predetermined formula. The mixture is then added to a revolving drum which already contains rotting sludge compost. Optimum composting conditions are maintained.

*Patents, *Sludge treatment, *Waste disposal, Recycling, Mechanical equipment, Heat treatment, Waste treatment, Waste water treatment

Composting

C115
AERATION TANK FOR ACTIVATED SLUDGE TREATMENT OF WASTE WATER - IS SMALLER AND REQUIRES LESS POWER FOR A GIVEN TREATMENT CAPACITY,

Netherlands Patent NL 7610-431. Issued March 28, 1977. Derwent Netherlands Patents Abstracts, Vol. Y, No. 15, p D5, May, 1977.

A patent was issued for an activated sludge treatment aeration tank. The tank was constructed as a horizontal, elongated rectangle. It contained offset immersed flow passages in several compartments formed by transverse partitions. Each division contained an aerating agitator. The liquid passed continuously between an inlet and an outlet at each end of the tank. Each compartment had a length/width ratio of 0.59 to 1.70, the preferred ratio being 0.60 to 1.00. The flow passage covered 30-80% of the immersed cross-sectional area of its partition. Rotary agitators were used. This design was smaller and required less power for a given capacity than conventional units.

*Patents, *Aeration, *Equipment, Design, Flow, Activated sludge, Liquid wastes, Treatment facilities, Sewage effluents, Waste water treatment

Aeration tanks

C116
OXIDISING ORGANIC REFRACTORY CPDS. IN WASTE WATER BY CONTACT WITH OZONE CONTG. GAS AND SIMULTANEOUS UV IRRADIATION,

French Patent FR 2309-480. Issued December 31, 1976. Derwent French Patents Abstracts, Vol. Y, No. 9, p D5, April, 1977.

A patent was issued for a process to treat organic refractory compounds of bio-refractory compounds in a liquid medium. The medium was oxidized with ozone-containing gas and simultaneously subjected to ultraviolet radiation to enhance the process. The treatment was applicable to industrial and municipal water purification. The process was especially useful for wastes that could not be converted to carbon dioxide and water by secondary treatment and carbon adsorption. The combined treatment proved more effective than either individual treatment.

*Patents, *Oxidation, *Irradiation, *Organic compounds, Liquid wastes, Waste treatment, Industrial wastes, Municipal wastes, Ultraviolet radiation, Water purification, Ozone, Carbon dioxide, Carbon, Adsorption, Waste water treatment, Gases

C117
AEROBIC SEWERAGE DIGESTION PROCESS (42 C. PROCESS),

Rein, D. A.

United States Patent 4,026,793. Issued May 31, 1977. Official Gazette of the United States Patent Office, Vol. 958, No. 5, p 2118-2119, May, 1977. 1 fig.

A patent was issued for an aerobic sewage digestion process. The process was designed to biologically reduce the solids content of an aqueous, biodegradable, organic sludge containing waste activated sludge. The sludge was first introduced into a vessel where total volatile solids concentration was maintained at less than 2.5% by weight. Sludge temperature was maintained in the range of 38-46 C, while oxygen was added to promote the growth of Monadidae protozoa and aerobically digest the sludge in their presence.

*Patents, *Aerobic bacteria, *Suspended solids, *Biological treatment, Microorganisms, Temperature, Oxygen, Sludge treatment, Activated sludge, Waste water treatment

C118
DISPOSAL METHOD AND USE OF SEWAGE SLUDGE,

Webster, W. C., Hilton, R. G., and Cotts, R. F.

IU Conversion Systems, Incorporated,
Philadelphia, Pennsylvania. (assignee)

United States Patent 4,028,130. Issued June 7, 1977. Official Gazette of the United States Patent Office, Vol. 959, No. 1, p 272, June, 1977.

A patent was issued for a sludge disposal method. The sludge was admixed with lime and fly ash. The final composition of the admixture should be: 1-15% lime, 1-50% digested sludge solids, 20-90% fly ash, and 5-50% moisture content. The latter must be based on weight percent of dry solids. The final process step consisted of drying the admixture under atmospheric conditions.

*Patents, *Sludge disposal, Lime, Fly ash, Solid wastes, Moisture content, Drying, Waste disposal, Waste water treatment

C119
PROCESS FOR TREATING MUNICIPAL WASTES TO PRODUCE A FUEL,

Livingston, A. D.

Guaranty Performance Company, Incorporated,
Independence, Kansas. (assignee)

United States Patent 4,026,678. Issued May 31, 1977. Official Gazette of the United States Patent Office, Vol. 958, No. 5, p 2083-2084, May, 1977.

A patent was issued for a process to treat municipal wastes for use in fuel production. Solid wastes, containing organic matter (15% by weight) that could be fiberized, were treated to produce a substantially homogeneous pulp-like mixture. This mixture should have a moisture content of 20-70% by weight. An air-fluidized stream of this mixture, with a temperature of 130-180 F, was then produced. This stream, which contained the fiberized material in a solids fraction, possessed a moisture content that enhanced the organic material's adhesive properties. The fiberized organic material content was maintained at a minimum of 15% by weight. The solids fraction was collected while maintaining its temperature level, and was finally formed into self-sustaining bodies.

*Patents, *Fuels, *Solid wastes, Waste treatment, Municipal wastes, Moisture content, Organic matter, Temperature, Waste disposal, Waste water treatment

C120
PHOSPHORUS REMOVAL FROM WASTE WATER,

Bykowski, M. J., and Ewing, L.

Ewing Engineering Company,
Milwaukee, Wisconsin. (assignee)

United States Patent 4,029,575. Issued June 18, 1972. Official Gazette of the United States Patent Office, Vol. 959, No. 2, p 751, June, 1977. 1 fig.

A patent for a process which treats waste water containing dissolved phosphorus compounds is described. The aqueous reaction products of elemental iron are mixed with waste water and are exposed alternately to anaerobic and aerobic conditions. The resulting liquid-solid suspension is clarified. Suspended solids, including insolubilized phosphorus compounds, are removed.

*Phosphorus compounds, *Nutrient removal, *Patents, Phosphorus, Aerobic treatment, Waste treatment, Anaerobic digestion, Suspended solids, Waste water treatment

C121
APPARATUS FOR THE TREATMENT OF LIQUIDS,

Marquardt, K., and Buchholz, R.

Hager and Elsaesser,
Stuttgart, Germany. (assignee)

United States Patent 4,033,874. Issued July 5, 1977. Official Gazette of the United States Patent Office, Vol. 960, No. 1, p 307, July, 1977. 1 fig.

An apparatus for liquid-solid separations is described. A treatment column containing treatment material, a solvent extraction column, and a washing column are joined to form a closed system. Connections are provided for the addition and removal of washing liquid, solvent, treatment material, and waste water. Volume adjustment is accomplished by telescopically adjusted pipes that extend into the treatment and washing columns depthwise.

*Separation techniques, *Solvent extractions, *Liquid wastes, *Waste water treatment, *Equipment, Solvents, Waste treatment, Patents

C122
WASTE WATER TREATMENT APPARATUS,

Besik, F.

Ontario Research Foundation,
Sheridan Park, Canada. (assignee)

United States Patent 4,033,875. Issued July 5, 1977. Official Gazette of the United States Patent Office, Vol. 960, No. 1, p 307-308, July, 1977. 1 fig.

A patent has been issued for an apparatus which treats waste water containing a variety of contaminants. The apparatus consists of a cylindrical container having a truncated cone at the lower end, into which is placed an inverted funnel. Untreated waste water is pumped in through the base of the container in the truncated cone portion for first treatment. Treated waste water is discharged from a pipe at the top of the cylinder. A riser tube extending up through the container conducts material upward through the container, and also contains a gas feed tube for discharge at the lower end of the riser.

*Waste water treatment, *Equipment, *Patents, *Treatment, *Water pollution treatment, Instrumentation, Liquid wastes

C123
AQ. FERRIC CHLORIDE SOLN. FOR WATER TREATMENT--OBTD. BY NEUTRALISING AND CHLORINATING PICKLING LIQ. CONTG. FERROUS CHLORIDE,

French Patent FR 2320-911. Issued April 15, 1977. Derwent French Patents Abstracts, Vol. Y, No. 21, p D2, July, 1977.

A patent has been issued for a process to produce $FeCl_3$ in an aqueous solution from a pickling liquid containing $FeCl_2$ and HCl. The liquid is first evaporated to a minimum $FeCl_2$ concentration of 34.25% by weight and then neutralized in a fluidized bath of iron oxide particles. Next, the mixture undergoes counter-current chlorination at 35-75 C for 73-86% chlorination and then at 40-100 C for 27-14% chlorination. The process is reported to produce a solution containing a minimum of 40% $FeCl_3$, below 0.1% $FeCl_2$, and below 0.1% free HCl.

*Chlorine, *Iron compounds, *Chemical reactions, Patents, Treatment, Waste treatment, Flocculation, Waste water treatment

*Ferric chloride, *Ferrous chloride

C124
SLUDGE PURGING CONTROL FOR WASTE WATER PURIFICN. PLANT--AUTOMATICALLY PREVENTS OVERPURGE WITHOUT ENDANGERING QUALITY OF TREATED WATER,

Netherlands Patent NL 7612-303. Issued May 10, 1977. Derwent Netherlands Patents Abstracts, Vol. Y, No. 21, p D2, July, 1977.

A patent has been issued for the automatic control of sludge purging from a sludge concentrator. Turbidity is measured at two different levels above the sludge bed. When measurements at the upper sampler reach a certain preset value, the sludge purge valve is opened and the lower sampler is activated. When turbidity at the lower level sampler drops below a preset level, the sludge purge valve is closed and the upper sampler reactivated. A constant level illuminated tank and a photoelectric cell which is attached to a galvanometer are suggested for turbidity measurements. This method is reported to minimize excess water loss and errors due to local variations in turbidity above the sludge bed.

*Sludge treatment, *Turbidity, *Sampling, *Automatic control, Equipment, Instrumentation, Patents, Physical properties, Waste water treatment

*Sludge purging control

C125
EFFLUENT PURIFICATION BY BIOLOGICAL ROTARY CONTACTOR--WHICH IS ROTATED BY AIR WHICH DISPLACES LIQUID FROM RADIAL POCKETS,

German Patent DS 2428-910. Issued May 18, 1977. Derwent German Patents Abstracts, Vol. Y, No. 21, p D3, June, 1977.

A patent for the biological treatment of waste water using a basin equipped with a circular, rotatable arrangement of biological beds has been issued. The beds are contained in pockets which are a part of a radial contact arrangement. Gases flowing out of a pipeline below the contact arrangement are caught in the pockets, causing the contact arrangment to rotate. It is suggested that pockets be placed on the radial outer side of the contact arrangement on non-adjacent circular discs which are part of the contact element arrangement.

*Biological treatment, *Patents, *Packed beds, *Waste water treatment, *Biodegradation, *Water purification, Equipment, Treatment

C126
WASTE WATER ORGANIC RESIDUE DETOXIFICATION--BY TWO STAGE THERMAL TREATMENT AND SEPARATION AT SPECIFIED TEMP.,

Soviet Patent SU-514-773. Issued September 23, 1976. Soviet Inventions Illustrated, Vol. Y, No. 22, p D2, July, 1977.

A patent has been issued for a more economical method for the detoxification of organic wastes. Waste water containing a high concentration of organic substances is heated to 120-130 C and separated into a highly concentrated precipitate and a weakly concentrated filtrate which requires no further treatment. Maintenance of proper temperature is important to insure good separability and minimum contamination of the filtrate. In a test using excess active sediment with W(p) of 97.5% and COD of 2.2 kg/cu m, the described method produced a precipitate with a COD of 4-6 kg/cu m. After heating to 180-200 C, separating, and drying, the volume of the precipitate was 0.05 cu m and the filtrate volume was 0.45 cu m, with a COD of 21 kg/cu m. Energy consumption for the process was 290,000 kcal of heat.

*Separation techniques, *Organic wastes, *Waste water treatment, *Heat treatment, Waste treatment, Chemical oxygen demand, Patents

C127
METHOD FOR THE TREATMENT OF WASTEWATER,

Torpey, W. N.

Autotrol Corporation,
Milwaukee, Wisconsin. (assignee)

United States Patent 4,035,290. Issued July 12, 1977. Official Gazette of the United States Patent Office, Vol. 960, No. 2, p 777-778, July, 1977.

A patent for the continuous treatment of waste water has been issued. The method utilizes a rectangular treatment tank which contains an upper biological treatment zone and a lower settling zone, separated by a horizontal baffle. The biological treatment zone is divided longitudinally into three bays which contain rows of biological contactors parallel to the flow direction of the waste water which enters and exits at opposite ends of the tank. Waste water is introduced into the two outer bays where it is treated by the rotating biological contactors. The two parallel streams of waste water are combined in the center bay and treated further while flowing back in the direction of the inlet tank. The combined stream is conducted to the lower settling tank and the flow reversed again. Treated waste water is removed via the outlet end of the lower settling tank.

*Patents, *Waste water treatment, *Biological treatment, *Equipment, Biodegradation, Waste treatment, Water purification

*Rotating biological contactors

C128
EFFLUENT WATERS CLEANING AUTOMATIC CONTROL--USED FOR DOMESTIC AND INDUSTRIAL WASTES AND BASED ON COLOUR MONITOR TO CONTROL COAGULANT SUPPLY,

Soviet Patent SU-514-774. Issued September 22, 1976. Soviet Inventions Illustrated, Vol. Y, No. 22, p D2, July, 1977.

A patent has been issued for a system designed to control the coagulation treatment of domestic and industrial effluents in a reaction vessel. The system is comprised of a coagulant dispenser controlled by a buffer meter and a color meter. The amount of coagulant initially added to the reaction vessel is determined by the oxygen-base buffer meter, which dispenses a dosage based on alkalinity of incoming effluents. After the treated effluent leaves the reaction vessel, its color is monitored. If the color of the effluent exceeds preset limits, a signal generated by the color meter adjusts the dosage added by the coagulant dispenser.

*Coagulation, *Effluents, *Color, *Automatic control, *Instrumentation, Patents, Remote control, Automation, Equipment, Waste water treatment

Oxygen-base buffer meter

C129
LIQ. E.G. AQ. EFFLUENT TREATMENT WITH OZONE--EMPLOYING USED OZONE AND THEN FRESH OZONE, BOTH PRESSURIZED,

French Patent FR 2321-299. Issued April 22, 1977. Derwent French Patents Abstracts, Vol. Y, No. 21, p D6, July, 1977.

A patent for the oxidation of waste water by exposure to pressurized ozone has been issued. Pressurized gas containing a proportion of residual ozone is used to pretreat the effluent stream. In the second stage of the treatment process, freshly made ozone at a concentration of at least 10 weight percent of the carrier gas and at higher pressures (0.07-2.1 kg/sq cm) than in the initial phase is added to the effluent stream. The ozone used in the second stage can be recycled for use in pretreatment of the next batch of effluent. Pretreatment is reported to increase the rate and efficiency of ozonation in the second stage. This process can be used for the disinfection of waste waters.

*Oxidation, *Ozone, *Waste water treatment, *Disinfection, *Liquid wastes, Treatment, Waste treatment, Organic compounds, Gases, Patents

*Ozonation

C130
SEWAGE TREATMENT APPARATUS,

Peasley, H. P.

United States Patent 4,036,754. Issued July 19, 1977. Official Gazette of the United States Patent Office, Vol. 960, No. 3, p 1271-1272, July, 1977.

A waste water treatment apparatus for the clarification of a mixed liquor of sewage water and suspended solids by bacterial degradation has been patented. Mixed liquor is aerated and circulated in a main treatment tank which also has a smaller internal clarification compartment. An auxiliary compartment is provided for overflow from the main tank. The clarification compartment and main tank can be periodically back-flushed. A digester compartment is attached to the side of the main tank for bacterial treatment of raw sewage. When sewage in the tank reaches a predetermined level, the digester tank is filled by overflow from the main tank via a weir. Air is injected into the digester tank to aerate the sewage and maintain solid materials in suspension. Clarified effluent is removed from the clarification tank through a longitudinal slot on the bottom of the compartment.

*Sewage treatment, *Biological treatment, *Patents, *Clarification, *Suspended solids, Design data, Effluents, Aerobic treatment, Digestion, Waste water treatment

C131
WASTE WATER TREATMENT METHOD AND APPARATUS,

Miura, M., Matubayasi, H., and Iwai, S.

Miura Engineering International Company Limited,
Osaka, Japan. (assignee)

United States Patent 4,039,447. Issued August 2, 1977. Official Gazette of the United States Patent Office, Vol. 961, No. 1, p 256, August, 1977. 1 fig.

A method of waste water treatment using magnetic powder has been patented. Flocculated waste water to which magnetic powder has been added is continuously fed into a two-chambered tank which contains a number of rotating magnetic discs. Co-flocs of magnetic powder and suspended solids are collected on the magnetic discs, removed from the treatment tank, and then separated by agitation to allow recovery of the powder. The treatment apparatus itself is divided into a large chamber for collecting co-flocs and a small chamber for separating them. The rotary magnetic discs are attached to a rotating shaft which extends through both chambers. A scraper is used to remove co-flocs from the discs for separation in a smashing tank.

*Separation techniques, *Flocculation, *Magnetic studies, *Patents, Design data, Suspended solids, Waste water treatment

*Magnetic separation

C132
EVAPORATION OF TREATED WASTE WATER,

Smith, A. J.

United States Patent 4,039,451. Issued August 2, 1977. Official Gazette of the United States Patent Office, Vol. 961, No. 1, p 257-258, August, 1977.

A patent for a waste water evaporation system is described. The system includes a horizontally elongated evaporation bed which contains an upper layer of rock pieces, a median layer of sand, and a lower rock layer. Waste water is recirculated through the layers by a sump system which collects excess water from the lower rock layer and repumps it through the upper rock layer. Septic tank contents are piped to the upper rock layer for slow percolation through the bed and subsequent evaporation.

*Evaporators, *Drying, *Patents, *Design data, *Sewage treatment, Evaporation, Septic tanks, Filtration, Waste water treatment

C133
TREATMENT OF AQUEOUS WASTE STREAMS,

Australian Patent 483,271. Issued May 26, 1977. The Australian Official Journal of Patents, Trade Marks, and Designs, Vol. 47, No. 18, p 1654, May, 1977.

A process for removing chlorinated isocyanurates from waste water has been patented. Aqueous waste water at a pH of from 0.5 to 7.0 is treated with hydrogen peroxide at a pH of from 0.5 to 12.0. The isocyanurates are thereby dechlorinated to form a precipitate of cyanurate, and evolved. The precipitate is then removed from the waste water stream.

*Chemical wastes, *Patents, *Chlorination, *Organic compounds, Chemical reactions, Chemical precipitation, Waste water treatment

Chlorinated isocyanurates

C134
ANAEROBIC WASTE TREATMENT FACILITY,

Garrott, W. A., Jr.

United States Patent 4,040,963. Issued August 9, 1977. Official Gazette of the United States Patent Office, Vol. 961, No. 2, p 759, August, 1977.

An anaerobic digester which contains a mixing zone, a quiescent zone, a clear zone, and an inlet and outlet for the movement of waste water has been patented. The system can prevent the entry of large particles from the quiescent zone into the clear zone, and selectively circulate material between the mixing and clear zones with a rotor below the liquid level in the digester. Rotary circulation is accomplished by a stationary conduit rotor and a second conduit member which is vertically moveable with respect to the first rotor. Vertical motion of the second rotor is limited so that is is also confined below the liquid level in the sludge digester. The digester itself is a flat-bottomed tank with outwardly sloping side walls and a cover.

*Anaerobic digestion, *Sludge digestion, *Patents, *Digestion tanks, *Mixing, Design data, Sludge treatment, Waste water treatment

C135
SEWAGE SLUDGE-IRRADIATION DEVICE,

La Roche, U.

BBC Brown Boveri and Company Limited,
Baden, Switzerland. (assignee)

United States Patent 4,038,028. Issued July 26, 1977. Official Gazette of the United States Patent Office, Vol. 960, No. 4, p 1705, July, 1977.

An apparatus for the sterilization of sewage sludge by irradiation has been patented. The device contains a conveyor system with at least two separate conveyor belts. Sewage sludge is supplied to at least one of the conveyor belts and spread to form a substantially coherent thin layer on the belt surface. The two conveyor belts are positioned to provide a passageway and mixing gap between them. The irradiating device is positioned so that sludge is subjected to radiation immediately prior to mixing in the interbelt gap.

*Disinfection, *Radiation, *Sludge treatment, *Design data, *Sewage treatment, *Patents, Microorganisms, Irradiation, Waste water treatment

Sterilization

C136
ANAEROBIC DIGESTION PROCESS,

Ort, J. E.

RecTech, Incorporated,
State College, Pennsylvania. (assignee)

United States Patent 4,040,953. Issued August 9, 1977. Official Gazette of the United States Patent Office, Vol. 961, No. 2, p 755, August, 1977.

A two-stage anaerobic digestion process for the treatment of organic wastes and the production of gases, including methane and carbon dioxide, has been patented. A liquid slurry of organic wastes is maintained in the digesters for a total retention time of at least 24 hours with an air space above the slurry allowing for a volume-to-interface ratio of at least 100 gallons per square foot. Methane is produced and collected during both stages of anaerobic digestion. After the second stage of digestion is complete, the sludge is transferred to a stripping zone where sludge pH is adjusted to 6.0-6.5 to remove carbon dioxide. After carbon dioxide removal the sludge is recycled to the first digester for further digestion and methane production.

*Sludge digestion, *Anaerobic digestion, *Patents, *Methane, Sludge treatment, Carbon dioxide, Organic wastes, Digestion tanks, Waste water treatment

C137
PROCESS FOR DEWATERING SEWAGE SLUDGE,

Talbert, N. K.

Agway, Incorporated,
Syracuse, New York. (assignee)

United States Patent 4,038,181. Issued July 26, 1977. Official Gazette of the United States Patent Office, Vol. 960, No. 4, p 1747, July, 1977.

A chemical process for dewatering unprocessed sludge containing at least 75% water has been patented. Urea and the common salts of ammonium and potassium are mixed with an equivalent or lesser amount of sludge. After dissolution of the chemicals, the sludge-chemical mixture separates into a liquid phase containing the added chemicals dissolved in water and a solid or semi-solid phase of sludge solids. The two phases can then be physically separated.

*Dewatering, *Separation techniques, *Chemical reactions, *Sewage treatment, *Ureas, Salts, Ammonium compounds, Potassium compounds, Sludge treatment, Patents, Waste water treatment

Chemical dewatering

C138
PROCESS OF DEWATERING SEWAGE SLUDGE,

Talbert, N. K.

Agway, Incorporated,
Syracuse, New York. (assignee)

United States Patent 4,038,180. Issued July 26, 1977. Official Gazette of the United States Patent Office, Vol. 960, No. 4, p 1747, July, 1977.

A method for dewatering nongaseous sewage sludge has been patented. In the treatment process, sewage sludge with a low enough water content to render it non-compressible is mixed with a mineral acid or anhydride. The water is extracted to form a mixture of sludge solids and water-diluted acid. The mixture is then placed in a reaction vessel with enough base to sufficiently react with the previously added acid or anhydride, and heated to remove the remaining water. The treatment process produces a granular mixture of sludge solids and a salt.

*Dewatering, *Separation techniques, *Sewage treatment, *Chemical reactions, *Patents, Sludge treatment, Acid-base equilibrium, Salts, Waste water treatment

C139
SLUDGE DEWATERING,

Cox, C. H.

United States Patent 4,041,854. Issued August 16, 1977. Official Gazette of the United States Patent Office, Vol. 961, No. 3, p 1065-1066, August, 1977.

A patented sludge dewatering device includes an outer funnel-shaped cylindrical shell which is equipped with a sludge inlet and a sludge outlet. The filter-dewatering shell diameter is largest at the sludge inlet and narrows toward the sludge outlet. A rotary shaft extending through the filter-dewatering shell is equipped with a screw-like sludge compression blade. A coil-spring blade supported by the main compression blade is provided to scrape sludge from the inner surfaces of the shell. A secondary shaft within the main rotary shaft is mounted and powered so that it rotates in a direction countercurrent to the direction of the main shaft. A filter-cake discharging blade is attached to the outlet end of the secondary shaft.

*Dewatering, *Patents, *Sludge treatment, *Equipment, *Filtration, *Separation techniques, Design data, Waste water treatment

Sludge dewatering

C140
REMOVAL OF PHOSPHOROUS FROM WASTE WATER,

Field, J. R., and Andrew, K. G.

Allied Colloids Limited,
Bradford, England. (assignee)

United States Patent 4,043,910. Issued August 23, 1977. Official Gazette of the United States Patent Office, Vol. 961, No. 4, p 1749, August, 1977.

A process for the removal of phosphates from waste water has been patented. The method is applicable to raw sewage, effluents from primary or secondary sedimentation, and food processing wastes. Soluble and colloidal phosphate is precipitated from aqueous waste by the addition of multi-valent metal cation-containing inorganic coagulant. Typical cations which may be used include aluminum, ferrous and ferric iron, and calcium. A cationic polyelectrolyte is then added to the waste after an interval of about 15 seconds to 4 minutes after the addition of the coagulant. The cationic polyelectrolyte is in the form of a quarternary ammonium salt of a copolymer with a molecular weight which yields a viscosity of more than 2000 in centipose of an aqueous solution at pH 6, 25 C, and a polymer solution of 1% by weight. The polymer structure is illustrated.

*Phosphates, *Phosphorus, *Ammonium salts, *Chemical precipitation, *Patents, *Coagulation, Polymers, Polyelectrolytes, Separation techniques, Sewage treatment, Effluents, Industrial wastes, Chemical reactions, Ammonium compounds, Salts, Waste water treatment

Phosphate removal

C141
PROCESS FOR PROMOTION OF ALGAE GROWTH IN A SEWAGE MEDIUM,

Dor, I.

United States Patent 4,043,903. Issued August 23, 1977. Official Gazette of the United States Patent Office, Vol. 961, No. 4, p 1747, August, 1977.

A process and apparatus to promote the growth of algae in a sewage medium have been patented. Algae is placed in pure water separated from sewage water by a dialysis membrane which has a porosity of about 250A to 24A. The algae is subjected to light of an intensity of at least 15,000 lux. An osmotic interaction occurs across the membrane as a result of the difference in concentration gradient.

*Algae, *Microorganisms, *Patents, *Aquatic algae, *Growth chambers, Dialysis, Membrane processes, Treatment, Sewage, Plant growth

Algae growth

C142
WASTE WATER TREATMENT METHOD,

Takeda, T., Atarashi, Y., and Mori, A.

Kao Soap Company, Limited,
Tokyo, Japan. (assignee)

United States Patent 4,043,904. Issued August 23, 1977. Official Gazette of the United States Patent Office, Vol. 961, No. 4, p 1747, August, 1977.

A waste water treatment process has been patented which removes formaldehyde-produced water-soluble salts of condensates of sulfonates of mono- or fused poly-cyclic benzenoid aromatic hydrocarbons having from 1 to 12 benzene rings. An inorganic flocculating agent at a concentration of from 50 to 1000 ppm is added to the waste water. The pH is maintained from about 6.5 to 9.5 during the process. Flocs which contain a portion of the condensates are then removed from the waste water. Activated carbon at concentrations of from 50 to 400 ppm is then added to the partially treated waste water. The solution is agitated over a period of time for sufficient absorption of the condensates. The activated carbon is then filtered from the treated waste water.

*Organic compounds, *Flocculation, *Chemical precipitation, *Salts, *Patents, *Organic wastes, Chemical wastes, Waste water treatment

Hydrocarbons, Formaldehyde

C143
APPARATUS FOR REMOVING SOLID MATERIAL FROM SEWAGE OR OTHER LIQUID,

Wilson, R. A. E.

Jones and Attwood Limited,
Stourbridge, England. (assignee)

United States Patent 4,042,506. Issued August 16, 1977. Official Gazette of the United States Patent Office, Vol. 961, No. 3, p 1277, August, 1977.

A device for separating solid and liquid matter in sewage or other liquids by screening has been patented. The device includes a duct through which sewage flows. Two screens are provided for sewage filtration. A cylindrical screen extends vertically through the duct and is rotatable about its vertical axis. A second vertically extending screen receives solid material from the first screen. A lifting plate over the top of the second screen lifts the solid material from the screen to a position above the main sewage flow. The solid material is then removed from the lifting plate to a horizontally extending compression chamber.

*Filtration, *Patents, *Sludge treatment, *Screening, *Equipment, Sewage treatment, Waste water treatment

C144
PROCESS AND APPARATUS FOR THE TREATMENT OF WATER-CONTAINING SUBSTANCES AND APPLICATION OF THIS METHOD FOR THE PREPARATION OF PASTEURIZED DRIED SLUDGE,

Galliker, J.

Patelhold Patentverwertungs- and Elektro-Holding Company,
Glarus, Switzerland. (assignee)

United States Patent 4,043,047. Issued August 23, 1977. Official Gazette of the United States Patent Office, Vol. 961, No. 4, p 1469, August, 1977.

A process for drying water-containing substances, including sludge, has been patented. The water-containing substance is conveyed to the first treatment station, where elongated electrodes energized by alternating current for heating purposes dry the substance. The pre-dessicated substance is then transported to a second treatment station, where it is dielectrically heated to remove all but a few percent of the initial water content. The dielectric heat is furnished by condenser plates which are powered by a high-frequency source.

*Dewatering, *Separation techniques, *Heating, *Heat treatment, *Drying, Equipment, Patents, Sludge treatment, Electrical equipment, Waste water treatment

C145
REMOVAL OF SLUDGE FROM WASTE WATER TREATMENT PLANT-BY ROTARY SWEEP FOOTBRIDGE WITH INBUILT SUCTION SCRAPER,

French Patent FR 2320-909. Issued April 15, 1977. Derwent French Patents Abstracts, Vol. Y, No. 21, p D2, July, 1977.

A rotary sweep footbridge, which is bearing-mounted on one end and carried on rollers around a circumferential track at the other end, has been patented as a device for the removal of sludge from a waste water treatment plant. The bridge is a trapezoidal-section channel with a walkway across the larger, upper face. An electric collection rotor and a suction outlet pipe are coaxial with the central bearing. A metal service pit for the sludge suction manifold system, a sludge scraper, and suction pipes are carried by the beam. The footbridge assembly, used to remove settled sludge from settling basins, is capable of directly pumping sludge from the basin without additional storage or transport.

*Settling basins, *Patents, *Equipment, *Sludge treatment, Sludge disposal, Hydraulic transportation, Separation techniques, Dewatering, Pumping, Waste water treatment

Footbridges, Sludge transport

C146
WASTE WATER AERATING AND CLARIFYING TANK-HAS PERFORATED PLATE FOR CIRCULATION BETWEEN AERATION AND CLARIFICATION ZONES,

Soviet Patent SU-387-935. Issued November 14, 1973. Soviet Inventions Illustrated, Vol. Y, No. 26, p D1, August, 1977.

Design data for a patented aerating and clarifying basin are presented. The waste water treatment tank contains a casing equipped with a water removal channel; a water supply pipe; aerators; and partitions separating the aeration, clarification, and pulse-damping zones. The partitions, composed of perforated plates, extend horizontally over the clarification zone to stabilize the fluidized bed and to intensify recirculation between the aeration and clarification zones. Vertical sloping partitions divide the tank into a central compartment for aeration and two lateral compartments for clarification. Effluent is saturated with air in the central compartment of the flat-bottomed tank and is treated with activated sludge from the clarification zone. Intense mixing in the aeration zone results in accelerated oxidation of organic impurities.

*Activated sludge, *Clarification, *Aeration, *Oxidation, *Patents, Sludge treatment, Design data, Organic wastes, Waste water treatment

C147
ELIMINATION OF NITROGEN CPDS. FROM WASTE WATER BY DOWNWARDS PASSAGE THROUGH BIOLOGICAL TREATMENT UNITS IN A SUITABLE ATMOS.,

Netherlands Patent NL 7613-165. Issued May 31, 1977. Derwent Netherlands Patents Report, Vol. Y, No. 24, p D6, July, 1977.

A process for the biological removal of nitrogen compounds, nitrates, nitrites, and ammonia compounds has been patented. Waste water is conducted through a distribution chamber and a series of recipients for the biological reduction of nitrates and oxygen removal. The waste water then flows into a gas distribution chamber, where a nitrogen atmosphere is produced by the introduction of gas which flows in a direction counter-current to the waste water stream. The series of superimposed recipients is fitted with interconnecting overflow tubes. The lower portion of the recipients is filled with nutrient-treated, innoculated porous bodies which denitrify bacteria. The biological treatment process is reported to eliminate dissolved nitrogen compounds in a few minutes at costs much lower than those for chemical treatment processes.

*Biological treatment, *Nitrogen compounds, *Denitrification, *Patents, *Ammonia, Nitrates, Nitrites, Ammonium compounds, Reduction (chemical), Bacteria, Nitrogen, Waste water treatment

C148
OXYGEN ADDN. REGULATION IN WATER AND SEWAGE PURIFCN.-USING EJECTORS TO SECURE INTIMATE CONTACT WITH ACTIVATED SLUDGE,

French Patent FR 2320-908. Issued April 15, 1977. Derwent French Patents Abstracts, Vol. Y, No. 21, p D2, July, 1977.

A method of activated sludge oxygenation for use in facilities with cascade-mounted units has been patented. Waste water is agitated with gas containing at least 20-45 volume percent of oxygen. Water is fed to two units from an inlet in the suction side of a recycling pump. The activated sludge mixture is pumped through an oxygen injector with recycled gas furnished by a compressor. Settled sludge is transported to the first unit in the cascade and goes into suspension. The quantity of oxygen furnished to the first unit is dependent upon the amount of biodegradable material present and upon the amount of oxygenation necessary to maintain an oxygen concentration of 0.25 mg/liter. Oxygen concentrations are measured with a probe. Oxygen is rapidly transferred to the finely-divided activated sludge.

*Activated sludge, *Patents, *Aeration, *Oxygenation, *Aerobic conditions, Biodegradation, Organic wastes, Oxygen requirements, Sewage treatment, Waste water treatment

C149
AQ. EFFLUENT PURIFICATION BY MICROBIAL FERMENTATION-FEEDING BIOMASS TO PROTOZOA TO FORM BIOMASS AS PROTEIN SOURCE,

Belgian Patent BE-849-148. Issued June 7, 1977. Derwent Belgian Patents Abstracts, Vol. Y, No. 24, p D1, July, 1977.

A biological process for the treatment of waste water which contains biodegradable organic materials is described. Organic wastes are used as a culture medium for the exponential growth of microorganisms. The waste is cultured until it provides a suitable medium for microorganism-consuming protozoans. The protozoal biomass can then be removed from the waste water and used as a protein source for livestock feeds. Suggested microorganisms include aerobic bacteria and/or yeasts (specifically, Pseudomonas and Brevibacterium) and Torula yeasts. Ciliated protozoa are suggested for microorganism consumption, including Tetrahymena pyriformis and Colpidium camphilium.

*Microorganisms, *Food chain, *Biodegradation, *Protozoa, *Patents, Nutrients, Proteins, Fermentation, Cultures, Sludge treatment, Sewage treatment

Pseudomonas, Brevibacterium, Torula yeasts, Tetrahymena pyriformis, Colpidium camphilium

TREATMENT METHODS

D001
WATER USAGE AND WASTEWATER CHARACTERIZATION AT A CORPS OF ENGINEERS RECREATION AREA,

Francingues, N. R., Jr., and Green, A. J., Jr.

United States Army Engineer Waterways Experiment Station,
Vicksburg, Mississippi,
Environmental Effects Laboratory.

January, 1976. 44 p, 7 fig, 10 tab, 5 ref. Paper No. Y-76-1.

A field monitoring study to collect information on water usage and waste water characterization at a Corps of Engineers recreation area was conducted in order to develop guidelines for assisting Corps of Engineers districts in optimizing the design and operation of recreation area waste water management systems. Water usage and waste water production rates were significantly less than those presently being used by Corps of Engineers districts. The characteristics of the waste water from the camping areas were not substantially different from those for picnic, rest, or other day-use areas (comparable to medium-strength domestic waste water), except for ammonia nitrogen which was somewhat higher. It appears that the sizing of water supplies and waste water treatment facilities should be based on the number of occupied campsites in overnight areas and not on the number of people. Suggested design values for waste water treatment facilities serving Corps of Engineers recreation areas are tabulated.

*Recreation facilities, *Waste water (pollution), *Water requirements, *Water utilization, *Water management (applied), Ammonia, Nitrogen compounds, On-site investigations, Monitoring, Design criteria

D002
CHLORINE DISINFECTION OF TREATED WASTEWATER IN A BAFFLED CONTACT CHAMBER AT LESS THAN 1 C,

Gordon, R. C., Davenport, C. V., and Reid, B. H.

Environmental Protection Agency,
College Alaska,
Arctic Environmental Research Laboratory.

October, 1973. 67 p, 11 fig, 7 tab, 35 ref. Working Paper No. 21.

The disinfection of treated waste water at temperatures in the 0-10 C range was studied. Batch treatment of one primary and three secondary effluents with chlorine revealed that effective disinfection was attained in all samples at a temperature of less than 1 C when the actual contact time was 60 min and the final chlorine residual was about 1 mg/liter (orthotolidine). Studies in an 8-compartment, 60-liter contact chamber with flow rates providing 30, 60, and 120 min theoretical contact time revealed that fecal coliforms were essentially destroyed (less than 5/100 milliliter) at temperatures of less than 1 C regardless of the flow rate or chlorine residual maintained. However, reduction of total coliforms to less than 1000/100 milliliter did not occur when the theoretical contact time was 30 min, even when the chlorine residual was 3.3 mg/liter (orthotolidine). For a theoretical contact time of 60 min, nearly 2 mg/liter chlorine residual were required before total coliforms were sufficiently reduced. Only slightly more than 0.5 mg/liter chlorine residual was required for sufficient reduction in total coliforms when the theoretical contact time was 120 min. Reductions in fecal streptococci were generally between those observed for total and fecal coliforms. Raising the temperature from 1 to 10 C did not significantly affect disinfection.

*Disinfection, *Waste water treatment, *Chlorine, *Temperature, *Bacteria, Coliforms, Streptococcus, Effluents, Performance, Evaluation

D003
SHIP-TO-SHORE SEWAGE HOSE HANDLING TESTS,

Campbell, F. J.

Naval Construction Battalion Center,
Port Hueneme, California,
Civil Engineering Laboratory.

October, 1975. 98 p, 42 fig, 22 tab, 9 ref. Technical Note N-1404.

Procedures and equipment for transferring waste from a ship's holding tank to pier waste-handling facilities were evaluated. The procedures tested included: loading, transporting, connecting, disconnecting, unloading, cleaning, and hose storing. The equipment tested included four types of transport vehicles, plastic and rubber hoses, metal and plastic hose caps and plugs, two powered reels, two types of storage and loading racks, a hose cleaning rack, a hose cleaning apron, and two types of hose supports. The systems selected as best suited to future sewage transfer operations included one for high- and low-load, high-turnover ports and a second for high- and low-load, low-turnover ports. Criteria for determining manpower and equipment requirements for the systems are outlined.

*Waste disposal, *Waste treatment, *Ships, *Transfer, *Design criteria, Evaluation, Performance, Equipment, Hoses

D004
SYSTEM FOR DEWATERING DILUTE SLURRIES,

Lippert, T.

Environmental Protection Agency,
Washington, D. C.

November, 1974. 16 p, 7 fig. Publication No. PB-245 720.

An improved system for dewatering dilute slurries such as waste activated sewage sludge is described which allows for higher solids yields by decreasing the solids loading which in turn allows for a proportionally larger decrease in the sludge-belt contact time to effect dewatering. The device includes a spring-loaded or balanced sludge feed tray incorporating an adjustable flow splitter plug along with spring-loaded sludge side guides. A sludge cake compression section design which allows two-position adjustment of the compression roller is employed as a component in the backflushing of the sludge carrier screen using cake effluent.

*Sludge treatment, *Dewatering, *Equipment, *Design criteria, *Activated sludge, Waste treatment, Performance

D005
ADVANCED TRICKLING FILTER FOR WASTEWATER TREATMENT,

Leschber, E. W.

Gary Aircraft Corporation,
San Antonio, Texas.

August, 1975. 44 p, 13 fig, 4 tab, 3 ref. Air Force Report No. AFCEC-TR-75-6.

A prototype advanced trickling filter unit for purifying secondary-treated waste water is described. The unit uses a foamed silica medium (GaryGlas) and has a design hydraulic load of 700,000 gallons/day. The design organic load (biochemical oxygen demand) and design solids load are 80 and 60 pounds/1000 cu ft/day, respectively. The unit is capable of reducing effluent biochemical oxygen demand from 29 to 18 milligrams/liter, and reductions in total suspended solids from 64 to 32 milligrams/liter have been achieved. These reductions are sufficient for upgrading existing treatment plants to a level consistent with newer effluent limitations. Detailed design drawings of the trickling filter are provided.

*Trickling filters, *Tertiary treatment, *Waste water treatment, *Biological treatment, *Design criteria, Suspended solids, Biochemical oxygen demand, Equipment, Treatment facilities, Performance

D006
ULTRAVIOLET DISINFECTION OF ACTIVATED SLUDGE EFFLUENT
DISCHARGING TO SHELLFISH WATERS,

Roeber, J. A., and Hoot, F. M.

Clow Corporation,
Florence, Kentucky.

December, 1975. 94 p, 12 fig, 13 tab, 7 ref. Environmental Protection Agency Report No. EPA-600/2-75-060.

The feasibility of using ultraviolet radiation for the disinfection of activated sludge effluent discharging to shellfish waters was investigated. A tertiary treatment plant and an ultraviolet disinfection chamber were installed at the outlet of an activated sludge unit at the municipal sewage treatment plant in Saint Michaels, Maryland. Flow-through tests indicated that a total of 16 germicidal 36-watt ultraviolet lamps were capable of achieving a most probable number count of not more than 70/milliliter when the flow was not in excess of 40,000 gallons/day and when the turbidity was less than 11 Jackson turbidity units. Ultraviolet radiation absorption appeared to be much more dependent on chemical oxygen demand than on turbidity, indicating that the effluent's appearance is not the best criterion for estimating the desired ultraviolet treatment rate. Coliform inactivation followed first order kinetics until 99.99% inactivation occurred; the inactivation then followed a tailing-off curve. Bacteriophage followed first order kinetics up to the maximum available ultraviolet rate. Both coliforms and bacteriophage which were exposed to sublethal doses of ultraviolet radiation multiplied when subsequently exposed to visible light.

*Ultraviolet radiation, *Bacteria, *Sewage treatment, *Disinfection, *Feasibility, Chemical oxygen demand, Turbidity, Coliforms, Bacteriophage, Treatment facilities, Municipal wastes, Microorganisms, Kinetics, Performance, Evaluation, Tertiary treatment, Activated sludge

D007
RESEARCH NEEDS FOR THE POTABLE REUSE OF MUNICIPAL WASTEWATER,

Linstedt, K. D., and Bennett, E. R.

Colorado University,
Boulder,
Department of Civil and Environmental Engineering.

December, 1975. 202 p, 18 fig, 31 tab, 88 ref. Environmental Protection Agency Report No. EPA-600/9-75-007.

Research needs associated with the potable reuse of municipal waste water are discussed. Topics covered include: Environmental Protection Agency research strategy for waste water reuse, current municipal waste water reuse practices, waste water treatment technology for potable reuse, treatment reliability and effluent quality control for potable reuse, socio-economic aspects of water reuse, research needs related to treatment for potable reuse, and the health effects of potable reuse associated with inorganic and organic chemical pollutants as well as with viruses. The identified research is designed to serve as a basis for future Environmental Protection Agency projects dealing with potable reuse of waste water.

*Water reuse, *Reclamation, *Municipal wastes, *Waste water treatment, *Reclaimed water, *Potable water, Social aspects, Economics, Organic compounds, Inorganic compounds, Viruses, Research priorities, Toxicity

D008
AMMONIA REMOVAL FROM WASTEWATER BY LIGAND EXCHANGE,

Smith, L. M., Lyerly, G. A., and Dooley, M. E.

Gillette Research Institute,
Rockville, Maryland.

April, 1976. 78 p, 21 fig, 13 tab, 27 ref. Environmental Protection Agency Report No. EPA-600/2-76-103.

A ligand exchanger consisting of copper ions on a hydrous zirconium oxide ion exchanger was tested in terms of its effectiveness in removing ammonia from secondary-treated municipal waste water and its regeneration capacity. Maximum ammonia uptake by the ligand exchanger occurred at a pH of 10-11 and corresponded to 0.1 millimole ammonia/millimole copper. Steam regeneration was temperature dependent, with maximum regeneration being complete after four column volumes of condensed steam at 135 C. Repeated loading and regeneration through 25 cycles resulted in no physical particle breakdown nor copper leaching, though some ammonia capacity was lost. Common inorganics and organics exerted a minimal effect on the overall process. Runs with secondary-treated waste water through five cycles were successful, with the exchanger capacity being near that for pure ammonium chloride solution and essentially no loss of capacity occurring.

*Waste water treatment, *Ion exchange, *Municipal wastes, *Ammonia, *Feasibility, Performance, Evaluation, Waste treatment, Chemical wastes, Alkalinity, Temperature

Ligand exchange

D009
TECHNICAL ASSISTANCE PROJECT GREELEY WASTEWATER TREATMENT FACILITY, GREELEY, COLORADO. JUNE-JULY, 1972,

Environmental Protection Agency,
Denver, Colorado,
Technical Support Branch.

August, 1972. 21 p, 5 fig. Publication No. S and A/TSB-4.

Improvements in the performance of an activated sludge/trickling filter waste water treatment plant handling municipal and industrial wastes in the Greeley, Colorado area are outlined. Modifications to the facility resulted in an increase in 5-day biochemical oxygen demand removal from 40% to 70%. Most of the improvement was due to the discovery of a partially opened valve which provided a cross-connection between the mixed liquor from the activated sludge plant and the final effluent. An improved operational mode for the activated sludge portion of the plant also resulted in better effluent quality. Wasting to the primaries was optimized by monitoring the sludge blanket in the primary clarifiers, and wasting was continued until the primary clarifier blankets began to increase to the point that bulking of solids from the primaries would occur. Thus, all of the solids that could be handled by the system as well as all of the biochemical oxygen demand that could be utilized in solids production were removed. Consistent effluent quality is expected to be difficult to achieve at the plant due to the organic overload received and the plant's inability to handle sludge solids.

*Waste water treatment, *Treatment facilities, *Activated sludge, *Biochemical oxygen demand, *Optimization, Trickling filters, Municipal wastes, Industrial wastes, Biological treatment, Performance, Efficiencies, Sludge, Organic compounds

Solids bulking, Cross connections

D010
NITROGEN REMOVAL FROM WASTEWATERS BY COLUMN REACTORS,

Smith, J. M.

In: Advanced Waste Treatment Seminar, Session 1, Nitrogen Removal From Wastewater, October 28-29, 1970, San Francisco, California, p 35-38. 1 fig, 3 ref.

When a number of facultative bacteria common in waste water are supplied with a suitable organic carbon source under anaerobic or near anaerobic conditions, they can convert nitrates formed in sewage treatment to nitrogen gas in columnar nitrate reduction. The long cell residence time, large contact surface, and short diffusion distances in a packed column provide an efficient system for rapid denitrification. Greater than 90% nitrate reduction can be achieved at contact times of 10 min for sand and 30 min for 3/4 in. stone. Media varying in size from one in. to 2 in. aggregate have been successfully used to denitrify agriculture subsurface drainage. Methanol is used as a supplemental organic carbon source for denitrification because of its low cost, biodegradability, and ease of handling. The interdependence of nitrification and denitrification stages will limit total nitrogen removal efficiencies to a practical value of about 90%. The design of denitrification systems is straightforward and involves basic principles of biological oxidation and filtration. Anaerobic filters have been successfully used for removal of nitrates from irrigation return flow collected in drain tiles.

*Waste water treatment, *Sewage treatment, *Biological treatment, *Treatment facilities, *Nitrogen, Waste water (pollution), Bacteria, Alcohols, Carbon, Anaerobic conditions, Nitrates

Column reactors

D011
AMMONIA NITROGEN REMOVAL BY STRIPPING WITH AIR,

Farrell, J. B.

In: Advanced Waste Treatment Seminar, Session I, Nitrogen Removal from Wastewater, October 28-29, 1970, San Francisco, California, p 39-41.

Problems associated with the stripping (desorption) of ammonia from waste water are discussed. Waste water contains ammonium ion at concentrations which typically range from 15-25 mg/liter; and if the ammonium ion is converted to dissolved ammonia by raising the pH, the ammonia may be stripped out by contacting the waste water with air. Problems associated with the use of stripping towers for ammonia removal include: the effect of cold air in the winter on cooling the waste water and raising the ammonia solubility and the formation of scale when previously lime-treated effluents are being stripped. Although it is possible to heat the incoming air to temperatures above 0 C and add moisture to prevent freezing of the waste water, this procedure is economical only if subfreezing days are rarely encountered. The best approach for minimizing scale and its effects involves the use of a pH of about 10.5, countercurrent rather than cross-flow operation, and the use of an open fill to allow for easy flushing of accumulated solids.

*Waste water treatment, *Ammonia, *Sorption, *Solubility, *Chemical wastes, Liquid wastes, Freezing, Scaling, Treatment facilities, Alkalinity, Lime, Effluents, Design criteria, Nitrogen compounds

Stripping, Desorption

D012
ION EXCHANGE FOR NITRATE REMOVAL,

Dobbs, R. A.

In: Advanced Waste Treatment Seminar, Session I, Nitrogen Removal from Wastewater, October 28-29, 1970, San Francisco, California, p 45-46.

The feasibility of using ion exchange for removing nitrate from irrigation return drain water was investigated, and the conclusions were extrapolated to municipal waste water treatment. Although the concentration of anions in drain water is considerably higher than the corresponding concentration in waste water, the ratio of nitrate to chloride is quite similar for both waters, thus permitting the extrapolation of conclusions from drain water treatment to waste water treatment. Commercially available anion exchange resins with a selectivity for nitrate over chloride exist; an estimated selectivity ratio of about 20:1 appears to be necessary for the economical removal of nitrate from waste water. Assuming that resins with this degree of selectivity can be developed, problems associated with the regeneration of the selective ion exchange resin and with the ultimate disposal of nitrate laden brine produced during regeneration must be solved. Based on nitrate anion alone, the efficiency of sodium chloride regeneration is only about 1%. A nitrate removal process based on the use of a porous solid absorbent containing a nitrate-selective, water-immiscible extractant is currently being investigated. The process has the advantages of liquid ion exchange technology and the ease of operation associated with granular bead resin systems.

*Waste water treatment, *Ion exchange, *Nitrates, *Municipal wastes, *Feasibility studies, Irrigation, Liquid wastes, Chemical wastes, Nitrogen compounds, Separation techniques, Absorption, Chlorides, Ions

D013
NITROGEN REMOVAL BY BIOLOGICAL SUSPENDED GROWTH REACTORS,

Barth, E. F.

In: Advanced Waste Treatment Seminar, Session I, Nitrogen Removal From Wastewater, October 28-29, 1970, San Francisco, California, p 31-34. 1 fig, 11 ref.

For nitrogen removal by biological denitrification to be highly efficient, the biological transformation of ammonia nitrogen to nitrate nitrogen must be under good process control. Reduced nitrogen compounds introduced into the denitrification stage will pass through the process unaltered and impair overall nitrogen removal efficiency. The three sludge system allows management of the separate biological transformations needed for successful denitrification. The high rate system handles the bulk of the carbonaceous removal. Thus, the nitrification stage receives a predominantly ammonia nitrogen feed. An enriched culture develops because each system has its own sludge recycle. The latter nitrification stages are protected by the high rate system from toxic chemicals. Since this is a staged system, no direct short circuiting of materials from the influent to the effluent can occur.

*Waste water treatment, *Biological treatment, *Activated sludge, *Nitrogen, *Denitrification, Nitrogen compounds, Control, Efficiencies, Growth chambers

D014
SALT CREEK TWO STAGE NITRIFICATION PLANT METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO,

Woodward, R. L.

In: Advanced Waste Treatment Seminar, Session I, Nitrogen Removal from Wastewater, October 28-29, 1970, San Francisco, California, p 51-55.

The design of a two-stage activated sludge waste water treatment plant with nitrification/denitrification capability is described for the metropolitan sanitary district of Greater Chicago. The design calls for the plant to handle an average dry weather flow of 30 million gallons/day and a maximum flow of 50 million gallons/day. After coarse racks, pumping, screening, and grit removal, the sewage will flow to the first aeration stage which will provide 3 hr of detention. Sedimentation will be in circular clarifiers with an overflow rate of 1450 gallons/day/sq ft based on maximum day flow plus 30% sludge return. Second-stage clarifiers and sedimentation tanks will be identical to those in the first stage. Nitrogen removal by denitrification can be accomplished in the filters which follow the second-stage clarifiers by providing a carbon source (methanol) to permit the development of a denitrifying flora in the filters. Pilot plant studies with the basic design indicate almost complete nitrification even for sewage temperatures in the 40-50 F range.

*Sewage treatment, *Treatment facilities, *Nitrification, *Denitrification, *Activated sludge, Biological treatment, Aeration, Pilot plants, Design criteria, Municipal wastes, Illinois

D015
REMOVAL OF AMMONIA NITROGEN BY SELECTIVE ION EXCHANGE,

Dean, R. B.

In: Advanced Waste Treatment Seminar, Session I, Nitrogen Removal from Wastewater, October 28-29, 1970, San Francisco, California, p 42-44.

The use of ion exchange for removing ammonia nitrogen from waste water is discussed. Certain zeolites, including the naturally occurring mineral clinoptilolite, exhibit a high selectivity for ammonium in natural and waste waters. Preliminary experiments were performed with columns filled with clinoptilolite which was ground and sieved to 20 by 50 mesh. The water was first passed through an inclined-tube settler clarifier to remove turbidity from the feed and prevent clogging of the ion exchange columns. The clarified water was treated by passing it in conventional downflow through two columns in series. When ammonia breaks through the second column, the first column is taken offstream and a third column containing freshly regenerated clinoptilolite is added after the second column which now becomes the first in the series. The loaded column is regenerated by backwashing with lime water containing sodium chloride. The ammonia laden lime water is then pumped through a packed column through which heated air is blown to remove the ammonia. The problems of ammonia dispersal to the atmosphere are similar to those encountered in direct air stripping of ammonia. The cost of removing ammonia from waste water using zeolite ion exchange methods is estimated at about 10 cents/1000 gallons.

*Waste water treatment, *Ammonia, *Ion exchange, *Zeolites, *Chemical wastes, Liquid wastes, Costs, Treatment, Nitrogen compounds

Clinoptilolite

D016
OTHER METHODS FOR REMOVING NITROGEN,

Dean, R. B.

In: Advanced Waste Treatment Seminar, Session I, Nitrogen Removal from Wastewater, October 28-29, 1970, San Francisco, California, p 47-50.

Techniques for the removal of various forms of nitrogen in waste water are reviewed. Efficient clarification and filtration are effective ways of removing organic nitrogen compounds which are present in particulate form both in raw sewage and in secondary effluents. Soluble nitrogen compounds, with the exception of urea, are ionized in water, and 85-90% of them can be removed by such deionizing or desalting processes as reverse osmosis, electrodialysis, ion exchange, or distillation. None of these processes have a favorable selectivity for ammonium or nitrate ions, and it is thus necessary to remove about 90% of the salts in order to remove 90% of the soluble nitrogen compounds. Breakpoint chlorination can be used to destroy ammonia in addition to its use for disinfection. Hypochlorite is preferred to chlorine for chlorination purposes since the former is much safer than the latter. Nitrates can be chemically reduced to nitrogen gas and some nitrous oxide using ferrous sulfate; however, the byproduct is a voluminous sludge of ferrous-ferric hydroxide, and a large part of the sulfate remains in the waste. The process appears to have marginal value for special situations.

*Waste water treatment, *Sewage treatment, *Nitrogen compounds, *Chemical wastes, *Separation techniques, Reverse osmosis, Ion exchange, Electrodialysis, Chlorination, Filtration, Distillation, Reduction (chemical), Organic compounds, Ammonia, Nitrates, Ions

D017
NITROGEN REMOVAL FROM WASTEWATERS -- STATEMENT OF THE PROBLEM,

Barth, E. F., and Dean, R. B.

In: Advanced Waste Treatment Seminar, Session I, Nitrogen Removal from Wastewater, October 28-29, 1970, San Francisco, California, p 22-30. 1 fig, 10 ref.

Nitrogen contents range from 15 to 25 mg/liter in untreated and primary settled municipal wastes; the nitrogen is divided between organic compounds, which are mostly insoluble, and ammonia. Biological treatment converts most of the organic nitrogen to ammonia, which under favorable conditions may be oxidized to nitrates. To achieve nitrification consistently, the period of aeration must exceed a minimum value which depends on the concentration of activated sludge, the temperature, and the strength of the sewage. Under conditions favoring nitrification, the rates of nitrification and consumption of oxygen due to this process will tend to an equilibrium level proportional to the concentration of activated sludge under aeration. In an aeration unit through which the liquid travels with ideal flow the effluent ammonia concentration under equilibrium conditions will be normally very small. Eutrophication in lakes that are young in the aging process may be more likely to be nitrogen limited than in lakes that have started down the eutrophication pathway. In some areas dissolved oxygen deficits are mainly attributable to the nitrogenous demand or organic matter from waste water discharges. Ammonia and particulates containing nitrogen are effectively removed in the soil. Bound ammonia is converted to nitrates by nitrifying bacteria if there is insufficient plant growth in the soil to use it. Nitrates are poorly adsorbed in the soil; excess nitrates rapidly reach the groundwater. Ammonia is more poisonous to aquatic species than to humans, but details are not completely clear. The toxicity of nitrates for both plants and animals is low.

*Waste water treatment, *Sewage treatment, *Biological treatment, *Activated sludge, *Sewerage, Nitrogen, Waste water (pollution), Nitrogen compounds

D018
DECONTAMINATION OF WATER CONTAMINATED WITH POLYCYCLIC AROMATIC HYDROCARBONS (PAH). I. ACTION OF CHLORINE AND OZONE ON PAH DISSOLVED IN DOUBLY DISTILLED AND IN DE-IONIZED WATER,

Sforzolini, G. S., Savino, A., Monarca, S., and Lollini, M. N.

Oak Ridge National Laboratory Translation No. ORNL-tr-2960, 19 p, 11 tab, 59 ref. Translated from Igiene Moderna, Vol. 66, No. 3, p 309-335, 1974.

The destructive effects of ozone and chlorine on various polycyclic aromatic hydrocarbons in bidistilled or deionized water were investigated. Ozone proved to be more effective in destroying such compounds as pyrene, 1,2-benzoanthracene, 3,4-benzopyrene, 3,4-benzofluoroanthene, and 11,12-benzofluoroanthene. Ozone in the form of ozonized air at a concentration of 0.40 mg/liter and with a contact time of 30 min produced stronger destructive effects than aqueous chlorine solutions with a concentration of 2 mg/liter did over the same contact time. Ozone was most effective against 3,4-benzopyrene, with reductions amounting to as much as 100%. Spectrophotometric evidence for the formation of new chloro derivatives of pyrene and 3,4-benzopyrene was observed after their reaction with chlorine. Thus, ozone appears to be preferable to chlorine for the oxidation of polycyclic aromatic hydrocarbons in water.

*Water treatment, *Oxidation, *Hydrocarbons, *Ozone, *Chlorine, Organic compounds, Chemical reactions

Polycyclic aromatic hydrocarbons, Pyrene, Benzoanthracene, 1,2-, Benzopyrene, 3,4-, Benzofluoroanthene, 3,4-, Benzofluoroanthene, 11,12-

D019
ESTUARINE POLLUTION CONTROL: OBJECTIVES AND PRIORITIES,

Staples, K. D.

Proceedings of the Institution of Civil Engineers, Vol. 60, Part 1, p 329-343, August, 1976. 5 fig, 2 tab, 8 ref.

The forms and hydraulic regimes of estuaries are described along with the nature and effect of pollutants arising from sewage and industrial waste discharges on developed estuaries. Pollutants contributed to a developed estuary normally include three important elements: suspended solids, dissolved colloidal biodegradable compounds, and dissolved toxic chemicals including heavy metals. The effect of individual pollutants on a particular estuary is dependent on their volume and the estuary regime, particularly the tidal excursion and retention period within the waters. The point of pollutant contribution is important in all cases, with the pollutants's effect being greater at higher points of contribution in the estuary. Where high water quality is desired, a minimum dissolved oxygen level of about 40% is recommended. Mathematical modeling procedures can be used to equate pollutant input with the dilution and transport effected by the tidal flow and the reaeration and oxidation potential of the estuary, thus allowing for the establishment of pollution control policies that minimize expense. The costs of proposed estuary pollution control works for several major British estuaries are compared, and priorities for the staged implementation of typical control schemes are discussed.

*Estuaries, *Water pollution control, *Hydraulics, *Sewage, *Industrial waste, Suspended solids, Organic compounds, Heavy metals, Toxicity, Dissolved oxygen, Tidal effects, Control Systems, Economics, Aeration, Mathematical models, Surface waters, Effluents

Great Britain

D020
COLESHILL ADVANCED WASTEWATER TREATMENT PROJECT,

Clough, G. F. G., and Maskell, A. D.

Proceedings of the Institution of Civil Engineers, Vol. 60, Part 1, p 383-400, August, 1976. 7 fig, 2 tab, 6 ref.

A full-scale advanced waste water treatment installation at Coleshill, Great Britain is described. The facility utilizes mobile process units which allow for the linking up of various experimental treatment sequences. The basic treatment steps employed at the facility include: lime addition and flocculation, primary settling, recarbonation and secondary settling, sludge consolidation, multi-media filtration, activated carbon treatment, activated sludge treatment, and final settling. A sludge dewatering facility is also provided. Initially, physical-chemical processes for sewage treatment are being examined. An important objective of the experimental waste water treatment program is to obtain information on which an economic assessment of advanced waste water treatment can be based.

*Treatment facilities, *Tertiary treatment, *Waste water treatment, *Biological treatment, *Physical control, Activated sludge, Sludge treatment, Dewatering, Filtration, Settling basins, Separation techniques, Sewage treatment, Economics, Flocculation, Activated carbon, Lime, Evaluation, Performance

Recarbonation

D021
OPTIMIZE THE EFFLUENT SYSTEM. PART 6: BIOCHEMISTRY OF ACTIVATED SLUDGE PROCESS,

Grutsch, J. F., and Mallatt, R. C.

Standard Oil Indiana,
Chicago.

Hydrocarbon Processing, Vol. 55, No. 8, p 137-142, August, 1976. 7 fig, 2 tab, 15 ref.

The biochemistry of activated sludge treatment is discussed, with particular emphasis on the role of enzyme reactions and the transport of substrate through the bacterial cell wall and membrane. Exoenzymes are needed to hydrolyze colloidal and suspended solids into smaller soluble molecules that can pass through cell membranes for food. However, these enzymes may be dispersed and lost in the effluent or destroyed by exposure to changes in pH, salinity, and other conditions. Endoenzymes on the other hand are at least partially protected from these environmental changes by the bacterial cell wall and membrane; thus, using the biological process for the removal of only soluble contaminants is consistent with obtaining a stable system. Moreover, activated sludge units that utilize only soluble contaminants can be operated at very high sludge ages, thus permitting much higher biological cell inventories which in turn increases stability, capacity, and purification while minimizing the generation of excess biological cells.

*Activated sludge, *Waste water treatment, *Enzymes, *Biochemistry, *Bacteria, Chemical reactions, Microorganisms, Biological treatment, Solid wastes, Liquid wastes, Solubility, Suspended solids, Colloids, Performance, Optimization

D022
ADVANCED WASTE TREATMENT PLANT HAS PHYSICAL-CHEMICAL OPTION,

McDowell, D. L., and Goldman, M.

Buchart-Horn,
Consulting Engineers and Planners,
Lewisburg, Pennsylvania.

Public Works, Vol. 107, No. 9, 2 p, September, 1976.

The design of an advanced municipal waste water treatment plant with physical-chemical options is described. Waste water passes through a grit chamber and comminutor to a pumping station, and the pumped wastes are discharged directly to twin oxidation ditches which are circular and have a common wall. The oxidation ditches are designed to provide a 24-hour retention period at a design flow rate of 130,000 gallons/day. The remaining plant features to achieve advanced waste water treatment consist of triple-media filters (equipped for backwash and surface wash) operating in conjunction with flocculation equipment and tube settlers plus a chlorine contact tank. An aerated equalization tank of reinforced concrete intervenes between the clarifier and filter complex to maintain a constant feed to the filters. The flocculator and tube settler are incorporated into the design for phosphorus removal if desired or for physical chemical treatment of raw waste water. A chemical feed system is also built into the plant for phosphorus removal. A chlorine contact tank capable of dosing up to 27 pounds of chlorine/day at the design flow also serves as a reservoir for filter backwash water. The filtered effluent is expected to have a chemical oxygen demand of 25 milligrams/liter and a suspended solids level of 4 milligrams/liter.

*Waste water treatment, *Tertiary treatment, *Treatment facilities, *Municipal wastes, *Biological treatment, Design criteria, Flocculation, Chlorination, Aeration, Oxidation, Equipment, Filtration, Chemical oxygen demand, Suspended solids, Liquid wastes

D023
PHOSPHORUS REMOVAL WITH ALUM FROM SECONDARY EFFLUENT,

Francisco, D. E., Strauss, M., and Dempsey, B. A.

North Carolina University,
Chapel Hill,
Department of Environmental Sciences and
Engineering.

Journal Water Pollution Control Federation, Vol. 48, No. 8, p 2002-2006, August, 1976. 1 fig, 5 tab, 12 ref.

The effect of sodium tripolyphosphate on alum removal of phosphorus from synthetic raw waste water samples was investigated. Waste waters containing different forms of phosphorus (ortho-phosphate, sodium tripolyphosphate, and combinations of the two) were biologically treated in a 5-hour detention activated sludge unit prior to the treatment of the effluents with alum in a jar test apparatus. While phosphorus removal increased with alum dosage to an alum:phosphorus ratio of 1.8 in all samples, there were no significant differences between the samples in terms of alum requirements for phosphorus removal. Thus, previous findings suggesting that sodium tripolyphosphate raises the alum requirement for phosphorus removal in waste water were not duplicated in this study. Apparently some other constituent in the waste water, either alone or in combination with sodium tripolyphosphate, was responsible for previously observed alum requirement increases. The effect of calcium hardness on phosphorus removal by alum was also investigated, and a hardness of 150 milligrams/liter was found to decrease the amount of alum required for an equivalent alum dosage.

*Waste water treatment, *Phosphorus, *Phosphates, *Chemical wastes, *Chemical properties, Biological treatment, Performance, Efficiencies, Evaluation, Calcium, Hardness (water)

Alum, Sodium tripolyphosphate

D024
DENITRIFICATION OF NITRIFIED SEPTIC TANK EFFLUENT,

Sikora, L. J., and Keeney, D. R.

Wisconsin University,
Madison,
Department of Soil Science.

Journal Water Pollution Control Federation, Vol. 48, No. 8, p 2018-2025, August, 1976. 7 fig, 2 tab, 26 ref.

Denitrification of nitrified septic tank effluent was achieved in continuous flow columns packed with limestone chips using methanol as an energy source. Nearly complete nitrate removal was attained in 17 hr at 5 C, 13 hr at 13 C, and in less than 2 hr at 20 C. The general kinetics of the systems were best depicted as first order. An Arrhenius relationship was also demonstrated, with the calculated activation energy being 12.25 kilocalories/mole of nitrate nitrogen. Nitrogen was the gas detected in highest concentrations, but oxygen, methane, and occasionally carbon dioxide were also present in the system. Oxidation-reduction potentials in the columns were generally in the 100-200 millivolt range. The performance of in situ oxidation-reduction electrodes during the denitrification experiment demonstrated their potential use for monitoring the efficiency of operating field systems. Carbon analyses performed during denitrification at 5 C revealed a ratio of 0.89 milligrams of methanol carbon oxidized to 1 milligram of nitrate nitrogen reduced.

*Denitrification, *Septic tanks, *Feasibility studies, *Waste water treatment, *Nitrates, Kinetics, Chemical reactions, Monitoring, Oxidation, Reduction (chemical), Performance, Measurement, Limestones, Alcohols

Methanol

D025
WASTE WATER PROCESSING WITH HGMS (HIGH GRADIENT MAGNETIC SEPARATORS),

Oder, R. R., and Horst, B. I.

Bechtel Corporation,
San Francisco, California.

Filtration and Separation, Vol. 13, No. 4, p 363-364, 366, 368-369, 377, July/August, 1976. 5 fig, 10 tab, 15 ref.

A conceptual process for high gradient magnetic separation treatment of municipal secondary effluent based on recent bench-top laboratory results was used as a model for comparison with more conventional solids separation techniques. The conceptual process is designed for 80-90% solids reduction when processing typical municipal secondary effluents containing a nominal 50 ppm suspended solids. Estimated high gradient magnetic separator treatment costs for waste water treatment plants with 1, 10, and 100 million gallon/day capacities were 68, 22, and 15 cents, respectively. For process capacities of 10 million gallons/day, these costs compare favorably with those of conventional two-stage tertiary lime treatment. In addition, high gradient magnetic separators also offer economy of space.

*Waste water treatment, *Suspended solids, *Tertiary treatment, *Magnetic studies, *Separation techniques, Liquid wastes, Economics, Feasibility, Efficiencies, Municipal wastes

High gradient magnetic separators

D026
NITRIFICATION IN HIGH-SLUDGE AGE CONTACT STABILIZATION,

Zoltek, J., Jr., and Lefebvre, L.

Florida University,
Gainesville,
Department of Environmental Engineering Sciences.

Journal Water Pollution Control Federation, Vol. 48, No. 9, p 2183-2189, September, 1976. 4 fig, 1 tab, 11 ref.

Nitrification of raw waste water in a high-sludge age, contact-stabilization activated sludge plant was investigated. The unit substrate (ammonium ion nitrogen) removal rate was directly proportional to the overall substrate removal rate and inversely proportional to the mass of the activated sludge. Initial hydrolysis of organic nitrogen to ammonia proceeded quite rapidly during the early stages of aeration for raw waste water, but then began to level off at a very slow rate. Unless the return sludge ratio is very high, contact stabilization modification of activated sludge systems does not appear to be feasible for producing a substantial degree of oxidation of ammonia nitrogen and organic nitrogen to nitrate nitrogen when raw waste is treated.

*Nitrification, *Waste water treatment, *Activated sludge, *Kinetics, *Ammonium compounds, *Nitrogen compounds, Organic compounds, Nitrates, Chemical reactions, Biological treatment, Oxidation, Feasibility studies, Aeration

Contact stabilization

D027
MINNEAPOLIS-ST. PAUL: LAND OF THE 'SHINING BIG-SEA-WATERS',

Vandervoort, T. J., and Denisen, K. A.

Minneapolis-Saint Paul Metropolitan
Waste Control Commission,
Minneapolis-St. Paul, Minnesota.

Journal Water Pollution Control Federation, Vol. 48, No. 9, p 2107-2113,
September, 1976.

Efforts by the Minneapolis-Saint Paul Metropolitan Waste Control Commission to upgrade waste water treatment facilities in the area and to improve the water quality of lakes and rivers in the region are reviewed. Only three of 33 waste water treatment plants in 1971 met all state and federal effluent standards consistently, and the overall average removal efficiencies of biochemical oxygen demand and total suspended solids were 68% and 78%, respectively. Since that time, seven outmoded waste water treatment plants have been phased out, and existing plants have been upgraded so that by the end of 1974, 13 out of 21 treatment plants consistently met the secondary treatment definition set forth by the Environmental Protection Agency. In 1973 two new treatment plants were placed in operation, one being the first full-scale physical-chemical treatment facility in the nation. Nearly 100 miles of new sewer interceptors were also constructed. During 1975 the Commission routinely sampled 26 locations on six rivers and one creek for over 50 water quality parameters. Dissolved oxygen concentrations in the Mississippi, Minnesota, and Saint Croix Rivers during 1975 were never below the 5 milligram/liter standard in contrast to dissolved oxygen concentrations of below 1 milligram/liter which were observed in 1970.

*Waste water treatment, *Water quality, *Water pollution control, *Treatment facilities, *Minnesota, Surface waters, Rivers, Lakes, Biological oxygen demand, Dissolved oxygen, Suspended solids, Construction, Sewers, Programs, Monitoring, Municipal wastes

Minneapolis-Saint Paul

D028
HEAVY METALS-INDUCED DEFLOCCULATION OF ACTIVATED SLUDGE,

Neufeld, R. D.

Pittsburgh University,
Pittsburgh, Pennsylvania,
Water and Environmental Engineering Program.

Journal Water Pollution Control Federation, Vol. 48, No. 8, p 1940-1947,
August, 1976. 11 fig, 9 ref.

The influence of shock loadings of heavy metals (mercury, cadmium, and zinc) on activated sludge deflocculation was investigated in cultures maintained in a captive condition with no deliberate sludge wasting. No operational difficulties in terms of the underflow control of gravity cell separators are anticipated based on the above experiments, but potential problems involving the possibility of substantial loss of biomass in the form of pinpoint discrete solids over the effluent weir of gravity separators can be expected as a result of heavy metal shock loadings. Such problems may be overcome by using polyelectrolytes or other types of liquid solid separators (sand filters for effluent polishing or continuous centrifuges for cell separation) in conjunction with cell recycling. Maximum deflocculation in the experimental continuous culture system used occurred after 3-4 days for mercury addition, 12-14 days for cadmium addition, and 10-12 days for zinc addition. While deflocculation did not result at cadmium and zinc levels lower than 20 or 40 milligrams/liter, respectively, virtually any mercury level resulted in some degree of deflocculation.

*Activated sludge, *Waste water treatment, *Heavy metals, *Flocculation, *Biological treatment, Biomass, Performance, Sludge, Microorganisms

Deflocculation

D029
SALT WATER DOMESTIC WASTE TREATMENT,

Kessick, M. A., and Manchen, K. L.

Rice University,
Houston, Texas,
Department of Environmental Science and
Engineering.

Journal Water Pollution Control Federation, Vol. 48, No. 9, p 2131-2136,
September, 1976. 6 fig, 17 ref.

The feasibility of using salt water as a flush medium for domestic wastes was investigated, with particular emphasis on the effect of salt water wastes on coagulation and flocculation processes which are normally used in the first step of any physical-chemical treatment process. Laboratory experiments with samples of primary domestic waste water containing sea salts indicated that increasing the salt content of such waste water causes no net precipitation or salting out of organic material. Alum and lime proved to be effective coagulants for simulated salt water domestic waste. Alum coagulation was equally effective for turbidity and organic content removal in both fresh and salt water waste samples; while the addition of lime was associated with an increase in the nonsettleable organic fraction, although the turbidity was still reduced. Biodegradation of the soluble fraction of domestic waste with resident bacteria was unaffected by sea salt added to levels expected in a seawater waste system. However, sea salt addition markedly inhibited the biodegradation of the suspended fraction. Thus, if the suspended fraction of salt water domestic wastes is dumped in the ocean, it may not exert an oxygen demand equivalent to that exerted in freshwater environments when metabolized by members of the waste's own resident microbial population.

*Domestic wastes, *Saline water, *Waste water treatment, *Water conservation, *Coagulation, Flocculation, Organic compounds, Suspended solids, Turbidity, Biodegradation, Bacteria, Salinity, Physical properties, Chemical properties, Waste disposal, Lime

Alum

D030
SOLAR SEWAGE PLANT 75% ENERGY SELF-SUFFICIENT,

Engineering News-Record, Vol. 197, No. 12, p 20, September, 1976. 1 fig.

The design of a 450,000-gallons/day primary and secondary waste water treatment plant that will treat waste water from 4200 residents of rural Wilton, Maine, using solar energy as an integral part of the biological treatment process is described. The sun's radiance will heat the process via solar collectors from the time waste water enters the plant through economical screw pumps until the treated effluent is passed through energy recycling heat pumps and out into a small stream. The plant's components are to be stacked and compacted to conserve heat and to allow waste water to flow in short runs, for the most part by gravity. The building is shaped to hold snow on the roof and sides for natural insulation and is located in a man-made dish so that sunlight reflecting off snow-covered hills can be used for heating. Methane gas which is generated by the sludge digestion process will be stored in tanks for heating the building on rainy days, running an electric generator, and for use as a back-up heat source for the digesters. The projected result is a treatment plant that will supply more than 75% of its own energy requirements, saving roughly $4450/yr in fuel and electricity costs.

*Waste water treatment, *Municipal wastes, *Treatment facilities, *Solar radiation, *Recycling, Biological treatment, Heat transfer, Symbiosis, Economics, Energy transfer, Methane, Construction, Design criteria, Liquid wastes, Maine

D031
THE INFLUENCE OF THE RAW WATER CONDITIONING ON THE WORKING DATA OF A REVERSE OSMOSIS PLANT TO PRODUCE ULTRA-PURE WATER (EINFLUSS DER ROHWASSERKONDITIONIERUNG AUF BETRIEBSDATEN EINER UMKEHROSMOSE-ANLAGE ZU REINSTWASSERERZEUGUNG),

Marquardt, O. K.

Vom Wasser, Vol. 45, p 129-158, 1975. 13 fig, 6 tab.

The use of reverse osmosis to produce reclaimed water from water contaminated by salt is discussed, with particular emphasis on the importance of raw water preconditioning. Less than satisfactory performance obtained with reverse osmosis units in the past is attributed to a lack of raw water pretreatment which is especially important when polyamide hollow fiber-membranes are used in reverse osmosis units. Raw water conditioning will reduce the fouling index of reverse osmosis units such that special rinses are necessary only at infrequent intervals. The use of raw water conditioning to reduce the passage of salt through reverse osmosis units also allows for the effective utilization of ion exchange treatment after the reverse osmosis process.

*Reverse osmosis, *Desalination, *Waste water treatment, *Reclaimed water, *Saline water, Reclamation, Liquid wastes, Performance, Ion exchange, Fouling

D032
SPRAY IRRIGATION SOLVES DISPOSAL PROBLEM,

Harvey, W. B.

Van Note-Harvey Associates,
Princeton, New Jersey.

Water and Wastes Engineering, Vol. 13, No. 10, p 31-33, October, 1976.

A spray irrigation system that will ultimately remove 1.0 million gallons/day of municipal wastes from direct river discharge is described. The system which is located in East Windsor, New Jersey is one of the largest municipal spray irrigation applications in the northeast, serving a population of about 20,000. Sewage first enters a pumping station where it is screened for the removal of fibrous material. It is then pumped to a 300,000 gallon equalization basin, and heavier grit and inorganic material are settled in a conical section of the basin's bottom. Effluent from the basin is then pumped to activated sludge units, and the flow is subsequently polished in an aerated lagoon which provides tertiary treatment. After tertiary treatment, the effluent is chlorinated. Two deep-well turbine pumps lift the polished effluent to the irrigation site where 80 acres of hay are treated with 600,000 million gallons/day of the effluent. Different valve combinations are used to achieve the proper waste water application over different portions of the site. A network of 13 test wells is located throughout the site to sample groundwater.

*Irrigation, *Waste water disposal, *Waste water treatment, *Spraying, *Municipal wastes, Crops, Biological treatment, Tertiary treatment, Aeration, Chlorination, Pumps, Valves, Symbiosis, Water reuse, Monitoring, Sampling Activated sludge, Farms, New Jersey

D033
FEASIBILITY OF HIGH-ENERGY ELECTRON TREATMENT OF MUNICIPAL SLUDGE,

Trump, J. G., Wright, K. A., Sinskey, A. J., Merrill, E. W., and Shah, D. B.

Massachusetts Institute of Technology,
Cambridge,
Electrical Engineering Department.

American Institute of Chemical Engineers Symposium Series, Vol. 71, No. 151, p 367-374, 1975. 9 fig, 9 ref.

Studies on the feasibility of using high-energy electrons for the disinfection of municipal sludge and waste water are reported. Small quantity irradiation studies using a 3-million electron volt Van de Graaff electron accelerator indicate that high energy electrons can be used to adequately control bacteria, viruses, and parasites. In addition to primary disinfection and deinfestation of waste water and sludge, electron radiation also appears capable of achieving substantial chemical oxygen demand reductions if adequate oxygen is available. Currently, an investigative system for teating 100,000 gallons/day of sludge with 400,000 rads is being constructed. The facility will use a standard 50 kilowatt electron beam system. Capital and operating cost estimates for a modular electron injection unit capable of treating 100,000 gallons/day of sludge are projected at $500,000 and $100,000/yr, assuming that 450,000 rads proves to be an adequate minimum dosage and that electron beam power can be utilized to produce this minimum dosage with an overall utilization efficiency of 33.3%.

*Waste water treatment, *Sludge treatment, *Municipal wastes, *Ionization, Feasibility studies, *Disinfection, Electronics, Bacteria, Viruses, Parasitism, Economics, Chemical oxygen demand

Ionizing radiation, Electron beam treatment

D034
WASTEWATER REUSE-INDUSTRIAL, MUNICIPAL, OR BOTH,

Fritsche, B. R., and Schima, R. W.

Maintenance Engineering Corporation,
Houston, Texas.

American Institute of Chemical Engineers Symposium Series, Vol. 71, No. 151, p 242-247, 1975. 3 tab.

The reuse of industrial and/or municipal waste water for industrial water needs is discussed. Although municipal waste water is adaptable for limited reuse (cooling water and process water) with minor pretreatment, municipal treatment processes increase the total dissolved solids level (sodium and chloride) significantly which in turn increases water consumption, pretreatment costs, and internal treatment costs. Such increases in total dissolved solids do not occur in industrial process waste water. Also, if municipal waste water is to be used in steam generation systems, phosphorus removal is necessary; ammonia removal may also be necessary, depending on the use of the steam. The only type of industrial waste water that can be considered for reuse is process waste water since cooling water and boiler water blowdowns are normally concentrated with respect to scale formation and corrosion, making these streams impracticable for reuse under circumstances where further concentration occurs or adverse conditions exist. Although industrial waste water may contain process contaminants which must be removed prior to reuse, the utilization of industrial waste water may significantly reduce water consumption requirements.

*Water reuse, *Waste water treatment, *Industrial wastes, *Municipal wastes, *Industrial water, Reclaimed water, Recycling, Symbiosis, Liquid wastes, Dissolved solids, Phosphorus, Ammonia, Sodium, Chlorides

D035
OPEN TANK PURE OXYGEN SYSTEM BEGINS OPERATION,

Public Works, Vol. 107, No. 9, p 106, September, 1976.

A pure oxygen activated sludge demonstration system using uncovered tanks has begun operation under a grant from the Environmental Protection Agency at the Metropolitan Denver Sewage Disposal District Number 1 Plant. For the demonstration, one of 36 diffused air activated sludge basins was converted to an open-tank oxygen system by installing rotating active diffusers and associated oxygen control equipment suited to a wide range of loading conditions. Effluent from this tank passes to one of 12 final clarifiers which has been isolated from the rest of the plant. The diffusers rotate slowly in the mixed liquor, producing very fine micron-size bubbles that achieved 90% or greater oxygen transfer. Electrical signals from dissolved oxygen sensors automatically regulate pneumatic oxygen control valves to satisfy the oxygen demand for a given point in the basin. The limiting factor of the system will be the solids and hydraulic loadings of the single clarifier. During the last phase of the project, the flow will be increased in steps from its current 10 million gallons/day until the upper operating limit of the system is determined.

*Activated sludge, *Sewage treatment, *Municipal wastes, *Oxygenation, *On-site tests, Aerobic conditions, Performance, Evaluation, Efficiencies, Treatment facilities

D036
PACKAGED PLANT FOR VIRGIN ISLANDS,

Water and Waste Treatment, Vol. 19, No. 7, p 22, July, 1976.

The largest complete sewage treatment plant manufactured out of glass fiber reinforced plastics in the United Kingdom is described. The plant operates by the extended aeration activated sludge process and is capable of serving a population of 500 people. The plant is designed to treat a domestic sewage dry weather flow of 25,000 gallons/day. It consists of a rectangular glass fiber reinforced plastic tank, 11 m by 6 m by 3.5 m, divided into an aeration chamber and a settling chamber of the upward flow type. An adjustable weir controls the overflow rate in the settling chamber and ensures the quiescent conditions necessary for efficient settling. A scum removal system keeps the surface of the settling chamber free from floating solids. Particular advantages of the glass reinforced plastic construction are corrosion resistance and light weight which makes the plant easy to transport and simple to install.

*Sewage treatment, *Treatment facilities, *Plastics, *Activated sludge, *Biological treatment, Materials, Construction, Equipment, Design criteria, Aeration

D037
GLASS COATED STEEL TANKS,

Water and Waste Treatment, Vol. 19, No. 7, p 23, July, 1976.

The use of glass-coated steel plates for the construction of tanks used for the storage and treatment of water and waste water is reported. The plates are in standard sizes of 2,730 mm long by 1,445 mm high and in half plate sizes 2,730 mm long by 800 mm high. Each plate is sprayed with glass frit and fired at high temperature. The plates are lap jointed at vertical and horizontal seams with 58 mm lap at the vertical joints and 50 mm lap at the horizontal joints. All laps are sealed using a moisture curing sealant and are then bolted. The steel tanks are erected on reinforced concrete foundations. Tank sizes vary with diameters ranging from 2.558 m to over 30 m and heights ranging from 1.377 m to 11.155 m. The tanks are normally supplied open topped for effluent and water treatment, although coated steel roofs and reinforced butyl rubber debris covers can also be supplied for water and effluent storage. The tanks have a high resistance to corrosion and are simple to erect.

*Storage tanks, *Waste water treatment, *Steel structures, *Coatings, *Construction, Materials, Equipment, Corrosion control

D038
EFFICIENCY OF DIFFUSED AERATION SYSTEMS IN WASTEWATER TREATMENT,

Mavinic, D. S., and Bewtra, J. K.

British Columbia University,
Vancouver,
Department of Civil Engineering.

Journal Water Pollution Control Federation, Vol. 48, No. 10, p 2273-2283, October, 1976. 11 fig, 1 tab, 7 ref.

Factors affecting the oxygenation efficiency of diffused aeration systems employed in activated sludge waste water treatment are examined. A process of aeration using a countercurrent flow of air bubbles and waste water is shown to result in increased contact time and thus higher oxygenation efficiencies. The operating conditions of the system are such that the average velocity of the water is equal to or less than the velocity of the rising air bubble in order to provide maximum contact times for countercurrent flow of air and water. The process can possibly be adapted to existing conventional aeration systems so that treatment efficiency can be improved.

*Activated sludge, *Waste water treatment, *Aeration, *Oxygenation, Biological treatment, Bubbles, Flow characteristics, Efficiencies, Performance

D039
WASTEWATER PLANT DOES NICELY WITHOUT NATURAL GAS,
THANK YOU,

Karnat, L.

Sewage Treatment Plant,
Reading, Pennsylvania.

Water and Wastes Engineering, Vol. 13, No. 10, p 25-26, October, 1976.

The use of on-site methane generation for supplying waste water treatment fuel gas needs at the sewage treatment plant in Reading, Pennsylvania is described. The plant produces an average of 150,000 cu ft of methane/day which is enough to supply heat for the two primary digesters and one secondary digester plus heat for two of the plant buildings. Methane is metered via two rotating-vane type positive displacement meters installed on each of the two primary digesters. While measuring methane production, the meters also indicate whether the digesters are operating properly and show the amount of methane used to heat the digesters. The meters are also equipped with flow-totalizing readouts to provide statistical information on methane production required by the Commonwealth of Pennsylvania. Surplus methane is burned off by flares.

*Sewage treatment, *Treatment facilities, *Methane, *Energy conversion, *Digestion, Monitoring, Waste water treatment, Municipal wastes, Cities, Pennsylvania

Reading, Fuel generation

D040
DEGRADATION OF NTA ACID DURING ANAEROBIC DIGESTION,

Moore, L., and Barth, E. F.

Environmental Protection Agency,
Municipal Environment Research Laboratory,
Cincinnati, Ohio,
Biological Treatment Section.

Journal Water Pollution Control Federation, Vol. 48, No. 10, p 2406-2409, October, 1976. 3 fig, 1 tab, 3 ref.

The degradability of the sodium salt of nitrilotriacetic acid, a proposed substitute for tripolyphosphate in synthetic detergent formulations, during anaerobic digestion of primary sludge and a mixture of primary and waste activated sludge was investigated. Experiments involving the addition of 20 milligrams/liter of the nitrilotriacetic acid salt to an anaerobic system containing only primary sludge did not reveal any degradation of the salt over a period of 120 days. However, when 20 milligrams/liter of the salt was added to an anaerobic system containing 50% primary sludge and 50% waste activated sludge that was acclimated to the degradation of sodium nitrilotriacetate, almost complete degradation was observed after 2 months. When this mixture of primary sludge and acclimated waste activated sludge was gradually returned over a 20-day period to a daily feed consisting entirely of primary sludge, degradation continued, indicating that the acclimated culture can be retained in the digestion process when the daily feed is returned to zero.

*Waste water treatment, *Activated sludge, *Biodegradation, *Detergents, *Anaerobic conditions, Organic acids, Salts, Sludge, Performance, Evaluation, Biological treatment

Nitrilotriacetic acid (sodium salt), Sodium nitrilotriacetic acid, Detergent additives

D041
DIGESTION IS A GOOD EGG IN LOS ANGELES,

Kam, J. F., and Schank, J. F.

Water and Wastes Engineering, Vol. 13, No. 10, p 28-29, October, 1976.

The use of egg-shaped anaerobic digestion tanks for a waste water treatment plant in the city of Los Angeles is reported. The tanks which are patterned after a German design possess the advantage that they don't accumulate grit and scum. The shell of the digester is built with post-tensioned concrete, with the bottom of the container being as steep as possible (generally under 45 degrees inclined from verticle) so that the digested sludge flows by gravity into the tip of the hopper. The digester reduces in area in an upward direction so that the scum area stays small compared with the digesting area. Dead corners that form deposit are avoided. Digester gas is bubbled at the circumference of the lower tank area to intensify the digestion and prevent scum formation. Screw impellers for scum destruction are installed at the top of the digesters. The inside of the digester above the sludge level is epoxy coated for corrosion protection. The middle section of the digester is constructed in sections (like an orange peel), whereby the forming and scaffolding are built for one section at a time, rotated into place, and used repeatedly.

*Digestion tanks, *Construction, *Design criteria, *Waste water treatment, *Concrete structures, Equipment, Materials, Scum, Coatings, Corrosion control, Anaerobic conditions

Grit

D042
PILOT PLANT TRAVELS ON WHEELS,

The American City and County, Vol. 91, No. 10, p 98, October, 1976.

A mobile pilot plant for evaluating the effectiveness of a clay-polymer drainage and evaporation system in improving the sludge clarification capabilities of two waste water treatment plants in the city of Birmingham, Alabama is described. The mobile plant is able to treat up to 100 million gallons/day of water during the clay-polymer test. Tests at a treatment facility with an 8.5 million gallons/day flow revealed that polymer and clay levels of 2.0 ppm and 8.0 ppm, respectively, were sufficient to obtain results that were superior to those obtained with conventional alum treatment. At a treatment plant with an average flow up to 50 million gallons/day, 1.2 ppm of polycationic polymer and 9.0 ppm of clay were used. The clay-polymer system produces finished water of good clarity and a low volume of sludge with good handling and dewatering properties.

*Waste water treatment, *Pilot plants, *Sludge, *Dewatering, *Municipal wastes, Cities, Treatment facilities, Evaluation, Performance, Alabama

Birmingham

D043
FLUID-BED REACTOR MAY CUT SEWAGE COSTS,

The American City and County, Vol. 91, No. 10, p 26, October, 1976.

A fluidized bed biological waste water treatment process that is potentially capable of reducing treatment plant capital costs for some municipalities is described. The process provides secondary biological treatment, nitrification, and denitrification for domestic sewage. The fluidized-bed reactors take up only one-fifth the space a standard activated sludge system requires. The process eliminates the huge concrete tanks and basins required for conventional waste water treatment by substituting compact fluidized bed reactors containing bacteria-coated media with a high biomass concentration and a short detention time. A pilot installation located at an advanced waste water treatment plant is achieving better than 99% denitrification.

*Biological treatment, *Activated sludge, *Waste water treatment, *Nitrification, *Denitrification, Domestic wastes, Municipal wastes, Pilot plants, Efficiencies, Evaluation, Performance, Economics, Tertiary treatment, Biomass

D044
SANDWICH CONSTRUCTION G.R.P.,

Water and Waste Treatment, Vol. 19, No. 7, p 26, July, 1976.

The use of sandwich construction glass reinforced plastics in sewage treatment plant equipment is reported. Equipment constructed of glass reinforced plastic includes integral launders in sections fitted to form a circle within final settling tanks as well as similar launders installed in thickening tanks. Glass reinforced plastic offers the advantages of increased strength and a smooth surface which minimizes algal growth. The material is also non-corrosive.

*Plastics, *Sewage treatment, *Treatment facilities, *Equipment, *Materials, Settling basins, Construction

D045
THERMOPHILIC BIO-OXIDATION OF HIGH-STRENGTH ORGANIC WASTEWATERS AND SLUDGES,

Kalinske, A. A.

Camp Dresser and McKee Incorporated,
Boston, Massachusetts.

American Institute of Chemical Engineers Symposium Series, Vol. 71, No. 151, p 34-40, 1975. 2 fig, 3 tab, 13 ref.

Processes for the thermophilic bio-oxidation of waste water and sludges containing high levels of organics are discussed. Thermophilic activated sludge treatment of waste waters with high levels of soluble organics appears to be feasible, especially if the waste water originates at a temperature of 40 C or higher. At a 5-day biochemical oxygen demand above about 30 g/liter, sufficient heat can be generated so that the process is self-sustaining as far as temperature is concerned. Thermophilic organisms do not appear to have bioflocculating properties; thus their removal by plain settling is not possible. Aerobic digestion of sewage sludges and other organic solid wastes in liquid suspensions at high mesophilic and thermophilic temperatures (35-60 C) is possible and can be self-sustaining at volatile solids concentrations above 3%. Composting of organic solid wastes by thermophilic aerobic organisms also appears feasible. Tests with a mechanical composting unit handling dewatered sewage solids having 75% moisture revealed that at a temperature of 60 C and a retention time of about 6 days all pathogens were killed or inactivated. Recycle and forced aeration were used to achieve final composted solids with a moisture content of 25% and a 6-day stabilization time.

*Biological treatment, *Waste water treatment, *Sludge treatment, *Thermophilic bacteria, *Activated sludge, Solid wastes, Temperature, Aerobic conditions, Microorganisms, Biochemical oxygen demand, Organic compounds, Digestion, Sewage sludge, Feasibility studies, Oxidation

Composting

D046
STUDIES OF THE REMOVAL OF AMMONIA NITROGEN BY ION EXCHANGE,

Wilson, T. E., and Riddell, M. D.

Greeley and Hansen,
Engineers,
Chicago, Illinois.

American Institute of Chemical Engineers Symposium Series, Vol. 71, No. 151, p 118-125, 1975. 4 fig, 4 tab, 9 ref.

Pilot studies to evaluate the effectiveness of an ion exchange process using the natural zeolite, clinoptilolite, for removing ammonia nitrogen from the filtered secondary effluent generated by an activated sludge municipal waste water treatment plant were conducted. Ion exchange beds (6-feet deep) consisting of two columns with 3 ft of media were used. A sodium chloride-sodium hydroxide brine was generally used for regeneration of clinoptilolite. Effluent ammonia nitrogen levels often averaged less than 1.0 milligrams/liter for one-column operational mode but commonly averaged closer to 1.5 milligrams/liter for two-column operation. The calcium content of the influent did not appear to affect either the effluent ammonia concentration or the clinoptilolite's ammonia capacity. Calcium breakthrough tended to precede ammonia breakthrough and thus might be used as an early indicator of ammonia breakthrough. Both the ammonia and calcium capacities of the clinoptilolite tended to decrease with increasing hydraulic loading. Activated carbon pretreatment had no effect on effluent ammonia concentration.

*Ion exchange, *Waste water treatment, *Ammonia, *Zeolites, *Activated sludge, Nitrogen compounds, Calcium, Pilot plants, Performance, Effluents, Liquid wastes, Municipal wastes, Treatment facilities, Separation techniques

Clinoptilolite

D047
RECOVERY AND REUSE OF ALUM FROM WATER FILTRATION PLANT SLUDGE BY ULTRAFILTRATION,

Lindsey, E. E., and Tongkasame, C.

Massachusetts University,
Amherst,
Environmental Engineering Program.

American Institute of Chemical Engineers Symposium Series, Vol. 71, No. 151, p 185-192, 1975. 5 fig, 2 tab, 6 ref.

A system for the recovery and reuse of alum from water filtration plant sludge by ultrafiltration is described. The settled, used sludge from water treatment is acidified with sulfuric acid to a pH of about 2.5, and the clarified overflow from the acidification is subjected to ultrafiltration at a pressure differential of about 50 lb/sq in with an acid-resistant synthetic copolymer membrane. A portion of the solution which does not go through the membrane contains most of the color and the high molecular weight organics removed by the alum floc. Since the underflow from acidification is relatively small in volume and more easily dewaterable, there is a greatly reduced problem in ultimate disposal. The solution through the membrane contains up to 90% of the original aluminum in a soluble form that is suitable for reuse as a coagulant after pH adjustment. A cost comparison with other means of sludge disposal such as landfill shows that the recovery system can result in significant savings.

*Sludge treatment, *Recycling, *Aluminum, *Waste water treatment, *Filtration, Byproducts, Membrane processes, Economics, Coagulation, Sludge disposal, Symbiosis, Color, Organic compounds

Alum

D048
ASPECTS OF SLUDGE TREATMENT,

Shabi, F. A., and Hanbury, M. J.

Effluent and Water Treatment Journal, Vol. 16, No. 7, p 343-346, 350-351, July, 1976. 2 fig, 5 tab, 7 ref.

Waste water sludge treatment processes being utilized in Great Britain are reviewed. The most widely used sludge treatment process in Great Britain is anaerobic digestion which serves about half of Britain's population. Dewatering by mechanical means (filter press, vacuum filtration, and centrifugation), however, is becoming increasingly more attractive both in terms of cost and convenience. Sludge pretreatment to achieve flocculation or coagulation of the sludge particles is achieved either by thermal conditioning or by the addition of chemical coagulants. The development of polyelectrolytes which can be added in very small quantities (about 1%) to achieve sludge particle coagulation has improved the efficiency of sludge mechanical dewatering systems as illustrated by a sludge concentrator which is capable of producing a cake with a solids content in the range of 8-16%. The use of wet air oxidation in waste water treatment is another means of making the residual sludge more amenable to dewatering. At one facility using this waste water treatment modality, the utilization of overloaded drying beds was extended by eight-fold, while the sludge volume was reduced by over 80%.

*Sludge treatment, *Dewatering, *Coagulation, *Anaerobic conditions, *Oxidation, Waste treatment, Filtration, Centrifugation, Flocculation, Solid wastes, Waste water treatment, Liquid wastes, Separation techniques, Treatment facilities, Polyelectrolytes

D049
A DISCOURSE ON THE BIOCHEMICAL OXIDATION OF SEWAGE,

Stones, T.

Effluent and Water Treatment Journal, Vol. 16, No. 7, p 352-355, July, 1976.
4 tab, 21 ref.

The kinetics of the biochemical oxidation of settled domestic sewage was investigated. Data obtained from experiments in which the dissolved oxygen contents of portions of 1/100 dilution of settled domestic sewage were determined at various intervals during incubation over 20 days at 20 C were substituted into an expression for a second-order reaction. The results was a reasonably constant value throughout a period of about 10 days. During this period, therefore, the course of biochemical oxidation closely followed a second-order reaction, with the rate of oxidation at any instant over this period being governed jointly by the residual dissolved oxygen concentration and the unsatisfied biochemical oxygen demand. After a slight fall in the velocity coefficient value during the first 5 days, however, there was a gradual increase which became more rapid after the 10th day. This was presumably due to the onset of nitrification, the occurrence of which did not become apparent until more than 15 days had elapsed.

*Sewage treatment, *Biological treatment, *Kinetics, *Biochemical oxygen demand, *Dissolved oxygen, Domestic wastes, Nitrification, Oxidation, Chemical reactions, Waste water treatment

D050
POLYMERS CUT COST OF PHOSPHORUS REMOVAL,

Check, T. G.

Frank A. Thomas and Associates,
Willoughby, Ohio.

Water and Wastes Engineering, Vol. 13, No. 8, p 23-24, August, 1976. 1 fig, 2 tab.

A pilot plant study at a tertiary waste water treatment plant was conducted to investigate the feasibility of substituting wet or dry anionic polymers for sodium aluminate in the phosphorus removal system. The purpose of sodium aluminate or polymer addition is to achieve secondary coagulation and subsequent flocculation. Both Calgon WT 3000 (a dry powder) and Nalco 7744B (a liquid polymer) proved to be effective polymers for achieving the above purpose, with phosphorus concentrations of less than 1.0 milligrams/liter being achieved. Solids carryover was 10 milligrams/liter. Each polymer also resulted in the production of less sludge, thus reducing sludge pumping and lagoon capacity requirements. Using bulk delivery chemical costs, the total expense per month for the dry and liquid polymers is $80 and $116, respectively, as compared with $1100 for sodium aluminate.

*Tertiary treatment, *Phosphorus, *Polymers, *Waste water treatment, *Feasibility studies, Pilot plants, Costs, Ions, Coagulation, Flocculation, Sludge

D051
AN ECONOMIC EVALUATION OF DEEP TANK AERATION FOR WASTEWATER TREATMENT,

Edwards, L. L., Leber, B. P., Jr., and Jackson, M. L.

American Institute of Chemical Engineers Symposium Series, Vol. 71, No. 151, p 154-157, 1975. 4 tab, 13 ref.

An economic comparison between a deep-tank aeration system and a conventional aerated stabilization basin for the treatment of 4.5 million gallons/day of waste water from a sulfite pulp mill is presented. The deep-tank aeration system is in reality a vertical flow reactor which takes advantage of the large partial pressure driving force for oxygen transfer at the bottom of the tank. The analysis consists of modeling oxygen transfer in deep tanks and designing a minimum-cost deep-tank treatment process. The deep tank system is designed with standby capacity for pumps, compressors, deep tanks, and a settling tank to insure continuous operation. The economic analysis indicates that the deep-tank system requires a capital investment of $647,000 which is 10% lower than that for the aerated basin. The deep-tank system also results in a 58% reduction in total electrical energy usage.

*Aeration, *Cost analysis, *Waste water treatment, *Stabilization, *Oxygenation, Transfer, Oxygen, Economics, Model studies, Pulp and paper industry, Industrial wastes, Liquid wastes, Waste treatment

Deep tank aeration

D052
OXYGEN TRANSFER IN A 23-METER BUBBLE COLUMN,

Jackson, M. L., James, D. R., and Leber, B. P., Jr.

American Institute of Chemical Engineers Symposium Series, Vol. 71, No. 151, p 159-165, 1975. 4 fig, 2 tab, 5 ref.

Oxygen transfer efficiencies in an aeration column (7.6 cm in diameter) were observed for liquid depths up to 21 m. Although higher air rates and liquid depths increased the oxygen transfer rate and overall efficiency, the transfer area was reduced with increasing liquid level because of the higher pressures on the entering bubbles. A diffuser provided 96% oxygen transfer at 8 m, and a pipe inlet provided 63% transfer at a liquid depth of 21 m. The performance of the narrow column may also be used to judge applications to large diameter aeration tanks with multiple inlets. The design of a plant for the treatment of 15,000 cu m/day of waste from a sulfite paper mill based on the results observed for the narrow column was analyzed in terms of treating the same waste in a lagoon; the results were favorable for tall tank aeration.

*Aeration, *Waste water treatment, *Oxygen, *Transfer, *Efficiencies, Waste treatment Performance, Evaluation, Pulp and paper industry, Industrial wastes, Bubbles

D053
DENVER'S HEADWORKS REFLECTS COMPLEXITY OF SYSTEM,

Henderson, R. W.

Rodney Hunt,
Orange, Massachusetts.

Water and Wastes Engineering, Vol. 13, No. 10, p 63-64, October, 1976.

Denver's waste water treatment program is described, with particular emphasis on the complexity of the city's headworks. From Denver's large northern primary treatment plant, influent arrives through two modulating 54 by 54 in sluice gates for secondary treatment; and interceptor lines bring flows from outlying areas in the east and west for both primary and secondary treatment. Incoming flow is metered through a Parshall flume before entering the headworks. It is then aerated and routed through screens and bar channels and subsequently sent to grit basins for full treatment or diverted directly to primary clarifiers. Influent requiring primary treatment passes through 14 Rodney Hunt slide gates to the grit basins, and from there flows are sent to the plant's four primary clarifiers. The liquor flows out of the primary clarifiers to the primary effluent pump station where six pumps provide the boost necessary for the remaining gravity flow processing. From the pumphouse, flow continues to eight 23-foot deep aeration basins and then to secondary clarifiers after which it is discharged to an outfall channel leading to the Platte River. The plant is capable of handling average and peak flows of 168 and 200 million gallons/day, respectively.

*Municipal wastes, *Waste water treatment, *Treatment facilities, *Flow, *Hydraulics, Pumps, Slide gates, Sluice gates, Aeration, Separation techniques, Colorado

Denver

D054
TOXICITY OF AMMONIA TO ALGAE IN SEWAGE OXIDATION PONDS,

Abeliovich, A., and Azov, Y.

Hebrew University,
Jerusalem, Israel,
Human Environmental Sciences Laboratory.

Applied and Environmental Microbiology, Vol. 31, No. 6, p 801-806, June, 1976.
5 fig, 2 tab, 24 ref.

The effects of ammonia on the growth and photosynthesis of axenic cultures of algae in a high-rate sewage oxidation (stabilization) pond were investigated. Ammonia at concentrations above 2.0 millimoles and at pH values over 8.0 inhibited the growth and photosynthesis of Scenedesmus obliquus, a dominant species in high-rate oxidation ponds. Photosynthesis of Chlorella pyrenoidosa, Anacystis nidulans, and Plectonema boryanum was also susceptible to ammonia inhibition. Methylamine exerted the same effect as ammonia, and its penetration into algal cells was pH dependent. When operated at a 120-hour detention time, the high-rate oxidation pond maintained a steady state with respect to algal growth and oxygen concentration, and the concentration of ammonia did not exceed 1.0 millimoles. Shifting the pond to a 48-hour detention caused an increase in pond water ammonia concentration to 2.5 millimoles, and the pond gradually turned anaerobic. Photosynthesis, which usually elevates the pH of pond water to 9.0-10.0, could not proceed beyond a pH of 7.9 because of the high concentration of ammonia. The dominant factors in determining the oxygen regime and growth rate in oxidation ponds run at short detention times thus appear to be ammonia concentration and pH.

*Algal poisoning, *Oxidation lagoons, *Ammonia, *Algal toxins, *Sewage treatment, Biological treatment, Kinetics, Oxidation, Alkalinity, Growth rates, Photosynthesis, Stabilization, Nitrogen compounds

Methylamine, Amines, Chlorella pyrenoidosa, Anacystis nidulans, Plectonema boryanum

D055
THE INFLUENCE OF CARBON-NITROGEN RATIO ON THE CHLORINATION OF MICROBIAL AGGREGATES,

Characklis, W. G., and Dydek, S. T.

Rice University,
Houston, Texas,
Environmental Science and Engineering Department.

Water Research, Vol. 10, No. 6, p 515-522, 1976. 10 fig, 12 tab, 27 ref.

Experiments were conducted with attached microbial films in a continuous flow reactor to determine the response of the films to hypochlorite treatment as a function of influent substrate concentration, influent carbon/nitrogen ratio, and shear force at the slime-water interface. Experiments were also conducted in batch systems with suspended organisms grown at varying carbon/nitrogen ratios. Hypochlorite appeared to react with attached microbial films grown at high carbon/nitrogen ratios, causing disruption and partial detachment from the inert growth surface. Hypochlorite also inactivated a portion of the active biomass. Experiments involving mercuric chloride addition indicated that the oxidizing characteristics of hypochlorite rather than its bactericidal effectiveness are responsible for slime removal. Experiments with microbial suspensions revealed that extracellular microbial polysaccharides affect the rate of chlorine demand and to a lesser extent the total chlorine demand in such suspensions. Hypochlorite addition significantly reduced the suspended solids concentration also.

*Chlorination, *Oxidation, *Bactericides, *Microbiology, *Slime, Waste treatment, Chlorine, Carbon, Nitrogen, Suspended solids, Kinetics

Polysaccharides, Substrates, Microbial films

D056
KEEP COOL WITH SEWAGE EFFLUENT A TWO-WAY SAVING OF WATER,

Wood, R.

Process Engineering, p 71, June, 1976. 1 fig.

A procedure using sewage effluent as cooling water in power plants was discussed. Croydon Power Station, built on top of a sewage works in Britain, was the example used. Treated effluent with borehole water for makeup has been successful. No metallic corrosion problems appeared and there was no need for manual cleaning of condensers or acid washing. The natural draught cooling towers acted as nitrifiers and the pond acted as an activated sludge system; thus, effluent quality was improved. The towers also maintained necessary nitrification during the winter. It was concluded that sewage effluent may be used in other applications to provide water savings.

*Water reuse, *Sewage effluents, *Nitrification, *Cost analysis, *Cooling water, *Power plants, Recycling, Cleaning, Activated sludge

D057
COMBINED PROCESS OF PYROLYSIS AND COMBUSTION FOR SLUDGE DISPOSAL,

Takeda, N., and Hiraoka, M.

Kyoto University,
Kyoto, Japan,
Department of Sanitary Engineering,
Faculty of Engineering.

Environmental Science and Technology, Vol. 10, No. 12, p 1147-1150, November, 1976. 5 fig, 2 tab, 2 ref.

A double hearth incinerator was used to test the effect of pyrolysis and combustion on sewage sludge. The incinerator was used with a secondary combustion furnace. Sludge supplied through the top of the incinerator was thermally decomposed, and the pyrolysis gases were burnt in the secondary combustion furnace. Some flue gas was passed to a venturi-type scrubber for particulate collection efficiency study. The sludge, a cake of mixed primary and surplus activated sludge from a municipal sewage treatment plant, was combined with heavy metal chlorides to study their behavior. At temperatures as low as 450 C, pyrolysis can reduce feed sludge bulk density by 50%. Low temperature pyrolysis minimizes vaporization of heavy metals in air, while high temperature pyrolysis can produce an air pollution problem. Hydrocarbons produced by pyrolysis can be burned in a secondary combustion furnace to prevent pollution. Low temperature operation did not effectively suppress sulfur oxides, but 40% of the sulfur compounds oxidize to sulfur oxides between 450 and 600 C. Hydrogen chloride can react with alkalis and nitrogen oxides can be controlled by controlling product gases of pyrolysis. A temperature of 600 C minimized nitrogen oxide emissions. Dust collection was effected through water scrubbing.

*Incineration, *Sewage sludge, *Sludge disposal, Municipal wastes, Waste water treatment, Sludge treatment, Sulfur compounds, Temperature, Treatment facilities

*Combustion, *Pyrolysis, Hydrocarbons, Water scrubbing

D058
SLUDGE DEWATERING PILOT PLANT DESIGN,

Cheremisinoff, P. N., and Maglio, M. A., Jr.

New Jersey Institute of Technology,
Department of Civil & Environmental Engineering.

Water and Sewage Works, Vol. 123, No. 11, p 90-95, November, 1976. 4 fig, 12 tab.

Design considerations for a sludge dewatering plant were discussed in part one of a two-part article. First, the pilot plant was designed to handle secondary sludges as well as industrial sludges. Wide variations in sludge compositions at different plants and industries made this a necessity. Treatment stages included chemical treatment, heat treatment, and the dewatering process. The addition of chemicals such as lime to destroy pathogenic bacteria, and ferric chloride and ferrous sulfate to provide charge neutralization and coagulation was discussed. Heat treatment was considered as a means of improving sludge dewatering properties. Finally, a dewatering process was presented to deal with such factors as particle density, particle size, particle charge, degree of hydration, and compressibility.

*Sludge treatment, *Industrial wastes, *Design criteria, *Pilot plants, Heat treatment, Dewatering, Treatment facilities, Chemical precipitation, Coagulation, Sludge disposal

Chemical treatment

D059
DORR-OLIVER TO MARKET ECOLOTROL WASTE WATER TREATMENT PROCESS,

Chemical Engineering Progress, Vol. 72, No. 10, p 104, October, 1976.

A process which removes carbonaceous BOD (activated sludge), nitrifies ammonia nitrogen to nitrate form, and denitrifies nitrates to nitrogen was introduced. Fluidized bed reactors using microorganism-saturated media with high biomass concentration proved more economical than the more common concrete tanks or basins. The Hy-Flo system passes waste water up through a reactor partially filled with sand or a similar substance. After fluidization, the media becomes a vast surface on which microorganisms become attached. Biomass and biological reactions are like those of other biological treatment systems. In 15 min, 85-90% of carbonaceous BOD can be removed. Ninety percent nitrification is obtained in 18 minutes. Denitrification (99+%) can be achieved in 6 minutes. A pre-engineered equipment package will be developed for smaller plants.

*Waste water treatment, *Biological treatment, *Biochemical oxygen demand, *Activated sludge, *Nitrification, *Denitrification, Ammonia, Nitrogen, Microorganisms, Equipment

Fluidized bed reactors

D060
HIGH GRADIENT MAGNETIC FILTRATION,

Harland, J. R., Oberteuffer, J. A., and
Goldstein, D. J.

Sala Magnetics, Incorporated,
Cambridge, Massachusetts.

Chemical Engineering Progress, Vol. 72, No. 10, p 79-80, October, 1976.
1 fig, 2 tab, 7 ref.

Magnetic filtration may be used in waste treatment in two areas. First, it can directly filter suspended magnetic particles. The process may also remove non-magnetic materials by a seeding method. A simple high gradient magnetic separator is composed of a fibrous ferromagnetic packing or matrix filter bed which is externally magnetized. Economics of this method depend upon the form of the ferromagnetic matrix and the efficiency of the magnetic field. Contaminated material is passed through the filter and magnetic materials are trapped on the matrix fibers. In cases of non-magnetic suspended solids, a magnetic seed material, such as magnetite, is added to the water which is then flocculated to allow non-magnetic impurities to adhere to the seed material. Removal then occurs as with magnetic impurity removal. This technique has worked well in removing microbial cells and most viruses in treatment of raw sewage. Design features are given for a pilot plant and a total operating cost estimate of $0.10 to 0.15/1,000 gallons is given for a system which processes 27,000 gallons per minute of waste water.

*Waste water treatment, *Filtration, *Filters, *Equipment, *Pilot plants, Sewage treatment, Economics, Costs, Operating costs, Waste treatment, Sewage treatment

*Magnetic filtration

D061
SLUDGE INCINERATION,

Environmental Science and Technology, Vol. 10, No. 12, p 1080-1082, November, 1976.
2 tab, 6 ref.

Incineration of sewage plant sludge is discussed and compared to other methods of sludge control. EPA studies have proved sludge incineration adequate in meeting present air quality standards. This is true of both multiple-hearth and fluidized-bed incinerators. A 1972 study noted that most sludge incinerators of the time did not use high-efficiency particulate control devices and traces and small quantities of specific metals, PCBs, and pesticides could be found in stack emissions. Particulate control is a part of all sewage sludge incinerators now. Most metals either oxidize and are collected in the bottom ash or are collected during the particulate scrubbing phase. Sludge incinerators have been proven to destroy 99% of pesticides and 94% of PCBs when they are coincinerated with sludge. In terms of overall economics, sludge incinerators have proven to be half as costly as land application in Boston, Massachusetts. The same study rated incineration slightly better in terms of environmental impacts. It is also the best alternative to ocean disposal in the near future. The ash is free of pesticides, viruses, and pathogens, and easily transported to landfill sites.

*Sewage treatment, *Sewage sludge, *Sludge treatment, *Incineration, *Sludge disposal, Metals, Pesticides, Polychlorinated biphenyls

Multiple-hearth incinerators, Fluidized-bed incinerators, Particulates

D062
WASTE-TREATMENT 'FARM' HARVESTS FIRMS,

Chemical Week, Vol. 119, No. 11, p 51-52, September, 1976.

A waste water treatment farm that uses partially treated waste water to irrigate and fertilize 4500 acres of corn is described. Waste water is collected from industrial sources and 13 municipal systems and is piped for distances up to 11 miles to the site. After biological treatment (aeration and settling) and percolation through the soil, the treated water has a biochemical oxygen demand value of 2.7 ppm and phosphorus and nitrogen levels of 0.02 ppm and 2 ppm, respectively. During the winter, incoming waste water is stored in a 850-acre lagoon with over 5-billion gallon capacity. The return from the sale of crops at the farm is offsetting the treatment costs which are surprisingly low for tertiary treatment. Users are charged 22 cents/1000 gallons, with an additional 2 cents/1000 gallons in acreage assessments by municipalities. The main problem encountered with this waste water treatment farm which is located in Muskegon, Michigan is the generation of odor from paper mill wastes.

*Tertiary treatment, *Irrigation, *Municipal wastes, *Industrial wastes, *Waste water treatment, Aeration, Percolation, Biochemical oxygen demand, Nitrogen, Phosphorus, Odor, Pulp and paper industry, Economics, Fertilizers, Crop production, Michigan, Symbiosis, Water reuse

D063
USE OF SLUDGE LEFT AFTER WASTE WATER DECANTATION AS A FERTILIZER OR SOIL CONDITIONER (Les boues de decantation d'eau residuaires utilisees comme fertilisant ou comme conditionneur de sols),

De Haan, S.

Bulletin d'Information, Institut Belge pour l'Amelioration de la Betterave-Tiene (Belgium), Vol. 11, No. 7, p 60-62, 1976. 1 tab.

The average inhabitant in the Netherlands produces 60 cubic meters of waste water per year, containing 40 kg of solid organic matter and 30 kg of mineral material. Secondary (microbial) sludge contains large numbers of microorganisms, which are very rich in nitrogen and phosphorus. This sludge is customarily dephosphated with ferric chloride or aluminum sulfate and stabilized by addition of thickeners. After maturation for one year, moist sludge develops very favorable physical properties. It is then dewatered and preconditioned, and sterilized to destroy pathogenic organisms and worm eggs before agricultural or horticultural use. The effect of nitrogen is predominant for sludge in the first year of application, and is generally positive. Undesirable effects of heavy metals can be avoided by addition of lime. Percolation water from sludge is heavily contaminated. It is recommended that not more than 2 tons of municipal sludge/ha/yr, calculated as dry weight, be added to soil.

*Waste water treatment, *Sludge disposal, Metals, Lime, Recycling

Netherlands, Land application

D064
SPECIFIC ROLE OF LIME IN MUNICIPAL WASTE WATER TREATMENT-EXPECTATIONS AND REALITY (Die spezifische Rolle des Kalks in der kommunalen Abwasserreinigung-Erwartungen und Realitaeten),

Kickuth, R.

Forum Umwelt Hygiene, Vol. 27, No. 2, p 300-305, September, 1976. 2 fig, 1 tab, 13 ref.

Addition of lime directly to municipal waste water has been proposed for two distinct purposes: waste water purification and phosphate recovery. However, reaction of phosphate with lime can also be carried out in a separate process following precipitation with Fe or Al, and therefore, there is no compelling reason for the use of lime in the actual clarification process. Hydrolytic decomposition of iron and aluminum phosphates by lime would have to be carried out within the sludge loop of the municipal water system. Addition of lime to municipal clarified sludges containing iron phosphate to produce equilibrium pH values of 11 would result in 90-95% conversion of the iron-bound phosphate to usable calcium phosphate. A maximum of 2 g calcium hydroxide would be required for each gram of iron in the sludge, for an average addition level of 500 g calcium hydroxide per cubic meter of sludge. The sludge volume in a municipal sewage treatment system amounts to about 1% of the waste water volume, for a daily municipal clarified sludge volume of about 150,000 cubic meters in the Federal Republic of Germany. Therefore, about 27,375 tons of calcium hydroxide per annum would be required for the conversion of iron phosphates.

*Waste water treatment, *Lime, *Municipal wastes, *Phosphates, *Water purification, Recycling

Federal Republic of Germany

D065
ORIGIN OF NITROGEN POLLUTION IN SURFACE AND WASTE WATERS
(Origines des pollutions azotees dans les eaux superficielles et les eaux usees),

Bebin, J.

Techniques et Sciences Municipales--L'eau, 71(8/9):347-362, August/September, 1976. 11 fig, 13 tab, 18 ref.

New developments are reported in the elimination of the problem of nitrogen pollution in both surface waters and waste waters. The nitrogen concentration has increased in surface waters over the past few years. The major sources of the increase are domestic sewage and industrial waste waters. Nitrogen pollution must be abated in sewage treatment plants, in order to avoid further eutrophication of rivers. Nitrification may be achieved quite simply by oxygenation, followed by the use of an anoxic tank. Sewage can then be used as a source of carbon, allowing both denitrification and further reductions in biochemical oxygen demand.

*Nitrogen, *Pollution abatement, *Waste water treatment, *Sewage treatment, *Nitrification, Surface waters, Biochemical oxygen demand, Oxygenation, Water pollution control

D066
SLUDGE WHERE WILL WE PUT IT?,

Haines, R. F.

CH2M Hill,
Corvallis, Oregon.

Water and Wastes Engineering, Vol. 13, No. 7, p 60, 62, 64, 66, July, 1976. 2 fig.

The problem of sludge disposal has become one of major importance. Estimates place the cost of sludge treatment and disposal at 25 to 50% of total waste water management costs in the United States. Until now, purification was the main objective of treatment. The EPA is setting standards for treatment and the management of resultant residues. Landfill disposal is losing ground to other disposal options. Lagooning, ocean disposal, use as fertilizer, use of sludge-derived methane, and incineration have become attractive alternate methods. Future emphasis will be on improved operating techniques, recycling and minimizing waste streams, and on holding down water costs. Social, economic, and environmental factors must be included in all future planning.

*Sludge disposal, *Sludge treatment, *Waste water treatment, *Costs, Landfills, Lagoons, Recycling, Fertilizer, Incineration

D067
WASTE WATER'S FUTURE IS CLOUDY,

Storck, W. J.

Water and Wastes Engineering, Vol. 13, No. 7, p 20-22, July, 1976.

A great deal of concern has been expressed for the future development of waste water treatment systems. The major problem is that research will probably be lessened in order to rush practical development. The primary concern is for finding means of re-using treated waste water instead of merely disposing of it. One projection involves the direct reuse of waste water as potable water. This depends upon public acceptance of the idea as well as the introduction of systems which can provide water of the required quality. Sludge also receives attention as a product of waste water treatment. It is suggested that its use as landfill or fertilizer may be extremely viable alternatives. Pyrolysis and the use of sludge-derived methane gas are also considered. Any system or method must be cost effective.

*Waste water treatment, *Sludge disposal, *Water reuse, Recycling, Potable water, Landfill, Incineration, Cost analysis, Treatment facilities

D068
ACTIVATED CARBON FROM ACTIVATED SLUDGE,

Bosch, H., Kleerebezem, G. J., and Mars, P.

Twente University,
Enschede, The Netherlands,
Department of Chemistry.

Journal Water Pollution Control Federation, Vol. 48, No. 3, p 551-561, March, 1976.
5 fig, 2 tab, 21 ref.

Investigations were conducted to determine if activated carbon with a sufficiently high surface area can be prepared from sludge; if this active carbon has necessary adsorption qualities; if the presence of carbon particles affects the rate and/or degree of biological oxidation; and if the active carbon acts as a filter aid in dewatering. Primary and secondary sludges were studied. The samples were centrifuged, dried, and the sludge carbonized in nitrogen gas. The samples were activated with steam. Pore structure, adsorption capacity, and the influence of active carbon on biological oxidation and floc structure in an activated sludge tank were investigated. This process facilitated regeneration of powdered carbon and the addition of commercial powdered carbon with a higher adsorption capacity may be beneficial. Adsorption is faster and more effective and an extra separator for carbon used in the tertiary purification is unneeded. Salts will be partly insoluble due to the regeneration procedure.

*Activated carbon, *Activated sludge, *Adsorption, Oxidation, Filtration, Dewatering, Centrifugation, Pores, Waste water treatment, Biological treatment

D069
DESIGN AND CONTROL OF NITRIFYING ACTIVATED SLUDGE SYSTEMS,

Lawrence, A. W., and Brown, C. G.

Cornell University,
Ithaca, New York,
Environmental Engineering Department.

Journal Water Pollution Control Federation, Vol. 48, No. 7, p 1779-1803, July, 1976.
13 fig, 8 tab, 20 ref, 1 append.

A pilot study was conducted to determine criteria for the application of microbial growth kinetics and continuous-culture theory in the nitrification of activated sludge. A comparison of one- and two-sludge nitrifying systems was also made. This activity was done to aid the upgrading of a regional trickling filter plant in Cheektowaga, New York. Laboratory tests at 8 and 20 C investigated temperature effects on nitrification; process stability against changing hydraulic, carbonaceous, and nitrogenous loads; and the use of biological SRT (sludge age) and controlled solids wasting. Steady-flow studies, reactor performance, settling characteristics, and microbial oxygen uptake, were considered. Experimental results indicated no essential differences in efficiency and performance of one- and two-sludge nitrifying systems operated under the same growth and temperature conditions; that nitrification can be controlled by applying biological solids retention time concepts and appropriate sludge-wasting policies; that nitrification is practically complete at temperatures of 8 and 20 C with biological solids retention times of 20 and 10 days, respectively; and that maximum growth rates of nitrifying bacterial at 8 and 20 C is approximately 0.25 and 0.5 days, respectively. Nitrification is definitely temperature dependent and use of either the one- or two-sludge systems should depend upon economic considerations.

*Kinetics, *Nitrification, *Activated sludge, *Sludge treatment, Temperature, Oxygen demand, Waste water treatment, Trickling filters

Oxygen uptake

D070
FLOTATION FOR WATER AND WASTEWATER TREATMENT,

Pullin, J.

Surveyor, Vol. 4383, No. 147, p 39-40, June 11, 1976. 2 fig.

Microflotation is based on the idea that, for effective flotation, the bubbles which take the solids or oil particles to the surface should be numerous but small in size. After chemical treatment and aeration, the effluent flows down a 10 m deep divided shaft, which keeps the downward flowing effluent away from the effluent which rises into the flotation tank. Air is injected at the bottom of the shaft. Floc agglomeration begins when the effluent, free from undissolved air, begins to rise up the shaft toward the flotation tank, and gas bubbles form as the gas content of the effluent exceeds the saturation level. A dissolved air flotation plant has been in continuous operation at a sewage treatment works for 3 years with few operational problems. The plant produced a consistently good sludge float averaging 4% dry solids, good effluent and solids removal efficiencies of over 99.7%. After a series of trials using different polyelectrolytes, Zetag 94 was used as a flotation aid. It might be possible to use flotation units to elutriate and thicken digested sludge prior to mechanical dewatering, instead of using elutriation tanks. Operational experience in potable water treatment is also discussed. Practical examples are included.

*Waste water treatment, *Sewage treatment, *Sewerage, *Treatment facilities, *Flotation, Water treatment, Waste water (pollution), Bubbles

*Microflotation

D071
AERATION AND OXYGEN TRANSFER IN BIOLOGICAL REACTORS,

Eckenfelder, W. W., Jr.

La Tribune du Cebedeau, No. 389, p 160-167, April, 1976. 5 fig, 1 tab, 14 ref.

The supply of oxygen to an aerobic biological treatment system is a critical aspect of proper design and operation. Oxygen, which is sparingly soluble in water, is transferred from the gas phase to the liquid phase by diffusion and convection to a concentration in accordance with Henry's Law. Under turbulent flow conditions assuming that the resistance of the liquid film controls oxygen transfer rate, transfer of oxygen from the gas to the liquid phase is a function of the overall transfer coefficient and the oxygen deficit. When oxygen is supplied to fluidized systems treating waste water via aerobic biological oxidation, a correction factor must be defined which relates the oxygen transfer to the nature of the waste. Aeration equipment is categorized into three systems: diffused aeration, turbine aeration, and mechanical aeration. All three are discussed. Diffused aeration systems include bubbler aeration and static aeration. Air is discharged from a pipe or sparge ring beneath the rotating blades of an impeller in turbine aeration.

*Waste water treatment, *Biological treatment, *Treatment facilities, *Aerobic treatment, *Aeration, Aerobic conditions, Oxygen, Transfer, Equipment

*Oxygen transfer

D072
CONCENTRIC WASTE-TREATMENT PLANT SAVES LAND, CUTS COST,

Brisbin, S. G.

Stearns and Wheler,
Cazenovia, New York.

Civil Engineering-ASCE, Vol. 46, No. 2, p 74-76, February, 1976. 2 fig.

In 1969 the village of Camden, New York, located in the cold snow belt region immediately north of Oneida Lake, recognized that its waste water treatment facilities were inadequate and began planning the needed facility. The Village wanted a plant located near its existing Imhoff-type primary treatment plant that would be reliable, require a minimum of attention, be simple to operate, be compatible with the harsh winter conditions, be economical and easy to maintain. An extended aeration type process was selected, using three circular concentric tanks, the outer two for aeration and the central circle utilizing a covered final settling tank. It was designed to treat waste from an equivalent population of 4700, with an average flow of 800,000 gallons per day and a peak flow of two million gallons per day, and to provide 85% biochemical oxygen demand (BOD) and suspended solids reduction at average flow. The treatment process is relatively simple. Excess sludge is removed routinely from the system by pumping from the final clarifier to sludge holding and drying beds, then disposed of at a landfill or used as soil conditioner. Emergency generation equipment works automatically, when needed, to guarantee continued operation and treatment. Replacing portions of leaking sewers resulted in considerably reduced flows. Operating results indicate over 90% removals of all monitored pollutants. This plant cost only 60% of the cost of a conventional plant.

*Waste water treatment, *Biochemical oxygen demand, *Treatment facilities, *Waste treatment, *Land use, Landfills, Costs, New York, Weather, Aeration, Sludge disposal

Imhoff treatment, Land application

D073
EXPERIMENTS ON WASTEWATER SEDIMENTATION,

White, J. B., and Allos, M. R.

Manchester University,
England,
Institute of Science and Technology.

Journal Water Pollution Control Federation, Vol. 48, No. 7, p 1741-1752, July, 1976.
8 fig, 2 tab, 2 ref, 1 append.

Tests were conducted to examine the performance of circular center-feed sedimentation tanks in the primary stage of waste water treatment. Major variables involved were the rate of flow through the tank, the concentration of suspended solids in the feed, and the settling characteristics of the suspension. Various tests were made on a full-sized tank with no control of these variables and in a small tank with means of controlling them. Settling column tests were also run on samples of the waste water used. Settling column tests on raw waste water had results which differed from those of discrete suspensions. Suspended solids concentrations decreased with time, and the rate of decrease lessened with time. Concentrations increased little with depth. Initial suspended solids concentrations greatly affected the degree of clarification in a given time. There was evidence of highly variable settling characteristics in waste water. The relationship of effluent and influent concentrations and detention time in the tank tests and column tests were such that the column tests results gave an approximation of performance in the tanks. It was shown that, after two hours, only little further clarification can be expected. Other tests with reconstituted waste water indicated that the limit of concentration may decrease with decreasing surface loading.

*Flow rates, *Sedimentation rates, *Tanks, *Waste water treatment, Suspended solids, Settling, Effluents, Clarification

*Circular center-feed sedimentation tanks

D074
THE ROTOR AERATOR: GROWING USE IN U.S. WASTE-TREATMENT PLANTS,

Civil Engineering-ASCE, Vol. 46, No. 2, p 76-77, February, 1976. 1 fig.

The rotor aerator was developed in the early 1950's as a low-cost method of sewage treatment. It has been used in sewage treatment plants ranging in size from 20,000 gpd to 40 mgd. In most cases, the rotor aerator is installed in an oxidation ditch with a race-track geometry. Using a ditch 10 to 16 ft deep was made possible by installing a baffle just downstream of the rotor aerator. When the aerated stream strikes the baffle, it plunges to the bottom of the ditch, then up again. Diffuser aerators have only about half the oxygen transfer efficiency of mechanical surface aerators. Turbine aerators have a more limited radius of influence than the rotor aerator. One-way movement around the oxidation ditch, with two rotor aerators 180 degrees apart, has an important advantage in nitrogen removal. The dissolved oxygen concentration tapers off downstream of the reactor. When it falls below 0.5 mg/liter, bacteria attack the nitrate ion, releasing both nitrogen and oxygen as a gas.

*Waste water treatment, *Sewage treatment, *Sewerage, *Treatment facilities, *Aeration, Aerobic treatment, Waste treatment, Aerobic conditions, Dissolved oxygen

*Rotor aerators

D075
ELEMENTAL DISTRIBUTION DIAGRAMS FOR BIOLOGICAL WASTEWATER TREATMENT,

Sherrard, J. H., and Benefield, L. D.

Virginia Polytechnic Institute and State University,
Blacksburg, Virginia,
Department of Civil Engineering.

Journal Water Pollution Control Federation, Vol. 48, No. 3, p 562-569, March, 1976.
7 fig, 1 tab, 7 ref.

A method is illustrated that may be used to account for waste water carbon, nitrogen, and phosphorus and to specify the form in which each may be found after treatment. In the activated sludge process, the organic components of the waste are partially oxidized by microorganisms, after which the microbial mass is separated as sludge by settling from the supernatant liquid. The supernatant may undergo further treatment, and the concentrated microbial mass is recycled to the aeration chamber. Once a waste water has been defined on a biokinetic basis, effluent quality, sludge production, nitrification, and other parameters may be predicted based on the concept of mean cell residence time. A laboratory study is required to define the biokinetic constants for carbon removal and nitrification to plot the forms of carbon, nitrogen, and phosphorus as a function of mean cell residence time as they appear after treatment. Determining the distribution of phosphorus as a function of mean cell residence time is relatively simple, because phosphorus is either incorporated into the sludge produced in the carbon removal and nitrification steps or it will pass directly into the effluent. It is suggested that several uses be made of the graphical relationships involved, the most important being a realization of what a process can or cannot do under a specific operating condition. It is suggested that elemental percentage distribution diagrams may be easily determined for a specific waste water for a variety of process operating conditions that may exist at a treatment plant.

*Waste water treatment, *Biological treatment, *Activated sludge, *Analytical techniques, *Treatment facilities, Carbon, Nitrogen, Phosphorus, Kinetics, Microorganisms

D076
FACTORS AFFECTING POWDERED CARBON TREATMENT OF A MUNICIPAL WASTEWATER,

Wallace, R. N., and Burns, D. E.

Envirotech Corporation,
Salt Lake City, Utah,
Eimco-BSP Division.

Journal Water Pollution Control Federation, Vol. 48, No. 3, p 511-519, March, 1976.
7 fig, 3 tab, 3 ref.

A nominal 50-gpm pilot plant operated for about 15 months using carbon treatment to remove soluble organics from waste water. To quantify pertinent system variables, periods of reasonably stable carbon system operation and performance were identified by plotting effluent quality, carbon dosage, and carbon system solids retention time for each day of pilot plant operation. The Freundlich adsorption model is used for evaluations. Organic removal in the pilot plant carbon system is considerably higher than predicted for adsorption by laboratory tests, reinforcing the thesis that a removal mechanism in addition existed in the carbon contactor. Treatment effects analyzed are: number of stages, chemical pretreatment effects, biological effects, and regeneration effects. In contrast to a previous study, this study showed adsorption and biological removal to be operative in both stages. Because it is impossible to model practically or predict theoretically carbon system response, pilot plant studies for developing sizing criteria for powdered carbon systems are strongly recommended. It seems that organic removals for two-stage countercurrent treatment using powdered carbon are higher than those for single-stage treatment, but single-stage carbon treatment might be economically justified for relatively weak waste water.

*Waste water treatment, *Analytical techniques, *Treatment facilities, *Carbon, *Waste water (pollution), Municipal wastes, Pilot plants, Organic compounds

Carbon treatment

D077
INHIBITING NITRIFICATION IN WASTEWATER TREATMENT PLANTS,

Stover, E. L., Esfandi, A., Little, H., and
Kincannon, D. F.

Water and Sewage Works, Vol. 123, No. 8, p 56-59, August, 1976. 5 fig, 11 ref.

Apparent inhibition of nitrification was studied in continuous flow and batch studies using an experimental bench-scale activated sludge unit. Many compounds inhibit nitrification by interference with the general metabolism of the cell or with the primary oxidative reactions. When the influent chemical oxygen demand (COD) to an activated sludge plant increased and a sharp increase in biological solids occurred, the nitrification efficiency of the system decreased. Glucose concentrations under 750 mg/liter COD did not change nitrification rates in batch reactors containing nitrifying microorganisms, but concentrations of 777 mg/liter and 1139 mg/liter inhibited nitrification rates in the same type systems. In completely mixed one-stage activated sludge treatment plants, substrate concentrations of this magnitude would seldom occur, and the organic substrate by itself would not inhibit the biological nitrification process in such systems. A reasonable explanation would be the production by the heterotrophic microorganisms at fast growth rates of intermediary metabolic byproducts which inhibit biological nitrification. This is supported by data from other nitrification investigations. As the influent COD or biochemical oxygen demand (BOD) concentrations to a system increase, the rate of carbonaceous microorganism growth increases and depresses the nitrification rate of the system.

*Waste water treatment, *Biological treatment, *Activated sludge, *Biochemical oxygen demand, *Chemical oxygen demand, Treatment facilities, Pollutant identification, Nitrification

D078
U. S. AIR FORCE GREENS COLORADO,

Water and Sewage Works, Vol. 123, No. 8, p 62-64, August, 1976. 7 fig.

Final polishing of effluent from the United States Air Force Academy's sewage treatment plant enables treated water to be recycled and used to irrigate the campus. Recycling water makes it possible to produce greenery unusual in this semi-arid region. Up to 20% of the wastes coming into the plant emanate from dining halls as garbage grindings, making the sewage twice as strong as what would normally appear in Colorado Springs. The plant uses primary sedimentation, industrial grit removal with full aeration, primary and secondary treatment filters, and intermediate clarifiers. Wastes are further purified in a four-stage reservoir system offering retention periods of 30 to 60 days and producing biochemical oxygen demand (BOD) that compares favorably with that of running streams. The water is used to irrigate lawns and shrubbery. Operation of the plant began in 1958.

*Waste water treatment, *Sewage treatment, *Sewerage, *Biochemical oxygen demand, *Treatment facilities, Colorado, Military reservations, Effluent, Recycling, Water reuse

D079
SLUDGE DRYING BEDS ARE PRACTICAL: PART 2,

Beardsley, J. A.

Water and Sewage Works, Vol. 123, No. 8, p 42-44, August, 1976. 4 fig.

Chemical conditioning is important to the efficient operation of sludge drying beds. Using polymer flocculants to treat sludge prior to bed drying offers several benefits, including increased production from existing beds, heavier loadings without blinding, reduced odor because of rapid drainage, application of variable sludges and supernate, less sludge hauling because of drier cake, and easier unloading because sludge does not form small fractured crumble. Cationic polymer flocculants are most appropriate for sewage sludges. The polymer flocculant will release large quantities of free water while forming a large well-defined floc. The flocculant ties up fine supernate solids and removes the greatest volume of liquid from the digester for a given amount of solids, prevents upsets in the primary due to recycling anaerobic colloidal solids, and provides for longer stabilization time of the remaining solids. Solution flocculants allow simpler feed systems than dry polymers, but both require dispersing and metering equipment. Chemical application has made it possible for a plant using a trickling filter and mixed sludge to switch from anaerobic to aerobic digestion without adding more sand beds. In one experiment, much more water was drained from a treated sludge bed than from a similar untreated bed. Chemical addition dramatically improved dewatering at a plant where an alum-anionic flocculant program resulted in additional solids to dewater.

*Waste water treatment, *Sewage treatment, *Treatment facilities, *Sewage sludge, *Drying, Chemicals, Efficiencies, Sludge treatment

*Drying beds

D080
SHELTERS BOOST WINTER TREATMENT EFFICIENCIES,

Long, L. W.

Anderson-Nichols and Company, Incorporated,
Boston, Massachusetts.

Water and Sewage Works, Vol. 123, No. 8, p 32-33, August, 1976. 2 fig.

Prefabricated, aluminum and fiberglass-plastic shelters around Mount Desert, Maine, sewage treatment facilities have resulted in a steadier demand in aeration requirements, energy savings, and less equipment wear in winter operation. All treatment plants on Mount Desert Island are of the secondary treatment type, utilizing extended aeration. The type of panels used in the shelters encourages heat from the sun to build up. At two plants, each made up of two aerator units, the seasonal load is sufficiently reduced in the winter that only one unit is needed, and only one was covered. Side wall panels are hinged so that they can be opened in summer for greater air circulation and maintenance. The steadier environment has resulted in less use of heaters. It is estimated that the energy savings alone could enable the shelters to pay for themselves.

*Waste water treatment, *Sewage treatment, *Sewerage, *Treatment facilities, *Winter, Efficiencies, Materials, Maine

D081
THE APPLICATION OF THE FOAM FRACTIONATION PROCESS TO THE REMOVAL OF VIRUSES. PART I. THE PRODUCTION OF A MATHEMATICAL MODEL TO PREDICT THE EFFICIENCY OF VIRUS REMOVAL,

Guy, M. D., McIver, J. D., and Lewis, M. J.

Trent Polytechnic,
Nottingham, United Kingdom,
Department of Life Sciences.

Water Research, Vol. 10, No. 8, p 737-744, 1976. 2 fig, 3 tab, 4 ref.

A laboratory scale foam fractionation plant was used to study factors affecting the removal of viruses. Viruses were represented by Escherichia coli Bacteriophage MS-2, and the surfactant was Arquad T50, a cationic agent composed of a blend alkyl quaternary ammonium chlorides. The level of Arquad T50 likely to be used in foam fractionation is toxic to Bacteriophage MS-2. If the water to be treated is mixed with the surfactant for a period before fractionation, the percentage of such bacteriophages that would be destroyed could be predicted mathematically. The removal of Enteroviruses with this cationic surfactant is not affected by toxicity. Virus removal depends on their adsorption to the surfactant and their physical removal as free virus particles entrapped in the interstitial liquid.

*Laboratory tests, *Waste water treatment, *Analytical techniques, *Treatment facilities, *Foam fractionation, *Bacteriophage, Mathematical models, Efficiencies, Surfactants, Viruses

D082
EFFLUENT VARIABILITY ESTIMATION FOR COMPLETE-MIX ACTIVATED SLUDGE TREATMENT SYSTEMS,

Novotny, V., Englande, A. J., Jr., and Majgani, P.

Marquette University,
Milwaukee, Wisconsin,
Department of Civil Engineering.

Water Research, Vol. 10, No. 8, p 699-709, 1976. 14 fig, 1 tab, 14 ref.

To meet effluent guidelines, it is necessary to quantitatively define activated sludge behavior with respect to transient loading conditions. A frequency transform technique was employed for developing mathematical models describing the waste water influent variability removal for completely-mixed biological treatment plants. The influent variability was simulated by a pulse function, a step function, a harmonic function, and a random signal. A principle of superposition can be applied for more complex influent variation patterns. The solution was presented for waste water treatment systems consisting of one mixed basin with decay or of two mixed basins, second with decay. A practical design equation was developed. Laboratory experiments were performed in an effort to verify the design equations. First, the steady state substrate removal coefficient was evaluated in a bench-scale study. Refinery waste water was used due to its relatively slow degradability. For random influent variation, input concentrations were changed at 2 hr intervals using a random number table. A pulse function was introduced by a 5 min application of a sample with 4200 mg/liter total organic carbon (TOC) followed by a return to the original 480 mg/liter TOC. A step function input was produced by a sudden 480 mg/liter increase in TOC concentration which was maintained. While some deviation from the theoretical model was indicated for random inputs, general agreement was within 5%. Both pulse and step function response showed excellent agreement with the theoretical equations, with observed error of 13 and 2%, respectively.

D083
BEHAVIOUR IN CONVENTIONAL SEWAGE PURIFICATION PROCESSES OF COLIFORM BACTERIA WITH TRANSFERABLE OR NON-TRANSFERABLE DRUG-RESISTANCE,

Grabow, W. O. K., van Zyl, M., and Prozesky, O. W.

Council for Scientific and Industrial Research,
Pretoria, South Africa,
National Institute for Water Research.

Water Research, Vol. 10, No. 8, p 717-723, 1976. 6 tab, 39 ref.

The effect of biofiltration, sedimentation, chlorination, and sand filtration on coliform bacteria with transferable (R+) or nontransferable (R-) resistance to five common drugs was investigated. Grab samples were taken at a municipal sewage works after conventional primary sedimentation, biofiltration and secondary sedimentation, about 10 min after addition of chlorine to a total chlorine content of about 4 mg/liter, and after rapid sand filtration of the chlorinated effluent. The percentage of R- coliforms resistant to ampicillin (A), chloramphenicol (C), or streptomycin (S), but not kanamycin (K) or tetracycline (T) was slightly reduced. On the average the percentage of R+ coliforms resistant to one or more of these drugs was reduced by about 50%, mainly by biofiltration and sand filtration. The ratio of transferable to nontransferable resistance for drugs other than streptomycin increased during secondary sedimentation and chlorination. R factor transfer may occur in water. Rapid passage over stony surfaces in biological and sand filters is unfavorable for conjugation, while R factor transfer can be expected under the relatively stagnant conditions in sedimentation and chlorination tanks. The incidence of R factors conferring resistance to all five drugs simultaneously increased through treatment. The incidence of Escherichia coli I among R+ coliforms did not exceed 50%. The limited effect of conventional sewage purification on the incidence of drug resistance in bacteria supports the view that sewage should be treated by more advanced methods prior to discharge.

*Bacteria, *Waste water treatment, *Sewage treatment, *Biological treatment, *Sewerage, *Analytical techniques, Treatment facilities, Filtration, Sedimentation, Sampling, E. coli

Drug-resistance

D084
CORRELATION BETWEEN BOD - TOC - TOD (Zusammenhang Zwischen BSE5 TOC TOD),

Offhaus, K.

Vom Wasser, Vol. 46, p 35-63, 1976. 11 fig, 3 tab, 8 ref.

Total organic carbon (TOC), biochemical oxygen demand (BOD), chemical oxygen demand (COD), and total oxygen demand (TOD) are important parameters for examining waste water. The difference in capacity for peptone degradation between a mixed culture and a Pseudomonas putida mono-culture is discussed in light of experiments performed. Using the effluent of a laboratory scale activated sludge plant, it can be demonstrated that Pseudomonas displays no stronger degradation capabilities than a mixed culture. The varying efficiency of the TOC and COD analysis, particularly with regard to carboxy-carbon, is mentioned. For oxidation of this type of carbon compounds, no external source of oxygen is provided which the carbon dioxide determines in TOC analysis. Extensive experiments indicate that in conventional COD determination nitrogen is not oxidized, in contrast with the TOD method with the Swing TOD analyzer where nitrogen is transformed into nitrous oxide. The correlations between COD, BOD, and TOC are discussed. The TOC value will, under certain conditions, allow BOD and COD to be rather precisely estimated. To reliably correlate BOD and TOC, numerous BOD determinations are required.

*Waste water treatment, *Pollutant identification, *Activated sludge, *Biochemical oxygen demand, *Chemical oxygen demand, Treatment facilities, Organic compounds, Carbon

Total organic carbon

D085
SEWAGE PLANT FOR BRITISH VIRGIN ISLANDS,

Reinforced Plastics, Vol. 20, No. 5, p 138, May, 1976.

A complete sewage treatment plant made of glass fiber reinforced plastics was designed for the Virgin Islands. The structure has the advantages of being corrosion resistant and light weight. It was designed to treat a 25,000 gpd dry weather flow of domestic sewage. The system consists of a GRP tank divided into an aeration chamber and an upward flow type settling chamber. A surface scum removal system avoids the problem of floating solids. Sewage enters the aeration chamber, is mixed with activated sludge, aerated, and transferred to the settling chamber. Solids from activated sludge settle to chamber base and return to the aeration chamber to be mixed with incoming sewage. Clarified effluent is discharged over a castellated weir. Air enters the aeration chamber through coarse bubble aerators. Construction is such that additional units can be added as needed. This system, for a population of under 500, is rectangular; a circular arrangement is recommended for populations of 800 or more.

*Sewage treatment, *Treatment facilities, Plastics, Aeration, Scum, Bubbles, Construction, Activated sludge, Mixing, Equipment

*Virgin Islands, Glass fiber reinforced plastics

D086
THE OPTIMIZATION OF CHEMICAL PRECIPITATION: FLOCCULATION OF MUNICIPAL WASTE WATERS,

Lee, F-M.

Dissertation Abstracts International B, Vol. 37, No. 1, p 426, July, 1976.

A study was conducted to investigate means of optimizing the chemical precipitation-flocculation phase in the treatment of domestic raw waste water. Parameters of investigation were the removal of turbidity, suspended solids, organic matter, phosphorus, and nitrogen. Jar tests and a 2 gallon per minute continuous flow pilot plant were used for evaluation. Of the coagulants which had the highest removal efficiency of organics, suspended solids, total phosphate and organic nitrogen, lime gave the better effluent quality. It was also the most economical chemical for treating the raw waste water. The lime treatment of raw domestic sewage thus became the major thrust of testing. Process modifications and the kinetics of lime dissolution in water of various chemical composition and in various waste waters were studied.

*Chemical precipitation, *Flocculation, *Domestic wastes, *Waste water treatment, *Sewage treatment, Turbidity, Suspended solids, Phosphorus, Nitrogen, Coagulation, Pilot plants, Lime

D087
LARGE FACTORY-BUILT PUMP STATION BEGINS OPERATION,

Water and Sewage Works, Vol. 123, No. 8, p 86, August, 1976.

As part of its new sewage project, Kansas City, Kansas, installed a new pump station. The station employs a variable frequency control system with two 200-hp pumps and another on standby. It can pump 11,250 gallons per minute of waste water up a 77.1 ft head through 44 in. sewer lines. It is designed to provide more interior room and use less steel, and can accomodate a variety of pump types inside. The energy efficient design should provide substantial operational savings.

*Pumps, *Sewerage, *Energy, Control systems, Design criteria, Waste water treatment, Equipment, Sewers, Pieplines, Operating costs

Pumping stations, Kansas City (Kan)

D088
'GIVE FLOTATION A TRY' WAS CHALLENGED,

New Civil Engineer, p 16, June 10, 1976.

The water authorities of Britain were urged to consider flotation as an alternative to filtration in water treatment. Claims based on Scandinavian experiences indicated that treated water quality is such that final filtration is sometimes unnecessary. It was suggested that thorough flocculation and separation tests would speed use of the flotation process in most surface water treatment plants. Advocates of the system have claimed several advantages for the process: smaller tank sizes with surface loading up to 10 times that of sedimentation tank loading, reduced chemical usage due to lighter flocs used, higher treated water quality from better solids recovery, and drier sludge. However, there would be higher energy costs and increased maintenance requirements due to the greater mechanical equipment needed. With the benefits of improved sludge handling and cheaper disposal, flotation has some cost advantage over sedimentation and, if filtration could also be replaced, the system could provide substantial financial savings.

*Flotation, *Filtration, *Water treatment, Water quality, Separation techniques, Flocculation, Surface waters, Sludge disposal, Sludge treatment, Treatment facilities, Sedimentation, Costs

D089
SMALL VILLAGE GETS ADVANCED TREATMENT,

The American City and County, Vol. 91, No. 8, p 69, August, 1976.

The new sewage treatment plant installed at the small village of McAlisterville, Pennsylvania, is an extended aeration plant. Due to the low flow rate of the receiving stream from April to October, 95% BOD removal is required. During the rest of the year, 90% BOD removal is achieved, meeting Pennsylvania's Department of Environmental Resources requirements. Design features include twin circular oxidation ditches with a common wall into which pumped wastes are discharged. The "doughnut" is an oxidation ditch and the "hole" is a clarifier, separated by a common wall. Rapid sand filters are used to further reduce BOD and suspended solids to the required levels. The sand filters have a top layer of coarse anthracite coal, a middle layer of common sand, and high-density garnet sand at the bottom. A chlorine contact tank provides chlorination and also serves as a reservoir for filter backwash water. Sludge is treated by aerobic digestion and land disposal. A chemical feed system is ready if phosphorus removal becomes necessary. Flocculation and tube settling mechanisms supplied with the sand filters can aid phosphorus removal.

*Tertiary treatment, *Treatment facilities, *Sewage treatment, Flow rates, *Filtration, Oxidation, Aerobic digestion, Biochemical oxygen demand, Suspended solids, Flocculation

*Extended aeration, Phosphorus removal, Sand filters

D090
BIOCHEMICAL MECHANISMS IN THE METHANE FERMENTATION OF GLUTAMIC AND OLEIC ACIDS,

Weng, C-N., and Jeris, J. S.

Buck, Seifert and Jost,
Consulting Engineers,
Englewood Cliffs, New Jersey.

Water Research, Vol. 10, No. 1, p 9-18, 1976. 5 fig, 4 tab, 9 ref, 1 append.

A series of 2-1 laboratory scale digesters fed on a batch basis similar to typical field operations were used to determine the biochemistry involved in anaerobic digestion processes used in waste water treatment. L(+)-glutamic acid and oleic acid were the substrates fed. Identifications were made by chemical analyses of the liquid feed and effluent and radioactivity analyses of the gases produced was by liquid scintillation techniques. It was concluded that glutamic acid was probably degraded to methane and carbon dioxide through mesaconic, pyruvic, lactic, propionic, and acetic acids. Beta-oxidation seemed to be the major mechanism in oleic acid fermentation. The major volatile acid intermediate found in methane fermentation of L(+)-glutamic and oleic acids was acetic acid.

*Anaerobic digestion, *Waste water treatment, *Laboratory tests, *Methane, Radioactivity, Chemical analysis, Chemical reactions, Fermentation

Glutamic acid, Oleic acid

D091
SORPTION OF POLIOVIRUS FROM AQUEOUS SOLUTION
WITH ACTIVE CARBON,

Carlson, R. H.

Dissertation Abstracts International B, Vol. 37, No. 2, p 675-676, August, 1976.

The use of activated carbon for removal of enteroviruses from raw domestic sewage was examined. The Mahoney strain of Type I poliovirus was used for testing. A qualitative plaque assay using HeLa cell monolayers in a double overlay technique was employed. Secondary sewage effluent components seemed to lower carbon capacity and toxic factors prevented a quantitative evaluation of the amount of inhibition. Poliovirus adsorption was influenced by physical factors such as the size of the carbon particles used. There was a direct relationship between rapid virus titer losses at acidic pH values in the absence of carbon absorbent and the pH value of the suspending solution. It is a function of the net charge on the particle. This pH-specific factor may have resulted in the misunderstanding of recently published virus adsorption studies.

*Viruses, *Activated carbon, Toxicity, Sewage treatment, Sewage effluent, Hydrogen ion concentration, Absorption

Enteroviruses, Poliovirus

D092
LARGE SCALE SEWAGE TREATMENT PLANT WITH SLUDGE INCINERATOR,

Chemical Age of India, Vol. 27, No. 7, p 651-652, July, 1976.

The treatment process of a large industrial sewage treatment plant was described. The plant, located at the Grenzach Work of Ciba-Geigy AG, Basel, Switzerland, treats wastes from the production of dyestuffs, textile auxiliaries, and industrial chemicals as well as municipal sewage from nearby communities. Major plant sections are a chemical-physical section, clarifying section, biological section, sludge and waste incinerator section. Chemical works effluent is pretreated in the chemical-physical section. The effluent has a high salt content, acidic pH, residual solvents, non-ferrous metals, and other organic substances which inhibit biological decomposition. This section contains the acidic flocculation and flotation stage, the alkaline flocculation and sedimentation stage and a buffer basin. Municipal sewage is pretreated in the mechanical clarifier parallel to the industrial effluent treatment line. A mixture of both is fed to a distributor basin. Biological treatment consists of aeration, deaeration and secondary settling. The return sludge is recirculated and the cleaned sewage is fed into the Rhine river. The sludge is dewatered and burned in a fluidized-bed furnace and the ash (6 cu m per day) containing no more than 1% organic matter is hauled to a dump. The plant also contains a refuse incinerator which burns all kinds of industrial wastes.

*Waste water treatment, *Sewage treatment, *Biological treatment, *Sewerage, *Treatment facilities, Sludge, Sludge disposal, Incineration

D093
EFFECT OF HIGH DISSOLVED OXYGEN CONCENTRATION IN ACTIVATED SLUDGE SYSTEMS,

Chapman, T. D., Matsch, L. C., and Zander, E. H.

Journal Water Pollution Control Federation, Vol. 48, No. 11, p 2486-2510, November, 1976. 7 fig, 7 tab, 69 ref.

An evaluation of the UNOX oxygen activated sludge system was given to prove its advantages. The system is designed to use high purity oxygen for the dissolved oxygen (DO) requirements, to use a covered basin for contact between biomass, oxygen, and waste water, to operate in the same average range of power densities as air systems but at lower ones near the end of the train to develop a well flocculated biomass, to handle a broad range of F:M loadings, and to operate at a DO level range of 2 to 6 mg/liter. Aspects discussed are the effect of DO in activated sludge, organic loading and effluent quality, settleability of OE solids and MLSS levels, sludge production nitrification, and process stability. Oxygen systems have no advantage relative to settleability, operation at higher organic loadings, or waste sludge production. But at DO levels of 4 to 6 mg/liter (oxygen system) and 1 to 2 mg/liter (air system) the following observations were made. Higher DO level oxygen systems can operate at biomass loadings (F:M) of more than twice that of air systems with the same BOD5 and SS quality effluent. Settleability of oxygen system sludge is greater, allowing higher solids loading on the clarifier with higher recycle solids and MLSS concentrations. There is also improved dewatering of oxygen activated sludge. Less sludge is produced with the oxygen system at equivalent apparent F:M ratios. It was concluded that these characteristics were due to the increased viability of the oxygen system mixed liquor resulting from increased oxygen penetration into the floc matrix.

*Waste water treatment, *Activated sludge, *Biochemical oxygen demand, *Dissolved oxygen, *Oxygen, Basins, Biological treatment, Biomass

D094
COMPARISON OF AIR AND OXYGEN ACTIVATED SLUDGE SYSTEMS,

Kalinske, A. A.

Camp Dresser and McKee, Inc.
Environmental Engineers,
Boston, Massachusetts.

Journal Water Pollution Control Federation, Vol. 48, No. 11, p 2472-2485, November, 1976. 2 fig, 2 tab, 57 ref.

A study to determine the reality of claims made for oxygen activated sludge systems was conducted. It was claimed that elevated DO caused basic changes in the metabolic activity and characteristics of organisms composing an activated sludge floc; that flocculant suspension settles at a higher velocity for any given concentration of such flocculant biomass; that an elevated DO reduces microbial cell growth or synthesis will be reduced for the removal of a given amount of organic substrate or BOD; and that an elevated DO permits a higher bio-oxidation rate and higher BOD loadings for equal BOD removals. Results indicated that for most physical and biochemical parameters, both systems were comparable. An elevated DO above 2 mg/liter had no influence. A lower mixed liquor pH may cause some inhibition of nitrification at lower temperatures in oxygen systems. Oxygen systems can supply a high oxygen input needed for high strength wastes for which air systems need increased mixing intensity. Higher DO levels possible with oxygen systems provide a short period reservoir of oxygen when uptake increases, but if this uptake lasts, DO levels will drop to zero if supply does not match demand. But this is true for all systems. With monitoring and automation, both systems can perform equally in this respect. In large plants, costs are relatively equal. There is no basis for the assumption that oxygen systems demand less power.

*Waste water treatment, *Biological treatment, *Activated sludge, *Biochemical oxygen demand, *Air, *Oxygen, Dissolved oxygen, Metabolism

D095
OXYGEN AND AIR ACTIVATED SLUDGE: ANOTHER VIEW,

Parker, D. S., and Merrill, M. S.

Brown and Caldwell,
Walnut Creek, California.

Journal Water Pollution Control Federation, Vol. 48, No. 11, p 2511-2528, November, 1976. 13 fig, 2 tab, 46 ref.

A study was conducted to compare and clarify conflicting claims made for the oxygen and air activated sludge processes. The activity of DO was studied by consideration of the effects of macromixing and micromixing on activated sludge floc size, substrate concentration, F:M ratio, and DO penetration. It was found that oxygen activated sludge required higher DO levels to maintain floc penetration of DO than air activated sludge. Oxygen systems can be designed at higher F:M levels than air systems. However, oxygen systems had a better ability to cope with unexpected increases in organic loading. The systems were proved equal in operation when a minimum DO of 2.0 mg/liter was maintained in regard to settleability. The previously mentioned minimum DO ensured an equal sludge production for most municipal waste waters. DO control in air activated systems is no more costly or difficult on an annual basis than in an oxygen activated system. The oxygen activated system has produced high performance standards which only well-designed and operated air systems can compete with. The oxygen system is best applied in situations where space limitations occur, where there is a side load fluctuation, or when strong municipal or industrial waste waters are treated.

*Waste water treatment, *Activated sludge, *Oxygen, *Air, *Dissolved oxygen, Mixing, Flocculation, Aquatic microorganisms

Food to microorganism ratio

D096
ULTRAVIOLET DISINFECTION: AN ALTERNATIVE TO CHLORINATION,

Oliver, B. G., and Carey, J. H.

Canada Centre for Inland Waters,
Burlington, Ontario, Canada,
Process Research Division,
Water Chemistry Section.

Journal Water Pollution Control Federation, Vol. 48, No. 11, p 2619-2624, November, 1976. 2 fig, 6 tab, 16 ref.

Because chlorine residues are toxic to aquatic life, UV disinfection of waste water was studied. This is done with a UV wavelength of about 254 nm. It did not become popular because chlorine was cheaper and provided some degree of residual protection. Major problems encountered with UV disinfection were: the need to maintain residual protection from bacterial contamination during transport and the difficulty of obtaining totally sterile water from a raw water supply with variable turbidity and color. Studies have shown that 99% of total coliform, fecal coliform and fecal streptococcus could be killed with low doses, that bacterial kill was independent of light intensity, and that ultrasonic pretreatment produces a higher bacterial kill. Experiments were conducted with UV lights over secondary clarifiers in an activated sludge plant. This indicated that total coliform and fecal streptococcus are less sensitive to UV light than fecal coliform bacteria. All pathogens and viruses studied were as sensitive or more sensitive to UV light than fecal coliforms. Problems encountered were large surface areas of clarifiers which altered effluent residence time near the surface and the variable flow rate at waste water treatment plants. Flat weirs on final clarifiers are necessary before UV disinfection is practical. This method would also suppress algae growth on the weirs. Its major advantage is that it is less harmful to the environment than chlorination, though chlorine is cheaper.

D097
FLOW EQUALIZATION BY USE OF AERATION TANK VOLUME,

Speece, R. E., and LaGrega, M.

Drexel University,
Philadelphia, Pennsylvania,
Department of Environmental Engineering.

Journal Water Pollution Control Federation, Vol. 48, No. 11, p 2599-2608, November, 1976. 8 fig, 8 ref.

Flow equalization was examined as a method for producing waste treatment effluent with a better average quality. It was expected that this process would improve overall treatment efficiencies, extend plant design life, reduce operating costs, and reduce waste water quantities by-passed. Economic advantages of the system were not clear. However, a study showed that a separate upstream equalization basin is more costly than basing design overflow rates for the clarifiers on the peak rather than average flow. There was a definite relationship between overflow and suspended solids in the effluent. A reduction in effluent was accompanied with a reduced BOD. Several methods were tried in flow equalization, such as basins to equalize raw flow before reaching treatment plant; some waste water flows were equalized to provide uniform 24-hr discharge to anaerobic contact processes; and some industries store a 24-hr waste water flow, check it for toxicity and then discharge it to a biological treatment unit. Aeration tank volume has been used for equalization purposes and oxygen transfer has also been a consideration in the process. Other considerations discussed were the probability of overflow, concentration equalization, soluble BOD removal, location of equalization systems in the flow scheme, and regulatory approval.

*Waste water treatment, *Biological treatment, *Biochemical oxygen demand, *Treatment facilities, *Flow, Flow control, Flow rates, Aeration

D098
VIRUS AND BACTERIAL REMOVAL FROM WASTE WATER BY LAND TREATMENT,

Gilbert, R. G., Gerba, C. P., Rice, R. C., Bouwer, H., and Wallis, C.

United States Department of Agriculture,
Agricultural Research Service,
Water Conservation Laboratory,
Phoenix, Arizona.

Applied and Environmental Microbiology, Vol. 32, No. 3, p 333-338, September, 1976. 1 fig, 5 tab, 19 ref.

This study was conducted to evaluate the effective removal of viruses and bacteria from secondary sewage effluent and to evaluate their movement in soil during flooding. Results indicated that fecal coliforms, fecal streptococci, and total bacteria were decreased about 99.9% in renovated well water and Salmonella were not found in 5 liter well water samples from the east center well at two samplings. There were no detectable viruses in the well water which indicated that 99.99% of them were removed during percolation of waste water through 9 m of sandy loam soil. Sewage effluent samples contained poliovirus types 2 and 3, echovirus 7 and 15, coxsackiervirus B4, and reovirus types 1 and 2, which varied with the time of year. It was proved that human bacterial and viral pathogens were mostly removed from sewage effluent when it percolates through the soil. After eight years of operation, the project showed that viruses, enteric bacterial pathogens, and pollution indicator organisms in renovated sewage effluent were very decreased or nondetectable after filtering waste water through soil recharge basins. Land treatment was shown to be a very satisfactory method of waste water renovation. Studies on the detection and assessment of the survival potential of virus populations retained in the soil should be undertaken.

*Waste water treatment, *Sewage treatment, *Pollutant identification, *Viruses,

D099
HEAT INACTIVATION OF POLIOVIRUS IN WASTE WATER SLUDGE,

Ward, R. L., Ashley, C. S., and Moseley, R. H.

Sandia Laboratories,
Albuquerque, New Mexico.

Applied and Environmental Microbiology, Vol. 32, No. 3, p 339-346, September, 1976.
3 fig, 5 tab, 20 ref.

The study was designed to determine the effects of raw and anaerobically digested sludge on the rate of heat inactivation of poliovirus. Three types of poliovirus were grown and plaqued on a line of HeLa cells. A 10-fold dilution of virus was placed in the sludge samples at room temperature and then flamed to eliminate infectious virus that may have remained above the water line in the incubation bath. Then they were incubated at specified times and temperatures, placed in an ice bath and analyzed by the SDS-sonication procedure. Results showed that viruses are readily inactivated by heat, though the inactivation rate is most dependent on environment. Raw sludge proved consistently protective of poliovirus during heat treatment and digested sludge had erratic effects. The latter, when dilute and at low temperatures, protects the virus but, at high temperatures and concentrations, loss of viral plaque-forming units is more rapid. The difference between the two sludge types is attributed to the acquisition of virucidal activity during digestion. It seemed that a virucidal agent associated with the liquid component of sludge is produced during digestion. Solids of raw sludge are protective during heat inactivation, and this can be reversed by the addition of the liquid fraction of digested sludge.

*Waste water treatment, *Pollutant identification, *Heat, *Viruses, *Sludge, Anaerobic digestion, Waste dilution, Temperature

Poliovirus, Inactivation

D100
SODIUM BICARBONATE NEUTRALIZES,

Barber, N.

The American City and County, Vol. 91, No. 11, p 54-55, November, 1976.

Large amounts of waste paper fibers collecting in the primary settling basin of the West Nyack, N. Y. sewage treatment plant caused a serious digester souring problem. The system's pH had fallen from 7 to 4.8. Raw sewage was pumped into the primary digester, but the anaerobic microorganisms were adversely affected and recovery was doubtful. About 700 lb/day of sodium bicarbonate was added and the pH began to rise, ranging from 6.9 to 7.1. Alkalinity rose from less than 2000 mg/liter to 4000 mg/liter. Waste digestion improved greatly. When reasonable pH and alkalinity levels were reached, about 150 lb/day of sodium bicarbonate were applied as a preventative. The gradual addition of sodium bicarbonate was also used to clear emulsion blockage of the settling tanks. Sodium bicarbonate functions as a buffer in the maintenance of desired acidity-alkalinity ratios for microbial activity. Sodium bicarbonate also plays a role in pH control and is an ideal medium for increasing methane production in anaerobic systems and precipitating toxic metals.

*Waste water treatment, *Sewage treatment, *Biological treatment, *Sewerage, *Treatment facilities, Sodium compounds, Bicarbonates, Neutralization

Sodium bicarbonate

D101
RECENT DEVELOPMENTS IN THE USE OF POLYELECTROLYTES,

Moll, D. B.

Water and Waste Treatment, Vol. 19, No. 9, p 39, September, 1976. 2 tab.

Synthetic polyelectrolytes have received much attention in Britain for use in the solid-liquid separation process of sewage treatment. They are generally reliable in achieving a high degree of solids recovery and have been used in mechanical dewatering and vacuum filtration. "In-line" dosing of sludge has proved suitable for most sludge pumps and eliminates the need for chemical preparation and dilution tanks, thus offering considerable cost savings. Polyelectrolytes have successfully replaced traditional conditioners such as the lime-copperas combination and aluminum chlorohydrate. Their use has proven advantages which include: elimination of scaling problems, increased press capacity, reduced chemical handling problems, elimination of inorganic conditioner-induced corrosion, reduction of chemical storage space needs, and a non-contribution to ash loading when incineration is considered. It is concluded that further investigation will reveal other productive uses for synthetic polyelectrolytes.

*Waste water treatment, *Sewage treatment, *Sewerage, *Polyelectrolytes, *Separation techniques, Solid wastes, Liquids, Dewatering

D102
AN OPERATOR'S APPROACH TO AEROBIC DIGESTER SUPERNATANT DISPOSAL PROBLEMS,

Fricker, R. G.

Montgomery County Sewer Authority,
Oaks, Pennsylvania.

Water Pollution Control Federation Highlights, Vol. 13, No. 10, p D2-D3, October, 1976.

Problems associated with aerobic and anaerobic digester supernatant and means of detecting them were discussed. Two major problems encountered with aerobic supernatant are the tremendous hydraulic loading caused by abruptly returning large amounts of supernatant to the head of the plant and the possibility of high SS levels returned to the head of the plant with the supernatant. The first problem can be determined by noticing SS concentrations at the influent and effluent end of the primary and secondary clarifiers and by noticing solids washing over the weirs during supernatant return. Scheduling the liquid return for low flow times and slowing the rate reduces the hydraulic load on the treatment units. Some form of settling aid can reduce the second problem. With anaerobic digester supernatant excessive BOD can be formed which can be monitored by keeping good BOD records for influent and effluent of each treatment unit and by DO tests to determine the freshness of the incoming load. A black septic sludge on top of primary tanks can indicate a problem. A hydraulic overload may be countered by methods similar to those used with the problem in aerobic digester processes. Turbidity and SS tests can determine high solids loading. Hydrogen sulfide content can be determined by tests or by a rotten egg odor in the plant. Problems with pH can be handled by monitoring the pH of the supernatant. The amount of suspended solids in the supernatant can be controlled by polyelectrolytes.

*Waste water treatment, *Pollutant identification, *Biochemical oxygen demand, *Treatment facilities, *Digestion, Aerobic treatment, Waste disposal, Anaerobic digestion

D103
SUPERNATANT DECANTING OF AEROBICALLY DIGESTED
WASTE ACTIVATED SLUDGE,

Paredes, M.

Carmel Sanitary District,
Carmel, California.

Water Pollution Federation Highlights, Vol. 13, No. 10, p D4-D5, October, 1976.
2 fig.

The Carmel Sanitary District, in 1973, began operation of a secondary activated sludge treatment process. It included two aeration tanks which were aerated and mixed by two surface aerators which ran continuously. Supernatant decanting basins in each tank helped to settle sludge and return solid materials to the digestion area. Submerged entrance ports allowed mixed sludge to enter the basins and settle on the bottom while clarified or decanted supernatant passed over outlet weirs to return to the waste water flow ahead of the secondary sedimentation tank or to the final clarifier. The sludge was returned to the main digestion area. Because of turbulence in the supernatant decanting basins a clear decanted liquid was impossible. The tanks were alternately shut down creating the problems of sludge rising to the top and going over the weirs and bad odors after start-up. A hole was cut in one side of the decanting basins which extended above and below the water line and a wooden sluice box was attached to the outside of the settling basins over the hole to allow it to slide up and down until clear liquid could be brought into the settling basin and the surface sludge kept out. This caused poor settling in the digestion area and one tank was permanently shut down to receive sludge from the other and act as a settling tank. This cleared the decanted supernatant and improved sludge settling in the main digestion area. A submersible pump was installed 60 cm below water level in the decanting basin of the settling tank to pump clear supernatant to the aeration basins and aid in the clarification of the final clarifier. Drawing off sludge regularly from the bottom of the settling tank, not running an aerator in this settling, and keeping water sprays on top of the tank produces a consistently clear supernatant.

*Waste water treatment, *Activated sludge, *Treatment facilities, *Aerobic treatment, *Digestion, Sewage treatment, Aeration, Mixing

D104
AN AUTOMATED METHOD FOR THE DETERMINATION OF LOW-LEVEL
KJELDAHL NITROGEN IN WATER AND WASTE WATER,

Elkei, O.

Canada Centre for Inland Waters,
Water Quality Branch,
Ontario Region,
Burlington, Ontario, Canada.

Analytica Chimica Acta, Vol. 86, p 63-68, 1976. 2 fig, 2 tab, 10 ref.

An automated system was developed to determine low Kjeldahl nitrogen concentration levels with good accuracy and precision. The device consisted of standard Technicon AutoAnalyzer II nodules with various proportioning and micrometric pumps. Also involved were a continuous block digester, a rotary mixer, heating elements, a double-reservoir helix, colorimeter, vacuum pump, strip chart recorder, and a digital printer. Reagents were high quality certified reagent grade and distilled deionized water was used. An ammonium sulfate solution was the stock solution for making working standards. Sensitivity was unsatisfactory with the colorimetric method based on the Bertholet reaction with alkaline phenolate-hypochlorite reagents. A more sensitive color reaction was found between ammonia and a weakly alkaline mixture of sodium salicylate and dichloroisocynurate. The digestion mixture of perchlorate was slightly better for guanosine and quinine, but for proline and amino acids, peroxide and the perchlorate-selenium mixture were equally good. Hydrogen peroxide was a good alternative to the latter mixture and had the highest digestion capacity of tested digesters. The method proved satisfactory.

*Pollutant identification, *Analytical techniques, *Automation, *Nitrogen, *Waste water (pollution), Water, Pumps, Digestion

Kjeldahl nitrogen

D105
INTERMITTENT SAND FILTRATION OF HOUSEHOLD WASTEWATER,

Sauer, D. K., Boyle, W. C., and Otis, R. J.

Wisconsin University
Madison,
Department of Civil and Environmental Engineering.

Journal of the Environmental Engineering Division-ASCE, Vol. 102, No. EE4, p 789-803, August, 1976. 3 fig, 10 tab, 9 ref, 1 append.

Intermittent sand filtration of septic tank and aerobic treatment unit effluents was investigated as an alternative to subsurface disposal for household waste water treatment. Filters at one homesite treated septic tank effluent, while those at another homesite treated activated sludge extended aeration effluent. Twenty-four hour composite samples were obtained from the septic tank, aerobic unit, and intermittent sand filter effluents. Combined aerobic and sand filter treatment provided a highly treated effluent in terms of BOD, COD, and TSS. The effluent quality meets suggested current surface discharge effluent standards. It operated successfully at an average hydraulic loading rate of 3.5 gal/day sq ft for 9 mo. before surface sand maintenance was required. Sand filtration of septic tank effluent at an average hydraulic loading rate of 5 gal/day/sq ft produced complete nitrification and BOD and TSS that meet surface discharge effluent standards. Successful maintenance for sand filters used with a septic tank included removing the top 2 to 5 in. of clogged sand and replacing it with clean sand and raking it without adding clean sand. Total annual costs for treating and disposing of household waste water using intermittent sand filter systems ranged from $400 to $700, depending on the use of septic tanks or aerobic treatment units and the size and method of maintenance of the sand filters.

*Waste water treatment, *Activated sludge, *Pollutant identification, *Biochemical oxygen demand, *Chemical oxygen demand, Treatment facilities, Filtration, Sands

D106
TERTIARY TREATMENT OF SEWAGE EFFLUENTS,

Kershaw, M. A.

Mander, Raikes and Marshall Consulting Engineers,
Bristol, England.

Process Biochemistry, p 21-23, 25, September 1976. 10 ref.

A review is presented of tertiary treatments, or polishing processes, applied to sewage effluents to make them comply with standards more stringent than 30 ss (suspended solids):20 BOD. In upward flow filters, the larger solids are trapped in the bottom, coarse medium and the finer solids in the top, fine medium. Their performance depends on the flow rate; with filter effluent loading of 100 cu m/sq m/day 90% solids removal can be achieved. With Micro strainers, results vary with the quality of fabric on the drum, and the key to successful performance is the quality of the influent. Rapid gravity sand filters are successful as treatments for percolating filter and activated sludge effluents. Normal loading is between 200 and 250 cu m/sq m/day. Slow sand filters are found at older, smaller sewage works; they produce higher costs than other methods of effluent polishing. With the upward flow carrier, the effluent is passed up through a bed of pea gravel and the suspended solids are removed from the influent by flocculation and settlement. The action of lagoons or maturation ponds consists of a combination of buffering sedimentation and biological activity. For a retention period of 4 days 40% ss and BOD reduction and 70% E. coli reduction are often achieved. In the operation of grass plots, the first consideration is to ensure that the feed liquor is evenly distributed and does not pond or short circuit. This form of treatment is well suited to small sewage works in rural areas where land is available.

*Waste water treatment, *Sewage treatment, *Biological treatment, *Treatment facilities, *Tertiary treatment, Sewage effluents, Biochemical oxygen demand, Suspended solids

D107
AEROBIC BIOLOGICAL TREATMENT OF A COLLOIDAL WASTEWATER,

Khararjian, H. A.

Dissertation Abstracts International B, Vol. 37, No. 4, p 1805B, 1976.

Contact stabilization was studied as a modification of the activated sludge process. Colloidal waste water made from yogurt, beef extract, and mineral salts was used in the study. Batch type experiments conducted at 0, 23, 43, and 54% colloidal percentages showed that not all colloidal wastes undergo a period of adsorption onto biological floc followed by release back into solution. Continuous flow experiments conducted on two model treatment units showed that the completely mixed and contact stabilization processes both have similar COD removal efficiencies when compared on a total sludge basis. Sludge productions in the contact stabilization processes were lower than in the completely mixed system. A mathematical model was developed for the use of design engineers and plant operators for use in process optimization.

*Waste water treatment, *Biological treatment, *Activated sludge, *Chemical oxygen demand, *Aerobic treatment, Colloids, Waste water (pollution), Stabilization

D108
PRIMARY SURVEY OF THE INVENTORIES OF RURAL PUBLIC UTILITIES
(Premier Apercu Sur Les Inventaires Des Equipements Publics Ruraux),

Basalo, C.

Techniques et Sciences Municipales-L' Eau, No. 8-9:363-368, August-September, 1976.

The inventory of rural public utilities in France shows that sewer systems are now serving 32% of the population compared to 23% in 1971 and that the adjunction of purification plants has risen from 12% (in 1971) to 22%. An estimated 8 billion francs will be spent to add to the sewer system and 2 billion to expand purification facilities. It is estimated that the immediate needs of the growing communities will be met within 10 years. The capacity for rural sewage treatment has recently risen from that for 4,180,000 inhabitants to 9,500,000. At present, out of 28,000,000 inhabitants who could be served by communal facilities, only 19,500,000 are so served.

*Waste water treatment, *Sewage treatment, *Sewerage, *Treatment facilities, *Rural areas, Public utilities, Sewers, Human population

France

D109
BIOLOGICAL PURIFICATION OF URBAN WASTEWATERS BY MEANS OF ROTATING BIOLOGICAL DISKS (EPURATION BIOLOGIQUE DES EAUX USEES URBAINES AU MOYEN DE DISQUES BIOLOGIQUES TOURNANTS),

Tan, B. H., Giffard, M., and Martin, G.

Techniques et Sciences Municipales-L'Eau, No. 6:281-284, June, 1976.

For six months, the municipal waste waters of Rennes were fed into a pilot biological purification plant consisting of two drums, each with eleven rotating biological polystyrene disks. The total functional surface of the disks was 130 sq m and the total immersed surface 56 sq m. The rotating speed was 2 rpm and total volume 690 liters. Eight flow rates were tested. Charted results show that BOD, COD, and N-NH4+ can be effectively reduced by this process. About 50% nitrification can be achieved in 2 hours whole time with a load of 25,000 sq m/cu m/min. The BOD5 load per liter of growth on the disks is 7.2 g compared to 7.7 g in conventional bacterial beds. The advantages of rotating biological disks are a predictable yield, a good tolerance to toxic substances, easy maintenance, and a short whole time.

*Waste water treatment, *Biological treatment, *Pollutant identification, *Biochemical oxygen demand, *Chemical oxygen demand, Treatment facilities, Water purification, Cities

D110
TECHNICAL ASSISTANCE FOR OPERATORS OF PURIFICATION PLANTS IN THE SEINE-NORMANDIE BASIN (ASSISTANCE TECHNIQUE AUX EXPLOITANTS DES STATIONS D'EPURATIONS DANS LE BASSIN SEINE-NORMANDIE),

Pinoit, R.

Techniques et Sciences Municipales-L'Eau, No. 8-9:363-368, August-September, 1976.

Free technical assistance to purification plants in communities and industries have been available in lower Normandy since 1971. Technicians visit a plant four times a year to check, correct, and improve the facility. Two day sessions are held for plant operators to teach them more about the plant; they are also made to participate in practical demonstrations and tests. This technical assistance system has aroused more interest in operators for their jobs and has improved overall functioning of the plant by approximately 10%.

*Waste water treatment, *Treatment facilities, *Operations, *Water purification, *Personnel, Industries, Training, Operation and maintenance

Treatment facility operations, Normandy, France

D111
WASTE WATER STORAGE-SIMULATION OF INSTREAM EFFECTS,

Tapp, J. S.

Kentucky Department for Natural Resources and
Environmental Protection,
Frankfort, Kentucky,
Division of Water Quality.

Journal of the Environmental Engineering Division-ASCE, Vol. 102, No. EE6, p 1151-1159, December, 1976. 4 fig, 7 tab, 1 ref, 1 append.

The applicability of storage and timed release of waste water into streams was investigated as a means of compliance with water quality standards of Public Law 92-500. The test site was a small stream in Mississippi with nearly 233 sq mi of drainage area above two major dischargers, a municipality of 20,000, and a large wood products area. The following assumptions were made for purposes of the study: that dischargers were constant inputs into the system, except for the industry where flow was considered a constant input to the storage pond; that velocity-flow and depth-flow in DO models by Shindala were applicable; that a steady-state model would be representative at all streamflows; that reaction rates of BOD decay and nitrogen oxidation to nitrate would not change significantly with flow changes; that BOD, oxidizable nitrogen, and DO concentrations in stream above discharges would remain constant at all flows; and that the ratio of flow by each subdrainage area to total flow would be the same at all flows. The relationship of waste water flow and stream flow at a given temperature for a given DO target was investigated. It was also studied under conditions with and without operation of the storage pond. Results indicated that the storage pond kept DO concentrations at acceptable levels by smoothing valleys in instream DO concentration curves. It was proved that storage of industrial waste water during times of low natural streamflow and release under higher flow conditions significantly increases instream DO levels. The frequency of violation was calculated to be once every 4 to 5 calendar years. Equations were derived for proper storage pond operation.

*Pollutant identification, *Biochemical oxygen demand, *Waste water (pollution), *Waste storage, *Water storage, Model studies, Natural streams, Water pollution effects

D112
DEVELOPMENTS AT WATER RESEARCH CENTRE,

Process Biochemistry, Vol. 11, No. 9, p 24-25, September, 1976.

Several projects viewed at an open-house of the Stevenage Laboratory of the Water Research Centre were discussed. Investigations suggested the use of flotation as an alternative to conventional upflow clarification of potable water, a sedimentation alternative, and a clarifier of sewage effluent and sludge thickener. Methods of improving overloaded sewage treatment facilities were also discussed. These included the adoption of alternating double filtration or effluent recirculation, the use of plastics, and proposals for upgrading the performance of biological filtration plants. Oxygen injection in rising-main sewers was also studied. There were continuing investigations of sludge treatment. The use of polyelectrolyte dosing and slow stirring to thicken alum sludge and the disposal of waterworks sludge to sewers were under investigation. The Centre also undertook the study of means for co-ordinating analytical data for determining and maintaining water quality standards.

*Waste water treatment, *Sewage treatment, *Biological treatment, *Treatment facilities, *Research and development, Research facilities, Projects, Laboratories, Investigations

*Water Research Centre

D113
THE COST OF MUNICIPAL WATER SUPPLY: A CASE STUDY,

Clark, R. M., Stevie, R., and Trygg, G.

United States Environmental Protection Agency,
Cincinnati, Ohio,
Municipal Environmental Research Laboratory.

1976. 42 p, 8 fig, 13 tab, 5 ref. Tech. Rept. EPA-600/2-76-179.

Water supply problems have become increasingly important recently. Spreading urban boundaries force many potential customers to locate farther from available water sources. Therefore, studying factors affecting the costs of water supply management is important. These factors are examined for the Cincinnati Water Works, Cincinnati, Ohio, and the application of a functional approach to the analysis of water supply costs is documented. This approach provides the basis for determining the cost of service for any given consumer within the Water Works service area. Ultimately this or a similar approach will of necessity be used to analyze the impact of regional water supply systems. Costs are defined functionally for support services, acquisition, purification, power and pumping, and transmission. Operating and maintenance, capital, and labor costs are evaluated. Manpower costs are significant and play an increasingly important role in the total cost of water as delivered to the consumer. As water is pumped from treatment plant to consumer, costs are added, increasing with respect to distance from the central supply. Cost zones are developed for the Water Works service area. Actual charges and construction costs are compared for the Water Works' 10 largest water users. The basic principles discussed apply to all water supplies. They must be considered in planning and designing water systems; the functional analysis is extremely important for regional considerations.

*Treatment facilities, *Cost analysis, *Economics, *Management, *Planning, Utilities, Water supply, Systems analysis

D114
EVALUATION OF THE USE OF SLUDGE CONTAINING PLUTONIUM AS A SOIL CONDITIONER FOR FOOD CROPS,

Myers, D. S., Silver, W. J., Coles, D. G., Lamson, K. C., and McIntyre, D. R.

California University,
Livermore,
Lawrence Livermore Laboratory.

November, 1975. 18 p, 5 fig, 6 tab, 11 ref. Tech. Rept. UCRL-77318.

During a 3-wk period approximately 32 mCi of plutonium 239 was inadvertently released into a sanitary sewer system. Sampling confirmed that the Pu239 was essentially all contained in the digested sludge at the sewage treatment plant. In view of the widespread use of sludge as a soil conditioner, possible adverse health implications associated with use of the sludge were studied. Two uptake pathways were studied: resuspension and inhalation of Pu239 from sludge used as soil conditioner, and Pu239 uptake by plants grown in the sludge and subsequent ingestion by people eating the crops. Approximately 13 cu m of the dried sludge was spread 7.5 to 10 cm deep over an experimental plot. After a 4 wk drying period, the soil was rototilled to a depth of about 14 cm. A control plot was rototilled without soil conditioner. The dust cloud generated was sampled with a high-volume Anderson cascade impactor. Dissolution characteristics of the plutonium in body fluids were studied using simulated blood serum. Corn, turnips, broccoli, tomatoes, cucumbers, and melons were raised in the test plot. Harvested vegetables were cleaned using techniques approximating those home gardeners use. Fifty to 100 g of each were chemically digested and counted using alpha spectrometry to determine Pu239 content. Estimated 50-yr radiation doses to the pulmonary region of the lung, bone, and liver from inhalation are 0.00016 rem, 0.0012 rem, and 0.000055 rem, respectively. The 50-yr doses from vegetables were 0.000022 rem to the bone and 0.000015 rem to the liver. The maximum credible 50-yr lung, bone, and liver dose commitments associated with the contaminated sludge are approximately 0.04% of the annual maximum permissible dose.

*Waste water treatment, *Pollutant identification, *Sewage treatment, *Sewerage, *Treatment facilities, Evaluation, Sludge, Sweet corn, Tomatoes, Melons, Radioisotopes

Plutonium, Soil conditioner

D115
NUTRIENT CONTROL BY PLANT MODIFICATION AT EL LAGO, TEXAS,

Ryan, B. W., and Barth, E. F.

Harris County Water Control and Improvement District No. 50,
Seabrook, Texas.

July, 1976. 123 p, 24 fig, 20 tab, 2 append. Tech. Rept. EPA-600/2-76-104.

An existing small trickling filter plant was modified for advanced waste water treatment. The need for advanced waste treatment at El Lago, Texas, the plant location, is based on the requirements of the Texas Water Quality Board to protect the receiving water, Clear Lake, from excessive pollution by organic carbon, suspended solids, ammonium nitrogen oxygen demand, and phosphorus. All existing facilities of the nominal 0.3 mgd plant were utilized. Phosphorus is controlled by metallic salt addition to the primary settler, carbonaceous removal by trickling filters, and nitrogenous oxygen demand by suspended growth second stage activated sludge. Nitrogen is removed via attached growth column denitrification and tertiary solids by granular media filtration. These processes operate in series. An effluent with the following residual concentrations can be obtained at the design flow of 0.3 mgd: biological oxygen demand, 5 day, 4 mg/liter; chemical oxygen demand (COD), 25 mg/liter; suspended solids, 2 mg/liter; total phosphorus, one mg/liter; and total nitrogenous content, 2 mg/liter. The feasibility of modifying an existing small trickling filter plant to control nutrients in waste water discharge was demonstrated. The conversion to an advanced waste water treatment plant need not disrupt services. Dosing of metallic salts for phosphorus control did not interfere with anaerobic digestion or overload the sand drying bed capacity. Tertiary filtration of effluent to control particulate matter enhanced the visual qualities of the final product.

*Waste water treatment, *Biological treatment, *Activated sludge, *Chemical oxygen demand, *Treatment facilities, Waste water (pollution), Nitrification, Phosphorus

D116
DIFFUSION COEFFICIENT OF OXYGEN IN MICROBIAL AGGREGATES,

Ngian, K. F., and Lin, S. H.

Melbourne University,
Parkville, Victoria, Australia,
Department of Chemical Engineering.

Biotechnology and Bioengineering, Vol. 18, No. 11, p 1623-1627, November, 1976.
3 fig, 1 tab, 11 ref.

The question of oxygen transfer in microbial aggregates is of interest for biological waste treatment and aerobic fermentation processes. If oxygen is transferred within microbial aggregates by diffusion, as it is assumed, the transfer can be described by Fick's law. Various experimental approaches to determine the diffusion coefficients have been tried; they all indicate that the diffusion coefficient of oxygen in the microbial aggregates is less than that in water. A convenient method recently proposed for evaluating the diffusion coefficient assumed that oxygen uptake by the pellets can be described by a Michaelis-Menten type equation, according to which initial oxygen concentration can be plotted against the half-life of oxygen concentration to yield the desired coefficients. However, this equation is only valid in the absence of mass transfer resistance, and the presence of this factor has been detected, especially at low growth medium agitation speeds. The kinetic parameters can be evaluated directly from the oxygen uptake and concentration with a Lineweaver-Burke plot and can then be used to determine the diffusion coefficient. The agitation speed should be kept as low as possible and small pellets used to minimize pellet break-up effects. A diffusion coefficient ratio (diffusion in pellet compared to diffusion in water) of 0.525 was obtained. Thus, the method of Miura et al was sound, and can be useful if the proper experimental conditions are selected.

*Waste treatment, *Biological treatment, *Aerobic treatment, *Oxygen, *Transfer, Microorganisms, Diffusion, Kinetics

Oxygen transfer, Fick's Law, Michaelis-Menten equation, Lineweaver-Burke plot

D117
AWT AT WOODLANDS, TEXAS,

Matson, J. V., Callegari, W. A., and Hassan, M. R.

Houston University,
Houston, Texas,
Civil Engineering Department.

Water and Wastes Engineering, Vol. 13, No. 12, p 22-25, December, 1976. 1 fig, 3 tab.

Innovations in the water treatment system of Woodlands, Texas were presented and discussed. As a HUD new community project, the system was designed after extensive ecological and environmental planning. Treated waste water will be recycled into a lake which will serve as a recreational facility and a reservoir for irrigation and domestic waters. Thus, a high quality effluent is required. The system consists of four process stages: activated sludge, lime precipitation, pressure filtration, and parallel ozonation and chlorination facilities. Sludge treatment is handled by an aerobic digester, thickener, and vacuum filter. Construction is in four stages with completion in the mid-1980's. The system is designed to handle a population of 150,000. Lime precipitation is used to remove phosphorus in order to prevent excessive algae growth. Ozone was used to control chlorine levels and for disinfection. The plant is provided with an emergency power generator.

*Waste water treatment, *Tertiary treatment, *Sewage effluents, *Recycling, *City planning, Irrigation systems, Watershed management, Algal Control, Chlorination, Ozone, Lime, Phosphorus

D118
SODIUM BICARBONATE AIDS PLANT SWITCHOVER,

Water and Wastes Engineering, Vol. 13, No. 12, p 17, December, 1976.

Sodium bicarbonate was used to solve digester souring problems in a New Jersey sewage treatment plant during a changeover from primary to secondary treatment. Problems occurred when plant capacity was doubled and the new treatment system added to meet new demands and EPA standards. Alkalinity washout resulted from inadequately thickened sludge and a 12 ft high scum blanket formed and disabled some digester piping. Production of methane gas, used for digester temperature regulation, was reduced from 25,000 (winter) and 40,000 (summer) cu ft/day to as low as 465 cu ft/day. This caused the use of much expensive natural gas. The addition of one to three hundred pound bags of sodium bicarbonate daily for two months countered these problems. Alkalinity increased from under 2000 milligrams/liter with a pH of 5.4 to 4000 milligrams/liter with a pH of 7.0. With this stabilization, methane production went as high as 49,000 cu ft/day and the use of natural gas was reduced by 98%.

*Waste water treatment, *Sewerage, *Sewage treatment, *Digestion tanks, *Alkalinity, Sludge digestion, Methane, Sodium compounds

Sodium bicarbonate

D119
KEEPING UP WITH SLUDGE AT WPCF,

Storck, W. J.

Water and Wastes Engineering, Vol. 13, No. 12, p 35-37, December, 1976.

A review of issues discussed at the Water Pollution Control Federation annual conference was presented. Sludge treatment and disposal and a variety of related topics were treated by persons involved in various projects. One discussion on the economics of energy use and recovery in sludge disposal was concerned with the influence of different sludge handling and disposal methods on energy consumption and total plant capital and operating costs. It was concluded that incineration will continue to be economically viable, but more effective heat recovery will be necessary. Another discussion indicated that anaerobic digestion is again becoming popular because it is economical and technical advances can easily devise more stable systems. A dewatering economy was suggested in the use of a combined gas turbine and dryer energy sharing proposal. The Basic Extractive Sludge Treatment (B.E.S.T.) system was evaluated. It dewaters and dries many types of inorganic and organic sludges to produce 95% dry, pathogen-free solids, clear sterile water, and it recovers greases and oils. Various land applications of wastes were considered for treating waste water. Finally, the effects of various legal, social and political considerations on the development of treatment systems was discussed.

*Sludge treatment, *Sludge disposal, *Economics, *Anaerobic digestion, *Dewatering, Drying, Incineration, Social aspects, Legal aspects, Political aspects, Technology

Basic Extractive Sludge Treatment

D120
WASTE WATER TREATMENT BY HEATED ROTATING BIOLOGICAL DISCS,

Prensner, D. S., Muchmore, C. B., Gilmore, R. A., and
Qazi, A. N.

Southern Illinois University,
Carbondale, Illinois,
Department of Thermal and Environmental Engineering.

Biotechnology and Bioengineering, Vol. 18, No. 11, p 1615-1621, November, 1976.
3 fig, 3 tab, 11 ref.

Investigations were performed to find means of improving the performance of rotating biological discs in the treatment of waste water. Treatment is usually performed at 68 F where mesophilic organisms metabolize wastes. Studies have shown that operation at temperatures about 131 F, where thermophilic organisms with a higher metabolic rate predominate, is more efficient. In this study, two identical disc systems were used; one was heated and the other maintained at 68 F. Actual domestic sewage was used in the experiment. Results indicated that, at 86 and 131 F, COD and BOD removal was much higher than with the 68 F system. At 131 F, BOD and COD removal of 86 and 80%, respectively, was achieved. Biological activity on the discs was instrumental in degrading wastes.

*Waste water treatment, *Biological treatment, *Sewage treatment, *Sewerage, *Treatment facilities, Microbial degradation, Biochemical oxygen demand, Chemical oxygen demand

Mesophilic organisms, Thermophilic organisms, Biological discs

D121
PROCESS ALTERNATIVES FOR REMOVAL OF CARBONACEOUS, NITROGENOUS, AND PHOSPHORUS MATERIALS FROM CONCENTRATED WASTE STREAMS,

Engineering-Science, Incorporated,
Research and Development Laboratory,
Oakland, California.

November, 1970. 22 p, 7 fig, 2 tab, 1 ref. Tech. Rept. NTIS PB-245 125.

Laboratory studies were conducted to evaluate the performance of separation and conversion processes in treating waste water effluents. Digester liquid was used as a representative waste stream. Economic evaluation indicated that daily treatment costs increased as flow increased, that each ten-fold increase in flow rate produced a seven to nine-fold economic cost. Highly concentrated streams produced lower treatment costs than treatment of diluted waste streams. The use of wet air oxidation reduced solids content and precluded chemical solids conditioning before vacuum filtration, but increased daily treatment costs. It was concluded that presently available technology for evaluating unit process performance can be applied to evaluating waste treatment systems. Some systems proved applicable for waste treatment after cost analysis were: chemical solids and phosphorus conversion, gravity thickening, vacuum filtration and centrifugation, and ammonia air stripping.

*Waste water treatment, *Economics, *Nutrients, *Evaluation, *Chemical precipitation, Flow rates, Lime, Iron

Separation processes, Conversion processes, Alum

D122
DETERMINATION OF RADIUM REMOVAL EFFICIENCIES IN IOWA WATER SUPPLY TREATMENT PROCESSES,

Schliekelman, R. J.

Iowa Department of Environmental Quality,
Des Moines, Iowa.

1976. 212 p, 47 fig, 67 tab, 31 ref, 1 append. Tech. Rept. ORP/TAD-76-1.

Water from nine municipal water treatment plants in Iowa was sampled and analyzed to determine the efficiency of radium-226 removal in various treatment processes and provide cost data for these processes. Supplies with a high naturally occurring radium content over 5 pCi/liter in Jordan and Dakota sandstone formation well water were selected. Reverse osmosis, iron removal filtration, sodium ion exchange, and lime-soda ash softening were studied. Radium-226 removals through reverse osmosis, sodium ion exchange, and lime-soda ash softening plants were in the range of 95%. Hardness removals with reverse osmosis and ion exchange were generally nearly identical to radium removal. The soda ash shortage caused considerable variation in hardness and radium removals in lime-soda ash softening; generally, radium removals were greater than hardness and iron removals. Radium removal in iron removal plants ranged from 12 to 38%. Total annual capital and operation costs and plant operation and maintenance costs were highly variable and typical cost data could not be developed.

*Pollutant identification, *Treatment facilities, *Radioactivity, *Potable water, *Water treatment, Radium radioisotopes

Natural radioactivity

D123
REVERSE OSMOSIS STUDY ON MUST WASTEWATER TREATMENT,

Jennings, J. L., and Furukawa, D. H.

Universal Oil Products Company,
San Diego, California,
Fluid Sciences Division.

1975. 103 p, 18 fig, 8 tab, 3 append. Tech. Rept. NTIS AD-A014 270.

A new, non-cellulosic, reverse osmosis membrane (NS-100) and one and two stage reverse osmosis recycle operations were evaluated for field hospital waste other than human waste. The test unit consisted of two parallel first stages followed by a second stage that could take feed from either first stage. One first stage contained NS-100 membranes, the other standard cellulose acetate membranes. The second stage contained NS-100 membranes. Various compounds were added as an inter-stage treatment in an attempt to increase organic rejection by the second stage. With low molecular weight organics passing the membranes, vacuum air stripping was evaluated as a removal method. Foaming was also evaluated for increasing flux and organic rejection. Recycling reverse osmosis was proven reliable and simple for producing reusable water. The NS-100 membrane did a very good job of removing organics, but is not yet suitable for field hospital use. Problems occurred with fouling, cleaning, and fabrication. Two stage operation increased performance over single stage operation, but not enough to justify the additional cost and power consumption. None of the inter-stage treatment compounds significantly improved organic rejection. Foaming the feedwater in a column reduced total organic carbon (TOC) and volatile organic carbon, but not fouling. Air stripping reduced TOC by 50%.

*Waste water treatment, *Treatment facilities, *Reverse osmosis, *Waste water (pollution), *Hospitals, Membranes, Organic wastes, Foaming

Hospital wastewater, Non-cellulosic membranes, Air stripping

D124
LAND APPLICATION OF WASTEWATER: THE FATE OF VIRUSES, BACTERIA AND HEAVY METALS AT A RAPID INFILTRATION SITE,

Schaub, S. A., Meier, E. P., Kolmer, J. R., and Sorber, C. A.

United States Army Medical Bioengineering Research and
Development Laboratory,
Fort Detrick, Frederick, Maryland.

1975. 57 p, 17 fig, 9 tab, 17 ref, 1 append. Tech. Rept. 7504.

Rapid infiltration (RI) land application of waste water was studied to determine if significant quantities of specific microbiological and chemical waste water constituents could percolate into the groundwater. The study had been in operation over 30 yr. Primary sewage effluent was used. Bacteriophage was added to the waste water as a tracer virus. Indigenous indicator bacteria concentrations were determined. Samples from five soil layers extending to approximately 30 in. beneath the surface were analyzed for heavy metals. Neither renovated nor unrenovated RI cell soils were capable of adsorbing viruses from primary effluent. Tracer bacteriophage penetrated into the groundwater. The tracer and indigenous enteroviruses were sporadically detected in significant numbers in the groundwater at horizontal distances up to 600 ft from the application point. Fecal indicator bacteria were concentrated on the soil surface, but significant numbers can migrate into the groundwater. They were detected at the same locations as the viruses. A subsurface black layer in unrenovated cells had a high total organic carbon and heavy metal content. This layer disappeared several months after sewage application was discontinued. Renovated beds had high total organic carbon and heavy metal accumulation on the soil surface only. Because the groundwater intercepts a polluted river, there is little direct health hazard from the study site.

*Waste water treatment, *Pollutant identification, *Sewerage, *Bacteriophage, *Coliforms, Enteric bacteria, Groundwater, Heavy metals

D125
VIRUS ELIMINATION IN WATER AND WASTEWATER,

Katzenstein, L. B., and Braswell, J. A.

Naval Coastal Systems Laboratory,
Panama City, Florida.

1976. 37 p, 2 tab, 128 ref. Tech. Rept. NCSL 269-76.

Considering the extremely small concentration of viruses necessary for infection, a major sanitary engineering goal is total removal of viruses from water which humans might consume. Major emphasis has been placed on assuring sufficient sewage treatment. The effectiveness of various techniques for disinfecting sewage and drinking water are discussed, emphasizing virus elimination. Disinfection technology currently applied is not adequate to insure that treated water or waste water does not contain harmful viruses. Relatively minor alterations of conventional treatment processes can greatly enhance their effectiveness. Alum and lime can contribute to virus removal by the formation of virus-adsorbing flocs or by adjusting the pH to levels which inactivate viruses. Ferric chloride and other coagulants are also effective. If coagulants are used with sand filtration, the otherwise less effective filtration process can accomplish substantial removal of viruses. Improved mixing can greatly enhance terminal disinfection by chlorination. The quantity of chlorine required can be reduced, reducing the potential hazard of chlorinated effluents. Ozone compares very favorably with chlorine for the elimination of viruses. The state-of-the-art for virus removal through economically feasible treatment of water and waste water appears well ahead of the technology currently being applied. Substantially improved virus removal should be possible at little additional cost to a well-run treatment facility.

*Waste water treatment, *Sewage treatment, *Sewerage, *Treatment facilities, *Waste treatment, Water treatment, Waste water (pollution), Sedimentation

D126
HOW TO KEEP AN OLD PLANT RUNNING,

Water and Sewage Works, Vol. 123, No. 12, p 71, December, 1976.

A two-year souring cycle in the anaerobic sludge digester was recently broken at the Tonawanda, New York, sewage treatment plant. A sodium bicarbonate treatment consisting of a 500 pound/week spring dosage and the use of a combination of $NaHCO_3$ and soda ash or continued sodium bicarbonate dosing on a year-round basis were instrumental in discontinuing the souring. A stable pH of 7 has been maintained. A drop in methane production was the first indication of souring and caused increased acid formation and a drop in pH. The effect snowballed until pH reached 6.5 or lower where methane formation is impossible. To a plant where methane gas fuels the digester, this was a major problem. The poor solubility of lime and the lengthy period it took to raise pH, as well as a stabilization problem made it a poor solution. It was estimated that 15 tons of sodium bicarbonate are used yearly. Temperature drops do not affect bicarbonate and it performs well where lime was poor.

*Anaerobic digestion, *Sludge treatment, Waste water treatment, Digestion, Treatment facilities, Sodium compounds, Bicarbonates, Hydrogen ion concentration, Methane, Lime, Temperature, Alkalinity

Digester souring, Tonawanda (NY), Sodium bicarbonate

D127
ANAEROBIC DIGESTER SUPERNATANT DOES NOT HAVE TO BE A PROBLEM,

Mignone, N. A.

Water and Sewage Works, Vol. 123, No. 12, p 57-59, December, 1976. 8 tab, 26 ref.

The problem of poor quality supernatant from anaerobic digestion is discussed in the first of a 3-part series. This was defined as any liquid flow from either a single-stage or two-stage anaerobic digester which is not scum, gas, or liquid pumped from the bottom half of the digestion tank. Its color varies from clear to yellow, to black; and the odor can be pleasant to nauseating. Quality and quantity of supernatant depends on the character of solids, the type of solids and the digester design (temperature, loading, and mixing). Total solids increases with the fineness of division of suspended solids removed during treatment. The three most common municipal sludges handled are primary, primary with waste activated, and primary plus trickling filter. Recent concern with phosphorus removal has created sludge with high proportions of chemicals. The effects of chemical sludges on anaerobic digestion and the release of phosphate and metal ions into the supernatant are of great concern. Several studies of primary plus waste activated sludge with two stage, mesophilic, anaerobic digestion with hydrated lime, aluminum sulfate, ferric chloride, and sodium aluminate for phosphorus removal show no effects on the anaerobic digestion process and release of soluble phosphorus was minimal. Treatment by a single stage, mesophilic, anaerobic digester treating primary sludge with ferric chloride, primary sludge with lime, primary sludge with alum, and primary plus trickling filter sludge with alum, produced similar results.

*Anaerobic digestion, *Sludge treatment, Waste water treatment, Digestion tanks, Suspended solids, Municipal wastes, Trickling filters, Metals, Phosphorus, Lime, Chlorides, Sludge, Temperature, Odor, Color

*Alum, Supernatant

D128
EVALUATION OF ROTARY VACUUM PRECOAT FILTRATION FOR SLUDGE DEWATERING,

Bell, G. R., and Wirsig, O. A.

Johns-Manville Sales Corporation,
Denver, Colorado,
Research and Development Center.

1976. 110 p, 19 fig, 25 tab. Tech. Rept. 0276-1.

Bench scale studies were performed to determine general areas of feasibility for rotary vacuum precoat filtration (RVPF) and specific conditions for the subsequent pilot plant studies. RVPF provides a means for dewatering sludges containing substantial amounts of finely divided, relatively impermeable solids. It achieved very high suspended solids capture when filtering untreated and chemically pretreated concentrated chemical toilet human waste, Erdlator blowdown sludge, and laundry waste. It removed varying amounts of total organic carbon (TOC) and chemical oxygen demand (COD) depending on the age of the human waste. Filtrate from Erdlator blowdown sludge and laundry waste had the clarity of potable water. Waste cake dry solids from the various sludges ranged from 38 to 51%, averaging about 45%, and would be suitable for landfill or incineration. Design of treatment systems using RVPF would be a matter of incorporating small commercially available components. One modification necessary for human waste filtering would involve a revolving knife to handle the paper fiber content of the waste. An alternative single stage process using RVPF to provide simultaneous solids removal and carbon treatment was demonstrated.

*Waste water treatment, *Chemical oxygen demand, *Treatment facilities, *Filtration, Carbon, Diatomaceous earth, Filters, Suspended solids

Suspended solids removal, *Rotary precoat filter

D129
OVERLAND FLOW TREATMENT OF RAW WASTEWATER WITH ENHANCED PHOSPHORUS REMOVAL,

Thomas, R. E., Bledsoe, B., and Jackson, K.

Robert S. Kerr Environmental Research Laboratory,
Ada, Oklahoma,
Wastewater Management Branch.

1976. 44 p, 7 fig, 5 tab, 8 ref. Tech. Rept. EPA-600/2-76-131.

The capability of overland flow to provide complete treatment of raw comminuted waste water year-round in mild climates was evaluated. A 36-month pilot study was conducted at a loading of 10 cm/wk with a special 15-month adjunct on phosphorus removal by chemical precipitation with aluminum sulfate. A well-operated system can produce an effluent with less than 10 mg/liter of suspended solids and biochemical oxygen demand (BOD), while removing 70 to 90% of the total nitrogen. Phosphorus removal is about 50% with relatively minor seasonal variation but can be improved to 90% by precipitation using aluminum sulfate. Data for chemical oxygen demand (COD) and total organic carbon are also covered in detail. Overland flow was shown to be a simple and reliable treatment process. The effluent from the 36 month evaluation was substantially better than established criteria for secondary treatment.

*Waste water treatment, *Pollutant identification, *Biochemical oxygen demand, *Chemical oxygen demand, *Sewage treatment, Land use, Nitrogen cycle, Overland flow

Phosphorus cycle

D130
WASTEWATER TREATMENT FACILITY EVALUATION, RICKENBACKER AFB OH,

Pauls, C. F.

United States Air Force Environmental Health Laboratory,
McClellan Air Force Base, California.

January, 1976. 165 p, 10 fig, 10 tab, 16 ref, 4 append. Tech. Rept. 76M-1.

The waste water treatment facility at an Air Force base was evaluated, including analyzing operating conditions and performance, evaluating past operating records, and preliminary evaluation of techniques that can be applied to upgrade the facility to insure compliance with future discharge limitations. The primary sedimentation basins provided 43% mean biochemical oxygen demand (BOD) removal and 50% mean suspended solids (SS) removal, the latter below that expected for this facility. The trickling filter provided 27% mean BOD removal efficiency; the trickling filter/secondary sedimentation basins combined provided 69% BOD removal efficiency. Mean effluent BOD and SS concentrations were within current National Pollutant Discharge Elimination System (NPDES) specifications; maximum daily effluent BOD exceeded the allowable concentration in two instances. Final effluent fecal coliform concentrations exceeded the allowable maximum 4 of 9 days tested and chlorine residuals 5 of 7. Final effluent pH was acceptable. Mean SS concentrations based on operating logs for the raw sewage, primary effluent, trickling filter effluent, and final effluent were 79, 45, 37, and 18 mg/liter, respectively. Mean BOD concentrations in the raw sewage, primary effluent, trickling filter effluent, and final effluent are 162, 88, 44, and 33 mg/liter, respectively. The BOD removal efficiency of the existing trickling filters can be improved substantially by extending their arms to utilize the full available area and increasing the recirculation ratio. Jar tests indicate that the use of alum, lime, or lime and magnesium carbonate to coagulate and precipitate either the trickling filter effluent or final clarifier effluent will produce an effluent complying with the 1977 NPDES limitations.

*Waste water treatment, *Pollutant identification, *Sewage treatment, *Sewerage, *Biochemical oxygen demand, Treatment facilities, Biological treatment, Lime, Magnesium carbonate

Alum

D131
MUNICIPAL WASTEWATER TREATMENT WORKS CONSTRUCTION GRANTS
PROGRAM SUPPLEMENT NO. 1,

August, 1976. 103 p, 1 fig, 7 tab, 15 ref, 4 append. Publication MCD-02.1.

Minor revisions are made to the material in the Environmental Protection Agency Municipal Wastewater Treatment Works Construction Grants Program Manual of References to assure compatibility with a revised system for issuing policy and instructions relating to the Construction Grants Program for Municipal Wastewater Treatment Works. The new system is summarized. Policy directives issued after the manual was published are included.

*Waste water treatment, *Treatment facilities, *Municipal wastes, *Construction, *Grants, Programs, Publications, Waste treatment

D132
OPTIMIZATION OF MULTISTAGE SECONDARY CLARIFIER,

Lee, C. R., Fan, L. T., and Takamatsu, T.

Seelye, Stevenson, Value and Knecht,
Consulting Engineers,
New York, New York.

Journal Water Pollution Control Federation, Vol. 48, No. 11, p 2578-2589, November, 1976. 13 fig, 1 tab, 32 ref, 1 append.

Modeling, simulation, and optimization of the removal efficiency of the secondary clarifier were undertaken. Investigations were aimed at the determination of optimal operating conditions, geometry, and allocation of the compartment volumes. Results showed that the multistage system was more efficient and produced a more stable effluent. Volume or detention time are not major considerations, if there is no scouring, of removal efficiency in either clarifier type.

*Waste water treatment, *Analytical techniques, *Treatment facilities, *Optimization, *Model studies, Sewage treatment, Efficiencies, Simulation analysis

*Clarifiers

D133
MANY DESIGN PROBLEMS OVERCOME IN STATEN ISLAND PLANT,

Mitchell, R. D.

Malcolm Pirnie, Incorporated,
White Plains, New York.

Water and Wastes Engineering, Vol. 13, No. 12, p 57-59, 68, December, 1976. 1 fig, 1 tab.

Various problems received unusual solutions in the upgrading of the Port Richmond, New York City, waste water treatment plant. The original extension plan provided for a modified aeration process without primary settling. With changes in federal regulations, alteration to a step aeration activated sludge process was necessary. It was also necessary to provide continued operation of the primary plant until the new one was ready. Additional problems included laying lines under an elevated railway. Criteria for design included: plant operation with step aeration and provisions for use of activated aeration, aeration by fine-bubble diffused air, covered liquid surfaces, grit removal with sludge in primary settling tanks and separation from sludge by cyclone separators, hauling of screenings to disposal areas, and that sludge be digested and barged to sea. The plant features a hypochlorite disinfection system and the use of gas produced in boilers to provide space heating and sludge heating.

*Activated sludge, *Design, *New York, *Aeration, *Sewage treatment, Waste water treatment, Treatment facilities, Air, Regulations

Port Richmond (NY)

D134
SEWAGE TO AID CITY POWER PLANT,

The American City and County, Vol. 91, No. 12, p 25, December, 1976.

A 5.7 mgd phosphate removal facility is being built by the City of Glendale, California, to process effluent from a new water reclamation plant for use as cooling tower makeup water for its power plant. It involves a physical-chemical phosphate stripping process which upgrades incoming filtered secondary effluent through the addition of alum or sodium aluminate, flocculation, precipitation of aluminum phosphates, and final filtration in a dual granular media filter. Polymers will be added for aiding flocculation and chlorine added to inhibit slime growth. Plant equipment includes solids contact clarifier, chemical feed systems, dual media filter, spent backwash holding reservoir, a pumped distribution system, and an automatic control system. Automatic operation is a feature of this project.

*Water reuse, *Sewage treatment, *Sewage effluents, *Waste water treatment, Filtration, Chlorination, Electric powerplants, Automatic control, Cooling water

*Phosphate removal, Cooling tower makeup water, Glendale (Calif)

D135
WHITHER VILLAGE SEWAGE?,

Pullin, J.

Surveyor, Vol. 148, No. 4407, p 9-11, November, 1976.

The problem of handling sewage in rural England is approached from two viewpoints. These involve using either regionalized sewage treatment facilities or individual community plants. On an economic basis, costs varied from 404 to 788 pounds per property for a regional system and 375 to 1,498 pounds per property for a community system. Financing procedures and sources are being re-evaluated. Future trends point towards larger regionalized schemes. On the basis of size, regional plants have several advantages: full-time attendants to quickly detect malfunctions, electronic monitoring that is too expensive for smaller plants, designed-in flexibility in larger plants, and minimalization of natural diurnal variations in flow. Disadvantages include the problem of bacterial slime build-up on pipes in a longer pipeline for regional systems and the fact that additions to either system would cost about the same. Examples were given of various rural systems, some of which use activated sludge processes, even in small plants. It was concluded that there is no one plan which could be recommended for all rural areas.

*Waste water treatment, *Activated sludge, *Sewerage, *Sewage disposal, *Sewage treatment, Economics, Pipes

Regional treatment plants, Rural areas

D136
EFFLUENT AND WATER TREATMENT: THE ECONOMICS OF LIME DOSING AND IN-HOUSE WASTE TREATMENT,

Surveyor, Vol. 148, No. 4407, p 7, November, 1976. 1 tab.

Data from experimental plants at Stevenage and Coleshill, England, were used to evaluate the economics of lime in waste treatment and industrial in-house waste treatment was discussed. Costs were evaluated for the treatment of a flow of 45,000 cu m/day in plants using conventional treatment and those using different quantities of lime. Results showed that substantial savings were achieved in capital and operating costs when lime was used in activated sludge treatment. High costs for lime and sludge dewatering or disposal outweighed savings with high-dosage lime treatment. Plants using lime doses of 25, 50, 100, and 200 milligrams/liter had lower costs than conventional treatment plants with filter presses operating at 29 cycles/week. With 14 cycles/week or sludge disposal to land, all but the 100 milligrams/liter dose were cheaper than conventional treatment and disposal. Lime use with systems where primary sedimentation is the only treatment appear to provide the greatest advantages. With in-house waste treatment, increasing costs and effluents to be disposed suggest that reducing the amount of waste water needing treatment should be a primary objective. Options available to companies include: having some or all effluent treated at local sewage facilities; minimizing waste by changing processes, reclamation of wastes and reuse of water or waste materials; separating solids or highly contaminated wastes from main waste stream; and pretreating waste partially or to a standard acceptable for river discharge.

*Waste water treatment, *Industrial wastes, *Lime, *Activated sludge, Capital costs, Operating costs, Sedimentation, Waste water disposal, Water reuse

Industrial in-house treatment

D137
SLUDGE BULKING CONTROL WITH BICARBONATES,

Salvador, M.

Water Pollution Control Facility,
Cohasset, Massachusetts.

Public Works, Vol. 108, No. 1, p 65, January, 1977.

Alum treatment was replaced by sodium bicarbonate as a cure for sludge bulking in a Cohasset, Massachusetts, activated sludge waste water treatment facility. The use of alum temporarily cured the problem but caused a pH drop from 6.9 to 5.0. Attempts at control by lime and caustic soda created problems with stabilization. Alum was discontinued to allow a return to equilibrium and sodium bicarbonate was added, at a dosage of 10 lbs/day, to the aeration tank, settling basins, and chlorine contact chamber. Within four weeks, the pH of these components increased from 6.5-6.8 to stability at about 7.0 with an alkalinity of 250 milligrams/liter. Bulking stopped, while BOD, and settleable and suspended solids removals increased. The suspended solids content of the effluent decreased from a high of 257 milligrams/liter to an average of 25 milligrams/liter and BOD removals increased from 65% to 90%. Sodium bicarbonate, one grain per gallon, is still added for pH control. Dosage is doubled at a pH of 5.8 or lower.

*Waste water treatment, *Activated sludge, *Treatment facilities, *Sludge treatment, *Sodium compounds, Aeration, Settling basins, Biochemical oxygen demand

Bulking, Alum, Sodium bicarbonate

D138
SOLVING AN INTERIM PROBLEM OF TREATMENT PLANT OVERLOAD,

Hopkins, M. P., and Burstein, D.

Water Resources Division,
Public Works Department,
Santa Barbara, California.

Public Works, Vol. 108, No. 1, p 62-63, January, 1977. 1 tab.

A "problem-solution" approach was used to determine necessary changes for upgrading Santa Barbara, California, waste water treatment facilities. Additional concerns included the prohibition of ocean disposal of sludge, stricter effluent limits for settleable and suspended solids, inability of handling more than 8 mgd flows, and the poor condition of the submarine outfall. Hydraulic overloading was controlled by five corrective measures. A Barminutor was used in a bypass channel to increase comminuting capacity during high flows. Manually cleaned bar racks were used to prevent large objects from entering comminuting facilities. Influent pumps were overhauled for increased capacity and efficiency. A portable pump was installed to aid influent pumps during heavy flows. Twenty and twenty-four inch pipes were used to connect clarifier effluent troughs and the effluent structure was raised to accommodate peak flow heads. Clarifier performance was improved by installing new baffle systems for basin influent and effluent, installing new effluent weirs in the clarifiers, regrouting each basin bottom, installing new scum scrapers, and adding polymer feed systems to aid settling. New chlorination equipment was installed. Sludge digestion was improved by replacing digester feed pumps with plunger type pumps, installing an added sludge recirculation pump, installing a new digester gas mixing compressor, and replacing most of the digester gas piping. Several general safety hazards were also corrected. With these changes, performance met new standards, operational costs were reduced, and the new equipment could be used in a new facility.

*California, *Effluents, *Waste water treatment, *Hydraulics, *Sludge digestion, Pipes, Sludge disposal, Treatment facilities

Santa Barbara (Calif)

D139
OZONE MAKERS HOPE TO REPLACE CHLORINE IN SEWAGE USES,

Chemical Marketing Reporter, p 7, 17, November 22, 1976.

An EPA contract was awarded for a prototype ozone disinfecting system at a sewage treatment plant in Marlboro, Massachusetts. A new approach involves ozone generation by a high-volume electron beam generator directly in untreated air. It was estimated that a one million gallon per day discharge can be treated. The system is expected to be cheaper than chlorination systems being used, producing ozone at a price of 4 to 8 cents per pound. Ozone is an attractive alternative because of the higher cost of chlorine and problems related to its use as well as its toxicity. This method is expected to produce up to thirty pounds of ozone an hour and only two to five pounds are needed to treat the proposed daily output. Savings in energy, plastic, and rubber are expected due to the fact that ozone oxidizes at room temperature. Accelerators developed a beam which produces ozone from untreated air at a cost of less than 10 cents per pound. The generator is combined with a purification device. This system is estimated to reduce by 67% the present ozone treatment energy costs of 30 cents per pound of ozone. Related equipment costs are also reduced over costs with conventional ozone treatment systems.

*Sewerage, *Treatment facilities, *Prototypes, *Waste water treatment, *Sewage treatment, Ozone, Chlorination, Economics

Marlboro (Mass)

D140
RECONCENTRATION OF POLIOVIRUS FROM SEWAGE,

Farrah, S., Wallis, C., Shaffer, P. T. B., and Melnick, J. L.

Baylor Medical College,
Houston, Texas,
Department of Virology and Epidemiology.

Applied and Environmental Microbiology, Vol. 32, No. 5, p 653-658, November, 1976.
1 fig, 6 fig, 7 ref.

A study was carried out to determine optimal conditions for reconcentration of viruses adsorbed from sewage. A type 1 poliovirus was added to sewage effluent, concentrated by an Aquella virus concentrator, and this mixture is clarified to remove solids. The clarified effluent is treated with acid and $AlCl_3$ for a pH of 3.5. This fluid was passed through virus adsorbents and the virus was eluted from the adsorbents. The eluted virus was readsorbed to a series of filters. Results indicated that organic compounds and metal ions can be concentrated during viral concentration using the Aquella virus concentrator. While processing relatively clean water, adsorbed viruses can be reconcentrated on smaller membranes. This is a simple procedure, though reconcentration of eluates from filters that process sewage effluents is problematical. At low pH, the organic compounds and metal ions form flocs and clog the filters used for reconcentration. Solving this problem by using tetrasodium ethylenediaminetetraacetate (EDTA) created problems of interference with viral adsorption to the smaller filters. Reconcentration on smaller filters was effective when carbon and ion-exchange resins were used to remove organic compounds. With this procedure, a mean recovery of 40% of the initial virus count was achieved. A very clean final concentrate was obtained since most organic compounds were removed by carbon and anion-exchange resins.

*Waste water treatment, *Sewage treatment, *Viruses, Adsorption, Anion exchange, Organic compounds, Filtration, Carbon

*Viral reconcentration, Metal ions, Aquella virus concentrator, Tetrasodium ethylenediaminetetraacetate (EDTA)

D141
RISING TO SEWAGE PROBLEMS,

Materials Reclamation Weekly, Vol. 128, No. 22, p 25, November, 1976.

The gravity-filled Electromatic Sewage Ejector was used to alleviate a sewage flow problem involving blocked suction pipework and pump casings at a hospital. The problem inflow consisted of items from clothes to toys. Correction included installation of an ejector system which was 50% more efficient than regular systems which had capabilities of up to 81/sec (100 gpm). A screening apparatus was developed for the inlet chamber of the main sewer to handle the large amounts of previously unscreened waste. The system works by air displacement and is said to be more effective than rotary valve or electrode control units. Materials entering cause air to pass through nylon transfer tubes to a switch which operates a solenoid when closed. Air passes from the receiver into the ejector body and reduces grease or crude sewage problems.

*Sewerage, *Treatment facilities, *Pollutant identification, *Sewage, *Gravity, Pipes, Sewage treatment, Pipe flow

Electromatic Sewage Ejector, Sewage screening

D142
GENERATION OF ELECTRICAL ENERGY FROM MUNICIPAL REFUSE AND SEWAGE SLUDGE,

Ruf, J. E., and Brown, H. T.

Burns and McDonnell Engineering Company,
Kansas City, Missouri.

Public Works, Vol. 108, No. 1, p 38-41, January, 1977. 1 fig, 2 tab.

Design considerations are discussed for a proposed energy recovery system involving incineration of mixed solid waste and dried sewage sludge. Designs are based on filter press dewatering and direct drying of vacuum filtered sludge. Filter presses were estimated to provide sludge with a 40% solids content and a higher heating value (HHV) of 2500 Btu/pound. Dried sludge estimates were an 85% solids content and a HHV of 6400 Btu/pound. Costs to power companies for energy produced was suggested to be $0.015 per KWH for firm energy and $0.008 per KWH (1976 prices). A concurrent materials recovery process was considered due to its compatibility with energy recovery processes. Ferrous metals recovery is now feasible and aluminum recovery should be effective before 1980. Alternative systems which were devised included the grate-fired waterwall incinerator, suspension-fired waterwall incinerator, and the "Purox" pyrolysis system. Economic factors such as annual operation and maintenance costs and annual credits were discussed and evaluated.

*Sewage treatment, *Electric power production, *Sewage sludge, *Municipal wastes, *Energy, Electricity, Sludge treatment, Economics

Energy recovery, Materials recovery

D143
PLANT UPGRADED WITH ROTATING BIOLOGICAL SURFACE SYSTEM,

Mather, S. E. J.

Public Works, Vol. 108, No. 1, p 59-60, January, 1977.

The Newell Company of Newell, West Virginia, has planned the addition of a rotating biological surface system to its existing primary sewage treatment facility. This was required to meet EPA standards of a 95% BOD reduction, suspended solids and phosphorus removal. The added unit, Bio-Surf, consists of a series of 12-foot diameter high density polyethylene sheets in corrugated sections for maximum surface area for microbial growth. There are two 25-foot shafts with a total of 176,000 sq ft, divided into four stages. Flow is parallel to the shaft and perpendicular to the medium. Clarified primary effluent enters the Bio-Surf unit where fixed aerobic microbial cultures remove dissolved and suspended organic matter from the water. Each stage is a completely mixed, fixed-film biological reactor with a dynamic equilibrium between the biological growth rate and the sloughing rate of the bio-mass. The degree of treatment is increased, as waste water and sloughed bio-mass progress from stage to stage, by biological cultures adapted to the changing waste water. Bio-Surf section effluent is not recirculated and operating power requirements are minimal. Excess waste water and bio-mass from the last treatment stage enter circular secondary clarifiers at the tank periphery and clarified effluent is drawn out over weirs at the center. Sludge and skimmings can be returned to the sludge digester or to the inlet end of existing primary settling tanks. After drying, digested sludge is removed by truck to landfill or dumping. The clarified effluent is discharged into a chlorine contact tank with final effluent discharged into the Ohio River.

*Sewage treatment, *Sewerage, *Treatment facilities, *Waste water treatment, *Biochemical oxygen demand, Biological treatment, Biodegradation, Sludge

*Bio-Surf

D144
WETTED AREA, SLIME THICKNESS AND LIQUID PHASE MASS TRANSFER IN PACKED BED BIOLOGICAL FILM REACTORS,

Atkinson, B., and Ali, M. E. A. R.

UMIST,
Manchester, England,
Department of Chemical Engineering.

Transactions of the Institution of Chemical Engineers, Vol. 54, No. 4, p 239-250, October, 1976. 16 fig, 9 tab, 18 ref.

Trickling filters or packed-bed biological film reactors are inserted between sedimentation tanks in systems for biological purification of domestic and industrial waste water. The performance of one such reactor containing Biopac high-porosity plastic packing and washed "clean" each day with a high pressure water hose was examined. The biological film was composed of a mixed culture of microorganisms with glucose as the sole limiting substrate. The biological film thickness and the efficiency of substrate removal were satisfactorily consistent. Throughout the experiment, the biological film thickness remained uniform, as confirmed by the fact that independent parameters fitting the experimental data at different flow rates, using two different optimization methods, gave similar biological film thickness values. The experimental data were well represented by a mathematical model in which liquid phase mass transfer was interpreted as involving a mass transfer coefficient. The values of the mass transfer coefficients obtained for all flow rates investigated were very high. Thus all the parameters of a packed bed biological film reactor can be obtained from a pilot plant investigation and an estimation of the kinetic coefficients. The design requirements for any microbe/substrate system are reduced to a knowledge of the kinetic coefficients in trickling filters with controlled microbial hold-up.

Filtration, *Biological treatment, Microbial degradation, Waste water treatment, Trickling filters, Sewage treatment, Industrial wastes, Domestic wastes, Biochemical oxygen demand, Filters, Model studies, Microorganisms

D145
CONSIDERATIONS FOR ELECTRICAL DESIGN IN SEWAGE LIFT STATIONS,

Applegate, L. M.

Public Works, Vol. 107, No. 12, p 59-60, December, 1976. 2 fig.

The Oroville (California) Sewerage Commission has built sewage lift stations in an area which is several feet too low for complete gravity collection. The pumps raise sewage for gravity drainage to a much larger pump station. However, the flow is such that the problem of on-off operation develops when pumps operate at full speed. To solve this problem, a Variable Frequency Drive (VFD) system with a full-load efficiency of about 95% was implemented. In this system, 60-hertz commercial power is rectified into unidirectional current which produces a 3-phase group of single-phase waves. These are remade into alternating sequences of square waves, forming a 3-phase square-wave counterpart of 3-phase sine waves. The motors operate as if they were served a normal sine-wave input. The system works well if the original alternating current source is not affected by left-overs from rectification. There is a possible drawback with standby generators. If they have power ratings similar to the motor load ratings, they can be incompatible with the load if the generator voltage regulator is sensitive and fast in response to voltage changes. The problem can be overcome. This was the problem with the new station. Capacitors were used to smooth out and slow up regulator response. The modification allowed the generator to start and carry perfectly both 50-hp motors operating through VFD. The designed flexibility of the pumps created a necessity for consideration of a simpler and more economical design of the VFD system.

*Pumps, *Performance, *Hydraulic machinery, *Sewage treatment, Waste water treatment, Treatment facilities, Electrical design, Electric motors, Capacitors, Pumping plants

Oroville (Calif), Variable Frequency Drive

D146
SUBSURFACE APPLICATION SOLVES COMMUNITY'S SLUDGE DISPOSAL PROBLEM,

Public Works, Vol. 107, No. 12, p 67-68, December, 1976.

A Lancaster, Pennsylvania, treatment plant has successfully experimented with the application of raw sludge to farmland. This eliminated a costly step in the treatment process. Because the plant is designed to treat a 9.6 mgd flow and often treats a 12 mgd flow, a means of handling the excess sludge was needed. The system absorbs about 70% sanitary wastes and serves a population of 60,000. The sludge is used on farmland producing field corn and several grasses eaten by cattle. It cannot be used on land used for crops aimed at human consumption. Although a sludge/acre ratio of 5 tons/acre has been found tolerable, less has been used during experimentation. A Big Wheels application unit was used. It can knife in 600 to 800 gallons per minute of waste material at 6 miles per hour. Critics complain of odor and runoff problems which can be solved by plowing under the waste material with a disc or plow. Bacterial and viral contamination was also a concern. Guidelines have been developed for acceptable amounts of heavy metals. The Big Wheels system eliminates problems associated with compacting soil with tires and sludge runoff during rainy weather. The major drawback is difficulty in injecting sludge into frozen ground. The benefits to the farmer (fertilizer savings of $35 per ton) and the reduction of the load on waste treatment facilities outweigh this disadvantage.

*Sludge treatment, Waste water treatment, Fertilizers, Waste treatment, Anaerobic digestion, Waste disposal, Domestic wastes, Industrial wastes, Pathogenic bacteria, Viruses, Runoff, Odor

*Land application, Lancaster (Pa)

D147
THE ULTIMATE DISPOSAL OF SLUDGE,

Silvester, D. K., and Lewis, K.

The Public Health Engineer, Vol. 4, No. 6, p 153-159, November, 1976. 4 tab, 3 ref.

Three forms of land disposal of sludge were considered with a discussion of the treatment methods necessary in each case. Sludge can be disposed to land as a liquid, as organic matter, or as an inert material. Local conditions must govern which methods are suitable and economically advantageous. The form and location of disposal dictate the extent of required treatment. The type of sludge controls the form of treatment. Treatment can be divided into two stages: thickening and conditioning, and dewatering and drying. Several forms of thickening and conditioning are described, such as gravity thickening, flotation thickening, elutriation, anaerobic digestion, chemical conditioning, heat treatment, and polyelectrolytes. Dewatering and drying include drying beds, filter presses, vacuum filters, belt filters, sludge concentrators, centrifuges, composting plants, and incinerators. The Buckland Water Pollution Control Centre in Newton Abbot, South Devon, England, was described as a demonstration of the evolution of a means for selecting and rejecting various alternatives.

*Ultimate disposal, *Sludge disposal, Waste water treatment, Sludge treatment, Drying, Dewatering, Polyelectrolytes, Filters, Incineration, Liquid wastes, Organic matter, Treatment, Economics, Centrifugation

Sludge thickening, Sludge conditioning, Gravity thickening, Land application

D148
PRESSURIZED AIR SIMPLIFIES CONVEYING SEWAGE SOLIDS,

Blanchard, C. T.

Neptune CPC Engineering Corporation,
Sturbridge, Massachusetts.

Water and Sewage Works, Vol. 123, No. 11, p 78-79, November, 1976. 3 fig.

Pneumatic systems have been used for material transport for over 50 years. The application of pneumatic ejectors in sewage treatment was proposed over 40 years ago, but a system which could tie into modern treatment works has just recently been developed. The CPC Pneumatic Ejector System is capable of moving dry sand and pumping water as well as moving solids with a moisture content varying between these extremes. The basic theory of operation is Boyle's Law. The material is fed into the top of the ejector by conveyor and air (stored at 100 psi) moves the material in the pipeline to its destination. Critical factors involved are sizing the air receiver and compressor as well as the design of the ejector cycle profile. Ejectors, control valves, discharge pipe, fittings and special discharge hoppers are designed and manufactured for maximum protection against wear. Manual and automatic control panels are available. In addition, there is a "bottom loading" ejector for thickened sludge or other materials that behave like a liquid. Advantages of pneumatically conveying grit, screenings and sludge safely in enclosed pipe, in any direction, can be applied to small or large plants. It can be applied to new construction or it can be an economic alternative for upgrading older plants.

*Sewage treatment, *Pipelines, *Pressure conduits, Solid wastes, Mechanical equipment, Distribution systems, Sewerage, Treatment facilities, Automatic control

CPC Pneumatic Ejector System

D149
THE USE AND RE-USE OF SEWAGE EFFLUENT,

Cox, G. C., and Humphris, T. H.

Water Pollution Control, Vol. 75, No. 4, p 413-427, 1976. 10 fig, 2 tab, 23 ref.

Experiences at the Croydon Power Station, in England, with sewage effluent used as cooling water for condensers was reported. This use of sewage effluent has proven economical and beneficial to the waterway receiving the effluent. At this plant, sewage effluent was combined with small amounts of borehole water. In addition, concern was shown for cleaning the condensers. The condenser deposit was a form of calcium phosphate and small quantities of calcium carbonate. Laboratory tests were conducted to determine characteristics of the sewage effluent for control purposes. In comparison with other cooling water systems, it was found that bacterial oxidation could be used as a means of reducing chemical treatment costs. The use of sewage effluent may provide a way around the use of enormous amounts of fresh water and the waste heat of generating plants can be used in sewage treatment. Conditions in a power station cooling tower are nearly optimum for nitrification and could prove valuable in sewage treatment. Cooling towers might also be used for denitrification purposes. Experiments are suggested to determine the usefulness of developing combined power generation and sewage treatment plants.

*Water reuse, *Power plants, *Cooling towers, *Waste water treatment, *Sewage effluents, Treatment facilities, Biological treatment, Nitrification, Denitrification, Sewage treatment

Croydon Power Station

D150
WASTE WATER TREATMENT UNIT FEATURES FLUIDIZED BED,

Chemical Engineering, Vol. 83, No. 23, p 87-88, October, 1976. 1 fig, 1 tab.

The Hy-Flo fluidized-bed waste water treatment system is described for biologically treating waste water for carbonaceous BOD removal, nitrification of ammonia nitrogen to nitrates, and denitrification of nitrates to nitrogen. The modular system is economically competitive with other systems and can increase plant capacity by the addition of reactors. It is a closed system requiring no activated sludge return to the reactor. It is composed of a vertical column filled with a medium, such as sand, with a bacterial and other high-order microorganism population coating the surface of each particle of the medium. Waste water, which can be preoxygenated, is introduced into the bottom of the column at a flow rate of 10-25 gallons/minute/square foot of reactor cross-section area. Continuous fluidization of the bed is assured and eliminates packing of solids and reactor clogging. Treatment times were found to produce 85-90% removal of BOD in 15 minutes compared to normal removal times of 6-8 hours. The system is less susceptible to toxic shock loads.

*Filtration, *Waste water treatment, *Biological treatment, Nitrification, Denitrification, Activated sludge, Biochemical oxygen demand, Flow, Microorganisms, Treatment facilities

Fluidized-bed

D151
GAS FROM SEWAGE, SLUDGE PYROLYSIS ENERGY SOURCE SAYS CALIFORNIA STUDY,

Canadian Pulp and Paper Industry, Vol. 29, No. 11, p 10, November, 1976.

Tests at the Concord, California, Waste Water Treatment Plant proved that pyrolysis of municipal solid waste and sewage sludge could be an energy source for waste water treatment plants. A multiple hearth furnace was used for the pyrolysis of various mixtures of refuse and sludge. The object was to cut costs of tertiary waste water treatment and solids disposal at a new plant being constructed. The new plant was to recycle domestic sewage into high quality water for cooling and industrial processes. The recommendation was that there be shredding accompanied by metal removal and air classification of solid waste to produce a refuse-derived fuel (RDF). This fuel is then fed to the furnace with the sewage and pyrolyzed into a combustible gas. No other fuel is needed for the process. The fuel gas has sufficient entropy to make steam and power generation economically viable. Temperatures of more than 2400 F were achieved.

*Incineration, *Ultimate disposal, Waste water treatment, Treatment facilities, Sewage disposal, Municipal wastes, Tertiary treatment, Fuels, Domestic wastes, Water reuse

*Pyrolysis, Multiple hearth furnace, Refuse-derived fuel, Concord (Calif)

D152
THE OXYGEN-ACTIVATED SLUDGE PROCESS -- THEORY AND PRACTICE,

Singh, R. C.

Journal of The Institution of Engineers (India), Vol. 56, Part EN 3, p 108-114, June, 1976. 2 fig, 2 tab, 16 ref.

The ability to produce oxygen economically has made its use possible instead of air in the activated sludge process. An oxygen atmosphere creates a different environment from an air atmosphere, and the two should be evaluated independently. Theoretical considerations, experimental evidence, and working results of pilot and full scale plants are discussed. The advantages of using oxygen in the activated sludge process are presented. The oxygen activated sludge process has been proved economically viable in actual field installations treating municipal and varied industrial wastes. Its advantages arise from its ability to maintain a high dissolved oxygen level in the mixed liquor, efficient oxygen transfer at low mixing velocities, quick removal of the gases of decomposition, and capability for automatic operation. Due to use of covered reactors, less land area is needed. Treatment time is significantly reduced. The effluent is well nitrified. The excess sludge has higher bio-mass per unit volume and a low sludge volume index. The food to micro-organisms ratio is increased, making possible higher biochemical oxygen demand (BOD) loading per unit weight of mixed liquor volatile suspended solids (MLVSS). High MLVSS concentration can be maintained in the reactor so that more BOD per unit reactor volume can be applied. The sludge settling and compacting properties are excellent. Pumping for sludge recirculation is less expensive. Dewatering, processing, and disposing of excess sludge are easier. Bulking is eliminated. The effect of temperature on oxygen absorption rate is minimized. The covered aeration tanks minimize odor nuisance.

*Waste water treatment, *Biological treatment, *Activated sludge, *Biochemical oxygen demand, *Treatment facilities, Oxygen, Air, Aerobic conditions, Microorganisms, Dissolved oxygen

*Oxygen activated sludge

D153
FILTRATION RESEARCH IN UK UNIVERSITIES,

Wakeman, R. J.

Exeter University,
Exeter, United Kingdom,
Department of Chemical Engineering.

The Chemical Engineer, No. 314, p 683-685, 703, October, 1976. 4 tab, 75 ref.

Current contributions to research in filtration by workers at British universities and research centers are briefly surveyed. Measurements of the influence of slurry concentration on filter cake moisture contents are being made, and cake dewatering mechanisms are being examined with respect to the nature of the particles, their size distribution, and the compressibility of the cake. Pilot scale experiments on depth filtration as applied to water treatment are being extended to full scale filters with particular reference to the use of anionic polyelectrolytes suitable for the treatment of low turbidity reservoir waters and to the kinetics of phenol oxidation within filters. Sludge dewatering is being examined, with some emphasis on the nature of the solids found in effluents and the validity of filtration theory when applied to sewage sludges. Research in the United Kingdom is making an important contribution to the gradual transformation of filtration from an art to a science.

*Waste water treatment, *Treatment facilities, *Filtration, *Research and development, *Foreign research, Universities, Slurries, Moisture content, Dewatering, Filters

Filter cakes

D154
POLYELECTROLYTES FILTER BED COATINGS (Impregnacja zloz filtracyjnych polielektrolitami),

Dziegielewski, B., Kowal, A. L., and Mackiewicz, J.

In: Metody Fizykochemiczne Oczyszczania Wod I Sciekow (Referaty Z Konferencii Naukowo-Technicznej), May 6-7, 1976, Lublin, Poland, Marie Curie Sklodowska University, Lublin, Vol. 1, p 59-68, 8 fig, 7 ref.

Filter bed coating with polyelectrolytes increases filtration efficiency in decoloring water with low suspended matter concentrations. Cationic and anionic polyelectrolytes were studied. During the first two hours of a 10-14 hour filter run, 0.1-0.2 ppm doses were applied. Raw water turbidity was 25 ppm; that of the effluent was less than 3 ppm. Filtration velocity was 7.5 meters/hour and the filter bed capacity for suspended solids was 1.95-2.85 kilograms/square meter. Anionic polyelectrolyte, Polyhall 650 proved most efficient at doses around 0.01 ppm. Calgon M-502 was very efficient with jar test coagulation, but useless for filter coating. Filtration effectiveness was increased by filter bed coating without prior coagulation.

*Filtration, *Waste water treatment, *Polyelectrolytes, Coagulation, Suspended solids, Color, Cations, Anions

Filter bed coatings, Polyhall 650, Calgon M-502

D155
PURIFICATION OF WASTE SULPHURIC ACID BY DIALYSIS ON WEAKLY-BASIC ANION-EXCHANGE MEMBRANES (Dialityczne oczyszczanie odpawdow stezonego kwasu siarkowego przy pomocy slabozasadowych membran anionowymiennych),

Mika-Gibala, A., and Winnicki, T.

In: Metody Fizykochemiczne Oczyszczania Wod I Sciekow (Referaty Z Konferencii Naukowo-Technicznej), May 6-7, 1976, Lublin, Poland, Marie Curie-Sklodowska University, Lublin, Vol. 1, p 1-10. 3 fig, 1 tab, 7 ref.

Studies were conducted to determine more economic means of neutralizing sulfuric acid wastes formed during sulfonation of organic compounds. Purification by dialysis was investigated. The test solution contained about 13 moles/cu dm of H_2SO_4 and up to 200 grams/cu dm of organic impurities, the post-sulfonation degradation products of iso-butyl naphthalene. Weakly-basic, anion-exchange membranes were used because of their superiority in relation to the specific mechanism of hydrogen ion transfer. Determinations were made of the diffusion coefficient and rate of dialysis for ion-exchange membranes of varying capacities. Results indicated that these membranes were substantially better than the Selemion DMT membrane.

*Waste water treatment, *Sulfur compounds, Organic compounds, Acids, Degradation, Anion exchange, Neutralization, Hydrogen, Ion exchange, Membrane processes

Ion-exchange membranes, Selemion DMT membrane

D156
MEMBRANE SCALING PREVENTION IN AN ELECTRODIALYSIS DESALINATION OF BRACKISH WATER (Zapobienganie powstawaniu kamienia membranowego podczas elektrodializy wod slonawych),

Blazejewska, G., Winnicki, T., and Gudra, T.

In: Metody Fizykochemiczne Oczyszczania Wod I Sciekow (Referaty Z Konferencii Naukowo-Technicznej), May 6-7, 1976, Lublin, Poland, Marie Curie-Sklodowska University, Lublin, Vol. 1, p 11-16. 3 fig, 1 tab, 1 ref.

Several considerations involved in the electrodialitic process were discussed. Concentration polarization, precipitation of heavily dissolving salts, and other factors were investigated to determine their influences relative to the process. Experiments were described which evaluated ultrasonic vibrations as a means of preventing membrane scaling. Determinations were made on the effect of ultrasonic vibration intensity on the amounts of sludge in the concentration chamber.

*Membranes, *Treatment facilities, *Brackish water, Water treatment, Desalination processes, Electrodialysis, Sludge, Scaling

*Ultrasonic vibration

D157
COAGULATION OF WATER WITH HIGH CONCENTRATION OF COLOR MATTER
(Oczyszczanie wody o wysokiej barwie),

Kowal, A. L., and Kurowski, Z.

In: Metody Fizykochemiczne Oczyszczania Wod I Sciekow (Referaty Z Konferencii Naukowo-Technicznej), May 6-7, 1976, Lublin, Poland, Marie Curie-Sklodowska University, Lublin, Vol. 1, p 17-23. 4 fig, 1 tab, 5 ref.

Investigations were made of groundwater with very high color (950 ppm Pt) and permanganate value (90 ppm O2). Color removal was by alum and lime coagulation. Doses of alum were near 300 ppm (calculated as aluminum sulfate), and that of lime was 400 ppm CaO. Lime coagulation in a sludge blanket clarifier followed by multilayer filtration produced best color removal (99.5%) and permanganate value (93%). The sulfate or chloride concentrations in treated water increased when alum coagulation and oxidation of color matter with chlorine (700 ppm Cl2) was used. With lime coagulation, recarbonation was necessary to reduce water hardness.

*Subsurface waters, *Water properties, *Water analysis, *Color, Sludge, Filtration, Sulfur compounds, Chlorides, Coagulation, Groundwater

Alum coagulation, Lime coagulation, Permanganate value, Hardness(water)

D158
EFFECT OF pH ON SOME WATER TREATMENT UNIT PROCESSES
(Wplyw odczynu na niektore procesy oczyszczania wody),

Kowal, A. L., and Mackiewicz, J.

In: Metody Fizykochemiczne Oczyszczania Wod I Sciekow (Referaty Z Konferencii Naukowo-Technicznej), May 6-7, 1976, Lublin, Poland, Marie Curie-Sklodowska University, Lublin, Vol. 1, p 32-37. 5 fig.

The efficiencies of purification processes are affected by pH levels of the treated waters. In water from the river Odra, optimum pH for alum coagulation and filtration was from 5.2 to 5.5, though the raw water pH was 7.4 to 7.8. A relationship was found between optimum pH of alum coagulation and water temperature. Water pH and the presence of manganese oxides on the filter bed sand determine the efficacy of iron and manganese removal. Manganese removal at a lower water pH can be achieved by preliminary chlorination. A pH of 7.0 allowed the most efficient sorption process with active carbon.

*Treatment facilities, *Water treatment, Waste water treatment, Water purification. Water temperature, Hydrogen ion concentration, Chlorination, Filtration, Rivers

D159
REMOVAL OF LEAD IN WATER TREATMENT (Badania nad usuwaniem olowiu z wod),

Kowal, L., and Swiderska-Broz, M.

In: Metody Fizykochemiczne Oczyszczania Wod I Sciekow (Referaty Z Konferencii Naukowo-Technicznej), May 6-7, 1976, Lublin, Poland, Marie Curie-Sklodowska University, Lublin, Vol. 1, p 38-43. 3 fig.

Studies were conducted of lead removal in water treatment processes. Lead sorptions on activated carbon and suspensions of clay, chemical coagulation, and filtration were investigated. Test solutions containing lead (from 0.1 to 1.0 ppm Pb up to 67.0 ppm Pb) were analyzed by atomic absorption. The processes studied were affected by lead concentration, water pH, coagulants applied and their doses, and the methods for removing suspended solids. The introduction of iron coagulation and filtration produced the best results.

*Waste water treatment, *Lead, *Activated carbon, Hydrogen ion concentration, Filtration, Adsorption, Suspended solids, Iron, Coagulation

D160
RESIDUAL SATURATION OF DEWATERED FILTER CAKES,

Wakeman, R. J., Rushton, A., and Brewis, L. N.

Exeter University,
Exeter, England,
Department of Chemical Engineering.

The Chemical Engineer, No. 314, p 668-670, October, 1976. 5 fig, 1 tab, 15 ref.

When a packed bed of solid particles initially saturated with a liquid is drained by a desaturating driving force, a quantity of liquid, the residual saturation, is retained at equilibrium. In cases such as sewage sludge, transport costs of wet sludge may be reduced considerably by effective dewatering. Movement and retention of fluid in centrifuged filter cakes have been studied experimentally. Ballotini and sieved sand fractions were used as solids with a vertical, 0.2286 m diameter, perforate bowl centrifuge. A cake formed by filtering the particles into the centrifuge was allowed to drain to a final equilibrium saturation level corresponding to the centrifugal force developed at a specific rotational speed. The measured values of the residual equilibrium saturation were compared with previously predicted saturation levels. The inadequacy of the capillary number and previously used permeability expressions to correlate residual saturation data was demonstrated, along with the failure of the simple two-regime model. It is doubtful that capillary drain height correlations from gravity drained beds can be applied to centrifugally dewatered cakes. The effect of rotational speed on cake permeability was explained in terms of the range of pore sizes contributing to fluid flow.

*Waste water treatment, *Analytical techniques, *Treatment facilities, *Saturation, *Dewatering, Packed beds, Liquids, Equilibrium

Filter cakes

D161
USES AND CULTIVATION OF SEAWEEDS,

Fralick, R. A., and Ryther, J. H.

New Hampshire University,
Plymouth,
Department of Natural Sciences.

Oceanus, Vol. 19, No. 4, p 33-39, Summer, 1976. 5 fig, 1 tab, 13 ref.

The uses and cultivation of seaweeds are discussed. They include a project begun in 1970 at the Woods Hole Oceanographic Institution to develop a waste recycling-marine aquaculture system. Secondary sewage effluent, mixed with seawater, is used to grow phytoplankton which is later fed to oysters, clams, and other bivalves. The algae remove nutrients, primarily nitrogen, from the waste water, and the shellfish remove the algae, providing tertiary sewage treatment as well as commercially valuable seafood. Metabolism of the animals in the system remineralizes some of the nutrients; nitrogen and phosphorus return to the water by way of the animals' wastes. This phenomenon necessitated the addition of seaweeds grown in suspended culture to remove the regenerated nutrients. Initially Chondrus crispus was used in this project, but it grew solwly and became heavily overgrown with epiphytic seaweeds. It was replaced by other warm-water species that appear as summer annuals in the Woods Hole region. The growth of these algae, especially Neoagardhiella and Gracilaria, has been so successful that a separate project was begun in which the seaweeds alone are grown in mixtures of sewage effluent and seawater as a one-step waste recycling-aquaculture system. Similar experiments were started in 1973 at the Harbor Branch Foundation, Ft. Pierce, Florida, using more tropical species of seaweeds.

*Waste water treatment, *Sewage treatment, *Biological treatment, *Cultivation, *Projects, Recycling, Shellfish farming, Sewage effluents

*Seaweeds

D162
FILTRATION WITH GRANULAR BEDS,

Cleasby, J. L.

Iowa State University,
Ames,
Civil Engineering Department.

The Chemical Engineer, No. 314, p 663-667, October, 1976. 2 fig, 4 tab.

Granular bed filtration as applied to water and waste water treatment is discussed. It involves the passage of dilute suspensions of particulates through beds of granular material 0.6 m to 1.8 m deep to separate the unwanted solids. The suspensions may reach 50 mg/liter in waste water filtration. The beds may be composed of natural sand or crushed anthracite, flint, garnet, illmenite, or pumice. The materials are sieved to provide the desired size range. Such filters can process large quantities of water at low cost. The traditional slow sand filter has been largely supplanted by the rapid filter. Rapid, granular filters are used to polish the effluent from conventional secondary biological treatment works to meet more stringent effluent quality requirements. Various designs have evolved to accommodate higher solids loads. Removal results from a combination of interstitial straining, transport mechanisms, and attachment mechanisms. Macroscopic physical models of filtration are based on the fact that the rate of removal per unit depth of filter is proportional to the local concentration of suspended solids. More recent attempts to model deep bed filter behavior have been founded on the trajectory of small particles as they approach a larger collector. Three basic backwashing systems are currently in use: air scour followed by water at velocities barely sufficient to fluidize the bed, upflow wash with water at sufficient velocity to fluidize the bed fully, and simultaneous air scour and water upwash.

*Waste water treatment, *Biological treatment, *Analytical techniques, *Treatment facilities, *Filtration, Suspension, Sands, Coals, Suspended solids, Filters

Granular bed filtration

D163
EVALUATION OF PROCESS DESIGN PARAMETERS FOR PHOSPHORUS REMOVAL FROM DOMESTIC WASTE WATERS BY CHEMICAL CLARIFICATION,

Bowen, S. P.

Dissertation Abstracts International B, Vol. 36, No. 9, p 4608, 1976.

The increased use of chemical waste water treatment requires the development of optimum values, and a means for their determination, of design parameters. These parameters include the coagulant, dose, pH, flocculation intensity and duration, and sedimentation time. Alum and lime treatments were the subjects of investigations. Coagulation was studied in the treatment of raw domestic sewage by using jar tests and a column flocculation-sedimentation apparatus. Procedures were developed to determine the effect of coagulant dose and pH interaction on the removal of total phosphorus, suspended solids, turbidity, and total organic carbon. Results showed that alum coagulation produces optimum removal at a dose of about 175 milligrams/liter and a pH of 5.9. Small variations produce large alterations in pollutant removal. There was no optimum dosage for lime treatment coagulation and pollutant removal increased as the dose and pH increased. Coagulation at low lime dose, the use of ferric iron as a coagulant aid and sludge recycling were also studied. Studies on the effect of flocculation mixing intensity and sedimentation time on pollutant removal using the above data indicated that flocculation intensity was relatively unimportant. Overflow rate, dose, and pH for lime and alum produced enough energy to prevent floc settling during flocculation. A lighter, slower floc was produced by alum and alum coagulated water overflow rates must be lower to produce comparable results. Hydraulic variations more easily upset alum floc than lime floc. Alum sludge was more voluminous and more difficult to dewater than that of lime.

*Phosphorus, *Analytical techniques, Coagulation, Flocculation, Sedimentation, Lime, Waste water treatment, Hydrology, Sludge treatment, Hydrogen ion concentration, Chemical precipitation

Alum, Chemical treatment

D164
PURIFICATION PLANTS OF THE CARROUSEL TYPE FOR THE PURIFICATION OF COMMUNAL, TRADE AND INDUSTRIAL WASTE WATER (Klaeranlagen vom Typ Carrousel fuer die Reinigung Kommunaler, Gewerblicher und Industrieller Abwaesser),

Christ, W.

Industrieabwaesser, p 13-19, 1976. 3 fig, 11 tab, 9 ref.

A carrousel-type sewage treatment plant for the purification of municipal, occupational, and industrial sewage was described. The carrousel system was developed as a modification of the oxidation ditch. Its advantages could be applied to high connecting values. The system under discussion was based on the use of rotary aerators in oxidation ditches with separation of the ventilation zone and aerators from the rest of the ditch content. The rotary aerator was thereby adapted to the capacity required while vouchsafing the oxygen input. In the remaining parts of the tank, divided into two by a partition wall, the necessary speeds were maintained by rotary aerator action. The spiral motion engendered by the aerators continued as a straighforward current through the entire ditch and was returned at its end to the rotary aerator by opening the partition wall. The benefits of this process involved greater padding capacity attributable to the large sludge quantity, large storage capacity for excess sludge, high load tolerance for sewage and sludge peaks, squat construction, and simple procedure and nitrification/denitrification processes. Comparison of construction costs of carrousel-type installations with those of other wholly biological purification plants showed an economy of up to 35%.

*Water purification, *Treatment facilities, *Oxidation, *Oxidation lagoons, Aeration, Municipal wastes, Industrial wastes, Waste water treatment, Biological treatment,

D165
NEW REFUSE INCINERATOR TO BURN ATOMIZED SLUDGE,

Millbank, P.

Surveyor, Vol. 148, No. 4405, p 15, November, 1976.

A new British refuse incinerator capable of handling up to 3,700 tons of domestic and bulky household waste a week for a population of 600,000 is described. Eventually the facility will handle 1,440 tons of 5% solids sludge from a planned treatment plant. A 1970 report on waste disposal options recommended incineration and, though considered, electrical generation and district heating utilizing waste heat was dismissed. Vehicles enter the facility and enter an eight bay tipping hall. Two bays have restraining chains to secure unstable collection vehicles during tipping. The bunker has two main sections with a small pit for bulky household wastes. Shears are installed for bulky waste which is then discharged into the main sections. Two cactus grabs feed the twin furnaces and air extraction grilles are set above the feed chutes and lower down the bunker to reduce dust. The twin stream incinerator has four rocking grates in each furnace, inclined at 11 degrees with a drop between each. Pretreatment and screening equipment designed for the new treatment plant is currently at this plant so that the sludge will be below 6 millimeter particle size. Sludge will be injected with air from the back wall of the furnace over the moving grate. This avoids the problem of wet sludge landing on the grate and 'balling' with refuse. Injection will be at 750 C, ideally at 800 C.

*Treatment facilities, *Incineration, *Waste disposal, *Sludge disposal, Waste water treatment, Domestic wastes, Sludge treatment, Disposal, Solid wastes, Ultimate disposal

D166
THE ELECTROFLOTATION OF ORGANIC WASTES,

Barrett, F.

Chemistry and Industry, No. 20, p 880-882, October, 1976.

A discussion was presented on the development and application of electroflotation for effluent treatment. Electroflotation was investigated as a means of avoiding the disadvantages of other methods of separation in waste water treatment. The forms of this method have been air injection or diffusion for a froth separation system, and air dissolution in the effluent, under pressure, released as bubbles into the main portion of the liquor at normal pressure. Major considerations for the use of electroflotation include: good coverage of the container area by suitable electrode arrangements if used to produce gaseous bubbles; assistance of flocculation of particles if bubbles produced were introduced with minimum turbulence in the liquor body; and variation in dwell time under these conditions to suit the effluent under treatment and intensify the action. The unit is composed of a holding tank (rectangular) containing the effluent and a pair of electrodes near the bottom with the cathode above the anode. Direct current potential is applied across the electrodes which causes electrolyzed water to produce bubbles of oxygen at the anode and hydrogen at the cathode. These rise to the surface, carrying suspended particles with them, thus producing a floating sludge layer which can be removed by brushing or scraping. Titanium electrodes have proven less susceptible to corrosion and produce better results than mild steel, stainless steel, or platinized titanium. Application of this method was most suitable to sludge thickening and to treating waste effluents from printing units applying flexographic ink, until the less expensive and longer-lived electrode material was developed.

*Separation techniques, *Waste water treatment, *Sludge treatment, *Flocculation, *Treatment, *Electrodes, Sewage effluent, Corrosion, Frothing, Flotation

D167
ADSORPTION, COAGULATION AND FILTRATION MAKE A USEFUL TREATMENT COMBINATION - PART 1,

Wang, L. K., Ross, R. G., and Ciccone, V. J.

Water and Sewage Works, Vol. 123, No. 12, p 42, 44-47, December, 1976. 1 fig, 5 tab, 17 ref.

A study was conducted to determine the applicability and practicality of adapting a mobile water purification plant using an adsorption-coagulation-filtration process to military applications in treating field kitchen, laundry, and shower waste waters. The preliminary process selection and subsequent technical approach to treatability studies were presented. Factors involved included: characteristics of target wastes; level of waste treatment required, mobility of the treatment facility; simplicity of installation and treatment; compatibility of treatment facilities with other military operations; costs involved; and preference of military administration and management. Since the waste streams to be treated contain nonhazardous anionic surfactants, and dissolved and suspended solids, treatment equivalent to secondary biological waste treatment was suggested. With these criteria in mind, a literature search was conducted to find feasible waste treatment processes which use the units of feeding, mixing, flocculation, filtrations, and sludge concentration. Selected processes included powdered activated carbon adsorption, polymer coagulation, and diatomaceous earth filtration. After the treatment system was planned, laboratory tests were conducted to determine the optimum types and dosages of powdered carbon and polymer, and optimum operational conditions. A summary of the procedures and results were presented.

*Treatment facilities, *Waste water treatment, *Domestic water, *Domestic wastes, *Military aspects, Laboratory tests, Biological treatment, Adsorption, Filtration, Coagulation, Economics, Analytical techniques

D168
DISINFECTION OF VIRUSES IN SEWAGE BY OZONE,

Katzenelson, E., and Biedermann, N.

Hebrew University-Hadassah Medical School,
Jerusalem, Israel,
Environmental Health Laboratory.

Water Research, Vol. 10, No. 7, p 629-631, 1976. 2 fig, 6 ref.

Ozone was found to be a very potent viral disinfectant, even in contaminated water. Tests were conducted for the ability of ozone to inactivate waterborne viruses during sewage treatment. In one method, filtered sewage together with a virus inoculum was added to a buffer solution containing known concentrations of ozone. The complete disappearance of ozone immediately after the addition of the effluent was found. At the same time, a rapid reduction in virus titer occurred, but after initial reduction this titer remained unchanged. The degree of virus inactivation was dependent upon ozone concentration and the amount of organic matter in the effluent. In a second method, ozone was bubbled into filtered sewage containing a virus inoculum. Inactivation of the virus began after a 30 second lag, even before residual ozone could be detected. Inactivation of 99.999% of the virus was found when the ozone residual was 9.6 mg/liter. Similar experiments using buffer rather than sewage showed that the process took place at an even faster rate.

*Ozone, *Viruses, *Disinfection, Sewage treatment, Chemical reactions, Reduction (chemical), Organic matter, Sewage effluent, Treatment, Analytical techniques

D169
ADDITIONAL STUDIES ON THE USE OF CRACKING CATALYSTS IN CONJUNCTION WITH ACTIVATED SLUDGE WASTE WATER TREATING,

Schwartz, R. D., and McCoy, C. J.

Corporate Research Laboratories,
Exxon Research and Engineering Company,
Linden, New Jersey.

Water, Air, and Soil Pollution, Vol. 6, No. 1, p 97-102, August, 1976. 1 fig, 5 tab, 1 ref.

Fresh, spent, and regenerated cracking catalysts were examined to see if observed activity could be due to carbon and metals deposited on the catalyst during cracking operations. Earlier studies were repeated and adsorption isotherm tests were conducted. Sludge and waste water samples were taken during wet-weather conditions which were probably responsible for poor settling and compaction noted with controls. Catalyst addition caused test activated sludge to compact better than the control. The failure of catalysts fines to settle resulted in poor supernatant optical clarity. It was thought that adding the catalyst would aid operation under wider loadings and throughputs without affecting sludge settling and compaction. There was little difference in the performance of fresh, spent, or regenerated catalyst and the ability to operate at concentrations as low as 0.5 g/100 millimeters. When sludge and water were sampled during more normal conditions, the catalyst addition produced the same increases in settling and compaction. Results indicated that carbon and metals on the catalyst surface had no effect on settling and compaction improvement when the catalyst is present and they did not affect TOC removals. None of the catalysts adsorbed soluble TOC well and the catalyst could possibly stabilize the activated sludge system during wet weather conditions.

*Catalysts, *Waste water treatment, *Analysis, *Sludge treatment, Sedimentation, Compaction, Chemical reactions, Carbon, Metals, Activated sludge

D170
THE FIRST FLUOSOLIDS INCINERATOR COMMISSIONED IN THE U.K.,

Engineers' Digest, Vol. 37, No. 11, p 51, November, 1976.

The Thames Water Authority (England) has constructed a treatment plant which comprises a mechanically raked screen, detritor, primary sedimentation, biological filters, humus tanks, micro-strainers, and sludge incineration. Humus sludge is returned to primary sedimentation tanks and mixed sludge is pumped to one of three thickeners which have automatic dewatering cells designed to remove supernatent and subnatent water bands. Sludge dewatering is by vacuum filtration. Sludge from the thickeners is pumped to rotating conditioning tanks where lime and coppers are used for conditioning before filtration. Conditioned sludge is fed into the coilfilter bath and sludge cake from this step is fed to the sludge pumps which feed the FluoSolids reactor or into a skip for transportation. The reactor fluid bed is a mixture of sand and gases in suspension and provides an ideal environment for thermal oxidation of sewage sludge. The water content of the sludge cake evaporates quickly and the organic content reacts with oxygen, providing complete combustion with minimum excess oxygen at a minimum temperature. Exit gases flow into the heat exchanger and then into a scrubber followed by a multi-tray cooling system. Solids are transferred from the gas stream to the liquid scrubbing stream. Scrubber water is recycled and as ash content builds up, scrubber water with about 2% ash is pumped to lagoons where rapid settling leaves a bed of inert ash. The plant can be shut down instantly without harm or a need to provide quench water or maintain cooling air.

*Incineration, *Sludge treatment, Sedimentation, Filtration, Oxygen, Oxidation, Organic matter, Temperature, Water reuse, Mechanical equipment

D171
TOTAL WASTE RECYCLE SYSTEM FOR WATER PURIFICATION PLANT
USING ALUM AS PRIMARY COAGULANT,

Wang, L. K., and Yang, J. Y.

Calspan Corporation,
Buffalo, New York.

May, 1974. 33 p, 4 fig, 10 tab, 34 ref, 3 append. Technical Report ND-5252-M-1.

Potential alum recovery and reuse techniques for water purification were evaluated. Alum floc can be recovered from sludge by solubilization with either acid or alkaline reagents. The solubilized reagent must be subjected to pH adjustment to regenerate alum floc. Waste water and alum sludge were collected from a water treatment plant employing aeration, chemical addition, mixing, flocculation, sedimentation, pH adjustment, fluoridation, and chlorination. Waste recycling consisted of treating filter backwash water in a sludge separator, dividing the sludge for alum solubilization in acid and alkaline treatment units, screening inert silt for disposal, and returning solubilized alum for reuse as a flocculation agent. The process was designed to provide a cost effective system for zero waste discharge. Experimental results suggest designs based on the proposed system are feasible. Alum recovered from waste sludge was substituted effectively for new alum in raw water flocculation. Filter backwash water is reusable as high quality raw supply water requiring only a short retention presedimentation treatment. Both acid and alkaline reagents can effectively treat waste sludge for alum recovery. Regenerated alum does not give rise to contaminant build-up in the finished water. Recovery with lime or hydrated lime gives low yield efficiencies and high hardness in the recycled alum-treated water. Using sulfuric acid regenerated filter alum and caustic soda alum in combination eliminated the need for solution pH adjustment. Alum recovery efficiency is improved when the waste sludge aging is minimized and the treatment temperature elevated.

*Treatment facilities, *Recycling, *Aeration, *Chlorination, *Flocculation, Coagulation, Sludge, Sludge treatment

*Alum

D172
PROCESSING OF COMBINED DOMESTIC BATH AND LAUNDRY WASTE WATERS
FOR REUSE AS COMMODE FLUSHING WATER,

Hypes, W. D., Batten, C. E., and Wilkins, J. R.

National Aeronautics and Space Administration,
Hampton, Virginia,
Langley Research Center.

October, 1975. 66 p, 9 fig, 18 tab, 4 ref. Technical Report NASA TN D-7937.

Processes and system configurations for reclaiming combined bath and laundry waste waters for reuse as commode flush water were investigated experimentally. In the absence of applicable standards, processes and hardware were tested by comparing their relative ability to improve the chemical/physical and microbiological qualities of waste waters. Filtration by single-pass, 90 min recycle, and 120 min recycle flows through a diatomaceous earth cake filter was investigated. A 90 min recycle flow effectively removed particulates down to one micron in maximum dimension and improved other physical characteristics to the extent that the filtered water was subjectively acceptable for reuse. Adsorption during single-pass and 90 min recycle flows through activated charcoal following filtration by diatomaceous earth was investigated as a further improvement. A 90 min recycle flow was more effective and noticeably reduced color, turbidity, and sudsing. Heating the waste water to 135 F and 145 F for 15, 30, and 45 min and chlorination at available chlorine concentrations of one, 15, 20, and 25 mg/liter to reduce total organism counts were investigated. Coliform counts can be reduced to near zero by heating the water to 145 F for 30 min or chlorinating to 20 mg/liter. If additional processing is accomplished after the initial chlorination, subsequent chlorination to 10 mg/liter or less may be required. The volume of bath and laundry water from a typical family of four is significantly greater than the volume of water required for commode flushing when the shallow-trap commode is used. Collection-tank overflow and tank drainage to remove accumulated particulates may require a small volume of makeup tap water. The energy-use rate for the reclamation system using diatomaceous earth filtration and chlorine sterilization averaged 0.695 kWh/day.

*Waste water treatment, *Water reuse, *Waste water (pollution), *Physical properties, *Physicochemical properties, Absorption, Aquatic microbiology, Testing

D173
SUMMARY OF PLANT EVALUATION: CITY AND COUNTY OF DENVER'S NORTHSIDE WASTEWATER TREATMENT FACILITY AUGUST-SEPTEMBER 1972,

December, 1972. 18 p, 1 fig, 1 tab. Technical Report PB-245 781.

The Denver Northside Wastewater Treatment Plant was evaluated to determine whether it was being operated and maintained satisfactorily to achieve the best protection for the waters of the South Platte River. The plant follows a basically sound operational program that should routinely provide adequate treatment. It may be possible to improve present operations by changing the ratio of primary digesters to secondary digesters. Digestion may also be improved by increasing the concentration of solids removed from the primary clarifiers. Present sampling of plant influent is inadequate to describe the incoming waste load. Sampling is not proportional to incoming flow and supernatant liquor is included in the influent sample. The laboratory appeared to be generally well equipped and to provide reliable data. The preventive maintenance program was good. The quantity of waste discharged by the various industrial contributors to the system has been reduced. The capacity of the plant is not exactly known. Presently, bypassing is done at 130 MGD.

*Waste water treatment, *Pollutant identification, *Treatment facilities, *Waste water (pollution), *Sewage treatment, Industrial wastes, Waste treatment, Colorado, Interstate rivers

North Platte River

D174
A POTENTIAL ORGANIC DISINFECTANT FOR WATER PURIFICATION,

Wang, L. K., and Peery, G. G., III.

Rensselaer Polytechnic Institute,
Troy, New York,
Department of Chemical and Environmental Engineering.

In: The 1975 New England Water Works Association Meeting, January 16, 1975, Waltham, Massachusetts, p 1-24. 4 fig, 7 tab, 28 ref.

Dosages of cetyltrimethylammonium bromide (CTAB), cetyldimethylbenzylammonium chloride (CDBAC), and dialkyldimethylammonium chloride (DDAC) from 2.5 to 10.0 mg/liter were added to aged tap water containing high concentrations of Escherchia coli and no residual chlorine. All but one gave zero residual coliform counts at room temperature, nearly neutral pH, and 10 min contact time. All three surfactants had strong bactericidal properties and could be potential disinfectants for water purification and waste water treatment. All were overdosed. Further experiments were conducted at 0.5 mg/liter and 1.0 mg/liter using CTAB and CDBAC. Some residual coliforms were detected. Best results were obtained with one mg/liter at 10 min contact time. Residual disinfectant concentrations were close to initial disinfectant concentrations. Apparently CTAB and CDBAC are not oxidizing agents. Although CTAB seems to have slightly better bactericidal properties than CDBAC, the latter was chosen for further study because it is considered nontoxic at low concentrations. pH was adjusted at 5 to 9 using sulfuric acid and sodium hydroxide; 0.5 mg/liter CDBAC and 5, 10, and 15 min contact times were used. Minimum contact time was tentatively concluded to be 10 min, the longer the better. Optimum pH range was 7 to 9. Contact times of 5, 10, and 15 min and 0.25, 0.5, and 1.0 mg/liter CDBAC were compared; the optimum was 10 min at 1.0 mg/liter under the pH, temperature, and coliform concentration conditions used. Final tests were conducted at 22 and 30 C and 0.25, 0.5, and 1.0 mg/liter CDBAC. There was no difference in residual coliform counts for the two temperatures. All tests indicated zero residual coliform count at one mg/liter. For treating excellent sources of water supply, 0.5 mg/liter CTAB or CDBAC with 5 min contact time will be sufficient.

*Waste water treatment, *Organic compounds, *Disinfection, *Domestic water, E. coli, Water temperature, Hydrogen ion concentration

D175
STORAGE OF WASTES FROM WATERCRAFT AND DISPOSAL AT SHORE FACILITIES,

Cohen, S.

General Dynamics Corporation,
Electric Boat Division,
Groton, Connecticut.

April, 1970. 67 p, 22 fig, 4 tab. Technical Report NTIS PB-245 116.

A program was established to determine the use of an impoundment system with disposal at a shore facility for commercial and recreational watercraft to control sanitary and galley wastes as a pollution source. A demonstration unit was built and installed on a commercial tugboat and evaluated for two months. Component performance, system effectiveness, equipment and installation costs, and system operating costs were determined and evaluated. The control devices increased effective capacity of a compact (120-gallon capacity) holding tank to acceptable levels. Seawater flushing was used for toilets and urinals, and specially designed sanitary flush control and galley sink volume control devices were used to accomodate the holding tank capacity. The tank is corrosion resistant and had a level sensing system, an odor controlled vent line, automatic flushing system, and high level alarm. Suction pump-out by a quick-connect deck fitting was used to transfer tank wastes to shore. Solid galley wastes were stored in a special trash compactor. Study results indicated moderately initial cost for equipment and installation, minimal operation and maintenance considerations, ease of use and psychological acceptance, freedom from odor, components small enough to fit through hatchways and doors, design compatible with many watercraft, and compatibility with many shore disposal techniques.

*Waste storage, *Storage requirements, *Boats, *Water pollution sources, Liquid wastes, Solid wastes, Sanitary engineering, Plumbing, Pollution abatement, Economics

D176
WASTE WATER TREATMENT. AERATION OF WASTE WATER BY OXYGEN,

NATO Committee on the Challenges of Modern Society,
Brussels, Belgium.

January, 1973. 107 p, 26 fig, 10 tab, 10 ref. Technical Report NTIS PB-250 397.

Reports are presented from an expert workshop of the NATO Committee on the Challenges of Modern Society (CCMS). Results of various international test groups indicated that oxygen enriched air or industrial oxygen would be suitable for waste water treatment. Several advantages of aeration by pure oxygen were cited. Though the use of air entails the use of uneconomical amounts of energy, a high oxygen level can be maintained in aeration tanks with slightly more energy needed than to dissolve the feed gas. High oxygen levels allow increased sludge concentrations in aeration tanks without impairing the specific removal efficiency of the sludge, producing a higher pollution load capacity per space unit. Use of industrial oxygen results in a waste gas that is about 1% that produced in conventional processes. Little additional machinery is needed for adjusting the gas feed to a wide range of varying loads with oxygen and less excess sludge and better sludge characteristics are also produced. An oxygen utilization of more than 90% was obtained in several tests. The most likely instances of oxygen or oxygen enriched air appear to be with wastes having high organic loads of varying concentration, wastes with easily volatile components and tending to emit odors, and over-loading of existing plants in which local conditions preclude area extensions. Many questions on specific mechanics and characteristics remain to be studied.

*Waste water treatment, *Aeration, *Oxygen, *Sludge treatment, Treatment facilities, Aerobic treatment, Waste treatment, Economics, Activated sludge, Municipal wastes, Industrial wastes, Oxygenation

D177
THE USE OF INDUSTRIAL OXYGEN IN THE ACTIVATED SLUDGE PROCESS,

Liebmann, H., and Scherb, K.

In: Waste Water Treatment. Aeration of Waste Water by Oxygen, NATO Committee on the Challenges of Modern Society, January, 1973, Brussels, Belgium, p 5-17, 5 fig, 6 ref. Technical Report NTIS PB-250 397.

The Union Carbide system for the aeration of activated sludge, using industrial oxygen, was evaluated. It consists of a series of airtight sealed tanks. Oxygen is introduced into the gas chamber, at low pressure, in the first tank. Compressors then remove the oxygen and introduce it into the water-sludge mixture by the hollow shaft of an agitator. The oxygen diffuses through perforated pipes or filters, and is distributed in the water-sludge mixture by stirring paddles. Oxygen content decreases from stage to stage, being about 40-50% in the last. Oxygen escapes the last tank by an exhaust pipe. Processes which vary this procedure are mentioned. Energy requirements range between 0.2 and 0.4 kilowatt hours/kilogram of O2, depending on the process used. Oxygen aeration is not fundamentally different from conventional aeration. More than 90% of the oxygen can be utilized, which is much greater than conventional methods. Operation with very high sludge concentrations is possible and there is the advantage of reduced excess sludge formation in multi-stage plants. This process also appears to be a reliable means for treating industrial wastes with high organic load.

*Aeration, *Oxygen, *Activated sludge, *Sludge treatment, Waste water treatment, Treatment facilities, Aerobic treatment, Energy, Industrial wastes, Waste treatment, Oxygenation

*UNOX, *Oxygen activated sludge

D178
THE PURIFICATION OF HIGHLY POLLUTED WASTE IN A TEST PLANT, USING PURE OXYGEN,

Hegemann, W.

In: Waste Water Treatment. Aeration of Waste Water by Oxygen, NATO Committee on the Challenges of Modern Society, January 1973, Brussels, Belgium, p 18-42, 5 fig, 4 tab, 4 ref. Technical Report NTIS PB-250 397.

Tests were conducted to determine optimum operating conditions for a plant treatment using pure oxygen to purify wastes. Results indicated that a sludge concentration of 5 grams/liter could be maintained with the oxygen aeration process. Sludge indices were much lower than 100 cu meters/gram and activated sludge thickened readily in the final settling tank. The amount of excess sludge produced was much lower than that in previous experiences. Oxygen consumption was much greater than in conventional processes. The characteristic odor of aeration plants was not found in either the sewage effluent or the waste gas. Smaller tanks could be used with this process, but their expense would not produce any cost savings.

*Aeration, *Oxygen, *Activated sludge, Sludge treatment, Waste water treatment, Treatment facilities, Aerobic treatment, Industrial wastes, Municipal wastes, Waste treatment, Oxygenation, Odor

*Oxygen activated sludge

D179
BIOLOGICAL PURIFICATION OF WASTE WATER, USING OXYGEN,

Wuppertal, K. M.

In: Waste Water Treatment. Aeration of Waste Water by Oxygen, NATO Committee on the Challenges of Modern Society, January, 1973, Brussels, Belgium, p 43-56, 8 fig, 3 tab. Technical Report NTIS PB-250 397.

Studies on waste water purification by pure oxygen were conducted at a pilot plant at Elberfeld, Germany. The test plant had two stages, each with its own secondary settling tank. The first stage consisted of four tanks and the second stage had two tanks. Results indicated that oxygenation had several advantages over conventional aeration. Because the pressure of pure oxygen is greater than atmospheric oxygen, there is a higher oxygen content in activated sludge tanks, allowing operation with higher sludge concentrations and loads. There is about 90% utilization of industrial oxygen, and the remaining waste gas contains about 50% oxygen. Odor can be removed by catalytic or thermal oxidation if needed. Closed systems are used for purification by oxygen and about 1% waste gas is produced compared to conventional aeration. Odor emissions and germ distribution caused by stripping effects are much reduced. Settling characteristics are greatly improved and less excess sludge is produced, thus reducing the costs of sludge treatment. Drawbacks include the expense of pure oxygen and the expensive closed system required to handle it. The choice of suitable materials and the problem of corrosion have not been sufficiently handled yet, and no final conclusions have been drawn. The prospects for the process are still excellent.

*Aeration, *Oxygen, *Activated sludge, *Pilot plants, Treatment facilities, Aerobic treatment, Industrial wastes, Sludge treatment, Waste water treatment, Oxygenation, Odor

D180
RESEARCH INTO THE USE OF OXYGEN IN SEWAGE TREATMENT IN THE UNITED KINGDOM,

Goodman, A. H.

In: Waste Water Treatment. Aeration of Waste Water by Oxygen, NATO Committee on the Challenges of Modern Society, January, 1973, Brussels, Belgium, p 57-65, 2 fig. Technical Report NTIS PB-250 397.

British treatment plants must increase nitrification of effluents in order to increase the dilution capabilities of rivers. Trickling filter or activated sludge plants using air could achieve this goal, but their size would be economically prohibitive. The use of more compact plants using oxygen could resolve many problems involved. Three experimental plants were constructed to test the pure oxygen theories. One pilot plant which was operational produced the following results: waste water was satisfactorily oxidized to produce a low soluble BOD in the final effluent; suspended solids content was high because of carry-over activated sludge from the final settling tank; nitrification was limited to an average concentration of oxidized nitrogen of 5 milligrams/liter. Settling characteristics were excellent at all times. An intermediate settling tank and conversion to a two-step operation were hoped to increase nitrification.

*Aeration, *Oxygen, *Activated sludge, *Sludge treatment, *Nitrification, Aerobic treatment, Treatment facilities, Waste water treatment, Sewage effluents, Pilot plants, Trickling filters, Biochemical oxygen demand, Suspended solids

Great Britain

D181
REPORT ON THE TEST CARRIED OUT AT THE MUNICH-GROSSLAPPEN SEWAGE WORKS, USING THE OXYGEN AERATION PROCESS,

Karnovsky, O. F.

In: Waste Water Treatment. Aeration of Waste Water by Oxygen, NATO Committee on the Challenges of Modern Society, January, 1973, Brussels, Belgium, p 66-76. Technical Report NTIS PB-250 397.

Water authorities of the Munich, Germany region have built a test treatment plant operating with oxygen in order to test the UNOX process, to compare it with similar compressed-air plants, and to obtain data for design and operation of future facilities. Results showed an average BOD5 removal of 95% and an average COD removal of 84%. Average sludge content was 7.2 milligrams/liter and average solids content of return sludge was 2%. There was a 95% utilization of oxygen.

*Aeration, *Oxygen, *Activated sludge, *Sludge treatment, Waste water treatment, Treatment facilities, Aerobic treatment, Biochemical oxygen demand, Chemical oxygen demand, Planning, Oxygenation

*UNOX, Munich (Germany), Oxygen activated sludge

D182
PRELIMINARY RESULTS OF PARALLEL TEST WITH FINE BUBBLE AERATION AND OXYGENATION BY THE LINDOX PROCESS,

Scherb, K.

In: Waste Water Treatment. Aeration of Waste Water by Oxygen, NATO Committee on the Challenges of Modern Society, January, 1973, Brussels, Belgium, p 77-89, 2 fig, 2 tab. Technical Report NTIS PB-250 397.

Parallel tests were conducted in a pilot plant constructed in Germany. One test involved waste water treatment with pure (99%) oxygen, and the other used an air-oxygen (52% oxygen) mixture. The LINDOX process of oxygen aeration was used. Results revealed that the sludge index with the oxygenation process was less than conventional treatment and that excess sludge production was slightly lower than the conventional process. The occurrence of fungi in the activated sludge was characteristic and had no unfavorable effect on settling characteristics. No fungi formed in activated sludge of the conventional process. There were no significant differences in phosphorus content, ammonium and organic nitrogen or occurrence of nitrification in the two processes. Determination of excess sludge was difficult during the second test because of the high sludge index. It was suggested that optimum conditions of operation must be determined for the individual oxygenation plant. Further results indicated that BOD5 removal was similar for both processes and excess sludge production was 10-20% less in the oxygenation process. This was especially true when sludge was aged beyond six days.

*Aeration, *Oxygen, *Activated sludge, *Sludge treatment, Waste water treatment, Aerobic treatment, Pilot plants, Test facilities, Biochemical oxygen demand, Sewage effluents, Fungi, Nitrogen, Phosphorus, Nitrification

*LINDOX process

D183
MODULES PERMIT EASY EXPANSION,

Weaver, J. H.

Robert and Company Associates,
West Palm Beach, Florida.

Water and Wastes Engineering, Vol. 13, No. 11, p 73-74, November, 1976. 1 fig.

A regional treatment facility was recently constructed in West Palm Beach County, Florida. A regional plant was chosen because West Palm Beach and other neighboring communities were facing various difficulties with waste disposal and inadequate treatment facilities. Ocean dumping was considered an environmental hazard, some communities were being pushed to upgrade their treatment, and there was pressure to join a federally funded program to aid financing of treatment expansion. Unique features of the plant include: modular design for easy expansion; large diameter high-volume disposal wells, and the use of extended aeration activated sludge treatment in a large facility. Deep-well disposal is an innovative alternative to ocean outfall disposal. Other available options are opportunities to add treatment stages to produce high quality water to supplement regional raw water supplies. The plant is composed of measuring flumes, bar screens, grit removal devices, aeration basins, secondary clarifiers, recirculation and waste sludge pumps, a chlorination chamber, aerobic sludge digesters, an effluent pump station, and the effluent wells. Treatment is based on "solid retention time" and BOD and suspended solids removal is over 90%, while 100% of the bacteria is removed. Cost saving design features produced about a 15% reduction over costs for conventional activated sludge treatment, rather than the estimated 15-20% increase in costs. Emergency power systems are provided. The plant is fed electricity from two feed lines in opposite directions because the area is hurricane-prone.

*Treatment facilities, *Activated sludge, *Sewage treatment, *Sludge treatment, *Waste disposal, Environmental control, Costs, Sludge digestion, Aeration, Underground waste disposal, Design, Energy

West Palm Beach County (Fla), Deep-well disposal

D184
SLUDGE TREATMENT SPECIALISTS,

Power and Plant, p 1, 4, November, 1976. 2 fig.

Various items manufactured by Alfa-Laval, Limited found extensive use in municipal and industrial waste treatment. Previously involved in plants using sludge dewatering by centrifugation, Alfa-Laval has expanded its product range to include waste activated sludge concentration plants, sludge pasteurization and/or digester heating, and sludge drying. The waste activated sludge concentration plant can continuously thicken municipal or industrial sludges from 0.15% w/w D. S. to 6% w/w D. S. depending on the feed characteristics. The pasteurization plant uses short time/high temperature sludge treatment which reduces costs. Sludge drying equipment dries the sludge after dewatering and produces it in a sterilized powder usable as fertilizer. It applies a maximum temperature to the solid surface and maintains a moist surface by diffusion within the solid. Because these items are sized to fit existing centrifuge sludge dewatering equipment, a sterile powdered sludge can be produced from raw primary or waste activated sludge feed.

*Sludge treatment, *Equipment, *Dewatering, *Sludge digestion, *Sludge disposal, Activated sludge, Drying, Municipal wastes, Industrial wastes, Waste water treatment

Sludge thickening, Pasteurization

D185
OZONE DISINFECTION OF SECONDARY EFFLUENTS,

Nebel, C., Gottschling, R. D., Unangst, P. C., O'Neill, H. J.,
and Zintel, G. V.

Welsbach Ozone Systems Corporation,
Philadelphia, Pennsylvania.

Journal of the Boston Society of Civil Engineers Section-ASCE, Vol. 62, No. 4,
p 161-187, January, 1976. 19 fig, 3 tab, 41 ref.

Previous studies have established that ozone treatment of sewage is useful at several dosage levels: as a treatment for primary sewage and storm water overflow where ozone dosages of 10 to 100 mg/liter are required; as a tertiary treatment to convert secondary effluent to water of potable quality where dosages of over 50 mg/liter are required; and as a replacement for chlorine for disinfection whereby a certain degree of tertiary treatment is concurrently observed and ozone dosages of 5 to 15 mg/liter are required. This investigation details the specific ozone dosages required for disinfection and discusses the effectiveness of removal of specific contaminants in the effluent. Ozone disinfection is often chosen because it leaves no harmful residual or reaction products in the receiving stream. Contaminant removal by using ozone to produce a frothing operation is described. In addition, visual characteristics of the ozonated effluent, such as suspended solids, turbidity, and color are reduced. A correlation was made between the rate of reduction and the initial COD level of the effluent. Additionally, the effect of ozonated secondary effluent on the environment was discussed, taking into account such considerations as dissolved oxygen levels, pH changes, safety, and the removal of cyanides, detergents, pesticides, and phenols.

*Ozone, *Sewage treatment, *Sewage effluents, *Tertiary treatment, *Disinfection, Froth flotation, Suspended solids, Chemical oxygen demand, Dissolved oxygen, Environmental effects

D186
WASTE WATER OZONATION: A PROCESS WHOSE TIME HAS COME,

Rosen, H. M.

Union Carbide Corporation,
Linde Division,
Tonawanda, New York.

Civil Engineering-ASCE, Vol. 46, No. 3, p 65-69, March, 1976. 4 fig, 1 tab.

Several case histories of plants using ozone for waste water treatment are presented. There has been an increasing interest in the use of ozone for municipal waste water treatment due to the higher degree of required treatment under new pollution control legislation; recognition of toxicity problems associated with chlorine; a chlorine shortage in 1974; trends toward reuse of treated water; technological advances in ozone generation and application; increased understanding of ozone benefits when used as a strong oxidant and disinfectant that creates no secondary pollution problems; and the installation of many oxygen activated sludge secondary treatment systems. Ozone has been used in both industrial and municipal waste water treatment systems and is effective in removing phenols, cyanides, and color, as well as taste and odor, manganese and iron, organic carbon, bacteria and viruses.

*Ozone, *Waste water treatment, Oxidation, Disinfection, Odor, Municipal wastes, Toxicity, Industrial wastes, Organic matter

D187
NEW SCREENINGS REMOVAL AND DEWATERING APPARATUS,

Effluent and Water Treatment Journal, Vol. 16, No. 11, p 583, November, 1976.

An apparatus called a 'Screezer' was designed to fine screen raw sewage, lift screenings clear of the liquid and press them, and remove fibrous and harder material in a nearly dry condition. Water and softer material fall back into the main sewage flow. The screenings are ejected in a 60% compacted condition. The 'Screezer' is easily fitted to existing sewage works. It is made of a sectioned drum with cutter bars for the softer material and a spiral flow 'Screezer' chamber, and an inverted siphon attached to the chamber which empties into the downstream channel. The chambers should be constructed in concrete, but asbestos cement forms can be used as permanent shutterings in the form of 'U' bends below the apparatus.

*Screens, *Sewage treatment, *Dewatering, Waste water treatment, Equipment, Hydraulic equipment, Suspended solids, Effluents, Filters, Waste treatment

Screezer

D188
GEORGIA PLANT IS A PEACH,

Cason, C. E.

R. L. Jackson Plant,
Clayton County Water Authority,
Morrow, Georgia.

Water and Wastes Engineering, Vol. 13, No. 11, p 106-107, November, 1976. 1 tab.

The Clayton County (Georgia) Water Authority built a new treatment plant utilizing anaerobic digestion and tertiary lagoons because of the rapid industrial and residential growth of the Atlanta, Georgia, region. Processes in the three-year-old plant involve passing influent through a grit collector and a bar screen; moving mixed liquor clockwise around an aeration tank where dissolved and colloidal solids are oxidized to settleable solids; and passing solids to the head of the plant as "return sludge" while effluent is being discharged. At this plant, 140,000 gallons of sludge is returned and 270,000 of effluent is discharged during the process. Return sludge aids aerobic action on the raw influent. Tertiary treatment is automated. A baffle creates rising air bubbles with the aid of screens. High BOD is achieved and suspended solids reduction is substantial. BOD removals average 97% or better; suspended solids removal is as high as 93%. In addition to domestic wastes, septic tank wastes are treated after direct dumping into the system ahead of the bar screen and grit collector. The diffused-air tertiary system has proven beneficial in handling this type of loading. Lagoon effluent is very clear. Power and maintenance requirements are very slight because there is little equipment, the only moving parts being in the two blowers for creating bubbles in the lagoon. Line cleaning requires about 120 pounds/annually of anhydrous HCl gas.

*Treatment facilities, *Anaerobic digestion, *Tertiary treatment, *Sewage treatment, Waste water treatment, Domestic wastes, Septic tanks, Separation, Sludge treatment, Biochemical oxygen demand, Suspended solids

Clayton County (Ga)

D189
SLUDGE INCINERATOR PROVES A SUCCESS,

Water and Waste Treatment, Vol. 19, No. 11, p 38-39, November, 1976.

An extremely sophisticated sludge incinerator has proven successful in Britain. The system duplicates all principle ancillary equipment and utilizes recirculated treated waste water for its water needs. After shutdown periods, heat losses from the shell and heat reservoir of the sand bed are minimal. With no movable parts in the reactor, shutdown can be instantaneous without harm to the facility. Performance has been better than expected and costs lower than predicted. The treatment is composed of a mechanically raked screen, a detritor, a primary sedimentation, biological filters, humus tanks, micro-strainers, and a sludge incinerator.

*Incinerators, *Sludge treatment, *Treatment facilities, Waste water treatment, Water reuse, Costs, Performance, Evaluation, Water utilization, Equipment

D190
SLUDGE, GARBAGE MAY FUEL CALIFORNIA SEWAGE PLANT,

Sieger, R. B., and Bracken, B. D.

Brown and Caldwell,
Walnut Creek, California.

The American City and County, Vol. 92, No. 1, p 37-38, January, 1977. 1 fig, 1 tab.

The Contra Costa (California) Sanitary District's new 30 mgd waste water treatment plant utilizes a multiple hearth incinerator which produces an off-gas with enough heat energy to power the whole plant. A study was conducted to recommend the most efficient resource recovery method. After laboratory testing, combustion and pyrolysis of sewage sludge and refuse-derived fuel (RDF) in multiple-hearth furnaces was accepted. Testing indicated that the furnace could operate in an autothermic condition with RDF instead of fossil fuel under incineration and pyrolysis conditions. Considerations for RDF preparation and a description of the various technical factors involved in the system are presented.

*Fuels, *Treatment facilities, *Sludge treatment, *Incineration, Energy, Fossil fuels, Gases, Waste water treatment, Sewage treatment, Separation

Pyrolysis, Multiple-hearth furnaces, Resource recovery, Contra Costa Sanitary District (Calif)

D191
NEW METHODS TREAT SEWAGE PLANT DISCHARGES,

Engineering News Record, Vol. 198, No. 2, p 12, January, 1977.

Two new processes for sewage plant discharge treatment were reviewed. The first disposes sludge by mixing with shredded solid waste and producing a pasteurized compost, while the second utilizes ozone as an effluent disinfectant to eliminate carcinogens formed by chlorine disinfection. The composting plant combines dewatered sludge and nonrecyclable solid wastes to avoid the odors associated with land disposal. With this system, the sludge-refuse mix is formed into 25 lb briquettes and allowed to cure aerobically for 2-3 weeks to eliminate the odors. The ozone method produces ozone directly in untreated air with a miniturized high-volume electron beam generator. This method is predicted to provide treatment at one-third the cost of chlorine treatment. Costs of the first system are expected to be about $4.3 million for the construction of a facility to handle 480 tons/day and $6/ton for operational expenses.

*Sewage treatment, *Ozone, *Dewatering, *Solid wastes, *Sludge disposal, *Aerobic treatment, Costs, Chlorination, Disinfection, Treatment facilities

Composting, Land disposal

D192
ADVANCED SEWAGE TREATMENT PLANT OPERATIONAL,

Effluent and Water Treatment Journal, Vol. 16, No. 11, p 581, November, 1976.

One of the most advanced sewage treatment plants has become operational near Norwich, England. It involves a computer-based process control system that allows nearly complete automatic control of plant processes. These controls have aided expansion of the works from a 34,000 cu m/day facility to one with a capacity for 55,000 cu m/day. The control system makes only a minimal work force necessary and treatment includes biological filtration and an activated sludge system. For the activated sludge process, the controls automatically measure and control flow rates and dissolved oxygen levels, and they monitor electrical systems for optimal operation. There are controls to protect against flooding possibilities. Details are given for the automatic control of specific processes. Though a small staff is used with automatically controlled plants, it was suggested that personnel be well-trained.

*Sewage treatment, *Tertiary treatment, *Automatic control, *Control systems, Engineering, Treatment facilities, Activated sludge, Biological treatment, Waste water treatment, Engineering education

Norwich (England)

D193
OZONATION OF RECLAIMED WATER,

Effluent and Water Treatment Journal, Vol. 16, No. 11, p 559, November, 1976.

The Stander Water Reclamation Plant, Daspoort, South Africa, uses chlorine to disinfect water reclaimed from sewage. Investigations were made concerning the use of ozone as a substitute for chlorine disinfection. Advantages of ozone were found to be a fourfold increase in effectiveness with one-fourth the quantity of disinfectant, more effective oxidation, and more complete removal of organic compounds when combined with active carbon adsorption. Ozone does not react with ammonia to the same degree as chlorine and chlorine produces greater mineralization of the water.

*Ozone, *Waste water treatment, *Chlorine, *Disinfection, Treatment facilities, Oxidation, Active carbon, Adsorption, Ammonia, Organic matter

Reclaimed water, Stander Water Reclamation Plant (South Africa)

D194
A REFRESHER ON SODIUM HYPOCHLORITE,

Water and Pollution Control, Vol. 115, No. 1, p 11-12, January, 1977.

Hypochlorite, long used as a textile bleach, has found its way into water treatment and sewage plants as a disinfectant. It is used as an odor control agent and disinfectant in filtration plants, wells, reservoirs, new watermains, and waste water treatment facilities. It is simple, safe, easy to use, and it does not change from liquid to gas during use. It requires no preparation for use and the dosage can be added manually or automatically. Only a storage tank and metering pump are necessary. It has similar performance characteristics with chlorine. It is convenient and economical for drinking water treatment and is often substituted for chlorine because of its safety in use. The usual dosage is 0.2 to 0.6 ppm available chlorine. The quantity of hypochlorite needed is largely dependent on the amount of chlorine needed for water treatment. In waste water treatment, hypochlorite can be added at any point in treatment, depending on the type of treatment facility. It can be used as a pretreatment for odor control. In industrial applications, no corrosion is probable if a satisfactory pH for the water is maintained. To remove odor from air, hypochlorite is exposed to the odorous air and the offensive components are oxidized.

*Disinfectant, *Odor, *Waste water treatment, *Water quality, Sewerage, Reservoirs, Treatment facilities, Chemical properties, Physical properties

D195
NEW YORK CITY AREA EXAMINES ALTERNATIVE TO OCEAN DUMPING,

Solid Wastes Management, Vol. 19, No. 12, p 18, December, 1976.

The Interstate Sanitation Commission of the New York/New Jersey metropolitan area has recommended the alternative of sludge composting and land disposal to ocean disposal of sludge by 1981. It was suggested that sludge which could not be disposed of on land be subjected to pyrolysis. The report indicated that sewage treatment would triple in the area during the next 25 years, and the proposed solution would avoid environmental pollution. The options of pyrolysis and land spreading provide the best balance of environmental, technological, and cost factors when ocean disposal is discounted. Land spreading of composted sludge makes the best use of the sludge, but without ocean dumping, pyrolysis may be an attractive option. Treatment of wastes to remove toxic substances before they enter sewers was also emphasized. Further research on pyrolysis is to be undertaken in the near future.

*Sludge disposal, *Planning, *Incineration, *Landfills, Environmental control, Ultimate disposal, Treatment facilities, Sewage treatment, Economics, Costs, Toxicity

New York/New Jersey metropolitan area, Pyrolysis

D196
SOME EFFECTS OF LIME ADDITION ON HIGH SOLIDS, COMPLETELY MIXED, ACTIVATED SLUDGE WASTE WATER TREATMENT,

Faro, R. C.

Dissertation Abstracts International B, Vol. 37, No. 4, p 1859, 1976.

An investigation was conducted to determine the effects of lime addition to the aeration basin of a heavily loaded activated sludge sewage treatment system. A domestic sewage was treated which was fortified with glucose and nutrient broth. Comparisons between control and lime addition indicated a BOD removal increase from 88.6% to 90.7%. Organic loading increased from 45.6 to 121 lb BOD applied/day/1,000 cu ft. These and other results indicated that lime aided BOD removal at high organic loadings, and high MLSS concentrations seemed to contribute to increased loss of effluent total suspended solids. Lime aided nitrification and phosphorus removal and increased waste sludge production. Cost comparisons indicated that the control treatment cost was $0.40/1,000 gallons and lime addition cost was $0.53/1,000 gallons.

*Sanitary engineering, *Activated sludge, *Lime, Sewage treatment, Sludge treatment, Domestic wastes, Aeration, Biochemical oxygen demand, Phosphorus, Nitrogen, Waste water treatment

D197
WATER PLANT PLANS ZERO DISCHARGE,

Vasilik, G., and Doe, P. W.

Havens and Emerson, Limited,
Saddle Brook, New Jersey.

Water and Wastes Engineering, Vol. 13, No. 11, p 67-68, 70-71, November, 1976.
1 fig, 3 tab.

The Passaic Valley Water Commission treatment plant in Clifton, New Jersey, was built to achieve the goal of zero discharge by 1985. The elimination of discharge into the Passaic River has been achieved by thickening and filter pressing sludges, which are then disposed of in landfills. Liquid products are returned to the treatment plant inlet or used for internal purposes in the sludge disposal system. The facility is flexible relative to the quality and quantity of sludge to be processed. The sedimentation basins have variable rate sludge pumps, for example. There are two independent sludge processing systems for continuous plant operation. The plant is centrally located and designed to use a minimum of land. The second level of the sludge press building is acrylic walled to allow public view of the sludge processes and control panel. The facilities were designed to be compatible with present treatment equipment and processes. Engineering and construction data are described.

*Treatment facilities, *Engineering, *Sewage treatment, *Sludge disposal, Sludge treatment, Environmental control, Ultimate disposal, Lime, Hydraulic equipment, Filtration

Clifton (NJ), Passaic River

D198
AUSTENITIC STAINLESS STEELS AND TITANIUM FOR WET AIR OXIDATION OF SEWAGE SLUDGE,

Oettinger, T. P., and Fontana, M. G.

Zimpro Incorporated,
Rothschild, Wisconsin.

Materials Performance, Vol. 15, No. 11, p 29-35, November, 1976. 13 fig, 5 tab, 8 ref.

Austenitic stainless steel and titanium were investigated as construction materials for sludge wet air oxidation (WAO) facilities. Conclusions were based on a five-year data collection from thirty sewage treatment plants. It was found that stainless steel (Types 304 and 316) could be used in WAO of domestic sewage sludge with chloride concentrations up to 400 mg/liter at 177-288 C. Individual evaluations must be made of sludges with a high industrial/domestic sewage input ratio, or those subject to factors which substantially affect overall composition, regardless of chloride content. When exposed to sludges with more than 400 to 600 mg/liter chloride concentrations, stainless steel was subject to pitting. Titanium resisted damage at chloride levels of 3000 mg/liter at 204 C. There was no sign of corrosion with titanium under these conditions. Results of the study should not be extrapolated to wastes other than domestic sewage sludge.

*Sludge treatment, *Oxidation, *Treatment facilities, *Structural analysis, *Stainless steel, *Titanium, Metals, Air, Domestic wastes, Sewage treatment

Wet air oxidation

D199
EFFECTS OF MUNICIPAL COMPOST AND NITROGEN FERTILIZER ON SELECTED SOILS AND PLANTS,

Duggan, J. C., and Wiles, C. C.

Compost Science, Vol. 17, No. 5, p 24-31, Winter, 1976. 1 fig, 13 tab, 14 ref.

The effects of different amounts and rates of application of municipal compost and chemical fertilizers on plant yield and soil properties were investigated. Test plots were monitored for cadmium, chromium, nickel, lead, zinc, and copper. Selected subplots were monitored for crop yield, uptake of heavy metals, soil bulk density, and soil moisture. The compost was fortified with sewage sludge and nitrogen fertilizer, and applied at rates of 200 tons and 160 pounds per acre. Results indicated that corn grain yields were increased and soil physical properties improved with annual compost application of 200 tons per year for five years. After compost application ended, residual corn crops still registered positive responses. No adverse effects were observed from the presence of heavy metals, but other crops might be less tolerant of them.

*Sludge disposal, *Municipal wastes, *Fertilizers, *Heavy metals, Crops, Nitrogen, Soil properties, Physical properties, Chemical properties, Disposal

Municipal compost

D200
SIMULTANEOUS INCINERATION OF REFUSE AND SEWAGE SLUDGE: THE PRINCIPLES AND APPLICATION AT BOWHOUSE, ALLOA, SCOTLAND,

Fraser, J. McL.

Babtie Shaw and Morton,
Glasgow, Scotland.

The Public Health Engineer, Vol. 4, No. 6, p 160-164, November, 1976.

The principles involved in simultaneous refuse and sewage incineration at the Bowhouse, Alloa, Scotland, treatment plant are reviewed. A multiple-hearth furnace is described. Circumstances surrounding the choice of plant type for the area were given. These included: developing a means of refuse disposal and disposal of sludge from a treatment plant being built; uncertainty about the composition of sewage-derived sludge though a heavy metals content was expected; and the future possibility of industrial sludge disposal. Reliable cost information has not yet been obtained. Other operational requirements are not tabulated due to a long down-time from a structural fault.

*Incineration, *Sewage disposal, *Sludge disposal, Waste water treatment, Municipal wastes, Gases, Treatment facilities, Liquid wastes, Industrial wastes, Engineering

Refuse incineration, Bowhouse (Alloa, Scotland)

D201
FRESNO ADOPTS 'OUTSTANDING' MANAGEMENT PLAN,

Jenks, J. J., and Wyckoff, B. M.

Jenks and Harrison,
Palo Alto, California.

Water and Wastes Engineering, Vol. 13, No. 11, p 39-41, November, 1976.

The City of Fresno, California, instituted an integrated water supply and waste water management program. The program meets water pollution control requirements, potable water augmentation needs, irrigation supply and groundwater resource protection requirements. It also solves the problem of wine industry waste treatment and disposal. Cost-effectiveness was achieved by combining two primary waste water treatment facilities into a secondary treatment plant. A separate industrial waste transport and treatment facility handles wine industry wastes. Infiltration beds of 2,000 acres are used for agriculture and disposal of waste water on land. Twenty-one extraction wells ultimately pump discharge into an irrigation system. Relevant engineering and construction information was presented.

*Water management, *Waste water treatment, Industrial wastes, Municipal wastes, Treatment facilities, Water reuse, Groundwater, Domestic wastes, Activated sludge, Engineering, Irrigation

Fresno (Calif)

D202
AUSTRALIA MAKES IMPRESSIVE PROGRESS IN POLLUTION ABATEMENT,

Water and Pollution Control, Vol. 115, No. 1, p 20-21, January, 1977.

Australian pollution control programs have recently become priority concerns. The federal ministry responsible for pollution control has passed more authority to the six Australian States. Low population numbers and coastal development have promoted the nation's swift progress in this area. The Sydney Metropolitan Water, Sewerage and Drainage Board has spent $A200 million annually. Waste treatment expenditures have been a considerable part of this total. Australians have made strides in treating industrial effluents from meat processing, sugar cane milling, food processing, and landfill leachates. The treatment facilities recycle process water for cooling, with make-up water from storm water run-off. Investigations are being made of the possibility of reusing municipal effluents through recharge of groundwater. Municipal treatment facilities are practicing irrigation with processed industrial effluents. Industries regularly recirculate process waters. Sewage farming has become popular with Melbourne treatment plants using aerobic and anaerobic lagoons. Incineration is used in Perth which operates activated sludge plants and primary treatment processes. In Sydney, activated sludge plants, large primary treatment plants, and biological filtration are used. An advanced treatment plant is being constructed in Canberra. It will employ chemical precipitation, dewatering by centrifugation and incineration, effluent denitrification, filtration, chlorination, and dechlorination. Problems with mining industries are serious future concerns.

*Pollution abatement, *Treatment facilities, *Water pollution control, *Planning, Industrial wastes, Municipal wastes, Tertiary treatment, Waste water treatment, Water reuse

Australia

D203
APPLICATION OF WEAK BASE ION-EXCHANGE RESINS FOR REMOVAL OF PROTEINS,

Foster, D. H., Engelbrecht, R. S., and Snoeyink, V. L.

Illinois University,
Urbana,
Department of Civil Engineering.

Environmental Science and Technology, Vol. 11, No. 1, p 55-61, January, 1977.
8 fig, 2 tab, 24 ref.

Studies were conducted to determine the application of resinous sorbents to waste stream treatment which contained complex organic molecules. Weak base resins were used to treat effluent containing a model protein and a model virus. Results indicated several mechanisms responsible for the sorption of amphoteric macromolecules onto weak base resins: molecule configuration, nature of sidechains, the amount of water bound to resin and protein present, and electrostatic factors. Between pH 5 and pH 8, protein uptake appeared to be by an ion exchange mechanism involving protein carboxyl groups. Sorption was accompanied by a decrease in solution pH and an increase in ionic strength. Weak base resins have good potential for proteinaceous and organic matter removal from secondary effluents. Sorption capacity for viruses was good, but strong interference was observed by competing organics which reduced acceptable operation time compared to a similar system where only virus and buffer were present. Caustic regeneration results in a nearly complete recovery of applied protein with the first few bed volumes. Resin fouling associated with strong base resins should not be a problem.

*Waste water treatment, *Ion exchange, *Resins, *Sorption, *Viruses, *Organic matter, *Hydrogen ion concentration, Proteins, Sewage effluents

D204
NO BYPASS, ZERO DISCHARGE, PLANT PROTECTS MAUI COASTLINE,

Koblitz, G.

Water and Wastes Engineering, Vol. 13, No. 11, p 31-36, November, 1976. 1 fig, 3 tab.

No bypass and zero discharge were required by Maui County, Hawaii, to prevent potential water pollution and help solve chronic water supply problems along its coastline near Kihei. The extreme development of resorts and tourist attractions has made pollution a prime concern. An average of 12 inches of rainfall annually has limited water available for domestic and agricultural purposes. Limited funds also placed the requirement of inexpensive solutions in the forefront. The answer was found in a 4.0 mgd waste water collection and water reclamation system built with State and local monies. It was the first large-scale activated sludge waste water reclamation facility. It employs innovative plant design, ranchland, and parkland irrigation for effluent disposal. The activated sludge process, eliminating primary clarifiers and aerobic digestion without thickening, is used to prepare organic solids for soil conditioning and fertilizing. Life-time savings over a conventional activated sludge system with primary clarification and anaerobic digestion is estimated to be $50,000. Maximum reliability and capability were ensured by dual units and standby capacity. Two parallel flow streams are employed with the capacity for flow routing between major units at all points. A waste water/crop management program which demonstrates the use of treated effluents was provided on leased ranchland. There is a capacity for irrigating 400 acres, and up to 250,000 gpd of plant effluent receives additional treatment by mixed-media pressure filter to prepare it for parkland irrigation.

*Treatment facilities, *Sewage treatment, *Pollution abatement, Waste water treatment, Sludge treatment, Sludge disposal, Irrigation, Activated sludge, Water reuse, Design criteria

Zero discharge, No bypass, Maui County (Hawaii)

D205
NEW SYSTEM PROVIDES FOR GROWTH,

Meyer, J. L., Scalf, B. G., and Walker, J. T.

Meyer, Meyer, LaCroix and Hixson,
Alexandria, Louisiana.

Water and Wastes Engineering, Vol. 14, No. 1, p 28, 31, 49, January, 1977. 3 fig.

A new sewerage system in Alexandria, Louisiana, is economical and reduces BOD and suspended solids concentrations below state and federal standards. An engineering study recommended a system with adequate growth capacity for a 20-year period that would meet present and future pollution control requirements, that was economical, and that was simple to operate. Economies were made by using existing collection system and lift stations where possible and by using one as the major delivery station for sewage to the treatment site. Two new lift stations were constructed and three existing ones were modified. A 14 mgd treatment plant was built consisting of a grit and grease removal unit, primary aeration cells, clarifiers, secondary aeration cells, wet weather storage lagoons, chlorination facilities and an administration and laboratory building. All sludge is recirculated to the head of the plant, eliminating sludge handling or disposal equipment. Endogenous respiration is calculated to help reduce sludge build-up. Liquid alum feed facilities introduce the alum to the influent well of the clarifiers without mechanical mixing or flocculation. The project cost was about $10.3 million.

*Treatment facilities, *Sewage treatment, Construction, Sludge treatment, Pollution abatement, Waste water treatment, Costs, Design criteria, Economics

Alexandria (LA)

D206
EARTH, FIRE.....AND SLUDGE,

The Consulting Engineer, Vol. 40, No. 12, p 41, December, 1976.

The population of Esher, Surrey, England, is served by a sludge incinerator utilizing a fluidized bed combustor. The plant has a dry weather flow of 16,000 cu m/day and incinerator operation occurs during a 7 hour shift each day. Sludge is conventionally dewatered until there is a solids concentration of about 7%. Conditioning by lime and copperas follows with feed into coil-filter drum-type vacuum filters. Sludge cake, with a solids concentration of 22%, is removed and discharged to the incinerator feed pumps. The incinerator has a diameter of 5 meters and a height of 10.3 meters and is constructed of steel with a full-height refractory lining. The sand bed is fluidized by a blower with a capacity of 9,400 cu m/hour. Exit gases are cooled after passing through a scrubber. Heat is removed from the exhaust and used to warm inlet air for the fluidized bed to a temperature of 500 C. Ash content ends up as a slurry after mixing with water and is fed to holding ponds for drying. Fuel oil consumption is about 315 liters/hour. Sand consumption averages 150 kg/week. The inert ash is claimed to be useful as fill even though it would be expensive.

*Incineration, *Sludge treatment, *Treatment facilities, *Dewatering, Filters, Temperature, Waste water treatment, Waste treatment, Gases, Equipment

Esher (Surrey, England)

D207
SLUDGE IN A STATE OF PURITY,

The Consulting Engineer, Vol. 40, No. 12, p 38-39, December, 1976. 2 fig.

The original intent of sewage purification was to use the treated sewage as fertilizer. The practice has been to treat sewage for disposal but, with improved processes, especially the irradiation of sewage sludge, modern practice may include this alternative. Irradiation, or irradiation combined with heat, can destroy bacteria, viruses, and parasites which are present in raw sewage sludge. Composting is presently the most viable process involving irradiation because the irradiation can be added as a final stage. Recent experiments indicated that irradiation at 300 krads was able to reduce fecal streptococcus bacteria by about two logs; reduce coliform bacteria by 10 logs; reduce viable parasitic ova by 4 logs at a minimum; reduce viruses by one log; and improve settling and filtration by a factor of three. A pilot plant to study the process was proposed for Albuquerque, New Mexico. It was suggested that irradiation could, at relatively low doses (less than 1 Mrad), ensure a sterilized, commercially marketable compost. At a pilot plant near Munich, Germany, irradiation has proven successful. Results with a mean dose of 300 krad for 210 minutes were the same as heat sterilization at 80 C for 30 minutes.

*Sludge treatment, *Irradiation, *Sludge disposal, Bacteria, Viruses, Animal parasites, Fertilizers, Sewage treatment, Waste water treatment, Pilot plants

D208
EXPANSION COMES QUICKLY TO AWT PLANT,

Lockward, G. M.

Connell Metcalf and Eddy,
Coral Gables, Florida.

Water and Wastes Engineering, Vol. 14, No. 1, p 26-27, January, 1977. 1 tab.

The Miami-Dade (Florida) Water and Sewer Authority has expanded a waste water treatment facility so that it can handle a 200% increase from 2.0 mgd to 6.0 mgd of influent. The additions were: new contact stabilization activated sludge units with minor modifications, rapid sand filtration units, expanded phosphorus removal equipment, expanded chlorination treatment with automatic dosing, new flow measuring devices, conversion from outfall disposal to subsurface disposal, expanded sludge drying beds, added air blowers, added standby power capacity, expansion of the laboratory, and new office space. The activated sludge units can be easily altered to a conventional process involving aeration, but would require additional digestion tanks. This would also allow single-stage nitrification. When this change is effected, sodium aluminate will be used for phosphorus removal instead of alum. Though operating at 65% of capacity, the plant has proven successful in its effluent treatment.

*Treatment facilities, *Waste treatment, *Tertiary treatment, *Activated sludge, *Equipment, *Waste disposal, Waste water treatment, Design, Underground waste disposal, Automatic controls

Miami-Dade (Florida) Water and Sewer Authority

D209
WASTE WATER REUSE PRACTICE IN THE UNITED STATES,

Brunner, C. A.

Municipal Environmental Research Laboratory,
U.S. Environmental Protection Agency,
Cincinnati, Ohio.

In: Polish/U.S. Symposium on Waste Water Treatment and Sludge Disposal, February 10-12, 1976, Cincinnati, Ohio, EPA Environmental Research Center, Cincinnati, Vol. 2, p 151-156. 4 tab.

The reuse of treated municipal waste water should be considered as an alternative plan for meeting future water demands. Present usage and future predictions of water demands make water resource conservation, renovation, and reuse of waste water imperative. Presently, waste water reuse is being applied to agricultural, industrial and recreational problems. Nonpotable domestic water applications are to be added to this group, as well as potable uses which may be practical at some future time. An EPA survey reported that 58% of water reused in 1971 was for agricultural purposes, with the great majority being used in irrigation. Forty percent was used for industrial needs. Much of this was used as cooling water. Recreational reuse programs include man-made lakes. For these uses, water must be treated to maintain a low oxygen demand and to keep toxicity levels low. Domestic reuse schemes do not yet include potable water programs, and one problem is the necessity for a separate distribution system for the renovated water. Trace organics and pathogens, especially viruses, are the major restrictive agents in the development of water reuse programs for potable water needs.

*Water reuse, *Municipal waste water, *Water demand, *Waste water treatment, *Water conservation, *Water purification, Sewage treatment, Water sources, Groundwater, Irrigation, Domestic water, Lakes, Industrial water, Recreation

D210
RENOVATED WATER FROM MUNICIPAL SEWAGE TREATMENT PLANTS,

Kowal, A. L.

Wroclaw Technical University,
Wroclaw, Poland,
Institute of Environment Protection Engineering.

In: Polish/U.S. Symposium on Waste Water Treatment and Sludge Disposal, February 10-12, 1976, Cincinnati, Ohio, EPA Environmental Research Center, Cincinnati, Vol. 2, p 141-150. 10 tab.

Laboratory and pilot tests were conducted to investigate the renovation of secondary effluent from a trickling filter and an activated sludge process. Coagulation, sedimentation, recarbonation, filtration and sorption were used. Trickling filter test results showed treatment efficiency as follows: 77.8% reduction of permanganate, 86.1% BOD removal, 33% ammonia nitrogen reduction, and 37.1% phosphate removal. The secondary effluent coagulated with lime or aluminum sulfate and was subjected to sedimentation, filtration on a sand bed, and passage through the activated carbon filters. Sewage was recarbonated with carbon dioxide before filtration when lime was used. A simultaneous coagulation with a carbon slurry provided the best laboratory results. Pilot plant studies with aluminum sulfite or lime did not significantly remove ammonia nitrogen. Calcium oxide was reduced when filtered on a sand-anthracite bed and further reduced on a sand-carbon bed. Permanganate was significantly decreased, although sewer hardness was very high. Laboratory tests with the activated sludge reduced permanganate by about 50%, and removed phosphate and turbidity. High concentrations of either required high lime doses. Recarbonation was achieved by bringing carbon dioxide to the water and coagulating with lime, mixing rapidly, bringing pH up to 8.3, mixing slowly, settling, and decanting. The best alkalinity and hardness removal occurred with recarbonation after coagulation and sedimentation. Raised permangante values were found in all recarbonated water samples. Coagulation with ferric or aluminum sulfate resulted in increased dissolved solids concentrations.

*Reclaimed water, *Trickling filter, *Activated sludge, *Coagulation, *Sedimentation, Carbon, Filtration, Sorption, Treatment facilities, Waste water treatment, Laboratory tests, Pilot plants, Sludge treatment

Renovated water, Recarbonation

D211
COMPOSTING OF SEWAGE SLUDGE AND SOLID WASTE MATTER,

Cebula, J.

Department of Waste Water Technology and Sludge Disposal,
Ministry of Administration,
Local Economy and Environment Protection,
Warsaw, Poland.

In: Polish/U.S. Symposium on Waste Water Treatment and Sludge Disposal, February 10-12, 1976, Cincinnati, Ohio, EPA Environmental Research Center, Cincinnati, Vol. 2, p 18-32. 5 fig, 4 tab, 28 ref.

Textile and chemical sludges were composted with municipal solid wastes at the Gluszyca, Poland, treatment plant to determine the value of composting in sludge management. Six areas were studied: treatment and preparation of sewage sludges for final disposal; characteristics of domestic wastes accumulated in the catchment area; joint sludge and wastes composting; role and effects of heavy metals on soils and plants; and practical aspects of sludge compost usage. Sludges were analyzed after dewatering and thickening. They contained less organic matter and essential components, in considering fertilizing and biological properties (C, H, N, P, K, Ca), than household solid wastes. The latter contained 61% fractions by weight and most of the organic matter suitable for composting. Sludge was difficult to dewater, emitted a disagreeable odor, and was greasy before composting. Afterwards the compost was not sticky and was easy to apply on soil. It stimulated plant growth. A 6 to 8% sludge content and 10 t/ha dose were considered optimum. Mathematical statistics were used to determine trace element occurrence distribution as well as the reliability of results. The variability of occurrence was found to be a useful tool in establishing the suitability of sludge for agricultural disposal and indicated the potential toxicity of soil under consideration. It was concluded that industrial composts were suitable for agricultural use.

*Sludge treatment, *Sludge disposal, *Solid wastes, *Industrial wastes, *Municipal wastes, *Domestic wastes, *Heavy metals, Trace elements, Environmental sanitation, Organic matter, Analysis

Composting, Gluszyca (Poland)

D212
TRENDS IN SLUDGE TREATMENT AND DISPOSAL PRACTICES IN THE UNITED STATES,

Farrell, J. B.

Municipal Environmental Research Laboratory,
U.S. Environmental Protection Agency,
Cincinnati, Ohio.

In: Polish/U.S. Symposium on Waste Water Treatment and Sludge Disposal, February 10-12, 1976, Cincinnati, Ohio, EPA Environmental Research Center, Cincinnati, Vol. 2, p 11-17. 1 tab, 11 ref.

Sludge disposal in the United States was a nuisance situation resulting from waste water treatment. Until recently, most sludge treatment procedures and equipment were borrowed from existing technology with little need for innovation. No standards were developed for sludge treatment which were comparable to those of waste water treatment. Cost has been the greatest factor in sludge treatment and disposal. This situation has begun to change. Several factors which now influence disposal include: process considerations, disposal choice, site and related circumstances, and ecological considerations. Protection and conservation have become major factors in treatment and disposal during the past decade. Oceans, as well as communities, must be protected from environmental dangers of improper disposal. Odor, particulate discharge, and groundwater pollution must be controlled or eliminated. Proper safeguards should be developed relative to incineration and landfilling. Resource conservation must also be emphasized. Efforts are underway to develop methods for control of sludge composition in sewers and landfills, incinerator standards for heavy metals, and fuel conservation in sludge treatment processes. The future seems to indicate discontinued ocean disposal, coincineration and copyrolysis with solid wastes, conversion of sludge to other forms, and improved beneficial land disposal methods.

*Sludge treatment, *Sludge disposal, *Waste water treatment, *Environmental sanitation, Groundwater, Water pollution, Landfills, Sewerage, Incineration, Planning, Heavy metals, Standards, Fuels

Ocean disposal, Composting, Pyrolysis

D213
THE CURRENT ROLE OF WASTEWATER DISINFECTION,

Murphy, K. L.

Water and Pollution Control, Vol. 115, No. 1, p 13-16, 36, January, 1977. 5 fig, 4 tab.

Disinfection has become a unit process in municipal waste water treatment, primarily because of the success of chlorination. This process reduces disease-causing enteric pathogens which would otherwise impair potable water sources, shellfish harvesting areas, and recreational resources. The number of coliforms in water for certain uses has been limited by law. Studies have been conducted to determine the relationship of water quality to risk of infection, but no concise conclusions have been drawn. In addition to chlorine, hypochlorous acid (hypochlorite ion), which reacts with ammonia and amino groups to form chloramines, is also used as a disinfectant. Studies relating to disinfection of waste water by these substances and their effects on pathogenic organisms are reviewed. Because effluent toxicity may be increased by chlorination, careful monitoring should determine whether overall benefits exceed negative environmental effects.

*Disinfection, *Waste water treatment, *Municipal wastes, *Chlorination, Coliforms, Pathogens, Water utilization, Infection, Environmental sanitation, Ammonia, Organic compounds

Hypochlorous acid, Amino groups

D214
THE PLIGHT AND PROMISE OF ON-SITE WASTE WATER TREATMENT,

Hershaft, A.

Interstate Electronics Corporation,
Arlington, Virginia.

Compost Science, Vol. 17, No. 5, p 6-12, Winter, 1976. 3 fig, 2 tab, 36 ref. 2 append.

The problems faced in the development of on-site domestic sewage treatment stem from the assumption that such treatment is primitive and unenlightened. However, it is being proposed as a viable alternative to centralized treatment systems. Prototype sewer systems were used as early as 3750 B.C. in an Indian culture. New York City, in 1805, built the first American sewer system and added a treatment plant in 1870. The present American system is basically the same as the Roman design with the addition of treatment facilities. Several drawbacks seen in the system of centralized sewerage are pollution of ground and surface waters, dispersal of toxic substances, groundwater depletion, induced development of communities, and high construction costs. These involve eutrophication and drawing water from aquifers to surface waterways. In 1973, the total cost for building municipal treatment and collection facilities which were eligible for Federal funding was $60 billion. On-site treatment usually involves some type of water conservation and effluent discharge into soil. Two types of on-site treatment are cesspools, and septic tanks. Studies are being made of the applicability of aerospace and advanced technologies to the improvement of on-site treatment.

*Sewerage, *Municipal wastes, *Domestic wastes, *Septic tanks, *Cesspools, Treatment facilities, Pollution abatement, Water pollution sources, Planning, Costs, Treatment, Water conservation

On-site treatment

D215
SUBSURFACE INJECTION-HOW MUCH DOES IT COST?,

Houck, C. P., and Smith, J. L.

Black and Veatch,
Denver, Colorado.

Water and Wastes Engineering, Vol. 14, No. 1, p 35-42, January, 1977. 1 fig, 13 tab.

The cost considerations involved in subsurface injection are explored. The decision to use a land application system for sludge disposal may be either dependent or independent of in-plant sludge stabilization and handling costs. Sludge-associated costs are in-plant stabilization costs; transportation costs from plant to disposal site; and costs for subsurface injection. There are various points where these costs may merge. Other factors concerned are land area needs based on sludge quantities which, with plant size, influence costs; land preparation costs; and system hardware costs. Examples were given for calculating costs involved in the decision process.

*Decision making, *Sludge disposal, *Costs, Treatment facilities, Underground waste disposal, Analysis, Planning, Waste water treatment, Sewage disposal, Ultimate disposal

Subsurface injection, Land applications

D216
TREATMENT OF SEWAGE BY ELECTRONS AND GAMMAS,

Physics Today, Vol. 29, No. 12, p 20, December, 1976.

High energy electron and gamma ray treatment of sewage sludge for use as fertilizer was studied. MIT designed a facility to treat 100,000 gpd. A sludge slurry (2-5% solids) flows through an electron beam from a high-voltage accelerator which disinfects and destroys bacteria. Ionization may possibly break up toxic chemical pollutants such as PCB's and pesticides. Advantages of this system are the availability and controlability of the ionizing energy and the lack of radioactivity introduction into the treated matter. Economic analysis suggests the system may be practical. Sludge with 5% solids could be treated for approximately $16/dry ton of sludge processed. Capital costs would be about $500,000 and operational costs would be about $120,000. A 400,000 rad exposure eliminates coliforms and salmonella and reduces bacteria and viral counts. Sandia Laboratories, Albuquerque, New Mexico, investigated gamma ray sewage treatment. The system uses heat and radiation to produce liquid sludges suitable for soil conditioning and restoring depleted soils. Studies indicated possible restoration of treated wastes to the food chain as animal feed. A major advantage is the high penetrating capability of gamma rays. Economic feasibility has been projected for this system. Other experiments attempted to remove the curing process to allow treatment of larger waste volumes. Costs are estimated as $3-5 per ton.

*Sewage treatment, *Irradiation, *Ionization, *Electronic equipment, Sludge treatment, Disinfection, Heat treatment, Toxicity, Viruses, Bacteria, Chemical wastes, Costs

Electron treatment, Gamma ray treatment, Massachusetts Institute of Technology, Sandia Laboratories (Albuquerque, NM)

D217
NEW VISIBILITY FOR ON-SITE WASTE TREATMENT SYSTEMS,

Smyser, S.

Compost Science, Vol. 17, No. 5, p 12-14, Winter, 1976. 2 tab.

A review was presented of EPA involvement in on-site waste treatment development and demonstration projects. This is an emphasized area because the economic and environmental costs of sewerage has greatly increased. Past EPA performance in this respect has been criticized as being inadequate and slow. Prohibitive costs make alternative developments a great need in many communities. It was revealed that the most detailed comparative cost information was from industry sources. One study indicated that individual composting toilets could produce a 79% saving over central sewerage in two small Massachusetts towns. Another study in Sterling, Connecticut, showed that the use of on-site composting units would eliminate annual operating costs, reduce water consumption by 40%, cut garbage disposal and chlorine costs, and make a zero-discharge situation possible. The lack of reliable information on composting systems is the major hindrance. Other studies and investigations reviewed were water recycling for garden fertilizing and the several far sighted efforts in Maine, New Hampshire, and Oregon relative to environmental planning: separated waste water systems, water use reduction schemes, and evaluation of self-contained sewage treatment systems.

*Waste treatment, *Sewerage, *Treatment facilities, Sewage treatment, Domestic wastes, Industrial wastes, Waste water treatment, Planning, Costs, Sewage disposal, Project planning, Projects, Economics

On-site treatment development

D218
UNOX SYSTEM FOR WASTE WATER TREATMENT,

Braunscheidel, D. E., and Gyger, R. G.

Union Carbide Corporation,
Linde Division,
Tonawanda, New York.

Chemical Engineering Progress, Vol. 72, No. 11, p 71-72, November, 1976. 1 fig.

Various aspects of nitrification in waste water treatment were investigated. The Monod model was used as a convenient means of describing ammonia substrate removal and bacterial growth of nitrifying organisms. Specific cell growth rate is proportional to substrate concentration until a maximum is reached and it becomes independent of this factor. Nitrifying bacteria growth rates are determined by evaluating effects of temperature, pH, and dissolved oxygen levels. Mass balances for ammonia and bacteria are determined relative to the activated sludge system. A relationship is formed between system sludge residence time (SRT) and the above parameters. A pH between 7.0 and 8.0 has been found preferable for nitrifying bacteria. Toxins and inhibitory substances suppress or inhibit bacteria growth. Experiments supported data predictions of the model. Single and two-step systems were described. The first system performs carbonaceous removal and nitrification in the same reactor at low organic loadings and long retention times. With low loadings, solids production per unit BOD5 is low and oxygen use per BOD5 unit is higher than in conventional carbonaceous systems. The two-step systems separate the two processes and carbonaceous removal is not as efficient as in the one step system. However, high food to biomass ratios allow low SRT's and small tank volumes. Influent is fed to the second step, low in BOD, allowing low food/biomass ratios and short SRT's. Total oxygenation tank volume of the two-step method is less or equal to that of the one step system. Oxygen consumption is higher and sludge production is lower in the one step process. Economics and waste water characteristics should determine the system used.

*Waste water treatment, *Nitrification, *Bacteria, *Growth rates, *Toxins, *Ammonia, Temperature, Hydrogen ion concentrations, Dissolved oxygen, Biomass, Biochemical oxygen demand, Sludge treatment, Model studies, Economics

UNOX, Monod model

D219
DESIGN AND CONTROL OF SECONDARY SETTLEMENT TANKS,

White, M. J. D.

Water Research Centre,
Stevenage Laboratory,
Stevenage, England.

Water Pollution Control, Vol. 75, No. 4, p 459-467, 1976. 8 fig, 2 tab, 17 ref.

The determination of settled volume at one solids concentration was studied as a parameter of the design and control of secondary settlement tanks. Solids loadings (mass flux) has two components - that of floc settling under gravity and that of sludge withdrawal from the tank bottom. Plotting the solids loading curve against that for solids concentration reveals the maximum solids loading. A method was given to make these determinations by assaying settled volume of mixed liquor in a stirred cylinder and dividing by the solids concentration to give the stirred specific volume (SSV) in milliliters/gram. The reciprocal of the resultant figure multiplied by 100, converting the units to percent, reveals the stirred sludge density (SSD). This experimental data measured the settling characteristics which were used to predict maximum solids loadings. Calculations made at a suspended solids concentration of 3.5 grams/liter were found adequate for these determinations. Results indicated that a low sludge return rate was best for design purposes. The concern was to decide on a SSV value. Design-related SSV predictions showed that SSV may be 80-140 milliliters/gram for partial-treatment plants with a sludge age less than 1.5 days with no nitrification; SSV of 100 milliliters/gram is good for plants with fully nitrified effluents and sludge age greater than 5 days; and SSV of 120-160 milligrams/gram is sufficient for plants with sludge age between 1.5 and 5 days. For settlement tank control, SSV calculations ensure a better determination of maximum solids loading. Maximum MLSS concentrations at a given flow rate or the maximum flow rate for a given MLSS can be calculated. In nitrifying plants, denitrification in the final tank and filamentous organism growth can be prevented by employing an anoxic zone.

*Sedimentation, *Sedimentation basins, *Design criteria, *Suspended solids, Sludge treatment, Nitrification, Denitrification, Flow, Equipment, Waste water treatment

Stirred specific volume, Stirred sludge density, Solids loading, Filamentous organisms

D220
SLUDGE DEWATERING PILOT PLANT DESIGN. PART 2,

Water and Sewage Works, Vol. 123, No. 12, p 64-67, December, 1976. 2 fig, 23 ref.

The design of a pilot plant for on-site or laboratory pilot testing was presented. The design was for a system which would operate during the entire cycle and have integrated recorders to graph pressure and total flow for the cycle. Criteria established included: a 15 gallon capacity and a filter press; the duplication of actual treatment and process control; equipment for chemical and heat treatment before dewatering; full instrumentation and recording devices for documentation of the filtration cycle for scale-up to the actual system; easy portability and ruggedness; a 3 to 10%, by weight, range for sludge suspended solids; constant pressure filtration; and automatic system controls. Design specifications were given for sludge storage and heat treatment vessels, chemical addition pumps, and the automatic control apparatus.

*Sewage disposal, *Dewatering, *Sludge treatment, Filtration, Pilot plants, On-site tests, Treatment facilities, Waste water treatment, Pumps, Temperature

D221
FAST-TRACKING CUTS COSTS 16% ON ADVANCED WASTE WATER PLANT,

Engineering News-Record, Vol. 197, No. 26, p 47-48, December, 1976.

The construction of a 15 mgd advanced waste water treatment plant near Hillsboro, Oregon, involved the first application of fast-tracking in treatment plant building practices. This method resulted in a $3.8 million saving and a completion date nine months earlier than with conventional methods. Savings were also realized by bidding the project in small packages, eliminating general contractor markup of subcontractor bids, and eliminating equipment markup. Forty-one of forty-eight contracts have been awarded and the project is 54% complete. Construction packages included excavation, raw sewage pump station, and construction of primary treatment facilities. Some consideration should be given to the fact that project approval time-lag might negate any time savings from fast-tracking. One advantage is that the owner will probably know more about the facility after construction, which may aid more effective operation. The plan involved a 10-year plan to replace six smaller and less efficient plants which will be dismantled. Salvageable equipment will be sold. The plant will be able to handle a 45 mgd peak flow. Primary treatment facilities include a raw sewage pump station, comminution basin, grit basin, four 100-foot diameter primary clarifiers and a primary sludge pump station. There is a pure oxygen activated sludge system and waste water will be treated with alum and polymers to remove phosphorus and remaining settleable organic matter. Advanced treatment sections will only be used during summer, and waste sludge will be used as fertilizer. Methane gas from sludge digesters will be used by the plant.

*Treatment facilities, *Construction, *Construction costs, *Sewage treatment, Sludge treatment, Waste water treatment, Tertiary treatment, Economics, Equipment

Fast-tracking, Hillsboro (OR)

D222
ADSORPTION, COAGULATION AND FILTRATION MAKE A USEFUL TREATMENT COMBINATION-PART 2,

Wang, L. K., Ross, R. G., and Ciccone, V. J.

Water and Sewage Works, Vol. 124, No. 1, p 32-36, January, 1977. 2 fig, 5 tab, 17 ref.

The use of a mobile water purification unit in waste water treatment has been investigated. The unit combines adsorption, coagulation, and filtration processes. In testing, the mobile unit was adapted for treatment of kitchen, field laundry, and shower waste waters. The unit contained three 1500 gallon collapsible storage tanks and one blending tank of the same capacity for waste water equalization. Treatment also involves using powdered activated carbon, polyelectrolytes, sludge concentration, and a diatomite filter. Another change made was the use of the raw water pump for pumping waste water from the mixing tank to the Erdlator (upflow clarifier) tank. The unit was designed for transport on rotary and fixed-wind aircraft and general purpose lightweight ground vehicles. Each waste water stream was individually treated before combined treatment proceeded. Treatment results indicated turbidity removal of 99.9%, BOD removal of 81%, and TOC removal of 92%.

*Waste water treatment, *Adsorption, *Coagulation, *Filtration, *Domestic wastes, Domestic water, Activated carbon, Polyelectrolytes, Sludge, Design criteria, Treatment

D223
STABILISATION LAGOONS INCLUDING EXPERIENCE IN BRAZIL.
PART 1,

Bradley, R. M., and Alvares Da Silva, M. O. S.

Effluent and Water Treatment Journal, Vol. 16, No. 12, p 619-622, 624-625, December, 1976. 1 fig, 6 tab, 40 ref.

Design criteria for stabilization lagoons are summarized. Under discussion are anaerobic, aerobic facultative, aerated, and polishing lagoons. Because numerous factors are involved in algal-bacterial processes, a rational design procedure is difficult to establish and many different methods are used. Principal factors which affect anaerobic lagoon purification efficiencies are temperature, pH, liquid detention time, and solids retention. Efficient methane production is ensured in a pH range of 6.8 to 7.2; BOD reduction is usually about 50% to 70%. The use of aerobic lagoons requires a knowledge of the density of algal cells and a method of relating oxygen production to light conversion efficiency and light intensity. A rational design procedure has been developed specifically for aerobic lagoons. Facultative lagoons achieve purification of organic wastes by aerobic and anaerobic processes in inter-related reactions, and many are designed on the basis of organic loading rates. Polishing lagoons are designed on the basis of detention time for the purpose of improving effluent which has received a high degree of purification by previous biological treatment. Increased algal growth and higher suspended solids levels and turbidity in the final effluent must be balanced against the increased reduction of bacteria and viruses resulting from longer detention times. Specific design criteria, based on experience with stabilization lagoons, were presented.

*Design criteria, *Oxidation lagoons, *Aerated lagoons, *Anaerobic treatment, *Aerobic bacteria, Sewage lagoons, Photosynthesis, Sludge treatment, Waste water treatment, Industrial wastes, Methane, Temperature, Hydrogen ion concentration, Biological treatment

Aerobic lagoon, Facultative lagoon, Polishing lagoon

D224
ACID SOLUBILIZATION OF SEWAGE SLUDGE AND ASH CONSTITUENTS
FOR POSSIBLE RECOVERY,

Oliver, B. G., and Carey, J. H.

Canada Centre for Inland Waters,
Burlington, Ontario, Canada.

Water Research, Vol. 10, No. 12, p 1077-1081, 1976. 3 fig, 2 tab, 15 ref.

The disposal of sludge incineration matter has posed a potential hazard, since its ash contains some heavy metals which are leachable. An investigation was done to determine the possibility of using acid solubilization of sludge and ash constituents to reduce the problem. Digested sludge samples were collected from eight southern Ontario activated sludge treatment facilities. A procedure was adopted, based on data from the samples, for acid extraction of sludges. H_2SO_4 or HCl was added to lower sludge pH to 1.5, and solids were then separated from the leachate by vacuum filtration. The residue was rinsed with an equal volume of water to restore a normal pH and the solids could be disposed on agricultural land. Leachate can be processed for recovery of valuable components. Testing revealed that toxic trace metals recovery from wet sludges does not seem economically viable. Other studies showed that soil bacteria, especially under aerobic conditions, release high percentages of heavy metals in digested sludge when applied to agricultural land. Removal and recovery of metals and phosphates from sludge incinerator ash was not proven economically attractive. Investigations on the effect of incineration parameters on leachability of ash components is needed because temperature in this process has a great effect on leachability of ash metals.

*Heavy metals, *Activated sludge, *Acids, *Sludge disposal, *Sludge digestion, Sludge treatment, Treatment facilities, Leachates, Resources, Incineration, Waste water treatment, Sewage disposal, Temperature

Acid solubilization

D225
FUEL GAS AND ELECTRICITY FROM MUNICIPAL SEWAGE,

Bargman, R. D., and Betz, J. M.

In: Symposium on Clean Fuels from Biomass, Sewage, Urban Refuse, and Agricultural Wastes, January 27-30, 1976, Orlando, Florida, p 115-121. 4 tab.

Methane gas can be a useful by-product of activated sludge treatment. This aspect of waste water treatment has gained interest since a federal law now requires secondary treatment of waste water before disposal. Methane gas is formed by a biological process during which micro-organisms decompose organic matter during sludge treatment. The City of Los Angeles, California, operates the Hyperion Treatment Plant which has produced methane by this process for 25 years. In this, as in most instances, methane gas production is insignificant in comparison to community needs, but is usually quite enough to operate machinery at the plant with the possibility of some excess gas production. In addition to providing gas for diesel engines for driving compressors or producing electricity, this plant also provides energy for the start-up process of a nearby power plant in emergency cases. The total electrical energy produced by the plant is 140,000 kwh/day at a cost of $.0120/kwh. The gas produced contains 65% methane and 35% carbon dioxide and provides about 94% of the fuel requirements of the plant's diesel engines.

*Fuels, *Methane, *Gases, *Activated sludge, Sludge treatment, Biological treatment, Methane bacteria, Energy, Electricity, Treatment facilities, Microorganisms, Waste water treatment

Hyperion Treatment Plant, Los Angeles (Calif)

D226
FLUOSOLIDS INCINERATOR COMMISSIONED AT ESHER,

Water Services, Vol. 80, No. 970, p 753-754, December, 1976.

Operational aspects of the fluosolids incinerator at Esher, England, were reviewed. The plant was designed to cope with the ultimate disposal of sludge residue from treatment plants by employing incineration. The process includes a mechanically raked screen, detritor, primary sedimentation, biological filters, humus tanks, microstrainers, and sludge incineration. After thickening, conditioning by lime and copperas, and dewatering by coilfilters, the coilfilter sludge cake is fed to the fluosolids system for incineration. The sludge cake is mixed within the hot sand bed to evaporate the water content and the organic components react with oxygen in the fluidizing air to achieve complete combustion with a minimum of excess oxygen at minimum temperatures. Exit gases pass through a heat exchanger and then to a venturi scrubber with a multitray cooling section. This removes solids/particulate matter from the gas stream and adds alkali for maximum SO_2 removal. Water droplets with particulate solids are removed from the gas stream in a vane separator. The fluosolids reactor operates at a temperature of 620 C. Minimal heat losses from the refractory lined shell and the heat reservoir of the sand bed allow a short reheating time after shut down periods. The incinerators can be shut down instantly without harm or a need for quench water or cooling air maintenance. The reactor has no moving parts.

*Treatment facilities, *Incineration, *Sludge disposal, Sludge treatment, Solid wastes, Ultimate disposal, Sedimentation, Filters, Biological treatment, Dewatering, Lime, Oxygen, Gases, Waste water treatment, Organic matter

Copperas, Sulfur dioxide, Fluosolids

D227
WASTE WATER SYSTEM USES MICROWAVES,

Chemical Engineering, Vol. 84, No. 3, p 77-78, January, 1977. 1 fig.

Sterilized, dry solids which are ready for disposal are produced by the six-step Watertek waste water treatment system that employs a microwave oven. The process produces liquid discharges which are clear, odor-free, and meet EPA 1983 waste water effluent standards. Settling ponds, digesters, and sludge beds are eliminated by this process. A more compact design is possible because liquid and solid wastes can be fully treated in 60 minutes. A 250,000 gpd system uses a space of about 30 x 40 feet, with a height of about 15 feet. Each step of the process forms a module of the system. In the first step solids are passed through a micro-screen filter and then to the oven, while liquid passes to a pressure vessel for the addition of air. A cationic polyelectrolyte polymer is added to the liquid and the mixture moves to an air float chamber where micro-bubbles form. The polymer acts as a coagulant for solids which collect in the bubbles. A rotating skimmer collects the bubbles and they are fed to a vacuum filter and/or centrifuge and, then, to the oven. Water moves to an ozone disinfection cell for sterilization and is passed out of the carbon filter as a clear and contaminant-free solution. Solids are dewatered before entering the microwave oven and, depending on feed composition, can be used for fertilizer or landfill.

*Waste water treatment, *Microwaves, Water purification, Solid wastes, Liquid wastes, Treatment facilities, Coagulation, Filters, Polyelectrolytes, Disinfection, Ozone, Sewage effluents, Dewatering, Fertilizers, Landfills

Watertek

D228
PROCESS TECHNOLOGICAL BACKGROUND REGARDING NEW PROTECTIVE REGULATIONS OF WATER BODIES-RESULTS OF NITRIFICATION AND PHOSPHORUS ELIMINATION EXPERIMENTS IN ZURICH AND BERN. III. FILTRATION BY FLOCCULATION FOR THE ELIMINATION OF PHOSPHORUS FROM COMMUNAL WASTE WATER (Verfahrenstechnische Unterlagen im Hinblick auf die neuen Gewaesserschutzanforderungen-Ergebnisse der Versuche ueber die Nitrifikation und Phosphorelimination in Zuerich und Bern. III. Flockungsfiltration zur Elimination von Phosphor aus Kommunalem Abwasser),

Boller, M.

Gas-Vasser-Abwasser, Vol. 56, No. 11, p 615-622, 1976. 15 fig, 4 tab, 11 ref.

Advanced phosphorus removal process combinations with contact filtration as the last stage were evaluated in pilot scale experiments. The study indicated that contact filtration is especially feasible in the intake areas of lakes which are heavily loaded with phosphorus due to large point sources. The combination of contact filtration with other processes leads to very low phosphorus and suspended solids concentrations, averaging 0.1-0.4 milligrams/liter (phosphorus) and 0-5 milligrams (dry solids). An approximative calculation of annual costs for various phosphorus elimination processes and the annual costs per person for contact filtration combined with simultaneous precipitation indicated that they were about equal to those of a pH 9 post-precipitation system. More stable elimination performance and lower sensitivity to hydraulic shock loads are added advantages which shift the cost-benefit effect further in favor of contact filtration. Conclusions are reached concerning the design of contact filters for waste water treatment.

*Filtration, *Flocculation, *Phosphorus, Analysis, Suspended solids, Costs, Cost-benefit ratio, Waste water treatment, Performance, Evaluation, Filters, Design

D229
SLUDGE INCINERATION AT ESHER,

Effluent and Water Treatment Journal, Vol. 16, No. 11, p 559-560, November, 1976.

A new Fluosolids sludge incineration plant has become operational in Esher, England. The plant, now serving a population of 70,560 with a treatment capacity of 1,000 kg/hour, is capable of handling 200,000/hour, if necessary. There is no odor with this method and the sludge is reduced to a fine inert ash. After thickening, the sludge is treated with lime and copperas and transferred to coil filters for dewatering. A sludge cake is formed which can be discharged for transportation or fed into a three section reactor for incineration. Interlocking fail safe systems are provided.

*Incinerators, *Treatment facilities, *Sludge treatment, Equipment, Costs, Water utilization, Evaluation, Performance, Water reuse, Waste water treatment

Esher (England)

D230
WASTE WATER TREATMENT PLANT BUILT IN WET HOLE,

Svenson, G.

Western Construction, Vol. 52, No. 1, p 32, 34, January, 1977.

A $16,630,000 tertiary waste water treatment plant is being constructed in an excavation. The completed facility will be entirely underground. Various stages of construction are carried on at the same time. Several interesting construction techniques are employed. Pre-fabrication of steel piping, a point-of-need warehouse system, and a 70-ton crane, capable of reaching all parts of the structures, contribute to cost savings. Vertical trenching was specified for all underground piping and, because the site is below groundwater levels, it is constantly dewatered. Steel piping was coated, lined and prefabricated at one plant, allowing piping delivery before schedule. Most concrete is to be below water levels and wells were scattered about the site to allow building below grade. Specifics of construction and transport methods were presented.

*Treatment facilities, *Construction, *Construction costs, *Construction equipment, *Construction materials, Excavation, Concrete, Steel, Cranes, Fabrication

D231
UPGRADING BIOLOGICAL SEWAGE TREATMENT PLANTS TODAY,

Environmental Science and Technology, Vol. 11, No. 2, p 124-125, February, 1977.

Sodium bicarbonate has become a viable treatment chemical alternative. It is useful in adjusting pH, providing reserve alkalinity, and increasing efficiencies of aerobic and anaerobic processes. In a water treatment plant it can be added at any point giving access to the system. In secondary treatment plants, it can be added at the influent inlet of an aerobic system, at the primary settling tanks, or at the vacuum break of a digester. Sodium bicarbonate is most useful in plants with a 5 mgd flow with mostly low pH or acidic wastes. The treatment is uneconomical with facilities having a flow less than this. It is safe to handle, a natural buffer, and cannot be overdosed. No amount of dosing produces a pH greater than 8.1 to 8.3. Sodium bicarbonate was not widely used in municipal sewage treatment because lime, alum, and other chemicals had been successful over the years. With stricter requirements for effluent quality and monitoring, evaluation of sodium bicarbonate and its subsequent use increased. The relative ease and safety of sodium bicarbonate use make it an attractive alternative, especially where pH levels above 6.5 are required.

*Treatment facilities, *Biological treatment, *Municipal wastes, *Chemical treatment, Aerobic treatment, Anaerobic conditions, Sludge digestion, Alkalinity, Hydrogen ion concentration, Nitrification, Lime, Settling basins

Sodium bicarbonate, Alum, Sodium hydroxide, Buffering

D232
PURIFYING WATER,

CSIRO (Australia) Annual Report, No. 28, p 37-40, 1975/76. 2 fig.

Australian needs to purify water of poor quality for domestic and industrial use are expected to become urgent in the next 10 years. Desalination will be one of the processes used on a large scale for this purpose. Water from sewage and industrial effluents will also be recycled. Investigations are being made to study the use of polymers in water purification. Desalination with heat-regenerable resins used with polymer particles was thought to be economical, but micro-particles caused some handling problems. Techniques have been developed for the combination of acidic and basic micro-particles into conventional-sized composite beads which can be handled normally. Resins have successfully reduced water salt content from 3000 milligrams/liter to as low as 50-100 milligrams/liter. A desalination plant at Adelaide removes 80% of water salinity and produces 600 cubic meters of purified water per day. Modified polymers have been used for a great range of ion-exchange processes. Bicarbonate, calcium, magnesium ions, and heavy metals have been removed by these processes and they have been used to soften and decolor water. The use of resins has made possible a relatively continuous purification process since they are added at one end of a column and withdrawn and regenerated at the other. Magnetic polymers have been used as filter aids. Physical and chemical treatment processes studied include the use of lime treatment, ammonia stripping with air, coagulation with iron salts, sand filtration, chlorine disinfection, and activated carbon treatment.

*Water quality, *Water purification, *Water reuse, *Polymers, *Chemical treatment, Desalination, Sewage effluents, Industrial wastes, Heat treatment, Ion exchange, Resins, Pollution abatement, Waste water treatment

D233
DESIGN CRITERIA FOR WASTE WATER AERATOR DRIVES,

Van Gelder, P.

Water and Sewage Works, Vol. 124, No. 1, p 66-69, January, 1977. 1 fig, 2 tab.

Because of stricter pollution control laws, industrial firms are beginning to develop new water treatment facilities with technology often beyond their normal spheres of operation. One important area is that of aerator drives. Mechanical aerators oxygenate ponded waste water to quicken aerobic digestion. Two basic aerator types are the fixed-platform and the floating aerator. An engineering survey is necessary to determine the one best suited for any application. Several considerations are presented, although the most important is the definition of application conditions. It has been found that a totally enclosed fan-cooled motor is the only one suited for aerator drives. Concern should be given to the choice of voltage, factors of insulation and service, corrosion-proofing, and other protective devices. The latter include temperature and overload protectors, condensation protection, and vibration protection. Safety factors relative to motor operation require that lifting devices withstand forces five times the weight of the motor; that excessive motor speeds be eliminated; and that there is proper grounding. Various factors affecting gear reducer and driver operation were considered, including gear case design, lubrication, and loading.

*Design criteria, *Aeration, *Mechanical equipment, *Aerobic treatment, *Oxygenation, Water quality control, Treatment facilities, Legislation, Electrical equipment, Design, Corrosion control, Waste water treatment

Aerator drives

D234
THE OPERATIONS SECTION OF LINCOLN SEWAGE DIVISION,

Ramsden, I., and Pullen, K. G.

Surveyor, Vol. 148, No. 4411/4412, p 11-12, December, 1976.

The personnel and management structure of the Operations Section of the Anglian Water Authority, England, was described. The headquarters staff consists of the operational services officer and the scientific officer and three area managers. The services officer is responsible for such activities as transport, communications, electrical and mechanical maintenance, and health and safety. The science officer advises on works performance and assists on process design. The lower personnel structure is described, as is the policy decision-making process. Maintenance staffs and their respective duties are outlined relative to sludge treatment and disposal, electrical and mechanical engineering, and sewerage.

*Water districts, *Operation and maintenance, *Personnel, *Budgeting, Mechanical equipment, Power operation and maintenance, Engineering personnel, Scientific personnel, Maintenance, Sludge treatment, Sludge disposal, Sewers, Treatment facilities

Lincoln Sewage Division, Anglian Water Authority (England)

D235
ENERGY CONSERVATION AND HEAT RECOVERY IN WASTE WATER TREATMENT PLANTS,

Pallio, F. S.

Malcolm Pirnie, Incorporated,
Consulting Environmental Engineers,
White Plains, New York.

Water and Sewage Works, Vol. 124, No. 2, p 62-65, February, 1977. 4 fig, 7 tab.

Heat recovery has been considered as a useful approach to energy conservation in waste water treatment. Heat pumps, heat exchangers, and the energy wheel have been evaluated. Using processed waste water or other warm waste water sources for the heat pump provides a higher temperature source than that of ambient air. The Coefficient of Performance (COP) defines heat pump efficiency and is the ratio of useful heating output to the power input. The use of warm waste water results in a higher COP than air or water. Using heat pumps would allow recovery of available energy from waste water; provide 3 to 5 times more Btu/hr/kw than direct electric resistance heating units; have an economic advantage above oil-fired heating systems; and conserve energy resources. The energy wheel is a rotary air-to-air heat exchanger consisting of a revolving cylinder packed with coarse knit metal mesh. The cylinder rotates through an exhaust air stream, picks up heat, is purged of contaminated air, and finally, rotates through the outside air stream giving off the collected heat. Incoming cold air can be pretreated by using heat from the contaminated exhaust air stream. Other advantages are the reduction of cross contamination to less than 1%, and the availability of materials that allow moisture transfer from the exhaust to the incoming air stream, aiding recovery of sensible and latent heat from air-conditioned spaces. The use of the energy wheel can reduce the size of heating equipment, as well as the fuel and energy consumption. Both concepts can reduce annual heating costs.

*Energy, *Conservation, *Heat, *Heat pumps, Heating, Resource development, Refrigeration, Temperature, Performance, Costs, Equipment, Waste water treatment, Sludge treatment, Treatment facilities

Energy wheel

D236
MUNICIPAL WASTE WATER TREATMENT AS AN INDUSTRIAL OPERATION,

Guthrie, D. L.

Environmental Quality Systems, Incorporated,
Rockville, Maryland.

Water and Sewage Works, Vol. 124, No. 2, p 60-61, February, 1977. 1 fig, 2 tab, 16 ref.

More advanced treatment processes, upgraded facilities, and better operation and maintenance procedures will be needed to comply with the treatment goals of PL 92-500. The costs involved require that facilities be operated as efficiently as possible to offset increased construction and operation costs. The capital investment in a municipal waste water treatment facility may reach $10 million. The suggestion that municipal treatment facilities be operated on a basis similar to that of industrial plants was reviewed. These are operated for the most cost-effective and satisfactory results and can involve higher capital costs than municipal treatment plants. A comparison was suggested with a sulfuric acid plant. Variables involved in such a comparison were initial investment, amortization, plant age, number of employees, volume of production, dollar price of the end product, and raw material cost. For municipal waste water facilities, production volume is the combined volume of sludge and effluent and the dollar price of the end product is the cost to the taxpayer. It was concluded that water quality laws will not be successful unless municipal waste water treatment is considered a profit-making operation rather than a burden. The final product is "clean water" for the consumer.

*Treatment facilities, *Operation and maintenance, *Municipal wastes, *Industrial wastes, *Costs, Legislation, Tertiary treatment, Pollution abatement, Waste water treatment, Capital costs, Construction costs, Comparative costs

Federal Water Pollution Control Act Amendments, 1972 (PL 92-500)

D237
PLUG-IN CONCEPT FOR PILOT SEWAGE TREATMENT PLANT,

Pullin, J.

Water and Sewage Works, Vol. 124, No. 2, p 52-53, February, 1977.

Waste water treatment by use of oxygenation is being studied at the advanced waste water treatment facility at Coleshill, England. The project is a pilot project for the NATO Committee on the Challenges of Modern Society (CCMS). The oxygenation is combined with conventional biological processes. The Coleshill facility has two treatment streams with a dry weather flow of 100,000 gallons/day. Treatment of both industrial and domestic flows and combination flows are being tested. Fixed facilities include a service gantry, inlet works, reagent preparation plant, sludge dewatering plant, laboratory and workshop, and a substation and office buildings. Mobile treatment units may be added at either side of the gantry to allow maximum flexibility at the works. These allow the combining of laboratory functional flexibility and full scale operation. Mobile units provide chemical flashmixing tanks; chemical flocculation tanks; settling tanks; recarbonation tanks; surface aeration tanks; biological filters; screw pumping units; multimedia filters; and granular activated carbon columns. Fixed facilities provide lime, ferric sulfate alum, polyelectrolyte, acid and carbon dioxide dosing; pilot scale multimedia filters; granular activated-carbon columns; storage tanks for biological and chemical sludges; and a sludge treatment house. Results have produced 99% phosphorus removal, 90% suspended solids reduction, 70% BOD removal and 65% COD reductions with the addition of 400 milligrams/liter of lime slurry. Portable sensors monitor all plant performance.

*Pilot plants, *Treatment facilities, *Tertiary treatment, *Biological treatment, *Chemical treatment, Construction, Design, Domestic wastes, Industrial wastes, Equipment, Personnel

Coleshill (England), NATO Committee on the Challenges of Modern Society (CCMS)

D238
ELIMINATION OF ANAEROBIC DIGESTER SUPERNATANT,

Mignone, N. A.

Water and Sewage Works, Vol. 124, No. 2, p 48-49, February, 1977. 1 fig, 1 tab, 6 ref.

Secondary digesters are used to provide solid-liquid separation, thus reducing downstream sludge handling cost. Primary high rate anaerobic digestion combined with mechanical sludge dewatering may be more expedient. Present design practices produce a supernatant liquid stream that has a relatively poor quality. It has been felt that elimination of secondary digesters, and substitution of the above method, would not be detrimental to the treatment process. High rate anaerobic digestion and mechanical dewatering would not produce a variable supernatant stream, but one having a low solids content treatable by recycling to the influent of the secondary treatment process. Storage facilities to handle excess mechanical dewatering capacity would be unnecessary and primary digesters would provide enough non-sludge dewatering storage by using floating covers. Less land would be required. Raw sludge could be dewatered easily if the primary digester failed and a constant, predictable cake concentration would be produced for ultimate sludge disposal.

*Sludge digestion, *Anaerobic digestion, *Design criteria, *Sewage effluents, Sludge treatment, Dewatering, Heat treatment, Mechanical equipment, Treatment facilities, Separation

D239
ANAEROBIC FILTER TREATS WASTE ACTIVATED SLUDGE,

Haug, R. T., Raksit, S. K., and Wong, G. G.

Water and Sewage Works, Vol. 124, No. 2, p 40-43, February, 1977. 4 fig, 4 tab, 8 ref.

The State of California has ruled against ocean disposal of waste water solids. The City of Los Angeles has studied alternate disposal schemes including treatment of liquors from thermal conditioning of waste activated sludge by anaerobic filters. This process involved thickening sludge and subjecting it to thermal conditioning at 350 F for about 30 minutes. As much as 60-70% of suspended solids were solubilized, producing a solids content of about 1.2% after conditioning. A 9% sludge was obtained with dewatering characteristics that produced a 40% cake after centrifuging without chemical additions. Thermal conditioning entailed several problems: odor control; corrosion and organic fouling of heat exchanger tubes; the need for heat energy; and necessary treatment of the decanted liquor and centrate (heat treated liquor) before disposal. The anaerobic filter was investigated for treatment of this liquor. The reactor provides an upward fluid flow through a fixed media bed. Very short hydraulic detention times and long solids retention time can be maintained easily. It cannot handle wastes with high concentrations of suspended solids. Because this heat treated liquor had low solids concentrations, it was well-suited for the process. Results indicated 85% BOD removals and 76% COD removals with a 2-day hydraulic detention time; methane production would off-set much of the process energy requirement; and disposal by heat treating, followed by dewatering and thickening with anaerobic filter treatment of the liquor, is a promising disposal method. Further research, however, is necessary.

*Filters, *Anaerobic conditions, *Heat treatment, *Dewatering, Sludge treatment, Sludge disposal, Solid wastes, Pollution abatement, Disposal, Sewage effluents, Suspended solids, Activated sludge, Waste water treatment

Los Angeles (Calif)

D240
FAIL-SAFE WASTE TREATMENT SYSTEM,

Gunn, G. A.

CH2M/Hill,
Reston, Virginia.

Water and Sewage Works, Vol. 124, No. 2, p 12, February, 1977.

In order to prevent pollution of its water supply by sewage effluents, the Occuquan Sewage Authority, Virginia, has begun construction of an advanced waste water treatment system. This system will eliminate eleven treatment plants and will have many redundancy features to ensure operation under most foreseeable conditions. Funding of the project was aided by the EPA, the state of Virginia, and local government. A regional treatment facility will handle the loads now treated by the eleven facilities, and will employ a 15 mgd capacity, five raw sewage pump stations, and 150,000 lineal feet of interceptor sewers and force mains. Treatment will consist of primary and secondary treatment, chemical treatment for phosphorus removal, ion exchange for ammonia nitrogen removal, carbon absorption and multi-media filtration for residual organics removal, and chlorination for disinfection and residual ammonia removal. Effluent quality should have a BOD of less than 1 mg/liter, zero suspended solids, a COD of less than 10 mg/liter, less than 2 coliform bacteria per 100 milliliters, and less than 0.1 mg/liter of phosphorus. The duplication of facilities includes two alternate off-site power sources and an on-site standby power generation system; an automatic bypass of incoming raw sewage to an emergency retention basin during total power failure; and piping and valves designed to accommodate any failure.

*Treatment facilities, *Planning, *Waste water treatment, *Tertiary treatment, Chemical treatment, Environmental control, Water quality, Reservoirs, Natural resources, Construction, Automatic controls, Sewerage

Occuquan Sewage Authority (Va)

D241
PLASTIC SPHERES FOR WASTE WATER TREATMENT,

Water Services, Vol. 80, No. 970, p 737-738, December, 1976.

Mechanical purification systems have been developed using modifications of the activated sludge process which are more easily adapted to variations and shock loads. The Euro-Matic Bio-Drum was developed to combine the advantages of mechanical and natural purification processes. A pair of open mesh drums, filled with hollow plastic spheres which revolve around a shaft suspended by a 'swinging arm' attached to the side of the treatment tank are the basic mechanisms. This combines the trickling filter and activated sludge processes. The plastic balls are alternately dipped in liquor to take in organic matter, and exposed to the atmosphere, to absorb oxygen and generate biological activity. Results with hydraulic loads of 6 to 25 cu m/cu m/day and BODs from 1.2 to 4.7 kg/cu m/day showed reductions of 90% at lower loadings and 40% at higher loadings. With activated settled sludge returned to thicken the mixture in the tank, at 25 cu m/cu m/day and BOD of 5.5 kg cu m/day, a 90% BOD reduction was evidenced. Operation costs of a unit with a small single motor drive are minimal as is the installation cost.

*Plastics, *Waste water treatment, *Industrial wastes, Biochemical oxygen demand, Equipment, Filters, Organic matter, Sewage effluent, Waste water treatment, Sewage treatment

D242
SCREENINGS DEWATERING PRESS,

Water Services, Vol. 80, No. 970, p 737, December, 1976.

The Temact screenings dewatering press was developed to be used with sewage screens. It is made of a hydraulically operated press with a power and hydraulic control unit and an electrical control panel. Only interconnecting wiring, washing-down, and drainage facilities are necessary. Compression separates rags, paper, and like solids from liquid and fine matter which are subject to usual treatment processes. About two-thirds of the water is removed from screenings and weight and volume are reduced 55 to 60%. Discharged dewatered screenings are compact, relatively dry, and can be automatically bagged, if desired. They have a caloric value amenable to economical incineration.

*Dewatering, *Screens, *Sludge treatment, Equipment, Treatment facilities, Incineration, Solid wastes, Waste treatment, Waste water treatment

Dewatering press

D243
ADVANCED WASTE TREATMENT SEMINAR, SESSION III, REMOVAL OF SOLIDS AND ORGANICS, HELD AT SAN FRANCISCO, ON OCTOBER 28-29, 1970,

1970. 69 p, 23 fig, 5 tab, 31 ref. Technical Report NTIS PB 246-050.

A report of a seminar on the removal of solids and organics in waste treatment was presented. Design criteria were presented for removal processes, such as horizontal and vertical-upflow sedimentation tanks, and tube and lamella settlers. Dissolved air flotation, screening devices, in-depth filtration, ultrafiltration, and activated sludge processes were evaluated from performance and economic viewpoints. New developments in sludge handling and disposal were discussed, including ocean and land disposal, disposal of organic sludge, wet sludge treatment, oxidation, dewatering, and chemical treatment. Activated carbon treatment and the use of pure oxygen in solids removal were also evaluated.

*Conferences, *Solids contact processes, *Design criteria, *Organic matter, Separation, Sedimentation, Filtration, Performance, Economics, Sludge treatment, Sludge disposal, Waste treatment, Waste disposal, Oxidation, Dewatering, Chemical treatment, Activated carbon, Oxygen, Oxygenation, Treatment, Waste water treatment

D244
SLUDGE DEWATERING ON ALASKA'S NORTH SLOPE,

Industrial Wastes, Vol. 23, No. 1, p 19, January/February, 1977.

Modern treatment methods that meet EPA regulations are being used in Alaska to replace traditional sewage disposal which usually involved ocean dumping. Techniques used on the North Slope are described. Two oil companies, Atlantic Richfield and BP Alaska, use a biological aerated sludge treatment system and a combined biological and physical-chemical system, respectively. Both, however, use continuous decanter centrifuges for sludge dewatering. Dewatering reduces the volume of sludge and improves its handling characteristics prior to disposal. Less consumption of water in the arctic lifestyle produces sewage with a high BOD or solids level. The ARCO base camp treatment system produces 450-500 pounds of cake concentrate and 5,000 gallons of clarified water per day from a waste water flow of 6 gpm containing 1-3% solids. The clarified water is recirculated to the sewage plant primary stage. Flocculation is induced in the sludge by the addition of polyelectrolytes just prior to centrifugation. This increases the rate of solids separation. The BP process handles feeds of 1-3% solids at 6 to 8 gpm, and 1% solids at 3 to 6 gpm. After dewatering, the cake concentration has 15-20% solids. The BP process reduces fuel costs for incineration, provides for continuous unmanned operation and an overload device to prevent serious breakdowns, and uses a closed system installation having operational flexibility. The De Laval decanter/centrifuges consist of a cylindrical bowl inside of which is a screw conveyor, both rotating in the same direction, though the conveyor moves at a different speed to transport separated solids to the solids discharge area. Solids and clarified water are simultaneously discharged.

*Dewatering, *Centrifugation, Separation techniques, Sludge treatment, Sewage treatment, Flocculation, Polyelectrolytes, Biochemical oxygen demand, Disposal, Incineration, Alaska, Arctic

D245
SINGLE P/C UNIT REMOVAL OF NUTRIENTS FROM COMBINED SEWER OVERFLOWS,

Murphy, C. B., Jr., Hrycyk, O., Gleason, W. T., Field, R., and Fan, E.

O'Brien and Gere Engineers, Incorporated,
Syracuse, New York.

Journal Water Pollution Control Federation, Vol 49, No. 2, p 245-255, February, 1977.
8 fig, 2 tab, 7 ref.

An investigation, beginning with a pilot scale program and concluding with demonstration-scale facilities, was conducted to determine design criteria for the construction of a system to remove nutrients from combined sewer overflows. The unit developed was a high rate combined process using primary screening, in-line alum addition and coagulation, and contact with clinoptilolite. Alum dosages which produce an aluminum: phosphorus molar ratio of 1.2 to 1.8 removed 90-95% of the phosphorus. Phosphorus removal was not enhanced by excessive alum treatment. Polymer doses for removing solids depended upon the level of solids in the overflow waste water and on the solids generated by the alum. This system could be used to partially treat lake and reservoir tributaries with an algae problem during dry weather conditions, and to treat receiving streams immediately following a storm. Ammonia removal depended upon the NH3N concentration in the influent, the volume of clinoptilolite used, and the waste water application rates. Ammonia removals of 0.36 meq/gram (5.0 milligrams NH3N/gram of clinoptilolite) were achieved. Three contactors in a series are necessary to optimize the use of clinoptilolite. This system is ideal for conditions where treatment of a point source combined sewer overflow discharge is necessary, where space limitations do not allow conventional treatment, and where conveying waste water is impractical.

*Overflow, *Combined sewers, *Nutrients, Separation techniques, Treatment facilities, Phosphorus, Ammonia, Waste water treatment, Polymers, Design criteria, Aluminum, Lakes, Reservoirs, Surface waters, Tributaries

Alum, Clinoptilolite

D246
INFLUENCE OF PHOSPHORUS REMOVAL ON SOLIDS BUDGET,

Baillod, C. R., Cressey, G. M., and Beaupre, R. T.

Michigan Technological University,
Houghton,
Department of Civil Engineering.

Journal Water Pollution Control Federation, Vol. 49, No. 1, p 131-145, January, 1977.
4 fig, 13 tab, 16 ref.

A study was conducted to determine the influence of phosphorus removal on the solids budget of an activated sludge plant equipped with aerobic digestion. Specific objectives were the determination of the quantity, solids content, digestibility, and dewatering properties of the excess sludge produced, and the determination of the effect of alum addition on solids transformations within the activated sludge and aerobic digestion processes. An 81% total phosphorus removal was achieved with liquid alum doses of 1.7 moles of aluminum/mole of influent phosphorus. The same system without any chemical addition produced a 27% phosphorus removal. Chemical-biological activated sludge processes gave 50% more excess sludge on a dry weight basis and 16% more excess sludge on a volumetric basis. There was a marked net conversion or solubilization of the solids and phosphorus components to a dissolved form. In the control this was greater than in the alum unit. Volatile and fixed dissolved solids in both units showed net productions, and total solids, total fixed solids and phosphorus seemed to be conserved in each. Similar material balances for aerobic digesters showed the alum-biological sludge to be less amenable to aerobic digestion, but the alum sludge thickened much better than the control sludge. Alum-biological sludge total suspended solids reduction was low at about 12%. It was concluded that the aerobic digestion of chemical-biological sludge would be best for sludge storage and thickening. Dewatering studies indicated that both sludges were amenable to conventional processes. Two stage aerobic digestion followed by basket centrifugation seemed to be the most economical means of dewatering for the alum-biological sludge.

*Phosphorus, *Activated sludge, *Aerobic digestion, Chemical treatment, Biological treatment, Suspended solids, Sludge treatment, Dewatering, Physical properties, Chemical properties, Waste water treatment, Economics

Alum, Phosphorus removal

D247
RECYCLING OF ALUM USED FOR PHOSPHATE REMOVAL IN DOMESTIC WASTE WATER TREATMENT,

Cornwell, D. A.

Dissertation Abstracts International B, Vol. 37, No. 7, p 3564-3565, January, 1977.

A process was developed for the economical recovery of aluminum used as a coagulant for phosphorus removal in domestic waste water treatment. Aluminum-phosphate-organic sludge was used. It was thickened to a solids concentration four times that of raw sludge, and reacted with sulfuric acid to dissolve the aluminum and phosphate. Sedimentation produced a 93% separation of available aluminum, and vacuum filtration produced a 100% aluminum separation. The acidified aluminum was separated from the phosphate by a solvent extraction process using a kerosene solution of alkyl phosphates. The aluminum-rich kerosene phase was contacted with 6N H_2SO_4 and the kerosene:acid volume ratio was adjusted to form a final aluminum concentration equal to that in commercial alum (about 5%). Recovered aluminum was reused as a coagulant in phosphorus precipitation and the kerosene was recycled to the extraction stages. Overall recovery of aluminum was 89-93%.

*Aluminum, Sludge treatment, Phosphorus, Domestic wastes, Separation, Phosphates, Coagulation, Extraction, Chemical treatment, Filtration, Waste water treatment

Aluminum recycling, Phosphate removal

D248
THE USE OF POLYMERS FOR IMPROVING CHEMICAL SLUDGE DEWATERING ON SAND BEDS,

Novak, J. T., and Langford, M.

Missouri University,
Columbia,
Department of Civil Engineering.

Journal of the American Water Works Association, Vol. 69, No. 2, p 106-110, February, 1977. 13 fig, 3 tab, 8 ref.

An evaluation was conducted of the effect of polymers on the improvement of sand bed dewatering of chemical sludges. Polymer conditioning was found to produce a sludge satisfactorily dewaterable on sand beds. Bed penetration was the condition which most frequently ruled out sand bed use. Sludges of low cake solids and high specific resistance are considered most difficult to dewater by mechanical means, but they are susceptible to sand-bed dewatering. The long period needed for air drying makes other methods more economical for dewatering dense sludges such as lime-softened sludges. Most sludges with a substantial $CaCO_3$ content have a relatively low resistance and can be dewatered by vacuum filter without added polymers. Specific characteristics of the sludge determine bed-surface requirements and the need for polymer conditioning.

*Dewatering, *Polymers, Drying, Sludge treatment, Waste water treatment, Solid wastes, Vacuum filters, Physical properties, Chemical properties, Economics

Sand bed, Chemical sludges

D249
TREATMENT OF COMBINED SEWER OVERFLOWS VIA THIN FILM CHEMISTRY,

Peloquin, A. E., Poole, S. E., and Schauffler, F. K.

New England Interstate Water Pollution Control
Commission,
Boston, Massachusetts.

Journal Water Pollution Control Federation, Vol. 49, No. 2, p 206-215, February, 1977.
4 fig, 5 tab, 3 ref.

A new treatment system was described for combined sewer overflows and/or storm water discharges. Influent for the system is pumped from a manhole by two submersible screened-inlet pumps. It is discharged above the water line in a zone where mixing with lime and ferric chloride occurs. It is further mixed, an anionic polymer is added to aid floc growth, and then it is pumped into a high rate settler (HRS-1). Clarified waste water overflows to a flow equalization unit, and is pumped to a disinfection area, where it is disinfected by sodium hypochlorite using thin film technology. Disinfected waste water is pumped into HRS-2 and the effluent from HRS-2 is discharged into the river through a by-pass sewer. Sludge produced during treatment is discharged to the sewer line downstream of the influent manhole. This method is well-suited to treating overflows and an additional benefit would accrue from treating storm water mixed with the waste water. Cost reductions are expected from replacing chlorine with ozone, modifying chemical doses, and creating a new mixing system in the influent tank. Potential applications include treating small rural area waste water, septic tank pumpings, and holding tank wastes.

*Combined sewers, *Overflow, *Storm water, Water purification, Disinfection, Equipment, Polymers, Chlorine, Sludge disposal, Waste water treatment, Costs, Rural areas, Septic tanks, Treatment, Ozone

Thin film chemistry, Sodium hypochlorite

D250
THE FABRIC-LINED PURIFICATION BASIN,

Journal of Coated Fabrics, Vol. 6, No. 3, p 137-138, January, 1977.

The development of economical small and medium-sized waste water treatment facilities in Germany has become a major concern. This is primarily because waste water from nearly 50% of households and industries is still discharged unpurified. Excavated basins with feces-retaining membranes provide an economical solution to the problem. These basins may be covered or uncovered. Covered versions would allow placement nearer communities, thus eliminating expensive pipelines and odors, while providing a nonobjectional landscape. The prefabricated liner can be coated with polyvinyl chloride (PVC) as a sealant, and a PVC-coated high tenacity Diolen fabric can be used as a roofing material.

*Settling basins, *Linings, *Water purification, Waste water treatment, Industrial wastes, Domestic wastes, Sewage effluents, Construction, Construction materials, Economics, Costs, Sealants, Roofing materials, Plastics, Treatment facilities

Polyvinyl chloride (PVC), Diolen fabric

D251
AUTOTHERMAL AEROBIC DIGESTION,

Matsch, L. C., and Drnevich, R. F.

Union Carbide Corporation,
Tonawanda, New York.

Journal Water Pollution Control Federation, Vol. 49, No. 2, p 296-310, February, 1977.
3 fig, 10 tab, 7 ref.

Union Carbide has studied aerobic digestion systems using high purity oxygen since 1972. Aerobic digestion at temperatures greater than 45 C produces a sludge which is practically pathogen-free and more suitable for land or ocean disposal. A high degree of digestion at a residence time of 5 days or less can be obtained at this temperature. Reducing vaporization losses allows the oxygen to utilize the exothermal nature of endogenous metabolism and maintain the temperature above ambient. Autothermal thermophilic aerobic digestion (ATAD) is self-regulating due to a decrease in the digestion rate when temperature rises above 60 C and the system inhibits nitrification to decrease oxygen requirements. The process is very stable and recovers from extreme equipment malfunctions and operator errors within hours of correction of the problem. The sludge from this system dewaters as well as anaerobically digested sludge. A higher degree of digestion at the same retention time, an improved oxygen use and no pathogen leakage are advantages of the two-stage thermophilic digestion system over the single stage system. Defining "stable sludge" from an aerobic digestion system was also a part of the investigation. Different degrees of stability are required depending upon the means of ultimate disposal. The ATAD process was found to be less costly than a mesophilic system because of small reactor volumes, lower oxygen requirements, less energy requirements, and the production of a pathogen-free sludge.

*Aerobic treatment, *Sludge digestion, Temperature, Oxygen, Design criteria, Metabolism, Laboratory tests, Physical characteristics, Chemical characteristics, Waste water treatment, Nutrients

D252
EXPERIENCES IN EVALUATING AND SPECIFYING AERATION EQUIPMENT,

Stukenberg, J. R., Wahbeh, V. N., and McKinney, R. E.

Black and Veatch Consulting Engineers,
Kansas City, Missouri.

Journal Water Pollution Control Federation, Vol. 49, No. 1, p 66-82, January, 1977.
13 fig, 7 tab, 18 ref.

The advancement of testing methods and knowledge of aeration theory have allowed the proper application and evaluation of aeration equipment. Testing of aeration equipment is important, even though it adds to installation costs, because performance cannot be accurately predicted. Criteria for choosing equipment should include: oxygen requirements, maximum power use allowable, turndown requirements, mixing, noise, mist or spray, allowable power variation, and method of testing. The steady state and non-steady state aeration equipment tests are valid, although they do contain problems. Problems with the steady state test are the determination of the rate of O2 uptake by activated sludge and of the O2 transfer coefficient, and the correct values of DO saturation and of the DO residual. Problems with the non-steady state test are the values of DO saturation used for the determination of the O2 transfer rate coefficient and possible cobalt interference on the Winkler DO analysis. Direct analysis of test data is valid as a supplement to conventional methods of determining O2 transfer rate coefficients.

*Aeration, *Equipment, *Activated sludge, Theoretical analysis, Oxygen demand, Performance, Design criteria, Testing, Evaluation, Sludge treatment, Waste water treatment

D253
INTERMITTENT SAND FILTRATION FOR UPGRADING WASTE STABILIZATION POND EFFLUENTS,

Harris, S. E., Reynolds, J. H., Hill, D. W., Filip, D. S., and Middlebrooks, E. J.

Utah State University,
Logan,
Utah Water Research Laboratory.

Journal Water Pollution Control Federation, Vol. 49, No. 1, p 83-102, January, 1977. 12 fig, 9 tab, 7 ref, 1 append.

A simple, economical, low maintenance treatment method was found necessary for polishing lagoon effluent to meet the requirements of PL 92-500. The need was especially urgent because many communities with a population of less than 5,000 use stabilization ponds for economical waste water treatment and lack operators and maintenance crews having a high degree of technical knowledge. Research indicated that intermittent sand filters might economically satisfy the demands of this legislation. The length of filter run was found to be related to the influent suspended solids concentration and the hydraulic loading rate, as well as to algal growth in the standing water above the filter. These filters can produce an effluent with a BOD of less than 100 milligrams/liter and a suspended solids concentration of less than 10 milligrams/liter, as well as a volatile suspended solids concentration of less than 5 milligrams/liter. Winter effluent quality was slightly lower than warm weather effluent quality, but winter operation created no serious problems. Optimum single stage intermittent sand filter hydraulic loadings were about 0.4 to 0.6 million gallons/acre/day.

*Filtration, *Soil filters, *Filters, *Oxidation lagoons, Performance, Economics, Suspended solids, Phosphorus, Nitrification, Temperature, Costs, Waste water treatment, Water purification, Sewage effluents

Sand filtration

D254
BRISTOL REGIONAL SEWAGE TREATMENT WORKS--PAST, PRESENT AND FUTURE,

Steel, P. H.

Development and Planning Division,
Wessex Water Authority,
Bristol, England.

Chartered Municipal Engineer, Vol. 104, No. 1, p 5-12, January, 1977. 10 fig, 1 tab, 4 ref.

A review of past, present, and future sewage treatment in the Bristol, England, area was presented. Proposals and actual treatment plans from 1879 to the present were first explored. The present system contains a system of main sewers which intercept old outfalls into the River Avon and provide adequate trunk sewers for the area; pumping stations which raise sewage from low-lying areas into the trunk sewer system; a main inverted siphon under the River Avon to carry sewage from south of the city to the north of the river; a main pumping station to pump sewage from the main trunk sewer to the treatment facilities; and a treatment works which handles a dry flow of 21 mgd. Partial treatment includes comminution or screening, grit removal, sedimentation and sludge digestion and secondary treatment to provide water for industrial purposes. Also included in the system is an effluent outfall on the bank of the River Severn. The advantages and disadvantages of phased development were discussed. Future proposals include modifications of the main pumping station, storm sewage treatment, sedimentation tanks, sludge thickening, regional sludge disposal, sludge digestion, added generating stations, industrial water treatment, and a tidal pumping station. These proposed additions and alterations would provide an ultimate capacity flow of 100 mgd and a hydraulic capacity of 1,520,000 cubic meters/day for the main pumping station.

*Treatment facilities, *Planning, Water purification, Water quality control, Waste identification, Waste disposal, Waste water treatment, Water districts, Sanitary engineering, Sewage treatment, Sewage disposal, Drainage, Design, Costs, Comprehensive planning

Bristol Regional Sewage Treatment Works (England)

D255
EVALUATION OF ALTERNATE SOLIDS HANDLING METHODS FOR ADVANCED WASTE TREATMENT,

Bell, B. A., and Zaferatos, T. M.

Flood and Associates, Incorporated,
Jacksonville, Florida.

Journal Water Pollution Control Federation, Vol. 49, No. 1, p 146-155, January, 1977.
4 fig, 8 tab, 10 ref.

Various methods for handling solids in advanced waste treatment were explored. Eight systems considered included: single-stage recarbonation with disposal of dewatered sludge in landfill; single-stage recarbonation, dewatering, and incineration; single-stage recarbonation, recalcination of dewatered sludge, air classification, and lime recycle; single-stage recarbonation, wet centrifical classification, recalcination of dewatered sludge, air classification, and lime recycle; two-stage recarbonation, dewatered sludge recalcination, air classification and lime recycle; two-stage recarbonation, wet centrifical classification, dewatered recalcination and lime recycle; and two-stage recarbonation, wet centrifical classification, dewatered sludge recalcination, air classification and lime recycle. Each was considered as to equipment sizing and capital and operating costs. The solids material balance must be determined for proper sizing and economic comparison; wet centrifical classification of sludge is economical for most municipal waste waters. Two-stage recarbonation with intermediate settling was thought to be economical for many municipal waste waters, although prior piloting of two-stage recarbonation is recommended before design. Waste water hardness and alkalinity, cost and availability of ultimate disposal, and quality and quantity of sludge from two-stage recarbonation greatly affect the economics of lime recalcination and recovery.

*Solid wastes, *Solids contact processes, Tertiary treatment, Sludge treatment, Operating costs, Capital costs, Sludge disposal, Chemical treatment, Evaluation, Performance, Waste water treatment

D256
SURVEY OF ANAEROBIC DIGESTION SUPERNATANT TREATMENT ALTERNATIVES,

Mignone, N. A.

Water and Sewage Works, Vol. 124, No. 1, p 42-44, January, 1977. 5 tab, 31 ref.

Several options for the treatment of anaerobic digestion supernatant were explored. Intermittent mixing was considered and outperformed continuous mixing, which seemed to result in poor bio-flocculation and inefficient solids-liquid separation. Vacuum degasification increased the quality of sludge settleability and did not have the odor and foaming problems associated with air stripping. Activated carbon treatment is supposed to increase gas production and methane content, reduce odors, increase draining, and improve supernatant quality. Returning untreated supernatant to the treatment influent can cause increases in BOD5, in dissolved and suspended solids, and in nutrients in the effluents. Supernatant disposal to sand beds is considered a solution only for very small plants. Air stripping or oxidation has mixed results, probably because the nitrification demand of supernatant liquid is more important than the carbonaceous demand. The Kraus system uses supernatant to increase organic loading on aeration tanks, provides biological process stability with variable influent flow and organic inputs, provides a ready supply of excess oxygen, and is a means for immediate plant recovery from system upsets. Phosphate could be removed from supernatant in a form suitable as fertilizer or the supernatant could be used as a growth accelerator for fish. Elutriation reduces chemical conditioning cost and improves compaction, but the loss of solids in the elutriate is considered undesirable.

*Sludge digestion, *Anaerobic digestion, Sludge treatment, Activated carbon, Sludge disposal, Oxidation, Biological treatment, Fertilizers, Waste water treatment, Sewage treatment

Air stripping, Kraus system, Gas mixing, Sand beds

D257
PROCESS COULD SAVE MILLIONS OF POUNDS ON SEWAGE TREATMENT PLANTS,

Water Services, Vol. 80, No. 970, p 740, 742, December, 1976.

The Polysorb Process, developed by Chemviron, may reduce construction costs of British treatment plants. The process employs polymers and granular activated carbon in a two-step physical/chemical program. It is economical, more quickly installed, and requires 85% less land than conventional biological treatment systems. The system produces no secondary effluent, removes more than 90% of most organic matter, and eliminates odor. The first stage removes suspended solids and the second removes dissolved organics. After disinfection the effluent can be directly discharged into lakes and streams or used for recreational, agricultural, or wildlife management purposes. Granular activated carbon can also be used to remove objectional taste and odor from potable water. Estimates suggest that about one billion gallons of water/day could be saved by industry if activated carbon filters were used instead of sand, allowing nearly indefinite recycling of water within a plant. Many millions of pounds could be saved in the construction and operating costs of plants using this process.

*Adsorption, *Separation techniques, Flocculation, Suspended solids, Water purification, Organic matter, Odor, Sedimentation, Activated carbon, Disinfection, Waste water treatment, Costs, Potable water, Sewage treatment

Polysorb Process

D258
SLUDGE DEWATERING BY BELT FILTER,

Water Services, Vol. 80, No. 970, p 742, December, 1976.

The Roediger SSP (straining, suction and pressure zones) belt filter, marketed in Britain, uses gravity draining and vacuum dewatering stages before the belt press and milling zones, where final moisture removal is conducted. The belt filter can be used with domestic and industrial waste sludge and the design reduces operating costs by requiring a minimum of flocculant. The stages of the process ensure a high solids capture as compared to conventional belt presses. A sludge cake with high solids content is produced, minimizing reconstitution during storage and facilitating handling. The sludge is mixed with polyelectrolytes in a rotating drum, and is passed over a straining zone allowing water to run through the filter belt media into a collection system. It continues through a suction zone where low vacuum ensures a filtrate slightly contaminated by fine suspended solids, necessitating only sludge flocculation, and then is pressed. The reduced flocculation requirement produces substantial cost savings. Normal final solids content is 35-40% from digested sludge, up to 35% from primary sludge, and up to 30% from aerobically stabilized sludge.

*Dewatering, *Filters, Sludge treatment, Equipment, Domestic wastes, Industrial wastes, Operating costs, Polyelectrolytes, Suspended solids, Flocculation, Chemical properties, Physical properties, Waste water treatment

Belt filter

D259
WASTE WATER TREATMENT BY UPFLOW SAND FILTRATION,

Ittihadieh, F.

Dissertation Abstracts International B, Vol. 37, No. 7, p 3534-3535, January, 1977.

Upflow sand filtration systems were investigated to determine solutions to some design problems. Parameters tested were sand media sizes, flow-rates of waste water through filters, coagulation-flocculation, pressure buildups and head losses, and removal rates of suspended and dissolved material and oxygen demands. The degree of treatment under various filtration conditions was determined and the results were evaluated. A study was conducted to test activated sludge plant effluent, trickling filter plant effluent, and primary effluent. Results indicated that the upflow method was useful as a clarification unit and for filtering activated sludge effluent. The methods for laboratory evaluation of coagulation, flocculation, and filtration were useful and necessary. When activated sludge effluent was treated in the normal manner, there was effective removal of suspended and colloidal materials. Removal was good with 44-inch No. 8-20 or No. 6-12 size media at flow rates of 6 and 8 gpm/square foot. The coagulation-filtration tests revealed that better clarification was obtained with strong waste waters than with weak waste waters.

*Filters, *Soil filters, Filtration, Design, Potable water, Water reuse, Flow rates, Waste water treatment, Oxygen demand, Water purification, Coagulation, Flocculation, Suspended solids, Domestic wastes

Upflow filtration

D260
HYGIENIC ASSESSMENT OF TERTIARY ADSORPTION TREATMENT OF DOMESTIC SEWAGE AND INDUSTRIAL EFFLUENTS (Gigienicheskaya Otsenka Tretichnoyi Adsorbtsionnoyi Ochistki Bytovykh I Promyshlennikh Stochnykh Vod),

Boncharuk, E. I., Koganovsky, A. M., Girin, V. N., and Salata, O. V.

Gigiena i Sanitariya, No. 11, p 36-39, 1976. 2 fig, 2 tab, 2 ref.

A hygienic evaluation of a combined adsorption/ion exchange tertiary treatment system was conducted. A mixture of domestic and industrial sewage effluents was tested. Results showed a substantial removal of organic matter, pathogenic microorganisms, and bacterial pollution indicators. The treated effluent could be used as recirculated water.

*Adsorption, Tertiary treatment, Domestic wastes, Industrial wastes, Ion exchange, Organic matter, Pathogens, Microorganisms, Water reuse, Water purification, Waste water treatment

D261
WASTE WATER RECLAMATION AT ST. CROIX, U.S. VIRGIN ISLANDS,

Buros, O. K.

Dissertation Abstracts International B, Vol. 37, No. 7, p 3564, January, 1977.

Groundwater recharge was compared to a desalination program to determine the better means of augmenting freshwater supplies for the island of St. Croix, U. S. Virgin Islands. Several expensive desalination plants have been constructed to produce potable water, but their expense motivated research into the use of waste water effluent for groundwater recharge. Waste water treatment plant and recharge facilities were constructed with a capacity of 0.5 mgd/day. In operation, it was possible to recharge an average of one million gallons/week. At one site, no significant adverse effects were found in groundwater extracted downstream of the project, although there was a substantial increase in groundwater. Major problems encountered were the lack of waste water for treatment and recharge, the mechanical failure of equipment, and the transfer to the main treatment plant of waste water with a high seawater content. The latter problem was the result of a 1974 flood and the problem was expected to last through 1975. The process costs are higher than those for recovery of existing groundwater, but lower than those for the desalination process.

*Water reuse, *Groundwater recharge, *Desalination, Waste water treatment, Water resources development, Treatment facilities, Tertiary treatment, Freshwater, Groundwater, Potable water

St. Croix (U. S. Virgin Islands)

D262
TWO-STAGE FILTRATION OF SECONDARY EFFLUENT,

Biskner, C. D., and Young, J. C.

General Filter Company,
Ames, Iowa.

Journal Water Pollution Control Federation, Vol. 49, No. 2, p 319-331, February, 1977.
14 fig, 3 tab, 10 ref.

A study was used to evaluate a two-stage filter system for suspended solids removal from the effluent of a trickling filter plant. The two-stage filtration of secondary effluent produced effluent suspended solids concentrations equal to that of dual-media filters operating at similar average loading rates. More frequent backwashing of the first-stage filter allows the increase of filter runs and the reduction of backwash water volumes. The main advantage of the two-stage filtration system is its flexibility, allowing a broader range of media size combinations, and thus the use of granular media filters for treating effluents high in large-size suspended solids particles. However, the size of the first-stage media is very important. Only a small fraction of solids load passes to the second-stage if it is too small, and if it is too large, excess amounts are passed to the second-stage. It was found that single-media filtration with simultaneous air-water wash was promising in the elimination of many problems associated with conventional backwash procedures.

*Filters, *Suspended solids, *Trickling filters, Filtration, Waste water treatment, Sewage effluents, Evaluation, Water purification, Treatment, Equipment

Two-stage filter system

D263
A SECOND LOOK AT WATER REUSE,

Dugan, G. L., and McGauhey, P. H.

Hawaii University,
Honolulu,
Department of Civil Engineering.

Journal Water Pollution Control Federation, Vol. 49, No. 2, p 195-205, February, 1977. 2 fig, 16 ref.

A review of factors involved in the reuse of water was presented. Data and conclusions were drawn from experience involving a five-year investigation of the Indian Creek Reservoir, California, a three and one-half year waste water irrigation project in Oahu, Hawaii, and other related activities and projects at the Sand Island Outfall and Kaneohe Bay, Oahu. The waste water treatment plant at Kaneohe Bay was completed in the early 1950's to cope with cesspool wastes and secondary effluent which was discharged into the Bay. This disturbed natural erosion-resisting properties of the soil and vegetative covering and increased the quantity of nutrients and sediments in the Bay. Sand Island has had much more experience; proposals to improve conditions in the area involve protecting fresh waters from high oxygen-demanding wastes, upgrading treatment plants, and protecting waters from increased eutrophication by reducing nitrogen and phosphorus concentrations to remove oxygen-demanding materials. These materials, suspended solids, and other chemical concentrations are relatively unimportant in deep coastal waters and a variance to secondary treatment regulations is requested so Hawaii can reduce the financial burden of facilities where advanced primary treatment is adequate. It was noted that effluent standards are much easier to regulate than receiving water standards. The California reservoir project demonstrated the feasibility of using reservoirs and improved tertiary treatment in combination to provide waste water of a quality suitable for reuse. The goal of all the studies was to hasten improvement of receiving water quality by improving the sophistication of waste water treatment processes.

*Water reuse, *Irrigation, *Reservoirs, *Outfalls, Water purification, Waste water treatment, Oxygen demand, Eutrophication, Nitrogen, Phosphorus, Suspended solids, Coastal areas, Tertiary treatment

Oahu (HI), Indian Creek Reservoir (CA)

D264
AUTOMATIC ANALYSIS CONTRIBUTES TO WASTE WATER TREATMENT EFFICIENCY,

Instrumentation Technology, Vol. 24, No. 2, p 10, February, 1977.

Suffolk County, New York, is meeting municipal standards and more efficiently operating a waste water treatment plant with automatic measurement of mixed liquor suspended solids (MLSS). Complete treatment is provided before groundwater recharge. Groundwater wells provide all drinking water for the area. A nitrogen level of less than 10 milligrams/liter was required by the county environmental control agency. The plant operates in two stages: extended aeration/nitrification and suspended growth denitrification. The design capacity allows for 288,000 gpd, but the present operation rate is 50,000 gpd. The analyzer chosen consists of a sensing probe on the downflow side in the center of the aeration tank and a remote digital readout, in ppm, in the control building. Readouts are checked against MLSS gravimetric tests in the plant laboratory. Treatment goals included 85% BOD removal, 90% suspended solids removal, and continuous chlorination for disinfection.

*Instrumentation, *Measurement, *Treatment facilities, Aeration, Nitrification, Denitrification, Nitrogen, Biochemical oxygen demand, Suspended solids, Groundwater recharge, Water wells, Waste water treatment, Chlorination, Disinfection

Suffolk County (NY)

D265
LESS-COSTLY ACTIVATED CARBON FOR SEWAGE TREATMENT,

NASA Tech. Briefs, Vol. 1, No. 4, p 573, Winter, 1976. 1 fig.

A process was developed to produce supplemental carbon from coal for activated carbon sewage treatment. The goal was to make the activated carbon process self-sustaining. Coal is pyrolyzed with sludge which becomes a catalyst in the activation process. Gases which may be used to reduce the energy demand are produced during pyrolysis. Laboratory pyrolysis of a 50/50 mixture of pulverized coal and sludge was conducted at 850 C with a 20-minute steam application (1 pound of steam per pound of coal/sludge mixture). The resultant activated carbon was 61.7% ash with an iodine adsorption of 684 milligrams/gram of carbon. A sludge with a COD of 421 was reduced to a COD of 54 by treatment with 521 milligrams/liter of the activated carbon. Treatment with a commercial activated carbon produced a COD of 60. Lignite was the most effective coal for this purpose; sodium carbonate may be added to enhance activation.

*Carbon, *Activated carbon, *Coal, *Lignite, Heat treatment, Sewage treatment, Sludge, Adsorption, Chemical oxygen demand, Waste water treatment

Sodium carbonate, Pyrolysis

D266
AIR V. OXYGEN IN DORSET,

Water and Waste Treatment, Vol. 20, No. 1, p 14-15, January, 1977. 1 fig, 1 tab.

A preliminary evaluation was made of Europe's first municipal treatment plant which uses an oxygen activated sludge (UNOX) system. The plant at Dorset, England, has installed the system as an extension of existing facilities. It is a two-stage activated sludge system using oxygen in the first stage and air in the second. Surface aeration is employed in both stages. Conventional biological filtration is used with recirculation and the extension forms a separate parallel works with possible linkage to existing filters after the first stage tanks. Nitrification can be achieved by either filtration or second stage treatment. Flexibility is a design feature. Operation can be divided into two identical halves to treat one stream as a control and the other stream as a variation outside of the normal design limits. The plant can be operated in an automatic mode. In the oxygen stage, the gas space above water level is pressurized with high purity oxygen. Conventional mechanical aerators produce oxygenation. Air is compressed, cooled, dewatered, and passed into one of the beds of molecular sieve material where nitrogen is adsorbed. Three beds are used in sequence to maintain oxygen flow while the sieve material is regenerated. Claimed benefits of the system are lower capital costs, less required space, and lower sludge production.

*Oxygen, *Oxygenation, *Activated sludge, Air, Aeration, Treatment facilities, Filtration, Design, Automatic control, Equipment, Nitrogen, Sludge treatment, Waste water treatment, Municipal wastes

UNOX

D267
STRUCTURAL POLYMER,

Elastomers Notebook, No. 194, p 540, February, 1977.

Piping of reinforced fiberglass joined by glass-filled polyurethane fittings have been developed for use with the activated sludge aerator. Metal piping and fittings required corrosion protection and were heavy to support and manipulate. Adiprene urethane rubber by DuPont forms fittings which adhesively bond to fiberglass downpipes and diffusion headers. The smoother wall surfaces and larger internal diameter are added advantages, providing lower head loss and power costs at any given rate of air flow. Other features of this material are long-term water resistance, physical strength, chemical inertness, and abrasion resistance which allow urethane pipe fittings to complement fiberglass piping.

*Piping, *Plastics, *Polymers, Chemical properties, Physical properties, Aeration, Corrosion prevention, Construction materials, Equipment, Waste water treatment, Activated sludge, Rubber

Polyurethane, Reinforced fiberglass

D268
STATE PARK GETS GOOD TREATMENT,

Jay, F. A., and Kroesche, J. L.

Lockwood, Andrews and Newnam,
Austin, Texas.

Water and Wastes Engineering, Vol. 13, No. 11, p 65-66, 71, November, 1976. 1 fig.

A treatment system was designed for the Inks Lake State Park in Texas. Design considerations included: the handling of seasonal flow variations, a hilly and rocky terrain, a low budget, more than 250 camp and picnic units, and rest rooms. A solution comprising a pressurized collection network, a variable capacity extended-aeration treatment plant, and an effluent irrigation system was devised. Seasonal waste water flows averaged 6,000 mgd in winter, 20,000 gpd during the spring and fall, and 40,000 gpd in summer. By using the pressurized collection system costs and excavation difficulties presented by an abundance of granite in the area were avoided. Twelve grinder pumping stations with pumps mounted in 60-inch wet-wells of a 5.5-foot depth were constructed. Existing rest room septic tanks or 1000 gallon concrete tanks provided emergency holding capacity. The forced main network is made of two- to four-inch polyvinyl chloride pipe. An effluent quality of 20 milligrams/liter BOD and 20 milligrams/liter total suspended solids was required for irrigation. State restrictions on discharges to lakes are 5.0 milligrams/liter BOD and 5.0 milligrams/liter total suspended solids, and they often include nutrient removal. Extended aeration provides protection against biological upset and reduces sludge handling requirements. All systems can be expanded if necessary.

*Parks, *Recreational facilities, *Aeration, *Sewerage, Piping, Waste water treatment, Flows, Treatment facilities, Pumping plants, Irrigation, Biochemical oxygen demand, Suspended solids, Lakes, Nutrients, Sludge treatment, Design criteria

Inks Lake State Park (TX)

D269
GOLAR RUBBISH, OIL SLUDGE AND SEWAGE INCINERATOR,

Shipbuilding and Marine Engineering International, Vol. 99, No. 1204, p 680, December, 1976.

An incinerator, the Golar GS500, was developed for shipboard wastes. The unit weighs about 4,300 kilograms; it can burn solid wastes up to 75 kilograms/hour, oil sludge at nearly 80 kilograms/hour, depending on water content, sewage at nearly 30 kilograms/hour, or any combination to a maximum of 580 kilowatts. There is a top-mounted oil burner above the combustion chamber, but not in the interconnecting rubbish chamber. Combustion is usually at 1200-1400 C. Pyrolysis in the rubbish chamber, using radiant heat from the combustion chamber, occurs at 400-800 C. The oil burner has two diesel oil burning stages, at 36 and 16 kilograms/hour, with a pressure atomizing and a steam-atomized sludge burner stage. Particles up to an 8 millimeter diameter can be processed, allowing incineration of raw sewage sludge from common treatment facilities. Sewage sludge should be directly pumped into the oil sludge tank to produce a more combustible mixture. No sludge preheating is necessary. Rubbish can be loaded through a feed hatch for distribution to the combustion chamber by a manually-operated rotating sluice.

*Incineration, *Boats, Waste disposal, Sludge disposal, Equipment, Heat treatment, Sewage treatment, Treatment facilities, Oil wastes, Solid wastes, Ultimate disposal

Golar GS500 incinerator, Marine sanitation

D270
R & D PROJECT PROVIDES PHYS/CHEM DATA,

Gervais, J. T.

Water and Wastes Engineering, Vol. 14, No. 2, p 55-57, February, 1977. 1 fig, 1 tab.

A research and development project was instituted at Foxborough State Hospital, Massachusetts, to demonstrate physical-chemical waste water treatment processes and to train operators. Chemical clarification, dual media filtration, and carbon adsorption processes were investigated. The facility was designed to accomodate future investigations of treatment methods. It is housed by a fabric-skinned structure which is functional, portable, economical, and salvageable. All process equipment is standard and can be reused at other facilities. The facility was operated in a manner which simulated that of an actual treatment plant. Dual systems are provided for direct comparison testing. Polyvinyl chloride is used for all process lines. The facility has proven the feasibility of adding these treatment processes to secondary facilities to meet water standards.

*Research and development, *On-site investigations, Design, Costs, Prototypes, Research facilities, Tertiary treatment, Waste water treatment, Chemical treatment, Adsorption, Filtration

Foxborough State Hospital (MA)

D271
POLY ALUMINIUM CHLORIDE IN SLUDGE TREATMENT,

Water Services, Vol. 80, No. 970, p 748-749, December, 1976. 2 tab.

Poly aluminum chloride (PAC) has been recently marketed as a sludge conditioner. PAC is an aluminum hydroxy chloride of complex structure. Its controlled sulfate component ensures optimum coagulant performance and stability and it has a higher molecular weight than usual for inorganic flocculants. Its primary advantage is the floc structure it produces. These are larger and stronger, and form more rapidly than those of other inorganic coagulants. They also reform readily after disintegration. PAC is especially effective when used on sludges prior to dewatering on filter presses and rotary vacuum filters as an alternative to polyelectrolytes, iron compounds and lime or, in some cases, aluminum chlorohydrate. PAC is marketed as a liquid with 10% w/w Al2O3, and can be used without extensive systems modifications, such as those needed for the use of polymers. The product can also be used as a primary coagulant in potable water treatment and there are many industrial effluents it can effectively treat.

*Flocculation, *Sludge treatment, Chemical properties, Laboratory tests, On-site tests, Physical properties, Performance, Costs, Polyelectrolytes, Dewatering, Waste water treatment

Poly aluminum chloride

D272
LAKES WILL TAKE THE POLLUTION LOAD OFF OLD FATHER TAME,

Pullin, J.

Surveyor, Vol. 148, No. 4410, p 7-9, December, 1976. 2 fig.

A system of lakes was proposed to eliminate the pollution problem of the river Tame, near Birmingham, England. The river is one of the most polluted in England; 86% of the flow, at one point, is effluent from a sewage treatment facility. Urban runoff from the Birmingham area greatly contributes to the problem. Situating some of the lakes at the sites of former gravel workings was seen as providing benefits including improvement in river water quality at all flows, but especially at high flows; providing a form of tertiary treatment for sewage effluents; providing a diluting buffer for the downstream against accidental upstream pollutions; restoring fisheries in the river; providing recreation and amenity facilities; and potentially improving management of river water. A preliminary testing with a simulated scale lake indicated a reduction of suspended solids from 59 milligrams/liter to 35 and 15 milligrams/liter in winter and from 60 to 31 milligrams/liter in summer. BOD reductions were similarly impressive. Tests showed that lake one would reduce normal flow suspended solids by about 50% and storm flow suspended solids by about 75%. The completed system would dramatically reduce the pollution of the river. However, costs and financing are major problems. The first lake and related treatment facility will cost an estimated 5.9 million pounds. Evaluations will be made after completion of the project to determine the necessity of further construction.

*Lakes, *Rivers, *Water purification, *Water quality control, Pollution abatement, Water pollution effects, Water pollution control, Biochemical oxygen demand, Urban runoff, Suspended solids, Separation, Sedimentation, Pilot plants, Costs, Planning

Tame River (England)

D273
MULTI-STAGE FILTER PRESS,

Water Services, Vol. 80, No. 970, p 744, 747, December, 1976. 1 fig.

A multi-stage filter press for dewatering both organic and inorganic sludges from industrial wastes and sewage was considered. Sludge, mixed with a flocculating agent, is fed into polyester mesh pockets where initial dewatering occurs, and is then discharged onto the first of two continuous belts of finer mesh which move horizontally in the opposite direction for additional drainage. Afterwards, the sludge is caught between this and another belt, forming two wedges, to consolidate and reduce it into a homogeneous mass. After passing through a series of six rollers, high pressure is applied for final dewatering. Performance is good. After gravity dewatering, volume is reduced by 80% and dry solids by 15%; after medium pressure and high pressure dewatering, reductions are 90 and 92% for volume, and 32 and 40% for dry solids. Filtrate and wash water fall into troughs and drain to a concrete sump for return to primary settling tanks, or the equivalent, for treatment.

*Filters, *Dewatering, Sludge, Industrial wastes, Potable water, Equipment, Performance, Waste water treatment, Sludge treatment, Organic matter, Inorganic compounds

Multi-stage filter press

D274
PHOSPHORUS IS REMOVED AT LOW COST,

Williams, T. C.

Williams and Works,
Grand Rapids, Michigan.

Water and Wastes Engineering, Vol. 13, No. 11, p 52-54, 63, November, 1976. 1 fig, 2 tab.

Low cost phosphorus removal was achieved in Alma, Michigan, by a treatment process involving extended aeration, chemical precipitation using ferric chloride and a polymer, and chemical oxidation of sludge. The design of this new waste water treatment plant was influenced by the small size of the community, requiring relatively low operation and maintenance costs; and by site restrictions such as a nearby residential development, necessitating an odor-free system. Other factors relating to the design were the high sewer infiltration rate, and the periodic discharge of concentrated toxic materials from a metal finishing plant. The effluent produced by the plant was well within the discharge limits, even when flow was as much as 50% over design.

*Phosphorus, *Chemical treatment, *Polymers, Treatment facilities, Costs, Operation, Maintenance, Biological treatment, Design criteria, Waste water treatment

Alma (MI)

D275
BIOCHEMICAL AND PHYSICAL-CHEMICAL TREATMENT OF WEAK MUNICIPAL WASTE WATER,

Thirumurthi, D., and Orlando, J. R.

Nova Scotia Technical College,
Halifax, Canada,
Department of Civil Engineering.

Journal Water Pollution Control Federation, Vol. 48, No. 2, p 2708-2722, December, 1976.
4 fig, 7 tab, 14 ref, 1 append.

A study was conducted to compare the biological, biochemical, and physical-chemical treatment of weak municipal waste water (BOD less than 100 milligrams/liter). It was found that low-level lime addition to high-rate activated sludge treatment moderately improved phosphate removal. Low food:microorganisms ratios and high sludge ages had to be countered to achieve efficient biological or biochemical treatment processes. Colder temperatures had a negative effect on biochemical treatment of normal-strength waste water; an average temperature difference of 12 C reduced treatment efficiency as much as one-third. Lime doses high enough to produce a pH greater than 9.5 can be used without harm to bacterial populations when handling weak and normal waste waters due to the fact that carbon dioxide production by microbes can reduce influent pH by 1.5 units. The SVI (sludge volume index) was increased in biochemical treatment by lime addition and colder temperatures. Biological and biochemical treatments were of little use in dissolved solids removal. More than 95% phosphate removal at a high pH can be achieved in the physical-chemical treatment. A 5%, by volume, sludge recycle had no significant effect on treatment efficiency. Temperature reductions of 12 C did not affect physical-chemical treatment at the pH values tested. Physical-chemical processes with lime produced higher removals of BOD, suspended solids, and PO4 than an activated sludge plant. Low residual phosphate concentrations needed for algae growth were present only with physical-chemical treatment. Advantages and disadvantages of biological and physical-chemical processes can be combined by treating raw waste water by physical-chemical processes when a biological treatment plant is expanded. With enough microbial population in the aeration tank, biochemical treatment of weak waste water is the same as that of normal-strength waste water.

*Biological treatment, *Chemical treatment, Biological properties, Chemical properties, Physical properties, Microorganisms, Temperature, Hydrogen ion concentration, Lime, Phosphate, Growth rates, Biochemical oxygen demand, Chemical oxygen demand, Suspended solids, Waste water treatment

D276
IN-HOUSE TREATMENT,

The Consulting Engineer, Vol. 41, No. 2, p 25, February, 1977.

Options were presented for in-house treatment to lessen the impact of increased water and effluent charges. This could be accomplished through the reduction of effluent quantities and loads discharged. A formula was presented for the calculation of the cost of volume discharged independently of the load. The formula consisted of fixed elements, variable elements, and quality parameters. In Britain, it costs about 7.5 pounds/cubic meter to treat standard effluents at a sewage works. Just under half of this expense was fixed costs, directly proportional to volume. The remaining costs varied according to the load of BOD, COD, or suspended or settleable solids. The main alternative to disposal to sewers was the removal of some portion of the effluent in a concentrated form for disposal. Constraints and parameters included transportation expenses, treatment costs, discharge standards, possibilities of discharge to rivers, availability of capital and space, and life of process, plant, or factory.

*Waste water treatment, *Treatment facilities, Sewage effluents, Industrial wastes, Biochemical oxygen demand, Chemical oxygen demand, Solid wastes, Liquid wastes, Suspended solids, Costs, Waste disposal

In-house treatment

D277
AWT PLANT MEETS TOUGH DEMANDS,

Benham, J. F.

Benham Blair and Affiliates,
Oklahoma City, Oklahoma.

Water and Wastes Engineering, Vol. 14, No. 2, p 59-62, 75, February, 1977. 2 tab.

A tertiary treatment facility was constructed in Lawton, Oklahoma, to produce an effluent which meets stringent state requirements. Among these requirements are a 21-day BOD limited to 15.0 milligrams/liter and phosphate concentrations limited to less than 1.0 milligram/liter as phosphorus. Design provisions were made for future expansion to remove nitrogen. A contract with a power generating station calls for the use of purified effluent as make-up for its cooling lake. The treatment incorporates conventional preliminary and primary treatment followed by two-stage biological treatment, chemical precipitation, and granular media filtration. Plastic media trickling filters are used to remove carbonaceous BOD. There is a nitrogenous BOD removal system which is primarily an activated sludge process. The plant provided an adequate capacity for the treatment of all flow, including wet-weather flow peaks from infiltration and inflow into sewers; flows up to 40 mgd can be accommodated. There is a holding basin with a 15 million gallon capacity for excess flow. Another feature is a 500-acre effluent storage basin for storage of reclaimed water prior to transfer to the power station. Construction costs are $1.34 per gallon/day capacity and operating costs are expected to be about $0.25 per thousand gallons. Phosphorus removal consists of three steps: chemical feeding and clarification; recarbonation; and filtration. Planning and design allow an initial capacity of 10 mgd to be expanded by 33% with the construction of an additional trickling filter, aeration tank, and clarifier to most of the unit processes.

*Tertiary treatment, *Treatment facilities, Phosphate, Biochemical oxygen demand, Biological treatment, Filtration, Trickling filters, Nitrogen, Flows, Equipment, Construction costs, Operating costs, Chemical treatment, Design criteria, Water quality control, Water reuse, Waste water treatment

Lawton (OK)

D278
1776-1976: NOTES ON WATER QUALITY PLANNING,

Hey, D. L., and Waggy, W. H.

Simulation Network Newsletter, Vol. 8, No. 7, p 1-7, November, 1976. 20 ref.

Water quality planning in the United States was chronicled from 1776 to 1976. The urban concentration of the American population has risen from about 5% in 1776 to 73% in present times. The late nineteenth century saw an increase in the awareness of a need for water quality planning. By the 1930's, typhoid fever and other waterborne diseases were under control. This was achieved by chemical disinfection of domestic water supplies, and did not include treatment of industrial, municipal, or agricultural wastes. The first basic attempt at control was through disposal; not until the 1960's was attention turned to the protection of water resources. Disposal was primarily a matter of placing untreated wastes out of sight by employing surface runoff, filtration and removal by groundwater, or the use of cesspools or privy vaults. Where this was not practical, transmission to the nearest stream was employed. The combined sewer and toilets produced the first alternatives to these methods. Water treatments developed over the years included: filtration, in 1871, and chlorine disinfection, in 1911. Advanced waste water treatment development was hindered because of the easy and economical protection of domestic water supplies by using chlorine. Presently, most municipal waste water is treated. Industrial waste water treatment is being pushed under the impetus of legislation such as PL 92-500. Future treatment problems will deal with the disposal and reuse of treated effluents and by-products.

*Water quality control, *Planning, *History, Cities, Rural areas, Domestic water, Waste water, Disposal, Waste treatment, Waste water treatment, Industrial wastes, Domestic wastes, Municipal wastes, Groundwater, Runoff, Filtration, Treatment facilities, Tertiary treatment, Legislation, Water resources, Sewerage, Diseases

United States

D279
WATER AND WASTE WATER ENGINEERING FOR LOW INCOME COMMUNITIES IN DEVELOPING COUNTRIES,

Feachem, R., and Mara, D.

Proceedings of the Institution of Civil Engineers, Part 1, Vol. 62, p 163-165, February, 1977.

More than one billion people, or 86% of the rural population in developing countries, lack adequate water supplies. The 'quantity-quality' problem is aggravated by low income and the lack of technical skills in rural areas. Arguments in favor of providing inferior water suggest that inadequate maintenance would cause a breakdown of any treatment system and that adequate untreated polluted water would be less hazardous than inadequate quantities of water. Opposing theories suggest that a piped supply would increase users of a single source, creating epidemic transmission; that water-borne health risks would increase if a piped supply of greater quantity were inferior to an existing smaller supply of better quality; and that an engineer might be legally liable if health damages resulted from his design and installation of a low quality water supply system. It was concluded, in this instance, that any improvement in water was preferable to none at all. It was also suggested that distribution, not treatment, was the major cost in water supply systems. Major considerations in developing countries were discussed in terms of economic, institutional, and technical difficulties. The problem of rural residents moving to growing towns and cities and continuing their previous sanitation habits was discussed. It was also indicated that wind, animal, or human powered systems might help to eliminate the problems incurred with the use of more technical power systems. Disposal was also considered a problem; the reuse of nightsoil and sewage effluents was suggested.

*Water supply, *Rural areas, *Water quality control, Impaired water quality, Water reuse, Sanitation engineering, Environmental sanitation, Economics, Social adjustment, Social change, Social values, Waste water treatment, Water distribution (applied)

Developing nations

D280
WHAT'S UP WITH OXYGEN?,

Bracken, B. D.

Brown and Caldwell,
Walnut Creek, California.

Water and Wastes Engineering, Vol. 14, No. 3, p 18-22, 24, 26, 44-45, March, 1977.
3 fig, 2 tab, 12 ref.

Applying cryogenic oxygen generation to waste water treatment was considered. With more stringent effluent quality regulations, oxygen activated sludge systems will become more dominant in waste water treatment. The quantities of oxygen needed for treatment will depend upon waste strength, detention time, dissolution system design, waste water temperature, oxygen transfer efficiencies, and other factors. After the decision to use oxygen is made and the quantities necessary are determined, the means for providing pure oxygen must be evaluated. Gaseous oxygen is more economical to purchase than liquid oxygen if it can be piped to the treatment plant from a close generation facility. Liquid oxygen is generally employed for short-term use, oxygen plant start-up, back-up, and emergency use during generation plant failures. On-site generation can be achieved by a pressure swing adsorption (PSA) system for treatment plants using less than 30-40 tons/day of oxygen. Cryogenic air separation plants are usually best for plants exceeding this requirement. The separation plants produce oxygen by liquefaction of pressurized atmospheric air, followed by distillation to separate nitrogen and oxygen. The liquid oxygen is then delivered to a storage and vaporization system for automatic delivery of gaseous oxygen to the oxygen supply lines in response to low pipeline oxygen pressure. The standard plant produces 3-8% of its total output as liquid oxygen. The oxygen generally has a purity of 95-98 mole-percent, or percent by volume. Equipment needed for this process includes an air compressor, switching valves, a cold box, a reversing heat exchanger, a gel trap or hydrogen carbon adsorber, an oxygen superheater, and a nitrogen superheater.

*Oxygen, *Cryogenics, *Activated sludge, *Water quality control, Treatment facilities, Performance, Nitrogen, Equipment, Gases, Design criteria, Economics

Pressure swing adsorption, Cryogenic air separation

D281
STABILIZATION LAGOONS INCLUDING EXPERIENCE IN BRAZIL,

Bradley, R. M., and Alvares da Silva, M. O. S.

Effluent and Water Treatment Journal, Vol. 17, No. 1, p 21-23, 26-29, January, 1977. 3 fig, 4 tab.

Design criteria and operation data for lagoon systems treating domestic sewage in Brazil were discussed. There is no internationally accepted design procedure for stabilization lagoons since their operation efficiency depends on the climatic conditions of a given area. With adequate available land, these lagoons are an inexpensive means for reducing domestic sewage BOD. Greater efficiency, as well as land and excavation savings, result from using an anaerobic and facultative lagoon in series. In Brazil, using this method rather than a single facultative lagoon produces a 70% reduction in land area requirements, a 45% reduction in excavation volume, and a 55% detention time reduction, while yielding an effluent of the same quality. Facultative lagoons always contain algae. When 85-90% BOD removals are necessary, algal removal should be practiced. Facultative lagoons produce an effluent with substantial suspended solids, mainly algae, which are harmful to receiving streams. Aerated aerobic lagoons have a higher operational cost and produce an effluent higher in suspended solids concentrations than facultative lagoons. Brazilian practice is to accept the algae problems in order to achieve, over the widest area possible, some measure of reduction in the organic loads discharged to rivers. Basic sanitation can thus be provided to as many communities as possible, and effluent quality can be improved as financial resources increase. In densely populated areas, because land is scarce and effluent quality standards are to be raised, it is usual to use aerated lagoons which are convertible to activated sludge systems.

*Oxidation lagoons, *Design criteria, *Domestic wastes, *Aerated lagoons, Economics, Effluents, Biochemical oxygen demand, Suspended solids, Algae, Climates, Waste water treatment, Sanitary engineering

*Brazil, Facultative lagoons

D282
JOINT MUNICIPAL CORPORATION WASTE WATER TREATMENT,

Small, S. S.

Water and Sewage Works, Vol. 124, No. 1, p 72-75, January, 1977. 1 fig, 2 tab.

The rural community of Fort Fairfield, Maine, is constructing a waste water treatment facility to handle municipal and industrial wastes. The Great Atlantic and Pacific Tea Company operates a nearby plant which processes potatoes, french fries, potato puffs, and peas. The Company has installed a starch recovery system, infrared peeling system, caustic and blancher solution recycle systems, and part of a silt removal process in order to reduce waste strength to levels treatable by conventional primary and secondary methods. The plant had previously operated an industrial primary treatment program. The rotating biological surfaces (RBS) secondary treatment process was selected because it meets fluctuations in industrial and domestic loads; is easily expandable for future industrial discharge; does not require sludge recycle; uses smaller secondary clarifiers; and does not flush fixed bio-mass from the reaction tank during peak flows. It also recycles municipal sludge during A & P downtime to maintain a bio-mass sufficient for treating A & P waste water upon startup, and has trouble-free winter operation and lower overall costs. Finally, it is less complex than other processes. Hypochlorite was chosen for disinfection over chlorine gas because of lower capital costs. Sludge resulting from the process could be used as fertilizer or as an animal food supplement. It was decided to use a flotation thickener for secondary sludge, and a single vacuum filter for dewatering primary sludge to be used for animal feed supplement or for secondary sludge when all sludges would be land-disposed.

*Water districts, *Rural areas, *Community development, Municipal wastes, Industrial wastes, Chemical reactions, Sludge disposal, Waste water treatment, Treatment facilities, Performance, Costs, Sludge treatment

Fort Fairfield (ME), The Great Atlantic and Pacific Tea Company

D283
CONTROLLING SLUDGE BULKING,

Water and Sewage Works, Vol. 124, No. 3, p 54-55, March, 1977. 1 fig.

A hydrogen peroxide treatment was used to cure sludge bulking at a treatment plant in St. Augustine, Florida. Two years after the transition to secondary treatment, sludge began rising from the bottom of two clarifiers. Sludge was first drawn off into digesters before settling was complete, lowering clarifier solids concentrations. No plant mechanisms had malfunctioned, but the pH rose steadily. The problem was found to be caused by two filamentous bacteria, sphaerotilus and thiothrix. Hydrogen peroxide was added at a rate of 20 ppm directly into the head box of the degritter at the 3 mgd facility. A foam problem developed in the clarifiers and the system was relocated to allow peroxide to enter the overflow trough of one of the aeration basins at a rate of 12 ppm. Two days after restarting the facility the clarifiers were clear, foaming was gone, and sludge flocs did not pass over the air. Even later, the filamentous bacteria began to break up. The sludge volume index lowered from a high of 580 to 178, which was well below the bulking point.

*Sludge treatment, *Chemical treatment, *Sedimentation, Suspended solids, Bacteria, Sphaerotilus, Sewage bacteria, Hydrogen ion concentrations, Waste water treatment, Treatment facilities, Oxidation lagoons, Water purification

Hydrogen peroxide, St. Augustine (FL)

D284
PHYSICO-CHEMICAL TREATMENT OF SEWAGE AND THE COLESHILL PROJECT,

Clough, G. F. G.

Water Pollution Control, Vol. 76, No. 1, p 10-29, 1977. 6 fig, 1 tab, 2 ref.

Various aspects of the physico-chemical treatment (PCT) of sewage and of the Coleshill pilot plant, in England, were considered. Some of the procedures in this treatment are flocculation using lime or other floc ballast materials, foaming, and centrifugation. Solids removal may be required, and filtration may be used when solids concentrations are low. Dissolved organic matter may be treated with chlorine, ozone, lime, or calcium compounds, and removed by using activated carbon. Dissolved inorganic matter, such as nitrogen, phosphorus, and toxic metals, may also be removed by PCT. The use of flocculants will require some sludge dewatering by filter presses, rotary vacuum presses, or filter belt presses and centrifuges. PCT can be cost-competitive if sewage contains toxic materials, phosphorus removal is necessary, space is limited, incineration is the best method for sludge disposal, or if the load changes rapidly or between wide limits. The typical PCT system includes lime addition, settlement, pH correction, and activated carbon treatment. The Coleshill pilot plant consists of fixed and mobile facilities designed to eliminate large-scale trials of various treatment systems. Each mobile unit can perform one unit process operation. The plant can provide a process stream similar to a bench-scale plant, two treatment streams, and two sewage sources, domestic and industrial, for testing. PCT will be the first treatment system tested because of the dearth of information on the performance and economics of the system.

*Chemical treatment, *Oxidation, *Separation, Flocculation, Filtration, Separation techniques, Organic matter, Inorganic compounds, Activated carbon, Nitrogen, Phosphorus, Toxicity, Lime, Chlorine, Ozone, Hydrogen ion concentration, Sludge disposal, Sewage treatment, Waste water treatment, Pilot plants, Treatment facilities, Economics, Industrial wastes, Domestic wastes

Physico-chemical treatment, Coleshill (England)

D285
WASTE WATER RENOVATION BY SEWAGE ULTRAFILTRATION,

Sachs, S. B., and Zisner, E.

Desalination, Vol. 20, p 203-215, 1977. 5 fig, 8 tab, 4 ref.

Pilot studies were conducted to determine the feasibility of using the newly developed Hybrid Ultra Filtration (HUF) membranes to treat municipal oxidation pond effluent. The process, Sewage Ultrafiltration (SUF), combines ultrafiltration and reverse osmosis methods and treats the entire system by separating water from many types of contaminants. These membranes are non-cellulosic and resistant to hydrolysis or biological degradation; some of them withstand temperatures up to 120 C. The membranes are made of a strong polyelectrolyte permanently attached to an innert polymer porous structure. They carry a fixed charge capacity over the whole pH range. Tests showed impressive performance at low operating pressure (8 atm). There was a constant product flux through the membrane of 30-40 gfd at 95% water recovery. The system was cleaned by a sponge-ball once every 24-hours. The HUF membrane substantially reduced organic contaminants from very high concentrations to a lower level than biological or physicochemical processes would under similar conditions. The test plant removed 98% of total BOD and 78% of total COD in the oxidation pond feed, which was 99.3% of BOD and 99.4% of COD from the recirculation brine. Only minor treatment is needed to use this effluent for agriculture, groundwater recharge, industrial purposes, or complete municipal recycle.

*Membranes, *Filtration, *Reverse osmosis, *Pilot plants, Polyelectrolytes, Polymers, Oxidation lagoons, Sewage effluents, Water purification, Water reuse, Organic matter, Biochemical oxygen demand, Chemical oxygen demand, Physical properties, Chemical properties, Waste water treatment

Hybrid ultrafiltration (HUF) membranes, Sewage ultrafiltration (SUF)

D286
CONTINUOUS THICKENING OF BIOLOGICAL SLUDGES, AND THE INFLUENCE OF STABILITY,

White, M. J. D., Baskerville, R. C., and Lockyear, C. F.

Stevenage Laboratory,
Water Research Centre,
Stevenage, England.

Water Pollution Control, Vol. 76, No. 1, p 86-97, 1977. 5 fig, 5 tab, 17 ref.

Gravity thickening was considered in relation to sludge treatment and disposal. The stability of various sludges in storage was studied to determine BOD and COD production, the effect on filterability, and the amount of chemicals needed to condition sludge for mechanical dewatering. Tests were conducted with a small-scale batch thickener and a pilot-scale continuous thickener. A mixed primary sludge was continuously thickened in the pilot-scale thickener with a solids retention time of 18 hours. Solids concentration in the supernatant liquor was about 0.55% dissolved solids. The volume needed for this sludge was less than 75% of the size of the equivalent batch thickener. A continuous thickener size for more dilute feeds would be much smaller than an equivalent batch thickener. Anaerobically digested sludge and sludges from low-rate and extended-aeration activated sludge plants were relatively stable in terms of BOD and COD release into the liquor, and in terms of filtration characteristics. No penalties resulted from thickening this sludge. Primary and mixed primary sludge samples from sedimentation tanks were relatively stable. Filtration properties and the BOD and COD of the interstitial liquor revealed that significant deterioration had occurred in the sedimentation tank. High-rate biological treatment sludges were very unstable. Dewatering costs for these sludges were very high and substantial BOD and COD loadings might result from the return of their supernatant from thickeners to the head of the treatment facility. Gravity thickening was judged unsuitable for these sludges.

*Sludge treatment, *Physical properties, *Chemical properties, *Dewatering, Biochemical oxygen demand, Chemical oxygen demand, Chemical treatment, Anaerobic digestion, Sludge digestion, Activated sludge, Sedimentation, Biological treatment, Costs, Waste water treatment

Gravity thickening

D287
BOC BLOWS BUBBLES IN DIRTY BATH WATER,

Appleton, B.

New Civil Engineer, No. 229, p 19, February, 1977.

The British Oxygen Company (BOC) and the Wessex Water Authority have developed an oxygen injection system for sewers which improves final effluent quality by 30-60%. Previously used for hydrogen sulfide control, oxygen injection in this application can reduce capital expenditures. Microbial activity is induced in the final sewer section to reduce BOD of raw sewage. Biological treatment is enhanced as is the settleability of the oxygenated sewage. An injection rate of 45 kilograms/hour produced a small residual dissolved oxygen concentration at the delivery end of the main and improved the final effluent to 21 milligrams/liter of suspended solids and 19 milligrams/liter of BOD. Flocculation is improved, and filter performance is greatly enhanced by the reduced biological loading. Pump efficiencies, however, were decreased by an average of 8% because of a delay in reaching steady-state conditions. Performance was reduced in winter due to the temperature-sensitive biological activity in the sewers, but it was within the effluent ranges required.

*Sewers, *Oxygen, *Sewage effluents, Biological treatment, Biochemical oxygen demand, Capital costs, Oxygenation, Sedimentation, Suspended solids, Temperature, Flocculation, Performance, Filters

Effluent quality control

D288
CONTROLLING SLUDGE BULKING,

Liu, D., Kwasniewska, K., and Cohen, D. B.

Water and Sewage Works, Vol. 124, No. 3, p 52-53, March, 1977. 3 fig, 4 ref.

Filamentous microorganisms have contributed to the problem of activated sludge bulking. Various means used to control them include chlorination, hydrogen peroxide treatment, increasing the dissolved oxygen of the return sludge, and reducing the sludge loading rates. A program was conducted to establish means for isolating these microorganisms from normal and bulking sludges. Testing revealed two compounds which had a high selective specificity for filamentous microorganisms: n-amyl alcohol (n-pentanol) and iso-amyl alcohol. This provided the basis for procedures to isolate the microorganisms. Various amounts of n-amyl alcohol are added to four flasks containing a modified nutrient broth. The flasks are shaken to ensure homogeneity and one drop of bulking sludge is added to each. The broth is checked every 24 hours for the growth of filamentous microorganisms, after incubation at room temperature on a gyrotary shaker. If filamentous microorganism growth is substantial the broth should be streaked on a pre-dried modified nutrient agar plant for microorganism isolation. A second procedure involves adding bulking sludge or normal sludge to a sterile test tube, and then adding n-amyl alcohol and sterile distilled water. These are mixed, allowed to stand at room temperature, and mixed again. Three samples are quickly plated onto the pre-dried modified nutrient agar plates. The plates are incubated until there is complete colony development. Biochemical and taxonomical tests may be performed or colonies may be transferred to modified nutrient broth without n-amyl alcohol to confirm the procedure.

*Sludge treatment, *Activated sludge, *Microorganisms, Chlorination, Dissolved oxygen, Performance, Waste water treatment, Analytical techniques, Laboratory tests, Biological treatment, Chemical treatment

Sludge bulking, Filamentous microorganisms

D289
MICHIGAN TREATMENT PLANT ACHIEVES ZERO DISCHARGE, IRRIGATES CROPLAND,

Water and Sewage Works, Vol. 124, No. 3, p 42-44, March, 1977. 2 tab.

Paw Paw, Michigan, has built a sewage treatment plant which has met the EPA goal of zero discharge by 1985. The community treats domestic and industrial wastes in facultative lagoons, then retains it in an artificial lake up to six months. The final wastes are applied as crop irrigation water. There is no bulk sludge to handle since almost all organic substances are naturally reduced. Revenue estimates for the irrigation program have been as high as $450 per acre. The water is rich in nitrogen, phosphorus, and other nutrients. Sanitary sewers are tightly sealed from community storm sewers. Domestic flow averages 0.39 mgd and industrial flow averages 0.16 mgd. This system has provided 95-98% BOD removals and 80-89% suspended solids removals. System design is for a discharge of 2-3 inches per week for the entire treatment area, but flows are to be changed in consideration of soil types, natural rainfall, and the growth stage of each crop. The system was designed to absorb shocks and has treated BOD loadings of 7500 pounds without trouble. It was designed to handle a 4000 pound BOD loading. The system quickly dispels odor problems. Maintenance requirements and operational costs are reasonably low.

*Tertiary treatment, *Treatment facilities, Domestic wastes, Industrial wastes, Oxidation lagoons, Irrigation, Lakes, Organic matter, Nutrients, Flow, Crops, Growth rates, Soil types, Biochemical oxygen demand, Maintenance, Costs

Paw Paw (MI), Zero discharge

D290
PHYSICOCHEMICAL TREATMENT OF AN AUSTRALIAN MUNICIPAL WASTE WATER,

Ip, S. Y., Kolarik, L. O., Pilkington, N. H., Raper, W. G. C., and Swinton, E. A.

Division of Chemical Technology,
CSIRO,
Melbourne, Australia.

Water Research, Vol. 11, No. 2, p 173-180, 1977. 9 fig, 5 tab, 4 ref.

A pilot study was conducted to investigate physicochemical treatment (PCT) of waste water; to investigate integration of the 'Sirotherm' partial desalination process; and to test laboratory studies on applying magnetic ion-exchange resins to water purification. The plant uses lime coagulation at pH 11.5 with solids removal by flotation or sedimentation; ammonia stripping; neutralization to pH 10 by carbon dioxide; coagulation of precipitated calcium carbonate by ferric salts; clarification and sand-filtration; surfactant removal by foaming; water neutralization to pH 7; and granular activated carbon treatment. The plant produced a high-quality water from a constant flow of primary settled waste water. Operation was simple and practical. Lime scum flotation was effective with normal flows, but not when the flow was diluted with wet weather infiltration. Sedimentation was considered more reliable. Winter conditions did not substantially affect ammonia stripping, but packing scaling occurred. Granular carbon treatment was effective. Raw sewage treatment was not attempted; nor was operation in a total disposal mode or testing with varying flow rates. A buffer capacity between lime treatment and other stages was suggested.

*Pilot studies, *Ion exchange, *Resins, Coagulation, Sedimentation, Ammonia, Lime, Infiltration, Flows, Activated carbon, Filtration, Water purification, Waste water treatment, Treatment facilities, Desalination, Hydrogen ion concentration

D291
HIGH CAPACITY WASTE WATER TREATMENT SYSTEM,

Paper Trade Journal, Vol. 161, No. 2, p 46, March, 1977. 1 fig.

The Lightnin high capacity treatment system was introduced in the United States from Canada. For activated sludge applications, a mechanical aerator, surface or submerged, produces a flow to recycle settled sludge from an integral clarifier. The process handles flows from thousands to millions of gallons per day, and easily handles biological shock loads. It features common wall concrete construction and satisfied BOD and solids regulations for secondary treatment at wide BOD loading ranges and concentrations up to 3,000 milligrams/liter. The process can operate at MLSS concentrations of 2,000-12,000 milligrams/liter or higher. Phosphorus is removed by adding chemicals directly to the aeration basin and nitrification is easily achieved. There are minimum sludge handling costs, no submerged diffusers have to be cleaned, and there are no underwater bearings on the clarifier mechanism.

*Waste treatment, *Activated sludge, *Equipment, Aeration, Biochemical oxygen demand, Suspended solids, Nitrification, Phosphorus, Chemical treatment, Concrete construction, Waste water treatment

Lightnin treatment system

D292
BIOLOGICAL TREATMENT KINETICS OF LANDFILL LEACHATE,

Palit, T., and Qasim, S. R.

Texas University,
Arlington,
Department of Civil Engineering.

Journal of the Environmental Engineering Division-ASCE, Vol. 103, No. EE2, p 353-366, April, 1977. 8 fig, 4 tab, 3 append.

Results are presented of biological treatment studies with landfill leachate. Biological kinetic coefficients were determined for landfill leachate with mean cell residence time as the only variable. Comparisons were made with those of the sanitary sewage. Results indicated that landfill leachate could be treated in an activated sludge plant. Sludge bulking occurred several times during experimentation and could be a serious problem. Additional nutrients may be necessary to enhance plant performance since leachate contained low concentrations of prime nutrients. Combined leachate and sewage treatment may be beneficial, but further research is needed to determine the optimum mixing ratio. Conventional activated sludge with added phosphorus is an adequate treatment in areas where domestic sewers are not available.

*Leachate, *Landfills, *Kinetics, *Biological treatment, Activated sludge, Nutrients, Sewage treatment, Phosphorus, Sewers, Treatment facilities

D293
AERATORS CONTROL LIFT STATION ODOR AND CORROSION,

Mullins, W. H.

W. H. Mullins, Incorporated,
San Antonio, Texas.

Water and Sewage Works, Vol. 124, No. 3, p 75, March, 1977.

A preaeration process for the control of odor and corrosion at lift stations was described. Aerators with self-priming centrifugal pumps mix atmospheric oxygen with raw sewage to reduce organic solids to macroscopic size, to free solids from embedded and clinging gas particles, and to float suspended grease. Approximately 1,100 gallons of raw sewage can be circulated per minute. Recirculation from the wet well back to the first upstream manhole eliminates the release of hydrogen sulfide from raw sewage into the wet well. Upstream recirculation carries a raw sewage DO that varies from 4 to 6 milligrams/liter. Raw sewage color is changed from black to a foamy light tan. In addition to controlling odor and corrosion, this system also caused only grease to float on the surface of the primary clarifier; its effluent was relatively clear. The primary clarifier consistently removed 90-95% of settleable solids and 65-70% of BOD. The high degree of grease removal benefits the trickling filter secondary system of the treatment plant. BOD reduction between raw sewage at the lift station and at the plant varied from 10 to 20% depending on the time of day samples were taken.

*Aeration, *Wells, *Odor, *Corrosion control, Sewage treatment, Organic matter, Solid wastes, Hydrogen sulfide, Performance, Color, Dissolved oxygen, Biochemical oxygen demand, Trickling filters, Treatment facilities, Equipment, Effluents, Waste water treatment

Lift stations, Wet wells

D294
SLUDGE DISPOSAL IN THE NORTH WEST,

Symes, G. L., and Michaelson, A. P.

Water Pollution Control, Vol. 76, No. 1, p 50-58, 1977. 1 fig, 3 tab, 9 ref, 1 append.

Sludge disposal in areas controlled by the North West Water Authority, England, was discussed. The most common method is disposal to agricultural land. Seventy-five percent of the treatment plants supply liquid sludge for this purpose. Transport is accomplished by road tankers discharging sludge through irrigation pipes and rain guns, fixed pipes laid beneath fields, and slurry tanker disposal. Disposal to lagoons and tips is declining. Raw sludge is mixed with bulk transported refuse, in one case, to form stable lagoons which, when dry, aid land reclamation. Ocean disposal is carried out by pumping to an outfall and by ship transport. One major problem is that of sludge disposal in the Greater Manchester area. Planning and investigative groups are presently devising schemes to alleviate this problem.

*Sludge disposal, *Irrigation, Equipment, Planning, Analysis, Treatment facilities, Waste water treatment, Disposal, Land reclamation, Water districts

North West Water Authority (England), Ocean disposal, Marine sanitation

D295
SEWAGE TREATMENT IN DEVELOPING COUNTRIES,

Pickford, J.

Water Pollution Control, Vol. 76, No. 1, p 65-66, 1977. 1 tab.

Factors associated with sewage treatment in developing countries were discussed. The high growth rate of urban populations is characteristic of most of these nations, and the phenomenon of shanty-towns is a growing problem. Approximately two-thirds of these urban populations have access to piped water, though it may be intermittent or from public standpipes. Empty pipes contribute to inward leakage of groundwater which may be polluted where there is inadequate sanitation. Excreta is usually handled by municipal treatment, but often water is insufficient for basic needs, and it cannot be spared for toilet flushing. Pit latrines, septic tanks, and aqua-privies all have some drawbacks. Nightsoil is often buried in trenches but is usually treated with sewage sludge and in aerated lagoons. Separate sewage systems are used because of the heavy rainfalls in most developing countries and sewage blockage is common, as are problems resulting from hot climates, such as sewer corrosion. Stabilization ponds are ideal for many of these nations because they are simple, require easy maintenance, use little imported materials, and have no power requirements. Diffused-air activated-sludge treatment and biological filters can also be used, but capacity in tropical climates can be less than in temperate areas.

*Sewage treatment, *Urban areas, *Water supply, Water quality, Water quality control, Sanitation engineering, Sewage disposal, Domestic wastes, Septic tanks, Separate sewers, Oxidation lagoons, Corrosion, Economics, Activated sludge

Developing nations

D296
SUSPENDED SOLIDS MEASUREMENT GIVES IMPROVED CONTROL,

Posgate, E. S.

H. F. Instruments, Limited,
Bolton, Ontario, Canada.

Water and Wastes Engineering, Vol. 14, No. 3, p 30, 32, 35-36, March, 1977. 5 fig.

Turbidimeters have been adapted for monitoring and control at water and waste water plants. These reduce costs by regulating chemical input to actual demand. The basic process is a combination of gravimetric analysis with linear instruments for direct measurement in ppm of suspended solids. Factors involved in the use of this equipment are the type of water source, upstream discharges to the water source, seasonal climate, and weather changes. There is not a simple answer to what suspensions can be monitored directly. The major factor is that the suspension have uniform characteristics over a long term. Possible applications are monitoring activated sludge concentration and controlling flow rate for return to the primary stage, proportioning polymer input in sludge dewatering, final effluent monitoring, measuring sludge volume index, and making daily suspended solids measurements in advanced treatment systems. The automatic control system can reduce costs.

*Suspended solids, *Measurement, *Monitoring, *Automatic controls, Chemical treatment, Analysis, Equipment, Polymers, Flow rates, Physical properties, Chemical properties, Waste water treatment, Water purification

Turbidimeters

D297
TRENDS IN SMALL SEWAGE TREATMENT PLANTS,

Goulden, O. A.

Treatment Plant Contracts, Limited,
Hounslow, Middlesex, England.

Effluent and Water Treatment Journal, Vol. 17, No. 1, p 37-38, January, 1977.

Developing trends in small sewage treatment plants were delineated for the British nation. Six trends are of major importance. These include a growing septic tank market, the requirement of many water authorities that filter beds be used as well, a rise in maintenance costs, the increase in sophisticated treatment systems, the failure of various 'high technology' aeration tanks to produce capital and operational cost savings, and new sewage rates introduced by the government. These trends have become important because of the assumption that Britain would benefit from small privately owned plants in many ways. They are economical and produce multiple discharges of treated effluent into subsoils rather than a massive outfall from a major municipal plant. The small installations can comprise septic tank and soakaway or septic tank and filter bed and soakaway. Various economic considerations would require that treatment plants have a life of 30 years or more. This is not yet true of advanced treatment plants. A septic tank plus filter bed and soakaway for up to 15 people, and a biological filter bed for 15-1000 people fulfills this requirement. A full-time attendant and advanced technology are valid for installations for more than 1,000 people. This appears to be the best program until operational and maintenance costs for advanced treatment facilities can be achieved.

*Treatment facilities, *Septic tanks, *Aeration, Tertiary treatment, Municipal wastes, Domestic wastes, Economics, Waste water treatment, Filtration, Biological treatment, Legislation, Costs

Britain

D298
S.W.'S SLUDGE INCINERATION SCHEME,

Water and Waste Treatment, Vol. 20, No. 2, p 14-15, February, 1977.

A sludge treatment and incineration plant has begun operation in the South West Water Authority district of England. The plant treats a sewage flow of nearly 1 mgd from a population of about 20,000. The plant was designed for a population of 50,000 and provisions have been made for future duplication. Financial considerations have placed rural portions of the treatment system in limbo. The new pumping station has a 520 kw diesel generator to allay power failures.

*Incineration, *Sludge disposal, Treatment facilities, Planning, Design, Sludge treatment, Waste water treatment, Engineering structures, Activated sludge, Water districts

South West Water Authority (England)

D299
CHLORINE COMBINING WITH SEWAGE,

Water and Waste Treatment, Vol. 20, No. 2, p 18, February, 1977.

The Ontario Environment Ministry is investigating the possibility that toxic substances are being created from the chemical reaction of industrial wastes and the chlorine used in sewage treatment. The formation of chlorinated biphenyls can be an especially serious problem. Laboratory tests have produced these substances in ways which might be similar to what occurs during sewage treatment, but there is no evidence of chlorinated biphenyl production under actual conditions. PCB levels in the area of 40 sewage treatment plants have been monitored for two years, because of their potential cumulative risks. The production of chloroform is another worry of those concerned about chlorine treatment. The production of such toxic or carcinogenic agents has been a theoretical drawback to the extremely beneficial use of chlorine for sewage and drinking water. To avoid the possible dangers of using chlorine, ozone is being considered as an alternative treatment method.

*Chlorination, *Sewage treatment, Treatment facilities, Toxicity, Bacteria, Disinfection, Industrial wastes, Pollution abatement, Monitoring, Waste water treatment, Chemical reactions, Analysis

Chlorinated biphenyls, Polychlorinated biphenyls

D300
EVERYTHING FROM A PIPE FILTER TO A TURNKEY PROJECT,

Water and Waste Treatment, Vol. 20, No. 2, p 23-24, February, 1977.

The Sewage Treatment Division of Paterson Candy International, Limited, has undertaken the task of designing conventional and advanced treatment facilities and equipment for application in Middle Eastern nations. It has contracted many projects for water treatment to potable quality for use in boreholes, trailer and skid-mounted treatment facilities for the military, swimming pool purification plants, and pre-fabricated facilities for small residential/industrial applications. It has had much experience with desalination by reverse osmosis, chemical water treatment, sewage treatment, and water sterilization.

*Sewage treatment, *Treatment facilities, Tertiary treatment, Sanitary engineering, Reverse osmosis, Desalination, Water purification, Equipment, Filtration, Disinfection, Waste water treatment

Middle East

D301
KOWLOON SEWAGE TREATMENT AND DISPOSAL,

Effluent and Water Treatment Journal, Vol. 17, No. 2, p 94, February, 1977.

Various feasibility studies and investigations were conducted by the Hong Kong Government to develop treatment schemes as alternatives to ocean disposal of sewage and industrial wastes. A two-year study included float tracking and current measurement; determination of salinity and water temperature; and evaluation of the extent of pollution as expressed by dissolved oxygen levels and coliform bacteria counts. Sediment and bottom mud conditions were also studied. Design studies were conducted to develop treatment facilities in various areas of Hong Kong. Development will be carried out in two stages, at a cost of HK$520 million. A facility for North West Kowloon was suggested with interception of sewage and industrial wastes and conveyance by underwater pipeline to a treatment works on reclaimed land. The treatment works will have a main pumping station, and facilities for grit removal and fine screening. Screened and degritted sewage will be discharged by a new outfall and diffuser to the main harbor current stream. Added stages will include another interceptor and sewage and sludge treatment. Construction will have to survive typhoons and be such that shipping activities and harbor traffic will not be interrupted. This will probably be achieved by enclosing trunk sewers in immersed tubes. The completion of stage one is projected for 1980.

*Sewage treatment, *Sewage disposal, Water pollution sources, Pollution abatement, Industrial wastes, Domestic wastes, Design, Treatment facilities, Piping, Separation, Equipment, Planning, Urban areas

Hong Kong

D302
PROGRESS IN MHI'S INTEGRATED TECHNIQUES FOR ENVIRONMENTAL PROTECTION,

Matsumoto, K.

Environmental Technology Department,
Mitsubishi Heavy Industries,
Tokyo, Japan.

Technical Review, Vol. 13, No. 3, Ser. 37, p 173-191, October, 1976. 15 fig, 9 tab.

Results of recent advancements in water and air pollution control technology developed by Mitsubishi Heavy Industries, Limited, were presented. Water pollution control developments included treatment techniques for potable water, industrial water, sewage, night soil, and industrial wastes. Sludge concentrating devices, vacuum filter, centrifugal, and filter press dehydrators, and incinerators were discussed and described, as well as various water reuse schemes. New techniques have been developed to forecast effluent dispersion for preventing water pollution. Denitrification and trickling filter development were discussed with advances in solid wastes treatment. In addition, air pollution control, detection, and abatement were reviewed.

*Water pollution sources, *Air pollution sources, *Pollution abatement, *Environmental control, Treatment facilities, Water reuse, Sludge treatment, Sludge disposal, Organic matter, Drying, Incineration, Oil wastes, Biological treatment, Denitrification, Filtration, Solid wastes, Liquid wastes, Analytical techniques, Water quality control, Gases, Waste water treatment

D303
SEWAGE WORKS IS ABOVE GROUND LEVEL,

Water and Waste Treatment, Vol. 20, No. 2, p 13-14, February, 1977.

Normanton, Yorkshire, England, has replaced an inadequate treatment plant with one using the latest techniques. A regional facility, to handle increased industrial and housing development, is being constructed in two phases. The completed facility will be able to handle sewage for a population of 58,000, and would cost about 3.5 million pounds. Differences from other advanced systems include the pumping of all flows to the head of the works, and above ground treatment units. The sedimentation tank water level is about 3 meters above ground, allowing all associated pipe work to be placed in a covered gallery on the hopper end of the tank. This protects the pipes from the environment and provides workmen with a good work area. The piping is of ductile iron and flanged design. The versatility of this piping allowed the creation of a neat and endurable pipe system immune to accidental damage and extremely resistant to internal corrosion. Push-button operation of the de-sludging valves aid checking of sludge consistency through a sight glass. Sedimentation tank feed ports are designed to diffuse the flow an entry to establish early solids settling. These ports are made of glass-fiber reinforced plastic to ensure a long trouble-free life.

*Treatment facilities, Sewage treatment, Costs, Flows, Industrial wastes, Water districts, Design, Piping, Corrosion control, Monitoring, Engineering structures, Waste water treatment, Construction

D304
THE SANITARY LANDFILL LEACHATE CONTROL PLANT IN KOBE,

Technical Review, Vol. 13, No. 3, Ser. 37, p 273-274, October, 1976. 2 fig, 1 tab.

A leachate control plant was constructed in Kobe, Japan, to treat leachate containing high amounts of BOD, COD, suspended solids, ammonia, and colored matter. The plant employs a storage dam to create a uniform quality and quantity of leachate for treatment; trickling filter towers for organic matter removal and ammonia nitrogen oxidation; sedimentation and flocculation-sedimentation facilities; denitrification columns; activated carbon adsorption columns; and dewatering processes. Special design considerations include a trickling filter process to avoid difficulties in the biological treatment of long-term landfill leachate, a biological filter process for denitrification which has few operational problems and low maintenance needs, and combined biological and physical-chemical treatment to adjust water quality for economical operation at optimum conditions.

*Leachate, *Landfills, Treatment facilities, Waste water treatment, Water quality control, Soil contamination, Design criteria, Sanitary Engineering, Biological treatment, Chemical treatment

Kobe (Japan)

D305
CHARACTERIZING SLUDGE FOR CENTRIFUGAL DEWATERING,

Vesilind, P. A.

Duke University,
Durham, North Carolina,
Department of Civil Engineering.

Filtration and Separation, Vol. 14, No. 2, p 115-116, 118, 120, March/April, 1977.
5 fig, 3 ref.

The design of sludge dewatering equipment must depend upon characteristics of the sludge to be treated. Sludge characteristics were described which would enable engineers to specify conditions for the guaranteed performance of their equipment. A procedure was outlined for the measurement of settling properties under high centrifugal forces. Batch settling tests could be performed at high gravitational forces using a desk top centrifuge and a strobe light. Sludge-filled tubes are spun horizontally and the strobe is synchronized with the centrifuge so the height of the slurry-liquid interface can be observed. Settling of the uppermost particle in the slurry can be followed and its velocity calculated. This velocity measurement has the disadvantage of being dependent upon the force imposed, which can be eliminated by using a "settling coefficient" concept. Other characteristics which indicate the ability of the sludge to be centrifuged include the clarity of the centrate and the ability of the sludge to be moved by the screw conveyor.

*Dewatering, *Centrifugation, *Sludge treatment, Solid wastes, Equipment, Physical properties, Chemical properties, Waste treatment, Waste water treatment, Design criteria

D306
OZONE AND CHLORINE IN WASTE WATER DISINFECTION,

Kawara, O.

Okayama University,
Okayama, Japan,
Department of Civil Engineering.

Memoirs of the School of Engineering, Okayama University, Vol. 11, No. 2, p 37-49, January, 1977. 20 fig, 3 tab, 4 ref.

The disinfection efficiency, oxidation power, and effects of ozone- or chlorine-treated secondary effluents on aerobic microorganisms were compared in ozone and chlorine waste water treatment. Disinfection of coliforms required a smaller dosage of chlorine than ozone, but chlorine could not sterilize them as completely, even at high doses, or as quickly, as ozone. Ozone should be used where both disinfection and organic compound removal are desired. Suspended solids are well-decomposed, as are the higher molecular compounds. Chlorine has little effect on these substances. Certain compounds which are conducive to aerobic bacterial growth are easily decomposed by ozone, but not by chlorine. Microbial growth rates were lowest in the control, and increasingly greater in ozone-treated effluents, chlorine-treated effluents, and secondary effluents. Ozonation increased biodegradability and chlorination decreased it. It was concluded that chlorination is an effective process when effluents do not contain high amounts of suspended solids and their removal is not the major desired result.

*Disinfection, *Chlorine, *Ozone, Oxidation, Aerobic bacteria, Toxicity, Suspended solids, Sewage effluents, Chlorination, Biodegradation, Waste water treatment

D307
UNSTRATIFIED-BED FILTRATION OF WASTE WATER,

Dehab, M. F., and Young, J. C.

Iowa Resources Council,
Des Moines, Iowa.

Journal of the Environmental Engineering Division-ASCE, Vol. 103, No. EE1, p 21-36, February, 1977. 11 fig, 4 tab, 2 append.

An investigation was conducted to determine the suspended solids removal and backwash characteristics of single-medium unstratified-bed filters and to determine the effect of media grain size and type on performance and backwash characteristics. Comparisons were made with dual-media filters. It was found that the unstratified-bed filters with the same effective size medium used as in the top layer of dual-media filters would provide the same effluent quality and run length as the dual-media filters. Use of these filters with combined air-water wash allows a larger filter medium size than that of dual or multimedia filters. In-depth filtration is improved with larger sized filter mediums, and solids capture capacity is increased, as is the run length. Suspended solids removal is not significantly reduced by increasing media size from 1 millimeter to 2 millimeters at filtration rates of 5-10 meters/hour. Filter bed depths above 914 millimeters produce no effective increase in effluent quality with filter mediums of an effective size of 1.3-1.5 millimeters. Backwash rates for effective cleaning of these filters are less than what is needed to fluidize the medium. Solids removal from the filter during backwash using air and water required nearly 4 cubic meters of water per square meter of filter area for backwash rates of 18.75-37.5 meters/hour. Combined air and water treatment during backwash improved the washout of large flocculated solids from the space above the filter bed, and eliminated mudball formation. Media loss during this last operation is significant unless appropriate design and operating control measures are used.

*Filters, *Suspended solids, *Performance, Filtration, Air, Flocculation, Design, Water purification, Analysis, Physical properties, Separation techniques, Waste water treatment

Unstratified-bed filtration, Backwash characteristics

D308
OXYGEN SYSTEM ACTIVATED SLUDGE PROCESS,

Effluent and Water Treatment Journal, Vol. 17, No. 2, p 83, February, 1977. 1 fig.

Development of the UNOX activated sludge treatment process has eliminated many of the drawbacks of traditional activated sludge treatment. The negative aspects included the need for large aeration tanks and land areas, odor problems from open tanks, and rapid effluent quality declines at loadings greater than design. Most of the problems were traced to a shortage, or transient shortage of dissolved oxygen. The use of pure oxygen provides a healthier, more efficient process. The UNOX system uses about 90% of the oxygen gas fed into it. This gas and activated sludge and sewage are contacted in multi-stage reactors. A near four-fold efficiency increase resulted from the use of pure oxygen. On-site oxygen supply can be accomplished by a pressure swing adsorption oxygen generator. The process maintains a DO of 2-8 milligrams/liter, creating an optimum environment for activated sludge. This allows the system to operate at high mixed liquor suspended solids concentrations with a more active biomass per unit volume. Because of this, retention times can be 25-50% less than in conventional plants. The system can easily respond to changes in load and can be adapted to existing activated sludge systems. Sludge production is less and can be treated for direct application to land. The plant requires less land than conventional systems and avoids most of the objectional features of them.

*Oxygenation, *Sludge treatment, Aeration, Activated sludge, Aerobic conditions, Oxygen, Gases, Oxygen demand, Design, Suspended solids, Treatment facilities, Waste water treatment, Tertiary treatment

UNOX

D309
THE USE OF PACKED BEDS IN WATER POLLUTION CONTROL,

Porter, K. E.

La Tribune du Cebedeau, Vol. 30, No. 398, p 30-42, January, 1977. 16 fig, 5 tab, 11 ref.

Various types and designs of packed beds, as well as design criteria and mass transfer mechanisms used in water pollution control were described. The filter bed process generally involves two settling tanks with an intermediate filter treatment step. Microorganisms which consume the organic pollutant, in packed filter beds, grow over the surfaces of the packing as a film. The biomass removes BOD and becomes the solid product to be settled out. Packed beds are economical in situations where there is high BOD and/or high BOD concentrations maintained throughout the packed bed. Higher organic loading on the packing produces lower treatment costs, but increases the chance of blockage. Mineral media have been traditionally used. Modern packings include plastics such as polystyrene, polypropylene, and polyvinyl chloride, and various forms of vertical sheets and vertical tubes which allow organic loading to be increased about twenty times that used with the traditional packing. Packed beds are used to partially treat industrial wastes and industrial waste waters that cannot be treated with activated sludge methods, and to increase the capacity of existing sewage plants. Design techniques are reviewed with data on design criteria. Equations are presented for the biochemical rate and limiting solutions for diffusion and reaction in the biomass film, and for boundary conditions. Factors involved in the derivation of design equations were also considered.

*Packed beds, *Design criteria, *Mass transfer, *Biological treatment, *Water pollution control, Filtration, Microorganisms, Biochemical oxygen demand, Industrial wastes, Plastics, Mineralogy, Organic matter, Separation techniques, Water purification, Treatment facilities, Costs, Physicochemical properties, Waste water treatment, Performance, Evaluation

D310
INCINERATION SOLVES TOUGH WASTE PROBLEMS,

Modern Power and Engineering, Vol. 71, No. 3, p 40, March, 1977.

Incineration is considered one of the best avenues for handling wastes. Advantages of the method include: weight reduction, volume reduction, sterile residues, and production of recoverable heat. The necessary performance requirements for the application of incineration are an ability to consume a wide variety of materials, adequate pollution controls, compatible operating and capital costs for the system, high disposal capacity per square foot of floor area, and adequate ash residue removal. The operation of a large incinerator for a short time is most economical and disposal of very hazardous materials only is economical for operations below 300 pounds/hour. Air pollution control is often a considerable cost factor. Improved incineration technology includes thermal incineration for gaseous wastes, direct-flame fume incinerators for control of noxious organic emissions by oxidation, fluidized bed incinerators, slagging pyrolysis, and suspension burning of finely divided materials in a vortex furnace chamber. Continued development and design revisions will make incineration a more economically sound treatment method.

*Incineration, *Waste treatment, *Waste disposal, Industrial wastes, Pollution abatement, Municipal wastes, Gases, Combustion, Oxidation, Economics

D311
TRAVELLING GRATE-TYPE FILTRATION SYSTEM USES PULVERIZED COAL TO LOWER BOD OF WASTE WATER,

Water and Pollution Control, Vol. 115, No. 3, p 38, March, 1977.

A traveling grate-type filtration system was developed to lower BOD loads of organic pollutant waste water, using pulverized coal. BOD is reduced to under 2 ppm and heavy metal ions are reduced by more than 90%. A revolving cylinder serves as the settling tank. Waste water and precipitation accelerators are introduced at the same time. Waste water passes from the bottom opening of the tank to a sump tank and then to the coal filter bed. After pollutant absorption, the coal is removed for disposal by a rake arm, along with suspended solids and other contaminants which settled out of the waste stream. Treated water is fed to a sprinking filter bed for biochemical treatment to lower organic content.

*Filtration, *Biochemical oxygen demand, *Coal, Equipment, Organic matter, Waste water treatment, Filters, Suspended solids, Liquid wastes, Heavy metals

D312
PROSPECTS STRONG FOR WASTE WATER OXYGENATION,

Chemical and Engineering News, Vol. 55, No. 13, p 17-18, March, 1977.

Oxygen aeration of waste water is becoming more attractive as waste water treatment is more strictly regulated. It can double treatment capabilities without necessitating a vast expansion of facilities. In addition, it could provide greater BOD removal, sludge digestion, and nitrification. There is the promise of greater removal efficiencies with lower operating costs than air aeration, though capital costs are greater. However, a section of P.L. 92-500 calls for 75% federal financing of eligible capital costs, and some state governments offer various subsidies. Oxygen aeration systems reduce air pollution in the form of odors and virus contaminants. Sludge disposal problems are reduced by the production of a denser, low-volume sludge. Improvements in oxygen production and modular construction are also considered to be advantages of this system.

*Oxygenation, *Waste water treatment, *Treatment facilities, *Aeration, Oxygen, Biochemical oxygen demand, Municipal wastes, Sludge, Costs, Equipment

D313
ENZYMATIC TREATMENT OF PRIMARY MUNICIPAL SLUDGE WITH TRICHODERMA VIRIDE CELLULASE,

Cinq-Mars, G. V., and Howell, J.

Republic Steel Research,
Independence, Ohio.

Biotechnology and Bioengineering, Vol. 19, No. 3, p 377-385, March, 1977. 3 fig, 3 tab, 9 ref.

Experiments were conducted to determine the feasibility of sludge pretreatment before digestion with cellulase in order to reduce cellulose content and viscosity. Pretreatment was either by sterilization at 120 C for 30 minutes, followed by adding 100 ppm merthiolate and homogenizing for 2 minutes, or by heat pasteurization to 95 C and cooling to 50 C. Hydrolytic experiments produced the following results. Up to 75% of the cellulose was converted, mostly to cellobiose, in 24 hours. Raw primary sludge was changed from a gel-like consistency to a slurry of fine particles amenable to ultrafiltration. Possible rate limiting steps in the conversion of cellulose to methane by anaerobic digestion could be reduced by converting cellulase to soluble reducing sugars before digestion; by making reducing sugars available to allow an increased generation of microbial populations; and by a faster transfer of dissolved products from liquid to gas phase. An economical, self-supporting treatment system might be possible with the use of process filtrate for cellulase, single-cell protein, or alcohol production.

*Sludge treatment, *Biological treatment, Physical properties, Chemical properties, Municipal wastes, Waste water treatment, Hydrolysis, Sludge digestion, Chemical degradation

D314
CHLOROBIPHENYLS AND PCB'S: FORMATION DURING CHLORINATION,

Gaffney, P. E.

Georgia State University,
Atlanta,
Department of Biology.

Journal Water Pollution Control Federation, Vol. 49, No. 3, p 401-404, March, 1977. 3 tab, 14 ref.

A study was conducted to discover if chlorobiphenyls were produced during actual and laboratory simulation of water and waste water treatment plant operation. Samples were spiked with biphenyl and chlorinated, extracted with hexane, and analyzed by gas chromatography. Results showed that various chlorobiphenyl isomers were produced during final chlorination. These and other organochlorines were produced in the laboratory chlorination of municipal plant influent and effluent. Mono- and dichlorobiphenyls were produced in the absence of iron; more were produced in its presence. Laboratory chlorination slightly increased dichlorobiphenyl concentrations in influents, but reduced them in effluents. Studies are being continued on the effect of these compounds on water and waste water treatment, on downstream ecosystems, and on water use.

*Chlorination, *Disinfection, *Polychlorinated biphenyls, Municipal wastes, Industrial wastes, Treatment facilities, Toxicity, Chemical reactions, Analytical techniques, Chromatography, Waste water treatment

Chlorobiphenyls

D315
IMPROVED GALVANIC DISSOLVED OXYGEN SENSOR FOR ACTIVATED SLUDGE,

Poole, R., and Morrow, J.

Fischer and Porter Company,
Warminster, Pennsylvania.

Journal Water Pollution Control Federation, Vol. 49, No. 3, p 422-428, March, 1977.
7 fig, 9 ref.

A galvanic dissolved oxygen sensor which uses gold as the cathode and copper as the anode was developed. The gold electrode is covered with a gas-permeable, liquid impermeable teflon membrane to separate the cell from the test solution. The interior chamber has an electrolyte capacity of 60 centimeters. A thermistor is cemented to the sensor body. The sensor can operate continuously for 15 months before recharge is necessary. The membrane is easily replaced in field operation and good temperature compensation results from its exposure to constant load resistance at all temperatures. Field tests produced good results in aeration tanks. Agitators are not necessary when the sensor is used in aeration tanks.

*Dissolved oxygen, *Monitoring, *Measurement, Equipment, Activated sludge, Membranes, Electrolytes, Electrodes, Mechanical engineering, Analysis, Waste water treatment

Galvanic sensor

D316
EFFECTS OF HIGH ORGANIC LOADING ON MIXED PHOTOSYNTHETIC WASTE WATER TREATMENT,

Miller, S., Abeliovich, A., and Belfort, G.

University of Cape Town,
Cape Town, South Africa,
Department of Chemical Engineering.

Journal Water Pollution Control Federation, Vol. 49, No. 3, p 436-440, March, 1977.
2 fig, 4 tab, 14 ref.

Hospital and domestic sludge was studied to determine the effect of high organic loading on mixed photosynthetic waste water treatment. The major inhibitors in hospital effluents on algal growth in treatment ponds are most likely to be detergents, solvents, and antibiotics. Tests were run to establish whether the greater carbon supplies and lower pH variation resulting from using sludge outweighed the disadvantage of decreased light penetration. Temperature, pH, dissolved oxygen, photosynthesis, and respiration rates were recorded daily. Results showed the more alkaline hospital sludge to have a lower buffering capacity than domestic sludge. Little pH variation was found in the mixed photosynthetic system. There was evidence that appreciable algae growth was possible with hospital effluents after the bacteria had adapted to environmental conditions. Respiration rates decreased continuously in reactors with sludge added. Dissolved oxygen proved a good indicator of the state of the system. Oxygen levels were high at high pH where carbon limitation might be evident. Sludge biodegradation, usually anaerobic, results in significant carbon losses in the form of CH_4 and CO_2. The tests showed that a greater algal yield without impairment of water quality can be expected in photosynthetic systems with high organic loading.

*Organic matter, *Loads (forces), *Photosynthesis, Dissolved oxygen, Bacteria, Temperature, Hydrogen ion concentration, Detergents, Biodegradation, Municipal wastes, Hospitals, Algae, Oxidation lagoons, Aerobic conditions, Biochemical oxygen demand, Carbon, Suspended solids, Nitrogen, Water purification, Waste water treatment

Hospital wastes

D317
EFFLUENT EMPHASIS UNDERLINES ENVIRONMENTAL EFFORT AT ENPOCON,

Wood, R.

Environmental Protection Survey, p 11-13, February, 1977. 3 fig.

Various waste effluent treatment methods were demonstrated at an English exhibition. A packaged dissolved air flotation plant was shown which was fabricated of steel to eliminate the time, costs, and land usage required for concrete tanks or lagoons built on site. The effluent is pumped from a wet well to a holding tank, with air introduced upstream from the pump. The air is in solution until it reaches the flotation cell in the coagulation chamber where it is released as tiny bubbles. The resultant float is removed by a scraper arm and placed into a sludge hopper. The effluent is removed and recycled. A system employing electrolytic treatment with flotation was claimed to reduce operating costs by as much as 50% when compared with air flotation. Chlorination units were also displayed. There was an 8,000 ppd liquid chlorine evaporator and a high capacity chlorinator, as well as one based on the use of solid tablets of a mixture of calcium hypochlorite and 1,3,4,6-tetrachloroglycoluril. A pure oxygen waste water treatment system and a submersible aerator were other units shown. Solutions to disposal problems were seen in a thermal sludge drying system which produced a pelletized material, and in incineration units.

*Water purification, *Liquid wastes, *Flotation, *Aeration, *Electrolysis, *Chlorination, *Flocculation, *Oxygenation, Oxygen, Pumps, Waste disposal, Equipment, Incineration, Sludge disposal, Pollution abatement, Polymers, Chemical treatment, Gases, Waste water treatment

D318
SEWAGE SLUDGE DISINFECTED BY ELECTRON-BEAM BOMBARDMENT,

Compost Science, Vol. 18, No. 1, p 24, January-February, 1977.

An irradiation process was developed for the disinfection of sludge. Greater restrictions on sludge disposal have spurred interest in this sludge treatment for the destruction of odor, bacteria, and viruses. Electron-beam bombardment is being tested by the Massachusetts Insitute of Technology and the University of New Hampshire at a Deer Island, Massachusetts, facility. Sludge water with 2-5% solids is treated in a 4 foot-wide, 2 millimeter-deep stream. This facility treats 100,000 gallons of sludge per day. A commercial facility equivalent to the test facility would require an initial investment of $500,000 and an annual operating budget of nearly $130,000.

*Sludge treatment, *Disinfection, *Irradiation, Heavy metals, Sludge disposal, Equipment, Bacteria, Viruses, Treatment facilities, Waste water treatment

D319
OXYGEN AERATION AT NEWTON CREEK,

Nash, N., Krasnoff, P. J., Pressman, W. B., and
Brenner, R. C.

Department of Water Resources,
New York, New York.

Journal Water Pollution Control Federation, Vol. 49, No. 3, p 388-400, March, 1977.
4 fig, 6 tab.

Plant-scale tests have indicated that pure oxygen substituted for process air can upgrade overloaded activated sludge plants. This method was further examined at the Newton Creek, New York, modified aeration plant. Over the three-year test period, effluent quality averaged 19 milligrams/liter of both BOD and total suspended solids, at flow rates of 38,200-134,000 cubic meters/day. The equivalent removal efficiences were 89% for BOD and 86% for suspended solids. Effluent quality was slightly poorer during warm weather, non-filamentous periods, although overall efficiency was slightly greater at those times. During four cold weather periods when fungal organisms proliferated the effluent quality dropped. The predominant fungus that caused recurrent difficulties in winter was identified as Geotrichum. The concentration of filamentous organisms in the system affected process efficiency in a proportional manner. Oxygen consumption averaged 1.0 grams/gram of BOD removed at, or above, design flow rates. At these levels, the power requirement averaged 0.95 kilowatt-hours per kilogram of BOD removed. During filamentous periods, solids production averaged 1.27 grams/gram of removed BOD, and 0.93 grams during nonfilamentous periods.

*Aeration, *Oxygen, Activated sludge, Treatment facilities, Performance, Sewage effluents, Biochemical oxygen demand, Suspended solids, Microorganisms, Sludge treatment, Waste water treatment

Newton Creek (NY)

D320
SLUDGE DEWATERING PRESS,

Industrial Wastes, Vol. 23, No. 2, p 17, March-April, 1977.

Dry-solids cakes can be made with a sludge dewatering press from dilute sludge produced by the sedimentation of industrial and municipal waste water processes. There are three stages: draining of sludge pre-flocculated with a polyelectrolyte; low-pressure pressing of the sludge between the drainage screen and a pressing screen, and pressing by a series of decreasing diameter perforated rollers which increase pressure gradually; and, finally, sustained high-pressure pressing by a series of one inch-wide belts which press the sludge against a perforated roller.

*Dewatering, *Sludge treatment, Equipment, Sedimentation, Industrial wastes, Municipal wastes, Flocculation, Polyelectrolytes, Waste water treatment, Separation techniques

D321
FLUID BED FOR SEWAGE SLUDGE BURN UP,

Martin, D.

Environmental Protection Survey, p 27, February, 1977.

The sludge incinerator plant at Esher, England, burns organic matter within a fluid bed of sand. Components of the installation are a mechanically raked screen, a detritor to remove grit, a primary sedimentation facility, biological filters, humus tanks, micro-strainers, and an oil-fired incinerator. Mechanical moving parts are not used so maintenance problems due to mechanical failure are avoided. A fail-safe system is employed to avoid mishaps from power failures. The fluid bed is a mixture of sand and gases in suspension, making an ideal environment for the thermal oxidation of sludge. Flexible feed pipes are used for the sludge to allow easy handling of blockages. Operation is on a continuing rather than batch basis. Dewatering is conducted by vacuum filtration and the pumps are reliable, accept liquid carryover and soft solids, are resistant to corrosion, have a cooling effect on explosive gas, and scrub dirty gas. Little maintenance is required for the pumps. The plant has lower odor levels than usual, clean stack gas, and an absence of ash.

*Incineration, *Sludge disposal, *Treatment facilities, Sedimentation, Separation, Filtration, Equipment, Oxidation, Sludge treatment, Oxygen, Temperature, Pumps, Dewatering, Pollution abatement, Operation and maintenance, Waste water treatment

Esher (England)

D322
AEROBIC DIGESTION OF SLUDGES PRECIPITATED FROM WASTE WATER BY LIME ADDITION,

Hamoda, M. F., and Ganczarczyk, J.

Waste Water Technology Center,
Canada Center for Inland Waters,
Burlington, Ontario, Canada.

Journal Water Pollution Control Federation, Vol. 49, No. 3, p 375-387, March, 1977.
4 fig, 7 tab, 12 ref.

Laboratory batch and semi-continuous aerobic digestion experiments were performed to examine the behavior of lime-primary sludges precipitated with various lime dosages over an operational pH range. Sludge samples were obtained from a Toronto treatment plant. Results indicated that aerobic digestion of lime-primary sludges was technically feasible, though high lime doses adversely affected digestion process kinetics. The buffering capacity of the digestion system was good. Total alkalinity of the lime-primary sludge did not decrease because of aerobic digestion. However, the primary sludge decreased in alkalinity as aeration time increased. Nitrification was adversely affected in digesters treating lime-primary sludges when lime doses were high. Primary sludges as well as lime-primary sludges bound soluble phosphorus and soluble organic carbon during digestion and released these components during storage. Settling and filtration qualities of the aerobically digested lime-primary sludges were good. Semi-continuous digesters produced sludges with higher oxygen uptake rates, better dewaterability, and higher supernatant quality than those of batch systems. The pollutant content of sludges from semi-continuous systems should not cause serious loading problems if the supernatants are recycled or discharged by treatment plants. A sizable population of stalked ciliates and rotifers was maintained in digesters treating lime-primary sludges. Stabilization of lime-primary sludges requires a 15-day detention period at 20 C, especially if they have initial pH values of 10-12.

*Aerobic treatment, *Sludge digestion, *Chemical treatment, *Lime, Physical properties, Chemical properties, Treatment facilities, Biological treatment, Evaluation, Waste water treatment

D323
AEROBIC DIGESTION OF WASTE ACTIVATED SLUDGE AT LOW TEMPERATURES,

Koers, D. A., and Mavinic, D. S.

Associated Engineering Services Limited,
Namaimo, British Columbia, Canada.

Journal Water Pollution Control Federation, Vol. 49, No. 3, p 460-468, March, 1977.
8 fig, 12 ref.

A study was conducted on the design and operating criteria of aerobic digestion systems handling activated sludge under cold climate conditions. Comparative data were generated for operation at various low temperatures. A field evaluation of laboratory results was the final part of the study. Study temperatures were 20, 10 and 6 C. Results indicated little difference between continuous and semi-continuous digester operations. The major exception was a volatile suspended solids (VSS) reduction at 5 C with the semi-continuous digester method. There was a good correlation between the product of sludge age and temperature and VSS reduction at 5-20 C. There is little VSS reduction after this product exceeds 250. At low temperatures, a 50-day sludge age results in the maximum VSS reduction of nearly 30%; 5 C is the lowest average monthly digester temperature. Full-scale operations were too variable for steady-state conditions to be established. Mixed liquor BOD was thought to be a promising parameter for measuring digested sludge stability during storage when odor is used as a criterion for stability. Sludge with a BOD5 of less than 9.29 grams/gram of VSS was odor-free after storage at 20 C. Stabilization was achieved at a sludge age of 40 days at 20 C, and at 60 days at 10 C, but not even 80 days achieved sludge stability at 5 C. Cell mass characteristics, measured by TOC, COD, organic nitrogen, and volatile content, was extremely constant for all systems. Biodegradability seemed to decrease with increased sludge age. The basic composition of the sludge cells did not appear to change during aerobic digestion.

*Sludge digestion, *Aerobic conditions, Temperature, Activated sludge, Waste water treatment, Sludge treatment, Treatment facilities, Biological treatment, Microorganisms, Biochemical oxygen demand, Oxygen, Hydrogen ion concentration, Chemical properties, Physical properties

D324
OIL-FLUSHED TOILETS GAIN,

Leich, H. H.

Compost Science, Vol. 18, No. 1, p 25, January-February, 1977.

An oil-flushed toilet has been developed which uses no water for the disposal of body wastes. A colorless, low-viscosity mineral oil replaces water as the flushing medium. The oil and wastes are carried to a holding tank where oil floats to the top and water-saturated wastes sink. The oil is recycled to toilet tanks after filtration. There is no odor, and no bacterial or viral presence in this system. Domestic water savings have been estimated at 30-40% of the water piped into a home when this system is used. The system was installed at restrooms in the Rocky Mountain National Park, Colorado, when facilities were expanded. It was found to be less expensive than regular systems and more environmentally acceptable. It has reduced water pumping in the park buildings from a daily pumping to one pumping every 7 to 10 days. There has been no need to close comfort stations because of water shortages. Operation during early and late seasons can be attributed to the fact that oil does not freeze. Sewage production has been reduced from 14,000 gallons daily to 1,800 gallons per week. Costs have been reduced from 20 cents per flush with water to 2 cents per flush with the oil system. The ultimate disposal of wastes from the system can still be a problem. The wastes are usually trucked to a municipal treatment plant or to farmland for agricultural use, but a plan for producing methane gas from them is being studied. A system for marine applications is being adapted for use in high-rise buildings. Water from sink, basins, bathtub, and washing machines could be disposed to a smaller septic tank and drain field after filtration when this method is installed in domestic applications.

*Domestic wastes, *Sanitary engineering, Oils, Odor, Bacteria, Viruses, Water utilization, Water conservation, Costs, Waste disposal

Oil-flushed toilets

D325
1.17 MILLION POUND WORKS AND SEWAGE SCHEME COMPLETED AT MARKET RASEN,

Surveyor, Vol. 149, No. 4423, p 32, March, 1977.

A treatment facility was constructed in England at a cost of 1.17 million pounds. The plant was constructed to handle flows up to 130 liters/second daily. Excess flows are discharged to a river by screw pump. Flows pass through a grit trap, a comminutor, a flow recorder, and then are divided between two sedimentation tanks. The effluent is next divided at the dosing tanks and passed to filter beds where recirculation occurs. Modified alternating double filtration will be added later. After filtration, the effluent is discharged to humus tanks, and finally into a river.

*Treatment facilities, Sewage treatment, Construction, Pumps, Sedimentation, Filtration, Sludge treatment, Dewatering, Water reuse, Waste water treatment, Sewers

Anglian Water Authority (England)

D326
DEWATERING: A NEW METHOD BOWS,

Bell, J. A., Higgins, R., and Mason, D. G.

Smith and Loveless Division,
Ecodyne Corporation,
Lenexa, Kansas.

Water and Wastes Engineering, Vol. 14, No. 4, p 33-34, 39-41, April, 1977. 5 fig, 10 tab, 2 ref.

A gravity-pressure filtration system, or sludge concentrator, has been developed to dewater sludges from various treatment processes and, especially, to take advantage of polyelectrolyte-conditioned sludge characteristics. The concentrator is provided with a sludge feed pump, a polymer system, a sludge conditioning system, and a two-stage dewatering unit. A combination flashmixer-flocculator provides optimum mixing of the diluted polymer and sludge to form large particles prior to gravity dewatering. In the pressure stage, three sets of compression rollers squeeze out more liquid and the dewatered sludge is discharged for final disposal. Sludge volume can be reduced as much as 80%. Models are provided which can process up to 1600 dry pounds of sludge/million gallons in a 40 hour week. Comparisons with vacuum filtration indicated that a 250-square foot vacuum filter would be needed to dewater the same amount of sludge as the larger concentrator model. The vacuum filter does use less polymer material, but this is offset in the concentrator by lower energy requirements. Operating costs are lower with gravity-pressure filtration. Two treatment plants operated at different flows were used for sludge evaluation. In one, a secondary treatment facility, effluent could be discharged or diverted to tertiary treatment with combined flashmixing, flocculation, clarification and thickening of chemically treated waste. Raw sewage was used in this facility. Secondary effluent was used instead of raw sewage in the same scheme for the second facility. Settling was aided by the addition of anionic polymers. Sludge from biological treatment was evaluated for its dewaterability. In both facilities, effluent quality met acceptable levels for the processes employed.

*Dewatering, *Filtration, *Sludge treatment, Equipment, Polyelectrolytes, Performance, Evaluation, Treatment facilities, Polymers, Chemical treatment, Sedimentation, Tertiary treatment, Aerobic digestion, Waste water treatment

Gravity pressure filtration

D327
AUTOMATIC CONTROL OF WHITLINGHAM SEWAGE TREATMENT WORKS NORWICH,

Thurley, B. L.

Process Biochemistry, Vol. 12, No. 1, p 26, 28-29, January/February, 1977. 1 fig.

A digital computer was used to provide automatic control for a treatment facility consisting of existing facilities and "in construction" extensions. The apparatus controls flow rate through the duty screen and operates a standby screen during Detritor scraper and grit rake operation; it also controls the flow to activated sludge and percolating filter plants, sequences the de-sludging process, and initiates the cleaning of flume float wells. A complete alarm-monitoring program is included in the computer controls. Ultrasonic sensors measure solids content to determine sludge withdrawal during primary sedimentation. Minimum head loss is maintained during activated sludge treatment, as is a predetermined dissolved oxygen concentration. The computer also controls the amount of sludge wasting, and monitors and integrates the amount passed to waste. Computer control is used with the two filtration systems employed: single filtration/recirculation, and single filtration/alternating double filtration. The sludge treatments involved are the automatic feed of sludge to primary digestion tanks, and displacement into secondary digestion tanks and filter pressing. Sludge is disposed to liquid sludge loading tanks, to land, and to drying beds.

*Automatic controls, *Monitoring, *Treatment facilities, Sedimentation, Activated sludge, Computers, Flow, Filtration, Sludge treatment, Sludge digestion, Sludge disposal, Waste water treatment

Norwich (England)

D328
DEWATERING MACHINES (Entwasserungsmachinen),

Shin, K. C.

Wasser, Luft und Betrieb, Vol. 21, No. 3, p 137-141, 1977. 8 fig, 3 tab, 3 ref.

The principal types of waste water sludge dewatering equipment used currently and their general characteristics are described. Centrifuges, belt filters, and chamber filter presses represent the most common means for dewatering sludge. Centrifuges can be used for any size waste water treatment plant because they are available for a wide range of throughput capacities. Chamber filter presses, which have separating efficiencies, are especially suitable for use in large-capacity waste water treatment facilities. Belt filters are used for treatment plants of small to medium capacity. S type filter belt presses can reach separation efficiencies as high as 99%.

*Dewatering, *Equipment, *Sludge treatment, Filters, Centrifugation, Filtration, Separation, Treatment facilities, Performance, Waste water treatment

D329
APPLICATION OF CORRUGATED SHEET SPRAYERS FOR WATER PURIFICATION
(Die Anwendung von Wellbahnrieslern in der Wasseraufbereitung),

Nagel, G.

GWF-Wasser/Abwasser, Vol. 118, No. 3, p 103-109, 1977. 14 fig, 1 tab, 4 ref.

Results are presented of field experiments with corrugated sheet sprayers used to aerate raw potable water for the removal of iron and manganese. At an air-to-water ratio of 1:1, optimal results were obtained at flowthrough rates of 600-1,000 cu m/hr per sq m. The new process has the advantage of providing for adequate oxygen concentration in the water without causing supersaturation or excessive loss of CO_2. This is because the water passes through a special degassing section after going through the aeration section. Test runs for several months showed no clogging in spite of considerable iron and manganese concentrations of up to 2.8 mg/l and 0.5 mg/l, respectively.

*Water purification, *Aeration, *Spraying, Iron, Manganese, Separation, Performance, Oxygen, Carbon dioxide, Gases, Equipment, Pollutants, Water treatment, Water quality control

Corrugated sheet sprayers

D330
PERSISTENCE OF MYCOBACTERIUM BOVIS BCG IN SOIL AND ON VEGETABLES SPRAY-IRRIGATED WITH SEWAGE EFFLUENT AND SLUDGE,

Van Donsel, D. J., and Larkin, E. P.

Public Health Service,
Bureau of Foods, Division of Microbiology,
Cincinnati, Ohio.

Journal of Food Protection, Vol. 40, No. 3, p 160-163, March, 1977. 3 fig, 1 tab, 20 ref.

Land disposal of sludge is currently under consideration in the United States, and studies are being conducted on the potential public health hazards which might be inherent in this practice. Tubercle bacilli represent a particular threat because they generally survive conventional waste water treatment processes. Cultured Mycobacterium bovis BCG was added to activated sludge and to unchlorinated secondary effluent, which was then sprayed onto lettuce or radish plants grown outdoors in plywood boxes. Soil suspensions and vegetable washings were assayed for BCG. The 90% reduction time on effluent-sprayed radishes was 6 days, and on sludge-sprayed radishes it was 4 days, which was not a significant difference. The results for lettuce were too variable to permit estimation of survival rates. Consistent, low-level isolation of the organisms indicated that a certain amount had become attached to the plants. Washout of the inoculum from the plots by rainfall was apparently minimal. Soil temperatures were high during the test period, and heat probably killed many of the mycobacteria. The results must be interpreted with caution in view of the known large differences between mycobacterium grown in vitro and in vivo, and because the numbers of tubercle bacilli found in urban sewage are very difficult to estimate.

*Irrigation, *Sludge disposal, *Sewage effluents, Soil contamination effects, Microorganisms, Vegetation, Municipal wastes, Analysis, Waste water treatment, Public health

Mycobacterium bovis BCG

D331
APPLICATION OF PHYSICO-CHEMICAL TREATMENT AS A METHOD OF ACHIEVING PARTIAL STANDARDS ON SEWAGE EFFLUENTS DISCHARGED IN ESTUARIAL AND COASTAL SITUATIONS,

Matthews, P. J.

The Public Health Engineer, Vol. 5, No. 2, p 31-37, March, 1977. 3 tab, 49 ref.

Applying various physico-chemical treatment (PCT) methods to wastes which would be discharged to estuaries and coastal waters in England was considered. There has been a continuing argument for and against treatment of wastes for this type of disposal. Those in favor of treatment stress that oceans must be protected, and that treatment would diminish disease, eliminate long outfalls conflicting with other water uses, and remove certain pollutants which would otherwise persist. Those opposing treatment emphasize that great amounts of oxygen in the sea purify wastes, and that dilution renders the waste similar to biologically treated effluent. They add that costs are less for operating an outfall and that a well-sited outfall is less aesthetically objectionable. PCT was used in the nineteenth century, but biological treatment outweighed it by appearing more effective and by producing a more easily disposable sludge. Chemically aided sedimentation can be of use, however, where there is a solids standard of 60 to 150 milligrams/liter of suspended solids, or where this standard and a BOD and/or a COD limit are appropriate. The most common systems of chemical sedimentation include lime, ferric and ferrous salts, alum alone or with anionic polyelectrolytes, and cationic polyelectrolytes. These can be added before wastes undergo flocculation chamber followed by sedimentation tank treatment, or before combined flocculation/sedimentation tank treatment. The sludges produced are less filterable than primary sludges, but they can be treated, disposed of, or used in agriculture. Lime seems to be the most cost effective coagulant/flocculant. Partial treatment allows for shorter effluent pipelines than needed for crude sewage outfalls. Higher hydraulic loadings permit reduced sedimentation tank size and reduced sedimentation capital costs. The drawbacks to lime treatment are possible increases in capital costs by as much as 200% and in operating costs by 10-20% over sedimentation costs. Finally, the effects of coagulants, flocculants, and their impurities on effluent quality and sludge production must be considered.

*Chemical treatment, *Physical treatment, *Water quality standards, Sewage effluents, Estuaries, Coasts, Water purification, Industrial wastes, Electrolysis, Waste water treatment

England

D332
USE OF OXYGEN IN ACTIVATED SLUDGE PLANTS (Utilizzazione dell'ossigeno allo stato puro negli impianti a fanghi attivi),

Masotti, L.

Facolta di Ingegneria dell'Universita di Firenze,
Florence, Italy.

Inquinamento, Vol. 19, No. 1, p 64-72, January, 1977. 6 fig, 1 tab, 16 ref.

Pure oxygen activated sludge treatment processes are replacing aerated systems because of the latter's weaknesses in transferring oxygen from the atmosphere to the liquid medium. In a pure oxygen system, the oxygen is infused in concentrated form into the liquid. As a result, the quantity of transferred oxygen is 6.4 times greater than in an aerated system. Large quantities of dissolved oxygen (6-8 mg/liter) can be present in the activated sludge without significantly affecting the oxygen transfer yield; in an aerated system, the maximum quantity of dissolved oxygen is 2-3 mg/liter. A pure oxygen system can achieve a 90-95% utilization of the dissolved oxygen compared to 5-6% in an aerated system. The success of a pure oxygen activated sludge system is based on its capacity to produce oxygen. There are two oxygen production processes, the classic cryogenic process and the molecular sieve adsorption process. The former uses the distilled fraction of air, thus producing liquid oxygen and nitrogen at very low temperatures. While the yield of almost pure oxygen is excellent, the process is complex and only used in large purification plants. The molecular sieve adsorption process is simple, completely automatic, and requires minimal maintenance. Air is pressurized through a sieve containing a granular substance which adsorbs carbon dioxide, nitrogen and water, and lets the residual gas, very rich in oxygen (90%), pass through. The process operates at room temperature and at a fairly low pressure.

*Oxygenation, *Activated sludge, *Adsorption, *Cryogenics, Dissolved oxygen, Treatment facilities, Temperature, Aeration, Nitrogen, Air, Automation, Maintenance, Water purification, Waste water treatment

Pure oxygen activated sludge treatment, Liquid oxygen

D333
WHAT LIES AHEAD FOR PAC?,

Culp, G. L., and Shuckrow, A. J.

Culp/Wesner/Culp Clean Water Consultants,
El Dorado Hills, California.

Water and Wastes Engineering, Vol. 14, No. 2, p 67-72, 74, February, 1977.

The development and use of powdered activated carbon were discussed. Granular activated carbon has found wider use because efficient regeneration systems for powdered activated carbon are lacking. Several advantages of the powdered carbon are: a significantly lower price; more rapid equilibration with soluble waste water organics; less capital investment; easily changed dosages; less head loss; and easy avoidance of hydrogen sulfide formation problems. Cost estimates of various treatment systems indicated that independent physical-chemical (IPC) systems, with either granular or powdered carbon, were not cost competitive with conventional activated sludge for BOD removal in municipal use when only secondary treatment was necessary. Granular carbon IPC systems were cost comparable to activated sludge followed by coagulation and filtration at carbon doses of 1500 pounds/million gallons. It was slightly less expensive at doses of 750 pounds/million gallons. Powdered carbon was not cost competitive with granular carbon. It has higher capital and labor costs, higher fuel requirements, and requires polymer conditioning for dewatering. Determining the minimum carbon dosages compatible with single clarifier-combined sludge handling systems would yield economically favorable results.

*Activated carbon, Costs, Cost comparisons, Municipal wastes, Waste water treatment, Polymers, Dewatering, Organic matter, Hydrogen sulfide, Activated sludge, Physical properties, Chemical properties

Granular activated carbon, Powdered activated carbon

D334
FILTERS AND SLUDGE DRYING BEDS,

Water and Waste Treatment, Vol. 20, No. 2, p 35, 38, February, 1977.

Naylor Brothers, Limited, in England, has marketed sludge bed floor tiles in the Middle East. The tiles, used for drying sludge, facilitate drainage and help ventilation to aid drying of the under-side of the sludge cake. Cost savings in construction are another advantage because the tiles replace layers of graded media. Filter tiles also aid the drainage of effluent from biological filters and provide basal aeration. Vitrified clay piping is used in the area to reduce hydrogen sulfide formation which can result from high temperatures, and low sewage dilution in sewers, and from flat gradients. These products are resistant to damage from chlorides and sulfates in Middle Eastern soils.

*Filters, *Drying, Sludge treatment, Clay pipes, Sewers, Hydrogen sulfide, Conduits, Temperature, Drainage, Chlorides, Design criteria, Construction materials, Equipment, Waste water treatment

D335
TREATMENT OF HIGH STRENGTH ACIDIC WASTE WATER WITH A COMPLETELY MIXED ANAEROBIC FILTER,

Chian, E. S. K., and DeWalle, F. B.

Illinois University,
Urbana,
Department of Civil Engineering.

Water Research, Vol. 11, No. 3, p 295-304, 1977. 10 fig, 1 tab, 23 ref.

High strength acidic waste water was treated with a completely mixed anaerobic filter. The waste water was a leachate typical of that in solid waste landfills, containing free volatile fatty acids and complex high molecular weight carbohydrate-like organics. Treatment by the mixed anaerobic filter was successful, and eliminated the costs of buffer solutions needed with plug flow anaerobic filters. Heavy metal toxicity was counteracted by adding sulfides. The system's response to increased organic loading and shockloads was quite good. A hydraulic detention time above 7 days produced high percentages of organic matter removal. Methane gas leaving the unit indicated a low bacterial solids manufacture, accounting for 93% of the COD removed. About 0.12 grams of volatile suspended solids were removed for each gram of COD removed. No nutrient additions were required because of the low solids production and initial anaerobic sludge seeding.

*Filtration, *Anaerobic conditions, *Biological treatment, *Alkalinity, Sludge treatment, Waste water treatment, Filters, Chemical oxygen demand, Suspended solids, Organic matter, Hydrogen ion concentration, Heavy metals

Mixed anaerobic filters

D336
HISTORY AND DEVELOPMENT OF THE OXIDATION DITCH,

Denton, R. S.

Process Biochemistry, Vol. 12, No. 1, p 3-6, January/February, 1977. 1 fig, 2 tab, 14 ref.

The oxidation ditch, developed in 1953, became one of the most satisfactory sewage and industrial waste treatment methods. The system originally operated on an intermittent, fill and draw principle. Continuous operation systems were later employed, using either a separate final settlement tank or a divided leg, with each section acting as a final settlement tank. This is known as a split ditch. The basic design is a continuous ditch with trapezoidal cross-sections. Oxygenation, circulation, and ditch content mixing is accomplished by aeration rotors. After aeration, the mixed liquor passes to a settlement tank, and the settled sludge is returned to the ditch. At least twice the amount of dissolved oxygen needed for BOD removal is provided, allowing for sludge mineralization and nitrification. These operations are completely mixed systems. High BOD loads are easily absorbed with no adverse effects on effluent quality. The advantages of this treatment method include: the production of a well-stabilized, low-quantity activated sludge but no primary sludge; system flexibility for loads and temperature; low construction and maintenance costs; low noise levels; and easy adaptation to sites. Severe under- and over-loading/aeration, excessive shock loading, nutrient deficiency, and raw sewage septicity and temperature can contribute to problems of poor settling and compaction, or can create an activated sludge with large amounts of filamentous organisms. Incorrect operation will also lead to these problems. An optimal sludge age of 20 days was recommended for operating oxidation ditches.

*Aeration, *Oxygenation, Liquid wastes, Sludge, Biochemical oxygen demand, Equipment, Sewage treatment, Nitrification, Industrial wastes, Domestic wastes, Waste water treatment

Oxidation ditches

D337
PRETREATMENT HELPS NIAGARA CUT COSTS,

Sirianni, J., and Richardson, E. C.

Water and Wastes Engineering, Vol. 13, No. 11, p 44-46, 51, November, 1976. 1 fig, 1 tab.

Pretreatment of industrial wastes and reuse of existing municipal facilities have reduced costs at a new treatment facility in Niagara Falls, New York. Alteration in treatment processes were investigated in 1971 due to the discharge into the river of 164 mgd of waste water by industries involved in electrochemical, electrometallurgical, paper, food, organic chemical, and abrasive products. Water quality standards were instituted for effective disinfection; substantial removal of settleable and flotable solids; an effluent phenol concentration of less than 5 ppb; a pH of 6.7-8.5; a minimum dissolved oxygen concentration of 4 ppm; and the maximum possible removal of phosphates. A physical-chemical process using activated carbon for filtration and adsorption was used. The plant has a 48 mgd capacity and is located on the site previously used by a power generating facility. The tailrace tunnel of the power plant was rehabilitated to be used as an outfall and a 210,500-foot-long, six-foot-diameter, concrete-lined rock tunnel intercepting sewer was constructed. Cost savings resulted from early industrial cooperation to reduce pollution; the joint treatment facility which created economy of scale savings; the reuse of the tailrace tunnel of the power plant; the use of parts of the city's former treatment plant foundation for the new pumping station; the regeneration of exhausted carbon used for filtration and adsorption; and the use of plant effluent to backwash carbon. The toxic effects of chemical wastes on microbial populations precluded biological treatment, so the physical-chemical system was used. Sludge is disposed in landfills. This arrangement allows nitrification, conventional activated sludge and contact stabilization, or combinations of any two processes.

*Treatment facilities, *Costs, *Pollution abatement, *Industrial wastes, Waste water treatment, Chemical treatment, Cities, Water purification, Nitrification, Activated sludge, Filtration, Adsorption, Water pollution sources

Niagara Falls (NY)

D338
NEW PLYMOUTH SEWERAGE SCHEME,

Fitzmaurice, J. R.

New Zealand Engineering, Vol. 32, No. 2, p 26-30, February, 1977. 4 fig, 6 ref.

Treatment schemes were devised for New Plymouth, New Zealand, after a survey to determine the inadequacies of its sewerage system. The studies indicated that outfalls would be very expensive and few locations were adequate for them. Surface movement of water near the shoreline and strong winds would not regularly assist diluted waste discharge movement in either direction along the coast. There are no present water quality standards for receiving waters, but any treatment system should be adaptable for easv and economical improvements if standards are later required. Several alternative plans were considered involving outfalls at various locations, varying treatment levels, disposal to oxidation ponds, and drainage systems. Environmental impact studies were also conducted. The treatment plant proposed for the area will be a primary treatment facility with provisions for adding secondary treatment and chlorination. The level of treatment will depend on water quality standards to be developed and may alter with time. Processes included will be screening, grit removal, sedimentation, and sludge digestion. Power will be derived from process methane and the on-site generation of electricity. Capital costs are expected to be about $8,230,000, with annual costs of about $965,000.

*Sewers, Drainage, Outfalls, Waste water treatment, Waste disposal, Bacteria, Sewage effluents, Treatment facilities, Environmental effects, Water pollution control, Construction, Costs

New Plymouth (New Zealand)

D339
MODUFLEX SEWAGE TREATMENT PLANTS PROVIDE THE ANSWER TO GROWTH,

Water and Pollution Control, Vol. 115, No. 4, p 36, 38, 39, April, 1977. 1 fig.

Unpredictable accelerations and decelerations of population growth rates create excessive or less than optimum flows that diminish sewage treatment plant performance. Smaller facilities have a smaller margin of allowable flow variation than larger ones. The Moduflex system was created as a solution to this problem. Modular concrete units can service 5 to 300 homes by progressive enlargement of the plant. Enlargement by unit addition and rearrangement of piping allows continued use of the original installations. The basic system is biological treatment with phosphorus removal, filtration, and nitrogen removal if desired. Unit processes include screening, comminution grinding, activated sludge treatment, chlorination, phosphorus removal by chemical treatment, secondary sedimentation, sludge digestion, and denitrification. When a community needs a full-scale treatment plant, the units may be disconnected, relocated, or sold. The manufacturer will contract to repurchase units, and will provide maintenance and monitoring under contract.

*Treatment facilities, *Design, Water quality control, Water purification, Growth rates, Human population, Equipment, Costs, Design criteria, Capital costs, Concrete construction, Biological treatment, Chemical treatment, Waste water treatment

Moduflex system

D340
REVERSE OSMOSIS ON SECONDARY SEWAGE EFFLUENT: THE EFFECT OF RECOVERY,

Wechsler, R.

Australian Atomic Energy Research Establishment,
Lucas Heights,
New South Wales, Australia.

Water Research, Vol. 11, No. 4, p 379-385, 1977. 6 fig, 1 tab, 5 ref.

The effects of reverse osmotic recovery on plant performance and product quality was evaluated in a pilot scale municipal waste water reclamation plant in Australia. Raw sewage was comminuted and screened, passed to grit chambers and pre-aeration tanks, moved to primary settling tanks, and passed to a step aeration activated sludge plant where waste sludge was recycled to pre-aeration tanks. The secondary effluent was passed to a canal system. The effluent was passed to the reclamation plant where chemical clarification and reverse osmosis with optional granular carbon polishing took place. The reverse osmosis plant consisted of two macroscopic tubular modules having membranes annealed at 80 and 86 C, respectively. Brine velocity was 120 cubic meters/second under a brine loop pressure of 40 atmospheres, and a temperature of 25 C. Results indicated that the product salt concentration increased as the plant recovery increased. Its organic component concentration did not significantly increase when recovery increased. The flux decline rate did not prohibit recovery if the crystallization of hardness causing substances was prevented. Lime clarification was recommended if recovery was to be reasonably economical. Cleaning by depressurization and sweet water flushing, daily, maintained membrane productivity at 90% of maximum. Cleaning was not affected by plant recovery. It was concluded that the salt concentration tolerated by the product, and not the rate of flux decline or organic matter concentration, limited recovery. Because of the cost of prior treatment steps, it was suggested that reverse osmosis be operated at maximum daily recovery.

*Reverse osmosis, *Treatment facilities, *Performance, Salinity, Pilot plant, Sewage treatment, Aeration, Sedimentation, Membrane processes, Chemical oxygen demand, Organic matter, Economics, Waste water treatment

D341
REMOVAL OF FLUORINE FROM WASTE WATERS. III. FUNDAMENTAL TESTS WITH CHEMICAL REAGENTS (Haisuichu no fusso jokyo nikansuru kenkyu. III. Shiyaku kei niyoru kisoshiken),

Mori, M., Iwasaki, Y., Utsumi, Y., Miura, H., and Ando, J.

Senkko to Skkai, No. 146, p 9-14, 1977. 2 ref.

Various chemical reagents were tested in an investigation of fluorine removal from waste water. Lime added to a dilute hydrogen fluoride solution produced minute calcium fluoride particles; a portion of these tended to pass through a filter. Magnesium was found to reduce crystal size, make precipitate gelatinous, and aid separation and coagulation. It did not reduce fluorine below 15 ppm since magnesium fluoride is more soluble than calcium fluoride. The length of time needed to reduce the supersaturation of calcium fluoride was the major obstacle in reducing fluorine to meet water quality standards. The addition of lime raises the pH and causes fluorine removal to be difficult in waters with a high concentration of alkaline substances. Reduction of fluorine was aided by the addition of an acid or soluble calcium compound.

*Fluorine, *Separation techniques, *Calcium compounds, Waste water treatment, Pollution abatement, Lime, Magnesium, Coagulation, Chemical reactions, Analysis

D342
SODIUM BICARBONATE CAN SETTLE MANY WASTE WATER PROBLEM UPSETS,

Barber, N.

Church and Dwight Company, Incorporated,
Piscataway, New Jersey.

Pollution Engineering, Vol. 9, No. 4, p 57-59, April, 1977. 1 fig.

Sodium bicarbonate has been used by engineers to prevent equilibrium disturbances in sewage treatment plants. It was used as a buffer to maintain the desired acid/alkali ratio for maintenance of an optimum environment for microbial growth. In anaerobic systems, sodium bicarbonate can control pH, increase methane production, increase biodegradation rates, precipitate toxic metals, and aid solids concentration. It was also substituted for lime and other alkalis in aerobic processes, where it was able to control pH and alkalinity, enhance nitrification, improve BOD reduction, reduce or eliminate odors, enhance settling characteristics, and pretreat industrial wastes.

*Bicarbonates, *Anaerobic digestion, *Aerobic treatment, Treatment facilities, Hydrogen ion concentration, Methane, Carbon dioxide, Microorganisms, Equipment, Alkalinity, Nitrification, Sedimentation, Physical properties, Chemical properties, Biochemical oxygen demand, Odor, Waste water treatment

Sodium bicarbonate

D343
ICI EFFLUENT SYSTEM TO BE USED IN ESSEX,

Environmental Health, Vol. 85, No. 2, p 43, February, 1977.

The Anglian Water Authority, England, has approved the construction of a treatment facility using the ICI Deep Shaft Effluent Treatment System. Mixed domestic sewage and industrial effluent will be treated. Completion of the system, involving biological treatment and solids separation stages, is estimated for the summer of 1977. Costs are expected to be about 650,000 pounds. Wastes are circulated in a sunken shaft, treatment is accelerated, space is saved, energy needs are reduced, and no odor is produced. Economical installation and a lessened environmental impact are the results of these advantages.

*Treatment facilities, Domestic wastes, Industrial wastes, Biological treatment, Separation, Economics, Environmental control, Municipal wastes, Waste water treatment, Costs

ICI Deep Shaft Effluent Treatment System, Anglian Water Authority (England)

D344
REMOVING SOLUBLE METALS FROM WASTE WATER,

Metzner, A. V.

Water and Sewage Works, Vol. 124, No. 4, p 98-101, April, 1977. 2 fig.

Soluble metal removal from waste water is necessary before process water can be discharged to municipal sewer systems or recycled. Five basic processes exist for metal removal: chemical oxidation and reduction, precipitation with clarification and/or filtration, evaporation, ion exchange, and membrane processes. Oxidation and reduction may be used to remove chromium and cyanides. Metals can be precipitated either as hydroxides or sulfides. Iron is commonly removed through precipitation. Chemical displacement and granular media filtration are effective treatment methods. Evaporation may be cost efficient, depending on the processing objectives and is useful for metal recovery. Evaporative wastes are crystalline and reduce sludge handling costs. Ion exchange is employed for metal finishing bath purification, demineralization of flows for recycling, polishing effluents following primary treatment, and recovering precious metals. Membrane processes are the most recently developed amongst these methods. They, and in particular, reverse osmosis, are used primarily for recycling water and recovering or concentrating solubles. Only 75% of the effluent from this process is a purified product. The remainder must be treated further before discharge.

*Metals, *Toxicity, Industrial wastes, Municipal wastes, Pollutants, Waste treatment, Sludge treatment, Water pollution sources, Physical properties, Chemical properties, Recycling, Oxidation-reduction potential, Separation techniques, Sulfides, Chemical reactions, Sedimentation, Filtration, Ion exchange, Membrane processes, Waste water treatment

Soluble metals

D345
RELIABLE PH MEASUREMENT WHEN EFFLUENT CONDITIONS GET TOUGH,

Kidder, R. J.

Electrofact,
Plymouth, Minnesota.

Pollution Engineering, Vol. 9, No. 4, p 30-33, April, 1977. 5 fig.

The reliability and use of pH measurement by automated systems was evaluated. Many components are available, and it was suggested that proper selection would produce a reliable and trouble-free system. Electrical components were listed and their electrical characteristics were briefly described, as were the problems associated with them. The reference electrodes discussed were of two types: diffusion or solid state electrodes, and flowing junction electrodes. Measuring electrodes were described and their design criteria were presented. They should be able to tolerate wide pH variations without chemical attack at ambient temperature, be suited to low pH solutions at high temperatures, and they should be constructed to provide suitable operation at low temperatures. Installation problems include unreliable or erroneous readings from common mode or ground loop voltages, and fouling by filming or solid deposits. Various solutions were offered for these problems.

*Automatic controls, *Hydrogen ion concentration, *Measurement, Instrumentation, Electrodes, Electrical properties, Monitoring, Equipment, Treatment facilities, Waste water treatment

D346
THE TRIALS AND TRIBULATIONS OF TREATMENT WORKS IN LOWER TRENT,

Surveyor, Vol. 149, No. 4424, p 33, March, 1977.

Investigations into problematic treatment facilities in the Severn-Trent Water Authority district, England, were reported. The first involved a medium-sized works which produced a poor quality effluent. It was found that BOD and suspended solids values were growing worse. The rectangular filter media were large and flat, and surface film growth had developed at the centers only. BOD maxima were found when the distributor was at the ends of the bed. Additional filter capacity was required and suggested remedies included using existing beds in a new filter and replacing the old media with new. Tests are being conducted to determine the effectiveness of these suggestions. The second facility was, again, experiencing difficulties of poor effluent. Hydraulic overloading of humus tanks was the problem. Trial solutions included using storm water tanks as secondary humus tanks, and recirculating the unsettled filter effluent. Both methods were successful. Reduction of hydraulic loads to the humus tanks reduced upward flow rates, improved solids removal, and positively affected settling characteristics of the treated suspension. At another plant, effluent problems seemed to be caused by the use of dewatering concentrators, which treated fibrous materials, on an effluent containing much fine material. Effluent quality improved when a belt press was used to replace the concentrator.

*Treatment facilities, *Performance, *Water quality standards, Sewage effluents, Biochemical oxygen demand, Filters, Biological treatment, Filtration, Humus, Hydraulic design, Dewatering, Sedimentation, Waste water treatment

Severn-Trent Water Authority (England)

D347
TRENCHING SLUDGE MAY BE SAFE,

Water and Wastes Engineering, Vol. 14, No. 4, p 17, April, 1977.

Experiments involving the trenching of sludge have revealed no significant groundwater contamination. Digested and undigested sludge was placed in two-foot deep trenches. The levels of nitrate, chlorides, and ammonium were not considered hazardous. Sludge trenching is being used by the Washington Suburban Sanitary Commission, District of Columbia. Trenching is effective for small plants treating less than one mgd sewage flows or serving cities with 10,000 people. Other tests showed lower nitrogen levels for undigested than for digested sludge. Both sludges had been in trenches for four years. Nitrogen levels for both sludge types were significantly lower after trenching than before the operation. It may be possible for economic savings to result from the elimination of the digestion process since undigested sludge also has lower levels of heavy metals than digested sludge.

*Sludge disposal, *Trenches, Water pollution, Treatment facilities, Testing, Nitrogen, Heavy metals, Sludge digestion, Cadmium, Copper, Nickel, Zinc, Lead, Chlorides, Nitrates, Ammonium compounds, Waste water treatment

D348
WHAT'S UP WITH OXYGEN?/2,

Bracken, B. D.

Brown and Caldwell,
Walnut Creek, California.

Water and Wastes Engineering, Vol. 14, No. 4, p 48-49, 52-56, April, 1977. 3 fig, 2 tab.

Design factors are discussed in the second of two articles on cryogenic oxygen plants. Heat exchange is a part of the oxygen production process. A cryogenic expansion turbine produces refrigeration for air separation and liquid production. Plants with a capacity of 180 tons/day or more generate enough work to justify the equipment necessary to recover the work as electrical power. About 75 kw can be obtained from a plant of this size operating at maximum design production. Liquid oxygen is stored near the cryogenic oxygen plant in horizontal or vertical tanks. These are double-walled and designed to reduce oxygen losses to 0.3-0.4% per day of contained oxygen by weight. Oxygen vaporizers are used to convert stored liquid oxygen to vapor for a supplemental or substitute oxygen source to supply the dissolution system. Vaporization of one ton of liquid oxygen stored at just under the boiling point will require 92 Btu/pound or 184,000 Btu/ton. Liquid oxygen vaporization can be conducted with a water-to-oxygen heat exchanger. This heat exchanger can provide the continuous heat so that vaporization may be instituted at any time necessary. Considerations for a cryogenic oxygen plant for municipal waste water treatment include plant size, electrical requirements, cooling water needs, effluent heat load, noise levels, instrument or dry, filtered, oil-free air requirements, staff requirements, site requirements, and instrumentation and control equipment.

*Oxygen, *Treatment facilities, Design criteria, Construction, Equipment, Water purification, Cooling water, Heat balance, Personnel, Instrumentation, Waste water treatment, Electric power demand, Heat exchangers

Liquid oxygen

D349
HORSHAM'S SEWAGE WORKS,

Water and Waste Treatment, Vol. 20, No. 3, p 23, March, 1977.

A sewage treatment plant is being constructed in Horsham, England, which will include four humus tanks and filter beds. Design capacity is for a population of 95,000. A single wide cutting was made in which the 25.9 meter diameter humus tanks and the ADF pumping station were built. It will be possible to install four additional tanks. A segmented shutter formed the outer ring of the humus tank bases and stiff concrete was used for the sloping bases. The tank walls were made of a steel shutter. Precast concrete was used for the effluent collection channels and the supporting columns. Additional treatment facilities include sedimentation tanks, biological filters, humus tanks, pumping stations, storm tanks, and sludge dewatering equipment.

*Humus, *Filters, Treatment facilities, Pumping plant, Construction, Dewatering, Construction materials, Concrete, Water purification, Waste water treatment

Horsham (England)

D350
PRE-TREATMENT IN THE SEWER,

Water and Waste Treatment, Vol. 20, No. 3, p 15, March, 1977.

Pretreatment of sewage by sewer oxygenation was tested. The Wessex Water Authority in England and a supplier of treatment components developed the system which involves the injection of oxygen into sewers at a pumping main. About one ton of oxygen is injected per day to treat aerobic conditions within the sewer in order to allow microbial activity for reducing the organic pollution load. Final effluent was improved by 30-60% after treatment in a plant which exhibited previous overloading. Costs for sewer oxygenation were substantially lower than construction costs for added conventional treatment facilities.

*Sewers, *Oxygen, Hydrogen sulfide, Water quality control, Sewage treatment, Aerobic conditions, Biochemical oxygen demand, Performance, Organic matter, Waste water treatment, Testing

D351
PLANT CAPACITY TO INCREASE,

Public Works, Vol. 108, No. 4, p 108, April, 1977.

A pure oxygen treatment system is being installed at a treatment plant in Wayne, New Jersey, to increase treatment capacity by nearly 80%. A model 100 F30 module is to be placed in two aeration basins. Capacity will be increased from 1 to 1.8 mgd, while only one-third of the existing aeration basin volume will be used. The remaining volume will be used to double the clarification capacity. In the F30 system, a free-fall oxygenation technique creates a turbulence which mixes oxygen and waste water. Oxygen is mixed and dissolved in a turbulent waste water fall zone within a reinforced concrete module. Because the pump is the only moving part, maintenance of the system is minimal.

*Treatment facilities, *Oxygen, Performance, Aeration, Oxidation lagoons, Water purification, Reinforced concrete, Maintenance, Pumps, Water pollution control, Waste water treatment

Wayne (NJ)

D352
PERFORATED, VITRIFIED CLAY PIPE USED IN PEORIA FACILITIES,

Water and Wastes Engineering, Vol. 14, No. 4, p 85, April, 1977.

East Peoria, Illinois, has used 54,000 feet of 4 inch, perforated vitrified clay pipe (VCP) in constructing eight sludge lagoons and a supernatant pumping station. The lagoon acreage was decreased by two feet. Eight foot dikes were built around each lagoon. Trenches 2 feet deep and 1 foot wide were dug 60 feet apart. The trench base was a 6 inch bed of well-graded gravel and the pipe was covered by 6 inches of gravel and 16 inches of well-graded sand. The lagoons were covered with pea gravel. They will be charged sequentially; the maximum accumulation of sludge in each lagoon will be 2 feet. A 1 year period will elapse before the organic soil is sufficiently dry to be scraped off and stored in an adjacent area. Experimental lagoons were used to determine the spacing and depth of pipe placement. It was found that a 2 foot depth would protect pipes from damage when machinery removed the organic soil. Influent is pumped into the lagoons and the supernatant is pumped to the river upstream from the plant. The influent is treated, and the clean water is discharged into the river. The system handles nearly 30 mgd, but is expected to treat 154 mgd after completion. There is no odor problem. The 5% solids which remain after lagoon treatment is called an organic soil stabilizer. It will be produced at an annual rate of 9 to 10,000 dry tons.

*Clay pipe, *Treatment facilities, Pumping plants, Excavation, Lagoons, Sludge treatment, Drying, Evaporation, Dewatering, Sludge disposal, Soil amendments, Waste water treatment, Pipes

D353
OXYGEN INJECTION FOR BATH'S SEWERS,

Water Services, Vol. 82, No. 973, p 129, March, 1977.

Bath, England, has been the site of sewer oxygenation testing to investigate the pre-treatment of sewage. The system has effectively improved treatment plant final effluent between 30 and 50%. The works previously operated under a 40% overload. The system, with an injection plant and oxygen, would cost about 19,000 pounds annually, whereas added conventional plant extensions would cost more than 500,000 pounds. With the injection of one ton/day of oxygen at the pumping station, aerobic conditions are created which last throughout the main. This aids microbial activity on sewer walls and in the main body to break down some of the organic pollution load. This load radically changes after primary settlement. Improved settling and sludge treatment have been shown. Summer operation is more effective because of higher temperatures and low river flows.

*Oxygenation, *Sewers, Water quality, Costs, Testing, Hydrogen sulfide, Aerobic treatment, Biochemical oxygen demand, Temperature, Biological treatment, Micro-organisms, Water purification, Waste water treatment

Bath (England)

D354
HIGHER GAS YIELDS AND REDUCED RETENTION TIMES OBTAINED FROM ANAEROBIC DIGESTER,

Water Services, Vol. 82, No. 973, p 171-172, March, 1977.

A Nash liquid ring vacuum compressor was used to improve the performance of an anaerobic sludge digester at an English treatment plant. The digester, with a capacity of 610,000 gallons, has its contents heated and agitated by units mounted on its exterior wall. Digesting sludge enters the bottom of the heating and mixing units under its own head pressure. Pressurized sludge gas is used to push sludge up and to inject it back into the digester top. Rising sludge passes through hot water jackets which heat the sludge. Inadequate gas pressure or volume will neither lift the sludge by the required head nor maintain the required flow rates. Heat transfer and/or agitation of the digester contents will thus be negatively affected. This will in turn have a negative effect on sludge digestion and gas production. The liquid ring vacuum compressor was selected because it provides low-cost production of needed pressure and flow rate for good digester operation, reduces maintenance costs and down time with a minimum of wear on parts, and can provide 10 years of trouble-free operation before overhaul is necesssary. The unit has provisions for complete shutdown if pressure falls below a pre-set level. Operation may be continuous or automatically controlled. Comparison of two six-month periods, before and after installation, indicated improved operation. Retention time was reduced from 30.5 to 27.6 days even though a 10.8% more sludge was handled. Feed sludge solids content and average ambient temperatures varied little. Gas production increased by 6.47% until gas flow meters were installed; afterwards, increases up to 29.9% were recorded, probably because of better mixing of the digester contents. This pump can also be applied to rotary vacuum filters and can be used to supply oil-free air for sub-surface aeration needs.

*Gases, *Anaerobic digestion, Sludge treatment, Heat transfer, Water purification, Pumps, Equipment, Filters, Sewage effluents, Waste water treatment

D355
OZONE DISINFECTION OF SECONDARY EFFLUENT,

Bollyky, L. J., and Siegel, B.

PCI Ozone Corporation,
West Caldwell, New Jersey.

Water and Sewage Works, Vol. 124, No. 4, p 90-92, April, 1977. 5 fig, 2 tab, 5 ref.

A New York City treatment facility was the site of a demonstration project for the disinfection of secondary effluent by ozone. Influent at the plant was of domestic origin. A disinfection level of 200 fecal coliform/100 milliliters was obtainable with an ozone dose of 1.75 milligrams/liter and a contact time of 3.5 minutes. The holding time was 10 minutes. Holding times were critical with low ozone doses because disinfection continues throughout that period. Costs should be reduced with low dose disinfection. Tests indicated that the performance of a well-designed diffusion system was equal to or better than a positive pressure injection or mechanical mixing system. Most disinfection occurred during the first four minutes of contact time when more than 2.5 ppm of ozone was present. Doses of less than 1.5 milligrams/liter were insufficient. Doses of 1.75 milligrams/liter with a 10-20 minute holding time produced the required disinfection. Most additional disinfection occurred during the first 10 minutes of holding time and little additional activity was found after 20 minutes holding time. Nearly complete destruction of fecal coliform was obtained with a 3.5 milligram/liter ozone dose and a 20 minute holding time. Increasing COD in a range of 22-34 milligrams/liter slightly reduced disinfection. Disinfection was also inhibited when suspended solids were increased in the range of 6-16 milligrams/liter. The quality of the influent waste water probably contributed to the success of these low doses. Further testing should be conducted to determine other influential factors. The availability of ozone for disinfection is determined by water ozone demand and chemical oxidation reaction rates. Other factors may include bubble size, diffuser pore size, water pressure, and surface tension. An economical approach to ozone usage might be the design of systems to allow the alternative of either ozone or chlorine disinfection.

*Ozone, *Disinfection, Performance, Evaluation, Costs, Coliforms, Design criteria, Water quality control, Oxidation, Chemical reactions, Chlorination, Domestic wastes, Waste water treatment

D356
ADVANCED WASTE TREATMENT DESIGN PROTECTS LAKE ALTON,

Maran, E., and Sulick, D. J.

Water and Sewage Works, Vol. 124, No. 4, p 68-69, April, 1977. 1 fig, 1 tab.

An advanced treatment system was used to produce a high quality effluent for discharge into Alton Lake, near St. Charles, Missouri. The lake was created by the construction of a flood control lock and dam on the Mississippi River, and is used for recreational purposes. The city's 5.5 mgd primary treatment plant was upgraded by the addition of activated sludge treatment and granular carbon adsorption. The entire system consists of a bar screen, comminutor, aerated grit chamber and primary clarifier, four aeration basins, and two secondary clarifiers. The sludge is thickened, filter pressed, and incinerated. Secondary clarifier effluent is pumped to the granular carbon system which functions as a suspended solids filter and adsorbs dissolved organic chemicals. The carbon life in each adsorber is about 200 days. The carbon is exhausted at a rate of nearly 200 pounds/milligram of waste water treated. Spent carbon is fed into a multiple hearth furnace operated at about 1650 F and fueled by natural gas or No. 2 fuel oil. The furnace has an afterburner and wet scrubber for complete organic matter combustion and removal of particulates from exhaust gases. Reactivated carbon is water-quenched and educted to an adsorber for reuse. A 5 to 7% carbon loss results from handling and reactivation. The design of the system provides for conversion of the plant to physical-chemical treatment in case of biological process failure. Chlorination is provided before and after carbon adsorption to reduce plugging of the carbon beds from the physical carryover of excess secondary slime growths, and to aid oxidation-reduction reactions of mono- or dichloroamines formed by free ammonia conversion at breakpoint chlorination. These reactions do not interfere with carbon adsorption properties. Carbon post-chlorination is for disinfection.

*Treatment facilities, *Water pollution control, Lakes, Activated carbon, Incineration, Biological treatment, Chemical treatment, Oxidation-reduction potential, Ammonia, Disinfection, Chlorination, Chemical reactions, Water purification, Waste water treatment

St. Charles (MO)

D357
SEWAGE SLUDGE INCINERATION SHOULD BE IMPROVED BY ADDITION OF NEWSPRINT PULP,

Water and Pollution Control, Vol. 115, No. 4, p 54-55, April, 1977.

Increased treatment plant size, treatment centralization, and the growing lack of landfill areas have increased investigations into using incineration for sewage disposal in Canadian municipalities. The addition of pulped newsprint to sludge should provide several benefits. A drier cake with less than a 70% water content should result in fuel savings of about 50%. The newsprint fibers, amounting to 10% of cake weight, can act as fuel to reduce supplemental fuel source needs. Replacing lime with newsprint pulp would aid vacuum filtration and eliminate lime scale on pipes, equipment, and tanks. A pulper and a press would be the only added equipment necessary, and the $160,000 costs could be repaid in two years through fuel savings. A low-cost newsprint source would be necessary; a domestic newspaper collection scheme was proposed as one way to obtain a newsprint supply. Field tests were conducted to establish the best proportions of newspaper pulp to sludge ratio, and to determine the best polyelectrolyte to use as a flocculant before vacuum filtration. Other studies showed that sludge dewatering produced a sludge cake suitable for pressing. Full-scale testing of the process is currently underway.

*Incineration, *Paper pulp wastes, Waste disposal, Performance, Equipment, Fuels, Vacuum filters, Municipal wastes, Flocculation, Polyelectrolytes, Testing, Waste water treatment, Cities

Canada

D358
WASTE WATER AERATION SYSTEM PRODUCES SMALL BUBBLES,

Chemical Engineering, Vol. 84, No. 9, p 81-82, April, 1977.

The Aerocleve submerged secondary treatment aeration system was described. It was promoted as being 150% as effective as mechanical surface aerators. A bubble diameter of 0.2-0.4 millimeters is produced as compared to 1-2 millimeters from diffused-air systems and 2-2 1/2 millimeters from mechanical surface devices. Air and recirculated waste water are concurrently passed at different velocities through the mixing chamber, creating air pockets. A vortex and fine air bubble mist are formed from exerting a compressive force on the air pockets. The bubble stream discharges as a high-velocity, turbulent horizontal plume. Increased dwell time is the result; this, combined with the small bubble diameter, produces an efficient use of energy. Operating costs are 50% that of diffused-air systems and 75% that of surface aeration. Capital costs are 30% less than diffused air and 20% less than surface aeration. Clogging is avoided in this system by eliminating porous plates and perforated sparges; the smallest passage is 1 1/4 inches in diameter. There are no moving parts in the manifolds or mixing chambers. Submerged parts are constructed of polyvinyl chloride or stainless steel. The system can be used for deep-tank applications, activated sludge aeration basins, and extended aeration lagoons. It is useful in upgrading conventional diffused-air systems and is especially useful in freezing climates. It can also be used in package treatment plants, and in chemical mass transfer and chlorination processes. Field tests showed a 50% reduction in power costs in municipal applications.

*Aeration, *Equipment, *Performance, *Evaluation, Operating costs, Capital costs, Oxidation lagoons, Chemical treatment, Chlorination, Treatment facilities, Municipal wastes, Waste water treatment

D359
SLUDGE TREATMENT: PROBLEMS AND SOLUTIONS, PART 1,

Smith, J. E., Jr.

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National Environmental Research Center, EPA,
Cincinnati, Ohio.

Water and Sewage Works, Vol. 124, No. 4, p 80-83, April, 1977. 5 fig, 7 tab.

Stricter waste water treatment effluent standards are expected to double secondary treatment sludges by 1985, and chemical sludges are expected to be produced in large quantities. Problems and suggested solutions were considered for future sludge treatment. The major concern is to evaluate process alternatives, to eliminate inappropriate methods, and to produce a total system of treatment. Various processes considered were sludge thickening, heat treatment, sludge conditioning, dewatering and filtration, and drying. Disposal techniques, such as landfilling and applying sludge agriculturally, were discussed. Mechanisms, chemical treatment, and resource recovery involved in municipal and various industrial sludge treatment procedures were evaluated.

*Sludge treatment, *Biological treatment, *Heat treatment, *Chemical treatment, Anaerobic digestion, Aerobic treatment, Pathogens, Microorganisms, Dewatering, Filtration, Drying, Sludge disposal, Landfills, Incineration, Pollutants, Suspended solids, Biochemical oxygen demand, Heavy metals, Waste water treatment

D360
COMPOSTING DESTROYS PATHOGENS IN SEWAGE SOLIDS,

Kawata, K., Cramer, W. N., and Burge, W. D.

Water and Sewage Works, Vol. 124, No. 4, p 76-79, April, 1977. 6 fig, 13 ref.

Composting can be most effective in the destruction of pathogens. Various past and present studies were used to describe the development of composting from its embryonic stages to its immediate state of usage. Many of the less industrialized nations have long used composting. Recently it has gained wider interest among the more industrialized, urbanized nations for their waste disposal programs. The most important factor in pathogen destruction by composting is the maintenance of temperature throughout the compost mass which will inactivate the organisms. In recent studies, Salmonella newport, Candida albicans, Ascaris lumbricoides, and poliovirus I were seeded in dewatered sludge. Results of activity in a fully aerobic and completely mechanized plant showed substantial organism reduction. Salmonella was inactivated at 60 C in 30 minutes, Candida at 70 C in 60 minutes, Ascaris at 60 C in 60 minutes, and poliovirus at 50 C in 30 minutes. Outdoor composting in windrows produces a pile with a temperature similar to ambient temperature, although it can rise to 70 C in the center of the pile. The pathogens are destroyed deeper in the pile, but survive on the pile surface. Evidence suggested that there is a temperature zone at which bacterial growth is optimum. This growth may continue as long as proper nutrients are available. It was shown that some pathogens survive waste water treatment and are included in waste solids. Composting has been shown to be a good option for waste disposal and destruction of these pathogens.

*Pathogenic bacteria, *Viruses, *Aerobic treatment, Temperature, Water purification, Bacteria, Growth rates, Nutrients, Waste disposal, Sewage treatment, Waste water treatment

Composting

D361
INSTRUMENTATION IMPROVES WASTE WATER TREATMENT PLANT CONTROL,

Skodje, M. T.

Water Reclamation Plant,
Rochester, Minnesota.

Public Works, Vol. 108, No. 4, p 88-90, April, 1977.

Research and pilot tests have resulted in more accurate design relationships for biological treatment processes. For these processes, such as trickling filter and activated sludge treatment, design formulas involve dissolved oxygen uptake rates, mixed liquor suspended solids, waste sludge concentrations, sludge wasting rates, return sludge concentrations, and sludge return rates. The operator can be aided by instrumentation which allows either rapid tests or continuous and reliable monitoring. Instrumentation testing has been undertaken by a Rochester, Minnesota, treatment plant for its expansion program. Fixed-probe dissolved oxygen meters and sonic sludge density controllers were tested. The plant contained parallel, rectangular plug-flow aeration tanks followed by circular clarifiers with peripheral feed and effluent collectors. Sensors were placed in the peripheral inlet channel of the clarifier, adjacent to the aeration tank inlet pipe, to obtain steady readings. These readings provide a correlation between inlet channel readings and desired aeration tank DO levels. Performance was very acceptable and cleaning of membrane surfaces and calibration were simple operations. Membrane replacement was not needed more than twice during the first year's operation. The sludge density controllers measured the absorption of sound waves transmitted across the pipe diameter. Installation was in a pipe line common to the primary tanks, where a mixture of primary and waste activated sludge was received. A shutdown control was set at a sludge density of 2.5%. A delay switch allowed up to 30 minutes pumping to clear the pipe of dilute sludge before the density unit would take control. The unit was reliable, but one with a visual indicator improved the instrument's value by inducing operator interest in its operation. So far only weekly flushing has been required for maintenance. Operation efficiency was greatly improved with these instruments.

*Instrumentation, *Treatment facilities, *Monitoring, Equipment, Operation and maintenance, Temperature, Dissolved oxygen, Sludge treatment, Analysis, Waste water treatment

Rochester (MI)

D362
IMPACT ON MARINE BENTHOS OF WASTE WATER DISCHARGE,

Orlob, G. T., and O'Leary, D. A.

California University,
Davis,
Department of Civil Engineering.

Journal of the Environmental Engineering Division-ASCE, Vol. 103, No. EE2, p 307-320, April, 1977. 8 fig, 1 tab, 8 ref.

Results were presented from recent investigations on the effects of waste water discharge from Point Loma into San Diego Bay. This plant began operation in 1963 and has been successful in restoring the Bay as a community asset. This review emphasized the response of marine benthos, including benthic animal populations, to changes occurring during the life of the outfall. At the time of this study, 1974, mean daily discharge was slightly less than 40% above hydraulic design capacity. Wastes treated were primarily domestic, with contributing industrial and commercial wastes. Most discharge regulations, except suspended solids removal, are being met even with this low efficiency operation. High BOD content in sediments on the ocean floor have not produced detrimental effects in marine organisms. The distinctive BOD pattern around the outfall has shrunken in recent years, creating an equilibrium with organic sediments from the outfall. The changes in benthic populations due to the changing organic content of the sediments appeared to be a response to the change in nutrient supply. Polychaetes and mollusks were stimulated by the outfall. Enchinoderms and crustaceans were less adaptable to the outfall environment, but were still prominent. The extreme resilience of the Bay environment, demonstrated by the recovery from high loadings of the 1960s, indicates that present load levels can be accepted without environmental deterioration. Increasing the plant's treatment efficiency was thought to be the key to increasing total flow treated and delivered to the Bay beyond present levels.

*Outfalls, *Pollution abatement, *Benthos, Water pollution sources, Biochemical oxygen demand, Monitoring, Sediments, Treatment facilities, Aquatic animals, Performance, Evaluation, Mollusks, Crustaceans

San Diego Bay (CA), Enchinoderms, Polychaetes

D363
RECYCLING OF ALUM USED FOR PHOSPHORUS REMOVAL IN DOMESTIC WASTE WATER TREATMENT,

Cornwell, D. A., and Zoltek, J., Jr.

Florida University,
Gainesville,
Engineering and Industrial Experiment Station.

Journal Water Pollution Control Federation, Vol. 49, No. 4, p 600-612, April, 1977.
6 fig, 4 tab, 21 ref.

A solvent extraction process was developed for alum recovery. The product was phosphorus-free and the same concentration as commercial liquid alum. An equal molar mixture of mono- and di(2-ethylhexyl) phosphoric acid was the most efficient extractant for aluminum recovery. Equilibrium curves were developed which could be used for countercurrent extraction systems design on the same scale that the curves were first developed. Aluminum recovery was 89-95%. The process necessitated low sludge flows and small detention times which would result in low capital costs. The process should be applicable to either large or small treatment facilities, but has thus far been tested only at the laboratory scale. Benefits include ease of operation, small amounts of required capital outlay, and a large decrease in sludge volume.

*Recycling, *Phosphorus, *Separation techniques, Domestic water, Coagulation, Chemical treatment, Hydrogen ion concentration, Treatment facilities, Economics, Waste water treatment

Alum

D364
NITROGEN CONTROL: DESIGN CONSIDERATIONS FOR SUPPORTED GROWTH SYSTEMS,

Murphy, K. L., Sutton, P. M., Wilson, R. W., and
Jank, B. E.

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Hamilton, Ontario, Canada,
Department of Chemical Engineering.

Journal Water Pollution Control Federation, Vol. 49, No. 4, p 549-557, April, 1977.
11 fig, 4 tab, 10 ref.

A review is presented of design criteria for nitrogen control in two supported growth biological reactors, a rotating biological contactor (RBC) and a submerged packed column (SPC). Nitrification and denitrification pilot plant studies were conducted with municipal waste water. The RBC process produced efficient and predictable TKN removal at all temperatures normally found in municipal waste water treatment. It was concluded that the nitrification rate in the RBC was not a function of filterable TKN concentrations. Nitrification in the RBC showed a relatively low temperature sensitivity. Covers should be installed on treatment units in cold climates to reduce icing problems and prevent the reduction of biological activity. Removal of NO3 + NO2 N was efficient and predictable under all temperature conditions with the submerged RBC reactor. Denitrification rates were not a significant function of this concentration. Low suspended solids concentrations were found in the effluent, even without clarification. Packed column reactors containing highly porous media removed significant quantities of NO3 + NO2 N. Inconsistent, unpredictable denitrification efficiencies were produced by non-steady state hydraulic conditions in packed column reactors. The problem was not solved by flushing the system. Such biological reactors were not recommended when high quality effluent is required.

*Nitrogen, *Control, Design criteria, Biological treatment, Microorganisms, Pilot plants, Treatment facilities, Nitrification, Denitrification, Analysis, Waste water treatment

D365
LOW COST PHOSPHORUS REMOVAL AT RENO-SPARKS, NEVADA,

Peirano, L. E.

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San Francisco, California.

Journal Water Pollution Control Federation, Vol. 49, No. 4, p 568-574, April, 1977.
8 fig, 1 tab, 2 ref.

Low cost phosphorus removal by the PhoStrip process has been implemented at Reno-Sparks, Nevada. The process uses activated sludge microorganisms for phosphorus concentration from waste water flow into a small sub-stream. Phosphorus removal by chemical precipitation from this stream is much less expensive than conventional methods. The lime-phosphorus reaction is pH dependent, not stoichiometric. Thus the quantity of lime needed is dependent upon the quantity of liquid treated rather than the quantity of phosphorus contained in the liquid. This factor produces savings. Return activated sludge (RAS) is held under anaerobic conditions to release phosphorus and create a phosphorus-rich supernatant. Phosphorous taken up by microorganisms in the aeration tank is released under anaerobic conditions. The supernatant liquor from this process is fed to the stripping tank where it settles, becomes anaerobic, and releases phosphorous. A portion of the anaerobic RAS, with phosphorous deficient microorganisms and phosphorous rich liquor, is continuously recirculated to the aeration tank. The microorganisms take up phosphorous and the cycle is repeated. Part of the anaerobic RAS is recirculated through the stripping tank so that supernatant from the surface will contain a maximum phosphorous concentration. Control parameters are the biomass quantity moving through the stripping tank, biomass detention time in stripping tank, and the withdrawal rate of supernatant from stripping tank surface. The plant-scale test at the Reno-Sparks treatment facility produced more than 90% phosphorous removal. The PhoStrip process produced a more stable and better settling activated sludge than conventional processes. Savings of $600-800,000 annually are expected for a 40 mgd treatment capacity.

*Phosphorus, *Separation, Costs, Chemical treatment, Biological treatment, Separation techniques, Lime, Hydrogen ion concentration, Treatment facilities, Waste water treatment

Reno (NV), Sparks (NV)

D366
ORGANIC MATTER REMOVAL BY POWDERED ACTIVATED CARBON
ADDED TO ACTIVATED SLUDGE,

DeWalle, F. B., Chian, E. S. K., and Small, E. M.

Illinois University,
Urbana,
Department of Civil Engineering.

Journal Water Pollution Control Federation, Vol. 49, No. 4, p 593-599, April, 1977.
5 fig, 1 tab, 19 ref.

Investigations were conducted on organic matter removal through the addition of powdered activated carbon to activated sludge. It was shown that powdered activated carbon added to activated sludge units with 5 and 10 day residence times decreased effluent organic matter concentrations. This was also true when additions were at low equilibrium concentrations. Powdered activated carbon was equally effective at both residence times. Organic matter reductions in the 5-day PAC units were partially biologically mediated. This was possibly attributable to formation of a denser sludge particle. Reduction in concentration of low-molecular-weight amino acids and carbonyl compounds excreted by bacteria during substrate removal is probably due to their restricted diffusion into the solution and subsequent rapid uptake. Removal of organic matter in the 10-day units were of a more physical nature due to removal of an intermediate molecular weight fraction, characterized by aromatic hydroxyl groups.

*Organic matter, *Separation techniques, *Activated carbon, Activated sludge, Chemical oxygen demand, Biological oxygen demand, Adsorption, Physical properties, Chemical properties, Sedimentation, Waste water treatment

Powdered activated carbon (PAC)

D367
NITRIFICATION IN A CHLORINATED ACTIVATED SLUDGE CULTURE,

Strom, P. F., and Finstein, M. S.

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New Brunswick, New Jersey,
Department of Environmental Science.

Journal Water Pollution Control Federation, Vol. 49, No. 4, p 584-592, April, 1977.
6 fig, 4 tab, 35 ref.

The effects of chlorination on nitrification in an activated sludge culture were investigated. A hospital activated sludge treatment plant in Marlboro, New Jersey, was used for the study. It was found that this underloaded activated sludge plant treating institutional waste water nitrified practically all of the ammonium during the first 6-8 hours of treatment. Nitrification was not decreased by the use of chlorination (30-40 milligrams of Cl2/liter return sludge) for bulking control. Nitrite concentration decreases were attributed to nonbiological reactions with the disinfectant. Laboratory incubations resulted in a nitrification end product accumulation of 1 milligram of nitrate nitrogen/hour/gram MLSS (dry weight). Nitrification rates were not affected by chlorine doses of 0, 5, 15, 25, or 50 mg/liter of return sludge. Total organic carbon and BOD removal were not significantly affected by these chlorine doses. MLSS settleability was improved. It was concluded that although chlorination can solve various biological treatment operational problems without harm to nitrification, it may create other undesired effects.

*Nitrification, *Activated sludge, *Chlorination, Treatment facilities, Performance, Trickling filters, Bacteria, Microorganisms, Evaluation, Waste water treatment

D368
PILOT-SCALE INVESTIGATIONS INTO THE USE OF RANDOM-PACK PLASTICS FILTER MEDIA IN THE COMPLETE TREATMENT OF SEWAGE,

Wheatley, A. D., and Williams, I. L.

Water Pollution Control, Vol. 75, No. 4, p 468-486, 1977. 11 fig, 4 tab, 28 ref.

Two pilot-scale biological filters were used to evaluate a new random-pack plastics filter medium for treating municipal sewage. Two loadings were tested, at 1.2 and 2.4 cu m/cu m d. Results indicated no major difference between the experimental plastic media and mineral media ecology. The number of grazing organisms was influenced by the organic matter levels of the filters. Film accumulation was significantly controlled by macrofauna and microfauna, with the numbers of microfauna being inversely related to the macrofauna. Psychoda and mites were the major macro-invertebrates during the first year of operation. Psychoda and Enchytraeidae were dominant as grazers in the second year. Major microfauna during both years were Opercularia and nematodes. Fungi and bacteria were dominant in the film of the high-rate filter and algae and bacteria dominated the low-rate filter. While film composition differed, quantity fluctuations were similar in both filters. Changes in ambient temperature and in sewage strength did not directly affect the amount of film in filters. This fluctuation could not be linked to filter performance changes. Average BOD removals were 87% for the low-rate filter and 83% for the high rate filter. Results suggest that a large-scale plant could meet effluent quality standards at the low filter rate. Nitrification was not good, but it was speculated that ammonia removal might be maintained over the long term, especially at the lower flow.

*Packed beds, *Filtration, *Plastics, Performance, Biological treatment, Equipment, Flow, Design, Evaluation, Filters, Biochemical oxygen demand, Suspended solids, Microorganisms, Nitrification, Organic matter, Waste water treatment

Plastic filter media

D369
DISINFECTION OF WASTE WATER BY PHOTODYNAMIC OXIDATION,

Gerba, C. P., Wallis, C., and Melnick, J. L.

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Houston, Texas,
Department of Virology and Epidemiology.

Journal Water Pollution Control Federation, Vol. 49, No. 4, p 575-583, April, 1977.
8 fig, 9 tab, 18 ref.

Waste water disinfection by photodynamic oxidation was investigated. Methylene blue was chosen as the test dye from those which render viruses, bacteria, and fungi sensitive to damage and destruction by light in the presence of molecular oxygen. The amount of coliforms and poliovirus inactivated by methylene blue photodynamic oxidation was affected by dye concentration, temperature, pH, and sensitization time. A pH of at least 9.0 was required, with the greatest effect on sensitization occurring between pH 9.5 and 10.0. Other heterotricyclic dyes are capable of sensitizing viruses in a neutral pH range, but were too expensive or not available in bulk. Optimal dye concentrations for viral photoinactivation were between 1 and 10 mg/liter. A range of 1 to 5 mg/liter would be preferable because higher concentrations absorbed most of the light near the surface. Light would penetrate deeper with lower concentrations and more light exposure would be necessary to inactivate given amounts of viruses than at higher dye concentrations. Organic matter concentrations did not affect the dye action or microorganisms. However, ultraviolet light would be ineffective for effluents with high organic matter concentrations. Wavelengths of 670 nm are not absorbed by organics and can penetrate to greater depths. Turbidity has an effect on visible light penetration into fluids, but turbidities of 4.5 to 10 JTU did not affect coliform or poliovirus inactivation. Photoinactivation would be most advantageous in advanced waste water treatment plants where high effluent quality is required. Plants using lime flocculation could be easily adapted to this process, as well as those with high pH levels for ammonia stripping. Dye removal by activated carbon would be productive for land disposal sites. The use of energy from sunlight was a practical alternative to artificial light, particularly for areas with yearround daylight. The process has its greatest applicability in systems which require large reductions of pathogenic bacteria and viruses.

*Disinfection, *Light, *Oxidation, Pathogenic bacteria, Viruses, Fungi, Toxicity, Dyes, Coliforms, Hydrogen ion concentration, Temperature, Organic matter, Waste water treatment

Photoinactivation

D370
RAPID SAND FILTRATION FOR BEST PRACTICAL TREATMENT OF
DOMESTIC WASTE WATER STABILIZATION POND EFFLUENT,

Boatright, D. T., and Lawrence, C. H.

Oklahoma University,
Norman,
Health Sciences Center.

Journal of Environmental Health, Vol. 39, No. 5, p 347-352, March/April, 1977.
1 fig, 3 tab, 16 ref.

Investigations were conducted to determine sand filtration modifications which would permit the use of a compact unit to improve waste stabilization pond effluents. Filtration efficiency, filtration rate, and the length of the filter run were evaluated for a range of sand sizes- 0.92, 0.50, 0.35, and 0.17 mm. A 5 to 7 foot hydraulic head, under continuous flow conditions, was used during periods of highest suspended solids concentrations in pond effluent. Efficiency was determined by comparison of influent and effluent BOD5, suspended solids, and fecal coliform concentrations. Filters of 0.50 to 0.35 mm were successful when operated at rates of 1 to 3 gallons/sq ft/min for minimum filter runs of 5 weeks. Effluents produced met the standards of 30 mg/liter of BOD5 and suspended solids and 200 fecal coliform/100 ml. Average BOD5 efficiencies were 70-94%. Reductions of fecal coliform ranged from 92 to 98%. Effluent concentrations were 6-37 mg/liter of BOD5, 9-43 mg/liter of suspended solids, and 42-173 fecal coliform/100 ml. Towards the lower end of the 0.35-0.50 filter range, efficiency increased and the stability of filtration rates and length of filter run substantially decreased. Filtration efficiency decreased and filtration rates and filter run length were acceptable and stable for the 0.50 millimeter filter size. These units were technically and economically feasible for small communities. Maintenance requirements were minimal and the system was considered applicable to rural effluents.

*Soil filters, *Oxidation lagoons, Domestic wastes, Biochemical oxygen demand, Coliforms, Economics, Design, Operation, Maintenance, Treatment facilities, Nutrients, Pollution abatement, Waste water treatment

D371
UPGRADING A COMPLEX MIX ACTIVATED SLUDGE WASTE WATER TREATMENT PLANT,

Uhte, W. R.

Brown and Caldwell,
Walnut Creek, California.

Journal Water Pollution Control Federation, Vol. 48, No. 12, p 2653-2668, December, 1976.
12 fig.

Modifications have been made to upgrade a complex mix activated sludge treatment plant where effluent suspended solids loadings and coliform MPN counts were near violation levels. The Sacramento County Central Wastewater Treatment Plant processes both domestic and industrial wastes and was subject to heavy organic loads during an approaching canning season. Major problems included an unstable activated sludge process, an inadequate waste solid processing and disposal system, and the unknown magnitude of industrial waste loadings. The first was the subject of this study and contributing factors were: the inability of plant aeration and settling to operate as a single system; inadequate control of return activated sludge (RAS); inability to maintain regulated waste activated sludge (WAS) flow rates; no chemical feed facilities to improve mixed liquor settling and control filamentous growths; insufficient maintenance of DO in aeration tanks; and varying mixed liquor flows to final clarifiers. Primary effluent and RAS were mixed before distribution to aeration bays and all secondary clarifier RAS flows were completely mixed before return to primary effluent. Operation was possible at higher solids levels with lower feed:solids ratios during peak cannery load periods. RAS was aided by the installation of two independent RAS pumps at each clarifier. For WAS control an aeration bay was changed into a reaeration bay, the WAS pump discharge header was raised, and a WAS magnetic meter with a higher peak capacity was installed. Ferric chloride and chlorine chemical feed facilities were constructed to provide flexibility during critical operational periods. Hydraulic losses were minimized and the use of equalizing overflow weirs in the aeration tank "H" produced equal distribution of mixed liquor to the clarifiers. After two years, plant operation was significantly improved.

*Treatment facilities, *Performance, *Activated sludge, Trickling filters, Oxidation lagoons, Industrial wastes, Sedimentation, Aeration, Chlorination, Disinfection, Operations, Equipment, Chemical treatment, Control, Waste water treatment

D372
AN APPROACH TO REDUCE WATER CONSUMPTION IN NEIGHBORHOODS THROUGH REUSE,

Mowli, P. P.

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Tirupati, India,
Department of Civil Engineering.

Indian Journal of Environmental Health, Vol. 18, No. 4, p 299-304, October, 1976.
1 fig, 3 tab, 5 ref.

A two-year study was conducted in India on the feasibility of waste water reclamation and reuse to lower domestic water consumption. The test site was a college residential area whose water consumption patterns were similar to that of developing upper income neighborhoods. It was suggested that waste water from baths, water closets, and washing could be used for gardening purposes when suitably treated. This would reduce fresh water demands by 20-34% depending upon gardening needs. Design criteria for a successful reuse scheme included: waste water treatment to a satisfactory level; construction of septic tank and other treatment units adjacent to the water closet and bath; construction of treatment units partially or fully above ground level so that treated effluent could flow into a storage tank; and using hose pipes to transport treated waste water to the plant beds. Open drains would be eliminated. In the test system, septic tank effluent was further treated in reverse filters before storage. Common-wall, compact construction resulted in cost and area savings. Elimination of house drains and head pressure conservation were accomplished by constructing the unit adjacent to the water closet and bath. The final effluent was very clean and had no objectionable odor or color. Hoses were supplied to avoid complaints against direct handling of reclaimed water in gardening applications.

*Water reuse, *Water demand, Water consumption (except consumptive use), Domestic water, Water treatment, Water purification, Filtration, Equipment, Waste water treatment, Urban areas

D373
SEWAGE EJECTORS AVOID MANUAL UNBLOCKING OF PIPES,

Process Engineering, p 11, March, 1977.

An East Anglian, England, hospital replaced sewage handling centrifugal pumps with gravity filled electromatic sewage ejectors. This immediately reduced the maintenance problems encountered through pipe blockage by cloth, toys, and other solid materials. A roller screen on skids prevented passage of such solid materials into the mechanism. The ejectors, with 30 hp compressors, were able to handle up to 12 liters/second. The ejectors have proven themselves most reliable and were considered more effective than rotary valve or electrode control units. There were no floats or electrodes in the sewage flow.

*Hydraulic machinery, *Sewage treatment, Screens, Pumps, Pipes, Liquid wastes, Solid wastes, Maintenance, Performance, Equipment, Waste water treatment

Sewage ejectors

D374
CO-BURNING OF SLUDGE AND REFUSE WITH WASTE HEAT RECOVERY,

Cosulich, W. F.

William F. Cosulich Associates, P.C.,
Environmental Engineers,
Woodbury, New York.

Public Works, Vol. 108, No. 5, p 76-79, May, 1977. 2 fig.

The co-burning of sludge and refuse is being developed by Glen Cove, N.Y., because of an EPA ban on ocean disposal and a New Jersey ban on out-of-state refuse dumping. Heat from the incineration process will be used to produce steam and electrical power for the waste water treatment plant and the incinerator. The facilities will consist of an 8 mgd activated sludge nitrification plant and a 200 ton/day incinerator. Four different incineration systems were considered: pyrolysis, multi-hearth, fluidized bed, and stoker fired. Pyrolysis was judged to be uneconomical for the community, and developmental multi-hearth incinerators showed no economic advantage over stoker fired incinerators. Fluidized bed incinerators were also in developmental stages and there was, again, no economic advantage. The stoker fired incinerator was recommended after examination of a plant in Norwalk, Connecticut. A mixture of 87% refuse and 13% sludge, by weight, provided excellent combustion efficiency. The system's major aspects include the method of feeding sludge to the furnace, the stoker, and the control system for combustion air. Sludge, fed into the furnace as a thin layer on top of refuse dries and burns during the 30 minute furnace residence time. The stoker should not have large openings but should provide a gentle agitation. Controlled temperatures minimize slagging on the refractory walls and are essential for steam and electricity production. The chosen system uses two 100 ton/day furnaces with double reciprocating stokes and a modulating air system. The high heat value of the refuse-sludge mix was estimated at 4,120 Btu/pound. This is expected to produce 34,000 pounds/hour of steam which will power a 2.2 megawatt multi-stage condensing turbine generator set. Air pollution controls are to be included and settled sewage or treated effluent could serve as condenser cooling water. Three 1,000 KW diesel generators will provide standby power.

*Incineration, *Waste disposal, *Sludge disposal, Equipment, Design, Costs, Temperature, Treatment facilities, Ultimate disposal, Cooling water, Steam, Electric power

D375
HYDROGEN PEROXIDE SUBDUES WASTE WATER PLANT PROBLEMS,

Public Works, Vol. 108, No. 5, p 105, May, 1977.

Stockton, California, has used hydrogen peroxide to solve several waste water treatment problems. Chlorine usage was reduced, hydrogen sulfide was eliminated, crown corrosion was prevented, and so was the septicity of raw sewage in the force mains. Use of hydrogen peroxide was instituted to prevent odors and concrete sewer corrosion. It was later used to ensure the operation of an overloaded treatment facility until the completion of a higher capacity plant. Prevention of septic waste water was accomplished by hydrogen peroxide addition at three lift stations. This raised DO concentrations at the primary clarifier and kept the wastes fresh. Hydrogen peroxide prevented corrosive H2S reactions in sewers and completely eliminated the need to use chlorine for odor control. Application of hydrogen peroxide is planned for trunk lines to the new plant which will handle flows having high H2S and BOD concentrations.

*Treatment facilities, *Sewers, *Performance, Hydrogen sulfide, Odor, Corrosion control, Chlorine, Dissolved oxygen, Biochemical oxygen demand, Sewers, Waste water treatment

Hydrogen peroxide, Stockton (CA)

D376
THURROCK TEST-BED FOR ICI DEEP SHAFT,

Appleton, B.

New Civil Engineer, No. 239, p 24-25, April, 1977. 1 fig.

The ICI deep shaft treatment process uses air injection to drive raw sewage down a central shaft and back up the space around the shaft annularly. It then overflows for final clarification after about 20 circuits. The system creates a longer air bubble contact time to produce a higher oxygen transfer efficiency. Purification rates are several times that of normal aeration and energy needs are reduced. The Thurrock facility of the English Anglian Water Authority will test the process. The 130 meter-deep, 1.86 meter-diameter shaft is expected to remove 7,000 kg of BOD/day from a mixture of industrial and domestic sewage equivalent to a 130,000 population sewage load. Cost comparisons indicated that the 750,000 pounds to be expended would equal the cost of an extended aeration program to treat the normal domestic sewage of a 30,000 population to Royal Commission standard.

*Aeration, *Treatment facilities, Sanitary engineering, Water purification, Biochemical oxygen demand, Oxygen, Industrial wastes, Domestic wastes, Costs, Waste water treatment

ICI deep shaft, Oxygen transfer, Anglian Water Authority (England)

D377
VIRUS AND BACTERIA REMOVAL FROM WASTE WATER BY RAPID INFILTRATION THROUGH SOIL,

Schaub, S. A., and Sorber, C. A.

U.S. Army Medical Bioengineering Research and
Development Laboratory,
Fort Detrick,
Federick, Maryland.

Applied and Environmental Microbiology, Vol. 33, No. 3, p 609-619, March, 1977.
6 fig, 6 tab, 15 ref.

The removal of viruses and bacteria from waste water by rapid infiltration following land disposal was investigated. The study site was a disposal field which has been operated continuously since 1942. Viral adsorption and enteric indicator bacteria studies were performed. It was found that all soil layers held viruses poorly (in primary effluent) and bacteriophage adsorption was minimal. Viral adsorption was significant, except in high organic content surface layers, when deionized water with metal cation was used. In unrenovated cells, adsorptive sites in upper soil layers were depleted. The f2 bacteriophage stabilized in groundwater at almost 50% of the applied virus concentration. Recovery of enteric viruses was about 10% of the waste water virus concentration. Laboratory tests indicated greater soil adsorption of enterovirus as compared to poliovirus. Indicator bacteria studies indicated a different behavioral pattern. Large concentrations of total coliform, fecal coliform, and fecal streptococcus were retained in surface soils. Bacterial concentrations dropped significantly, declining at slower rates than viruses, in subsequent layers. It was doubtful that adsorption played a large role in these results. Fecal streptococcus in groundwater did not correspond with tracer bacteriophage occurrence. This could be attributed to different migration times and to previous waste water applications.

*Viruses, *Bacteria, *Infiltration, Soil disposal fields, Adsorption, Soil contamination, Water pollution, Groundwater, Separation, Microorganisms, Waste water treatment

D378
NIRMALI SEED--A NATURALLY OCCURRING COAGULANT,

Tripathi, P. N., Chaudhuri, M., and Bokil, S. D.

Bhagalpur Engineering College,
Bhagalpur, India,
Department of Civil Engineering.

Indian Journal of Environmental Health, Vol. 18, No. 4, p 272-281, October, 1976.
6 fig, 4 tab, 15 ref.

Nirmali seeds and nuts have long been used in crushed form to clarify muddy water in India. An extract from the seeds was found to be an anionic polyelectrolyte which was effective as a coagulant and coagulant aid in the clarification of natural turbid water. The two main groups on the polymer were carboxyl and hydroxyl. It was an efficient flocculant for turbidity that was of an inorganic, hydrophobic nature. The extract performed poorly as a flocculant and coagulant for natural biocolloids, such as bacteria.

*Polyelectrolytes, *Coagulation, *Flocculation, *Clays, Bacteria, Evaluation, Water purification, Chemical treatment, Separation techniques, Waste water treatment

Nirmali seed

D379
WASTE WATER TREATMENT BY ANAEROBIC CONTACT FILTER,

Khan, A. N., and Siddiqi, R. H.

National Environmental Engineering Research Institute,
Nagpur, India.

Indian Journal of Environmental Health, Vol. 18, No. 4, p 282-291, October, 1976.
2 fig, 5 tab, 7 ref.

Laboratory studies were conducted to test the performance of an anaerobic contact filter unit. This was an upflow filter with waste introduced from the bottom. The filter was completely submerged. It contains a stone-filled bed, on which anaerobic microorganisms grow, that allows higher loading rates. Results showed an 80% reduction in applied COD at a loading of 225 pounds of COD/1000 cubic feet/day. Liquid detention time at this loading was 8 hours. The anaerobic contact filter compared favorably with other biological treatment methods. Performance was not significantly improved with a height greater than 4 feet. Treatment of soluble wastes with BOD concentrations as low as 500 mg/liter was feasible and the system was considered as an alternative to septic tanks themselves, or as a secondary treatment method for septic tank effluents in waterlogged or compact areas.

*Aerobic conditions, *Filtration, *Filters, Performance, Evaluation, Bacteria, Costs, Chemical oxygen demand, Liquid wastes, Anaerobic bacteria, Suspended solids, Waste water treatment, Equipment

Anaerobic contact filter

D380
EVALUATION OF CELLULOSE ACETATE MEMBRANES FOR REVERSE OSMOSIS SEPARATION,

Bal, A. S., and Lutade, S. L.

National Environmental Engineering Research Institute,
Nagpur, India.

Indian Journal of Environmental Health, Vol. 18, No. 4, p 253-271, October, 1976.
10 fig, 4 tab, 10 ref.

The performance of cellulose acetate membranes was evaluated for use in reverse osmosis separation. A spread casting solution of cellulose acetate, formamide, and acetone was spread on a suitable surface and allowed to evaporate. The film was immersed in cold water and the formamide was leached away, thus forming a highly porous membrane. Shrinkage was accomplished by heating under water. The membrane was tested to determine the effect of casting parameters such as casting temperature and relative humidity of the casting atmosphere. Results indicated that the most useful casting formula was, by weight, 25% of cellulose acetate, 30% of formamide, and 45% of acetone. Trends relative to temperature indicated an increase in product rate with increased casting temperatures. An increase in percent salt rejection was observed with increasing casting temperatures. Higher percent relative humidities are accompanied by higher flux rates and low rejection through the membrane. With casting temperatures of 23-26 C, a relative humidity of 65-78% produces the most productive membranes.

*Reverse osmosis, *Membranes, *Polymers, *Evaluation, Membrane processes, Temperature, Evaporation, Humidity, Physical properties, Chemical properties, Separation techniques, Water purification, Waste water treatment

Cellulose acetate membranes

D381
PASTEUR V CURIE,

The Consulting Engineer, Vol. 41, No. 4, p 43, 45, April, 1977. 1 fig.

Sterilization is a necessity before sewage can be used as an agricultural fertilizer. This can be accomplished by either irradiation or pasteurization. A German irradiation plant claims to produce results comparable to those of conventional pasteurization plants. It is composed of a sludge irradiation shaft, a built-in central pipe, and a recirculation system. Components requiring regular inspection and maintenance are remote from radiation sources and are safe during periods of operation. Varied safety measures have been taken and the source rods do not contact the sewage. A closed loop system is provided for cooling and leakage monitoring. The operation is a batch process. Irradiated sludge is discharged to a storage tank for separation of sludge and water. Operation is automatically controlled. A Danish pasteurization plant included mechanical and biological treatment, and anaerobic stabilization of the sludge. The plant treated about 40% of the sludge produced from the related municipal treatment plant. Sludge was passed to a spiral heat exchanger for indirect heat exchange preheating and was dispatched as pasteurized sludge. Radiation doses of 150 krad for 5 minutes was considered adequate for sludge dried to 25% solids and a 500 krad dose at the same exposure time was necessary for sludge dried to 10% solids. This was calculated to equal pasteurization at 80 C for 30 minutes. The pasteurization process with a shorter heating time does not claim complete bacterial destruction, but does destroy salmonella and escherichia bacteria. Operation was at 80 C for 5 minutes. The total bacterial count was reduced by 65-85%. COD was increased 200-300% during pasteurization at 75-85 C and by a minimum 900% at 90-95 C.

*Irradiation, *Heat treatment, *Fertilizers, Sewage treatment, Sewage disposal, Temperature, Equipment, Sludge disposal, Physical properties, Biological properties, Waste water treatment

Pasteurization

D382
WASTE PURIFICATION PROCESS,

Indian Chemical Journal, Vol. 11, No. 7, p 33, January, 1977.

A German installation of the Lindox biological waste water treatment process is described. The treated waste is highly contaminated with ammonia and has a strong odor. The process involves the introduction of waste into a stirred balancing tank and then into a two-stage activation basin. Oxygen is injected by two surface aerators to a concentration of 5-15 mg/liter. Waste is passed through a sedimentation basin and a 99.5% pure effluent is produced for disposal into a river. A 31-hour aeration time produces an effluent with a BOD of 23 mg/liter from an influent BOD of 5230 mg/liter. Specific oxygen demand is about 1.04 kg/kilogram of BOD. Low operating costs are produced from an electrical consumption of 0.32 kilowatt hours/kilogram of BOD.

*Treatment facilities, *Biological treatment, Ammonia, Odor, Oxygen, Aeration, Sedimentation, Biochemical oxygen demand, Oxygen demand, Costs, Water purification, Waste water treatment

D383
OXIDATION DITCH GIVES LOW-COST SECONDARY TREATMENT,

The American City and County, Vol. 92, No. 5, p 87-88, May, 1977. 1 fig, 1 tab.

A survey of secondary treatment facilities was conducted in EPA Region VII. Thirty facilities were evaluated for BOD5, COD, NFS, total P, NH3-N, TKN, NO2-NO3-N, and influent and effluent water temperatures. Activated sludge facilities and oxidation ditches presented the best performance, reaching 99% removals. Trickling filter plants were not as efficient. Nitrogen conversion was used as the measure of optimal performance. At temperatures less than 5 C, properly operated activated sludge plants and oxidation ditches can produce effluents containing less than 0.5 mg/liter of ammonia. Most secondary treatment plants did not perform efficiently. Collected data indicated that oxidation ditches could provide excellent treatment at low costs. These plants did not require highly trained operators for good performance. They could also be designed to provide complete nitrification in the coldest weather and a significant degree of denitrification. Unsatisfactory performance in some oxidation ditches could be traced to problems such as frozen sludge return lines and poor design.

*Oxidation, *Treatment facilities, Sewage treatment, Biochemical oxygen demand, Suspension solids, Toxicity, Organic matter, Nitrification, Denitrification, Activated sludge, Separation techniques, Waste water treatment

Oxidation ditches

D384
GROWTH OF TULIPS TREATED WITH SLUDGE CONTAINING DEWATERING CHEMICALS,

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Stillwater,
Department of Agronomy.

Environmental Pollution, Vol. 13, No. 1, p 11-20, May, 1977. 1 fig, 4 tab, 31 ref.

A greenhouse study was conducted to determine the effect of a ferric chloride-lime treated, dewatered sludge on tulip growth. Comparisons were made on the growth of plants receiving dried organic sludge, liquid organic sludge, primary effluent, and tap water. No additional chemicals were added to either of the organic sludges. Results revealed that tulips grown in chemical sludge had an average height shorter than that of the other tulips, with no buds or flowers. Liquid organic sludge, tap water, and primary effluent produced plants which flowered in 46 days. Dry organic sludge produced plants of a height intermediate to that of the others; these tulips had buds but no blooms. Growth was better with liquid organic sludge than with dry organic sludge. This suggested that more sludge could be applied to soil surfaces than could be mixed with or injected into the soil. The chemical sludge-treated soil produced highest soil nitrogen levels; phosphorus levels were medium to high in all soils. Extractable concentrations of trace elements and phosphorus were lower in soils treated with chemical sludge than those treated with dried or liquid organic sludge. Calcium was highest in soil treated with chemical sludge. Lime, in acidic soils, aids plant uptake of phosphorus; an excess of lime decreases available boron, iron, potassium, manganese, phosphorus and zinc. Ferric chloride in chemical sludge did not appear to be soluble. It was concluded that conditioned sludge containing ferric chloride and lime could not be used to grow tulips.

*Plant growth, *Chemicals, *Sludge disposal, *Waste disposal, Sludge treatment, Dewatering, Chlorides, Lime, Chemical treatment, Waste water treatment

Tulips

D385
PROBLEMS AND SOLUTIONS FOR SLUDGE TREATMENT. PART 2,

Smith, J. E., Jr.

Water and Sewage Works, Vol. 124, No. 5, p 81-85, May, 1977. 2 fig, 8 tab, 25 ref.

Experiments, pilot plants, and municipal treatment facilities are discussed in terms of current sludge treatment methods. Fe(+3), Al(+3), polymers, polyelectrolytes, and ferric chloride were used to test the effects on sludge treated in primary stages by chemical conditioning. Polymer conditioning produced good thickening results, and, with Fe(+3), a dry sludge cake was obtained. For sludge stabilization, lime addition was considered a relatively simple, inexpensive, and quick procedure useful in stabilizing large amounts of sludge. The use of sludge incinerator ash improved dewatering and produced a high-quality filtrate. For filtration, a top-feed rotary vacuum filter, moving belt filter presses, and a pressure filtration installation were studied. Top-feed vacuum filters produced a filter cake discharge that was superior to that of bottom-feed units. Little performance data were available for moving belt filters. Their operation depended on chemical addition, solids loading, and screen mesh size. Pressure filtration experience has been limited in the United States. A Cedar Rapids, Iowa, installation has used this system; treatment efficiencies and operating difficulties are described.

*Treatment facilities, *Municipal wastes, *Design criteria, Sludge treatment, Sludge disposal, Chemical treatment, Dewatering, Physical properties, Chemical properties, Polymers, Polyelectrolytes, Lime, Filtration, Equipment, Activated sludge, Waste water treatment

D386
ELEMENTAL COMPOSITION OF SLUDGE-FERTILIZED CHRYSANTHEMUMS,

Kirkham, M. B.

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Stillwater,
Department of Agronomy.

Journal of the American Society for Horticultural Science, Vol. 102, No. 3, p 352-354, May, 1977. 2 tab, 14 ref.

Chrysanthemums were treated with liquid sludge for 84 days to determine its effectiveness as a fertilizer. Liquid sludge contains nutrients needed by field crops, but no data are available on the applicability of sludge to greenhouse plants. These plants were treated with either liquid sludge or inorganic fertilizers at doses of 50, 100, and 200 ml/week. Tap water was also used. The growth media were soil, sand, and peat. The variously fertilized plants were analyzed for concentrations of elements found in their leaves, stems, roots and flowers. Sludge-treated plants, regardless of the medium, had the highest nitrogen and lowest potassium concentrations in their leaves. Zinc concentrations in leaves increased with the sludge application rate. Elemental concentrations in stems and flowers, however, did not vary significantly with any particular fertilizer treatment. Concentrations of N, Ca, and Mg in roots were greater in sludge-treated plants. Iron and copper concentrations were high in roots. Iron and copper in the leaves of plants grown in sand increased with the sludge application rate. Plants treated with 50 and 100 milligrams of sludge/week had similar nutrient concentrations, but the leaves were healthier in the 50 ml/week plants. Sludge raised the pH level in all the media, but especially in peat. Extractable concentrations of potassium were usually lower, and copper concentrations higher, in the sludge-treated media. Sand and peat media concentrations of calcium and magnesium increased as the sludge application rate increased. Trace element concentrations were not increased by using sludge fertilizer, nor was there any evidence of trace element toxicity. These experimental results indicated that chrysanthemum growth with liquid sludge as the only nutrient source was possible.

*Plant growth, *Fertilizers, *Sludge, Nitrogen, Potassium, Phosphorus, Nutrients, Trace elements, Toxicity, Hydrogen ion concentration

Chrysanthemums

D387
HOW SLUDGE CHARACTERISTICS AFFECT INCINERATOR DESIGN,

Novak, R. G., Cudahy, J. J., Denove, M. B., Standifer, R. L., and Wass, W. E.

Hydroscience, Incorporated,
Knoxville, Tennessee.

Chemical Engineering, Vol. 84, No. 10, p 131-136, May, 1977. 3 fig, 5 tab.

Incinerator design criteria are established based upon sludge characteristics. The moisture content of dewatered sludge directly influences incinerator size and auxiliary fuel costs. Various dewatering and conditioning systems were compared to determine the differences in sludge moisture content produced by each. Pressure filters produce the driest cake. This is an expensive dewatering method, but it conserves fuel. The resultant sludge can be burned in a relatively small incinerator. Dual-cell gravity/multi-roller press and belt press units require the lowest capital and labor expenditures. Centrifuge and vacuum filter methods are slightly more costly. All, except the pressure filter, produce cakes of approximately the same moisture content. The effects of conditioning chemicals on the quantity and composition of sludge, and on the ash produced, should also influence incinerator design. Multiple-hearth, fluid-bed, and rotary-hearth incinerators were described. The chemical composition of the sludge will determine whether or not secondary combustion on a multiple-hearth furnace is necessary. Other data necessary for choosing a particular incineration and disposal system are the ash content of the dry solids, the thermal characteristics of the ash, and the fraction of volatile and fixed carbon in the dry solids.

*Incineration, *Design criteria, *Sludge, Chemical properties, Physical properties, Dewatering, Equipment, Sludge treatment, Chemical treatment, Polyelectrolytes, Waste water treatment, Costs

D388
REVIEW AND EVALUATION OF AERATION TANK DESIGN PARAMETERS,

Gagnon, G. A., Crandall, C. J., and Zanoni, A. E.

Donohue and Associates, Incorporated,
Waukesha, Wisconsin.

Journal Water Pollution Control Federation, Vol. 49, No. 5, p 832-841, May, 1977.
4 fig, 8 tab, 39 ref.

The development of aeration tank design parameters was reviewed and these parameters were evaluated. The relationship between detention time and BOD removal has been a widely recognized parameter since the early 1900s. Organic loading per unit of volume and per unit of biomass have recently been recognized as more important parameters, in light of the activated sludge processes developed within the past thirty years. These parameters are more indicative of aeration tank conditions, such as the amount of biomass available for stabilization and the amount of organic matter to be stabilized. This study evaluated the efficiency of an activated sludge treatment plant as a function of three parameters. These were organic loading per unit volume, organic loading per unit of biomass, and organic loading per unit of biomass per unit time. There was no evident correlation between effluent BOD concentration and aeration tank loading in the range of 0.1-0.7 grams of BOD/gram of MLVSS/day. Percent BOD removals increased as aeration tank loading increased. Plant performance was more predictable at loadings above 560 grams of BOD/cu m/day, 0.3 grams of BOD/day/gram of MLVSS per day, and 35 grams of BOD/kg of MLVSS per day, than at lower loadings. Loadings up to 1,120 grams of BOD/cu m/day, 0.7 grams of BOD/gram of MLVSS per day, and 95 grams of BOD/kg of MLVSS per hour/per day produced BOD removals between 92 and 98%. Operation at these loadings is considered to be within the most effective range. Aeration tank size and construction costs would be reduced by a design for these higher rates. This would also provide the plant operator with a wide range from which to choose the plant loading rate.

*Aeration, *Treatment facilities, *Design criteria, Storage, Loads (forces), Biomass, Organic matter, Time, Biochemical oxygen demand, Evaluation, Waste water treatment

Aeration tanks

D389
CHEMICALLY ASSISTED BIOLOGICAL OXIDATION OF WASTES AND EXCESS SLUDGE,

Gaudy, A. F., Jr.

Oklahoma State University,
Stillwater,
Bioenvironmental Engineering Laboratories.

Water and Sewage Works, Reference Issue, p 48, 50-52, 54-56, April, 1977. 11 fig, 10 ref.

Extended aeration was investigated as a reliable means of producing a quality effluent without creating excessive biological sludge. It has been postulated that a process that did not involve sludge wasting would balance endogenous cellular metabolism and incoming sludge concentration by using the incoming waste for synthesis and growth. This would produce total waste oxidation. Those who have refuted this basic theory suggest that any success was due to solids going over the clarifier weir. A three-year investigation was conducted in which effluent was held in a holding tank, centrifuged, and returned to the holding tank to avoid solids being lost over the clarifier weir. The results revealed that neither a balanced condition between autodigestion and new sludge synthesis, nor a steady increase in biological solids concentration occurred. There were periods of solids accumulation and de-accumulation. The de-accumulation period was found to result from autodigestion exceeding sludge accumulation. Experimentation revealed that process malfunction would probably be due to impaired separation in the clarifier. Since centrifugation would not be practical in a field situation, solids would be channeled to the receiving stream. The insoluble portion of microbial cells released upon cell breakage, such as cell walls and membranes, consisted of polymers of compounds which were good substrates. Acid hydrolysis of these materials provided a substrate which was used to initiate autodigestion during de-accumulation periods. Further development of this "hydrolytic assist" procedure could make extended aeration a more cost-competitive sludge disposal method.

*Aeration, *Oxidation, *Hydrolysis, *Activated sludge, Metabolism, Effluents, Suspended solids, Waste disposal, Acidity, Chemical treatment, Waste water treatment

D390
SAFFRON WALDEN OPENS ITS LOW PROFILE SEWAGE WORKS,

Pullin, J.

Surveyor, Vol. 149, No. 4426, p 3, April, 1977.

A new treatment plant was opened at Saffron Walden, England. The former facility, located near a park, was overloaded. There was opposition to expansion of the old plant and demands that there be no environmental or aesthetic disturbance created by the new one. The routing of a footpath along the new site was also a problem. A revised design centralized the treatment works on one side of the path and the storm overflow and final effluent treatment area on the other side. Added costs incurred by the redesign have not been determined. High and low level gravity sewer systems provided sewage flow to the new plant. The first was fed by a new relief trunk sewer that intercepted the older system. The second discharged at the old site where effluent is pumped to the new works. Screenings from the inlet works were disintegrated and returned to the main flow through a detritor. A measuring flume diverted flows exceeding 3 mgd to storm water tanks. A central hopper received settled sludge. Settling tank overflow was mixed with humus tank effluent in the main pumping station and lifted to biological filters. Pump operation was automatically controlled. The biological filters were constructed as four beds. Flow then passed to humus tanks where effluent was divided for passage to the pumping station and recirculation. The remainder of this flow was passed to the river in winter or to microstrainers for polishing in the summer. A sludge consolidation unit received sludge from primary settling tanks. It was then stored for final treatment at a regional sludge center. The plant was constructed to a high architectural standard and its components were compact.

*Treatment facilities, *Sewers, Design criteria, Performance, Costs, Screens, Settling basins, Pumps, Filters, Biological treatment, Pumping plants, Sensors, Waste water treatment

Saffron Walden (England)

D391
SPRAY IRRIGATION-WASTE WATER TREATMENT FACILITY. NORTH BRANCH FIRE DISTRICT NO. 1, WEST DOVER, VERMONT.

Consulting Engineer. Vol. 48, No. 5, p 86, May, 1977.

A waste water treatment and disposal system, employing spray irrigation/land application, was completed in West Dover, Vermont. The ski resort community could not afford an expensive, technologically advanced treatment system. Activated sludge treatment and holding ponds were designed. The irrigation and land application portions provided means for tertiary treatment and ultimate disposal. A winter flow of up to 820,000 gallons/day was expected. Spraying could be used in winter because early snowfalls and the loose forest mat prevent frost penetration of soil. The spray field was located on a 55-acre hilly area. Nearly 4 miles of insulated steel spray laterals and a system of 600 fixed point spray nozzles at 25-foot intervals composed the automated system. Treatment facilities were placed in a control building that was designed as a barn. This is the first application of the system in New England. The demands for low-cost operation and maintenance of high quality surface and groundwater resources were met. Construction costs of $2,050,000 were less than estimates of $2,110,000.

*Irrigation, *Treatment facilities, Waste disposal, Activated sludge, Tertiary treatment, Ultimate disposal, Design criteria, Pumps, Chlorination, Dewatering, Storage, Municipal wastes, Waste water treatment

West Dover (VT)

D392
BIOLOGICAL FLUIDIZED-BED TREATMENT FOR BOD AND NITROGEN REMOVAL,

Jeris, J. S., Owens, R. W., Hickey, R., and Flood, F.

Ecolotrol, Incorporated,
Bethpage, New York.

Journal Water Pollution Control Federation, Vol. 49, No. 5, p 816-831, May, 1977.
14 fig, 8 tab, 12 ref.

Results of BOD and nitrogen removal studies in three fluidized bed pilot plants were summarized. The basic operation consists of an upward flow of waste water through a sand bed at a velocity which imparts motion to the sand. Test facility sizes ranged from 40,000 gpd for denitrification to 80,000 gpd for carbonaceous BOD removal and nitrification. Systems were operated independently of each other. Testing showed that conventional biological treatment design parameters could be applied to fluidized bed treatment. These included food/mass ratio, solids retention time, and oxygen utilization. Very high biological organism concentrations could be maintained in the reactor. Treatment times were reduced so that 93% BOD removals were achieved in 16 minutes, 99% NH3-N removals were produced in 11 minutes, and 99% NO3-N removals were obtained in less than 6.5 minutes. Space requirements were less than 5% of what is necessary for conventional treatment; intermediary clarifiers were eliminated. Oxygen transfer is the major technological area being optimized. About 40 to 50 mg/liter of oxygen can be dissolved in waste water under atmospheric conditions at most operating temperatures. Recycling would be advantageous in completing treatment when the oxygen demand is high. Many methods of oxygen transfer were being investigated. Flow equalization, used during the pilot study, was a more favorable operating condition as compared to plants which do not employ constant flow. The system combines the best aspects of activated sludge and trickling filtration into one process. Costs should be less expensive than conventional treatment costs due to the space and time savings of the process.

*Filtration, *Biological treatment, *Biochemical oxygen demand, *Nitrogen, Filters, Biomass, Pilot plants, Oxygen, Suspended solids, Sludge, Nitrification, Ammonia, Dissolved oxygen, Hydrogen ion concentration, Denitrification, Evaluation, Waste water treatment

Fluidized-bed treatment

D393
CONTINUOUS FILTER PRESS,

Effluent and Water Treatment Journal, Vol. 17, No. 4, p 199, April, 1977. 1 fig.

A newly developed continuous filter press was described. It consisted of a single lower endless belt and a shorter upper belt. Secondary and final dewatering stages were located between the belts. Sludge or slurry was pumped through a feed box with a polyelectrolyte injector and into a rotary drum with a fine mesh surface. About 60% of the total moisture content was drained at this point. Sludge was passed to the belt for dewatering by secondary and final squeeze stages. The final squeeze pressure was adjustable. It is possible for the final moisture content to be in excess of 40% solids. The filtrate can be used for belt washing or it can be discharged for additional treatment. The system can be used for most domestic sewage and water treatment sludges, as well as for industrial effluent and metal hydroxide sludges. Improved stability of polyelectrolytes has contributed to the reduction of costs for the system. Other benefits include simple design, low working speed and built-in variations to pressure, belt speed, sludge and flocculation dose.

*Filters, *Separation, Equipment, Suspended solids, Dewatering, Sludge treatment, Domestic wastes, Industrial wastes, Polyelectrolytes, Economics, Costs, Mechanical engineering, Waste water treatment

Continuous filter press

D394
TREATMENT OF COMBINED SEWER OVERFLOWS BY HIGH GRADIENT MAGNETIC SEPARATION,

Allen, D. M., Sargent, R. L., and Oberteuffer, J. A.

Sala Magnetics, Incorporated,
Cambridge, Massachusetts.

1977. 127 p, 23 fig, 18 tab, 15 ref, 6 append. Technical Report EPA-600/2-77-015.

High gradient magnetic separation was evaluated as a treatment for combined sewer overflows (CSO). Bench-scale and continuous pilot plant tests were performed. The method maximized the magnetic forces to increase separation performance. Process efficiency was greatest for removal of suspended solids (98.7%). turbidity (96.3%), apparent color (92.8%), BOD5 (92+%), and fecal coliform bacteria (99.85%). COD removal averaged 74%. The relative importance, sensitivities, and interactions of parameters were determined. Removal efficiency was found to have an important relationship to the coagulant and the pH level. Comparisons with other secondary treatment methods proved the system to be substantially more efficient. It was also economically competitive. Other favorable factors included high processing rates, decreased land requirements, and lower chlorine demand.

*Combined sewers, *Overflow, *Separation techniques, *Water treatment, Flocculation, Sewage treatment, Filtration, Suspended solids, Biochemical oxygen demand, Coliforms, Coagulation, Hydrogen ion concentration, Performance, Evaluation, Costs, Water purification

High gradient magnetic separation

D395
GEAR MOTOR SOLVES PLANT'S NOISE PROBLEM,

Water and Sewage Works, Vol. 124, No. 5, p 59, May, 1977.

Noise problems of secondary tank aerators were resolved during an expansion and modernization program at a Mecca, California, treatment plant. Noise from the gearbox drives was negated when a new aeration tank at the secondary stage was constructed. The mechanical aerator installed produced very little vibration, torquing, or tilting of a nearby catwalk. Tolerances of .0025 inches were maintained on drive train units. There was no oil spill or leakage and the unit ran cool to the touch. A "superfine" sparger supplied air through peripheral holes at 20 psi and about 100,000 cu ft/day. Aerator blades forced rising bubbles back down through the waste. Bubbles were also forced outward to the tank sides. This provided the oxygen demand needed by microorganisms. Around-the-clock operation has required little maintenance and noise complaints have dropped to zero. Constant density changes in the tank result from the highly efficient air mixing; this is related to shock load to the aerator and to the gear drive.

*Gears, *Pumps, Treatment facilities, Performance, Aeration, Oxygen demand, Equipment, Microorganisms, Activated sludge, Waste water treatment

Noise

D396
OPERATION CONTROL,

In: 1977 Public Works Manual and Catalog File, Billings, C. H., Conner, S. H., and Kircher, J. R., editors, p D52-D57, 1977.

Various aspects of operations control in waste water treatment facilities were reviewed. Expert design notwithstanding, a treatment plant's functioning greatly depends upon control of the many inputs to the treatment system, of its equipment, and of process parameters. Advanced instrumentation and analytical procedures contribute to the efficient operation of any plant. Equipment was described for measuring flow, gas, temperature, rain, and sludge. Quality control can be implemented through the measurement and analysis of process parameters which include suspended solids, settleability, biochemical oxygen demand, total organic carbon, pH, dissolved oxygen, and bacteriological activity. Various pieces of laboratory equipment for testing and analysis were presented for chemical, physical, and biochemical parameters. Safety instrumentation for the detection of combustible or poisonous gases were described, as were control systems for collection systems.

*Operations, *Measurement, *Instrumentation, Testing, Laboratory testing, Laboratories, Equipment, Flow, Gases, Sludge, Temperature, Analysis, Biochemical oxygen demand, Chemical oxygen demand, Safety, Microorganisms, Automation, Treatment facilities, Waste water treatment

D397
DISINFECTION AND ODOR CONTROL,

In: 1977 Public Works Manual and Catalog File, Billings, C. H., Conner, S. H., and Kircher, J. R., editors, p D49-D52, 1977.

Disinfection and odor control of waste water were discussed. The major choices for disinfection include chlorination and ozonation. These methods can control septicity and odor as well. However, odor can also be controlled by the use of hydrogen peroxide or other oxidizing agents to react with odor-causing substances or to act as masking agents. Procedures and equipment for chlorine and ozone application were included. Ultra-violet radiation has recently become a more widespread method of disinfection. Systems were presented for odor combustion and adsorption, as well as for ozone deodorization.

*Disinfection, *Odor, *Chlorination, *Ozone, Chemical treatment, Oxidation, Equipment, Costs, Irradiation, Cleaning, Operations, Water purification, Corrosion control, Waste water treatment

D398
SLUDGE DIGESTION AND DISPOSAL,

In: 1977 Public Works Manual and Catalog File, Billings, C. H., Conner, S. H., and Kircher, J. R., editors, p D38-D49, 1977. 3 fig.

Various processes for the digestion and disposal of sludge were presented. Though anaerobic digestion is the traditional means of organic matter stabilization, the required long detention times have produced certain nuisances, such as a liquid fraction which is difficult to handle. Aerobic digestion is most feasible at small plants, but both processes produce the problem of solids disposal. Means of combating these treatment problems include thickening, conditioning, stabilization, dewatering, heat drying, reduction, and final disposal by ocean dumping, subsurface injection, cropland applications, landfilling, and power generation. Pyrolysis may be a disposal solution for urban centers. Aspects of anaerobic digestion covered were tank design and capacity, biological action, sludge handling, gas collection, supernatant disposal, and mixing and scum breaking. The process of aerobic digestion and utilization and storage of resultant gases was described. A method of chemical stabilization was reviewed, and dewatering by air drying and vacuum filtration was assessed. Composting, sludge shredding, flash or spray drying, and rotary drying were presented. Disposal by incineration through wet-air oxidation and the use of fluidized beds was also discussed.

*Sludge digestion, *Sludge disposal, Anaerobic digestion, Aerobic treatment, Pathogens, Biological treatment, Gases, Heat treatment, Filtration, Instrumentation, Chemical treatment, Dewatering, Drying, Fertilizers, Equipment, Incineration, Oxidation, Design

Sludge conditioning, Composts, Wet-air oxidation

D399
ADVANCED TREATMENT,

In: 1977 Public Works Manual and Catalog File, Billings, C. H., Conner, S. H., and Kircher, J. R., editors, p D32-D38, 1977. 2 fig.

The term "tertiary treatment" was used to describe any treatment which follows conventional secondary treatment to produce an effluent of a substantially improved quality. Processes involved in this phase are multi-media filters or microstrainers, carbon filters or columns for nitrogen and organic adsorption, ion exchange, or combinations of these. Solids removal by filtration and the use of activated carbon to remove nutrients were described with process design criteria. Coagulant aids, such as aluminum sulfate, sodium aluminate, lime, ferric chloride, ferric sulfate, and ferrous sulfate were described in their various applications. A physical-chemical treatment was presented which involved pretreatment, clarification, filtration, adsorption, and disinfection. The reuse of treated waste water was described for land applications such as overland flow, rapid infiltration/percolation, and crop irrigation.

*Tertiary treatment, *Treatment facilities, *Chemical treatment, Phosphorus, Nitrogen, Biochemical oxygen demand, Suspended solids, Separation techniques, Ion exchange, Filtration, Anaerobic conditions, Adsorption, Activated carbon, Ammonia, Ultimate disposal, Nutrients, Coagulation, Organic matter, Disinfection, Waste water treatment

D400
LAND APPLICATION OF MUNICIPAL SLUDGE,

Dakes, G., and Cheremisinoff, P. N.

Water and Sewage Works, Reference Issue, p 38, 40-44, 46-47, April, 1977. 4 fig, 9 tab, 19 ref.

A summary was presented of information on the land application of municipal sludge. A brief history of sewage land application and an analysis of sludge characteristics were reviewed. Primary sludge contains high concentrations of fecal coliforms and lesser amounts of disease-causing organisms. These can be significantly removed through sedimentation. Sludge contains the major plant nutrients: nitrogen, phosphorus, and potassium. The four alternative methods of sludge disposal were incineration, ocean dumping, landfill, and land application. Properly operated and designed incinerators were able to meet particulate emission regulations, producing ash in volumes one-tenth that of dry sludge. However, disposal was still required, the removed water was a problem, and the process was expensive. Ocean dumping is to be completely phased out by 1981. Landfilling is an economic alternative and can accommodate concurrent disposal of municipal solid wastes. Pollution of groundwater from leachates and runoff is the most likely problem. Sludge must also be dewatered for this method. The costs to be considered for a land application system are sludge value, handling methods, transport, and distribution. Land acquisition and availability must also be considered. Any program must be prefaced by an understanding of the effects of metal toxicity to plants and the food chain. Several on-going experiments are seeking hard data on the subject. Various means have been suggested to avoid public health hazards. Means of pathogen destruction include long storage times, pasteurization, lime addition to raise pH, chlorination, and other chemical treatment. The final problem concerns the promotion of public acceptance. This should be solicited during developmental stages of a disposal program.

*Sludge disposal, *Municipal wastes, Incineration, Landfills, Fertilizers, Design, Economics, Water quality standards, Nutrients, Heavy metals, Pathogens, Monitoring, Chemical treatment, Microorganisms, Public health, Waste disposal

Land application, Ocean dumping

D401
PRIMARY TREATMENT,

In: 1977 Public Works Manual and Catalog File, Billings, C. H., Conner, S. H., and Kircher, J. R., editors, p D16-D24, 1977. 1 fig.

Primary treatment was defined in terms of methods which remove coarse and high specific gravity solids from waste water. These processes include screening, comminution, grit collection, clarification, settling, and scum removal. Various process aids are described, including flocculation, flotation, and sludge thickening. Screen types described were coarse and fine screens, drum screens, and rotating screens. Screenings disposal would be by incineration, burial, digestion with sludge, or shredding for return to the sewage. Comminution and its placement in the treatment cycle were briefly reviewed. Grit collection can be accomplished by channel collectors or washing collectors. Design and operational data were presented for settling tanks, scum removal, flotation, flocculation, and sludge thickening. Pre-designed factory assembled treatment units and components were mentioned with sources for their purchase.

*Treatment facilities, *Separation techniques, Screens, Settling basins, Flocculation, Flotation, Sludge treatment, Automatic controls, Scum, Suspended solids, Waste disposal, Equipment, Filtration, Design criteria, Waste water treatment, Incineration

Sludge thickening, Grit

D402
REDUCTION AND RECOVERY: KEYS TO ENERGY SELF-SUFFICIENCY,

Jacobs, A.

Metcalf and Eddy of New York, Incorporated,
New York, New York.

Water and Sewage Works, Reference Issue, p 24-26, 28-30, 32-34, 37, April, 1977.
15 fig, 6 tab, 17 ref.

Energy self-sufficiency was discussed for waste water treatment facilities. The economic savings potential from reducing electrical energy demand is substantial, since energy costs are second in magnitude only to salary expenditures. Prime consideration was given to reduction of energy consumption and to recovery of waste heat and energy. Suggested steps included the reduction of peak demand loads; the use of energy efficient processes and equipment; improvement of plant control and operations; and preventive maintenance schedules. Proper selection of pumps, improvement of heat value of incineration products, and improved dewatering would provide savings. Flow equalization, reduction of sludge processing side streams, and minimized hydraulic losses were considered for improving energy utilization in treatment processes. The use of sludge conditioners, such as organic polymers which do not reduce heat value, was suggested. Heat from incinerators could be used to preheat sludge and combustion air. Heat recovered from high temperature gases could provide an added energy source. Aerobic digester gas, and the liquid, gas, and solid residues of pyrolysis could be developed into fuel sources. Adopting any of these practices could reduce the requirements for outside power and fuel.

*Energy, *Fuels, *Electric power costs, Treatment facilities, Electrical power demand, Hydraulic machinery, Flow, Dewatering, Incineration, Heat, Gases, Sludge digestion, Polymers, Operation and maintenance, Waste water treatment, Economics

D403
POLYMER ADDITION IMPROVES WASTE WATER TREATMENT PROCESS,

Churchill, R. J., and Rybacki, R. L.

Tretolite Division,
St. Louis, Missouri.

Water and Sewage Works, Reference Issue, p 10-12, 14-17, 20, April, 1977. 8 fig, 2 tab, 5 ref.

Polymers are added to waste water treatment processes to improve performance and effluent quality. They have been used to balance intermittent fluctuations of influent characteristics. Polymers function as the primary chemical conditioning agent or as an aid to the primary conditioner. They are commonly applied for sludge conditioning in elutriation, thickening, and dewatering; enhancement of alum coagulation/flocculation; and improvement of alum, ferric, or calcium precipitation of phosphorus in waste water. Their use does not create additional sludge and they may be reused at several points in the treatment system. Solids control can be obtained in primary and secondary clarification, and in activated sludge systems bulking can be reduced. As a pretreatment additive, polymers can substantially decrease BOD load on the biological system through increased BOD and suspended solids removal. Polymer addition can increase the solids retention capacity of filters. Sludge settling rates and the underflow sludge concentration are also increased by polymer addition. Case studies were conducted to evaluate the benefits and limits of polymer addition. It was concluded that polymer addition could enhance treatment performance by smoothing temporary imbalances. It should not be considered the answer to all performance problems.

*Polymers, *Water quality, Performance, Treatment facilities, Sludge treatment, Biochemical oxygen demand, Suspended solids, Dewatering, Coagulation, Flocculation, Activated sludge, Filters, Waste water treatment

D404
SECONDARY TREATMENT,

In: 1977 Public Works Manual and Catalog File, Billings, C. H., Conner, S. H., and Kircher, J. R., editors, p D24-D32, 1977. 1 fig.

Secondary treatment was originally defined as methods involving microbial growth and its metabolic use of organics in waste water for purposes of solids removal. PL 92-500 effluent standards which were required under this heading were BOD and suspended solids of 30 mg/liter or less, and a pH between 6.0 and 9.0. This may be maintained by use of aerobic or anaerobic conditions. Settling basins and clarifiers usually operate under aerobic conditions, whereas solids are primarily digested under anaerobic conditions. Activated sludge processes, stabilization ponds, or trickling filters were the basic methods for the biological stabilization of waste water. Process and equipment criteria were presented for the activated sludge process. Equipment was described for diffused and mechanical aeration. Variations of the process which were described included activated aeration, mixing-aeration, contact stabilization, extended aeration, and the complete mixing activated sludge process. Design criteria were presented for oxidation ponds, especially for pond liners, and associated pipework. Construction, design, and maintenance of trickling filters were discussed.

*Treatment facilities, *Biological treatment, *Chemical treatment, Oxidation, Filtration, Biochemical oxygen demand, Suspended solids, Hydrogen ion concentration, Microorganisms, Aerobic conditions, Anaerobic conditions, Activated sludge, Aeration, Oxidation lagoons, Trickling filters, Design, Waste water treatment

D405
CONCURRENT WASTE WATER RENOVATION AND SOLID WASTE COMPOSTING,

Lightsey, G. R., Hines, A. L., and Henderson, R. W.

Mississippi State University,
Mississippi State,
Department of Chemical Engineering.

Compost Science, Vol. 18, No. 2, p 14-16, March/April, 1977. 2 fig, 2 tab, 10 ref.

A study was conducted to determine the effectiveness of using bark in a trickling filter medium to reduce BOD and COD in waste water before its land disposal. Bark used in trickling filters for this purpose is converted into a useful nitrogen enriched compost. Raw bark and composted bark, minus nitrogen, were evaluated. A waste water with high BOD and COD concentrations, and one with heavy metal concentrations similar to that in municipal waste water, were tested. Raw bark achieved constant BOD removals of 60-70% and COD removals of 35-40%. Composted bark produced much lower removal percentages. The small particle size of composted bark was the apparent reason for its poor performance. Composted bark absorbed more than 40% of heavy metal ions and raw bark removed nearly 13%. More than 75% of copper, cadmium and nickel was removed from the waste water by composted bark. Raw bark nitrogen concentrations increased from 0.28% to 0.9%. Trickling filters with raw bark media were judged to be potentially low cost means of pretreating waste water for land disposal. Further study should determine the optimum method for concurrent waste water pretreatment and conversion of solid wastes into useful compost. Maximizing the ion-exchange and adsorptive capacities of organic solid wastes by composting should also be investigated.

*Water reuse, *Waste disposal, Biochemical oxygen demand, Chemical oxygen demand, Heavy metals, Nitrogen, Ion exchange, Ultimate disposal, Phosphorus, Trickling filters, Waste water treatment

Composting

D406
INACTIVATION BY IONIZING RADIATION OF SALMONELLA ENTERITIDIS SEROTYPE MONTEVIDEO GROWN IN COMPOSTED SEWAGE SLUDGE,

Brandon, J. R., Burge, W. D., and Enkiri, N. K.

Sandia Laboratories,
Albuquerque, New Mexico.

Applied and Environmental Microbiology, Vol. 33, No. 4, p 1011-1012, April, 1977.
1 fig, 3 ref.

Ionizing radiation was evaluated as a polishing process to eliminate viruses, parasite ova, and pathogenic bacteria from composted sludge. Salmonella enteritidis ser. montevideo were inoculated into sterile composted sewage sludge to produce a count greater than 1,000,000,000/gram. A dosage rate of 15 krads/minute was used to irradiate the material to various levels. This material was then blended in physiological saline at a saline/sludge ratio of 4:1. The absorbed dosage needed per 90% reduction in population was found to be about 30 krads. The resistance of bacteria in the drier material, while expected to be greater, was about the same as that in liquid sludge treatments. This treatment should be very effective since a dose of 1 to 2 M rads would be used.

*Ionization, *Irradiation, *Pathogenic bacteria, Salmonella, Sludge treatment, Disinfection, Waste water treatment, Economics, Performance, Evaluation

Composted sludge

D407
CHARACTER AND DEWATERING PROPERTIES OF SLUDGES FROM WATER TREATMENT,

Novak, J. T.

AIChE Symposium Series, Vol. 73, No. 162, p 62-73, 1977. 15 fig, 3 tab, 13 ref.

Sludges from various Missouri treatment plants were analyzed to determine their character and dewatering properties. Two types of sludges were found to be dominant - coagulant sludges and softening sludges. Sludge characteristics would determine the best processes for improving dewaterability or reducing sludge volumes. The parameters used for sludge characterization were the rate of dewatering and the solids content of dewatered slurry. Dewaterability was determined by specific resistance measurements. Sludges containing substantial $CaCO_3$ filtered readily and those with no softening residues had greater resistances. Sludges from plants that combined softening and coagulation in a single basin filtered better than pure coagulant sludges. Increased magnesium content increased specific resistance slightly. Coagulant metal cation levels greatly influenced specific resistance. Dewatering was found to depend upon the coagulant metal ion used, the calcium/magnesium ration of the sludge, and the "purity" of the coagulant in the sludge. Increased magnesium levels decrease the capacity for obtaining high solids concentration levels. No pattern was found for sludge compressibility data. Four dewatering processes were evaluated. These included sand bed draining, centrifugation gravity thickening, lagooning, and vacuum filtering. A handleable sludge was produced by vacuum filtering, but the other methods dewatered sludges to a highly viscous sludge that could not be handled by conventional earth moving equipment. The study parameters were quite adequate for the prediction of process performance. A final choice of dewatering method should depend upon the sludge type, landfill location, available land, and equipment.

*Dewatering, *Coagulation, *Filtration, Metals, Ions, Physical properties, Magnesium, Calcium, Sludge treatment disposal, Equipment, Treatment facilities, Waste water treatment

Specific resistance

D408
PHOTODYNAMIC INACTIVATION OF INFECTIOUS AGENTS,

Hobbs, M. F., Gerba, C. P., Wallis, C., Melnick, J. L., and Lennon, J. S.

Environmental Engineering Laboratory,
FMC Corporation,
Santa Clara, California.

Journal of the Environmental Engineering Division-ASCE, Vol. 103, No. EE3, p 459-472, June, 1977. 9 fig, 3 tab, 13 ref.

Investigations were conducted to develop operating parameters and equipment for the disinfection of sewage effluents by continuous photodynamic inactivation. Tests were performed with clarified tap water and secondary sewage effluents which were inoculated with poliovirus. The parameters evaluated were a pH of 10 and methylene blue, a photoreactive dye. Technical grade methylene blue was added to produce a concentration of 1 to 5 mg/liter methylene blue. A plug flow cell and a flow-through cell operated in an upflow mode were used. Brief plug flow tests indicated effective photoinactivation in tap water at pH 10 with 5 mg/liter of methylene blue. Sewage effluent was treated with 2 mg/liter of methylene blue, at 22 C, with a 5 hour holding period. Results showed that treatment was effective, but the rate was about 50% of that achieved with clarified tap water. It was found that sewage effluents could be treated by high intensity lamps in direct contact with water to increase the inactivation rate. Inactivation rates were sensitive to heat and subsequent irradiation during sensitization. It was also proved that 1-2 mg/liter of dye was as effective as 5 mg/liter of dye. The increased rate and lower dye requirements could provide cost savings when considered as a unit process for waste water treatment. It was suggested that the process could easily be incorporated into physical-chemical treatment plants. It was also suggested for secondary treatment plants where tertiary treatment for nutrient and carbon removals was used. Water treatment plants using lime-softening would also benefit from this process. Chlorination and ozonation have lower capital costs. The facility's size would be about that of a tertiary plant for phosphorus and added carbon removal.

*Disinfection, *Irradiation, *Viruses, *Dyes, *Hydrogen ion concentration, Sewage effluents, Water purification, Equipment, Treatment facilities, Evaluation, Performance, Costs, Waste water treatment

Methylene blue

D409
METHOD FOR THE DETERMINATION OF THE CONDITIONABILITY OF SEWAGE SLUDGE (Erarbeitung von Methoden zur Ermittlung der Konditionierbarkeit von Klaerschlaemmen),

Leschber, R., and Niemitz, W.

Vom Wasser, Vol. 47, P 187-207, 1977. 9 fig, 3 tab, 10 ref.

A method for the determination of sludge amenability to conditioning processes was developed. The method was based on measurement of capillary suction time (CST) of sludge after the addition of water and two standard flocculants, $FeCl_3$ and Praestol 444K, in three dosages. Measurement was made after addition and specified periods of stirring in a standard device. Specific resistance to filtration of sludge samples treated is measured at reduced atmospheric pressure. Standard dosages for treatment were 10, 5, and 2.5% $FeCl_3$ and 0.5, 0.25, and 0.125% Praestol, as measured against the dry sludge residue. The resultant determinations are most useful in creating a more efficient sludge treatment process, especially for thickening and dewatering.

*Sludge treatment, *Analytical techniques, Particle size, Flocculation, Capillary action, Filtration, Physical properties, Chemical properties, Dewatering, Municipal wastes, Waste water treatment

D410
MIXER CUTS SOLIDS UP AND TIME DOWN FOR WASTE TREATMENT,

Process Engineering, p 79, March, 1977.

A mixer-disintegrator has been developed which could be applied to the improvement of effluent treatment. One application involved comminution. Industrial and domestic effluent debris, such as rags, rubber, and plastics, could be reduced to particles small enough to be pumped with the effluent. Such a mixer was used in a South African pumping station to reduce reeds growing in a channel from a nearby dam to the pumping station outlet. The same device was used in England to improve the homogeneity of a sampling station's samples. It was also applied in the aeration process for BOD reduction. Air introduced into a disintegrating head at a low level in the liquid is finely homogenized and dispersed through the container. This increases air surface area and, presumably, oxygen transfer. Contact time is also increased. The strong action of the head prevents clogging with activated sludge or other solids. Oxygen transfer levels of up to 30% are possible with this mechanism.

*Sewage effluents, *Mixing, *Aeration, Equipment, Industrial water, Domestic water, Solid wastes, Pumps, Pumping plants, Biochemical oxygen demand, Costs, Waste water treatment

D411
NEW WASTE WATER TREATMENT SYSTEMS,

Modern Power and Engineering, Vol. 71, No. 3, p 34-35, March, 1977.

New waste water treatment systems are being developed for effluent pollution reduction. A plant using high rate direct filtration is now operating in Ontario and serves a population of 100,000 with expansion provisions for 165,000. The plant cost was $15.8 million and expansion will add another $12.7 million. A river intake pipe provides a 40 mgd inflow which passes through a filtration and collection system at 5 gpm/square foot. Two systems, a mixed media and a dual media filter system, are used for comparison of plant operation and the development of information for future expansion. Six high-lift pumps with a 64 mgd capacity offset limited storage capacity. Elsewhere in Ontario, a 50 mgd filtration plant is being constructed with plant, reservoir and pumping station entirely underground. The cost of the $20 million project was raised by $1 million by the underground construction. Liquid chlorine will be used as disinfectant instead of chlorine gas. The system will utilize a 5,000 foot underground water intake pipe and sophisticated control devices. Future plans include remote operation of the plant from a filtration plant five miles away. A holding tank will allow treatment of backwash wastes and sludge will be discharged into sanitary sewers for treatment. Other innovative projects for industrial waste treatment and water recycling were surveyed.

*Treatment facilities, *Filters, Pumps, Chlorination, Sludge treatment, Municipal wastes, Industrial wastes, Costs, Design, Waste water treatment

D412
A NEW RAPID DIGESTION PROCESS FOR SEWAGE SLUDGE UTILIZATION (Ein neues Schnellrotte-Verfahren als Beitrag zur weitergehenden Klaerschlamm-Verwertung),

Widmer, P., and Konstandt, H. G.

Gas-Wasser-Abwasser, Vol. 57, No. 3, p 297-303, March, 1977. 5 fig, 5 ref.

A rapid sludge digestion process to prepare sludge for use in agricultural applications was described. Any such process should inactivate pathogenic and parasitic germs; preserve important plant nutrients, such as nitrogen and phosphorus; produce dry matter (less than 20% water) for storage purposes; and prevent unpleasant odors. The Fermentechnik/Roediger quick-rotting process fulfills these requirements. The nitrogen/carbon ratio of the product was evaluated and a flow sheet of individual process phases was provided. Cost estimates were given for a plant which would serve a population of 13,500 people.

*Sludge digestion, *Sludge disposal, *Fertilizers, Pathogens, Nutrients, Safety, Odor, Sludge treatment, Nitrogen, Carbon, Temperature, Waste water treatment

D413
STUDY OF THE DECOMPOSITION OF ORGANIC MATTER BY THE RESPIROMETRIC DILUTION METHOD (Untersuchungen ueber das Abbauverhalten organischer Stoffe mit Hilfe der respirometrischen Verduennungsmethode),

Wagner, R.

Vom Wasser, Vol. 47, p 241-265, 1977. 12 fig, 2 tab, 29 ref.

The decomposition of organic matter sewage was investigated with emphasis on biodegradation kinetics by the respirometric dilution method. This method used a nutritious matrix which contained great amounts of organic substances to compete as nutrients with the test substrate. A linear relationship was found between the reaction velocity constant logarithm and the time shift constant when adaptation by selection was not necessary. This indicated that biodegradation of individual compounds proceeded proportionately faster as degradation was delayed. A preferential sequence of chemical substances was found in the biodegradation of the nutrient matrix. Among tested substances, n-propanol was first and methanol was last in this sequence. Proper test substances would make possible quality checks for any nutrient matrix used in biodegradation studies.

*Biodegradation, *Kinetics, *Organic matter, Analytical techniques, Domestic wastes, Nutrients, Evaluation, Chemical properties, Sewage treatment, Waste water treatment

D414
PURIFICATION PLANT PROJECT,

Bainbridge, G.

ASEA Journal, Vol. 49, No. 6, p 141-142, 1976. 5 fig.

The largest and most modern Australian sewage treatment plant, serving the Melbourne area, recently became operational. Its design capacity is 291,000 cubic meters/day and a similar-capacity second stage will be needed in the early 1980s. A 32-kilometer gravity main trunk sewer, interceptor sewers, a purification plant, and a 56-kilometer outfall compose the treatment system. Activated sludge purification processes are used at the purification plant. Effluent is filtered for large objects by mechanically cleaned screens; pumped to other similar screens for textile and similar waste material removal; and subjected to grit removal, pre-aeration, sedimentation, aeration, digestion, biological treatment, and secondary sedimentation. Supply and distribution of electrical energy are handled by a power distribution plant and low-voltage switchgear. Eight unit substations are provided for power reticulation, including 415 V equipment and 6.6 kV/415 V dry type power transformers and associated isolating switches. The plant's equipment is of a standardized design, supplied in modular form for construction to minimize future modifications or extensions. All portions of the facility were constructed to strict specifications.

*Treatment facilities, Water purification, Filtration, Pumping plants, Separation, Sedimentation, Aeration, Biological treatment, Electrical equipment, Waste water treatment

Melbourne (Australia)

D415
ADVANCE SEWER PLANNING FOR RIO DE JANEIRO COASTLINE,

Ludwig, R. G., and Almeida, S. A. S.

ENCIBRA S. A.,
Rio de Janeiro, Brazil.

Water and Sewage Works, Vol. 124, No. 4, p 70-72, April, 1977. 3 fig, 3 tab, 4 ref.

Rapid development along the Rio de Janeiro coastline created a need for a comprehensive sewage treatment plan. The 15,000 hectare area has 20 kilometers of beach front on the Atlantic Ocean and a network of lagoons. Variations in tides, ocean currents, density structure, and coliform disappearance rates were studied to evaluate ocean disposal alternatives. Water and sediment quality, as well as profiles and seabed soundings, were evaluated to assist predesign and cost estimations. Seasonal variation of ocean currents was a major area of concern. Lagoon disposal was considered, but the difficulty of controlling eutrophication by nutrient removal and of maintaining a high degree of effluent quality made this alternative doubtful. Comparison showed that ocean disposal after treatment was more feasible. Two sewerage schemes were proposed: concentration of regional sewage at a single disposal point, and independent systems at the eastern and western poles of the area. The second was more economical in sewer costs, but the necessary treatment facilities would be more costly; collection and single-site disposal seemed most effective. Proper diffuser design and dilution values of 150 to 1 can produce waste concentrations less than those required for protection of the ocean environment. This and a diffuser with small ports for field submergence, aided by water currents, can produce diffusion of wastes along an extended ocean area. Interim treatment, collection, and trunk sewer systems were proposed for areas which are developing more rapidly.

*Planning, *Sewers, *Treatment facilities, *Outfalls, Design criteria, Economics, Analysis, Waste disposal, Sewage treatment, Waste water treatment

Rio de Janeiro (Brazil)

D416
RADIATION TREATMENT OF SEWAGE SLUDGE--EXPERIENCE WITH AN OPERATING PILOT PLANT,

Suess, A., and Lessel, T.

Radiation Physics and Chemistry, Vol. 9, No. 1-3, p 353-370, 1977. 5 fig, 11 tab, 9 ref.

A 2 1/2-year pilot study was conducted to evaluate sludge treatment by irradiation. The West German plant was constructed with the irradiation area underground to minimize costs. Regulatory equipment, control instruments, and a laboratory were housed above ground. System economics, pathogenic destruction, effects on sedimentation properties, and effects of treated sludge on plants were evaluated. Several advantages were noted. Operation at temperatures of 25-30 C reduced component corrosion. No breakdown of organic nitrogen was induced and sludge volume was not increased. Good dewatering properties could reduce flocculation chemicals and decantation facilities. Plant energy requirements could be reduced and nuclear fuel cycle wastes could possibly be used. The process prevented weed seed germination and could be used to destroy parasites in fresh sludge. The simple design required no additional service staff. The prime disadvantage was the steady decay of the Cobalt 60 employed. Irradiation was found useful only if sludge was to be treated during the entire year and the plant capacity was greater than 50 cu m/day. A treatment of 210 minutes at 300 krads reduced enterobacteria by 3-4 log units. Total bacterial count and enterococces were reduced by 2 log units. Different composition was evident in the irradiated sludge; plant germination accelerated slightly after application of irradiated sludge, and yields were the same or slightly lower than control studies. Pasteurized sludge, however, showed a nitrogen loss, a decline in plant germination, and lower yields. Soil type and water capacity influenced sludge effects. Studies indicated that nutrients and minor elements of sewage sludge may be used by plants, and mineral fertilizer may be replaced.

*Irradiation, *Pathogens, *Plant growth, Treatment facilities, Temperature, Physical properties, Chemical properties, Design, Fuels, Economics, Equipment, Nutrients, Waste water treatment, Sludge treatment

D417
WATERTIGHT CASE FOR POND LINERS,

Chemical Week, Vol. 120, No. 23, p 40, June, 1977.

A progress report was made on the usage of plastic linings in ponds, landfills, and reservoirs. About 110 million square feet was marketed in 1976. The amount could rise to nearly one billion square feet by 1980. Various manufacturers predict annual market growth rates of 15-20%. Groundwater protection regulations were one reason for the emphasis on liners. Stricter regulatory and monitoring requirements have forced a search for means to create leak-secure ponds. This has been especially true for landfill construction and the storage of hazardous materials. Reservoirs would also be covered to prevent vandalism, algal growth, evaporation, and contamination from airborne pollutants. Polyvinyl chloride and polyethylene liners have been the major alternative to traditional liner materials. New materials such as thermoplastics and elastomerics are becoming popular. Greater weatherability and resistance to a wider range of wastes outweigh cost considerations. They also provide simpler and more secure seam sealing methods. Cost comparisons were provided for the traditional and new plastic liner materials.

*Linings, *Plastics, Ponds, Landfills, Leachates, Water pollution control, Reservoirs, Construction materials, Costs, Waste storage, Phvsical properties, Waste disposal

D418
CHEMICAL TREATMENT OF SEWAGE,

Thakur, U. C., Dhabadgaonkar, S. M., and
Deshpande, W. M.

Military Engineering Services,
Chandigarh, India.

Indian Journal of Environmental Health, Vol. 19, No. 1, p 16-29, January, 1977.
10 fig, 1 tab, 14 ref.

A report was presented on the reduction of raw sewage COD by alum, ferric chloride, ferrous sulfate, and lime. Chemical treatment is an important part of advanced treatment systems used to produce highly purified effluents. COD was chosen as the parameter for measurement of pollution strength reduction because the test sewage contained industrial wastes and refractory compounds with non-biodegradable substances. Samples were analyzed for pH, temperature, and alkalinity and a portion was fixed with sulfuric acid to measure raw sewage COD. All coagulants were added in dosages of 0, 30, 60 and 90 mg/liter, except lime which was added to increase pH to 11.0. Results indicated an optimum alum dosage of 60 mg/liter for COD removals of 52-62%. Ferric chloride and ferrous sulfate optimum dosages were 30 mg/liter for COD removals of 60-70%. It was found that COD reductions for the coagulants above COD reductions without coagulation were 25-35% for 30 mg/liter of ferric chloride and ferrous sulfate. There was no significant COD removal above '0' dosage for alum up to 30 mg/liter; increasing dosages from 60-90 mg/liter produced no substantial benefits. Observations indicated that, at all dosages, there was an increase in percentage removal of COD with increased raw sewage COD up to 700-800 mg/liter. Lime at pH 11 caused a 78-88% COD reduction in raw sewage. The addition of alum to lime treatment increased COD reduction by 4-5% and improved effluent clarity. Without coagulants, raw sewage COD reductions varied from 35-55%. Alum was considered most suitable when sludge volume production was a major consideration. The ratio of sludge volume was highest when lime coagulation was used.

*Chemical treatment, *Water purification, Chemical oxygen demand, Sewage treatment, Coagulation, Analysis, Lime, Sludge, Treatment facilities, Waste water treatment

D419
WASTE WATER MICROBIOLOGY,

Taber, W. A.

Texas A&M University,
College Station, Texas,
Department of Biology.

Annual Review of Microbiology, Vol. 30, p 263-277, 1976. 238 ref.

Microbiological aspects of waste water composition and treatment are reviewed. Taxonomic classification of bacteria and yeasts present in waste water remains problematic. Little is known about the effect of environmental conditions and mixed nutrients on substrate utilization, or about possible interactions among microorganisms. Considerable advances have been made in the use of microorganisms for reducing BOD and nitrogen content of waters. Microbial waste water treatment mineralizes organic matter, lowering BOD; removes minerals by removing cells growing on wastes; and inactivates pathogenic bacteria, yeasts, and viruses. In activated sludge treatment, it is believed that the zoogloeal matrix or floc is produced by the bacterium Zoogloea ramigera Itz. There is also the possibility that the taxon does not exist or that the floc is produced by conventional bacteria. A zoogloeal mass is desired since it settles out and allows discharge of clarified supernatant with lowered BOD. Conventional bacteria are undesirable because they deter settling. High concentrations of flagellates reflect overloading of the system. Yeasts and molds are present, but play a minimal role in BOD reduction; however, fungi play a major role in the trickling filter. In addition, bacteria and algae are abundant in the trickling filter treatment. Algal growth in aerobic lagoons favors BOD removal during the day due to oxygen production, but inhibits BOD removal at night due to oxygen consumption. In anaerobic treatment systems, methane is produced from microbial activity and algae and photosynthetic bacteria are often present. The protozoa present are not useful in reducing BOD. Fungi and yeasts which may metabolize certain substrates are also in evidence.

*Microbiology, *Microorganisms, *Yeasts, *Waste water treatment, Industrial wastes, Bacteria, Biochemical oxygen demand, Temperature, Nutrients, Nitrogen, Methane, Gases, Biological treatment, Chemical wastes, Pulp wastes, Algae, Anaerobic conditions, Aerobic treatment, Tertiary treatment, Treatment facilities, Water purification

D420
NITROGEN FIXATION (ACETYLENE REDUCTION) IN A SALT MARSH AMENDED WITH SEWAGE SLUDGE AND ORGANIC CARBON AND NITROGEN COMPOUNDS,

Hanson, R. B.

Skidaway Institute of Oceanography,
Savannah, Georgia.

Applied and Environmental Microbiology, Vol. 33, No. 4, p 846-852, April, 1977.
2 fig, 5 tab, 36 ref.

Results of a 12-month study on nitrogen fixation in a sewage sludge-amended Spartina alterniflora salt marsh were reported. Four 100-meter plots were used, two of these treated with sludge to the equivalent of 4 grams of nitrogen per square meter. The effects of nutrient amendment were also studied on similar plots, divided into 10 treatment areas. Half of these areas were clipped of S. alterniflora and enclosed in lawn edging to prevent lateral root movement. Clipped and unclipped plots were injected with glucose, ammonium nitrate, a combination of the two, rhodamine WD, and distilled water as a control. The acetylene reduction method was used to measure nitrogen fixation. No significant difference was found between the sludge-amended plots and the controls. Apparently sludge enhanced rhizosphere nitrogen fixation in the soil through stimulation of Spartina production. Other processes, however, such as denitrification, may be inhibited by sludge treatment. In the clipped and unclipped plots, nitrogen fixation was significantly lower in the clipped plots due to the lack of carbon input via the roots. Nitrogen fixation in the ammonium nitrate-enriched unclipped plot was increased, indicating that increased Spartina production from nitrogen addition outweighed the inhibitory effect of inorganic nitrogen on nitrogen fixation. Glucose addition inhibited nitrogen fixation in the soil, perhaps due to its stimulation of microbial activity.

*Nitrogen fixation, *Salt marshes, *Marsh plants, Metabolism, Nutrients, Organic carbon, Nitrogen compounds, Algae, Sludge disposal, Waste water treatment

Spartina alterniflora, Glucose, Ammonium nitrate

D421
EXPERIENCES WITH THE ORGANIC CARBON ANALYZER (TOC) BY MERZ FOR ROUTINE MONITORING AT THE BASF PURIFICATION PLANT
(Erfahrungen mit dem TOC-Schnellbestimmer nach Merz in der Routineueberwachung der BASF),

Buechs, L., and Merz, W.

Vom Wasser, Vol. 47, p 267-274, 1977. 3 fig, 3 tab, 3 ref.

The analysis of treatment plant effluent and river water by the use of Merz's rapid TOC analyzer was discussed. TOC (total organic carbon) as a measure of the concentration of organic substances is more effective in monitoring received water than COD, which only measures chemical oxidizability. Methods were compared for measuring both TOC and COD in potable water, river water, non-contaminated cooling water, and effluents with various levels of contamination. Rapid TOC analysis was more accurate and less prone to interference than COD methods. The TOC method can be completely automated.

*Pollutant identification, *Organic carbon, Analytical techniques, Monitoring, Effluents, Chemical oxygen demand, Water pollution control, Automation, Water purification, Cooling water, Organic matter, Waste water treatment

D422
EFFLUENT TREATMENT VERSUS DISPOSAL THROUGH LONG SEA OUTFALLS,

Staples, K. D.

J.D. and D.M. Watson,
High Wycombe, England.

Chemistry and Industry, No. 9, p 333-335, May, 1977.

Considerations in choosing sewage disposal by long sea outfalls or additional effluent treatment in coastal areas were presented. Environmental and economic concerns were discussed. Policies which attempted to accomplish zero discharge were found very expensive and of doubtful necessity. Limited treatment and longer outfalls were proposed for some areas. Several limitations on marine disposal were listed. Wastes with buoyant, identifiable solids usually require treatment by screening to avoid possible accumulation on shorelines. Heavier solids should be removed when a long outfall is used in areas with high flow variations, to avoid pipeline siltation. Effluents with high oxygen demand, high or low pH, and degradable toxic compounds should only be discharged in long outfalls where high initial dilution is possible. Long outfall engineering involves a high initial cost and low operating costs when compared with land treatment plants. The outfall length would vary with effluent strength and character. Definitive cost evaluation must be made on the basis of individual situations. Cost factors may promote in-house industrial waste treatment with discharge to public sewer facilities for small waste quantities. Outfalls were considered most feasible when large waste quantities were disposed, or when wastes were easily degraded or oxidized at sea. They were also found viable when the waste source was reasonably close to the coast.

*Outfalls, *Water policy, *Planning, Treatment facilities, Sewage effluents, Oxygen demand, Solid wastes, Engineering, Hydrogen ion concentration, Costs, Physical properties, Chemical properties, Waste water treatment, Waste disposal

D423
FERMENTATION TECHNOLOGY,

Humphrey, A. E.

Chemical Engineering Progress, Vol. 73, No. 5, p 85-91, May, 1977. 15 fig, 18 ref.

The incorporation of fermentation into waste water treatment processes was considered among several applications of fermentation technology. These processes have been found to be important in the activated sludge treatment. Research during the development of the UNOX system showed that BOD could be controlled by the food/biomass ratio. It was noted that a sludge with much better settling characteristics could be produced. Waste water denitrification could be achieved with a one-pass system rather than the usual two-step system. Placing the anaerobic stage first, followed by an aerobic treatment, produced a high internal recycle system that required no carbonaceous energy source. Influent BOD drove the reaction and the process had a lower oxygen demand than a conventional activated sludge system. A system which involved the removal of phosphate in a polymeric form such as polymetaphosphate was recently investigated. It was shown that this form could perform as a phosphagen analogous to the energy transfer compound, creatine phosphate. The perfection of this system could avoid the banning of phosphate detergents. The production of methane gas was investigated as an energy source. Fermentation as a means of generating food and feed from raw material sources was also studied.

*Fermentation, *Waste treatment, Sludge treatment, Activated sludge, Sedimentation, Physical properties, Anaerobic conditions, Biomass, Biochemical oxygen demand, Denitrification, Phosphates, Waste water treatment, Gases, Foods, Energy

D424
IDENTIFICATION OF THE VIRUCIDAL AGENT IN WASTE WATER SLUDGE,

Ward, R. L., and Ashley, C. S.

Sandia Laboratories,
Albuquerque, New Mexico.

Applied and Environmental Microbiology, Vol. 33, No. 4, p 860-864, April, 1977.
3 fig, 3 tab, 4 ref.

Experiments were conducted to determine the identity of a viricidal agent in sludge. Raw and anaerobically digested sludge samples were mixed with a 10-fold dilution of virus and incubated. Sodium dodecyl sulfate was added to break up viral aggregates. General properties of the agent were determined. It was found to be small and heat stable. Attempts at isolation by distilling digested sludge recovered more than 95% of viricidal activity in the first 15% of the distillate. A fraction of the first 10% of the distillate was treated with activated charcoal since the agent was thought to be a small, volatile, organic compound. Ammonia was recovered from this process and tested, as ammonium chloride, to determine its viricidal activity. The results proved that ammonia was the source of poliovirus inactivation. Viricidal activity was evidenced by ammonia only at a pH greater than 8, and increased with increasing pH values. Viricidal activity in raw sludge was similarly pH-dependent. These results applied to poliovirus type 1 strain CHAT. Further tests showed that ammonia was an effective viricide for the picornavirus group, but that reovirus was insensitive to ammonia under these conditions. It was suggested that raising the pH of sludge would be effective in inactivating sludge viruses.

*Viricides, *Viruses, *Ammonia, Sludge treatment, Hydrogen ion concentration, Anaerobic digestion, Organic compounds, Chemical analysis, Waste water treatment

D425
LACEY, OLYMPIA, TUMWATER, AND THURSTON COUNTY WASTE WATER TREATMENT,

Consulting Engineer, Vol. 48, No. 5, p 79, May, 1977.

A study was conducted to develop cost effective waste water collection, treatment, and disposal processes for a complex treatment facility in Olympia, Washington. The objective was to upgrade receiving water to a state fit for water recreation and shellfish harvesting. The study had to provide a treatment program for a combined population of 50,000 and a brewery which produced major organic discharges. Water quality analysis, planning criteria development, environmental evaluation, treatment and disposal alternatives, and institutional and financial considerations were involved. The poor quality of the receiving waters was due to primary treatment, insufficient system capacity, and high inflow/infiltration in the collection system. This resulted in frequent and substantial overflows of untreated storm water and raw sewage mixtures into the inlet. Final recommendation was for a unified, upgraded, and enlarged treatment facility at the present primary treatment plant. This facility, with an improved and repaired collection system, would be sufficient. Equalization basins would store peak storm flow from all sources. Pure oxygen and ozone would be used to decompose organics and destroy bacteria and viruses. This plan would reduce treatment scale and plant site size, while eliminating the costs and problems of chlorine usage.

*Treatment facilities, *Sewers, Water purification, Infiltration, Organic matter, Water quality control, Storm water, Costs, Flow, Planning, Water resources development, Waste water treatment

D426
MICROFLOTATION IN EFFLUENT PURIFICATION (Mikroflotation in der Abwasseraufbereitung),

Dobias, B.

Vom Wasser, Vol. 47, p 210-217, 1977. 4 fig, 1 tab, 20 ref.

The theory and technology of microflotation in waste water treatment were reviewed. The foam separation method was found to remove finely dispersed particles from water or aqueous solutions. A summary of Stockholm's utilization of the flotation cell for waste water treatment was presented.

*Flotation, *Water purification, Separation techniques, Suspended solids, Particle size, Treatment facilities, Urban areas, Municipal wastes, Waste water treatment

Stockholm (Sweden)

D427
THE HANDLING OF NITROGENOUS WASTES IN RURAL INDIA,

Rao, T. S.

Andhra University, Waltair, India, Department of
Environmental Engineering.

Ambio, Vol. 6, No. 2-3, p 134-136, 1977. 1 fig, 1 tab, 13 ref.

The disposal of nitrogenous wastes in rural India was discussed. Human, agricultural, and animal wastes can be recycled so that their nitrogenous contents may be applied for useful purposes. Domestic human waste disposal systems were proposed depending upon depth of ground water tables. High groundwater areas allow the use of flushing toilets and public latrines. Wastes can be transported to oxidation lagoons via sewers and lined, open surface drains. Stabilized effluent may be discharged to waterways, used to recharge groundwater, or to fertilize crops. Treated effluent may also be pumped to a reservoir to provide nutrients for algal growth and increased fish production. Areas with low water tables could utilize less expensive disposal alternatives such as bore-hole latrines with or without water seal, pit-latrines, or leaching cesspools with earthen rings or bamboo-matting for lining. Aqua privies with reverse filters, septic tanks with soakage pits, or dispersion trenches could be used in hard and rocky areas with low water tables. The latter could be used in community bio-gas plants to produce methane gas for cooking and lighting. The sludge from this method has a high nitrogen content and could be used for composting. In sandy soils, latrines and cesspools must be well above the water table to avoid contamination. Drainage well above flood level was suggested. Costs for treatment plants were estimated to be about five times greater than that of oxidation ponds.

*Nitrogen compounds, *Oxidation lagoons, *Water tables, Waste disposal, Sewers, Drainage, Nutrients, Fertilizers, Methane, Gases, Soil types, Waste water treatment, Rural areas

India

D428
CONCEPT, RESEARCH, APPROVAL...AN EFFLUENT IRRIGATION PROJECT,

Consulting Engineer, Vol. 48, No. 5, p 77, May, 1977.

A marshland irrigation system was proposed for the disposal of treatment plant effluents in Michigan. Two possible advantages were seen: an estimated cost savings of $700,000 over the use of a conventional irrigation system, and improved food supply and wildlife proliferation in the marsh area. Because of the lack of data on wetlands irrigation in Michigan, a test program was conducted before project approval. The test area was evaluated through plant, soil, and insect samples and through water quality tests. The organic deposits proved excellent in nutrient removal without overloading, and no adverse effects were detected in the test program. The application of 12.5 million gallons of waste water during 1975 and 1976 continued to produce favorable results without adverse effects. The marsh ecosystem was not damaged, and plants grew larger and greener. The irrigation project was accepted as financially and environmentally feasible.

*Marshes, *Irrigation, Food chains, Wildlife management, Planning, Waste disposal, Organic matter, Nutrients, Treatment facilities, Costs, Waste water treatment

D429
TREATMENT OF EFFLUENTS: MODERN METHODS OF SEWAGE DISPOSAL,

Howell, J. A.

Swansea University, Wales, Department of Chemical
Engineering.

Oceans, No. 3, p 63-67, May, 1977.

Various treatments of sewage effluents and disposal methods were described. Major emphasis was placed on disposal involving the oceans. It was noted that the use of outfalls for raw sewage disposal was based on the assumption that there was no danger of bacteriological contamination of beaches. Most recent considerations of the matter suggest that outfalls can be used for partially treated sewage which contains no visible identifiable floating material or toxic compounds. The outfall should extend at least a kilometer beyond the low water level, far enough to avoid shoreline contamination. Ocean disposal of sludge was also considered as a major problem. Biological and physicochemical treatment processes were described. The activated sludge, UNOX, and ICI deep-shaft processes were valued for their production of low sludge volumes which could be disposed by such methods as incineration. Physicochemical treatment was suggested for three types of pollutants: heavy metals, exotic new chemicals, and bulk industrial effluents. Other treatment processes included settling, sand filtration, coagulation, and flocculation of colloids by polymers or aluminum hydroxide. These processes can be followed by disposal through chemical decomposition, incineration, or wet air oxidation.

*Water pollution control, *Waste disposal, *Outfalls, *Industrial wastes, *Municipal wastes, *Heavy metals, *Chemicals, Toxicity, Sludge disposal, Incineration, Biological treatment, Activated sludge, Chemical treatment, Flocculation, Waste water treatment

UNOX, Wet air oxidation, Ocean dumping

D430
PHYSICAL CHEMICAL TREATMENT PLANT DESIGN,

Culp, G. L.

CH2M-Hill,
Reston, Virginia.

1972. 33 p, 7 fig, 3 tab, 1 ref. NTIS Technical Report PB-256 957.

Techniques for determining the efficiency of physical-chemical treatment processes for waste water, and the parameters of treatment plant design, were discussed. All processes utilize coagulation and sedimentation for the removal of suspended solids, and of phosphorus in some instances. Some processes also use filtration for such removal. Soluble organics are removed in all processes by the use of activated carbon. Pilot studies should be done when possible to aid in determining design parameters. Laboratory studies on representative water samples can generate suitable data. Tests were presented to aid in the selection of coagulants--polymers, lime, iron salts, or aluminum salts. Design criteria considered include: flow; chemical feed, rapid mix, and flocculation; charifer sizing; recarbonation; filtration; granular carbon adsorption; and carbon regeneration. Other considerations include sludge dewaterability, disposal costs, and quantities.

*Design criteria, *Efficiencies, *Treatment facilities, Chemical treatment, Physical properties, Coagulation, Filtration, Sedimentation, Dewatering, Flocculation, Flows, Adsorption, Carbon, Phosphorus, Suspended solids, Sludge treatment, Waste disposal, Economics, Evaluation, Organic matter, Separation techniques, Water purification, Waste water treatment

D431
COST-EFFECTIVE COMPARISON OF LAND APPLICATION AND ADVANCED WASTE WATER TREATMENT,

Pound, C. E., Crites, R. W., and Smith, R. G.

USEPA Waterside Mall,
Office of Water Program Operations MCD (WH-547),
Washington, D. C.

1975. 25 p, 4 fig, 13 tab, 4 ref. NTIS Technical Report PB-257 448.

A report was presented on the cost-effective comparison of land application and advanced waste water treatment (AWT) systems. Important factors for comparison included: pretreatment, conveyance, storage, application, and local land assessment. The sensitivity of land application systems to design criteria variations was illustrated with cost curves. Several general conclusions were drawn from these curves. Land application systems presented less economy of scale than AWT systems. At low flow capacities land application systems could remain economically competitive, even with higher land costs, but were more sensitive to conveyance distance costs. Site conditions could create cost variations of 300+% for irrigation, overland flow, and infiltration-percolation systems. Irrigation cost variations were more extreme due to a greater number of cost component variables. The federal share is a higher percentage of total costs for land application systems than for AWT systems since for land application systems capital costs (75% federal) are higher and operating and maintenance costs (100% local) are lower. The data provided was for general comparisons of the two systems, and should not be used to determine costs of specific alternatives in the planning process.

*Design criteria, *Cost comparisons, *Tertiary treatment, *Irrigation, *Infiltration, *Percolation, *Flow, Economies of scale, Variable costs, Cost analysis, Water conveyance, Land appraisals, Sites, Storage, Overland flow, Water water treatment

Land application systems, Advanced waste water treatment

D432
ENVIRONMENTAL IMPACTS OF ADVANCED WASTE WATER TREATMENT AT ELY, MINNESOTA,

Kibby, H., and Hernandez, D. J.

Corvallis Environmental Research Laboratory,
Environmental Protection Agency,
Corvallis, Oregon.

1976. 30 p, 1 fig, 17 tab, 19 ref. Technical Report EPA-600/3-76-092.

Resource utilization and pollutant generation were assessed at an AWT facility in Ely, Minnesota. The plant used a conventional secondary treatment system followed by tertiary treatment. The latter treatment consisted of two solids-contact clarifiers, a flow-splitter box, and dual media filtration for phosphorus removal. Backwash water was returned to the secondary plant influent line. Filter effluent was either chlorinated and discharged, or recycled as process water. Annual direct use sources were: lime (538 tons), CO_2 (168 tons), chlorine (5.2 tons), electricity (780,000 kwh), fuel oil (63,000 gallons), $FeCl_3$ (44 tons), sulfuric acid (82 tons), and polymers (670 pounds). Data was also provided on the production of these resources. Resultant pollutants were grouped as discharges to air, land, or water. The collected data indicated resources needed and pollutants to be expected at any similar facility.

*Tertiary treatment, *Resources, *Pollutants, Pollutant identification, Water pollution, Air pollution, Soil contamination, Chemicals, Lime, Chlorine, Electricity, Fuels, Polymers, Chemical analysis, Waste water treatment

Resource utilization, Pollutant generation

D433
CLEANSING THE RIVER TYNE,

Norgrove, W. B.

Northumbrian Water Authority, Bosforth,
Newcastle-upon-Tyne, England.

Chemistry and Industry, No. 9, p 344-348, May, 1977. 3 fig, 1 tab, 4 ref.

Efforts to reverse the effects of pollution in the River Tyne, England, were reviewed. The river has received wastes from the coal and iron industries since the 19th century. Its self-purification and re-oxygenation capacities have been negated. Crude sewage from 88% of the population is directly discharged to the river; sewage from 7% is discharged through outfalls; 5% receives some treatment. Sea water and fresh water in the river produce an upstream bottom flow which traps much of the organic solids pollution. A long sea outfall was determined to be economically unfeasible. A two-site treatment system with interceptor sewers was chosen. Liquid crude sludge will be disposed at sea by tankers. New interceptor sewers are being constructed and designed to accommodate a population of 1.3 million and associated industrial influents. A vortex type overflow will be used, in areas where steep gradients and super critical flow velocities exist, to separate the initial combined flow. A progress report on construction, which began in 1973, was provided. The projected cost for this effort was expected to be about 142 million pounds.

*Water pollution control, *Rivers, Sewage disposal, Treatment facilities, Sludge, Overflow, Design criteria, Sewers, Waste water treatment, Planning

Tyne River (England)

D434
PRELIMINARY INVESTIGATIONS IN WATER TREATMENT WITH HIGH ENERGY ELECTRON BEAMS,

Gallien, C., Icre, P., Levaillant, C., and Montiel, A.

Radiation Physics and Chemistry, Vol. 9, No. 4-6, p 775-787, 1977. 2 fig, 5 tab, 17 ref.

An investigation of high energy electron beam waste water treatment was presented. Three aspects of this treatment were considered. The effects of treated water on biological processes were tested. Studies were conducted to determine chemical changes in the treated water. The question of adequate pathogen reduction, as well as optimum doses for this purpose, was investigated. An industrial irradiator was used which uniformly scanned a width of 400 millimeters with a maximum energy of 6 MeV and passage speeds of 0.12-12 meters/mn. Radiation was adjustable from 100 krads to 5 Mrads. Biological tests were conducted on embryonic development of the amphibian Pleurodeles waltlii (Michahelles). No perturbations in embryo development resulted from water treated with doses of 100 krads to 2 Mrads. There were no caryotvpe aberrations or mutagenic effects noted in the embryos grown in treated water samples. A "tanning" effect on the egg chorion may have resulted from chemical modification. Chemical analysis revealed no significant pH changes and minor chemical changes such as an increase in the nitrite ion concentration. Bacterial studies were conducted with E. coli, K. pneumoniae, and S. faecalis. The doses used were 200 krads and 1 Mrad. A dose of 200 krads completely destroyed the enterobacteria and produced a 99.93% reduction of S. faecalis. Data suggested that dose selection was only dependent upon the sterilization threshold objectives for a particular application and upon economic considerations. Irradiation was judged more satisfactory, from a biological standpoint, than chemical treatment.

*Irradiation, *Chemical reactions, *Genetics, *Radioactivity effects, Pathogenic bacteria, Coliforms, Streptococcus, Amphibians, Hydrogen ion concentration, Nitrites, Chemical analysis, Waste water treatment, Ionization

P. waltlii, K. pneumoniae

D435
SLUDGE PASTEURIZATION BY HEAT AND IONIZING RADIATION. RESULTS OF A STUDY FOR THE EFFLUENTS PURIFICATION PLANT, BERN-NEUBRUECK (Schlammhygienisierung durch Waerme und ionisierend Strahlen: Ergebnisse einer Verfahrensstudie fuer die ARA Bern-Neubrueck),

Huber, J., and Meyer, M.

Gas-Wasser-Abwasser, Vol. 57, No. 5, p 385-394, 1977. 8 fig, 1 tab, 22 ref.

The Bern-Neubrueck waste water treatment plant was designed to provide sludge for agricultural applications. Three sterilization processes were evaluated for a flow of 313 cu m/day. One option was pasteurization at 70 C for 30 minutes. Another was radiation with high energy electrons with an energy of 1 MeV at a dose of 300-400 krad. The third alternative was gamma irradiation with cobalt-60, using the batch process, at 300-400 krad. Data were presented on filtration and sedimentation characteristics of the treated sludge. Gamma irradiation was eliminated on the basis of economics. Since pasteurization and electron irradiation had approximately the same costs, a final decision should be based on other parameters. Electron irradiation might be more suitable for the Bern area because irradiated sludge is less odoriforous than pasteurized sludge.

*Irradiation, Gamma rays, Filtration, Sedimentation, Physical properties, Economics, Sludge treatment, Evaluation, Costs, Waste water treatment

Pasteurization, Electron irradiation

D436
ALUM SLUDGE DISPOSAL PROBLEMS AND SUCCESS,

Nielsen, H. L.

East Bay Municipal Utility District,
Oakland, California.

American Water Works Association Journal, Vol. 69, No. 6, p 335-341, June, 1977.
1 fig, 6 tab.

Government regulations on the discharge of pollutants were the basis of the investigation of alum disposal at two California treatment plants. One plant discharged effluents into a creek which had negligible natural flow during the summer. Creek waters were discolored and a fan-shaped area of turbid water extended into the San Francisco Bay. A minimum year-round flow was needed to eliminate odor problems caused by stagnant waters. Three options were considered after the plant was ordered to meet creek-discharge standards. One was ponding sludges on site with sludge thickening, air evaporation, and offhaul of dried sludge. The second involved ponding, thickening and pumping to watershed lands for final ponding, and air-drying. Maximum sludge dewatering and truck offhaul was the last alternative. The latter was the most economical solution. The process consisted of wash-water-settling basins, sludge clarifiers, a reclaim pumping plant to recycle reclaimed water to raw water line, and a dewatering chamber with scroll centrifuges. Clarifier overflow discharged to the creek provided the flow needed to reduce odor problems. The second plant's discharge effects were similar, but less severe. A reclamation facility was constructed to include wash-water-settling basins, a reclaimed water and sludge transfer pumping plant, and a continuous belt-type dewatering unit. Supernatant was recycled to the raw water system after pressure filtration. Sludge, with polymer added, was passed to the dewatering unit. The process produced minimal turbidity in the filter-plant raw water. A sludge with the necessary solids content for continuous dewatering was produced.

*Treatment facilities, *Sludge treatment, *Water pollution control, Water purification, Dewatering, Waste disposal, Polymers, Turbidity, Color, Odor, Performance, Equipment, Waste water treatment

Alum sludges

D437
REMOVAL OF ORGANIC RESIDUAL MATTER FROM EFFLUENTS WITH THE AID OF MACROPOROUS ADSORPTION RESINS (Entfernung von organischen Reststoffen aus Abwaessern mit Hilfe von Makroporoesen Adsorberharzen),

Rueffer, H., and Schilling, J.

Vom Wasser, Vol. 47, p 155-177, 1977. 19 fig, 7 tab, 27 ref.

Pilot and laboratory studies were performed to investigate the use of macroporous ion exchange resins for the removal of organic compounds from domestic and industrial sewage. Organic matter reductions up to 90% were evident after a 30-60 minute contact period. Large surface concentrations were found through equilibrium adsorption tests, especially with high concentrations of industrial waste water. Freundlich isotherms indicated an increased adsorption capacity when waste water concentrations were increased. Further study of the regeneration process was suggested.

*Organic compounds, *Adsorption, *Ion exchange, *Resins, Industrial wastes, Domestic wastes, Equations, Separation techniques, Sewage effluents, Waste water treatment

D438
BIOLOGICAL REGENERATION OF POWDERED ACTIVATED CARBON ADDED TO ACTIVATED SLUDGE UNITS,

DeWalle, F. B., and Chian, E. S. K.

Illinois University,
Urbana,
Department of Civil Engineering.

Water Research, Vol. 11, No. 5, p 439-446, 1977. 9 fig, 2 tab, 33 ref.

A study was conducted to investigate the effect of powdered activated carbon (PAC) on adsorption and biological regeneration in activated sludge units. PAC equilibrium concentrations of 0, 15, 300, and 1,000 mg/liter were introduced into plug-flow activated sludge units with sludge ages of 3, 5, 10, and 15 days. Average COD removals were found to be independent of sludge age. A mathematical model was developed for the prediction of organic matter concentration reductions resulting from PAC addition. The Freundlich equation was used to describe the adsorptive behavior. The daily regenerated capacity as affected by the ratio of biological solids to activated carbon was also included. An apparent increase of maximum adsorptive capacity was observed with increased cell residence time in the units. The removal of slowly degradable organics could be caused by biological processes. This would free or regenerate some adsorption sites and increase PAC apparent adsorptive capacity. An important parameter could be the relationship of activated sludge concentrations to activated carbon concentrations. It was noted that a higher relative magnitude of biomass produced easier PAC regeneration. It was concluded that the relative ratio of biological solids to carbon solids would determine the magnitude of daily regeneration. Daily regeneration increased approximately with the square root of the influent concentration. Further research was begun to confirm the model.

*Activated carbon, *Activated sludge, *Model studies, Separation techniques, Organic matter, Bacteria, Adsorption, Biological treatment, Physical properties, Equations, Chemical oxygen demand, Sludge treatment, Waste water treatment

Powdered activated carbon (PAC), Freundlich equation

D439
SELECTED ORGANIC PESTICIDES OCCURRENCE, TRANSFORMATION AND REMOVAL FROM DALLAS DOMESTIC WASTEWATER,

Saleh, F. Y.

Dissertation Abstracts International B, Vol. 37, No. 11, p 5590-5591, May, 1977.

A pilot study was conducted of the occurrence, transformation, and removal of chlorinated organic pesticides from waste water in Dallas, Texas. The plant studied contained completely mixed activated sludge units, chemical treatment, mixed-media filters, and activated carbon beds. Activated sludge units were operated in a nitrifying mode. Alum-lime and lime-ferric chloride mixtures were used as coagulants. The first study phase developed a characteristic profile of organic residues in feed and effluent from each process and traced the effects of each unit on the profile. Identification and quantification of major components, detected in the residue profiles, composed the second phase. The two-year study revealed a limited number of peaks with a relative retention time of 0.36 to 4.2. Major peaks were less than 1.3. These peaks were identified as aldrin; dieldrin; op'DDT and its analogs; pp'DDT and its analogs; 2,4-D alkyl esters; and inorganic salts of 2,4-D. Activated sludge biological treatment removed insignificant amounts of chlorinated organic pesticides. Transformation of one compound to another was characteristic of this process. Alum-lime and lime-ferric chloride treatment slightly reduced detected organic residues. Only DDT compounds were removed by chemical coagulation. Variable reductions were found for aldrin, dieldrin, and 2,4-D alkyl esters. Multimedia filters evidenced no effectiveness in the removal of organic residues from activated sludge effluents or solids contact effluents. Activated carbon columns were found best for removing chlorinated organic pesticides from chemically treated and filtered waste water. After a year, breakthrough of some compounds was observed in the activated carbon tests.

*Chlorinated hydrocarbon pesticides, *Pesticide residues, *Pesticide removal, *Pollutant identification, *Water purification, Chemical analysis, Biological treatment, Chemical reactions, Coagulation, Filtration, Activated sludge, Activated carbon, Municipal wastes, Domestic wastes, Waste water treatment

Dallas (TX)

D440
PHOSPHATE REMOVAL STUDIES AT BARRIE WATER POLLUTION CONTROL CENTRE,

Seldon, J.

Water and Pollution Control, Vol. 115, No. 5, p 30-32, May, 1977. 4 fig, 2 tab.

A study of phosphate removal was conducted at Barrie Water Pollution Control Centre, Ontario, Canada. Required removal was 80% of the total incoming phosphate, but the plant's goal was an environmentally more beneficial level of less than 1 mg/liter final effluent phosphate. The plant was adding approximately 115 mg/liter of aluminum sulfate at the discharge of the aeration tanks at the beginning of the study. The dosage was reduced to approximately 50 mg/liter over a 12-month period. Final effluent phosphate levels were found to increase in direct proportion to the decrease in aluminum sulfate dosage. It was found that under normal conditions, the addition of 55 mg/liter of aluminum sulfate consistently produced a total phosphate level of less than 1 mg/liter in the final effluent. This dosage appeared to be the minimum for acceptable phosphate removal. Reducing the dosage from 115 to 55 mg/liter resulted in a $40,000 annual saving in chemical costs.

*Phosphates, *Chemical treatment, *Sulfates, Separation techniques, Treatment facilities, Effluents, Waste water treatment, Costs

Aluminum sulfate, Barrie Water Pollution Control Center (Ontario, Canada)

D441
BRAZIL--A MARKET FOR BRITISH EFFLUENT AND WATER TREATMENT PLANT MANUFACTURERS,

Bradley, R. M.

Effluent and Water Treatment Journal, Vol. 17, No. 4, p 169-174, April, 1977. 2 fig, 3 tab, 9 ref.

The water treatment problem in Brazil is discussed. Brazil is one of the largest, fastest-developing, and resource-richest nations in the world. Rapid population growth, heavy industrialization, and urbanization have caused increased water pollution problems. Sanitation facilities have not kept pace with population, and industrial treatment facilities are inadequate. Even sewage which is collected is often disposed of in its raw state. Recently steps have been taken to balance industrial needs against health and environmental concerns. Through the 1971 National Sanitation Plan (PLANASA), instituted to finance public health engineering works, piped water connections have increased 38%. Simple treatments such as stabilization lagoons and long sea outfalls are stressed. Efforts to spur the economy have resulted in restrictions which favor the development of local water treatment manufacturing plants.

*Water pollution, *Regional development, *Sewage treatment, Sewers, Industrial wastes, Waste water treatment, Cities, Public health, Regional economics, Oxidation lagoons, Outfall sewers, Sanitary engineering, Municipal wastes

National Sanitation Plan (Brazil)

D442
STERILIZATION OF PURIFICATION PLANT SLUDGE BY MEANS OF ELECTRON RADIATION (Hygienisierung von Klaerschlamm durch Elektronenbestrahlung),

Tofaute, K.

Brown Boveri Mitteilungen, Vol. 64, No. 3, p 164-170, 1977. 11 ref.

A process for the electron radiation sterilization of purification plant sludge, with subsequent use as agricultural fertilizer, is described. It was found that a minimum dose of 300 krad was adequate to rid the sludge of microorganisms. The size of the electron accelerator, with indicators: accelerator voltage in kV or mV, beam current in mA, and beam efficiency as the product of the former and the latter in kW, depended on various operational parameters. Accelerator voltage (kV or mV) determined measurement for depth of beam penetration in mm and therefore magnitude for the thickness of the sludge layer to be formed. Beam efficiency (kW) was converted into energy dose performance (mrad x kg/hr) as magnitude for quantity of processed sludge at a certain dose involving beam efficiency utilization. Energy dose performance in mrad x kg/hr could be calculated from the beam efficiency based on the formula: 1 kW 360 mrad x kg/hr. The power dose performance transmitted to the purified sludge was determined by the beam efficiency level for the latter, set at 35-45%. The operation was subdivided into pre-treatment, radiation, storage, and discharge of sludge. Radiation screening for a 750 kV accelerator was considered sufficient when walls and ceiling were constructed of standard concrete, 1.10 m in thickness. No radiation protection for personnel was required. Depending on size of installation, treated sludge cost 1.0-1.5 Swiss Francs/cu m including power, which ranged from 0.4-0.6 SF/cu m depending on energy cost.

*Irradiation, *Sludge treatment, *Microorganisms, Equipment, Performance, Design criteria, Fertilizers, Waste treatment, Energy, Costs, Waste water treatment

D443
HYGIENIC EFFECTIVENESS OF DISINFECTION OF SEWAGE AFTER ITS MECHANICAL TREATMENT (Gigienicheskaia effektivnost' obezzarazhivaniia bytovykh stochnykh vod, proshedshikh mekanicheskuiu ochistku),

Cherkinskii, S. N., Kulikov, A. V., and Iakovleva, G. P.

Gigiena i Sanitariia, No. 3, p 18-22, March, 1977. 3 ref.

The effectiveness of disinfection of mechanically treated sewage by chlorination as required under epidemic conditions was studied. Counts of Escherichia coli and Salmonella paratyphi B were correlated with residual chlorine content after chlorination of sewage artificially infected with S. paratyphi B. This pathogenic germ was no longer detectable when the residual coli index was 3,000 or less and the residual chlorine content was at least 4.5 mg/liter. These values can be used as criteria for the routine check-up of the effectiveness of disinfection of sewage by chlorination. Disinfection can be considered effective and safe if the coli index does not exceed 3,000 at a minimal residual chlorine level of 4.5 mg/liter.

*Disinfection, *Pathogenic bacteria, *Chlorination, Sewage treatment, Coliforms, Bacteria, Microorganisms, Public health, Performance, Evaluation, Waste water treatment

D444
WASTEWATER PHOSPHORUS REMOVAL USING LAND APPLICATION,

Enfield, C. G.

Robert S. Kerr Environmental Research Laboratory,
U.S. Environmental Protection Agency,
Ada, Oklahoma.

Civil Engineering-ASCE, Vol. 47, No. 6, p 58-60, June, 1977. 4 fig.

A graphical approach for determining phosphorus removal, as a design parameter of a soil waste water treatment system, was presented. This approach was based on phosphorus concentrations of a given waste water. System failure could be caused by exceeding the soil phosphorus sorption capacity. Investigations have shown that finer textured soils have a greater capacity for phosphorus sorption. The recommended procedure involved a laboratory study of each major soil series on the proposed site. Forty duplicated analyses of each sample were made to determine phosphorus sorption capacity. During equilibrium time, samples should be agitated and maintained at a constant temperature. This temperature should be the mean annual temperature of the site since reactions are temperature-dependent. The resultant sorption isotherm data should be extrapolated to estimate results of additional equilibrating time.

*Phosphorus, *Design criteria, *Sorption, Chemical properties, Soils, Performance, Analytical techniques, Temperature, Chemical reactions, Waste water treatment

D445
SODIUM BICARBONATE PROVIDES PH RELIEF FOR DIGESTER,

Water and Wastes Engineering, Vol. 14, No. 5, p 57, May, 1977.

Sodium bicarbonate was used to solve several digester problems in Chatham Township, New Jersey. The major problems were pH and alkalinity. The addition of sodium bicarbonate raised these indicators to a neutral range, and maintained those levels. A 5-6 foot scum blanket and 6-9 foot grit accumulation had been cleaned out of the plant's only anaerobic digester. Soon after, a drop in methane production indicated the beginning of a souring problem. A two-month treatment of 200-400 pounds/day of sodium bicarbonate increased the pH from 5.6 to 6.5 at the end of the first month. The pH finally stabilized at 7.1. Alkalinity rose to 3900 mg/liter and methane gas production rose as high as 8,000 cubic feet/day. The high level of methane produced which could be used as fuel resulted in reduced fuel costs.

*Anaerobic digestion, *Hydrogen ion concentration, *Alkalinity, Treatment facilities, Methane, Fuels, Gases, Performance, Equipment, Waste water treatment

Sodium bicarbonate, Chatham Township (NJ)

D446
OXYGENATION OF AQUEOUS WASTES: THE PROST SYSTEM,

Othmer, D. F.

Polytechnic Institute of New York,
Brooklyn,
Department of Chemical Engineering.

Chemical Engineering, Vol. 84, No. 13, p 117-120, June, 1977. 2 fig, 8 ref.

The PROST (Pressure-Recycling Oxidation Sewage Treatment) system was described. This system provided the advantages of pressure digestion with air and/or oxygen as well as several improvements. Pressure digestion increased the speed of oxygen adsorption and the extent of digestion. Unit size and land requirements were reduced, and the character of the final effluent liquid and sludge was improved. This system's predissolved oxygen produces such calm oxidation that the unit may be concurrently used as a clarifier. Waste waters were depressurized after depletion of the dissolved oxygen. Other gases dissolved at the elevated pressure were then released. Process repetition dissolved the oxygen necessary to supply practically all of the BOD. The influent sewage entered a centrifugal pump and was mixed with air and/or oxygen. The liquid passed to the pressure vessel which acted as an organics digester. Most of the organic material was oxidized or digested by chemical, enzymatic, or aerobic bacterial action. The liquid overflowed the top of the pressure tank. There was an 80-90% BOD reduction and minimal turbidity. Sludge was discharged as the conventional underflow. Added BOD and turbidity reduction was possible by retreatment. Sludge recycling oxidized some of the organic carbon. A compact version was described which used a single vessel for BOD supply and clarification involving solid-liquid contacting.

*Oxygenation, *Waste treatment, *Oxygen, *Aqueous solutions, *Pressure, Air, Adsorption, Biochemical oxygen demand, Turbidity, Oxidation, Organic carbon, Dissolved oxygen, Equipment, Waste water treatment

Pressure-Recycling Oxidation Sewage Treatment (PROST)

D447
SLUDGE DISPOSAL STRATEGY: PROCESSES AND COSTS,

Burley, M. J., and Bayley, R. W.

Water Pollution Control, Vol. 76, p 205-215, 1977. 5 fig, 8 tab, 7 ref.

The minimization of sludge treatment and disposal costs was investigated. Disposal strategies included ocean dumping, landfilling, liquid disposal in lagoons, spreading on agricultural lands, and use as fertilizers. Incineration was considered as a form of treatment. Heavy metal and pathogen content must be considered in any choice. Options available for treatment to avoid risk of infection included: anaerobic digestion, heat treatment, and lagoons. Land application of untreated sludges was not generally accepted, but has sometimes been used without ill effects. Specific risks need to be further investigated. Capital and operating cost comparisons indicated that lagoon treatment with decanting could produce substantial savings. A procedure was presented for selecting appropriate methods of treatment.

*Sludge disposal, *Costs, *Performance, Landfills, Oxidation lagoons, Incineration, Fertilizers, Heat treatment, Heavy metals, Waste water treatment, Pathogenic bacteria, Anaerobic digestion

D448
STANDARDIZATION FOR WATER POLLUTION CONTROL WORKS,

Lloyd, D. O.

Water Pollution Control, Vol. 76, p 173-181, 1976. 2 fig, 4 tab, 14 ref, 3 append.

Factors involved in the standardization of treatment facilities were considered. The goals for water pollution control facilities were: use of standard design procedures; use of standard equipment and machinery; construction of standard treatment units; improved performance appraisal; and avoidance of cosmetic additions while encouraging innovation. It was considered most important to avoid weak standards which would impair performance and confidence in the standardized forms. Standardized preliminary treatment processes, sedimentation units, biological filters, sludge digestion, and mechanical equipment were expected to produce significant benefits. More effective standards could be determined by cooperation between designers, manufacturers, and users.

*Water pollution control, *Treatment facilities, *Design standards, Equipment, Filters, Sludge treatment, Mechanical equipment, Performance, Construction, Waste water treatment

D449
CHEMISORPTION OF PHOSPHORUS FROM PRECLEANED MUNICIPAL SEWAGE
(Verfahren zur absorptiven Phosphorelimination aus vorgereinigtem kommunalem Abwasser),

Klaentschi, N.

Gas-Wasser-Abwasser, Vol. 57, No. 5, p 379-384, 1977. 6 fig, 5 tab, 12 ref.

A treatment process for phosphorus removal was presented. This process, based on chemisorption, can produce sewage effluents with phosphorus concentrations of 0.1 mg P/liter. A pilot plant operation indicated that the process was technically and economically feasible for municipal effluent treatment. The process also reduced organic carbon and turbidity. A significant improvement was projected for treatment plants already using phosphate precipitation.

*Phosphorus, *Absorption, Separation techniques, Municipal wastes, Economics, Treatment facilities, Organic carbon, Water purification, Turbidity, Waste water treatment

D450
EVALUATION AND UPGRADING OF A MULTI-STAGE TRICKLING FILTER FACILITY,

Koon, J. H., Curran, R. F., Adams, C. E., Jr., and Eckenfelder, W. W., Jr.

AWARE, Incorporated,
Nashville, Tennessee.

1976. 138 p, 56 fig, 21 tab, 21 ref. EPA Technical Report EPA-600/2-76-195.

Treatment of wastes from a multiproduct organic chemical plant by trickling filter was investigated. The trickling filter was a full-scale, six-stage operation. Pretreatment processes included solvent separation, flow measurement, neutralization, equalization, and nutrient addition. The trickling filter system consisted of six 20-feet deep filters which operated in series. This was followed by a final clarification. Tests indicated that serial operation did not cause microorganism acclimation or enhance BOD removals. Air stripping and biological mechanisms significantly contributed to total BOD reduction. Filter performance was greatly improved by effluent recycle. A 90% BOD reduction, at a hydraulic loading of 2 gpm/square foot, required a 600% recycle. Bench scale activated sludge investigations supported the use of this process for system improvement. Determinations were made of kinetic parameters necessary for the design of activated sludge systems. Results of air and oxygen aeration studies suggested that treatment of wastes with volatile substances would be difficult in a closed oxygen system. Activated carbon adsorption, following activated sludge treatment, was found to be very effective in upgrading performance. Adsorption could remove some refractory organics and color-producing substances. A significant nonadsorbable organic fraction remained.

*Trickling filters, *Biological treatment, *Adsorption, *Activated sludge, *Activated carbon, *Biological oxygen demand, Microorganisms, Organic compounds, Recycling, Industrial wastes, Monitoring, Oxygen, Separation techniques, Waste water treatment

Air stripping, Organic chemical industry

D451
A METHODOLOGY FOR ASSESSING LAND APPLICATION OF SLUDGES AND WASTEWATERS,

Chatterjee, S.

Proceedings Institute of Environmental Sciences, p 107-113, 1977. 5 tab, 14 ref.

The Application on Land Assessment System (ALAS!) was presented for the assessment of environmental impact of sludge and waste water land application. Land application of these substances has become one of the most useful methods for meeting elimination or reduction goals for pollutant discharges. The ALAS! method involves five steps. The suitability of the sludge/waste water is first established. Application rate criteria and land suitability are then determined. The appropriate environmental parameters are identified and map areas classified. The collected data is then analyzed. Sludge application parameters include land slope, soil permeability and pH, flood frequency, and proximity to water sources. Other factors include: depth to bedrock, perched, or permanent water tables; proximity to surface water; and ponding. The most important parameters for waste water irrigation are drainage and soil types. The parameters for sludge application also apply to waste water applications. The approach consists of identifying magnitudes of various environmental parameters and relating them to various degrees of potentially adverse impacts. A simplified interaction analysis is the basis of this method. A study of the Miami (Ohio) Valley region was conducted with this method. Additional refinements may make ALAS! an effective implementation tool.

*Waste disposal, *Evaluation, *Sludge disposal, *Irrigation, Environmental control, Soil properties, Analytical techniques, Water table, Physical properties, Flooding, Waste water treatment

Application on Land Assessment System (ALAS!), Miami (OH) Valley Region

D452
THE ENHANCEMENT OF HIGH-RATE DISINFECTION BY THE SEQUENTIAL ADDITION OF CHLORINE AND CHLORINE DIOXIDE,

Tifft, E. C., Moffa, P. E., Richardson, S. L., and Field, R.

O'Brien and Gere Engineers, Incorporated, Syracuse, New York.

IN: Proceedings of Workshop on Microorganisms in Urban Stormwaters, 1976. p 96-119, 5 fig, 9 tab, 10 ref. Technical Report EPA-600/2-76-244.

A two-part evaluation was made of the treatment of combined sewer overflows (CSO) by chlorine or chlorine dioxide for the reduction of microbial organisms. The massive volume of CSO in highly developed urban areas precludes treatment by conventional techniques. This would require long detention times and large facilities. Bench-scale tests were conducted to determine the disinfectant doses needed to reduce microbial counts to acceptable levels. Full-scale plants tested those results for verification. It was found that point-source treatment by high-rate application of 25 mg/liter of chlorine or 12 mg/liter of chlorine dioxide reduced indicator organisms and viruses to levels acceptable for discharge to recreational waters. A sequential (15 to 30 second intervals) addition of 8 mg/liter of chlorine and 2 mg/liter of chlorine dioxide produced lower counts after two minutes contact time than corresponding single-stage disinfection. This was attributed to an interaction of the disinfectants. It was suggested that chlorine dioxide was regenerated by a reaction of chlorine with the chlorite produced by the decomposition of chlorine dioxide.

*Disinfection, *Chlorination, *Viruses, *Bioindicators, Microorganisms, Water pollution sources, Sewers, Overflow, Treatment facilities, Chemical reactions, Waste water treatment

D453
EVALUATION OF THE EFFECTIVENESS OF DEHELMINTIZATION OF WASTE WATER DURING MECHANICAL TREATMENT AT SMOLENSK (Otsenka effektivnosti degel'mintizatskii stochnykh vod pri mekhanicheskoi ochistke v Smolenske),

Ashnin, S. Y., and Lagutina, L. S.

Meditsinskaia Parazitologiia i Parazitarnye Bolezni, Vol. 45, No. 5, p 609-611, 1976. 1 tab.

The effectiveness of mechanical waste water treatment with chlorination in terms of dehelmintization was investigated at the Smolensk waste water treatment plant. Mechanical treatment with chlorination reduced the ascarid egg count by not over 50%. Ascarid eggs were found in non-disinfected sludge in lagoons, both on the surface and at 40 cm depth, 2 years after discharge; 80% of the eggs were viable. The findings indicate the low efficiency of mechanical waste water treatment in terms of the removal of helminths.

*Chlorination, *Disinfection, *Worms, *Biocontrol, *Animal parasites, Waste water treatment, Lagoons, Sludge

Smolensk (USSR), Mechanical treatment, Ascarids

D454
PRETREATING AN ACID WHEY WASTE FOR SEWER DISCHARGE,

Hopkins, E. S., Angle, H. G., and Zigler, H. C.

Public Works, Vol. 108, No. 6, p 58-61, June, 1977. 1 fig, 2 tab, 4 ref.

Treatment methods for converting acid cottage cheese manufacturing wastes to effluent acceptable for discharge into the Frederick, Maryland sewer system are discussed. Initial experiments with an industrial effluent consisting of equal parts whey and rinse water discharged after a six hour holding period showed BOD levels of 14,700 mg/liter, with 300 mg/liter being an acceptable level. Laboratory, field, and pilot plant studies were undertaken using air-microbiological procedures. Organisms from discharged raw sour milk were used as seed. Maintenance of proper nitrogen levels (7 mg/liter) and oxygen supplies was required for the organisms to destroy the whey wastes. Maintaining sufficient oxygen levels was the major practical difficulty, with absorptions per hour limited under procedure conditions. Anaerobic conditions induced fermentation with its consequent odor problems. Quantity of waste degraded was shown to be in direct proportion to quantity of oxygen absorbed, indicating the practicality of the air-microbiological approach. Air was supplied to the system both by a surface aerator and a diffuser ring at the bottom of the tank.

*Industrial wastes, *Acidity, *Effluents, *Aeration, *Biological treatment, *Food processing wastes, *Microbial degradation, *Anaerobic conditions, Waste treatment, Waste water treatment, Sewer systems, Sewerage, Nitrogen, Oxygen, Absorption, Fermentation

Frederick (MD), Cottage cheese wastes

D455
SOILS INFILTRATION AND EVAPORATION OF WASTEWATER BY AEROBIC PROCESSES,

Young, A. N., Jr.

Institute of Environmental Sciences. Proceedings of the 23rd Annual Technical Meeting, p 115-117, April 25-27, 1977. 4 ref.

The advantages of alternative disposal systems involving aerobic processing over those of conventional septic tank drainage field installations are discussed. Maintaining aerobic conditions allows the development of proper microorganisms which prey on anaerobic bacteria, the primary cause of soil clogging in on-site sewage treatment systems. Thus even in difficult soils porous conditions can be maintained and clogging prevented, while septic tank systems show a 50% failure rate within 2 years of installation. Alternate systems can also efficiently oxidize waste water nutrients, permitting their soil retention or uptake by vegetation and meeting EPA requirements for 1984 systems. Alternate systems meet federal requirements for maintaining safe drinking water that septic tank systems cannot. The importance of proper construction and maintenance of the aerobic treatment equipment and the evapo/transpiration bed is stressed as critical to the success of the system. The ability of this type of absorption bed to hold water over long periods of rainfall is maintained by proper sizing of the bed.

*Aerobic treatment, *Microorganisms, *Bacteria, *Septic tanks, *Transpiration, Sewage, Waste treatment, Waste water treatment, Water quality control

D456
KRAKSTAD WASTE WATER FACILITY: THE FIRST TO BE EQUIPPED WITH CONTACT ROLLS FOR BIOLOGICAL PURIFICATION (Krakstad renseanlegg forst med kontaktvalser til biologisk rensing),

From, J. O.

Teknisk Ukeblad/Teknikk, Vol. 124, No. 16, p 21-22, April, 1977.

A novel chemical and biological waste water treatment plant, designed for 1,500 persons in Krakstad, Norway, is described. After mechanical impurities are separated on sieves, biological purification is done by means of two cylinders measuring 3 m in diameter and about 5 m in length. These cylinders, partly immersed in the waste water horizontally, consist of 300 styropor/isopor discs, and have a surface of 4,200 sq m each for the bacterial cultures needed to purify the water. Consequently, there is no return sludge. The sludge obtained after biological purification and subsequent chemical flocculation is separated by plate separator. The waste water treatment cost amounts to the equivalent of 800 crowns per inhabitant.

*Biological treatment, *Treatment facilities, *Bacteria, *Sludge treatment, Waste water treatment, Costs, Water purification, Sewage treatment

Krakstad (Norway), Contact rolls

D457
SANDVIKA WASTE WATER TREATMENT PLANT IN OPERATION. EXPERIENCE WITH DESIGN, CONSTRUCTION, AND OPERATION (Sandvika renseanlegg i praksis. Erfaringer fra planlegging, bygging og drift),

Moen, A.

Teknisk Ukeblad/Teknikk, Vol. 124, No. 16, p 16, 18, 35, April, 1977. 5 fig, 1 tab, 1 ref.

Experience with the operation of a Sandvika-type municipal waste water treatment plant at Baerum, Norway, is reported. After mechanical treatment and sand trapping, flocculation is done with lime (250 g/cu m). Sea-water is used as a source of magnesium (4-5% of the effluent). The sludge, thickened gravimetrically to a solids content of 5.3%, is dewatered by centrifugation.

*Treatment facilities, *Municipal wastes, Waste water treatment, Design, Construction, Waste treatment, Sea water

Norway

D458
ONE PROCESS STEP CAN BE SKIPPED: BIOLOGICAL-CHEMICAL WASTE WATER TREATMENT PLANT BECOMING CHEAPER (Et prosesstrinn kan sioyfes: biologisk-kjemiske renseanlegg blir billigere),

Nettli, P., and Hustad, E.

Kjemi, Vol. 37, No. 2, p 40-41, March, 1977. 3 fig, 1 tab.

The Bio-Alwafloc waste water treatment unit developed by Alwatech is described. Filtered waste water is first purified with activated sludge for about 40 minutes. It is then sent immediately into a three-step aerated precipitation-flocculation-flotation unit without preliminary separation of the biological sludge. Trivalent iron salts, and possibly lime and an anionic polyelectrolyte, are added for chemical purification. The combination of biological and chemical separation in one step offers economic advantages without causing any marked reduction of the purification efficiency.

*Biological treatment, *Iron compounds, *Lime, *Costs, Filtration, Water purification, Sludge treatment, Waste water treatment, Waste treatment

Bio-Alwafloc

D459
COMBINED PROCESSING OF WASTEWATER AND SOLID WASTE,

Sieger, R. B., and Bracken, B. D.

Brown and Caldwell,
Walnut Creek, California.

AIChE Symposium Series, Vol. 73, No. 162, p 143-149, 1977. 4 fig, 1 tab, 5 ref.

A design for a combined waste water and solid waste processing facility has been successfully tested and approved for the Central Contra Costa Sanitary District in northern California. This design puts an emphasis on energy recovery to reduce purchased energy requirements. Incoming solid wastes, 1089 mg/day at plant capacity, are sent to landfill sites or to the processing plant depending on their salvageability. At the process plant the wastes are salvaged for ferrous metals and aluminum. Air classifiers divide the initially shredded wastes into light and heavy fractions. The heavy fraction, primarily non-combustibles, is examined for metals. The light fraction, sent through a second hammermill-type shredder, yields RDF (refuse derived fuel) for use in sludge burning at the water treatment plant. This plant uses a physical-chemical-biological waste water treatment process including lime recalcination and sludge burning. The RDF, mixed with sludge in rations controlled for both optimal furnace operation and plant energy needs, is fed into the 11-hearth sludge burning furnaces. Pyrolysis rather than incineration is used, yielding a gas to be used as a fuel in the lime recalcination furnace. Exhausts from the furnace are passed to a waste heater boiler to generate steam for the plant's cooling and heating needs and for the driving of turbines for several mechanical devices. While laboratory testing of this system showed several problems, these were due to the small scale of the test. A full-scale test gave results exceeding expectations.

*Energy, *Salvage value, *Fuels, *Recycling, *Sludge, *Sludge disposal, *Solid wastes, Waste treatment, Waste water treatment, Municipal wastes, Metals, Costs

California, Refuse derived fuel, Sludge burning, Pyrolysis

D460
BIOLOGICAL NITRIFICATION IN CONTACT AERATION SYSTEMS,

Abd-El-Bary, M. F., and Eways, M. J.

Water and Sewage Works, Vol. 124, No. 6, p 91-93, June, 1977. 3 fig, 2 tab, 11 ref.

A contact aeration unit has proven its ability to achieve a high degree of biological nitrification. The system investigated was a fixed film type capable of biologically nitrifying ammonia at rates of up to 0.8 lb/day per 1000 square feet of surface area. This system, which provides a fixed surface area for attachment of the biological mass, is contrasted with a suspended growth system (an activated sludge type system). Advantages of the contact aeration system include: nitrification at pH levels of normal domestic sewage; flow by gravity, making the plant less power-consuming; automatic plant operation; and quick recovery by plants after shock loading. Data were collected over a three month period, with the temperature ranging from 71 F to 72 F and pH varying between 7.0 and 7.4. Portions of the final effluent of a 0.8 MGD capacity contact aeration plant were pumped to the first stage aeration unit of a 0.3 MGD plant. Analyses of grab samples taken along the length of the aeration tank showed the rate of nitrification to be a linear function of the tank length. Thus, the data indicate that the nitrification rate is a zero order reaction (using the Monod Model) and independent of ammonia concentration.

*Aeration, *Nitrification, *Biological treatment, *Ammonia, *Sewage, Waste water treatment, Waste treatment, *Aerobic treatment, Sewage treatment, Effluents

D461
EFFECT OF SHAPE OF PADDLE AND CONTAINER ON FLOCCULATION PROCESS,

Bhole, A. G., and Limaye, P.

Journal of the Institution of Engineers (India), Vol. 57, Part EN 2, p 52-57, February, 1977. 11 fig, 3 tab, 4 ref.

A study of the controlling factors in the process of flocculation has concluded that the container and paddle geometry, in addition to other physical and chemical factors, can affect floc formation. The purpose of this study was to examine the effect of paddle and container shape on the removal of turbidity during the flocculation process. Container shapes examined were circular, hexagonal, pentagonal, square, and triangular. It was found that the pentagonal shape created maximum size flocs for fastest settling. Paddle shape was considered while keeping the area of the paddle and the shape of the container constant. A D'-shaped paddle was considered the most efficient for removal of turbidity, with the C'-shaped paddle being the next best. All experiments were conducted on Fuller's earth at pH 7, using acetic acid, sodium hydroxide, and sodium bicarbonate.

*Flocculation, *Turbidity, *Design criteria, *Chemical precipitation, *Liquid wastes, Water purification, Colloids, Waste water treatment

D462
DESTRUCTION OF COLIFORMS IN WATER AND SEWAGE WATER BY DYE-SENSITIZED PHOTOOXIDATION,

Acher, A. J., and Juven, B. J.

The Volcani Center,
Israel,
Institute of Soils and Water.

Applied and Environmental Microbiology, Vol. 33, No. 5, p 1019-1022, May, 1977. 3 tab, 4 ref.

A method for the reduction of virus and fecal coliform concentrations in sewage water by oxidation of organic matter by photosensitization was described. Samples of waste water containing Escherichia coli to which dye-sensitizers had been added were subjected to solar radiation. The effect of the presence of methylene blue on E. coli was measured over various concentrations, radiation times, and sunlight intensities. It was found that increasing the methylene blue concentration up to 5.0 mg/liter increased the bactericidal effect on both potable water and sewage water. Rose bengal was not as effective at destruction of E. coli under similar conditions. For methylene blue, concentration and radiation time were more important than sunlight intensity in effiency of photooxidation. The dye sensitizers can be removed from effluent by adsorption on bentonite.

*Coliforms, *E. coli, *Oxidation, *Photoactivation, *Dyes, Sewage bacteria, Enteric bacteria, Bactericides, Sewage treatment, Waste water treatment

Methylene blue, Rose bengal

D463
MIAMI PLANS INJECTION WELL FOR WASTEWATER DISPOSAL,

Water and Wastes Engineering, Vol. 14, No. 6, p 70, June, 1977. 1 fig.

A pilot study is being conducted by the Miami-Dade Water and Sewer Authority to determine design criteria for a deep well injection system for disposal of treated waste water. The target injection zone for the test well is a highly permeable dolomite zone which is overlain by approximately 1000 feet of dense carbonates, protecting the Floridan aquifer from contamination by waste water. Geophysical logging and drilling data will be used to determine optimum depths for the steel casings surrounding the test well.

*Saline water-freshwater interfaces, *Saline water intrusion, *Injection, *Injection wells, *Underground waste disposal, Waste water disposal, Municipal wastes, Aquifers, Aquitards, Environmental engineering, Waste water treatment

Miami (FL)

D464
POLYMERS ARE PRECISELY MANAGED,

Donahue, J.

Water and Wastes Engineering, Vol. 14, No. 6, p 58-61, June, 1977. 1 fig.

The Easterly Wastewater Treatment Plant in Cleveland, Ohio, uses an efficient and economical method for phosphate removal from waste water. Pumping of a polymer solution to primary sedimentation tanks and secondary tanks is precisely controlled by automatic comparison of actual flow rate of raw sewage with polymer flow.

*Phosphates, *Nutrient removal, *Polymers, *Flow measurement, *Flow control, Municipal wastes, Phosphorus compounds, Pumping, Control systems, Automatic control, Waste water treatment

Cleveland (OH)

D465
ANGLIAN OPENS ITS LARGEST SEWAGE TREATMENT WORKS,

Surveyor, Vol. 149, No. 4431, p 6-7, May, 1977. 1 fig.

Overloading of an existing activated sludge plant at Great Billing in East Anglia, England has led to the construction of additional sewage treatment facilities. An increasing proportion of industrial effluent from the area's tanning industries and fluctuations in load indicated the need for extensions to existing facilities. A two-stage filtration system including high rate and biological filters was installed to produce effluent that complies with Royal Commission standards. The treatment facility includes provisions for storm flow and diurnal variations in flow. After primary settlement is completed, the settled sewage is then divided between the original activated sludge plant and the new biological filtration plant. Modifications to the original plant include cleaning of dome diffusers in the aeration plant. The sludge treatment and disposal facilities at Great Billing are now the largest existing facilities in the Anglian Water Authority.

*Activated sludge, *Biological treatment, *Tannery wastes, *Waste water treatment, *Filters, Industrial wastes, Sludge treatment, Sludge disposal

England, East Anglia, Anglian Water Authority, Great Billing (UK)

D466
GROWTH AND BENEFITS OF LOW SPEED CONFIGURATION,

Guidi, E. J.

Water and Sewage Works, Vol. 124, No. 6, p 66-70, June, 1977. 3 fig, 7 tab.

High speed centrifuges have been used for the dewatering of raw and digested sludge. New developments which indicate that low speed centrifuging may be sufficient for dewatering purposes include: greater quantities of biological slimes which resist compaction at high speeds, more effective polymers for flocculation and dewatering of biological sludges, and a growing need for energy conservation. Advantages offered by the low speed design include less turbulence and resuspension, longer residence time, greater solids compaction, and better clarification and conveyability. Cost analyses for low and high speed centrifuging yield a cost of $12.33/ton of sludge processed by the low speed unit as compared to a cost of $27.93/ton for the high speed centrifuge. Noise levels, polymer consumption, energy use, and maintenance expenditures were also reported to be lower for the low speed unit.

*Sewage disposal, *Centrifugation, *Dewatering, *Sludge treatment, *Equipment, Cost comparisons, Sewage sludge, Drying, Waste treatment, Waste water treatment, Solid wastes

D467
IRRIGATION TRIAL WITH MORRO BAY WASTEWATER,

Wildman, W. E., Branson, R. L., Rible, J. M.,
and Cawelti, W. E.

California Agriculture, Vol. 31, No. 5, p 36-38, May, 1977. 2 fig.

While upgrading its sewage treatment plant, the community of Morro Bay considered reuse of treated waste water for irrigation of field and forage crops as an alternative to ocean disposal of effluent. An irrigation trial was carried out using three types of treatment: (1) effluent, (2) effluent plus gypsum, and (3) city water comparable to normal irrigation water. All plots were irrigated weekly, receiving a total of 17 feet of water by the end of the project. Soil samples were collected at various stages during the irrigation and analyzed for their sodium adsorption ratios to determine whether sodium added by the effluent posed an irrigation hazard. It was found that effluent water did raise the sodium adsorption ratios, but the addition of gypsum tended to lessen this effect. Infiltration tests showed no consistent differences between city and effluent waters. It was suggested that guidelines for sodium contamination by irrigation waters be reevaluated for sewage effluents.

*Irrigation practices, *Infiltration rates, *Irrigation effects, *Sodium, *Water reuse, Irrigation programs, Soil contamination, Agriculture, Grasses, Soil chemical properties, Waste water disposal, Waste water treatment

Morro Bay (CA)

D468
IRRIGATING WITH WASTEWATER IN SONOMA COUNTY,

Harwood, L. M.

California Irrigation, Vol. 31, No. 5, p 37-38, May, 1977. 1 fig.

Irrigation of forage crops with treated waste water in Sonoma County, California has been evaluated. Effluent supplied by the city of Santa Rosa for irrigation may have economic and other benefits for the area. Soil analyses over the three year test period indicated only minor changes, including slight increases in soil conductivity, phosphorus content, and pH. As nearly all soil types in Sonoma County are deficient in nitrogen and phosphorus, use of effluent for irrigation may significantly reduce fertilizer costs. It was noted that compaction of heavy clay soils could be alleviated by more frequent irrigations with smaller amounts of water. Concentrations of elements toxic to plant growth or animal health were not significant in the waste water used in Sonoma County.

*Irrigation practices, *Irrigation effects, *Water reuse, *Forage grasses, *Dairy industry, Irrigation effects, Fertilizers, Nitrogen, Phosphorus, Agriculture, Grasses, Waste water disposal, Soil chemical properties, Soil physical properties, Waste water treatment

Sonoma County (CA)

D469
DIRECT FILTRATION,

Culp, R. L.

Culp-Wesner-Culp,
Clean Water Consultants,
El Dorado Hills, California.

American Water Works Association Journal, Vol. 69, No. 7, p 375-378, July, 1977. 5 fig, 1 tab, 13 ref.

Direct filtration may be a viable treatment process for raw waters that are free of paper fiber and low in turbidity, color, plankton, and coliform organisms. As defined, direct filtration is a process in which filtration is not preceded by sedimentation. Flow sheets are illustrated for several types of filtering arrangements. The mechanisms by which coagulation during direct filtration removes turbidity and color are described. Possible applications and criteria for the use of direct filtration processes in waste water treatment are presented. The use of direct filtration results in reductions in capital, operating, and maintenance costs as well as smaller sludge volumes. Disadvantages include the high levels of turbidity, color, plankton, or paper fiber and the need for greater operator surveillance to insure proper effluent quality. Process design and operations are discussed, including filter media and dimensions. Criteria for quality control are presented for the control of the coagulant dosage and the use of polymers as filtering aids. Municipalities currently employing direct filtration are listed, including a partial survey of designs and processes in operation.

*Filtration, *Coagulation, *Polymers, *Water quality, *Waste water treatment, Flocculation, Separation techniques, Filters, Cost comparisons, Turbidity, Equipment

Direct filtration, Flow sheets

D470
CHLORINATION SEEMS BEST FOR REMOVING SUSPENDED SOLIDS
FROM LAGOON EFFLUENTS,

Harrison, R. B., and Haddock, J. K.

Gilbreath, Foster and Brooks, Incorporated,
Tuscaloosa, Alabama.

Water and Wastes Engineering, Vol. 14, No. 5, p 48-82, May, 1977. 4 fig, 4 tab.

Among the problems encountered with the use of lagoons or holding ponds are the periodically high levels of BOD, algae, and fecal coliform bacteria found in lagoon effluents. In this study on the improvement of an existing 3-celled lagoon in Vernon, Alabama, four effluent treatment schemes were evaluated. The first method investigated was chlorination using a chlorine contact chamber (reactor). It appeared to be the best method for reduction of BOD, destruction and settling of algae, and elimination of fecal coliform bacteria. The effluent and chlorine were fed into a model reactor chamber by means of gravity flow and detained for 2 hours. The model system was effective at removing 68% of the BOD, 63% of the solids, and 100% of the fecal coliform from the lagoon effluent. Coagulation-precipitation with alum, the second method investigated, removed as much as 83% of the solids but did not appreciably reduce BOD or coliform levels. A major disadvantage of this method was the production of large volumes of sludge which would require additional processing. Plain sedimentation, the third method examined, did not prove satisfactory, resulting in a small percentage of removal of suspended solids and no reduction of BOD or fecal coliform levels in the effluent. The fourth method, sand filtration, was considered to be adequate from other source studies.

*Suspended solids, *Algae, *Chlorination, *Coagulation, *Sedimentation, Lagoons, Oxidation lagoons, Biochemical oxygen demand, Coliforms, Waste water treatment, Model studies, Alabama, Flocculation, Effluents, Filtration

Vernon (AL)

D471
EFFECT OF ALUM ADDITION ON AEROBIC DIGESTION OF ACTIVATED SLUDGE,

Mitchell, G. F., Seyfarth, R. H., and Wilson, F. R.

Water and Sewage Works, Vol. 124, No. 7, p 58-62, July, 1977. 10 fig, 4 ref.

A study was conducted to determine if alum addition to the aeration tank for phosphorus removal affected the aerobic digestion process. Results indicated that the addition of 13 mg/liter of alum had no effect on the volatile suspended solids reduction rate and little effect on metabolic processes. Increases in specific oxygen uptake rate and specific resistance were observed during the first two days of aeration, possibly due to an increase in external substrate through cell lysis. Levels decreased after the fifth day of aeration to those of the control system (without alum), suggesting that the addition of alum at the experimental concentration does not significantly affect the efficiency of the aerobic digestion process.

*Phosphorus, *Activated sludge, *Aerobic digestion, *Biochemical oxygen demand, *Aeration, Stabilization, Sludge treatment, Chemical oxygen demand, Waste water treatment

D472
OPTIMIZING GAS PRODUCTION, METHANE CONTENT, AND BUFFER CAPACITY IN DIGESTER OPERATION,

Brovko, N., Chen, K. Y., Weinberg, M. S., and
Barber, N. R.

Southern California University,
Los Angeles,
Environmental Engineering Program.

Water and Sewage Works, Vol. 124, No. 7, p 54-57, July, 1977. 4 fig, 4 ref.

Carbonate equilibria and buffering capacities are evaluated for the production of methane during anaerobic digestion, to determine whether increasing bicarbonate concentrations above levels required for pH control could increase gas production and/or the methane content of gas produced. Results suggested that bicarbonate, used for its buffering capacities, may also stabilize the biological system, promoting more complete digestion and increasing methane production according to a linear function. Sodium bicarbonate was indicated as the source of bicarbonate alkalinity least likely to disturb the biological community. Reestablishing proper carbonate alkalinity was reported as essential in the recovery of a malfunctioning digester. Total alkalinity concentrations must be corrected for volatile acid alkalinity to obtain accurate values for bicarbonate alkalinity, as high values for volatile acid alkalinity can yield negative values for bicarbonate alkalinity. The use of somewhat higher levels of bicarbonate alkalinity in sludge digestion than those required for buffering (3500-5000 mg/liter instead of 2500 mg/liter) was recommended to provide additional safeguards and increase methane production.

*Methane, *Alkalis, *Bicarbonates, *Sludge digestion, *Anaerobic digestion, Sludge treatment, Hydrogen ion concentration, Chemcontrol, Waste water treatment

Buffers

D473
ENERGY USAGE AND RECOVERY IN SLUDGE DISPOSAL PART 1,

Jones, J. L., Bomberger, D. C., Jr, and Lewis, F. M.

Water and Sewage Works, Vol. 124, No. 7, p 44-47, July, 1977. 2 fig, 4 tab, 5 ref.

Relative energy requirements and cost sensitivities to recovered energy value have been compared for various methods of sludge treatment and disposal. Thermal processes such as incineration and pyrolysis are stressed. Trends in thermal processing and the status of existing types of thermal processing are outlined. The production of steam by a waste heat boiler is considered as a means of energy recovery from incineration. It was noted that the quantity of steam produced was dependent on the sludge solids content and the treatment process used. Use of the recovered steam for the generation of electric power proved to be uneconomical and inefficient, while the use of steam by the sludge heat treatment unit was considered feasible. A comparison of total national per capita energy consumption with energy consumption for waste water treatment indicated that energy use for waste water treatment amounted to less than 0.1% of the total U.S. energy expenditure.

*Sludge disposal, *Sludge treatment, *Energy, *Incineration, *Heat treatment, Waste disposal, Waste water treatment

Energy reuse

D474
OCCURRENCE OF ESCHERICHIA COLI B BACTERIOPHAGES IN MUNICIPAL WASTE-WATER AND THEIR REMOVAL AND INACTIVATION BY ACTIVATED SLUDGE SEWAGE TREATMENT,

Estevez, E. G.

Miami University,
Miami, Florida.

Dissertation Abstracts International B, Vol. 37, No. 12, p 5979-5980, June, 1977.

A modified plaque assay was used to examine the occurrence of E. coli B bacteriophages during various stages of the activated sludge treatment process. It was observed that coliphages, associated with suspended solids, may increase during the treatment process. Settled solids were found to contain more than 10,000 plaque-forming units per milliliter. Coliform bacteria and coliphages were reduced during anaerobic digestion of sludge, and inactivated by physical rupture of the virions during adsorption to suspended solids. Survival of coliphages after heavy chlorination was reported.

*Coliforms, *E. coli, *Activated sludge, *Bacteriophage, *Sewage bacteria, Anaerobic digestion, Suspended solids, Sludge digestion, Chlorination, Microorganisms, Waste treatment, Waste water treatment

D475
SIGNIFICANCE OF TEMPERATURE IN THE ACTIVATED SLUDGE PROCESS,

Lin, K.

Toronto University,
Toronto, Canada.

Dissertation Abstracts International B, Vol. 37, No. 12, p 6286-6287, June, 1977.

Statistical analyses of data collected from 13 waste treatment plants indicated that temperature plays an important role in the efficiency of the activated sludge process. The influence of temperature is second only to that of BOD5 and suspended solid concentrations in raw sewage. Greater percentages of removal, and lower concentrations in effluent, of BOD5 and suspended solids were observed at higher temperatures. The variability of temperature was observed to follow a sinusoidal curve over a 365-day period, with peaks at 30-day intervals, possibly due to differences in organic loading. Variabilities of BOD5 and suspended solids were more random in nature. It was suggested that continuous temperature readings be taken for raw sewage and mixed liquor, and that mixed liquor temperatures be used instead of raw sewage temperatures for biokinetic studies.

*Activated sludge, *Temperature, *Kinetics, *Sludge treatment, *Biochemical oxygen demand, Suspended solids, Regression analysis, Statistics, Effluents, Waste water treatment

D476
ALBUQUERQUE CLOSES WATER-WASTEWATER CYCLE,

American City and County, Vol. 92, No. 7, p 60, July, 1977.

Since water supplies for the Albuquerque area are limited, high-level treatment of waste water for reuse in irrigation and soil conditioning is encouraged. Processing by Albuquerque's two waste treatment plants includes grit removal, primary sedimentation and screening, high-rate trickling filtration, clarification, activated sludge processing, and chlorination. The resultant effluent discharged into the Rio Grande contains less than 30 mg/liter of BOD and 30 mg/liter of suspended solids. Reuse of waste water also allows the city additional groundwater rights to the area's underground aquifer. Problems encountered in waste processing after the activated sludge process was added in 1976 include an increase in sludge volume. Also, as the treatment plant contains no sludge thickening facilities and all sludge is air dried on sand beds, increased sludge volumes have presented storage problems during periods of unfavorable weather. Additional outlets for reuse and redistribution of dried sludge are currently being sought.

*Water reuse, *Irrigation water, *Fertilizers, *Water management (applied), *Water conservation, Water resources development, Water demand, Water supply, Waste water treatment, Waste water disposal, Waste treatment, Sludge treatment, Sludge disposal, Activated sludge

Albuquerque (NM)

D477
WATER TREATMENT PLANT SLUDGES: AN UPDATE OF THE STATE-OF-THE-ART,

Westerhoff, G. P., Albert, J. T., Doe, P. W., Forster, H. W., and King, P. H.

Water and Sewage Works, Vol. 124, No. 7, p 65-66, July, 1977.

Methods for the dewatering of water treatment plant sludges and the ultimate disposal of dewatered sludge are discussed. Mechanical and non-mechanical methods of dewatering are mentioned, including lagoon thickening, sand bed drying, centrifugation, vacuum filtration, and pressure filtration. Recommendations for further research and development are given for the following areas: minimization of sludge volumes; recovery of resources present in sludge, such as alum, lime, magnesium, and iron; and ultimate disposal of sludge in a safe, economical manner.

*Sludge disposal, *Sludge treatment, *Dewatering, *Waste disposal, *Centrifugation, *Sewage treatment, Waste water treatment

D478
SLUDGE TREATMENT, UTILIZATION, AND DISPOSAL,

Dick, R. I.

Delaware University,
Newark.

Journal Water Pollution Control Federation, Vol. 49, No. 6, p 1040-1067, June, 1977.
345 ref.

A review of literature on various methods of sludge treatment, utilization, and disposal is presented. Sludge management technology, operational costs, and energy costs are discussed for alternative sludge processing techniques. Topics discussed include quantity and quality of sludge, industrial and hazardous sludges, chemical sludges from phosphorus removal and water treatment, stabilization, conditioning, thickening, dewatering, inactivation of organisms and viruses, combustion, and pyrolysis. Various topics related to waste disposal are discussed, including reclamation, transportation of sludge, land application, land reclamation, landfills and lagoons, and ocean disposal.

*Sludge treatment, *Sludge disposal, *Industrial wastes, *Chemical wastes, *Reclamation, Stabilization, Dewatering, Sedimentation, Water Pollution Control Federation, Microorganisms, Viruses, Incineration, Transportation, Fertilizers, Land reclamation, Landfills, Lagoons, Ultimate disposal, Municipal wastes, Activated sludge, Biodegradation, Waste water treatment

Ocean disposal, Conditioning

D479
PHYSICAL AND CHEMICAL METHODS,

Scaramelli, A. B., and DiGiano, F. A.

Westvaco Research Center,
Charleston, South Carolina.

Journal Water Pollution Control Federation, Vol. 49, No. 6, p 992-1001, June, 1977.
90 ref.

A literature review of current physical and chemical methods of waste treatment is presented. Process applications and pilot studies for various methods of waste treatment and disposal are described. Procedures for clarification, coagulation, solids separation, and flocculation are reported. Adsorption capacities and kinetics are discussed for various organic compounds used in waste treatment. Membrane processes such as reverse osmosis, ultrafiltration, and electrodialysis are evaluated. Other topics discussed include ozonation, oxidation, and ion exchange for the selective removal of heavy metals and organic compounds.

*Waste treatment, *Ion exchange, *Adsorption, *Membrane processes, *Oxidation, Municipal wastes, Industrial wastes, Coagulation, Suspended solids, Flocculation, Model studies, Ozone, Irradiation, Kinetics, Water Pollution Control Federation, Waste water treatment

Physical methods, Chemical methods

D480
ACTIVATED SLUDGE,

Saunders, F. M.

Georgia Institute of Technology,
Atlanta.

Journal Water Pollution Control Federation, Vol. 49, No. 6, p 1005-1016, June, 1977.
114 ref.

A review of literature on activated sludge treatment methods and processes is presented. Various models for achieving optimal efficiency and specific effluent standards are outlined. Topics discussed include process performance, process design, oxygen uptake and transfer, sedimentation, nitrification, industrial waste waters, and microbial studies. Among the processes described are: extended aeration, settling, phosphorus removal, biodegradation, oxidation, and denitrification. Methods for detoxification of activated sludge are reported.

*Activated sludge, *Sludge treatment, *Nitrification, *Sedimentation, Industrial wastes, Microorganisms, Flocculation, Model studies, Biochemical oxygen demand, Phosphorus, Biological treatment, Industrial wastes, Municipal wastes, Organic compounds, Oxygen demand, Kinetics, Suspended solids, Waste water treatment

Process performance, Process design

D481
CURRENT TRENDS IN WATER RECLAMATION TECHNOLOGY,

Garrison, W. E., and Miele, R. P.

County Sanitation Districts of Los Angeles County,
Whittier, California.

American Water Works Association Journal, Vol. 69, No. 7, p 364-369, July, 1977.
3 fig, 6 tab, 11 ref.

Waste water reclamation and reuse is of particular interest for areas where water supplies are limited, such as in arid southern California. The Los Angeles Sanitation Districts have identified several potential uses for reclaimed waste water, including groundwater recharge, industrial reuses, irrigation, and recreation. Constituents in waste water causing the most concern are inorganics (metals, nitrate, phosphorus, and TDS), organics (trace organics, pesticides, and color), microorganisms, suspended solids, and turbidity. Various methods for the removal of inorganic constituents are described, including: demineralization by reverse osmosis, electrodialysis, and ion exchange; nitrogen removal by nitrification and denitrification; phosphate removal; and heavy metals removal. Activated carbon and ozonation are methods for the removal of organic material in waste water. Microorganism removal by disinfection and various tertiary treatment processes are described. The use of filtration and tertiary treatment processes is considered for the removal of suspended solids and turbidity. Cost estimates are presented for treatment processes necessary for the various modes of reuse. Groundwater recharge is indicated as the most economically feasible form of reuse by directly decreasing the amount of water which must be imported. The need for standard regulations governing water reuse is indicated.

*Water reuse, *Water resources development, *Water management (applied), *Groundwater recharge, Groundwater resources, Microorganisms, Organic compounds, Inorganic compounds, Suspended solids, Metals, Phosphorus, Demineralization, Phosphates, Heavy metals, Activated carbon, Ozone, California, Reclamation states, Nitrogen, Waste water treatment

Los Angeles (CA)

D482
BIOLOGY AND BIOTECHNOLOGY OF WASTE WATER TREATMENT (Biologie und Biotechnologie der Abwasseraufbereitung),

Hoffmann-Walbeck, H. P.

Zucker, Vol. 30, No. 4-5, p 204-209, April-May, 1977. 10 fig, 2 tab, 9 ref.

Biological processes and requirements are described for various methods of waste water treatment. Methods for aerobic and anaerobic digestion are discussed. Factors affecting the efficiency of the activated sludge treatment for carbohydrate-rich waste waters are outlined. Biochemical oxygen demands are evaluated at various temperatures and flow rates. Various forms of bacteria found in activated sludge are described.

*Activated sludge, *Biochemical oxygen demand, *Sludge treatment, *Biodegradation, *Bacteria, Aerobic digestion, Anaerobic digestion, Fermentation, Filtration, Biological treatment, Carbohydrates, Waste water treatment

D483
WATER HYACINTH CULTURE FOR WASTEWATER TREATMENT,

Dinges, R.

Texas Department of Health Resources,
Division of Wastewater Technology and Surveillance,
Austin, Texas.

1976. 143 p, 30 fig, 60 tab, 32 ref, 1 append. Texas Department of Health Resources.

Water hyacinths, Eichornia crassipes, have been considered as a means of improving effluent quality. In a study conducted in Austin, Texas, stabilization pond effluent was passed through shallow earthen basins which were covered with water hyacinths. Water hyacinths were found to be effective in removing algae, other suspended particles, and dissolved impurities from the effluent. They also reduced nitrogen, fecal coliform bacteria, BOD5, COD, and suspended solids in the stabilization ponds. Various heavy metals and other elements were observed to accumulate in plant tissue, including: Cl, P, As, Fe, Cu, Cr, Hg, Pb, Ni, Zn, Mg, Mn, and K. A one acre crop of mature plants was estimated to contain more than 2,500 pounds of minerals. Cultivation of hyacinths can be used to purify waste waters in climatically favorable zones, while sources of heat for hyacinth beds during colder winter periods might include use of raw sewage, incineration of garbage, anaerobic digester gas, cooling waters of power stations, and solar panels.

*Water hyacinth, *Aquatic plants, *Stabilization, *Waste water treatment, *Water quality, Heavy metals, Biochemical oxygen demand, Soil-water-plant relationships, Plant physiology, Biological treatment, Waste treatment

*Eichornia crassipes

D484
THERMAL CONDITIONING WITH AIR,

Water Services, Vol. 81, No. 976, p 341-342, 344, June, 1977. 1 fig.

High pressure heating of sludge has been used to facilitate dewatering. The Zimpro Thermal Conditioning with Air unit, which combines aeration with the heating process, also reduces odors by oxidation and improves heat exchange. A single stream Zimpro unit being installed at Worleston, Crewe, England, will thermally condition a mixture of waterworks sludge, digested primary sludge, and surplus activated sludge at a rate of 16.4 cu m/hr. Additional provisions will include dewatering by filter presses and autothermic multiple hearth incineration with waste heat recovery. A three stream plant being supplied to the Anglian Water Authority is planned to condition a mixture of primary, surplus activated, and humus sludge. Implementation of the Zimpro unit is expected to reduce the quantity of dewatered sludge for ultimate disposal as well as aid in the processing of industrial wastes.

*Equipment, *Dewatering, *Heat exchangers, *Sludge treatment, *Treatment facilities, *Oxidation, Activated sludge, Sludge disposal, Incineration, Municipal wastes, Industrial wastes, Waste water treatment

Zimpro Thermal Conditioning with Air, North West Water Authority (UK), Worleston, Crewe (UK), Anglian Water Authority, West Tilbury (UK)

D485
AIR BLOWERS FOR SEWAGE AND WATER TREATMENT,

Water Services, Vol. 81, No. 976, p 344, June, 1977.

Positive displacement air blowers have been used in the activated sludge treatment process to supply oil-free air which is used to agitate the sludge, coagulate colloids, and provide oxygen for aerobic processes. Air is also used to back clean filters. Peabody Holmes Ltd. of Turnbridge, Huddersfield, England has designed a rationalized series of positive displacement blowers, which covers the volume and pressure range from 80 cu m/hr to 50,000 cu m/hr. Higher rotational speeds resulting from strong impellers have reduced from 66 to 26 the number of machines necessary to cover the volume and range. Mechanical noise levels have been reduced. Peabody Holmes air blowers also contain various protection devices including automatic power shut-off, vacuum switches, pressure switches, and thermostatically controlled heaters.

*Equipment, *Aeration, *Oxygenation, Sewage treatment, Waste water treatment, Coagulation, Water treatment

*Air blowers, *Positive displacement air blowers

D486
THE PRESSURE DRUM FILTER FOR SLUDGE DEWATERING,

Water Services, Vol. 81, No. 976, p 348, June, 1977.

Stamford, Connecticut has purchased a British designed and manufactured Wickham pressure drum filter from the Wickham Filtration Engineering Division. It is estimated that using the new belt filter for sludge dewatering instead of existing equipment will save $40,000 to $90,000 for Stamford. The stainless steel filter belt is automatically adjustable for variations in sludge thickness. Raw feed sludge and dilute electrolyte pass from an in-line mixer to a sludge-chemical contact zone to produce large undamaged flocs. Application of light pressure stabilizes sludge after it undergoes gravity filtration. Stabilized sludge is then compressed by a filter-mesh-covered pressure drum and carried out on a conveyor belt.

*Equipment, *Sludge treatment, *Dewatering, *Filters, Sludge, Flocculation, Stabilization, Waste water treatment

*Pressure drum filter, Stamford (CT), Belt filter

D487
BASIC UNITS MANUFACTURED FOR SLUDGE TREATMENT,

Water Services, Vol. 81, No. 976, p 341, June, 1977.

A sludge thickening device, analagous to a picket fence, has been manufactured by Esmil/Envirotech Ltd., a British firm headquartered in Huntingdon, Cambridgeshire, England. Sludge is homogenized by a series of arms or pickets and raked to a central discharge hopper. The Eimco Dissolved Air Flotator produces thicker waste activated sludges than conventional gravity thickening and yields solids contents of 3 to 5 percent. Reported advantages of the flotator include smaller space required for operation, thick sludge production, and high oxygen content and low suspended solids in the effluent. The EimcoBelt continuous belt filter provides an alternate method for sludge dewatering at low cost for a wide variety of sludges, including raw primary, waste activated, thermally processed, and chemically/physically treated sludges. Operating at high vacuum, the filter discharges the dewatered sludge by passage of the filter cloth over a roller. Water jets applied to both sides of the filter cloth before it returns to the drum are designed to minimize blinding. Another mode of sludge treatment, the BSP furnace, is suited for the autothermic combustion of sludges with high moisture content. The multichamber zone effect, produced by a series of superimposed hearths in a refractory-lined cylinder shell, eliminates the need for pre-drying of feed and provides multi-stage process control.

*Dewatering, *Equipment, *Sludge treatment, *Waste water treatment, *Activated sludge, Incineration, Filtration, Waste treatment

Eimco Dissolved Air Flotator, EimcoBelt, BSP furnace, Esmil-Envirotech

D488
USING WETLANDS FOR WASTEWATER TREATMENT,

Journal Water Pollution Control Federation, Vol. 49, No. 7, p 1581, July, 1977.

The possible use of wetlands in Michigan and Florida for final treatment of municipal waste water has been considered. At a trial site in Florida, waste water is pumped into cypress ponds where nutrients are absorbed by vegetation. Costs for this method of treatment are approximately 50 percent less than for treatment by a conventional plant. At a trial site in Michigan, waste water is pumped into a peat marsh for the removal of nutrients.

*Wetlands, *Swamps, *Marshes, *Waste water treatment, *Nutrients, Cycling nutrients, Freshwater marshes, Water purification, Michigan, Florida, Water Pollution Control Federation

D489
PHYSICAL-CHEMICAL TREATMENT SYSTEM FOR SEWAGE,

Water Services, Vol. 81, No. 976, p 373, June, 1977. 1 fig.

Systems for the physical and chemical treatment of non-industrial sewage have been adapted by Japan's Ministry of Construction. Designed, manufactured, and marketed by the Nippon Kokan KK, the systems have standard capacities of 200,000, 400,000, and 600,000 cubic meters/day. In the system, activated carbon is used to remove organic wastes before flocculation by the addition of sulfuric acid and polymer. The remaining waste water is chlorinated and passed through an up-flow filter before it is discharged. At the time of discharge BOD and COD are at concentrations of less than 10 parts per million. While operating costs are slightly higher than those for a conventional activated sludge system, construction costs are about two-thirds lower.

*Municipal wastes, *Waste water treatment, *Activated carbon, *Chlorination, *Flocculation, Design, Sewage treatment, Costs

D490
OXYGEN INJECTION BLOWS NEW LIFE INTO DROUGHT HIT SEWAGE TREATMENT WORKS,

Martin, D.

Process Engineering, p 11, June, 1977.

A BOC system has been used by the Wessex Water Authority in England to supplement oxygen supplies and to cope with fluctuating demands on the Bournemouth sewage treatment system. Electronic sensors in the activated sludge tank monitor dissolved oxygen levels and trigger a high-pressure oxygen injection system when levels drop below preset values. The two Vitox systems in use can provide three and four tons of oxygen per day, respectively. Oxygen is stored in vacuum-insulated vessels which are filled by road tankers as necessary. The system proved useful as an alternative to construction of new facilities during a recent water shortage, when reduced water consumption resulted in more concentrated influent entering the system.

*Injection, *Oxygen requirements, *Dissolved oxygen analyzers, *Activated sludge, Aerobic conditions, Sludge treatment, Aerobic treatment, Sewage sludge, Waste water treatment

*Oxygen injection system

D491
PALO ALTO SEES GOLDEN GLINT IN SLUDGE,

The American City and County, Vol. 92, No. 7, p 23, July, 1977.

Precious metals from wastes from area electronics industries have been discovered in sludge ash from the Palo Alto sewage treatment plant. Various methods to recover the estimated ounce of gold and 15 ounces of silver per ton of sludge ash were considered. Although sewage treatment does concentrate metals in sludge, small particle sizes and the lack of a smelter in the immediate vicinity inhibit the use of magnetic separation and smelting in the recovery of these metals. Options being considered include sale of the ash to an outside processor or the construction of an on-site processing facility which would be operated on a profit-sharing basis by a private contractor and the city of Palo Alto. Although costs and environmental impact of an on-site facility have not yet been assessed, the use of a mining industry-related process for cyanide extraction of metals is being considered for Palo Alto sludge by the World Resources Company.

*Metals, *Gold, *Silver, *Reclamation, *Sludge disposal, Electronics, Industrial wastes, Chemical wastes, Sludge treatment, Separation techniques, Costs, Heavy metals, California, Waste treatment

Palo Alto (CA)

D492
MCALPINE WIN EFFLUENT TREATMENT WORKS CONTRACTS,

Water Services, Vol. 81, No. 976, p 367-368, June, 1977.

Two contracts for the construction of waste water treatment facilities have been awarded to Sir Alfred McAlpine and Son Ltd., England. A new effluent pre-treatment plant including a replacement pumping station will be constructed for ICI Ltd., Organics Division, at its Dalton works in Huddersfield. This plant is designed to comply with the Yorkshire Water Authority's requirements on pH and suspended solids levels in discharged effluent. The second contract was awarded by Ward Blenkinsop and Company Ltd. for the construction of treatment facilities which will include a twin 50 mm outfall sewer, pumping station, tanks, control house, lagoons, pipes, and roads.

*Treatment facilities, *Suspended solids, *Hydrogen ion concentration, *Pumping plants, *Waste water treatment, Waste treatment, Municipal wastes

Huddersfield (UK), Lancashire (UK)

D493
ANAEROBIC AND AEROBIC TREATMENT OF COMBINED POTATO PROCESSING AND MUNICIPAL WASTES,

Neel, J. K., Vennes, J. W., Fossum, G. O., and Orthmeyer, F. B.

1976. 132 p, 22 fig, 30 tab, 14 ref, 1 append. Technical Report EPA-600/2-76-236.

The use of unmixed detention and aeration in open ponds in the treatment of combined potato processing (72%) and municipal (28%) wastes was evaluated in a model study in Grand Forks, North Dakota. In a year-long study using four 0.94 hectare cells which received 13,409 Kg BOD daily for 9 months and 3,773 Kg daily for 3 months, the anaerobic-aerated series operation was observed to provide maximum BOD removal at 76% and COD removal at 64%. Variations in the pH of raw waste were controlled by the BOD concentration, which was, in turn, related to the activity of the potato processing industry. Although the treatment method did not remove phosphorus, it reduced nitrogen by as much as 30% to a final concentration of 43 mg/liter and was effective at air temperatures down to -35 C. Temperature and strength did, however, affect bacterial growth and volatile acid production. Organic solids were not settled in aerated cells, but did decrease in anaerobic cells. Construction suggestions include embankment slope protection, provision for gravity dewatering, and the avoidance of steel metal works, narrow dikes, and thin-walled airlines. Construction costs for the four-cell system were estimated at $672,000. Operational costs were estimated at 4.31 cents per kilogram of BOD satisfied.

*Aerobic treatment, *Anaerobic digestion, *Potatoes, *Industrial wastes, *Biochemical oxygen demand, Chemical oxygen demand, Lagoons, Aerated lagoons, Municipal wastes, Design criteria, Model studies, Settling basins, Costs, Food processing industry, Waste water treatment

Grand Forks (ND), Potato processing wastes

D494
PHYSICAL-CHEMICAL TREATMENT OF A MUNICIPAL WASTEWATER USING POWDERED CARBON: NO. II,

Burns, D. E., Wallace, R. N., and Cook, D. J.

Eimco BSP Division of Envirotech Corporation,
Salt Lake City, Utah.

1976. 328 p, 106 fig, 54 tab, 17 ref, 3 append. Technical Report EPA-600/2-76-235.

Chemical coagulation-precipitation followed by powdered activated carbon adsorption and granular media filtration has been examined as a method of physical-chemical treatment of waste water during a pilot study in Salt Lake City. With alum or FeCl3 pretreatment, two-stage counter-current powdered carbon contacting, and typical diurnal flow conditions, the process produced high quality effluent with less than 5 mg/liter COD, 5 mg/liter suspended solids, and 0.3 mg/liter phosphorus. In excess of 90 percent of used carbon was regenerated using a fluidized bed furnace. No significant loss of treatment effectiveness was observed when thermally regenerated carbon was reused in the powder activated carbon process. Costs for the alum-powdered carbon treatment of 10 mgd of Salt Lake City waste water were estimated at 36.2¢/1000 gal and were reduced to 33.4¢/1000 gal when carbon was thermally regenerated and reused. Cost sensitivity studies, comparison of parallel granular and powdered carbon systems, further pilot studies, and an evaluation of chemical-primary sludge dewatering alternatives are recommended.

*Activated carbon, *Chemical degradation, *Filtration, *Adsorption, Dewatering, Sewage treatment, Model studies, Diurnal distribution, Chemical oxygen demand, Suspended solids, Phosphorus, Treatment, Municipal wastes, Effluents, Water quality, Pilot plants, Waste water treatment

*Physical-chemical treatment, Powdered carbon, Carbon sludge thickening, Ferric chloride, Alum, Fluidized bed furnace, Salt Lake City (UT)

D495
PERIPHERAL MIXING TURNS SLUDGE INTO FUEL GAS,

The American City and County, Vol. 92, No. 7, p 58-59, July, 1977. 1 fig.

The addition of sludge around the sidewall of a digester as well as into its center is reported to have increased sludge handling capability and energy savings for Dayton, Ohio. Pilot studies of a multi-point injection system allowing for distribution of sludge to 10 points at the periphery of a digester at Dayton's sewage treatment plant suggest that the system may increase gas production in digesters by 13-25%. This is attributed to the formation of a larger active zone by peripheral mixing. The larger active zone may also be useful in dampening problematic effects caused by variations in pH, temperature, and sludge solids within digesters, leading to greater gas production and volatile solids reduction. Design suggestions include the placement of five inlet pipes at a single level around the perimeter, and the placement of a vertical pipe in the center of the digester tank to circulate warmed sludge over the scum blanket at the top of the digester. While conventional mixing methods such as mechanical mixing and gas induction require energy, peripheral sludge injection produces thermal convection currents for mixing, with energy consumption limited to that used to inject the sludge into the digester. Gas production from the digesters at the Dayton plant is more than sufficient to adequately heat the plant's buildings nd digesters.

*Digestion tanks, *Sludge treatment, *Energy, *Convection, Circulation, Mixing, Treatment facilities, Model studies, Design data, Municipal wastes, Energy conversion, Waste water treatment

*Peripheral mixing

D496
TWO CONTRACTS UNDERWAY TO COMPLETE SOUTH BAY AREA WATER TREATMENT PLANT,

Western Construction, p 40, 42, July, 1977.

Advanced waste treatment facilities are being constructed for the San Jose/Santa Clara Pollution Control Plant by four California firms jointly operating as the Waste Water Construction Company. Two contracts totalling $58,692,500 were awarded on January 13, 1976 for the construction of nitrification facilities and of multi-media type tertiary filter facilities. The nitrification facilities will include an activated sludge-type waste water treatment plant for the nitrification of ammonia in effluent from the existing secondary treatment facilities. A two-stage biological system will be formed by the addition of the new sludge treatment plant to the existing facilities, which will comprise the first stage used to remove organic carbon. Specialized bacteria and aerobic nitrifiers will be used for biological nitrification in the second stage of treatment by the new facilities. The tertiary filter facilities, which will be used to filter effluent from the ammonia nitrification facilities, will include gravity filters, chlorine contact basins, a filter service building, and a paint shop. Additional filtration processes will be provided for removal of BOD, suspended solids, coliform, and floatables. Federal and state funds will provide up to 87.5% of the costs of the $66,500,000 project which is scheduled for completion in August 1978.

*Tertiary treatment, *Activated sludge, *Nitrification, *Treatment facilities, *Filtration, Biological treatment, Ammonia, Nitrogen compounds, California, Construction, Waste water treatment

San Jose (CA), Santa Clara (CA), Waste Water Construction Company, Multi-media filtration

D497
ADAPTATION TO NITRIFICATION OF ACTIVATED SLUDGE SYSTEMS TREATING HIGHLY NITROGENOUS WATERS,

Verstraete, W., Vanstaen, H., and Voets, J. P.

Gent State University,
Gent, Belgium.

Journal Water Pollution Control Federation, Vol. 49, No. 7, p 1604-1608, July, 1977. 4 fig, 2 tab, 8 ref.

Nitrification processes occurring in activated sludge plants treating highly nitrogenous waste water can be unpredictable during the start-up of the plant. For this reason, an investigation was initiated to determine whether a start-up procedure could be designed on the basis of a nitrification-tolerance graph. The validity of the graph and the required time for establishing a maximum nitrifying community were then studied. Laboratory studies using various nitrogen loading rates indicate that an N-loading of about 1.2 mg/liter per day is the optimal start-up rate. Gradual auto-acidification of the mixed liquor is suggested during the adaptation phase to insure low NH3-N levels. Since nitrifying bacteria are sensitive to environmental changes, plant start-up for specific waste waters is suggested. A nitrification-tolerance graph was considered as a useful guideline for nitrification process control.

*Nitrification, *Activated sludge, *Nitrogen compounds, *Farm wastes, Bacteria, Waste water treatment, Water Pollution Control Federation, Nitrogen fixing bacteria, Model studies, Ammonification, Sludge treatment, Control, Operations, Waste treatment

Nitrobacteria, *Nitrification tolerance

D498
EXTENSIONS TO GREAT BILLING STW OPENED,

Water Services, Vol. 81, No. 976, p 329-333, June, 1977. 1 fig.

A two-stage filtration system using high rate filters followed by biological filters has been adapted for the Great Billing Sewage Treatment Works in Northampton, England. The works will receive sewage discharges through three gravity sewers of 1500 mm diameter and will treat 318 liters per capita per day. Processing of settled sludge is divided between the new biological filtration plant and the existing activated sludge plant built in 1953. Sludge is mechanically screen raked, and divided equally by five flumes which each control flow to a primary settling tank. Sludge is lifted by screw pumps to either the activated sludge plant or the new biological treatment plant. Sludge processed at the new plant undergoes high rate filtration which reduces the organic load by 80 percent. Screw pumps then lift the sludge to be divided equally among six biological filters, where filtration at a slower rate using smaller filtering media removes the remaining organic material. Effluent, collected in channels at the base of the filters, then flows to humus chambers where solid matter is settled out before discharge of the final effluent into the River Nene. The sludge removal system at Great Billing has been designed to offer greater flexibility for sludge routing by providing alternate methods by which sludge can be removed from primary settling tanks and fed to the storage tanks. Because treated sludge retains a significant amount of nitrogen and phosphorus, it is used as a soil conditioner for 200 hectares of farmland.

*Biological treatment, *Activated sludge, *Treatment facilities, *Sludge treatment, Filtration, Sewage treatment, Settling basins, Municipal wastes, Waste water treatment

*Great Billing (UK), High-rate filtration, Anglian Water Authority, East Anglia, England

D499
BIOLOGICAL CONTROL OF WATER POLLUTION,

Tourbier, J., and Pierson, R. W., Jr. (ed.)

Pennsylvania University,
Philadelphia,
Center for Ecological Research in
Planning and Design.

University of Pennsylvania Press, Philadelphia, Pennsylvania. 1976. 340 p.

A series of articles presented as part of an International Conference on Biological Water Quality Improvement Alternatives comprises this review of waste water pollution and treatment methods. Biological methods for the treatment and reclamation of waste water discussed include land application, the use of vegetation in nutrient cycling, controlled eutrophication, and bacterial cleaning of sewer lines. Aquatic ecosystems and nutrient cycles are discussed with respect to waste water treatment. More efficient methods of waste water treatment which also result in groundwater recharge are considered. Various aspects of drinking water are discussed, including possible contaminants, future supplies, and primitive treatment methods.

*Biological treatment, *Soil-water-plant relationships, *Potable water, *Waste water treatment, *Groundwater recharge, Artificial recharge, Municipal wastes, Model studies, Plant growth, Cycling nutrients, Marsh plants, Biochemical oxygen demand, Chemical oxygen demand, Absorption, Aerobic treatment, Color, Sewage treatment, Biocontrol

Water pollution biocontrol

D500
EXPERIMENTAL USE OF EMERGENT VEGETATION FOR THE BIOLOGICAL TREATMENT OF MUNICIPAL WASTEWATER IN WISCONSIN,

Spangler, F., Sloey, W., and Fetter, C. W.

Wisconsin University,
Oshkosh,
Department of Biology.

In: Biological Control of Water Pollution (ed. Tourbier, J., and Pierson, R. W., Jr.), University of Pennsylvania Press, 1976. p 161-171, 9 tab, 19 ref.

The use of a marsh and its associated vegetation in waste water purification has been investigated as an economical method to reduce bacteria, nutrients, and organic compounds in municipal waste water. In laboratory studies on the use of iris (Iris versicolor), softstem bulrush (Scirpus validus), and hardstem bulrush (Scirpus acutus) grown in gravel-lined basins, removal from effluent of BOD, COD, O-PO4, total-P, and dissolved solids was investigated for 5-, 3-, and 1.5-day retention times. Retention in all beds, including the gravel control, resulted in reductions of 49-98% of BOD and COD. Significant reductions in total-P and O-PO4 were observed for all planted beds, with bulrushes being more effective at removal than irises. A pilot plant, employing ten plastic-lined, gravel-filled retention basins, showed that gravel-filled control ponds were as effective at water purification as planted ponds. Retention times of as little as five hours resulted in significant reductions in BOD (87-92%), turbidity (77-91%), and coliforms (90-99.7%). Reductions of dissolved solids (0.3-9.5%) and total-P (5-25%) were not appreciable. It was suggested that water purification is actually caused by microflora on the growing media rather than the plants themselves.

*Soil-water-plant relationships, *Pilot plants, *Cycling nutrients, *Plant growth, Biological treatment, Nitrogen, Phosphorus, Absorption, Marsh plants, Vegetation establishment, Marsh management, Model studies, Waste water treatment, Sewage treatment, Aerobic treatment, Biochemical oxygen demand, Chemical oxygen demand, Waste treatment

Seymour (WI), Bulrushes, Irises

D501
RENOVATION OF MUNICIPAL WASTEWATER FOR GROUNDWATER RECHARGE
BY THE LIVING FILTER METHOD,

Sopper, W. E.

Pennsylvania State University,
University Park,
Institute for Research on Land and Water Resources.

In: Biological Control of Water Pollution (ed. Tourbier, J., and Pierson, R. W., Jr.), University of Pennsylvania Press, 1976. p 269-282, 10 tab, 9 ref.

Studies at the Pennsylvania State University were performed on the use of vegetative cover to supplement removal of waste water constitutents by soil interactions. Treated effluent was used to spray-irrigate forested areas and cropland for a period of 12 years (1963-1974) at a rate of 5 cm/wk. Samples of percolating water collected in agronomic areas at 120 cm soil depth indicated that phosphate had been consistently reduced by more than 98% and was not significantly higher than control values. Nitrate-nitrogen removal at this application rate was not adequate for Public Health Service drinking water standards in corn-planted areas, but was sufficient in canary grass covered areas. Although phosphorus was effectively removed in forested areas, without harvesting of trees it was continuously recycled. Nitrogen reduction was variable in forested areas, with an apparent system collapse when application rates were increased by 50%. Soil analyses showed that pH and concentrations of exchangeable K, organics, and N were not affected by spray irrigation. However, Ca, Mg, Na, P, and B increased significantly while Mn decreased. Harvesting of crops showed removal efficiencies of 334% of the applied N, 230% of the applied P, and 280% of the applied K for corn silage crops and 145%, 143%, and 130% for reed canary grass. One effect of spray irrigation was an annual groundwater recharge of from 10,300 cu m to 17,300 cu m per hectare irrigated. It was suggested that at an application rate of 5 cm/wk, 4 million liters of waste water could be disposed of on 52 hectares of land, using agricultural areas, recreation areas, and open space as available.

*Groundwater recharge, *Artificial recharge, *Soil-water-plant relationships, *Absorption, *Biological treatment, Soil contamination, Soil chemical properties, Phosphorus, Nitrogen, Forests, Forest soils, Agronomy, Corn (field), Forage grasses, Trace elements, Waste water treatment, Municipal wastes, Model studies

*Spray irrigation, University Park (PA)

D502
THE POTENTIAL OF SUBMERSED VASCULAR PLANTS FOR RECLAMATION
OF WASTEWATER IN TEMPERATE ZONE PONDS,

McNabb, C. D.

Michigan State University,
East Lansing,
Department of Fisheries and Wildlife.

In: Biological Control of Water Pollution (ed. Tourbier, J., and Pierson, R. W. Jr.), University of Pennsylvania Press, 1976. p 123-132, 8 fig.

Tertiary treatment of municipal waste water using submersed vascular plants in aerobic stabilization ponds has been investigated by Michigan State University. An on-campus pilot system designed to treat 2 million gallons of sewage per day includes a primary treatment unit, an activated sludge facility, four ponds comprising 40 acres, and 143 acres of land for spray irrigation. Growth of the larger, more easily harvested, submersed vascular plants in stabilization ponds was favored by aerobic conditions, temperatures above 10 C, and high water clarity which is, in turn, related to high concentrations of algae-grazing zooplankton. The introduction of fish which fed on zooplankton resulted in clouding of the water through unconstrained algae production. At a retention time of 28 days, harvested plants were reported to have concentrated 20-25% of the phosphorus, 50-70% of the nitrogen, 80-100% of the manganese, 20-30% of the iron, 5-10% of the copper and zinc, and 1-3% of the cadmium, chromium, cobalt, and nickel present in the effluent. Ultimate removal of these elements does, however, require harvesting to remove waste-enriched plants. As some vegetation must remain in the pond during the winter to insure continuous crop production, plant degeneration which returns a portion of the wastes to the pond may limit total ultimate removal.

*Pilot plants, *Aquatic plants, *Aquatic populations, *Biological treatment, Cycling nutrients, Soil-water-plant relationships, Absorption, Plant growth, Aerobic treatment, Nitrogen, Phosphorus, Trace elements, Model studies, Algae, Waste water treatment, Sewage treatment, Fish diets, Aquatic microorganisms, Waste treatment, Municipal wastes

East Lansing (MI), Submersed vascular plants

D503
MACROPHYTES AND WATER PURIFICATION,

Seidel, K.

Max Planck Institute,
Krefeld, West Germany.

In: Biological Control of Water Pollution (ed. Tourbier, J. and Pierson, R. W., Jr.), University of Pennsylvania Press, 1976. p 109-123, 9 fig, 6 tab, 4 ref.

The growth of plants in substandard water and waste treatment products has been studied to determine to what extent plant growth is affected by suboptimal conditions and to what extent plants influence water, subsoil, and sludge characteristics. Changes in chemical absorption and uptake, morphology, physiology, and growth rate were related to both species and sewage type. Root secretions of certain aquatic plants such as Mentha aquatica, Acorus calamas, Juncus effusus, and Phragmites communis were observed to have disinfective properties, reducing E. coli, Enterococci, and Salmonella by as much as 90% after two hours contact time with sewage. Schoenoplectus lacustris neutralized acidic or alkaline sewage. The use of plants was suggested for the purification, reclamation, dewatering, and sterilization of sludge. The Max Planck Institute has made several recommendations on the use of plants in sewage treatment, including: use of inert planting material to encourage nutrient uptake from waste water, oxygenation of root areas by periodic draining or cascade construction, use of algicides, equal distribution of effluent over planting beds, periodic harvesting of stems, and use of additional chemical treatment if necessary to insure high effluent quality.

*Soil-water-plant relationships, *Plant physiology, *Sewage treatment, *Pathogenic bacteria, *Waste water treatment, Sludge treatment, Effluents, Plant growth, Model studies, Hydrogen ion concentration, Disinfection, Coliforms, Salmonella, Waste treatment

Schoenoplectus lacustris, Phragmites communis, Mentha aquatica, Juncus effusus

D504
THE PURIFICATION OF WASTEWATER WITH THE AID OF RUSH OR REED PONDS,

De Jong, J.

In: Biological Control of Water Pollution (ed. Tourbier, J., and Pierson, R. W., Jr.), University of Pennsylvania Press, 1976. p 133-139, 7 fig, 5 tab, 5 ref.

A pilot study conducted in the Netherlands on the use of rushes, reeds (Phragmites australis), and polypropene fibers to reduce BOD, COD, N, and P in sewage is described. Campground sewage was emptied into ponds which initially had a star-shaped layout, later changed to a series of elongated ditches for ease in maintenance. Significant reductions of almost 100% in BOD, COD, and bacteria (MPN) for pond-retained influent were attributed to purification by soil infiltration and nutrient uptake by pond-dwelling organisms. A decrease in rate of removal in latter parts of the study was attributed to saturation of the organisms with respect to the measured parameters. Optimal purification was reported for retention times of greater than 10 days. In a comparison of Dutch treatment facilities, the pond detention purification method proved more effective and less costly than the use of trickling filters or the activated sludge process.

*Soil-water-plant relationships, *Sewage treatment, *Biochemical oxygen demand, *Infiltration, Chemical oxygen demand, Nitrogen, Phosphorus, Biological treatment, Plant growth, Model studies, Pilot plants, Aquatic populations, Aquatic plants, Waste water treatment

Phragmites australis, Flevoland, Lake Yssel, Netherlands

D505
WATER TREATMENT PLANT DESIGN IS COST-EFFECTIVE,

MacDonald, D. V., and Streicher, L.

Engineering-Science, Incorporated,
Arcadia, California.

Public Works, Vol. 108, No. 8, p 86-89, 114, August, 1977. 6 fig, 1 tab.

A water treatment facility planned for the city of Oceanside, California has been designed for lower than average construction costs and for lower energy and manpower requirements. Provisions for a suction-type traveling sludge collector and a special filter design have reduced construction costs by eliminating the need for below-grade pipe galleries, access tunnels, and pump pits. Designs for static mixing devices should reduce plant power requirements to 30-40% of conventional requirements. The facilities are planned to treat 16 mgd, with the plant flow scheme including flash mixing, flocculation, sedimentation, filtration, and disinfection. Design criteria are listed for chemical mixing, flocculation, settling, filters, backwash recovery, and sludge disposal basins. Hydraulic pressure from the San Diego County Water Authority's No. 2 aqueduct system is converted to turbulent energy for use in chemical mixing and flocculation, eliminating the conventional need for mechanical energy during these processes. A modified baffle arrangement, designed on the basis of computer calculations of velocity gradient, head loss, and detention time, should provide tapered-energy flocculation at reduced flow rates. Backwash water will be derived from plant effluent. Construction costs for the 16.5 mgd plant are estimated at $3.7 million, as opposed to $4.5 to $5.0 million for a plant of similar size with conventional design considerations.

*Design criteria, *Construction costs, *Energy, *Hydraulic engineering, *Treatment facilities, Model studies, Flocculation, Filters, Sludge disposal, Sludge treatment, Waste water treatment

Oceanside (CA)

D506
THERMAL DRYING OF SLUDGE,

Ianelli, M.

Ercole Marelli SpA,
Milan, Italy.

Water Services, Vol. 81, No. 976, p 336-338, June, 1977. 4 fig.

Unpredictable variations in volume of sludge produced by mechanical methods of dewatering such as centrifugation or filtration have prefaced this investigation into thermal drying of sludge. In thermal drying, hot air of relatively low humidity absorbs moisture from sludge and loses heat in the process by an isenthalpic transformation. Thermal drying produces sludge with a water content from 25 to 50 percent, as opposed to 65 to 85 percent produced by mechanical drying. Additional energy requirements for the production of heat for thermal drying may be furnished by incineration of raw sewage or production of gas for fuel in digesters. The Item patented thermal drier uses high-velocity injection of hot air to produce a sludge aerosol, maximizing sludge-hot air contact by decreasing sludge particle size and increasing particle surface area. Operation tests indicated a thermal efficiency of between 65 and 67 percent for the Item thermal drier. A prototype sludge drier which has been in operation in Milan for 4 years has proved adequate for sludge drying requirements of a population of 10,000.

*Dewatering, *Sludge treatment, *Heat, *Centrifugation, Filtration, Waste water treatment, Sludge disposal, Separation techniques, Pilot plants, Model studies

*Thermal drying, Thermal sludge drying

D507
EVALUATION OF SETTLING BASIN PERFORMANCE,

Coppock, E. R., III

New Haven Water Company,
New Haven, Connecticut.

Journal of the New England Water Works Association, Vol. 91, No. 2, p 143-164, June, 1977. 4 fig, 4 ref.

An evaluation of settling basin characteristics and performance is presented, with particular emphasis on an 8 mgd treatment facility in New Haven, Connecticut. Factors considered include floc characteristics, temperature and viscosity of the water, and settling basin hydraulics. Observed variations in color, turbidity, and floc distribution in settling basins at the New Haven plant brought about an investigation of the possibility of short-circuiting of flow through the basins. Flow patterns in the two basins were traced by the addition of sodium chloride to the flash-mix tank and subsequent chloride analysis for samples taken from various areas within the basins. Curves produced for chlorine concentrations as a function of travel were similar for both basins and indicated that the flow was, in fact, being short-circuited by the overlapping slab at the sludge collector return passage and by the normal course of flow through the basin. Calculation of a basin "efficiency curve" indicated that only 12% of the total basin contents was being detained for the designed theoretical detention time. Reduction of the plant flow from 8 mgd to 4 mgd increased the fraction of flow detained to 37% of the total flow. Solutions under consideration include the use of a rubber "membrane" at the sludge collector return passage to inhibit water flow, extension of the upper apron of the collector passageway, and the construction of baffle plates in the basin to equalize flow.

*Settling basins, *Suspended solids, *Evaluation, *Design criteria, *Flow control, Flow rates, Sedimentation rates, Flocculation, Settling velocity, Waste water treatment, Sewage treatment, Treatment facilities

Settling basin efficiency

D508
CHLORINATION DISINFECTION STUDY AT PROPHETSTOWN SEWAGE TREATMENT PLANT,

Water and Pollution Control, Vol. 115, No. 7, p 14-15, 17, 19, July, 1977. 2 fig, 1 tab.

The Penberthy unit was designed as an alternative to the conventional diffuser method of disinfection. A pilot study was initiated to determine if the unit could lower costs for disinfection by using less chlorine while still maintaining adequate bactericidal capacities. The Penberthy unit, operating on the principle of the plug flow reactor, rapidly mixes gaseous chlorine and waste water. The formation of hypochlorous acid and hypochlorite from the breakdown of chlorine, and the thorough bacteria-chlorine contact brought about by the rapid mixing, result in high disinfection rates for the unit. Tests indicate that the Penberthy unit requires only half as much chlorine to adequately destroy enteric bacteria as the conventional method of disinfection.

*Disinfection, *Chlorination, *Model studies, *Bactericides, *Equipment, *Enteric bacteria, Waste water treatment, Water purification, Costs, Chlorine, Sewage treatment, Treatment

Penberthy unit, Hypochlorous acid, Hypochlorite

D509
AEROBIC BIO-TREATMENT OF A HIGH-STRENGTH LEACHATE,

Uloth, V. C., and Mavinic, D. S.

Northern Purification Services Limited,
Vancouver, Canada.

Journal of the Environmental Engineering Division, Vol. 103, No. EE4, p 647-661, August, 1977. 4 fig, 3 tab, 12 ref, 1 append.

An aerobic biological treatment method to process high-strength leachates produced by sanitary landfills is described. The three phases of the study included: an acclimatization/metal removal study, an "extended aeration" efficiency study, and a "shorter detention time" efficiency study. Leachate used in the studies was generated by waste activated sludge from municipal and industrial sources. The acclimatization/metal removal study established a microbial population in the digester for use in later phases, and examined metal removal by the biological floc while monitoring total solids and BOD. The high levels of mixed liquor volatile suspended solids (MLVSS) of 8,000-16,000 ppm produced in this phase were in excess of those needed for activated sludge processes. Retention time (theta c) and food-to-microorganism (F/M) ratios were considered with respect to treatment efficiency and metal removal during the second and third phases of the study. With very high MLVSS concentrations and air and mechanical mixing, a retention time as low as 10 days was sufficient for foam control and stable digester operation. Heavy metals at high concentrations did not seem to affect the microbial digester community. High pH values (above 8.5) and high MLVSS in the digesters enhanced metal uptake by the biological floc. COD removals decreased at increasing F/M ratios, and increased with increasing solids retention times for both the mixed liquor and settled effluents. Recommended parameters for optimum treatment of a similar leachate were a retention time of at least 20 days and an F/M ratio of less than 0.15 kg BOD/kg MLVSS per day.

*Activated sludge, *Leachate, *Landfills, *Heavy metals, *Biological treatment, Suspended solids, Aerobic treatment, Microorganisms, Design data, Model studies, Chemical oxygen demand, Biochemical oxygen demand, Sludge digestion, Organic loading, Waste water treatment

D510
WATER QUALITY MANAGEMENT--RESEARCH AND DEVELOPMENT AREAS,

White, M. J. D.

The Public Health Engineer, Vol. 5, No. 3, p 72-75, May, 1977. 2 fig, 49 ref.

Current areas of research and development for improved effluent quality and reduced costs are discussed with respect to practical water quality management. Methods for suspended solids removal, which generally results in the removal of BOD, include flocculation and filtration by sand filters, microstrainers, pebble beds, and grass plots. As filter media require backwashing to prevent clogging, researchers in the United Kingdom and the United States are investigating air-water backwashing and the use of dual media as more efficient, more economical methods of backwashing. Dissolved air flotation, normally used for the treatment of drinking water, has been studied recently for removal of suspended solids from effluent. The use of anaerobic processes for removal of nitrate from secondary effluents is described as an alternative to the normal physico-chemical methods of nitrate removal. Alternate methods of sludge disposal, dewatering, and stabilization are considered as means of reducing costs while maintaining high effluent quality. Automatic control systems employing sensory devices, central processing, and integrated monitoring systems are discussed.

*Research and development, *Water quality, *Biochemical oxygen demand, *Treatment, *Filtration, Suspended solids, Treatment facilities, Model studies, Pilot plants, Nitrate, Costs, Design criteria, Activated sludge, Sewage treatment, Automatic control, Waste water treatment

Water Research Centre (UK)

D511
SEWAGE SLUDGE FOR AGRICULTURAL USE,

Pierce, R. G.

Waste Age, Vol. 8, No. 6, p 6, 8-10, 114, June, 1977. 3 tab.

Problems associated with the land application of sewage sludge, and the need for regular monitoring of heavy metal and nutrient levels in sludge designated for land application, are discussed. Dangers associated with heavy metals such as zinc, copper, nickel, and cadmium include accumulation in the soil, toxicity to plants, and re-entry into the food chain through accumulation in plant tissue. Research by the USDA's Agricultural Research Service examines the controlling factors on the toxicity and uptake of heavy metals, including plant species, soil characteristics such as pH, and sludge application rates. Studies indicate that uptake is minimized at pH values above 6.5 and low concentrations of inorganic metal salts. The Agricultural Research Service recommends that, in addition to the USDA guidelines for maximum metal concentrations in land-applied sludge, soil pH should be adjusted and maintained at 6.5 or greater. Cadmium should not exceed 1.8 lbs/acre, and sludge should not be used to fertilize crops of leafy vegetables. A regular monitoring program is suggested for solids, total-N, inorganic-N, Zn, Cu, Pb, Ni, and Cd. Concentrations of Se, As, Mo, Bo, Fe, Al, Hg, Ag, Ba, Co, S, and Na should also be established as sufficiently low before sludge application is considered.

*Heavy metals, *Sludge disposal, *Fertilizers, *Absorption, *Soil-water-plant relationships, Plant growth, Toxicity, Zinc, Nitrogen, Lead, Cadmium, Copper, Soil chemical properties, Hydrogen ion concentration, Application methods, Soil treatment, Waste disposal, Sludge, Waste water treatment

D512
ULTRAVIOLET LIGHT ENHANCES OZONIZATION OF ORGANICS
DISSOLVED IN WASTEWATER,

Chemical Engineering, Vol. 84, No. 16, p 18, August, 1977.

The Westgate Research Corporation of Los Angeles, California has developed a system for the oxidation of organics from ozone-enriched waste water by exposure to a series of ultra-violet lamps. The method is reported to oxidize all dissolved organic chemicals to carbon dioxide, water, and other oxidation by-products. It also eliminates viruses and other microorganisms. Heavy metals are precipitated as oxides or metals. The process is reported to be more efficient than carbon adsorption and not much more costly. The treatment system will be marketed in 20,000 gal/day modules which may be combined to increase treatment capacity.

*Ozone, *Ultraviolet radiation, *Polychlorinated biphenyls, *Organic wastes, Organic compounds, Oxidation, Chemical degradation, Waste water treatment

D513
IS THERE A POTENTIAL FOR PARASITIC DISEASE TRANSMISSION FROM LAND APPLICATION OF SEWAGE EFFLUENTS AND SLUDGES?,

Hays, B. D.

Pittsburgh University,
Pennsylvania,
Department of Life Sciences.

Journal of Environmental Health, Vol. 39, No. 6, p 424-426, May-June, 1977. 15 ref.

The increased use of sewage treatment plant products for land application and irrigation has led to an evaluation of the fate and distribution of various protozoan cysts and metazoan eggs of human and animal intestinal parasites which can occur in sewage. A literature review includes a survey of parasitic species which have been observed in sewage in the United States. Studies on the survival of parasitic organisms showed that although reduced in number by sewage treatment processes, in particular anaerobic digestion, parasitic forms are not totally destroyed during any process. Sewage-related transmission of intestinal diseases to humans or animals has, however, always been associated with raw or partially treated sewage. An examination of sludges collected from four treatment plants in the Pittsburgh, Pennsylvania area revealed some parasitic eggs in all samples, with the parasite species being related to the waste source. Greater attention to parasites in sludge and their potential for disease transmission is recommended for land treatment and resource recovery programs.

*Animal parasites, *Pathology, *Diseases, *Sludge disposal, *Sewage treatment, Model studies, Sewage disposal, Environmental sanitation, Effluents, Fertilizers, Irrigation, Infection, Waste disposal, Waste water treatment

Allegheny County (PA), Pittsburgh (PA)

D514
SALVAGING AN OLD SEWAGE PLANT CUTS TERTIARY TREATMENT COSTS,

Construction Week, Vol. 199, No. 2, p 23-24, July, 1977.

In upgrading its waste water treatment facilities, Dallas has added activated sludge and filtration treatment to its existing trickling filter plant. The city invested $38 million to achieve 96% removal of suspended solids and BOD instead of constructing new facilities at an estimated $150 million. Pilot studies were carried out at a plant which contained an activated sludge unit, a flocculation-sedimentation unit, two filtration units, two activated carbon columns, and two chlorine contact basins. Data from this pilot plant, which was designed for flexibility to accommodate changing water quality standards, were used to evaluate design standards for the larger facility. The new plant was designed to meet standards for effluent discharged into the Trinity River of 10 ppm each for suspended solids and BOD, with provisions for more stringent future regulations. Special features in the upgraded facility include chemical control of solids in the activated sludge process and effluent filters; chlorination of activated sludge, to prevent filamentous growth during sedimentation; and the addition of polymer after aeration, to prevent concentration of solids. Annual operating costs are estimated at $7 million, a $5 million increase over previous costs for a facility without tertiary treatment.

*Tertiary treatment, *Activated sludge, *Filtration, *Model studies, *Water quality, Suspended solids, Biochemical oxygen demand, Chlorination, Polymers, Sludge treatment, Municipal wastes, Cost comparisons, Aerated lagoons, Treatment facilities, Waste water treatment

Dallas (TX)

D515
WASTEWATER TREATMENT,

Water and Wastes Engineering, Vol. 14, No. 7, p 9, July, 1977.

An advanced waste water treatment facility designed to recycle waste water for municipal and industrial use has been constructed in Fountain Valley, California. The Orange County Water District had the facility built to provide an alternative to ocean disposal of waste water and to create a hydraulic fresh water pressure barrier to sea water intrusion. Treatment processes at Water Factory 21, which receives secondary treated sewage from the Orange County Sanitation District, include: coagulation and settling, ammonia removal, pH adjustment, filtration, carbon adsorption, demineralization by reverse osmosis, and chlorination. Treated water is diluted and then undergoes deep well injection for storage.

*Water resources, *Water reuse, *Tertiary treatment, *Deep wells, *Injection wells, Waste water treatment, Saline water intrusion, Sewage treatment, Reverse osmosis, Treatment facilities, Waste disposal, Water treatment

Water Factory 21, Orange County Water District, Fountain Valley (CA)

D516
AUTOMATIC DISSOLVED OXYGEN CONTROL,

Flanagan, M. J., Bracken, B. D., and Roesler, J. F.

Flanagan and Associates,
San Francisco, California.

Journal of the Environmental Engineering Division, Vol. 103, No. EE4, p 707-722, August, 1977. 9 tab, 5 fig, 3 ref, 1 append.

Various types of air and pure oxygen dissolution control systems for use in the activated sludge process are described and evaluated. Aspects of diffused air aeration for the production of air bubbles in mixed liquor include control of centrifugal blowers and the design and operation of diffused air aeration control systems. Mechanical aerators of plate, updraft, downdraft, combination, and brush types may also be used in the activated sludge process. Possible systems for control of mechanical aeration include on-off aerator control, two-speed aerator control, variable speed aerator control, variable impeller depth control, and variable level control. Cost comparisons for automatic dissolved oxygen control systems and system components are presented. Design data for typical activated sludge plant aeration systems have been calculated according to plant size. Operation and maintenance costs, capital costs, and acquisition feasibility have been estimated for various plant sizes and control systems. The use of automatic dissolved oxygen control is suggested for activated sludge plants handling more than 1 mgd with unequal loading conditions, sufficient oxidation tank or aerator capacity, and unlimited aerator turndown capacities to provide consistent effluent quality and less strain on aeration equipment.

*Automatic control, *Dissolved oxygen, *Activated sludge, *Aeration, *Cost comparisons, Dissolved oxygen analyzers, Cost-benefit analysis, Sludge treatment, Instrumentation, Economic feasibility, Analytical techniques, Operation and maintenance, Maintenance costs, Operating costs, Energy, Waste water treatment

Automatic dissolved oxygen control

D517
RHINELANDER SOLVES I & I PROBLEMS,

Larget, R. G.

Howard Needles Tammen and Bergendoff,
Department of Environmental and Municipal Engineering,
Milwaukee, Wisconsin.

Water and Wastes Engineering, Vol. 14, No. 7, p 46, 48, 50, July, 1977. 1 fig.

In compliance with EPA regulation PL92-500 an Infiltration/Inflow Analysis, a revised environmental statement, and a facilities plan were provided before construction of a secondary treatment facility at Rhinelander, Wisconsin. The Infiltration/Inflow Analysis included field monitoring of flow in the six major service areas in the system, with HNTB-designed fiberglass weir boxes equipped with interchangeable back plates for variable sewer sizes and stage flow recorders. Field study results and past records on plant operations, climatology, and water usage were used to predict average and peak flow contributions to sub-areas within each service area. Inflow was traced to three sources: 0.12 mgd added through manhole covers, 0.20 mgd from two groceries and cooling water from an industry, and 0.03 mgd from building roof drain connections. Infiltration rates were significant for one new sewer main, but not appreciable for any area. Costs for the recommended 1.9 mgd plant expansion were projected at $1.75 million.

*Sewerage, *Infiltration, *Treatment facilities, *Inflow, *Sewers, Monitoring, Data collections, Manholes, Industrial wastes, On-site data collections, Water utilization, Waste water treatment

Rhinelander (WI)

D518
REMOVE ALGAE AND HIGH COSTS TOGETHER,

Leininger, K. V.

CH2M Hill,
Portland, Oregon.

Water and Wastes Engineering, Vol. 14, No. 7, p 32-35, July, 1977. 2 fig, 21 ref.

In response to EPA regulations on stabilization ponds and effluent quality various methods for the removal of algae, BOD, and suspended solids from effluents are discussed, with emphasis on systems handling more than 1 mgd. Methods for improving effluent quality include upgrading of existing stabilization ponds and replacement of ponds by mechanical and chemical treatment facilities. Intermittent sand filtration and the removal of algae by chemical treatment followed by granular media filtration are suggested as the two most reliable alternative methods. Two configurations for chemical treatment and filtration are presented: the replacement of ponds by a secondary treatment facility, and the addition of an initial aerated pond and chemical treatment of pond effluent to existing stabilization pond facilities. Although the second alternative may require the acquisition of additional land, its capital, operation, and maintenance costs may be 20% less than for pond replacement. Methods of sludge handling and disposal considered include air drying on sand beds, recycling of chemical-algae sludge to stabilization ponds, mechanical dewatering, and vacuum filtration. Advantages in process flexibility of stabilization ponds include fast startup and shutdown, more hydraulic flexibility, and suspended solids removal adjustment by chemical dosages. Changes in productivity with weather conditions are suggested as possible disadvantages.

*Algae, *Chemical treatment, *Suspended solids, *Ponds, *Tertiary treatment, Sewage treatment, Filtration, Aeration, Dewatering, Cost comparisons, Waste water treatment

Stabilization ponds, Sand filtration, Granular media filtration

D519
INACTIVATION OF POLIOVIRUS IN WASTEWATER SLUDGE WITH RADIATION AND THERMORADIATION,

Ward, R. L.

Sandia Laboratories,
Albuquerque, New Mexico.

Applied and Environmental Microbiology, Vol. 33, No. 5, p 1218-1219, May, 1977.
2 fig, 11 ref.

Agricultural uses of treated waste water sludge may be limited by hazardous pathogens present in sludge. Experimental methods to rid sludge of bacterial pathogens, viruses, and parasites include exposure to ionizing radiation, alone and in combination with heat (thermoradiation). Since viruses can be insulated from inactivation by raw sludge and a variety of other substances, the effect of sludge on the rate of viral inactivation by radiation and thermoradiation was investigated. For these experiments the poliovirus type 1 strain CHAT was diluted 10-fold with phosphate-buffered saline (PBS) which contained appropriate amounts of raw sludge. It was established in control experiments that the D-value (the amount of radiation necessary to inactivate 90% of the virus) in PBS without sludge was 192 krads. The addition of small amounts of sludge to the PBS significantly increased the D-value. The D-value was 332 krads for sludge containing 0.78% solids and 340 krads for 2.34% solids for samples which were heated at 47 C for 10 minutes. The D-value approaches a plateau at approximately 1.00% solids, suggesting that small amounts of sludge are nearly as protective of viruses as larger amounts. An investigation into the effect of raw sludge on poliovirus inactivation showed that although raw sludge was very protective of poliovirus against heat and radiation inactivation, the effects were not additive. This suggests that thermoradiation treatment may be an effective method of virus inactivation in waste water as long as suspended solid concentrations are low.

*Viruses, *Thermal radiation, *Irradiation, *Bioassay, Sewage treatment, Sludge disposal, Waste water treatment, Human diseases, Pathology, Waste disposal, Microbiology

*Poliovirus, Virus inactivation, Thermoradiation

D520
CURRENT SLUDGE RESEARCH AT THE WRC,

Mabey, D.

Water Services, Vol. 81, No. 976, p 347-348, June, 1977.

Current research on sludge treatment and disposal at the Water Research Center (WRC) at Medmenham, England is described. Increased aeration and supplemental oxygenation are suggested as methods of upgrading an activated sludge plant when existing facilities are no longer able to produce high-quality effluent due to increased loads. An evaluation of an oxygen injection system being used by the Welsh National Water Development Authority indicated that, in spite of higher operating costs and hazards associated with the use and storage of liquid oxygen, oxygen injection may be a viable alternative to aeration, particularly when needed on a short-term basis only. Aspects of sludge dewatering under investigation by the WRC include volume reduction by low-speed centrifugation and the role that sewage depth plays in gravity dewatering. WRC is also attempting to define the controlling factors and sludge characteristics which influence sludge settleability. Anaerobic digestion is being considered for treatment of farm and food industry wastes. Quantification of sludge stability and standard costs indices for water and sewage disposal are being examined. Cost comparisons are being prepared for alternate routes for sludge disposal. WRC is also determining the fate and distribution of hazardous substances in sanitary landfills. A survey by the WRC of farmers using treated sludge for soil conditioning indicated that fertilizing capabilities of land-applied sludge should be better defined.

*Activated sludge, *Sludge disposal, *Dewatering, *Anaerobic digestion, *Oxygenation, Aeration, Oxygen requirements, Sludge digestion, Waste water treatment, Cost comparisons, Sludge treatment

Water Research Centre, Medmenham (UK)

D521
EVALUATION OF RESIDUAL CHLORINE CONTROL SYSTEMS,

Roop, R. N.

Fischer and Porter,
Warminster, Pennsylvania.

Journal Water Pollution Control Federation, Vol. 49, No. 7, p 1591-1603, July, 1977.
19 fig, 2 tab, 6 ref.

The high economic and energy costs of chlorine and the environmental hazard posed by overchlorination have made automatic control of residual chlorine in water and waste water treatment advantageous. Three systems for automatic gas dispenser control are currently used, with the choice being controlled by flow signal present in the system. In studies to determine the actual chlorine demand of waste water, results indicated that most of the demand for chlorination was satisfied during the first five minutes of contact time and that residual decay followed an exponential function. Five strategies for automatic control of residual chlorine were investigated using a laboratory-scale chlorination system with a hypochlorite pump. An evaluation of two-mode, three-mode, sampling, two-timer, and cascade control systems indicated that there were no obvious advantages of three-mode (proportional band, reset, derivative) over two-mode control (proportional band, reset). It was determined that for performance purposes controller response time was more important than the type of controller. Cascade control is suggested for residual control when the first sample point is 5 to 15 minutes downstream from the plant. Feedforward flow pacing is suggested to minimize differences between control methods.

*Chlorination, *Disinfection, *Automatic control, *Control systems, *Equipment, *Instrumentation, Monitoring, Chemcontrol, Chemical wastes, Water pollution sources, Costs, Model studies, Pilot plants, Electronic equipment, Waste water treatment

*Residual chlorine

D522
SLUDGE PROCESSING TO OPTIMIZE DIGESTIBILITY AND
ENERGY PRODUCTION,

Haug, R. T.

Regional Wastewater Solids Management Program
(Laloma Project),
Whittier, California.

Journal Water Pollution Control Federation, Vol. 49, No. 7, p 1713-1721, July, 1977.
6 fig, 3 tab, 9 ref, 1 append.

Previous studies on the improvement of anaerobic sludge digestion by thermal pretreatment have prefaced this investigation to verify and quantify the extent of increased biodegradability due to thermal conditioning. A method for thermal pretreatment and anaerobic digestion to improve degradability and increase energy production during the processing of primary and waste-activated sludges is described, in which residual heat from thermal conditioning is used to facilitate mesophilic or thermophilic digestion. To reduce odors, a significant problem in thermally treated sludges, the thermally treated sludge and liquor are not separated, but rather sent directly to a digestion tank. Energy balances were determined for various thermal treatment-anaerobic digestion systems. Energy production was highest for a system in which thermally treated sludge was combined with untreated primary sludge. Second highest in energy production was a system in which untreated primary and waste-activated sludges were used. The digested mixture in either case, however, would not be pathogen-free. A slight expenditure of energy to produce both thermally treated primary and waste-activated sludge would, however, result in a sterilized product. Further laboratory and field studies of the process are being conducted through the Regional Wastewater Solids Management Program (Laloma Project) for the Los Angeles-Orange County Metropolitan Area.

*Anaerobic digestion, *Energy budget, *Model studies, Sludge treatment, Biodegradation, Disinfection, Odor, Dewatering, Activated sludge, Digestion, Waste water treatment

*Thermal conditioning, Sludge pretreatment, Regional Wastewater Solids Management Program (Laloma Project)

D523
SLUDGE HANDLING,

Water and Wastes Engineering, Vol. 14, No. 7, p 10, July, 1977.

Municipal sewage sludge which has been thermally conditioned at an installation in Levittown, Pennsylvania has been successfully used for fertilizing and conditioning of two one-acre plots in the Portland, Maine area. Yields of corn crops grown on the plots were not appreciably different from control plots. Application of thermally conditioned sludge did not appear to result in excessive concentrations of heavy metals or other contaminants in plant tissues or groundwater. Sludge, with solids of 35%, was reported to contain more nitrogen and phosphorus and less potassium than cow manure. Other advantages to the use of thermally conditioned sludge include application with conventional farm equipment and possible storage over long periods of time without appreciable odor problems.

*Fertilizers, *Sludge disposal, *Heavy metals, *Soil-water-plant relationships, *Plant growth, Sludge treatment, Corn (field), Agronomy, Waste disposal, Waste water treatment

Portland (ME), Levittown (PA), Thermal conduction

D524
THE WASTE WATER TREATMENT BERGSTRASSE POSSIBILITIES AND SELECTION OF THE SLUDGE TREATMENT (Die Klaeranlage Bergstrasse Moeglichkeiten und Wahl des Schlammbehandlungs-systems),

Kaufhold, W.

Gesellschaft fur Klaeranlagen und Wasserversorgung
Mannheim,
Mannheim, Germany.

Wasserwirtschaft, Vol. 67, No. 6, p 162-168, 1977. 6 fig, 2 tab, 3 ref.

A centralized waste water treatment facility is being planned by the Bergstrasse Regional Water Authority in West Germany for the processing of wastes from 9 cities and 25 townships in the Hessen and Baden-Wurtemberg areas. Sludge treatment by thermal conditioning and dewatering in chambers has been chosen for use in the processing of the 20.68 tons/day of raw sewage expected to enter the facility. Other alternatives for sludge treatment which were investigated for possible use were: incineration; chemical treatment and flocculation with $FeCl_2$ and lime or with polyelectrolytes; and anaerobic digestion. Cost estimates for construction, operation, and maintenance were prepared for the various alternatives.

*Dewatering, *Sludge treatment, *Sludge digestion, *Feasibility studies, *Cost comparisons, Waste water treatment, Flocculation, Incineration, Sludge disposal, Municipal wastes, Chemical precipitation, Filtration, Biological treatment

Thermal conditioning

D525
HYGIENIZATION OF SEWAGE SLUDGE BY ELECTRON IRRADIATION,

Tofaute, K.

Brown Boveri Review, Vol. 64, p 180-186, March, 1977. 6 fig, 11 ref.

Hygienization of sewage sludge to remove infectious bacteria and parasites is often necessary before treated sludge can be used for agricultural purposes. A method of hygienization utilizing electron irradiation is described. After screening and homogenization, digested sludge is irradiated and passed into storage tanks for subsequent disposal. Irradiation is effective in reducing coliform bacteria and Salmonella, inhibiting future growth, and inactivating viruses. Physical characteristics of sludge are not adversely affected by irradiation, while coagulation and settling abilities may improve. Although fertilizing with untreated sludge is most effective, higher grain yields have been obtained with irradiated sludge than with sludge which has been subjected to steam pasteurization, the traditional method of hygienization. Operating costs indicate that electron irradiation as a method of hygienization is economically viable when the amount of sludge produced is 250 to 400 cu m daily.

*Fertilizers, *Sludge treatment, *Irradiation, *Microorganisms, *Disinfection, Application methods, Waste treatment, Sludge disposal, Sewage treatment, Tertiary treatment, Waste water treatment

D526
TREATMENT OF EFFLUENTS,

Howell, J. A.

Swansea University,
Swansea, Wales,
Department of Chemical Engineering.

Oceans, Vol. 10, No. 3, p 63-67, May-June 1977. 2 fig.

An historical review of methods of waste treatment used over the past several centuries is presented. Environmental implications of ocean dumping and outfall pumping, the alternatives to more costly plant waste treatment, are discussed. Biological treatment methods described include trickling filters, rotating biological filters, activated sludge processing, aeration, and the deep-shaft process. Possible uses of treated sludge in aquiculture and the production of livestock feed are considered. Toxic contaminants in effluents which may present ocean pollution problems or health hazards are described, including DDT, mercury, and oil. Physicochemical methods such as coagulation, flocculation, filtration, and oxidation are described as ways to treat toxic effluents.

*Oceans, *Biological treatment, *Chemical degradation, *Sewage treatment, *Waste disposal, Sludge disposal, Aeration, Oxidation, Treatment, Outfalls, Oxidation lagoons, Industrial wastes, Municipal wastes, Aquatic life, Aquiculture, Filtration, Anaerobic digestion, Aerobic treatment, Waste water treatment

Ocean disposal, Deep-shaft method

D527
LAGOONS AND OXIDATION PONDS,

O'Brien, W. J.

Black and Veatch Consulting Engineers,
Dallas, Texas.

Journal Water Pollution Control Federation, Vol. 49, No. 6, p 1016-1019. 53 ref.

A review of literature concerning various aspects of lagoons and oxidation ponds is presented. Published proceedings of a 1975 conference on lagoons and oxidation ponds are cited. Design considerations discussed were mixing, flow patterns, aeration, and cell number. Physicochemical parameters mentioned include pH, rates of methane fermentation and volatile acid production, nutrient strength, and concentrations of ammonia, algae, DO, and sulfide. Studies on detention time and pond depth are described. The use of plants and fish to upgrade effluent, and the use of spray irrigation of oxidation pond effluent, are discussed. Soil characteristics are considered with respect to heavy metal concentrations, infiltration rate, seismic sounding, and electrical resistivity.

*Lagoons, *Ponds, *Oxidation lagoons, *Aerated lagoons, *Sewage lagoons, Photosynthesis, Nutrients, Heavy metals, Infiltration, Microorganisms, Bacteria, Effluents, Waste water treatment, Water Pollution Control Federation

D528
TREATMENT OF ORGANIC WASTE WATER BY TOWER TYPE PACKED BIOFILTER
(Jutento shiki rosho ho ni okeru kaibunshiki shori no joka sokudo),

Yoshihara, K., Udo, S., Sanbuichi, M., Fujio, Y., and Ueda, S.

Kyushu University,
Fukuoka, Japan,
Department of Food Science and Technology.

Hakko Kogaku, Vol. 55, No. 3, p 129-133, 1977. 7 fig, 10 ref.

Laboratory studies on a biological method for the treatment of organic wastes are described. Operational time, recirculation, and batch volume were considered during the examination of COD removal by a tower-type biological filter which had been filled with 400 25-mm glass spheres. Aerobic conditions and a temperature of 22 C were maintained in the 100 mm filter throughout the experiments. Results indicated that, at a given batch volume and recirculation flow rate, COD removal was directly related to operational time. COD removal was observed to increase rapidly with recirculation rate up to a rate of 111 cu m/sq m/day and approached a maximum value at 146 cu m/sq m/day. Since these effects were attributed to the activity of the biofilm, it was suggested that recirculation flow rates be chosen for maximum use of the biological film without loss of adhesion of the film to the media. In pilot studies with batch volumes of 0.002-0.012 cu m, COD removal by the filter was observed at 3 to 4 kg COD/cu m/day for recirculation flow rates between 110 and 238 cu m/sq m/day.

*Chemical oxygen demand, *Filters, *Biological treatment, *Organic wastes, Waste water treatment, Filtration, Laboratory tests, Flow rates

*Biological filters, Tower-type biological filters

D529
DISINFECTION OF WASTEWATER TASK FORCE REPORT,

1976. 59 p, 1 fig, 14 tab, 24 ref, 4 append. Technical Report EPA-430/9-75-012.

A task force survey of various aspects of waste water disinfection is presented. Major topics discussed include possible toxic effects of chlorination on aquatic life and humans, public health considerations, and disinfection methods. Recognition of the potential danger of the formation of halogenated organic compounds as a result of chlorination has prefaced an investigation into alternative disinfectants such as ozone, bromine chloride, and ultraviolet light. Dechlorination with sulfur dioxide and activated carbon is examined. Task force recommendations include disinfection of waste water wherever required to maintain public safety, further investigation of alternate disinfectants, modification of present disinfection standards for more flexibility, and close monitoring of residual chlorine levels in receiving waters.

*Chlorination, *Ozone, *Bromides, *Ultraviolet radiation, *Disinfection, Halogens, Chlorides, Chemical reactions, Toxicity, Public health, Waste water treatment, Costs, Aquatic life, Fish, Effluents

D530
CHEMICAL TECHNOLOGY AND ECONOMICS IN ENVIRONMENTAL PERSPECTIVES: TASK II. REMOVAL OF BORON FROM WASTEWATER,

Lapp, T. W., and Cooper, G. R.

Midwest Research Institute,
Kansas City, Missouri.

1976. 27 p, 7 tab, 37 ref. Technical Report EPA-560/1-76-007.

Objectives of this study on the removal of boron from waste water were to assess public concern over the presence of boron in effluents, examine current practices and literature on boron removal, and determine the role that boron plays in the activated sludge process. Surveys determined that no sewage treatment facilities and very few boron-producing or -consuming industries were attempting to remove boron from their wastes. A literature survey on the effects of boron on sewage treatment processes indicated that in large quantities (greater than 10 ppm) boron may inhibit biological processes and COD removal, but the effect was largely dependent on individual circumstances. Three methods of boron removal are discussed, including the use of ion exchange resins, lime precipitation, and liquid-liquid extractions.

*Boron, *Public health, *Water pollution control, *Sewage treatment, *Trace elements, Waste water treatment, Industrial wastes, Municipal wastes, Chemical oxygen demand, Activated sludge, Salts, Ion exchange, Separation techniques, Chemical precipitation

D531
METHODS FOR IMPROVEMENT OF TRICKLING FILTER PLANT PERFORMANCE: PART II - CHEMICAL ADDITION,

Brown, J. C., and Little, L. W.

North Carolina University,
Chapel Hill,
Department of Environmental Sciences and Engineering.

1977. 120 p, 27 fig, 38 tab, 19 ref, 2 append. Technical Report EPA-600/2-77-012.

Laboratory, pilot, and full-scale studies at the Mason Farm Waste Water Treatment Plant, Chapel Hill, North Carolina, were used to examine methods of phosphorus removal. Preliminary studies on phosphorus removal included a survey of pertinent literature, jar testing of various coagulants (lime, alum, and iron salts), studies on the quality and quantity of plant flows, and examination of the effect of the time of alum addition during high-rate trickling filtration. Full-scale studies were then conducted using the two parallel identical treatment trains at Chapel Hill, with liquid alum dosages and flow rates varying for one train and the other train serving as a control. Plant flows, digester performances, and sludge production were monitored throughout the 18-month study, as were qualitative parameters on raw waste water, primary effluents, and secondary effluents. Results indicated that overall plant operation and the removal of phosphorus were enhanced by the addition of alum, particularly with a flow-paced alum feed system, limitation of dry weather settling tank surface loadings to 20.4 cu m/sq m/day, and fine solids removal by tertiary treatment. Alum addition resulted in decreased buffering capacities, alkalinity, and pH in primary digesters and lower solids concentrations in the secondary digester. Longer sand drying was therefore required for adequate sludge dewatering. At an alum dose of 175 mg/liter and cost of $58/ton of dry alum, alum treatment costs were $41/million gallons of waste water.

*Phosphorus, *Nutrient removal, *Trickling filters, *Coagulation, Model studies, Separation techniques, Chemical precipitation, Sludge treatment, Dewatering, Filtration, Sewage treatment, Sludge digestion, Waste water treatment

*Aluminum sulfate, Chapel Hill (NC)

D532
ANAEROBIC DIGESTION OF SOLID WASTE AND SEWAGE SLUDGE TO METHANE,

Hitte, S. J.

Office of Solid Waste Management Programs,
U. S. Environmental Protection Agency,
Cincinnati, Ohio.

1975. 13 p, 2 fig, 1 tab, 9 ref. Technical Report EPA/530/SW-159.

Controlled anaerobic digestion as a means of processing organic wastes and producing methane was examined in light of the energy shortage. Comparisons with other biological processes, current research in anaerobic digestion, and cost analyses were presented. Methane production estimates and possible uses of sludge-generated methane were considered. Resource recovery concepts related to waste treatment were discussed, including use of shredding waste as a supplemental fuel, pyrolysis, waterwall incineration, hydrogasification, and methane production. A description of biological processes associated with anaerobic digestion was presented. Parameters controlling methane production, such as temperature, anaerobiosis, pH, nutrients, and toxicity, were listed. Projected costs, advantages, and disadvantages are examined for a 1,000 ton per day bioconversion plant.

*Anaerobic digestion, *Methane, *Energy conversion, *Biological treatment, *Sludge digestion, Resources, Sludge treatment, Sewage treatment, Costs, Environmental effects, Waste water treatment

Methane production

D533
HAYLE'S LONG WAIT FOR ITS SEWAGE SCHEME IS OVER,

Pullin, J.

Surveyor, Vol. 150, No. 4439, p 10-11, July, 1977.

A new sewage treatment facility in the Hayle area of West Cornwall, England is described. Construction of the new facility began in 1975, 20 years after its initial conception. The treatment facility, designed to accommodate a population of 50,000, is intended to replace existing facilities which discharged directly into the Hayle Estuary which empties into St. Ives Bay. Municipal wastes, fluctuating with the area's tourist industry, and wastes from the St. Erth Creamery will be processed. Treatment facilities include primary sedimentation, media filtration, secondary biological filters, coagulation, and dewatering by gravity filtration. A landfill is intended for sludge disposal. Plans for regionalization of sewage treatment are being considered.

*Treatment facilities, *Sewage treatment, *Sludge disposal, *Municipal wastes, Filtration, Biological treatment, Dewatering, Settling basins, Waste water treatment

Hayle, West Cornwall, United Kingdom

D534
TREATMENT OF WATER AND EFFLUENT BY AIR FLOTATION,

Journal of the Institution of Engineers (India), Vol. 26, No. 9, p 30, March, 1977.

An air flotation process in which micro-bubbles are used to clarify waste water and remove impurities is described. A recirculating hydraulic pump is used to produce water which is saturated with air or some other gas. The system is reported to remove from 90 to 99 percent of suspended solids with low flocculant consumption. Use of the system is suggested for treatment of municipal wastes and a wide variety of industrial wastes. Other advantages of the system include low energy consumption (50 to 150 Wh/sq m), compact size, immediate start-up, resistance to corrosion and clogging, and automatic operation and installation.

*Flotation, *Aeration, *Suspended solids, *Clarification, *Waste water treatment, Municipal wastes, Industrial wastes, Sludge treatment, Equipment, Sewage treatment, Hydraulic equipment, Flocculation

D535
NITRIFICATION AND HEAVY METAL REMOVAL IN THE ACTIVATED SLUDGE TREATMENT PROCESS,

Richards, P. A.

Texas A & M University,
College Station,
Department of Civil Engineering.

1976. 172 p, 23 fig, 22 tab, 101 ref. Technical Report AD/A-031 748.

The purpose of this doctoral dissertation was to examine heavy metal concentrations in municipal sewage with respect to nitrification and various points within an activated sludge waste treatment system. A laboratory-scale, continuous flow, completely mixed activated sludge system was used to examine removal of silver and chromium from synthetically produced waste. Heavy metal removal was observed to be positively related to sludge production rate, sludge metal concentration, and sludge wasting rate of metal-rich sludge. Metal removal was negatively related to system metal loading rate and wasting rate of metal-poor sludge.

*Heavy metals, *Silver, *Chromium, *Activated sludge, *Nitrification, Sludge treatment, Physicochemical properties, Chemical reactions, Separation techniques, Model studies, Waste water treatment, Sewage treatment, Effluents

D536
DISINFECTION EFFICIENCY AND RESIDUAL TOXICITY OF SEVERAL WASTEWATER DISINFECTANTS: VOLUME I GRANDVILLE, MICHIGAN,

Ward, R. W., Giffin, R. D., DeGraeve, G. M., and Stone, R. A.

Grand Valley State Colleges,
Allendale, Michigan,
Department of Biology.

1976. 144 p, 1 fig, 50 tab, 86 ref. Technical Report EPA-600/2-76-156.

Possible toxic effects associated with chlorination of waste water have prefaced this study on waste water disinfectants. Chlorine, bromine chloride, and ozone were examined for relative bactericidal efficiency and residual toxicity at a waste water treatment plant in Grandville, Michigan. The Grandville plant uses secondary activated sludge processes and chemical removal of phosphates to treat an average flow of 2.6 mgd of municipal wastes. A manually-controlled feed system with a continuous residual chlorine analyzer and recorder is used to chlorinate effluent. For study purposes, a portion of the settled unchlorinated effluent was divided into three streams for ozonation, bioassay, and disinfection with bromine chloride. A portion of the chlorinated stream was dechlorinated with sulfur dioxide. Total and fecal coliform densities, suspended solids, volatile solids, COD, ammonia nitrogen, phosphate, turbidity, color, and pH were monitored for the five waste water streams. Studies indicated that disinfection was more reliable with chlorination, with or without SO2 dechlorination, than with bromine chloride treatment. Disinfection with ozone injection was adequate only after filtration. Acute toxicity tests on Daphnia, fathead minnows, and several species of fish indicated that the toxic effects of chlorination could be eliminated with sulfur dioxide dechlorination. No toxic effects were observed for chlorobrominated or ozonated effluents.

*Disinfection, *Chlorination, *Toxicity, *Ozone, *Bromine, Aquatic life, Model studies, Environmental sanitation, Microorganisms, Environmental effects, Bioassay, Sulfides, Bactericides, Daphnia, Fish, Efficiency, Municipal wastes, Waste water treatment

Bromine chloride, Ozonation, Grandville (MI)

D537
A REVIEW OF TECHNIQUES FOR INCINERATION OF SEWAGE SLUDGE WITH SOLID WASTES,

Niessen, W., Daly, A., Smith, E., and Gilardi, E.

Roy F. Weston, Incorporated,
West Chester, Pennsylvania.

1976. 236 p, 30 fig, 47 tab, 60 ref, 4 append. Technical Report EPA-600/2-76-288.

This comparison of co-incineration with separate municipal sludge and refuse incineration provided a state-of-the-art review of co-incineration practices and examined economic feasibility, environmental effects, and economic impact. Four methods of co-incineration were chosen for further study. Applicable techniques of current users of co-incineration for mixed municipal refuse and municipal sewage sludge were described. Feasibility studies were conducted for direct-drying, indirect-drying, multiple-hearth and pyrolysis co-incineration. Air pollution aspects and emissions controls for incineration were discussed. Economic considerations include basic cost calculations and cost comparisons for separate disposal and co-incineration. Circumstances which may affect co-incineration feasibility, such as geography, local political situations, public and private considerations, and funding, were presented.

*Incineration, *Economic feasibility, *Sludge disposal, *Cost comparisons, *Reviews, Sewage treatment, Dewatering, Environmental effects, Municipal wastes, Waste water treatment

*Co-incineration, Direct-drying incineration, Multiple-hearth incineration, Indirect-drying incineration, Emissions controls, Incineration methods

D538
RESIDUAL WASTE BEST MANAGEMENT PRACTICES: A WATER PLANNER'S GUIDE TO LAND DISPOSAL,

Neptune, M. D.

1976. 285 p, 26 fig, 46 tab, 4 append. Technical Report WPD EPA-440/9-76-022.

A handbook for waste disposal is presented to aid in decision-making in water quality management. Nine residual waste categories are discussed, including waste water sludge, septage residuals, water treatment, municipal refuse, combustion and air pollution control residuals, industrial wastes, feedlot residuals, mining wastes, and dredge spoil residuals. Quality, quantity, environmental effects, and compliance regulations are discussed for each waste category. Methods of ultimate waste disposal discussed include land application, waste reutilization, trench disposal, and ocean disposal. Various technical and scientific aspects which may affect waste disposal decisions include climate, topography, groundwater infiltration and hydraulics, subsurface chemistry, and vegetation. Legal consequences of alternative residual waste management plans and waste disposal regulations are discussed. Planning processes necessary to develop an effective comprehensive residuals management program are outlined and illustrated for a hypothetical example. Appendices to this report discuss field monitoring and sampling, laboratory procedures for residual wastes, a site evaluation checklist for land disposal, and a glossary of related terms.

*Waste disposal, *Landfills, *Sludge disposal, *Water management (applied), Costs, Water pollution sources, Industrial wastes, Municipal wastes, Farm wastes, Ultimate disposal, Underground waste disposal, Environmental effects, Legal aspects, Management, Waste water disposal

D539
BACKWASH OF GRANULAR FILTERS USED IN WASTEWATER FILTRATION,

Cleasby, J. L., and Baumann, E. R.

1977. 381 p, 110 fig, 53 tab, 145 ref, 1 append. Technical Report EPA-600/2-77-016.

The design, operation, and maintenance of deep granular filters used in waste water treatment are examined, with special emphasis on bed design, media size, and bed cleaning by backwashing for single-, dual-, and triple-media filters. Backwashing methods discussed include water fluidization, air scour followed by water fluidization, face wash and subsurface wash before and during water fluidization, and simultaneous air scour and subfluidization water backwash. Backwashing by water fluidization alone is considered too inefficient since abrasion between filter grains was negligible. Simultaneous air scour and subfluidization backwash of coarse sand filters is considered the most effective method of backwash, but results in media loss for finer materials. The remaining methods are considered acceptable for single-, dual-, and triple-media filters. Studies on filter performance indicate that filtering abilities of dual- and triple-media filters were comparable. Filter bed expansion, media intermixing, and the use of dual media are further examined. Filter designs are discussed with respect to performance and media size. A literature survey on waste water filtration and backwashing is presented.

*Filters, *Particle size, *Packed beds, *Equipment, *Filtration, Cleaning, Operation and maintenance, Separation techniques, Clarification, Sewage treatment, Waste water treatment

*Backwashing, Granular filters

D540
WATER RELATED UTILITIES FOR SMALL COMMUNITIES IN RURAL ALASKA,

Puchtler, B., Reid, B., and Christianson, C.

Arctic Environmental Research Station,
Corvallis Environmental Research Laboratory,
College, Alaska.

1976. 82 p, 17 fig, 5 tab, 5 ref. Technical Report EPA-600/3-76-104.

The Alaska Village Demonstration Projects (AVDP) were implemented to examine practical solutions to water supply and waste disposal problems where difficult terrain, unfavorable soil conditions, and severe climate prohibit conventional treatment methods. Major objectives of AVDP were to construct and evaluate central community facilities for communities where water distribution and collection systems were unpractical. Design data for the facilities at Wainwright and Emmonak are presented. Treatment of the high quality raw water for drinking purposes included only filtration, carbon adsorption, and chlorination. Treatment systems were provided for graywater (laundry, shower and sink waste water) and blackwater (toilet waste water). Since year-round sources of liquid water were not available, graywater was treated for reuse. Graywater treatment included disinfection with a quarternary ammonium compound, upflow clarification with lime, and chlorination. One problem associated with graywater treatment was variation in plant performance caused by influent temperature fluctuations and sludge carryover from the upflow clarifier. Blackwater was carried to the central facility, chemically treated, centrifuged, and incinerated. The community centers also provided laundry and bathing facilities and potable water for the village inhabitants. The Central Community Facility concept was a viable method of providing water services to Alaskan villages when combined with a vehicular distribution and collection system.

*Treatment facilities, *Alaska, *Cold regions, *Sewage treatment, *Municipal wastes, Laundering, Domestic wastes, Potable water, Water utilization, Water reuse, Waste treatment, Incineration, Pilot plants, Model studies, Chemical degradation, Public health, Waste water treatment

Central community facility concept

D541
NEW DEVELOPMENT,

Effluent and Water Treatment Journal, Vol. 17, No. 6, p 275, June, 1977.

A series of rotary drum microscreens produced by Paterson Candy International Limited is described. The microscreens are designed for sewage and water treatment and are used in the treatment of storm water overflows, final effluent polishing, BOD and turbidity removal, and algae and plankton removal. Water flows in through the open end of a horizontally rotating drum which is covered with panels of filter mesh. Filtered water flows out of the drum radially, leaving suspended solids inside the drum. The individually replaceable filter mesh panels contain a rigid polypropylene support grid at 20 mm square intervals and can be used with any commercially available media, including stainless steel mesh and polyester fabric. Continuous spray, time-sequenced and headloss monitoring are contained in backwash spray systems for filter cleaning and removal of retained solids.

*Filtration, *Screens, *Equipment, *Tertiary treatment, *Water treatment, Suspended solids, Biochemical oxygen demand, Turbidity, Clarification, Waste water treatment

Rotary drum microscreens

D542
BRISBANE COUNCIL'S FIRST IN AUSTRALIA AT SEWERAGE TREATMENT PLANT,

Engineers Australia, Vol. 49, No. 16, p 26, June, 1977.

Aluminum gantries furnished by Highgate Engineers are being used at the Luggage Point sewage treatment plant in Brisbane, Australia. Advantages to the use of the lightweight aluminum gantries include resistance to corrosion by the abrasive atmosphere of Moreton Bay, and reduced construction requirements for the load-bearing walls. The gantries will service four 4.4 hectare sludge drying beds, removing dried sludge, distributing sludge from digestion tanks to drying beds, and placing sand media in the beds. The first stage of the Luggage Point treatment facility is designed for sewage treatment for a population of 500,000 at a cost of $30 million; the second stage will be a duplication of the first.

*Treatment facilities, *Drying, *Sludge treatment, *Aluminum alloys, *Equipment, Separation techniques, Design data, Australia, Construction materials, Waste water treatment

Luggage Point, Brisbane, Australia, Sludge drying, Aluminum gantries

D543
GRANULAR ACTIVATED CARBON IN WATER TREATMENT,

McCreary, J. J., and Snoeyink, V. L.

Illinois University,
Urbana,
Department of Civil Engineering.

Journal of the American Water Works Association, Vol. 69, No. 8, p 437-444, August, 1977. 6 fig, 39 ref.

The use of granular activated carbon filtration in water treatment is reviewed. Activated carbon treatment is normally used to reduce odor and color derived from organics which may be added to water by industrial and municipal discharges, agricultural runoff and other nonpoint sources, decaying vegetation, and reaction of water-treatment chemicals such as chlorine with organic aqueous matter. The efficiency of granular activated carbon treatment for removal of biologically derived odor and carbon chloroform extract, odors of industrial origin, sulfide odor, pesticides, hydrocarbons, and haloforms is discussed. Various carbon types are examined for relative efficiencies of total organic matter removal. The presence of organic chlorine is considered for carbon choice. Pretreatment effects on the adsorption process resulting from clarification, ozonation, chlorination, softening, and manganese removal are described. Studies on competitive adsorption are referenced for bisolute systems and for single compounds in the presence of natural organic matter. Monitoring procedures, bed design, pilot studies, and biological activity in granular activated carbon beds are examined.

*Activated carbon, *Adsorption, *Odor, *Water quality, *Color, Organic compounds, Organic wastes, Model studies, Pilot plants, Organic matter, Water properties, Water treatment, Municipal wastes, Industrial wastes, Chlorination

Granular activated carbon

D544
CHARACTERISTICS OF PERCOLATE OF SOLID AND HAZARDOUS
WASTE DEPOSITS,

Brunner, D. R., and Carnes, R. A.

Solid Waste Research Division,
U. S. Environmental Protection Agency,
Cincinnati, Ohio.

Journal of the American Water Works Association, Vol. 69, No. 8, p 453-457, August, 1977. 6 tab, 22 ref.

Deleterious effects on groundwater and surface water of land disposal of municipal and industrial wastes have prefaced this review of waste disposal practices and percolates emanating from waste disposal sites. The nature and extent of land disposal problems are discussed with respect to the geographic distribution of waste, pollution control legislation, and the entry of waste contaminants into the hydrologic cycle. Common disposal methods considered include dumping, burial, and land application. Physical and chemical characteristics of percolates from municipal solid waste are described, including volumetric production, chemical composition, and the presence of pathogens and toxic organic compounds. Other hazardous wastes considered include arsenic, polychlorinated biphenyls, and heavy metals.

*Waste dumps, *Irrigation practices, *Landfills, *Waste disposal, *Environmental effects, Return flow, Sewage disposal, Underground waste disposal, Water pollution sources, Polychlorinated biphenyls, Heavy metals, Solid wastes, Municipal wastes, Percolating water, Waste water treatment, Industrial wastes

D545
VISCOSITY EFFECTS OF SLUDGE,

Water and Waste Treatment, Vol. 20, No. 6, p 34, 36, June, 1977.

Research by BHRA Fluid Engineering, Cranfield, Bedford, United Kingdom, on the viscosity effects of sewage sludge on rotodynamic pump performance and pipeline friction is described. BHRA in collaboration with the Water Research Center will also attempt to define limits of sludge solids concentrations for economical pumping and to correlate pump performance with sludge characteristics. A literature survey and on-site testing will be used in the evaluation program.

*Physical properties, *Sludge treatment, *Pump testing, *Pumps, Sludge, Model studies, Analytical techniques, Design criteria, Waste water treatment

*Sludge viscosity, Sludge characteristics, Water Research Center (UK)

D546
HIGH RATE FILTER AT RUGBY,

Water and Waste Treatment, Vol. 20, No. 6, p 14, June, 1977.

Rugby Water Reclamation Works in England has begun using a high rate filter manufactured by Norton Chemicals Process Products Limited, Stoke-on-Trent, in the treatment of a daily waste water flow of 15,000 cu m/d. A four-arm stainless steel trough-type distributor which is supported on a 1.2 m heavy-duty bearing is used to conduct waste water into the filter. The filter itself is 30 meters in diameter and filled with 200 cu m of plastic media. Effluent quality was increased from 33-39 mg/liter BOD and suspended solids to 19-23 mg/liter BOD and suspended solids with the use of the high rate filter. BOD of settled influent was reduced by 85% to 30 mg/liter.

*Filters, *Packed beds, *Filtration, *Sewage treatment, Biochemical oxygen demand, Effluents, Treatment facilities, Waste water treatment

*High rate filters, Plastic filter media

D547
MUNICIPAL WASTEWATER TREATMENT PLANT SLUDGE AND LIQUID SIDESTREAMS,

Kalinske, A. A.

Camp, Dresser, McKee, Incorporated,
Boston, Massachusetts.

1976. 123 p, 3 fig, 4 tab, 204 ref, 1 append. Technical Report EPA 430/9-76-007.

A general review of municipal waste water treatment plant sludge and liquid sidestreams is presented. Sludge characteristics are discussed for primary treatment, secondary treatment with trickling filters or activated sludge treatment, chemical treatment, and septic tanks. Various physical, biological, and chemical methods of sludge stabilization are described. Sludge thickening by gravity thickening, pressurized-air flotation, and centrifugation is discussed. Supernatants from biological digesters are considered with respect to aerobic and anaerobic digestion, treatment methods, and elutriation. Chemical conditioning, thermal treatment, and freezing are examined for sludge conditioning. Sludge dewatering and sidestreams produced by sand beds, vacuum filtration, centrifugation, filter presses, and screens are discussed. Various methods of sludge disposal considered include incineration, wet air (high-pressure) oxidation of liquid sludge, land application, landfill disposal, ocean and surface water disposal, deep well or underground injection, pyrolysis, and composting. Sludge reclamation and tertiary treatment methods are considered.

*Sludge treatment, *Dewatering, *Sludge digestion, *Filtration, *Incineration, Reviews, Separation techniques, Sewage treatment, Tertiary treatment, Incineration, Waste water treatment

D548
WANTED: BETTER WAYS TO CLEAN WATER,

Environmental Science and Technology, Vol. 11, No. 8, p 748-749, August, 1977. 1 fig.

Highlights of the Second Joint Conference of the Chemical Institute of Canada and the American Chemical Society in Montreal are discussed. Suggested methods for the removal of toxic organics in water or waste water treatment include the use of granular activated carbon and synthetic resins. Discussions on the application of ozone for disinfection and for removal of color, odor, and bad taste are described. Electrolysis with NaCl as the electrolyte is considered. The use of closed waste treatment systems to solve effluent problems, the need for groundwater protection, and the levying of pollution fines were also considered.

*Organic wastes, *Ozone, *Activated carbon, *Resins, *Electrolysis, Water management (applied), Groundwater, Disinfection, Effluents, Industrial wastes, Municipal wastes, Waste water treatment, Water treatment

Chemical Institute of Canada, American Chemical Society

D549
WASTE WATER TREATMENT SYSTEM,

Chemical Engineering, Vol. 84, No. 16, p 44, August, 1977.

A waste water treatment system for the processing of more than 10 mgd of industrial or municipal waste is being marketed by the Mixing Equipment Corporation in Rochester, New York. The system is reported to reduce BOD and suspended solids satisfactorily in the activated sludge process using sludge with initial suspended solids concentrations of up to 3000 mg/liter. Other aspects of the system include mechanical aerators for oxygenation of waste water, integral clarifiers for surface and settled sludge removal, and a large aeration basin. Operating conditions for the system are placed at mixed-liquor suspended-solids concentrations of 3000 mg/liter.

*Activated sludge, *Suspended solids, *Industrial wastes, *Municipal wastes, *Equipment, Biochemical oxygen demand, Aeration, Clarification, Sludge treatment, Treatment facilities, Waste water treatment

D550
THE CONSTRUCTION OF THE FIRST PHASE OF THE MODERNISATION OF SHIELDHALL SEWAGE WORKS IN GLASGOW,

Motion, J. T.

W. A. Fairhurst and Partners,
Glasgow, Scotland.

Chartered Municipal Engineer, Vol. 104, No. 7, p 121-127, July, 1977. 5 fig.

Plans for expansion by Fairclough Ltd. of the Shieldhall sewage treatment plant in Glasgow, Scotland, to provide biological treatment of up to 144 mgd of municipal and industrial wastes are described. The first phase of the two-part project is based on treatment needs of a design dry weather flow of 48 mgd with reserved space for future expansion. Construction details for the sewage collection system are presented. Sulfate-resistant cement externally coated with bitumastic plastic was used in sewer pipes to prevent corrosion by the area's acidic soils. A low level pumping station is used to transport wastes for an interceptor sewer to the pre-sedimentation works. The pre-sedimentation works include an entry channel, screening bays, six trapezoidal grit channels, and associated penstocks to the six screw pumps. Six screw pumps lift the sewage to permit gravity flow to the primary sedimentation tanks and the rest of the treatment facility. Construction details for the sludge pumphouse, sludge holding tanks, and tanker bay which follow the primary sedimentation tanks are provided. Storm tanks are being constructed to accommodate flows entering the system in excess of pre-sedimentation works capacity. The design of the storm tanks is analogous to that of the primary tanks except the storm tanks are constructed below the water table. Outfall works will be used at Shieldhall until biological treatment facilities are completed in the second phase of the project.

*Treatment facilities, *Construction, *Construction materials, *Sewerage, *Settling basins, Construction costs, Engineering structures, Concrete technology, Sewage treatment, Biological treatment, Municipal wastes, Design data, Structural engineering, Waste water treatment

Shieldhall, Glasgow, Scotland

D551
SEWER RENOVATION TECHNIQUES,

Surveyor, Vol. 150, No. 4440, p 15-16, July, 1977.

Methods of sewer rehabilitation in England which save replacement costs are reviewed. Mortar repointing for old brick sewers is described. Chemical grouting can be used to stabilize soil, fill voids around the sewer pipe, and seal small cracks or leaking joints. A chemical grout injection system developed by the American Cyanamid Company is described. Grouting equipment is positioned with the aid of closed-circuit television and a pneumatic packing device is used to isolate the section for repair. The use of waterproofing and sealing compounds is described as another method of non-structural sewer repair. Structural renovation methods which involve laying another pipe within an existing sewer are described. Slip-lining with polyethylene pipe can be used to renovate non-man-entry sewers. Pre-shot segmented sections of Gunite concrete or Gunite spray application can be used in man-entry sewers. Reduction in sewer size with lining implacement is considered as a limiting factor on structural renovation methods. Panelling with glass-reinforced cement or glass-reinforced plastics is considered. Panels can be installed without flow interruption, replaced individually, and preformed to the sewer profile.

*Sewers, *Pipes, *Repairing, *Maintenance, *Plastic pipes, Cast-in-place structures, Concrete pipes, Pipelines, Infiltration, Resins, Grouting, Cement grouting, Chemical grouting, Construction materials, Sealants

*Sewer rehabilitation, Slip liners

D552
TREATMENT IN THE SEWER CUTS THE WORKS' LOAD,

Pullin, J.

Surveyor, Vol. 150, No. 4440, p 21-22, 27, July, 1977.

In-sewer treatment with the addition of oxygen or air to anaerobic sewage has been used to curb sewage septicity, prevent build-up of sulfides, and extend treatment plant capacities. Compressed air or oxygen can be added to a rising main discharging to the works or to a pressure main that has a continuous upward slope. Dissolved oxygen levels in sewage can also be increased by the addition of hydrogen peroxide which gradually decomposes to yield water and oxygen. Approximately 50 treatment facilities in the United Kingdom currently use dissolved oxygen injection in rising mains to prevent sulfide build-up. The Water Research Center investigated anaerobic conditions in gravity sewers and found that aeration caused by turbulent flow was responsible for oxidizing up to 20 percent of organic impurities in sewage, and that anaerobic digestion partially treats sewage if dissolved oxygen levels are insufficient for aerobic processes. The addition of dissolved oxygen is also reported to increase settling basin performance. A pilot study by the Wessex Water Authority indicated that the use of an oxygen injection system can reduce BOD and suspended solid loads by approximately 50 percent, sludge volume by 10 percent, and pump power requirements by about 8 percent, as well as eliminate filamentous Leucothrix bacteria from sewage.

*Sewers, *Sewage treatment, *Dissolved oxygen, *Aeration, *Anaerobic conditions, Anaerobic digestion, Sulfides, Biochemical oxygen demand, Suspended solids, Treatment facilities, Sewerage, Settling basins, Waste water treatment

Hydrogen peroxide, Oxygen injection systems, Sewage pretreatment

D553
CONVEYOR SYSTEM MOVES SEWAGE QUICKLY, PREVENTS SPILLAGE,

Water and Sewage Works, Vol. 124, No. 8, p 47-48, August, 1977.

A belt conveyor system manufactured by the Bucket Elevator Company is being used at a sewage treatment facility in East Windsor Township, New Jersey, to move sewage, grit, and other solid and semi-solid waste products quickly and without spillage. Belting with corrugated siding is used to remove wastes from filters, screening devices, and centrifuges. The Corra-Trough conveyor meets the system's requirements of flexibility for maximum use of limited floor space and adjustability for accommodation of several sizes of trucks. Sludge dewatering at the East Windsor plant is accomplished by a Permutit DCG dewatering device, and a multi-roll press. A combination of four 12-inch wide conveyors, three portable and one stationary with adjustable discharge height and cleats, transports sludge between the dewatering device and multi-roll press. Conveyors also deposit material on an inclined conveyor for final disposal into a truck. Response to the system's maneuverability and maintenance was favorable.

*Conveyance structures, *Equipment, *Sludge treatment, *Sludge disposal, *Dewatering, Treatment facilities, Sewage disposal, Sewage treatment, Waste water treatment

Conveyor belts, East Windsor Township (NJ)

D554
COTTONVALLEY--THE ATTRACTIVE SEWAGE WORKS,

Pullin, J.

Surveyor, Vol. 150, No. 443, p 9, May-July, 1977.

The Cottonvalley sewage treatment facility at Milton Keynes, United Kingdom, is described. Commissioned by the Anglian Water Authority, the treatment plant was designed to relieve overloading of works at Bletchley and Wolverton. The facilities include automatic screen raking, Archimedean screw pumps, four primary settling tanks, four aeration tanks, and eight secondary settling tanks. Tertiary treatment will be provided by eight high-rate sand filters. Incineration will be the primary means of sludge disposal. The plant capacity will initially be designed for a population of 117,000 with later modification to increase the capacity to a population of 275,000.

*Treatment facilities, *Sewage treatment, *Tertiary treatment, *Settling basins, Municipal wastes, Incineration, Sludge disposal, Sludge treatment, Waste water treatment

Cottonvalley (UK), Milton Keynes (UK), United Kingdom

D555
BACTERIAL AND VIRAL PATHOGENS ASSOCIATED WITH LAND
APPLICATION OF ORGANIC WASTES,

Elliot, L. F., and Ellis, J. R.

Washington State University,
Pullman,
College of Agricultural Research Center.

Journal of Environmental Quality, Vol. 6, No. 3, p 245-251, July-September, 1977.
1 fig, 1 tab, 57 ref.

Hazards associated with possible bacterial and viral pathogens present in sewage are considered with respect to land application of organic wastes as a means of sludge disposal. The effects of waste treatment on virus survival and the removal and survival of bacterial pathogens are discussed. Factors which affect bacterial and virus survival in soil are reviewed. Pathogen dispersion by aerosols produced by waste and water treatment by sprinkler irrigation is examined. A number of studies on pathogens present in sewage sludge and on transmission of enteric diseases through waste water irrigation or sludge application for agricultural purposes are referenced. Factors which affect transmission probability of enteric diseases by land-applied wastes are discussed, including virulence, quantity, and waste-loading rates. Suggested application practices include restraint in sludge application during the current growing season for root crops and one month before harvest for above-ground crops. Restriction of grazing for 2 to 3 weeks after waste application is also recommended.

*Pathogenic bacteria, *Soil amendments, *Soil-water-plant relationships, *Viruses, *Enteric bacteria, Waste disposal, Aerosols, Sludge disposal, Municipal wastes, Disinfection, Water reuse, Crop production, Fertilizers, Return flow, Sewage disposal, Waste water treatment

D556
EFFECT OF DRIED ANAEROBICALLY DIGESTED SEWAGE SLUDGE ON YIELD
AND ELEMENT ACCUMULATION IN TALL FESCUE AND ALFALFA,

Stucky, D. J., and Newman, T. S.

Southern Illinois University,
Carbondale,
Department of Plant and Soil Science.

Journal of Environmental Quality, Vol. 6, No. 3, p 271-274, July-September, 1977.
5 tab, 13 ref.

This study was initiated to examine the effect of three application rates of dried anaerobically digested sludge on two different soil media on the establishment, yield, duration, and element accumulation in tall fescue and alfalfa. In a greenhouse study, acid strip-mine spoil and agricultural soil were used to compare plant growth in sewage-amended and untreated media. Sludge was applied at 0, 314, and 627 metric tons/hectare to the agricultural soil control and the strip mine spoil. Plant yields were significantly higher for strip-mine spoil amended with 627 metric tons/ha and for agricultural soil amended with 314 and 627 metric tons/ha. Concentrations of Mn, Ni, Cd, Zn, and Cu were measured in plants and soils. Concentrations of Mn, Zn, Ni, and Cd in tall fescue and alfalfa grown in strip-mine spoils were higher at higher sludge application rates. Sludge application rate did not affect Cu uptake. Concentrations of Mn, Zn, Ni, and Cd in tall fescue were highest during the 180 to 200 day growth period. For alfalfa Mn and Cd peak concentrations occurred during the same period, but Zn, Cu, and Ni uptake decreased with time. The study suggested that plant growth and erosion control in acid strip-mine spoils (pH 3.5) may be accomplished by dried sewage sludge applications of 314 metric tons/ha to a depth of 10 cm.

*Anaerobic digestion, *Fertilizers, *Alfalfa, *Fescues, *Sludge disposal, Spoil banks, Strip mine wastes, Heavy metals, Soil amendments, Nutrients, Sewage disposal, Soil-water-plant relationships, Plant growth, Erosion control, Hydrogen ion concentration, Soil treatment, Acidic soils, Waste disposal

D557
DISINFECTION OF MUNICIPAL WASTE WATER WITH GAMMA RADIATION,

Melmed, L. N.

City Health Department,
Laboratory and Technical Services Branch,
Johannesburg, South Africa.

Water SA, Vol. 2, No. 3, 131-135, July, 1976. 2 fig, 4 tab, 2 ref.

Gamma radiation disinfection was investigated for various effluents from the Johannesburg City Council's Northern Waste Water Purification Works in South Africa. The treatment facility uses two-stage biological filtration in the treatment of 105,000 cu m/day of municipal waste water. Major objectives of the study were to establish required doses of gamma radiation for disinfection of settled filter effluent and maturation pond effluent, and to determine whether disinfection could be enhanced by the use of gamma radiation in conjunction with chlorine. Radiation doses of from 10 to 2,000 krad using Cobalt 60 as the radiation source were applied to effluents at dose rates ranging from 36,000 to 42,000 rads per minute. Necessary dosages to reduce the E. coli content of settled filter effluent to less than 1,000 per 100 ml for irrigation or industrial reuse were 50 krad of gamma radiation, 4.3 mg/liter of chlorine, or 1 mg/liter of chlorine in combination with 30 krad of gamma radiation. E. coli were reduced to zero per 100 ml in maturation pond effluent with a minimum applied dose of 50 krad. To achieve drinking standards, dosages of 200 krad for maturation pond effluent and 2,000 krad for settled effluent would be necessary.

*Disinfection, *Gamma rays, *E. coli, *Chlorination, *Return flow, Municipal wastes, Radiation, Potable water, Water utilization, Sewage treatment, Effluents, Waste water treatment

Gamma radiation disinfection

D558
A REVIEW OF BIOLOGICAL PHOSPHORUS REMOVAL IN THE ACTIVATED SLUDGE PROCESS,

Barnard, J. L.

P. G. J. Meiring and Partners,
Sunnyside, South Africa.

Water SA, Vol. 2, No. 3, p 136-144, July, 1976. 9 fig, 12 ref.

Conditions necessary for optimum phosphorus removal during activated sludge treatment have been examined with bench-scale studies and observations of existing plug-flow systems such as those in San Antonio, Baltimore, and Los Angeles, and of the Pho-strip and Bardenpho methods of phosphate removal. Laboratory studies on phosphate removal indicated that higher pH values caused by CO2 stripping were probably not the only cause of phosphate removal during activated sludge treatment, and that the presence of nitrates reduced or eliminated phosphate removal. Anaerobic processes which are hindered in the presence of nitrates are postulated as the major contributor to the removal of phosphates. The Phorodex phosphate removal system in which an anaerobic basin is placed at the head of an activated sludge system to reduce the effects of nitrates is described. Clarifier underflow and feed are mixed in the basin to remove phosphate. Either an aeration basin for nitrification, or a series of anaerobic and aerobic basins for nitrification and denitrification, can be used after initial treatment in the anaerobic basin.

*Phosphates, *Nutrient removal, *Nitrification, *Denitrification, *Activated sludge, Anaerobic conditions, Design criteria, Biological treatment, Hydrogen ion concentration, Carbon dioxide, Aeration, Sewage treatment, Waste water treatment

Phosphate removal, San Antonio (TX), Baltimore (MD), Los Angeles (CA), Phorodex phosphate removal

D559
EFFECTIVE PHOSPHORUS REMOVAL FROM SEWAGE BY BIOLOGICAL MEANS,

McLaren, A. R., and Wood, R. J.

National Institute for Water Research,
Council for Scientific and Industrial Research,
Pretoria, South Africa.

Water SA, Vol. 2, No. 1, p 47-50, January, 1976. 5 fig, 1 tab, 5 ref.

The role of anaerobic processes in efficient biological removal of phosphorus was investigated in laboratory studies and pilot plant experiments. Settled domestic sewage from a pilot plant at Daspoort, Pretoria, South Africa, was used in a laboratory unit to treat 36 liters of sewage per day. Detention under anaerobic conditions for 15 days resulted in average COD removal of 93.4%, total nitrogen of 76.4%, total phosphorus of 95.1%, and calcium of 4.0%. Pilot experiments were conducted to examine how phosphate removal was affected by the addition of an anaerobic basin at the feed inlet before the three in-series denitrification basins. Phosphate was not effectively removed with this configuration, but was rapidly removed when the anaerobic basin was altered to two in-series basins of two-hour retention each. Laboratory-batch studies using pilot plant sludge indicated that biological mechanisms were probably responsible for phosphate removal, since both aeration and the addition of nitrate caused rapid uptake of phosphates which had been released under anaerobic conditions.

*Phosphates, *Nutrient removal, *Nitrification, *Denitrification, *Anaerobic conditions, Biological treatment, Sewage treatment, Pilot plants, Model studies, Sludge treatment, Aeration, Absorption, Waste water treatment

Phosphate removal

D560
STUDIES ON DISINFECTION AND CHEMICAL OXIDATION WITH OZONE AND CHLORINE IN WATER RECLAMATION,

Ross, W. R., van Leeuwen, J., and Grabow, W. O. K.

National Institute for Water Research,
Pretoria, South Africa.

Water SA, Vol. 2, No. 1, p 25-32, January, 1976. 6 fig, 2 tab, 35 ref.

Laboratory and pilot plant studies were used to examine the feasibility of ozone treatment for chemical oxidation of refractory organic compounds and disinfection in the reclamation of potable water from sewage. Test bacteria were isolated from humus tank effluent exposed to chlorine or ozone at a pilot plant. Sand-filtered effluent from the Stander Water Reclamation Plant at Daspoort, Pretoria, South Africa, was also used in disinfection studies. Laboratory studies indicated that Pseudomonas aeruginosa, Aeromonas hydrophila, and Acinebacter anitratum were more resistant to destruction by ozone and chlorine than E. coli, the common indicator organism. Although there was little difference in disinfection efficiencies of chlorine and ozone in chlorine demand-free water, ozone was at least four times more efficient in water with a chlorine demand. The lower disinfection efficiency of chlorine was attributed to the formation of chloramines in the presence of nitrogen compounds. Studies on the chemical oxidation of pesticides and detergents by ozone indicated that ozone, unlike chlorine, was highly effective in oxidizing parathion, fenthion, lindane, dieldrin, Manoxol OT, and LAS. A combination of ozonation, activated carbon filtration, and chlorination is recommended to improve efficiency and reduce costs of water reclamation from waste water.

*Ozone, *Chlorination, *Disinfection, *Return flow, *Water reuse, Bactericides, Microorganisms, Potable water, Sewage treatment, Pesticides, Detergents, Chemical wastes, Oxidation, Chemical degradation, Tertiary treatment, Municipal wastes, Pilot plants, Model studies, Waste water treatment

Ozonation

D561
A GUIDE FOR THE DESIGN OF DISSOLVED-AIR (PRESSURE)
FLOTATION SYSTEMS FOR ACTIVATED SLUDGE PROCESSES,

Bratby, J., and Marais, G. v. R.

Capetown University,
South Africa,
Department of Water Resources and Public Health Engineering.

Water SA, Vol. 2, No. 2, p 87-100, April, 1976. 20 fig, 8 ref.

Flotation or sedimentation may be used to produce solids separation in the activated sludge process. A dissolved-air (pressure) flotation system, containing a flotation unit and a saturator, is used to clarify or separate the solid phase from the liquid phase and thicken or dewater separated solids. Associated costs, efficiency, and sludge characteristics produced by flotation and sedimentation are compared. Operational considerations are described for the use of flotation in activated sludge treatment, including influent solids concentrations, the optimum air/solids ratio, and float solid depth. Design considerations examined for flotation systems include air dissolution control, total and partial pressurization, inlet arrangements for partial pressurization, downflow rate in design for clarification, design flow for loading fluctuations, float thickening and removal, process variables, float stability, maximum practicable size, scraper requirements, and subsequent float handling. An activated sludge plant operating at 4,500 kg/day total settleable solids and a hydraulic retention time of 0.5 days is used in design examples for a flotation system for clarification of whole mixed liquor flow and for a flotation system for thickening waste sludge to 4 percent (40 g/liter).

*Flotation, *Activated sludge, *Settling basins, *Design criteria, *Suspended solids, Separation techniques, Dewatering, Sludge treatment, Design data, Clarification, Costs, Model studies, Sewage treatment, Waste water treatment

Flotation systems

D562
DECEPTIVE HORSE BARN,

Consulting Engineer, Vol. 49, No. 2, p 112, 114, August, 1977.

A sewage treatment facility has been designed to treat from 25,000 to 150,000 gallons of waste water from raw sewage generated at Kentucky Horse Park. The park's sewage treatment plant, housed in two barn-like structures, will also supply fertilizer and irrigation water for the park's 23 acres of pasture land. Waterproof gravity-flow sewer lines are used to collect waste water. The facility includes three concrete lagoons and an aerobic secondary biological treatment process system manufactured by Autotrol of Milwaukee, Wisconsin. The project, which treats wastes from the park's one to two million annual visitors, was designed and engineered by Central Associated Engineers, Versailles, Kentucky.

*Treatment facilities, *Biological treatment, *Sludge disposal, *Sewage treatment, *Recreation facilities, Fertilizer, Sewage treatment, Aerobic treatment, Waste water treatment

D563
GAS TURBINE GEN-SETS FOR SEWAGE TREATMENT STANDBY,

Diesel and Gas Turbine Progress, Vol. XLIII, No. 8, p 56-57, August, 1977.

A dual drive, 3300 kW (continuous), Allison gas turbine generator set using the 501 KA engine is being provided for a waste water treatment plant in West Babylon, New York by the Western Engine Company of Addison, Illinois. The turbine generator will be used at the 30 mgd plant to power a 1725 hp blower for aeration, as well as various lift stations. It will also provide emergency power in case of a utility power failure. The generator set contains two gas turbine engines operating at 13,780 rpm and is started by a hydraulic high pressure pump within 36 seconds. Additional design and operating standards for the turbine set are presented.

*Turbines, *Generators, *Electric power, *Equipment, *Hydraulic turbines, Design data, Power operation and maintenance, Electric power production, Electric power failure, Waste water treatment

*Gas turbine generators, West Babylon (NY)

D564
UPGRADING EXISTING WASTEWATER TREATMENT PLANTS CASE HISTORIES,

Hazen and Sawyer, Engineers,
New York, New York.

1972. 38 p, 12 fig, 7 tab. NTIS Technical Report PB-258 818.

Four cases of waste water treatment plant improvement involving the South Buffalo Creek waste water treatment plant at Greensboro, North Carolina; a water reclamation plant at Livermore, California; the Wards Island waste water treatment plant in New York City; and an unnamed trickling filter plant are described. Upgrading of the South Buffalo Creek facility included expansion with phosphorus removal, special odor control measures, improved sludge handling, and effluent polishing with deep bed filters. Extensions to the Livermore water reclamation plant included preliminary treatment, roughing filters, activated sludge secondary treatment, pre- and post-chlorination, conversion of oxidation ponds to emergency holding ponds, additional sources for waste disposal, and more efficient nitrification and chlorination. Modifications to the Wards Island waste water treatment plant included alterations to final settling and aeration tanks. The expansion of an existing trickling filter facility with the addition of activated sludge treatment prior to filtration included diluting of raw waste water, covering of the preliminary tanks and trickling filter, ozonizing of exhaust gases for odor control, and pumping of sludge to a separate thickening tank before digestion. Treatment plant flow diagrams, design data, and capital costs are presented for all projects.

*Activated sludge, *Design data, *Sewage treatment, *Capital costs, *Treatment facilities, Cost analysis, Waste water treatment, Aeration, Design criteria, Trickling filters, Tertiary treatment, Sewage treatment, Sewage disposal

New York City (NY), Livermore (CA), Greensboro (NC)

D565
EXTENDED AERATION SEWAGE TREATMENT IN COLD CLIMATES,

Coutts, H. J., and Christianson, C. D.

Arctic Environmental Research Laboratory,
National Environmental Research Center,
College, Alaska.

1974. 87 p, 26 fig, 15 tab, 36 ref. Technical Report EPA-660/2-74-070.

Adaptations of biological waste treatment processes with extended aeration for use under the extreme climatic conditions in the subarctic were tested in Alaska on bench-scale units at the Arctic Environmental Research Laboratory, at a pilot plant southeast of Fairbanks, at Eilsen Air Force Base, and at the College oxidation ditch. Process performance, solids separation, the degree of environmental protection required for equipment and processes, aeration chamber mixing, and waste sludge production were examined. Design, operation, and performance data for the bench- and full-scale facilities are presented. Major factors affecting performance include organic loading effects, solids levels and separation, solids accumulation and wastage, dissolved oxygen levels, and plant upsets. Organic loading was most seriously affected by low temperatures, with performance decreasing as organic loading increased. The suggested maximum organic loading rate for sewage temperatures of 7 C or less is 0.08 Kg BOD/Kg MLSS/day. Nitrogen and phosphorus were not significantly removed by extended aeration at low temperatures, but coliform removal was from 90 to 98 percent. Adequate protection from freezing of vulnerable equipment such as pretreatment units, pumps, aeration equipment, and flow measurement devices is suggested. Other design suggestions include clustering of aeration devices in the center of the basin, mounting clarifiers within the aeration basin, and using submerged aerators instead of surface units.

*Alaska, *Cold regions, *Aeration, *Biological treatment, *Design data, Subarctic, Organic loading, Clarification, Freezing, Aerobic treatment, Municipal wastes, Activated sludge, Sewage treatment, Waste water treatment

College (AK), Extended aeration

D566
LAND APPLICATION OF EFFLUENTS IN THE ROCKY MOUNTAIN-PRAIRIE REGION,

Dean, R. J.

Colorado University,
Boulder,
Department of Civil and Environmental Engineering.

1974. 152 p, 11 tab, 163 ref, 3 append. NTIS Technical Report PB-255 245.

Results of a survey of land application of waste water effluents in the Rocky Mountain-Prairie Region states of Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming are presented. Areas using spray irrigation, overland flow, and ridge and furrow irrigation were examined. Engineering and technical issues considered include pretreatment requirements, effluent characteristics, site requirements and selection, and the fate of waste water constituents. Parameters controlling site requirements and selection include relative location, topography, geology, climate and evapotranspiration, local geology, loading rates, soil characteristics, groundwater and subsurface drainage, storage facilities, and pilot system performance. Waste water constituents may be dispersed by release to the atmosphere, runoff to surface waters, soil retention, absorption by plants, and leaching to groundwater. The fate and distribution of physical constituents, organics, major inorganic ions, nutrients, trace elements, toxic chemicals, and pathogens are discussed. Results of the survey on land application practices are provided. A copy of the survey questionnaire which elicited information on irrigation methods, crops and ground cover, a system description, site characteristics, legal restrictions and soil characteristics, is presented.

*Return flow, *Surveys, *Irrigation practices, *Sprinkler irrigation, *Rocky Mountain region, Grasslands, Colorado, Montana, North Dakota, South Dakota, Wyoming, Utah, Soil properties, Vegetation effects, Waste water disposal, Treatment facilities, Soil-water-plant relationships, Waste water treatment

D567
TECHNICAL ASSISTANCE PROJECT, UPPER EAGLE VALLEY SANITATION DISTRICT WASTEWATER TREATMENT FACILITY - AVON, COLORADO, MARCH-APRIL, 1973,

1973. 17 p, 1 fig, 2 ref. Technical Assistance Project S&A-TSB-23.

Findings of a U. S. Environmental Protection Agency technical assistance project involving the Upper Eagle treatment plant near Vail, Colorado, are presented. Treatment at the Upper Eagle plant includes pretreatment with bar screening, aeration, clarification, aerobic digestion, chlorination, sludge drying, and discharge of effluents to the Eagle River. EPA control testing at the facility included measurements of dissolved oxygen, centrifuge turbidity, settleability, and sludge blanket depth. Results indicated that plant performance was hindered by inadequate control over the return sludge flow rate caused by insufficient manpower at the facility and inadequate physical control. Other limitations were posed by the size of the aeration basin, the aerobic digester capabilities, and leaky seals in the final clarifier. Biological activity and adequate sludge digestion were limited by cold temperatures, inadequate detention times, and excessive solids loading to the digester. Also, no provisions existed for the removal of floating material. Suggestions by the EPA for modifications and additions to the Upper Eagle plant included monitoring of effluent quality and influent flow rate, regular repair of clarifier seals, cooperative treatment by the Vail and Upper Eagle Plants, enlargement of the aeration basin, covering and/or heating of the digester, removal of floatable material during final clarification, and an increase in plant staffing.

*Treatment facilities, *Colorado, *On-site tests, *Performance, *Sludge treatment, Aerobic treatment, Clarification, Monitoring, Waste water treatment

*Upper Eagle Treatment Plant, Avon (CO), Vail (CO)

D568
WATER RENOVATION OF MUNICIPAL EFFLUENTS BY REVERSE OSMOSIS,

Cruver, J. E., Beckman, J. E., and Bevege, E.

ROGA Division,
Universal Oil Products Company,
San Diego, California.

1975. 122 p, 38 fig, 19 tab, 28 ref, 2 append. Technical Report EPA-670/2-75-009.

Field experiments were performed to examine reverse osmosis for use in the treatment of municipal primary and secondary effluents with varying degrees of pretreatment. Effluents tested included primary effluent with and without sand filtration, sand-filtered activated sludge effluent, chemically clarified primary effluent with sand filtration, chemically clarified primary effluent with sand filtration and carbon pretreatment, and activated-carbon-treated secondary effluent. Studies indicated that spiral-wound reverse osmosis units were feasible for primary and activated sludge effluents with only moderate pretreatment, and that activated carbon pretreatment was unnecessary for successful treatment. Field tests using reverse osmosis at the Pomona Water Reclamation Plant of the Los Angeles County Sanitation District, California, resulted in permeates that were almost totally free of turbidity and of suspended and colloidal solid material. Removal of dissolved substances, including phosphate, COD, ammonia nitrogen, and nitrate, was also significant. Cost estimations for reverse osmosis operation and chemical membrane cleaning are provided.

*Reverse osmosis, *Separation techniques, *Activated carbon, *Membrane processes, *Tertiary treatment, Sewage treatment, Chemical reactions, Activated sludge, Filtration, Effluents, Costs, Waste water treatment

*Spiral-wound modules

D569
POLLUTION CONTROL BY INCINERATION,

Thorne, J. G. M.

Processing, Vol. 23, No. 7, p 34-35, July, 1977. 1 fig.

The Dorr-Oliver Company Ltd. has provided a fluidized bed combustion system to the Esher Water Pollution Control Works, Surrey, of the Thames Water Authority-Southern Division for the incineration of sewage sludge. Treatment at Esher includes mechanical screen raking, sedimentation, biological filtration, digestion, micro-straining, and sludge incineration. Dorr-Oliver Picket fence thickeners, 8.5 m in diameter and 3.4 m deep, remove supernatant and subnatant water from humus sludge with automatic dewatering cells. Vacuum filtration with two Komline-Sanderson Colifilters is used for sludge dewatering. Chemically conditioned sludge cakes are fed into the Fluosolids reactor by two Mono sludge pumps. The Dorr-Oliver Fluosolids System contains a windbox, a fluid bed, and a freeboard. Graded sand is air fluidized by a Blackman fluidizing blower to provide proper conditions for thermal oxidation to evaporate water and eliminate organic matter in the sludge cake. Fluidizing air at a temperature of 500 C is partially heated by the reactor exit gases. A Venturi scrubber followed by a multi-tray Swemco cooling system is provided for removal of SO2 and particulates from the exit gases. A TV monitoring system and an oxygen analyzer are used to monitor reactor performance.

*Incineration, *Sludge disposal, *Dewatering, *Screens, *Gases, Ultimate disposal, Treatment facilities, Equipment, Operation and maintenance, Burning, Oxidation, Organic wastes, Filtration, Monitoring, Waste water treatment

Fluidized beds, Thermal oxidation, Sludge conditioning, Emission control

D570
SINGLE-HEARTH SCREENINGS INCINERATOR,

Processing, Vol. 23, No. 7, p 35, July, 1977.

Neptune Nichols, in association with Nichols Engineering S. A., has developed a single-hearth incinerator for the disposal of dewatered screenings from sewage pretreatment. Screenings can be processed either in sacks or in loose form and without supervision between loadings. Two models are produced for the incineration of 100 and 200 kg of screenings per day or population equivalents of 100,000 and 200,000, respectively. The internal diameter of the smaller unit is 1.5 m, overall height is 3.25 m, and total weight is 5500 kg.

*Incineration, *Sludge disposal, *Dewatering, *Equipment, *Screens, Ultimate disposal, Operation and maintenance, Sewage treatment, Design data, Waste water treatment

Single-hearth screenings incinerators

D571
IMPELLER DESIGN KEEPS DOWN PUMP SET MAINTENANCE,

Surveyor, Vol. 150, No. 4440, p 29, July, 1977.

KSB Manufacturing Company Limited in London is marketing a series of centrifugal pumps equipped with single vane or free-flow impellers which allow unconstrained passage from the suction to the discharge end of the pump. Clumping of long-fiber constituents does not hinder pump operation with the single vane impeller. Balance vanes at the front and back of the impeller prevent solid matter from entering into and around the sides of the impeller and stuffing box. A radial vane free-flow impeller for use with gaseous sludges is recessed into the back of the pump casing. Horizontal and vertical impellers, renewable wear plates, interchangeable parts, and a back pull-out design with horizontal pumps are available. Horizontal impellers are able to handle 3,000 cu m/hr and vertical impellers 1,250 cu m/hr.

*Centrifugal pumps, *Centrifugation, *Design, *Impellers, *Pumps, Sewage treatment, Operation and maintenance, Sludge treatment, Gases, Equipment, Waste water treatment

D572
DESIGN OF SEWAGE OXIDATION PONDS FOR AUSTRALIAN CLIMATIC CONDITIONS,

Bliss, P. J.

New South Wales University,
Australia,
School of Civil Engineering.

The Institution of Engineers, Australia, Vol. CE 18, No. 2, p 69-73, 1976. 4 fig, 9 ref.

A method for designing the first in a series of oxidation ponds which consider climatic conditions, temperatures, pond area and depth, and influent BOD is presented. Oxidation pond design methods include empirical design factors, the Hermann and Gloyna method, and a kinetic-based design method. For empirical design, average liquid detention time is calculated on the basis of BOD loading, influent BOD concentration, and pond depth. The Hermann and Gloyna method is based on short-term studies of pilot-scale pond performance with corrections for pond water temperature and waste BOD. Oxidation pond design based on pond kinetics assumes that organic matter degradation is a first-order reaction, that the pond is a completely mixed system, and that evaporation and infiltration losses are small. Total mass of influent BOD is related to mass of effluent BOD and the mass of BOD removed in the reactor, which is the product of pond volume, permissible pond liquid BOD, and a reaction rate constant. The simplified design procedure presented here relates an area factor adjusted for maximum daily temperatures during coldest and warmest months, pond depth, and influent BOD levels. It is suggested that second and subsequent oxidation be designed according to the required reduction in indicator organisms. Temperature adjustments and the geographic distribution of adjustment factors are illustrated for Australia.

*Oxidation lagoons, *Design criteria, *Australia, *Climatology, *Biochemical oxygen demand, Aerobic treatment, Kinetics, Mathematical models, Organic loading, Temperature, Waste water treatment

D573
BAY-AREA INDUSTRIES TO RE-USE TREATED WASTEWATER,

Civil Engineering, Vol. 47, No. 8, p 76-77, August, 1977. 1 fig, 1 tab.

Central Contra Costa Sanitary District's 30-mgd waste water recycling plant at Pacheco on Suisun Bay in California will provide 17 mgd of treated waste water for five San Francisco Bay-area industries (Phillips Petroleum, Shell Oil, Stauffer Chemical, Monsanto, and Pacific Gas and Electric). Physical-chemical treatment is necessary because water reused by the area industries must be low in phosphorus, BOD, and suspended solids. Lime and ferric chloride introduced at the primary stage at a 1.5 mgd test facility removed 91% of the phosphorus, 75% of the BOD, 91% of suspended solids, 94% of the grease, and virtually all of the heavy metals. Treatment at the facility includes flocculation, sedimentation, oxidation and nitrification, chlorination, denitrification, and dual media filtration. Waste water effluent which is not reused by industry is discharged to Suisun Bay. A computer control system is used to operate and monitor the facility. Pyrolysis will ultimately replace existing multiple hearth incinerators for sludge disposal with refuse-derived fuel provided by a combination of combustible municipal refuse and sludge.

*Water reuse, *Treatment facilities, *Filtration, *Flocculation, *Sewage treatment, Municipal wastes, Lime, Denitrification, Nitrification, Effluents, Waste water treatment

Central Contra Costa County Sanitary District (Pacheco, CA), San Francisco Bay

D574
FLORIDA INSTALLATION DISPERSES EFFLUENTS VIA IRRIGATION SYSTEM,

Civil Engineering, Vol. 47, No. 8, p 16, August, 1977.

A waste water treatment facility in Winter Haven, Florida, has been constructed by Valmont Industries Incorporated of Valley, Nebraska. Treated effluent from the Winter Haven plant flows by gravity to a 31-acre holding pond and is pumped to nine spray units which irrigate a total of 630 acres of hay forage crops. Each spray unit in the Valmont system in use at Winter Haven includes nine center pivots and seven drive units which irrigate a total of 70 acres each. Biological treatment at the Winter Haven plant removes at least 95% of the biochemical oxygen demand and suspended solids. Spray irrigation of approximately 1,500 acres will be used to remove all the remaining organics and nutrients. The Valmont system has been applied elsewhere for municipal wastes and for a variety of industrial wastes from food, chemical and livestock processors.

*Treatment facilities, *Sprinkler irrigation, *Waste water disposal, *Irrigation practices, *Return flow, Hay, Forages, Field crops, Effluents, Waste water treatment, Irrigation systems, Municipal wastes, Industrial wastes

Winter Haven (FL)

D575
DEMONSTRATION OF A HIGH-RATE ACTIVATED SLUDGE SYSTEM,

Huang, C. H., Feuerstein, D. L., and Miller, E. L.

Engineering-Science, Incorporated,
Berkeley, California.

1975. 150 p, 25 fig, 22 tab, 46 ref, 1 append. Technical Report EPA-670/2-75-037.

Objectives of this study in Chino, California, were to develop an optimum performance high-rate activated sludge system, describe the activated sludge process by kinetic analysis, relate nutrient removal to process operating parameters, evaluate performance of alternative mixed liquor solids separation systems, and examine the feasibility of using plant effluent for recreational purposes. Studies indicated that full scale systems could produce high quality effluent (BOD of 5 mg/liter) at high growth rates and at high substrate loading (3.6 mg BOD/mg MLVSS/day). Kinetic analyses of the system at Chino resulted in a yield coefficient of 0.92 mg MLVSS produced/mg BOD removed, a decay constant of 0.027/day, a maximum substrate removal velocity of 4.1 mg BOD removed/mg MLVSS-day, a maximum specific growth rate of 3.8/day, and a half-saturation constant of 26 mg BOD/liter. Systems examined for activated sludge solids separation included vibratory screens, enhanced gravity separation, dissolved air flotation, and hydro-centrifugal cleaned screens. Studies at Chino indicated that screening was less efficient at solids removal than gravity settling. Nutrient requirements observed were 112 mg N/g BOD removed and 33 mg P/g BOD removed. Greater use of flow meters at various stages in the activated sludge process and more extensive research into dewatering techniques are recommended.

*Activated sludge, *Kinetics, *Nutrient removal, *Dewatering, *Model studies, Separation techniques, Nitrogen, Phosphorus, Biochemical oxygen demand, Sewage treatment, Filtration, Screens, Sludge treatment, Waste water treatment

Chino (CA), High-rate activated sludge systems, Biological kinetics

D576
HANOVER PARK TERTIARY STUDIES,

Zenz, D. R., Bogusch, E., Lue-Hing, C., and Obayashi, A. W.

Metropolitan Sanitary District of Greater Chicago,
Chicago, Illinois.

1976. 36 p, 7 fig, 7 tab, 2 ref, 1 append. Technical Report EPA-600/2-76-264.

The Hanover Park water reclamation plant in Chicago was the site of a year-long evaluation of 4 tertiary treatment units. Three deep-bed filters were tested with secondary effluent, including: the DeLaval Filter (an upflow sand filter); the Neptune Microfloc Unit (a downflow mixed-media gravity filter containing anthracite, sand, and garnet); and the Graver Filter (a downflow dual-media pressure filter containing anthracite and sand). A continuous-flow ion exchanger that removed phosphate from micro-screened secondary effluent was the fourth unit tested. The filters were tested at flow rates of from 2 to 6 gpm/sq ft. Results indicated that at 4 gpm/sq ft all filtration units were capable of producing filtrates from secondary effluent with suspended solids and BOD of less than 10 mg/liter. The Neptune Filter yielded slightly better results than the Graver or DeLaval Filters. Activated alumina in the continuous ion-exchanger was capable of removing up to 87% of the total phosphorus from micro-screened secondary effluent. It was also demonstrated that 0.4N sodium hydroxide was effective at regenerating phosphate-exhausted alumina. Further investigations of phosphate removal by activated alumina and of tertiary filtration as means of producing high quality effluents are recommended.

*Tertiary treatment, *Filtration, *Ion exchange, *Phosphorus, *Aluminum, Filters, Sewage treatment, Suspended solids, Porous media, Sodium compounds, Model studies, Operation and performance, Waste water treatment

Activated alumina, Deep-bed filters, Continuous ion-exchangers, Sodium hydroxide, DeLaval filters, Neptune Microfloc Unit, Graver filter, Dual-media filters, Mixed-media filters, Chicago (IL)

D577
EVALUATION OF FLOW EQUALIZATION AT A SMALL WASTEWATER TREATMENT PLANT,

Foess, G. W., Meenahan, J. G., and Harju, J. M.

Johnson and Anderson, Incorporated,
Pontiac, Michigan.

1976. 47 p, 11 fig, 11 tab, 12 ref. Technical Report EPA-600/2-76-181.

A twelve-month study of a flow equalization system at the Walled Lake/Novi waste water treatment plant in Novi, Michigan is described. At the Novi plant, activated sludge treatment and multi-media tertiary filters are used to treat domestic waste flows of 0.092 cu m/sec (2.1 mgd). Designs of the plant and its equalization basin are presented. Process streams under equalized flow conditions were monitored throughout the study for BOD, total suspended solids, and total phosphorus. Final settling and filtration efficiencies were examined with and without flow equalization. The flow equalization basin at Novi includes a 355,000 gal basin equipped with a diffused air mixing system and a sludge scraping mechanism. Results of the study indicated that the flow equalization basin was highly effective at leveling influent flow variations but was not appreciably effective at evening out concentrations of waste water constituents. During settling, BOD removal was greater under equalized flow conditions while total suspended solids removal was greater under non-equalized flow conditions. Removal of both constituents during filtration was greater during equalized flow than under diurnal flow conditions. Flow equalization is recommended for use upstream from granular media filters.

*Diurnal distribution, *Equalizing reservoirs, *Hydraulic structures, *Biochemical oxygen demand, *Suspended solids, Pilot plants, Model studies, Flow control, Load distribution, Sewage treatment, Phosphorus, Waste water treatment

Flow equalization

D578
CONVENTIONAL TERTIARY TREATMENT,

O'Farrell, T. P., and Bishop, D. F.

EPA-DC Pilot Plant,
Washington, District of Columbia.

1976. 30 p, 5 fig, 8 tab, 17 ref. Technical Report EPA-600/2-76-251.

Secondary effluent from the EPA-DC Pilot Plant in Washington was used in an evaluation of tertiary treatment with primary sedimentation, step aeration, two-stage or single-stage (lime-soda carbonate) high pH lime clarification, ammonia stripping, filtration, neutralization, and activated carbon adsorption. Studies indicated that two-stage lime clarification of secondary effluent with suspended solids of less than 25 mg/liter was able to reduce phosphorus to 0.13 mg/liter and BOD to 2.1 mg/liter. Dual media filtration further reduced phosphorus to 0.09 mg/liter and BOD to 1.4 mg/liter. Carbon adsorption with fresh carbon reduced total organic carbon to less than 3 mg/liter. Nitrogen removal by ammonia stripping was not adequate for District of Columbia standards. Organic solids concentrations greater than 25 mg/liter produced by filamentous growths in the activated sludge system impeded clarifier performance. Recalcined lime was effectively recycled through the clarification system. Physical-chemical treatment for phosphate and carbon removal as evaluated in this study is recommended for the production of very high quality effluent and for waste water reuse.

*Tertiary treatment, *Clarification, *Phosphorus, *Activated carbon, *Ammonia, Lime, Calcium compounds, Filtration, Pilot plants, Model studies, Waste water treatment, Water reuse

Washington (DC)

D579
REMOVAL OF NITRATE FROM EFFLUENT FOLLOWING DISCHARGE ON SURFACE WATER,

van Kessel, J. F.

Ministerie van Volksgezondheid en Milieuhygiene,
Leidschendam, The Netherlands.

Water Research, Vol. 11, No. 6, p 533-537, 1977. 4 fig, 2 tab, 16 ref.

The removal of nitrate from surface waters by denitrification in sediments was examined in field and laboratory experiments with secondary-treated effluent from a waste water treatment plant at Goor in the Netherlands. In field experiments, treated waste water was discharged from the plant into a canal whose depth was maintained at 1.3 m by an adjusted weir. Effluent samples were taken prior to discharge and along the canal at three stations (200 m above the discharge point, and 30 m and 830 m below the discharge point). Chloride, nitrate, nitrite, ammonia, water and sediment temperatures, and dissolved oxygen levels were measured throughout the study. For laboratory experiments, three undisturbed water-sediment columns were collected below the discharge point. Average nitrate-nitrogen concentrations for samples collected 30 m and 830 m below the discharge point were 0.14 and 0.33 mg/liter, respectively. For the 800-m length of canal with an estimated sediment surface area of 6240 sq m, the average rate of nitrate-nitrogen removal during the 19-day study period was 913 mg nitrate-nitrogen/sq m/day. Laboratory studies with water-sediment columns showed that nitrate-nitrogen removal from overlying water increased with incubation time. Denitrification in sediments is suggested as a possible solution to nitrogen-induced eutrophication of surface waters.

*Soil chemical properties, *Denitrification, *Nitrates, *Sediment-water interfaces, *Waste assimilative capacity, Eutrophication, Water pollution control, Model studies, Bacteria, Nitrogen, Waste water treatment

Goor (Netherlands)

D580
SURVIVAL AND MOVEMENT OF ENTEROVIRUS IN CONNECTION WITH LAND DISPOSAL OF SLUDGES,

Damgaard-Larsen, S., Jensen, K. O., Lund, E., and Nissen, B.

State Experimental Station,
Askov,
Vejen, Denmark.

Water Research, Vol. 11, No. 6, p 503-508, 1977. 2 fig, 6 tab, 16 ref.

Municipal sludges, seeded with coxsackievirus B3, were used in a study on the fate and distribution of enteroviruses during land disposal of sludge. Seeded sludges were placed on top of lysimeters containing different soil types, including a heavy clay soil, a neutral sandy soil, and an acidic sandy soil. Tritium was used to trace water movement through the columns. Analyses of lysimeter leachates indicated that soil type was not a controlling factor in virus inactivation, binding, or movement. Scintillation counting to determine tritium concentrations in lysimeter leachates revealed that water did not move through the lysimeters until three months after addition, and that little if any movement occurred in clayey soils. Leachate water samples did not contain demonstrable levels of coxsackievirus B3, with one exception which may have been due to a technical or analytical error. Viruses were apparently retained in the sludge layer on top of the lysimeter. Previous studies on the inactivation and movement of sludge-borne viruses are also described.

*Viruses, *Lysimeters, *Percolation, *Microorganisms, *Soil disposal fields, Soil chemical properties, Soil contamination effects, Sludge disposal, Municipal wastes, Sewage disposal, Waste water disposal

*Coxsackievirus B3

D581
CONTROL FUNCTIONS AT COPPERMILLS WORKS,

Water Services, Vol. 81, No. 977, p 407, 409, July, 1977.

Operation and automatic control of the Coppermills treatment works in London, England, are described. The filtration plant includes automatic aeration and washing sequences for the 24 filter beds. The hydraulic system which services the filters includes power equipment, filter bed control equipment, and filter valve starting equipment. Two power cabinet assemblies provide hydraulic power to the beds, each of which contains 4 motor pump units; 2 units for inlet, washout, upwash, and air valves; and 2 units for outlet valves. Each power cabinet assembly provides power for a bank of 12 of the 24 beds but can power the entire set of 24 beds in an emergency situation. Remote electrical control is used to regulate opening and closing of valves. A 610 mm square inlet penstock, a 915 mm square wash-out penstock, and the outlet butterfly valve are operated by linear starters. Upwash and air butterfly valves are operated by mounted semi-rotary valve starters. A Lockheed Hydraulic System controls the butterfly valves for the 16 pumps within the pumping station by means of double-acting hydraulic cylinders and four-way control valves. Portable manually-operated power packs provide emergency power for valve starters.

*Automatic control, *Filters, *Treatment facilities, *Hydraulic valves, *Hydraulic systems, Butterfly valves, Flow control, Hydraulic equipment, Pumps, Pumping plants, Electrical equipment, Waste water treatment

Coppermills (UK), London

D582
WATER POLLUTION ABATEMENT PROGRAM SERVES INDEPENDENCE, MISSOURI,

White, J. E.

Water and Sewage Works, Vol. 124, No. 8, p 50-51, August, 1977.

The Rock Creek and Sugar Creek Watersheds project was initiated to provide new interceptors, two raw waste water pump stations, peak flow detention facilities, and a secondary waste water treatment facility for the city of Independence, Missouri. Replacement of the existing interceptor sewer system involved the construction of approximately 37,500 ft of interceptors ranging in size from 12 to 54 inches in diameter. The Rock Creek pumping station is designed to handle a total waste flow of 60 mgd with separate pumping systems for wet weather peak flow and for waste water treatment. The Sugar Creek Watershed pump station is designed to handle 6.5 mgd. The 7.5 mgd waste treatment plant at Rock Creek includes four primary clarifiers, a primary thickening basin, four activated sludge basins, four secondary clarifiers, and two dissolved air flotation basins. Chlorine contact basins disinfect effluent before it is discharged to the Missouri River. Heat treatment, dewatering, and incineration are used for sludge disposal.

*Interceptor sewers, *Treatment facilities, *Sewage treatment, *Pumping plants, Construction, Sewerage, Clarification, Activated sludge, Sewage disposal, Sludge disposal, Waste water treatment, Sludge treatment

Independence (MO), Rock Creek (MO), Sugar Creek (MO)

D583
ADVANCED SEWAGE TREATMENT FAILS COST-ENVIRONMENTAL BENEFIT TEST,

Engineering News Record, Vol. 199, No. 8, p 13, August, 1977.

The Texas Water Quality Board has recently relaxed its advanced waste water treatment standards from 5-3-3 standards (5 ppm BOD, 5 ppm suspended solids, and 3 ppm ammonia) to requirements of 10 ppm BOD and 15 ppm suspended solids. The reduction in standards for the Mesquite plant near Dallas, Texas was in response to a permit for a proposed $12.5-million expansion and upgrading of the regional waste water facility. Costs for upgrading five Dallas/Fort Worth area waste water treatment plants to the new standards are estimated at $100 million, as opposed to the estimated $600 million necessary to upgrade all the facilities to the 5-5-3 standards. Because the five treatment plants discharge effluent into the Trinity River, which during dry weather is 98% effluent, plant operators considered the actual reduction in pollutant loads resulting from adherence to the stricter standards to be insignificant. The strict 5-5-3 standards were initially imposed by the Texas Water Quality Board in an effort to meet requirements of the Federal Water Pollution Control Act Amendments of 1972.

*Cost-benefit analysis, *Costs, *Water quality standards, *Federal Water Pollution Act, Treatment facilities, Texas, Effluents, Biochemical oxygen demand, Suspended solids, Water quality, Water pollution control, Sewage treatment, Waste water treatment

Texas Water Quality Board, Dallas (TX), Fort Worth (TX)

D584
WASTE SEGREGATION AS A MEANS OF ENHANCING ONSITE
WASTEWATER MANAGEMENT,

Siegrist, R.

Wisconsin University,
Ann Arbor,
Small Scale Waste Management Project.

Journal of Environmental Health, Vol. 40, No. 1, p 5-9, July-August, 1977. 1 fig, 4 tab, 16 ref.

Segregation of household wastes by use into black water (toilet wastes) and gray water (other household wastes) is suggested to enhance on-site or septic tank waste water treatment. Chemical/physical and biological characteristics of household waste water are described. Surveys indicated that levels of indicator bacteria (coliforms) can be very high in household septic tank effluent, and that pathogenic organisms (Pseudomonas aeruginosa, Staphylococcus aureus, and Salmonellae) can be present. The characteristics of separate gray and black water waste streams can, however, be very different. Gray water contributes most of the BOD, phosphorus, and flow to the household waste stream, at 63%, 70%, and 65% of the total, respectively. Black water contributes most of the suspended solids and nitrogen, at 61% and 82%. Indicator organisms and other bacteria are largely contributed by black water, but some proportion may enter the household waste stream from bath and laundry waste water. Black water treatment methods include non-water carriage toilets (composting, incinerating, and recycling systems) and low-volume flush toilets with provisions for off-site land disposal. Gray water disposal alternatives include the use of reduced-area soil absorption systems and sand filter systems.

*Domestic wastes, *Septic tanks, *Domestic water, *Laundering, *Separation techniques, Sewage treatment, Microorganisms, Coliforms, Soil disposal fields, Cesspools, Sewage bacteria, Sewage treatment, Sewage disposal, Waste water treatment

Toilets, Black water, Gray water

D585
ACTUATORS FOR EDINBURGH'S NEW SEWAGE DISPOSAL SCHEME,

Water Services, Vol. 81, No. 977, p 404, July, 1977.

Electric valve starters produced by Rotork Controls Limited (Lower Weston, Bath, Avon, United Kingdom) are being used for automatic monitoring and control at the Seafield sewage treatment plant in Edinburgh, Scotland. The Rotork 1400 series starter is used to control penstocks which regulate flow into and through the treatment works. Phase discriminators protect valves and penstocks from accidental damage caused by incorrect phase rotation or a dead phase. Echoes produced by sound waves are used to measure levels of sewage, sludge, or groundwater in tanks, channels, and pumps. A centralized control room receives information from level sensors and activates the Rotork system. The plant operation may be manually controlled, overriding the automatic system if necessary.

*Electrical equipment, *Automatic control, *Monitoring, *Sewage treatment, Treatment facilities, Valves, Hydraulic valves, Equipment, Penstocks, Waste water treatment

Seafield (Edinburgh, Scotland)

D586
WATER QUALITY MANAGEMENT -- WASTE DISPOSAL: A WATER AUTHORITY VIEWPOINT,

Jones, M. R.

The Public Health Engineer, Vol. 5, No. 4, p 100-102, July, 1977. 3 ref.

Various aspects of waste disposal in the United Kingdom are discussed and current means of disposal are outlined. Environmental hazards associated with waste disposal in sanitary landfills are described. General guidelines for waste disposal and site choice by the Thames Conservancy Division of the Thames Water Authority are described. Considerations for site choice include geology, groundwater and surficial hydrology, and topography of the area being evaluated. The Thames Conservancy Division discourages the placement of waste disposal sites in areas underlain by chalk and oolitic limestone, and encourages detailed hydrologic surveys prior to any waste disposal. Additional criteria are presented for the disposal of toxic wastes and for the operation of industrial waste treatment plants.

*Waste disposal, *Landfills, *Environmental engineering, *Geology, *Groundwater, Water pollution control, On-site investigations, Industrial wastes, Municipal wastes, Hydrologic aspects

Thames Water Authority

D587
EFFECT OF RESIDENCE TIME ON FIXED FILM REACTOR PERFORMANCE,

Cook, E. E., and Katzberger, S. M.

Journal Water Pollution Control Federation, Vol. 49, No. 8, p 1889-1895, August, 1977. 4 fig, 20 ref.

The effect of liquid residence time on organic removal efficiency by trickling filters was evaluated with a fixed film, rotating bed, biological reactor. Synthetic waste water was introduced to the reactor at flow rates of 25, 50, and 100 ml/min, corresponding to low, intermediate, and high rate hydraulic loadings used in conventional trickling filters. COD concentrations in the prepared waste water were 220, 440, and 880 mg/liter. The rotational speed of the reactor was set at 150 rpm and the inclination angles at 4, 10, 15, and 20 degrees from the horizontal since initial experiments indicated that the inclination angle had a greater effect on residence time than rotational speed. Tracer studies with NaCl were used to determine the effects of inclination angle, flow rate, and feed concentration on liquid residence time. Steady state conditions were established after 40 days with an inclination angle of 4 degrees when the reactor was seeded with microorganisms and loaded at 220 mg/liter COD and 25 ml/min. When flow rate or inclination angle was increased, liquid residence time decreased. Decreases in COD removal caused by decreased liquid residence time were greatest at high flow rates (100 ml/min) but were not significant at lower flow rates. Increased residence times at higher feed concentrations were attributed to increased biomass. Liquid residence time is suggested as a parameter in trickling filtration when COD feed concentrations and flow rates are high.

*Trickling filters, *Filtration, *Chemical oxygen demand, *Organic loading, Flow rates, Flow characteristics, Design criteria, Biological treatment, Waste water treatment

Fixed film reactors, Rotating biological beds

D588
"CO-DISPOSAL" FOR SOLID WASTES AND SEWAGE SLUDGE,

Sussman, D. B.

Waste Age, Vol. 8, No. 7, p 44, 46, 49, July, 1977.

Co-disposal of solid wastes and sewage sludge has been suggested as a more efficient means of municipal waste disposal. Basic methods of thermal co-disposal include incineration of sewage sludge using refuse-derived fuel (RDF) and the use of a solid waste incinerator, solid waste fired steam generator, or waterwall combustion unit to dewater sludge. Approximately 200 waste water treatment facilities in the United States utilize thermal sludge disposal, usually with multiple hearth or fluidized bed incinerators. A fluidized bed furnace at Franklin, Ohio is fueled with refuse-derived fuel as a combination of solid waste and sludge. An EPA-supported demonstration at Concord, California of the operation of a multiple hearth incinerator in pyrolysis mode is described. Combustion of pyrolysis gas resulted in sufficient energy for recovery in a waste heat boiler. Solid waste incinerator flue gases have been used in sludge dewatering at a 200 TPD refractory incinerator at Ansonia, Connecticut and a 50 TPD refractory incinerator at Holyoke, Massachusetts. The direct use of heat generated in solid waste combustion to dry and burn sewage sludge has been demonstrated at Norwalk, Connecticut and at Glen Cove, New York. Waterwall combustion thin film drying at Dieppe, France, and waterwall combustion flash drying at Krefeld, Germany, are described.

*Incineration, *Sludge disposal, *Dewatering, *Drying, *Fuels, Energy conversion, Waste disposal, Sewage disposal, Solid wastes, Equipment, Municipal wastes, Waste water treatment

Multiple hearth furnaces, Fluidized bed combustion, Spray drying, Rotary drying, Furnace drying, Waterwall combustion thin film drying, Waterwall combustion flash drying

D589
PLANNING, EXECUTING AND PROFITING FROM POLYMER TRIALS,

Hauck, J. P.

Calgon Corporation,
Pittsburgh, Pennsylvania.

Water and Sewage Works, Vol. 124, No. 8, p 32-34, August, 1977.

Synthetic organic polyelectrolytes or polymers are used in municipal and industrial waste treatment for clarification and sludge dewatering. Procedures and objectives for polymer use planning and evaluation are presented. Polymer evaluation may be initiated to improve production, improve solids concentrations in dewatered sludge, reduce costs, reduce filtrate or centrate solids, or evaluate polymer performance for municipal bid requirements. After the objective is defined, mechanical or operating constraints must be examined, including incinerator capacity, sludge pump capacity, filtrate pump capacity, and plant design and maintenance. Laboratory studies should be conducted to select a polymer which will produce optimum results at a practical cost and to determine the relative consumption and performance which can be expected at the particular facility. Full-scale trials should be conducted at the plant to verify laboratory predictions. The optimal polymer addition point, operational constraints, and sampling and feed equipment requirements should be examined during this phase of the evaluation. Polymer choice is finalized at a meeting between plant personnel and the polymer supplier to examine laboratory and plant trial results.

*Polymers, *Dewatering, *Planning, *Evaluation, *Polyelectrolytes, Organic compounds, On-site investigations, Pilot plants, Sludge treatment, Clarification, Municipal wastes, Operation and maintenance, Waste water treatment

D590
JAPANESE PHYSICO-CHEMICAL SYSTEM,

Water and Waste Treatment, Vol. 20, No. 6, p 13, June, 1977.

A physico-chemical sewage treatment (PCT) system, manufactured by Nippon Kokan in Japan, has been approved by Japan's Ministry of Construction. The system is designed for processing 200, 400 or 600 cu m of municipal sewage per day. Use of the PCT system instead of activated sludge treatment is reported to be advantageous when facilities are subject to large fluctuations in influent or slowdown of microbial action during periods of cold weather. With the PCT system, treatment begins when the amount of sewage in a storage well reaches a certain level. Treatment processes include activated carbon absorption, coagulation, flocculation and settling, and contact chlorination. After treatment the effluent passes through an up-flow filter before it is discharged with biochemical and chemical oxygen demands of less than 10 ppm. Estimated construction costs for the PCT system are projected at about two-thirds of costs for a comparable activated sludge system.

*Chemical degradation, *Activated sludge, *Sewage treatment, *Sewerage, *Treatment facilities, Biological treatment, Flocculation, Activated carbon, Settling basins, Costs, Waste water treatment

*Physico-chemical treatment

D591
PILOT-PLANT EXPERIMENTS ON SEWAGE PURIFICATION IN AN ACTIVATED SLUDGE SYSTEM WITH A SELECTOR (Poloprovozni Pokusy S Cistenim Mestske Odpadni Vody V Aktivacnim Systemu Se Selektorem),

Chudoba, J., Grau, P., Sazovska, E., Bitner, F., and Hartig, K.

Technologie Vody, Vol. F, No. 29, P 161-211, 1976. 24 fig, 11 tab, 18 ref.

Pilot studies in Olomouc, Czechoslovakia, on waste water treatment with activated sludge treatment are described. Two systems were used, including a model based on complete mixing and a selector system model incorporating two alternatives (with and without sludge regeneration). Mean and range values of BOD and COD in settled sewage were reported as 260 (+ or 56) mg/liter and 434 (+ or 97) mg/liter, respectively. The use of the complete mixing was ruled out for Olomouc sewage because of high sludge volume indices (300-1000 ml/g) caused by the growth of filamentous organisms during the process. Use of the selector system resulted in sludge volume indices of 150 to 350 ml/g which were further reduced to 100 ml/g with the addition of sludge regeneration. Operational parameters and physical and chemical characteristics for selector sludge were reported as follows: detention period 1 hour; regeneration period 2-3 hours; organic loading 2-4 kg BPD/cu m-d; sludge loading 0.3-1.0 kg BOD/kg MLSS-d; and BOD removals 84-99%. The selector activated sludge system is recommended over the completely mixed activated sludge system to reduce filamentous bulking during treatment.

*Activated sludge, *Model studies, *Pilot plants, *Sewage treatment, Biological treatment, Biochemical oxygen demand, Chemical oxygen demand, Microorganisms, Waste water treatment

Olomouc (Czechoslovakia)

D592
SELECTIVE RENOVATION OF EUTROPHIC WASTES PHOSPHATE/SULPHATE EXCHANGE,

Liberti, L., Boari, G., and Passino, R.

IRSA-CNR,
Bari, Italy.

Water Research, Vol. 11, No. 6, p 517-523, 1977. 8 fig, 3 tab, 7 ref.

Equilibrium data on the sulfate-phosphate exchange in the sulfate-phosphate-chloride ternary system are presented. Selective ion exchange, using anion resins regenerated by sodium chloride, was evaluated for the removal of phosphate derivatives from conventionally treated sewage effluents. Physical-chemical characteristics for the 50 anion resins evaluated in this study are presented. Equilibrium isotherms which represent the equilibrium molar fractions of phosphate in the resin and in the solution are presented for the various resins tested. Four classes of anion resins were differentiated on the basis of selectivity. In general, the selectivity for phosphates was greater than for sulfates and the selectivity for sulfates was much greater than for chlorides. Variations in resin selectivities were attributed to electrostatic interactions in the chloride-sulfate and phosphate-sulfate exchanges, and to water content phenomena in the chloride-phosphate exchange. A resin of the binary amino type functional group (a commercial, weak base resin) is suggested for use with treated sewage effluent. The resin would generally be a crosslinked polyacrylic matrix based on a diethylentriamine copolymer. Laboratory column experiments indicated that the use of a sodium chloride regenerant may allow the selective recovery of nutrients, such as phosphorus, from treated sewage effluents.

*Phosphates, *Sulfates, *Chlorides, *Resins, *Ion exchange, Absorption, Sodium chloride, Separation techniques, Nutrient removal, Anion exchange, Equilibrium, Sewage treatment, Waste water treatment

Anion exchange resins

D593
PROTECTION OF VIRUSES DURING DISINFECTION BY ADSORPTION TO PARTICULATE MATTER,

Boardman, G. D., and Sproul, O. J.

Maine University,
Orono,
Department of Civil Engineering.

Journal Water Pollution Control Federation, Vol. 49, No. 8, p 1857-1861, August, 1977. 7 tab, 9 ref.

Since viruses may survive waste water disinfection processes when they are adsorbed or embedded in solids, a study was undertaken to determine the actual extent of protection of viruses by adsorption onto particles during chlorination. Kaolinite, hydrate aluminum oxide, and calcium carbonate were used as adsorbents for the bacteriophage T sub 7. To produce the experimental systems, virus concentrations of between 200,000 PFU/ml and 400,000 PFU/ml were added to solutions which contained an adsorbent and were adjusted to pH 7. Centrifugation of solutions resulted in relatively high virus recovery. The virus was recovered by sonification of a 10-ml sample at an energy level of 22.5 watts for 30 seconds. Losses of virus prior to pH adjustment suggested that viral infectivity may be reduced at elevated pH values. Control studies on inactivation of T sub 7 with chlorination indicated that a chlorine dosage of 0.036 mg Cl/liter was sufficient for 100% inactivation. Inactivation by chlorination was not significantly affected by the presence of kaolinite, hydrated aluminum oxide, or calcium carbonate. It is suggested that total encapsulation of an infectious agent is necessary for protection from chlorination.

*Viruses, *Bacteriophage, *Disinfection, *Chlorination, *Adsorption, Laboratory tests, Kaolinite, Calcium carbonate, Aluminum, Sewage bacteria, Analytical techniques, Waste water treatment, Sewage treatment

Virus inactivation, T sub 7

D594
ENERGY USES AND RECOVERY IN SLUDGE DISPOSAL, PART 2,

Jones, J. L., and Bomberger, D. C., Jr.

Water and Sewage Works, Vol. 124, No. 8, p 42-46, August, 1977. 11 fig, 8 tab, 22 ref.

Since sludge disposal may represent as much as 25% of total plant operating costs, sludge disposal and treatment processes are examined with respect to costs and energy requirements. The base treatment unit used for comparison includes preliminary treatment, primary clarification and sludge thickening, activated sludge aeration, secondary clarification and sludge thickening, and sludge storage. Five sludge handling options were considered, using vacuum filtration or filter press dewatering in combination with chemical conditioning, high or low pressure wet oxidation, flash drying, sludge digestion, and multiple hearth incineration. Operating and capital costs and energy requirements were calculated for the various combinations in 10, 100, and 500 mgd facilities. At the 10 mgd level, chemical conditioning followed by filter press dewatering and sludge incineration was the least costly sludge handling option. At the 100 and 500 mgd levels, low pressure wet air oxidation followed by vacuum filtration and sludge incineration was the least costly option. In an overall comparison of energy usage based on electrical and fuel requirements, anaerobic digestion, filter press dewatering plus incineration, and heat treatment with low pressure wet air oxidation plus incineration had the lowest net BTU consumption. Energy usage for each of the sludge handling options was calculated for all three plant sizes.

*Sludge disposal, *Incineration, *Capital costs, *Energy, *Fuels, Sludge treatment, Cost comparisons, Operating costs, Treatment, Waste water treatment, Sewage treatment, Dewatering, Filtration

D595
REMOVAL OF PHOSPHATE BY POWDERED ALUMINUM OXIDE ADSORPTION,

Huang, C. P.

Journal Water Pollution Control Federation, Vol. 49, No. 8, p 1811-1817, August, 1977.
8 fig, 1 fig, 25 ref.

The feasibility of the use of powdered aluminum oxide for the removal of phosphate at dilute concentrations was examined. A commercial product, manufactured by the Cobalt Company in Boston, consisting of approximately 90% gamma-Al2O3 was used in laboratory adsorption experiments with NaH2PO4. The two major factors which were observed to affect phosphate removal efficiency were pH and the relative concentration of phosphate to alumina. Phosphate levels were reduced to below detection limits (0.01 mg/liter) at low phosphate:alumina ratios, but remained at 2 mg/liter with an increase of the phosphate:alumina ratio to 0.01. The pH range for optimal phosphate removal was also controlled by the phosphate:alumina ratio, narrowing with increasing ratios. Studies on the kinetics of phosphate removal indicated that phosphate removal was very rapid during the first hour of reaction, and decreased after the second hour to a linear relationship. Specific rate constants and initial rates as affected by pH and phosphate:alumina ratio are listed. Electrokinetics studies indicated that phosphate adsorption modified the electrophoretic mobility of gamma-Al2O3. The use of powdered gamma-Al2O3 is suggested for polishing secondary effluents or dilute aqueous solutions to remove phosphate.

*Phosphates, *Nutrient removal, *Aluminum, *Adsorption, *Kinetics, Hydrogen ion concentration, Chemical reactions, Tertiary treatment, Sewage treatment, Electrophoresis, Separation techniques, Waste water treatment

Gamma-Al2O3, Aluminum oxide, Adsorption kinetics

D596
PHOSPHATE REMOVAL FROM SEWAGE WATER BY SOIL COLUMNS,

Lance, J. C.

United States Water Conservation Laboratory,
Phoenix, Arizona.

Journal of Environmental Quality, Vol. 6, No. 3, p 279-284, July-September, 1977.
8 fig, 1 tab, 13 ref.

Phosphate removal from secondary sewage effluent by calcareous sand filters was investigated as a means of waste water renovation by high-rate land filtration. Columns packed with loamy sand were flooded with secondary sewage effluent for various time periods and infiltration rates. Infiltration rate was the major factor controlling phosphate removal, producing lower phosphate concentrations in filtrate with lower flow velocities. Phosphate content in filtrate could be increased by the addition of dextrose to the column to decrease infiltration rate. Suggested mechanisms for phosphate removal include initial adsorption by the column soil and subsequent precipitation as some form of calcium phosphate. Initial phosphate concentrations of column filtrate were low (0.5 to 1.0 ppm) for more than 200 days of flooding, and leveled off at equilibrium concentrations dependent upon the various filtration rates. Phosphate removal decreased when Bermudagrass (Cynodon dactylon) was grown in the soil columns, suggesting that plant roots kept phosphate in solution through Ca chelation, Ca uptake by plants, competition of organic ions with phosphate for adsorption sites, or a pH reduction in the rhizosphere. Studies indicated that up to 80% of the phosphate in sewage water can be removed by calcareous sand filters at infiltration rates below 15 cm/day.

*Filtration, *Phosphates, *Sands, *Soil filters, *Groundwater recharge, *Bermudagrass, Effluents, Sewage treatment, Artificial recharge, Return flow, Water reuse, Adsorption, Chemical precipitation, Infiltration, Pervious soils, Soil-water-plant relationships, Waste water treatment

Calcareous sands, Phosphate removal

D597
HIGH ENERGY ELECTRON IRRADIATION OF WASTEWATER LIQUID RESIDUALS,

Sinskey, A. J.

Massachusetts Institute of Technology,
Cambridge,
Department of Nutrition and Food Science.

Process Biochemistry, Vol. 12, No. 5, p 11-14, 32, June, 1977. 7 fig, 4 tab, 8 ref.

Land application of municipal waste water sludge for fertilizer and the possibility of contamination by enteric viruses which may survive conventional waste treatment processes have prefaced this investigation into the design and use of electron irradiation for waste water disinfection. The rate of inactivation of bacteria, viruses, and parasites, as well as the required radiation dosage for adequate disinfection, was examined for raw primary sludge, anaerobically digested sludge, secondary waste-activated sludge, dewatered sludge, and composted sludge. Design data for the irradiation facility at Deer Island in Boston are presented. Sludge was irradiated in a concrete-shielded vault as it passed over a rotating stainless steel drum. Microbial survival was not related to sludge solids contents, which ranged from 1.4 to 22 percent. Inactivation studies on Salmonella and Shigella indicated that a dosage of 200 krads was sufficient to reduce levels below detection limits. A dose of 210 krads eliminated fecal streptococci in digested sludge. Coliforms and gram negative bacteria were reduced by a six log cycle with a radiation dose of 150 krads. Greater reductions in bacteria were observed for irradiation in the presence of oxygen at 1 atm than for nitrogen or air at 1 atm. Preliminary cost estimates for incorporating radiation disinfection at the 10,000 gpd Deer Island facility were a capital cost of $450,000 and annual operating costs of $130,000, or $17 per ton of dry sludge.

*Irradiation, *Disinfection, *Sewage bacteria, *Coliforms, *Viruses, Model studies, Pilot plants, Shigella, Salmonella, Oxygen, Nitrogen, Microorganisms, Sludge treatment, Sludge disposal, Fertilizer, Waste water treatment

Deer Island Waste Water Treatment Plant (Boston, MA)

D598
MORE DISPOSAL OPERATIONS MIXING SEWAGE SLUDGE AND MUNICIPAL SOLID WASTES,

Sussman, D. B.

Solid Wastes Management, Vol. 20, No. 8, p 48, 50, 60, August, 1977.

Combination disposal practices in which the energy produced from the combustion of solids is used to dewater municipal sludge are discussed in an EPA update. Basic methods of thermal co-disposal include the use of the organic portion of solids as fuel for sludge incinerators and the use of a solid wastes incinerator, solid wastes fired steam generator, or a waterwall combustion unit to burn dewatered sludge. Approximately 200 waste water treatment plants in the United States utilize thermal processes for sludge disposal. The use of a fluidized bed furnace at Franklin, Ohio is described. An EPA-supported demonstration in Concord, California of the use of a multiple hearth sludge incinerator with refuse-derived fuel (RDF) is described. This incinerator, modified to operate in either incineration or pyrolysis mode, is fed RDF mixed with sludge which has a solids content of 16%. Incineration and spray drying at Ansonia, Connecticut produces dried sludge which is used by local residents for fertilizer. Incineration and rotary drying are used to dewater sludge at Holyoke, Massachusetts. Norwalk, Connecticut and Glen Cove, New York use incineration and furnace drying for waste disposal. Waterwall combustion thin film drying at Dieppe, France and waterwall combustion flash drying at Krefeld, Germany are described. Co-disposal of wastes is an energy-saving and possible fuel-producing technique of solid waste and sewage sludge disposal.

*Incineration, *Sludge disposal, *Dewatering, *Drying, *Fuels, Energy conversion, Waste disposal, Sewage disposal, Solid wastes, Equipment, Municipal wastes, Reviews, Model studies, Waste water treatment

Multiple hearth furnaces, Fluidized bed combustion, Spray drying, Rotary drying, Furnace drying, Waterwall combustion thin film drying, Waterwall combustion flash drying

ANALYTICAL TECHNIQUES

E001
MEASUREMENT AND FORMS OF NITROGEN AND PHOSPHORUS,

Barth, E. F.

Advanced Waste Treatment Research Laboratory,
Cincinnati, Ohio,
Biological Treatment Research Program.

In: Advanced Waste Treatment Seminar, Session I, Nitrogen Removal from Wastewater, October 28-29, 1970, San Francisco, California, p 1-16. 4 fig, 6 tab, 2 ref.

Nitrogen and phosphorus chemistry is discussed from a treatment standpoint. Nitrogen and phosphorus are in the same chemical family. Although their chemical reactions are similar, the resulting compounds vary significantly. A total phosphorus assay should be used to judge actual operating efficiency. This approach is necessary because many forms of phosphorus are found in waste waters and sludges. The most logical way to report results of phosphorus analyses is as elemental phosphorus. Nitrogen also occurs in waste waters in many forms, but the analytical procedures for nitrogen are specific for each form. The whole nitrogen series must be determined to get reliable data. Since the actual toxicant is nitrite, the Drinking Water Standards should be based on nitrite plus nitrate rather than only on nitrate nitrogen. Operators of automated analytical instruments should be sufficiently well informed to understand the limitations of the instruments.

*Waste water treatment, *Pollutant identification, *Analytical techniques, *Measurement, Nitrogen, Nitrates, Nitrites, Phosphorus, Phosphorus compounds

E002
ANALYTICAL STUDIES FOR ASSESSING THE IMPACT OF SANITARY SEWAGE FACILITIES OF DELAWARE COUNTY, OHIO,

Peltier, L., Lewis, M., Cuneo, J., Shea, G.,
Wagaman, D., and Whang, J.

Enviro Control, Incorporated,
Rockville, Maryland,
Environmental Studies Group.

October 24, 1975. 375 p, 63 fig, 54 tab, 202 ref. Environmental Protection Agency Report No. EPA-905/9-76-003.

An analysis of the environmental impact of a proposed sanitary sewage treatment facility and interceptor system for Delaware County, Ohio is presented. The environmental impacts of the sewage treatment facility at the chosen site are evaluated in terms of water quality, biology, land use, and aesthetics. The effects on water quality resulting from the proposed action are analyzed in terms of flow conditions, the waste loads introduced into the receiving stream, and existing and future ambient water quality conditions. Water quality problems of temporary duration which are associated with interceptor construction are also examined.

*Sewage treatment, *Sewers, *Treatment facilities, *Environmental effects, *Water quality, Land use, Interceptor sewers, Construction, Evaluation, Ohio

E003
SURVEYING AMERICA'S LAKES,

Environmental Science and Technology, Vol. 10, No. 9, p 862-864, September, 1976.

Preliminary results from a eutrophication survey of America's lakes are reported along with an example of how some lakes may be restored to higher quality. According to the National Eutrophication Survey, approximately 80% of the lakes and reservoirs in the eastern United States are eutrophic. Shagawa Lake, adjacent to the city of Ely, Minnesota, is an example of a eutrophic lake that has been partially restored by the removal of the algal growth-promoting nutrient phosphorus. The lake originally became eutrophic as a result of the city of Ely discharging its municipal waste water into it. The installation of a tertiary treatment system at the city's waste water treatment plant resulted in more than 99% removal of phosphorus from the effluent and a decline in eutrophic activity of Shagawa Lake. The effluent flowing into the lake contains only 0.05 milligrams/liter of phosphorus. Although the lake is in the process of repairing itself, it has not yet reached equilibrium, probably because of feedback mechanisms involving internal sources of phosphorus which may be retarding the restoration process. However, the project has demonstrated that phosphorus levels as low as 0.05 milligrams/liter can be achieved through lime precipitation.

*Lakes, *Eutrophication, *Surveys, *Nutrients, *Phosphorus, Surface waters, Minnesota, United States, Lime, Chemical precipitation, Waste water treatment, Municipal wastes, Treatment facilities, Tertiary treatment, Efficiencies, Evaluation, Algae, Algal control

E004
CORRELATION OF BOD, COD AND SOLUBLE ORGANIC CARBON,

Viraraghavan, T.

ADI Limited,
Consulting Engineers,
Fredericton, New Brunswick, Canada.

Journal Water Pollution Control Federation, Vol. 48, No. 9, p 2213-2214, September, 1976. 2 tab, 4 ref.

The degree of correlation between soluble organic carbon and oxygen demand (biochemical and chemical) was investigated for samples of raw sewage, septic tank effluent, and polluted groundwater. Biochemical and chemical oxygen demand were estimated by using the procedures in Standard Methods, and soluble organic carbon was measured by analyzing the filtrates of samples filtered through 24.25-centimeter glass fiber filters for organic carbon. The correlation coefficients between soluble organic carbon and biochemical or chemical oxygen demand for raw sewage and septic tank effluent were not significant at the 5% level; polluted groundwater also failed to show a significant correlation at the 5% level for soluble organic carbon and biochemical oxygen demand, although the correlation between the former and chemical oxygen demand was significant at the 1% level. Thus, the use of soluble organic carbon as a measure of organic matter in waste water should be made with caution.

*Carbon, *Organic compounds, *Biochemical oxygen demand, *Chemical oxygen demand, *Waste water (pollution), Sewage, Groundwater, Septic tanks, Effluents, Analytical techniques, Solubility, Statistics

Soluble organic carbon

E005
EVALUATION OF METALS IN WASTEWATER SLUDGE,

Stover, R. C., Sommers, L. E., and Silviera, D. J.

Soil Conservation Service,
LeVeta, Colorado.

Journal Water Pollution Control Federation, Vol. 48, No. 9, p 2165-2175, September, 1976. 9 tab, 17 ref.

Sequential extractions of lead, copper, zinc, cadmium, and nickel from 12 samples of sludges obtained from municipal waste water treatment plants revealed that sludges contain a wide variety of sites capable of metal retention. Retention mechanisms include ion exchange, sorption, chelation, and precipitation. Metal retention appeared to be highly variable, depending on the chemical properties of the sludge and on the nature of the metal in question. Because the predominant forms of the above metals are not the same in each sludge, it is expected that each metal will respond differently after incorporation into soil systems. Even though the exact forms of metals in sludge are not apparent, sequential extraction results obtained for sorbed and exchangeable fractions of the metals may indicate which metals can be most readily used by plants growing in soils treated with waste water sludge.

*Municipal wastes, *Sludge, *Heavy metals, *Chemical properties, *Physical properties, Lead, Copper, Zinc, Cadmium, Nickel, Soils, Soil amendments, Sorption, Separation techniques, Plant growth, Ion exchange, Chemical precipitation, Chelation, Chemical reactions

Extraction procedures

E006
SOYBEAN YIELD RESPONSES AND ASSIMILATION OF ZN AND CD FROM SEWAGE SLUDGE-AMENDED SOIL,

Hinesly, T. D., Jones, R. L., Tyler, J. J., and Ziegler, E. L.

Illinois University,
Urbana-Champaign,
Department of Agronomy.

Journal Water Pollution Control Federation, Vol. 48, No. 9, p 2137-2152, September, 1976. 5 fig, 5 tab, 13 ref.

A 6-year study of the effects of irrigating soybean plots with municipal sludge was performed. Applications of digested sludge significantly increased soil levels of zinc and cadmium which were reflected by increased concentrations of these metals in plant tissues. However, there were no indications that the absorption and translocation of relatively large amounts of these metals into leaves, petioles, and seeds had caused a phytotoxic condition. Only large amounts of phosphorus as a constituent of sludge caused a yield depression during one growing season, and the phosphorus-induced phytotoxic conditions were rapidly dissipated after sludge applications were suspended. During the following growing season, soybean yields were significantly higher on maximum sludge-treated plots than on fertile control plots. Accumulative applications of sludge affected zinc and cadmium concentrations in soybean tissues to a lesser extent than did a particular annual application rate. Thus, if phytotoxic conditions develop as a result of zinc and cadmium accumulation in soils amended with sludge over several years, they are expected to occur during the time of sludge application rather than after the applications have been terminated as suggested by other investigators.

*Sewage sludge, *Soil amendments, *Heavy metals, *Crop response, *Waste disposal, Phytotoxicity, Crops, Zinc, Cadmium, Phosphorus, Irrigation, Symbiosis, Sludge disposal, Municipal wastes

E007
TOWARD A MORE MEANINGFUL INDEX OF SLUDGE QUALITY,

Fitch, B., and Kos, P.

Journal Water Pollution Control Federation, Vol. 48, No. 8, p 1979-1987, August, 1976. 11 fig, 1 ref.

A new index of sludge quality which is independent of the concentration and characteristic of solids quality is proposed as a replacement for the conventionally used sludge volume index. The new index of sludge quality accounts for the functional relationship between sludge volume index and suspended solids and is based on the same test data as the sludge volume index. Although the existing procedure for sludge volume index determination correlates reasonably well with settleability when the settled sludge volume is below about 300 cu cm/liter, above that level the sludge volume index is a strong function of suspended solids concentration. The sludge quality index which takes this functional relationship into account thus offers a superior means for characterizing the settleability of activated sludge. When the solids settle to less than about 300 cu cm, the two indices are identical.

*Activated sludge, *Suspended solids, *Physical properties, *Measurement, *Waste water treatment, Biological treatment, Performance, Sludge, Mathematical studies

Sludge volume index, Sludge quality index

E008
MOVEMENT OF HEAVY METALS BELOW SEWAGE DISPOSAL PONDS,

Lund, L. J., Page, A. L., and Nelson, C. O.

California University,
Riverside,
Department of Soil Science and Agricultural Engineering.

Journal of Environmental Quality, Vol. 5, No. 3, p 330-334, July-September, 1976. 7 fig, 4 tab, 10 ref.

The extent of downward movement of zinc, cadmium, copper, chromium, and nickel in coarse-textured soils beneath sewage sludge and effluent disposal ponds at two sewage treatment plants was investigated. Concentrations of acid-extractable metals were greater under disposal ponds than at offplant control sites at both treatment plants. Metal enrichment was evident at depths as great as 3 m under some ponds; and zinc, cadmium, copper, chromium, and nickel levels at this depth ranged as high as 75, 10, 30, 30, and 70 micrograms/gram, respectively. The depth and degree of metal enrichment depended on the specific pond type and the treatment plant. Metal concentrations were greater under anaerobically digested sludge-holding ponds than under effluent ponds. Concentrations of the metals in saturation extracts of soils beneath the ponds were much greater than those typically found for California soils. The distributions of the metals with depth were closely related to changes in chemical oxygen demand of soil samples with depth, suggesting that the metals were transported as soluble metal-organic complexes.

*Heavy metals, *Sewage disposal, *Sludge disposal, *Soil analysis, *Treatment facilities, Zinc, Cadmium, Copper, Chromium, Nickel, Chemical oxygen demand, Metals, Ponds, Soil chemical properties, Soil contamination effects, Soil investigations, On-site investigations, Solubility, Sewage treatment

Metal-organic complexes

E009
DETERMINATION OF CHEMICAL OXYGEN DEMAND (DIE BESTIMMUNG DER CHEMISCHEN OXIDIERBARKEIT),

Sprenger, F. J.

Vom Wasser, Vol. 46, p 125-138, 1976. 1 tab, 10 ref.

The determination of chemical oxygen demand in water with dissolved organic compounds is discussed. Chemical oxygen demand determinations are made by oxidizing the organic matter in the water as completely as possible so that carbon dioxide and water are the final products. Preferred oxidizing agents include potassium permanganate in alkaline or acid solutions and potassium dichromate in acid solution. Generally, higher rates of oxidation are achieved with the latter compound. Although higher rates of oxidation may be obtained by increasing temperature and sulfuric acid concentration of the sample, secondary effects involving the simultaneous oxidation of chlorides rule out such means as being practical.

*Chemical oxygen demand, *Analytical techniques, *Waste water, *Organic compounds, *Oxidation, Chemical reactions, Kinetics, Temperature, Acidity, Alkalinity, Chlorides

Oxidizing agents, Potassium permanganate, Potassium dichromate

E010
INSTANTANEOUS METERING AIDS ACTIVATED SLUDGE PLANT,

Matzner, B. A.

Suffolk County Department of Environmental Control,
New York,
Operations Division.

Water and Wastes Engineering, Vol. 13, No. 8, p 18-20, August, 1976.

The feasibility of using an automatic instrument for the instantaneous measurement of mixed liquor suspended solids in the aeration tank of an activated sludge municipal treatment plant with extended aeration/nitrification and suspended growth denitrification was demonstrated. The analyzer consists of two parts connected with cables: a sensing probe (mounted on the downflow side in the center of the aeration tank) and a remotely located indicator assembly which gives a direct digital readout in ppm. In the event of a decrease in solids in the mixed liquor, the analyzer alerts the operator to introduce additional solids into the aeration tank. When the solids reach the top of the optimum ppm range, as indicated by the automatic analyzer, the operator turns off the return sludge system and begins wasting sludge from the clarifiers. Continuous testing of the analyzer at the sewage treatment plant indicates that the instrument is reliable and provides an accurate measure of mixed liquor suspended solids.

*Analytical techniques, *Monitoring, *Suspended solids, *Aeration, *Biological treatment, Activated sludge, Nitrification, Denitrification, Sewage treatment, Waste water treatment, Liquid wastes, Feasibility, Performance, Evaluation, Measurement, Treatment facilities, On-site investigations, Automation

E011
ALARM SYSTEM CONTINUALLY MONITORS PLANT FUNCTIONS,

Hartenstein, A.

Public Works, Vol. 107, No. 9, p 86, September, 1976.

An alarm system for continuously monitoring the functions of water and waste water treatment plants as well as pumping stations is described. During normal working hours, the alarm system is activated by a master control panel and dials a designated telephone number for the reporting of alarm conditions. Should a malfunction occur, one of 18 radio-equipped trucks will respond to the alarm. During non-working hours, the monitoring system activates a computer connection with the telephone company which automatically forwards the original call to a second telephone number via a telephone call diverter so that standby personnel who are available on a 24-hour basis can respond to the alarm. Functions that can be tied into the system include: low dissolved oxygen, high suspended solids, low chlorine residual, chlorine leaks, power failures, low pressure, and loss of air to a waste water treatment plant. The one-time charge for installing the system averages out to $1750 per installation with a monthly charge of $39.00 for telephone equipment.

*Monitoring, *Treatment facilities, *Automation, *Failures, *Computers, Waste water treatment, Water treatment, Pumping plants, Costs

E012
COLIFORM BACTERIA FROM DIFFUSE SOURCES AS A FACTOR IN ESTUARINE POLLUTION,

Faust, M. A.

Smithsonian Institution,
Edgewater, Maryland,
Chesapeake Bay Center for Environmental Studies.

Water Research, Vol. 10, No. 7, p 619-627, 1976. 3 fig, 5 tab, 35 ref.

The contribution of 849 hectares of rural watershed to the fecal coliform pollution of the Rhode River, a subestuary of Chesapeake Bay was estimated. The watershed has an animal population of 0.6 animal units/hectare and discharges between 7.5-669 million fecal coliforms/hectare-day. The fecal coliform discharge rate was seasonal and depended largely on the water flow. On the average, less than 1% of the fecal coliforms produced by the animals on the land was washed down by water runoff, although occasionally this figure reached as high as 4-6%. Fecal coliform numbers were high in the Rhode River close to the discharge points and became diluted further downstream by the river volume. Using the maximum number of fecal coliforms in the runoff, an estimated 2600 cu m of well mixed receiving water appears to be required for every hectare of watershed area if safe water standards for shellfish harvesting (14 equal fecal coliforms-most probable number/100 milliliters) are not to be exceeded.

*Watersheds (basins), *Estuarine environment, *Water pollution sources, *Coliforms, *Runoff, River systems, Microorganisms, Shellfish, Estuarine fisheries, Chesapeake Bay

Rhode river, Fecal coliforms

E013
MUSSEL TEST FOR BIOLOGICAL CONTROL OF WATER POLLUTION
(Kagylo-teszt vizszennyezesek biologiai hatasanak vizsgalatara),

Salanki, J.

Hidrologiai Kozlony, Vol. 56, No. 6, p 281-282, June, 1976. 3 fig, 5 ref.

The use of the fresh water mussel (Anodonta cygnea) as a biological indicator of water pollution is proposed. The fresh water mussel is a typical filter-feeding animal and reacts to various substances dissolved in the water by changes in the rhythmic and periodic activity of its adductor muscles. This activity can be monitored by recording the position and movement of the animal's shells which in turn reflect the concentration of pollutants like heavy metals as well as the oxygen level of the water.

*Mussels, *Bioindicators, *Monitoring, *Water pollution, Freshwater fish, Heavy metals, Oxygen

E014
A NEW LABORATORY DEVICE FOR WASTE WATER ANALYSES (RESPIROMETER).
PART II. MEASUREMENTS WITH BATCH OPERATION (Uj laboratoriumi szennyvisvizsgalo keszulek (respirometer) II. resz. Meresek szakaszos uzemmod mellett),

Fleps, W.

Hidrologiai Kozlony, Vol. 56, No. 5, p 201-207, 1976. 7 fig, 1 tab, 3 ref.

A respirator device for making waste water measurements in batch operation is described. The respirometer is capable of determining biodegradability, toxicity, nutrient demand, total biochemical oxygen demand, and the probable efficiency of treatment. The device also allows for a determination of the carbon and oxygen balance of degradation.

*Analytical techniques, *Waste water (pollution), *Monitoring, *Biochemical oxygen demand, *Nutrients, Biodegradation, Efficiencies, Toxicity, Measurement

Respirometers

E015
MINIMIZING THE WASTE DISCHARGES FROM WATER TREATMENT PLANTS,

Helfgott, T. B., and Lacy, W. J.

Connecticut University,
Storrs,
Civil Engineering Department.

American Institute of Chemical Engineers Symposium Series, Vol. 71, No. 151, p 166-169, 1975. 2 fig, 2 tab, 6 ref.

A solids power index for making normalized comparisons between various dewatering techniques is proposed. The power index expresses the energy utilization of a dewatering technique in kilowatt-hours/1000 lb dry solids. The parameter is limited in that it does not account for the specific chemical nature of the solids being dewatered nor dewatering characteristics as a parameter for filterability. Graphical comparisons involving the solids power index as a function of % solids are illustrated for dewatering via evaporation, vacuum filtration, double cell gravity concentrations, and screw press multi-roll sludge dewatering.

*Sludge treatment, *Dewatering, *Energy equation, *Solid wastes, *Waste water treatment, Electric power, Mathematical models, Waste treatment, Analytical techniques

Power indices

E016
A PROCEDURE FOR THE ROUTINE BIOLOGICAL EVALUATION OF URBAN RUNOFF IN SMALL RIVERS,

Pratt, J. M., and Coler, R. A.

Massachusetts University,
Amherst,
Department of Environmental Sciences.

Water Research, Vol. 10, No. 11, p 1019-1025, 1976. 1 fig, 1 tab, 16 ref.

Benthic macroinvertebrates were used in a procedure to evaluate pollution in small rivers. They offer the advantage of abundance and ease of collection, a limited vagility and long life span, and a capacity for a graded response to many kinds and degrees of stress. Species diversity is used as a parameter of pollution detection. Artificial substrates were suggested as a convenient method for obtaining data on upstream-downstream effects of urban runoff. Monitoring sites should be a reference site well upstream from the section receiving urban runoff and in the urban reach where one is exposed to minimal levels of urban runoff and one near maximum amounts. The number of substrates used should depend on the purpose of the survey and the time available for collection. Two baskets per site are minimal needs. A collection frequency of eight collections per year should suffice. Calculations are presented for processing the biological data. Interpretation should be guided by diversity and evenness indices. When monitoring sublethal effects, it should be considered that diversity of an artificial substrate is determined by differential drift and recruitment rates, and life histories of macrobenthic populations.

*Monitoring, *Water quality control, *Urban runoff, *Rivers, *Pollutant identification, Benthic flora, Benthic fauna, Bioindicators, Water pollution effects

Biological indices

E017
GROUNDWATER QUALITY ADJACENT TO A SEPTIC TANK SYSTEM,

Viraraghavan, T., and Warnock, R. G.

ADI, Limited,
Fredericton,
New Brunswick, Canada.

American Water Works Association Journal, Vol. 68, No. 11, p 611-614, November, 1976. 8 fig, 2 tab, 9 ref.

An investigation was performed to determine the adequacy of a septic tile system as a treatment to reduce constituents of septic tank effluent. Adjacent groundwater was analyzed to determine its chemical and bacteriological quality. The study site was near Ottawa, Canada. Low winter temperatures with snow cover and snow melting in the spring with high groundwater levels were the most significant climatic conditions affecting the study. A collecting tank was installed into which some of the septic tank effluent from the household system was diverted. In addition, an observation trench was constructed to install the lysimeters and collect soil water samples collected through the lysimeters. Groundwater from the observation trench was sampled and analyzed. Test site soil was evaluated as to its percolation rate and coefficient of permeability. Environmental factors considered were temperature, unsaturated depth of soil (depth of groundwater), and snow cover. Results showed that soil removed a high percentage of TSS, BOD, SOC, ammonia nitrogen, iron, coliforms, fecal coliforms and fecal streptococci from septic tank effluent. High ammonia reduction corresponded with increases in nitrate levels in adjoining groundwater, a possible health hazard. Groundwater levels affect soil limits for pollutant absorption. Pollutant concentrations in groundwater as well as nitrate nitrogen were higher near the tile and significantly decreased farther away from the tile end. Winter operation was not especially problematic, as the snow cover and hot water discharge from the system kept nearby ground warm.

*Groundwater, *Water quality, *Septic tanks, Water analysis, Tanks, Nitrogen, Pollutant identification, Soil water, Waste water treatment, Snow, Public health, Lysimeters, Soil analysis

E018
THE ELECTROLYTIC RESPIROMETER I. FACTORS AFFECTING OXYGEN UPTAKE MEASUREMENTS,

Young, J. C., and Baumann, E. R.

Iowa State University,
Ames,
Department of Civil Engineering.

Water Research, Vol. 10, No. 11, p 1031-1040, 1976. 11 fig, 1 tab, 10 ref.

A more complete and accurate measurement of the biochemical oxygen demand (BOD) of waste waters can be provided by the electrolytic respirometer. The apparatus has three major parts: a reaction vessel containing the sample and a magnetic stirring bar or other mixing device; an adaptor unit or alkali container with potassium hydroxide or another solution which absorbs metabolically produced carbon dioxide from atmosphere above sample; and a manometer cell containing a weak electrolyte (sulfuric acid or sodium hydroxide) which detects pressure changes and acts as an oxygen generator to maintain a constant partial pressure in the atmosphere of the sample container. The system is simple and provides a continuous oxygen uptake readout. Errors in measurement are usually contributed to the mixing rate and the concentration of oxygen demanding organic material in the sample. Increased mixing or oxygen enrichment of the air contacting the sample can overcome oxygen transfer limitations. Control of barometric pressure in the manometer cell is important since changes will alter oxygen readings. Corrections with this system are easily made. The coefficient of variability was less than 3.5% for samples with an ultimate BOD value between 20 and 500 mg/liter. BOD measurement is more precise with the electrolytic respirometer than with the dilution method.

*Biochemical oxygen demand, *Measurement, *Pollutant identification, *Electrolysis, Oxygen requirements, Equipment, Pressure, Mixing

E019
MODEL STUDIES IN AQUEOUS CHLORINATION: THE CHLORINATION OF PHENOLS IN DILUTE AQUEOUS SOLUTIONS,

Smith, J. G., Lee, S. F., Netzer, A.

University of Waterloo,
Waterloo, Ontario, Canada,
Department of Chemistry.

Water Research, Vol. 10, No. 11, p 985-990, 1976. 2 fig, 1 tab, 25 ref.

To further elucidate well known reactions of phenol which, when present as a contaminant of water supplies, can lead to unpleasant taste and odor in the chlorine-treated end product, model studies were performed to determine the end products of chlorination of phenols in aqueous solutions. Phenols tested were 2,4,6-trichlorophenol; 2,3,4,6-tetrachlorophenol; pentachlorophenol; and p-nitrophenol. These were examined at initial pH's of 6.0 and 3.5, the reaction products isolated by solvent extraction, the mixtures separated by column chromatography and the products identified by their spectral properties. It was found that chlorine displaced the nitro group and there was an aromatic substitution to a more highly chlorinated phenol. Phenol was also oxidized to a chlorinated benzoquinone. There was the addition of one mole of chlorine to the phenol to form chlorinated 2,5-cyclohexadienones and the addition of two moles of chlorine or hypochlorous acid to form chlorinated cyclohexenones and/or chlorinated hydroxycyclohexenones. Minor amounts of octachlorocyclohexadiene (from tetra- and pentachloro-phenols) and octachlorodibenzodioxin (from pentachlorophenol) were isolated. It was concluded that chlorination of phenols in dilute aqueous solution can produce highly chlorinated non-phenolic products.

*Chlorination, *Phenols, *Municipal wastes, Water pollution effects, Waste water treatment, Solvent extractions, Chromatography, Water analysis

Aqueous chlorination

E020
EFFECT OF WATER CHLORINATION UPON LEVELS OF SOME POLYNUCLEAR AROMATIC HYDROCARBONS IN WATER,

Harrison, R. M., Perry, R., and Wellings, R. A.

Imperial College,
London, England,
Public Health Engineering.

Environmental Science and Technology, Vol. 10, No. 12, p 1151-1156, November, 1976. 12 fig, 3 tab, 16 ref.

Eight polynuclear aromatic hydrocarbons (PAH) were subjected to chlorination and the results were evaluated against PAH removal at a water treatment plant. In lab tests, PAH's and a chlorinating agent were added to three aliquots of distilled water with one aliquot of distilled water as a blank. Various values of temperature, contact time, and reagent concentrations were tested. For comparison, samples from water treatment works were collected in glass vessels and extracted and analyzed by gas-liquid chromatography. The study revealed a 64-88% PAH removal by chlorination as compared to water treatment plant removal of about 60%. This difference is probably due to impurities in the water. Temperature, pH, and the concentrations of PAH and chlorinating agent have varying effects on PAH removal. Efficient filtration in treatment plants removes a substantial amount of PAH and chlorination furthers the process.

*Water treatment, *Chlorination, *Treatment facilities, *Temperature, Hydrogen ion concentration, Laboratory tests, Sampling, Water analysis, Analytical techniques

Hydrocarbons, Polynuclear aromatic hydrocarbons (PAH)

E021
CYANOPHAGE ANALYSIS AS A BIOLOGICAL POLLUTION INDICATOR-BACTERIAL AND VIRAL,

Smedberg, C. T., and Cannon, R. E.

North Carolina University,
Greensboro,
Department of Biology.

Journal Water Pollution Control Federation, Vol. 48, No. 10, p 2416-2426, October, 1976. 4 fig, 4 tab, 26 ref.

The use of the non-pathogenic, blue-green algal virus LPP-1 as an indicator of virus and coliform presence in waste water was investigated during field studies at a sewage treatment plant. This cyanophage attacks the filamentous, non-blooming blue-green algal genera Lyngbya, Phormidium, and Plectonema and can be used as an inexpensive monitor of virus and coliform removal from waste water. Its natural presence in waste water and its resistance to chlorination make it especially attractive as an indicator of animal viruses. Since the presence of cyanophages in waste water is paralleled by coliform presence, LPP-1 can also be used to detect fecal pollution. Results obtained with this monitoring test are tabulated for composite samples of waste water taken at initial screening points, before and after trickling filtration, and after chlorination.

*Analytical techniques, *Viruses, *Coliforms, *Monitoring, *Sewage treatment, Measurement, Indicators, On-site investigations, Waste water treatment, Performance, Biological treatment, Trickling filters, Chlorination, Screens, Feasibility studies

E022
A STUDY OF MIXING CHARACTERISTICS OF SEWAGE STABILIZATION PONDS WITH RADIOACTIVE TRACERS,

Iwugo, K. O., and Winnicki, R.

Birmingham University,
Birmingham, Great Britain,
Department of Civil Engineering.

The Public Health Engineer, Vol. 4, No. 5, p 138-142, September, 1976. 5 fig, 4 tab, 15 ref.

The actual retention times of domestic waste waters in two sewage stabilization ponds were determined using the fundamental fluid mechanics concept of residence time distribution and radioactive tracers. The dispersion index of mixing in each of the ponds was also deduced to quantify the degree of mixing in each of the ponds. Both tritium and chromium-ethylenediaminetetraacetic acid complex were found suitable for the determination of the residence time distribution. Tritium is more economical but has a half-life of 12-15 yr as compared with a half-life of 28 days for the chromium-ethylenediaminetetraacetic acid complex, making the latter tracer more attractive from an environmental standpoint.

*Analytical techniques, *Domestic wastes, *Sewage treatment, *Stabilization, *Tracers, Ponds, Mathematical studies, Fluid mechanics, Retention, Radioactivity, Measurement, Evaluation, Performance

E023
USE OF INTRINSICALLY SAFE INSTRUMENTATION,

Water Services, Vol. 80, No. 964, p 356-357, June, 1976. 2 ref.

Safeguards to prevent flammable gas explosions triggered off by electrically-operated monitoring equipment used within sewage collection networks and at sewage treatment plants are discussed. Monitoring and control equipment is frequently made intrinsically safe by the use of shunt diode barriers which effectively remove the risk of incendive levels of energy breaking through from remotely mounted equipment. The majority of shunt diode barrier applications in the sewage industry are straightforward and include the use of switches, thermocouples, resistance elements, thermometers, and solenoid pilot valves in pneumatic systems. Magnetic flowmeters are made safe by encapsulating the coil and increasing the safety terminal compartment. The probes and detecting circuit are normally made safe by the use of shunt diode safety barriers.

*Monitoring, *Analytical techniques, *Sewage treatment, *Explosions, *Gases, Electrical equipment, Design criteria, Safety, Treatment facilities

E024
ACTIVATED CARBON ADSORPTION IN MUNICIPAL WASTE WATER TREATMENT AND REUSE SYSTEMS,

Chow, D. K.

Dissertation Abstracts International B, Vol. 37, No. 2, p 939-940, August, 1976.

Activated carbon adsorption was investigated as a tertiary treatment in waste water treatment and reuse systems. Resistant compounds and the breakthrough characteristics of carbon adsorption in fixed beds were analyzed to provide data on the design and use of adsorption units. Fixed activated carbon beds were used to treat biological and chemical secondary effluents of municipal sewage. Several physical and chemical analytical techniques were used to classify organic and inorganic compounds. Breakthrough data was gathered for resistant compounds which were recycled to the carbon beds, and for those which were not. Characteristics such as breakpoint time and adsorptive capacity were examined. Organic compounds (chlorinated hydrocarbons, aliphatic acids, aromatic amines and phenolic compounds, and inorganic sodium and calcium salts) are resistant compounds. Most of them are small molecules and biodegradable. A method is offered to predict maximum buildup levels of these compounds and the number of recycles of treated water needed to achieve these levels. An empirical approach for the prediction of breakthrough curves for fixed carbon beds in secondary effluent treatment is presented.

*Activated carbon, *Adsorption, *Tertiary treatment, *Water reuse, *Waste water treatment, Effluents, *Municipal wastes, Analytical techniques, Organic compounds, Inorganic compounds

E025
MONITORING OF COMMUNITY WATER SUPPLIES,

Foley, P. D., and Missingham, G. A.

Ontario Ministry of the Environment,
Pollution Control Board,
Ontario, Canada.

American Water Works Association Journal, Vol. 68, No. 2, p 105-111, February, 1976. 6 tab, 11 ref, 1 append.

Water quality in Ontario, Canada, was subjected to an in-depth monitoring program. New and improved analytical techniques such as the electron microscope and gas chromatograph-mass spectrometer-computer analysis were used to confirm the presence of various substances at low concentrations in water supplies. Great concern was shown towards substances known to be toxic at great concentrations or carcinogenic. Substances investigated were asbestos, heavy metals, and organics. Resultant analyses indicated that the asbestos in water does not penetrate the gut wall and is not a health hazard. Heavy metals were not seen as a major problem. Their problems consist of particles from lead services or copper piping in the distribution system. High copper levels are controlled by raising the water pH, which lessens the lead problem, though that may require replacement of lead. Organic analysis revealed a great low-level incidence of haloforms. In drinking water, the only organic with an assessable history was found to be chloroform. It was not considered a health hazard. Pesticide and herbicide levels were not considered dangerous. It was finally concluded that the great differences in the orders-of-magnitude in doses and concentrations prevent any definite conclusions.

*Monitoring, *Water supply, *Water quality, Gas chromatography, Mass spectroscopy, Heavy metals, Organic compounds, Potable water, Computers, Analytical techniques, Public health, Electron microscopy

E026
LABORATORY STUDIES ON THE EFFECTS OF TEMPERATURE ON ACCUMULATION OF SOLIDS IN BIOLOGICAL FILTERS,

Shephard, M. R. N., and Hawkes, H. A.

Aston University,
Birmingham, England,
Department of Biological Sciences.

Water Pollution Control, Vol. 75, No. 1, p 58-72, 1976. 12 fig, 1 tab, 18 ref.

Laboratory scale filters under controlled temperature conditions with and without macrograzers were used to investigate seasonal variations in the film accumulation in biological filters. The BOD of feed and effluent, the wet weight of the film, and the CO_2 output for each filter were determined weekly. Results indicated that without macrograzers, solids accumulation was controllable at higher temperatures by microbiological activity. Contributing factors for this seemed to be alternating periods of build-up and sloughing caused by an increase in the microorganisms which are the attachment layer on the substratum die, grazing by microfauna, and the differential effect of temperature on the rates of BOD removal and oxidation of the removal BOD. There was a reduction in the oxidation rate as measured by CO_2 output at temperatures less than 20 C, though similar temperature reductions did not have a great effect on the BOD removal rate. The increased accumulated solids in the filter were partially responsible for reduced BOD removal efficiency at low temperatures. At 20 C, the amount of solids was controlled at a more uniform and lower level by grazing than by microbiological means. It seems that some applied organic matter is immediately oxidized by microorganisms while some may be stored and oxidized later.

*Sewage treatment, *Laboratory tests, *Temperature, *Filters, Biochemical oxygen demand, Microorganisms, Oxidation, Organic compounds

Biological filters

E027
INVESTIGATIONS ON THE IMPORTANCE OF THE ORGANIC CHLORO-COMPOUNDS AND THEIR ADSORBABILITY (Untersuchungen zur Bedeutung der organischen Chlorverbindungen und ihrer Adsorbierbarkeit),

Kuehn, W., and Fuchs, F.

Vom Wasser, Vol. 45, p 217-232, 1975. 8 tab, 25 ref.

Pyrohydrolysis, used to analytically determine organic chloro-compounds, also shows interesting results for controlling water treatment plants for the concentration in water of these compounds. Results for DMF-extract, dioxane extract, nonpolar organic chlorine and total organic chlorine in activated carbon samples from water works are given. Values for Lake Constance, the Rhine, and several other rivers were measured, and these substances' origins are discussed. More highly activated carbon is more selective for organic chlorine than lower activated carbon.

*Pollutant identification, *Analytical techniques, *Treatment facilities, *Organic compounds, *Chlorine, Adsorption, Water treatment, Chlorination, Dewatering, Incineration, Activated carbon

Pyrohydrolysis

E028
A NEW METHOD OF AUTOMATIC DETERMINATION OF NITRATE IN WASTE WATERS AND POLLUTED SURFACE WATERS (Ein neues Verfahren zur automatischen Nitrat-Bestimmung in Abwaessern und belasteten Oberflaechenwaessern),

Wagner, R., Frommert, I., and Koenig, R.

Vom Wasser, Vol. 45, p 271-284, 1975. 9 fig, 18 ref.

For manual nitrate determination in sewage, plant effluents, and receiving streams, the p-fluoro phenol method is very successful. Nitrate ions form 2-nitro-4-fluoro phenol in a nitration step included in the method. The 2-nitro-4-fluorophenol is transferred to an alkaline recipient by steam distillation, producing a yellow solution for spectrophotometric measurement. An AutoAnalyzer system, including distillation with a new pass through unit to heat the sample stream, based on a boiling thermostat, which is located in front of the distillation head, was prepared for automatic performance of the p-fluoro phenol method. The manifold is adapted for between about 0.1 and 30 ppm nitrate nitrogen; the sample frequency is 10 per hour. This automatic method may also be used in cases in which methods based on partial nitrate ion reduction to nitrite ions, due to irregular reduction rates, do not give reliable results.

*Surface waters, *Pollutant identification, *Sewerage, *Analytical techniques, *Automation, *Nitrates, Waste water (pollution), Effluents, Ions

Receiving streams, P-fluoro phenol method

E029
ULTRAVIOLET PURIFICATION SYSTEM,

Mechanical Engineering, Vol. 98, No. 6, p 51, August, 1976.

An automatic, self-monitoring system using ultraviolet radiation was developed to provide a continuous flow of bacteria-free process, product, or drinking water. Its capacity ranges from 6 to 100,000 gallons per minute. Sewage effluent is disinfected and all bacteria and viruses are destroyed without harmful chemical by-products. Color, taste, and pH are not changed. Components are a stainless steel purification chamber with high-intensity ultraviolet lamps, remotely housed electrical components and controls, a water quality monitor, and in-place cleaning capability. Operations are continuously monitored and any discrepancy is immediately indicated. It has proved to be an economical treatment process.

*Monitoring, *Ultraviolet radiation, Potable water, Sewage treatment, Water treatment, Waste treatment, Economics, Disinfection, Bacteria, Viruses, Pollutant identification

E030
NITRATE MONITORING,

Water Services, Vol. 80, No. 964, p 357-358, June, 1976. 1 fig.

The World Health Organization has fixed a limit for nitrate in potable water of 11.3 mg/liter nitrate as nitrogen. One major source of nitrate is sewage effluent, since nitrates are derived from ammonium compounds during secondary treatment in normal aeration plants and conventional sewage treatment has little effect on nitrate levels. Ion-selective electrode analysis for nitrate measurement has a wide range of applications and is comparatively unaffected by strong or highly colored solutions and suspended solids but requires frequent standardization and constant temperature control or compensation. Continuous monitoring is essential to prevent undetected gross pollution, and a suitable continuous monitor designed for on-line analysis has been developed. Measurement is made by a preset expanded scale pH amplifier. The sample is drawn from a constant head unit, through a heat exchanger and then pumped past a mixing cell fitted with the nitrate and reference electrodes. The first major use of this monitor for nitrate was northeast of London on the River Lee, which carries a high sewage effluent loading. The River Lee is also monitored for pH, temperature, dissolved oxygen, conductivity, suspended solids, and ammonia. Nitrate monitoring was added to the network in 1973. Nitrate has been shown to be useful for assessing pollution loading and denitrification.

*Nitrogen, *Waste water treatment, *Sewage treatment, *Pollutant identification, *Analytical techniques, *Treatment facilities, Nitrates, Monitoring, Sewerage, Potable water

World Health Organization

E031
AUTOMATION: A SHORT HISTORY, BUT A LONG FUTURE,

Norkis, C. M., and Gilman, H. D.

Greeley and Hansen,
Philadelphia, Pennsylvania.

Water and Wastes Engineering, Vol. 13, No. 7, p 97-98, 100, July, 1976. 1 fig.

Automation is rapidly entering the field of waste water treatment as the costs of computer hardware declines and more relevant computer systems are designed. The needs of waste water management include development of reliable sensors, performance specifications for new and existing hardware, research and development of control strategies, development of designers' guides, and study of interactions of unit processes. More computerized monitoring and control units are being installed and contribute to both centralized and distributed control systems. The U. S. Environmental Protection Agency has supported automation efforts, including the role of universities, development of digital technology to reduce costs, and mathematical modeling for waste water treatment. Instrumentation and automation in the Philadelphia area is described. Specific hardware and software is also detailed.

*Automation, *Waste water treatment, *Automatic control, *Computer models, *Design, Monitoring, Mathematical models, Instrumentation, Treatment facilities

Computer hardware, Computer software

E032
MICROBIOLOGICAL EXAMINATION OF WATERS AND EFFLUENTS,

Dutka, B. J.

Canada Centre for Inland Waters,
Microbiology Laboratories Section,
Burlington, Ontario.

ASTM Standardization News, Vol. 4, No. 1, p 19-21, January, 1976. 1 tab.

Some form of standardized water quality estimation procedures is needed to rectify the present situation in which analysts use many individually favored methods. Because of the many uses of bacteria as a tool in assessing water and effluents, standardization is necessary for meaningful data. Bacteriologists and microbiologists were consulted on a world-wide basis for input into the development of international standard procedures. Also an ASTM committee was charged with developing such procedures. One major concern is media formulation. The goals of this group are to define organism under study, to develop a simple biochemical definition of the organism, and to prepare isolation and enumeration procedures applicable to a variety of samples.

*Water quality, *Standards, *Water analysis, Bacteria, Microorganisms, Bioassay, Pollutant identification

*ASTM

E033
THE AERIAL PHOTO-WATER QUALITY LINK,

Environmental Science and Technology, Vol. 10, No. 3, p 228-229, March, 1976.

A new technique of analyzing aerial photography was applied to the study of eutrophication in lakes. The progression of eutrophication in lakes is accompanied by a change in water color from blue to green. The higher the concentration of algae, the greener the water color. One problem involved was whether satellite or aircraft should be used in the photography. Aerial photography has the advantage of being able to sample an entire lake in minutes or hours, rather than in days as with surface craft. New processing procedures allow sophisticated color separation which can be analyzed to determine areas where eutrophication is either beginning or increasing. Corrections may be made for atmospheric conditions which might interfere with photo interpretation. This process is being improved and can provide immense detailed information to scientists who must deal with this problem.

*Eutrophication, *Lakes, *Analytical techniques, *Aerial photography, Color, Algae, Pollutant identification

E034
THE LIMITATION OF THE RATIO OF FECAL COLIFORMS TO TOTAL COLIPHAGE AS A WATER POLLUTION INDEX,

Bell, R. G.

Agriculture Canada,
Lethbridge, Alberta, Canada.

Water Research, Vol. 10, No. 8, p 745-748, 1976. 1 fig, 2 tab, 11 ref.

A study was undertaken to determine whether the ratio of fecal coliform bacteria to total coliphage in raw sewage, sewage lagoon effluent, or river water, had any significance as a pollution index. Fecal coliform populations were determined using the most probable number technique. Total coliphage populations were determined using Escherichia coli B host cells. The ratios of fecal coliforms to coliphage were 87:1, 4.2:1, and 0.15:1, respectively. The ratio of fecal coliforms to coliphage in stored raw sewage decreased to about 1:1 within 7 days at 20 C and within 28 days at 4 C. The changes resulted from the greater longevity of the coliphage. The ratio of fecal coliforms to coliphage is not considered a reliable index of fecal pollution because it is influenced by prior contamination, presence of sediment, chlorination, and temperature.

*Pollutant identification, *Waste water treatment, *Sewage treatment, *Sewerage, *Analytical techniques, Treatment facilities, E. coli, Bacteriophage

Coliphage

E035
THE COST OF PRODUCING EFFLUENTS TO VARYING STANDARDS BY BIOLOGICAL TREATMENT TECHNIQUES,

Sidwick, J. M., and Preston, J. R.

Effluent and Water Treatment Journal, Vol. 16, No. 5, p 238-241, 244-247, May, 1976.
8 fig, 5 ref.

The capital costs of achieving various standards of effluent by biological methods are discussed. Various mathematical fits were examined with the assistance of a computer. Recorded and reported costs on civil engineering schemes are rarely on the same basis: unit costs may or may not include ancillaries. Principal biological treatment methods are subdivided into biological filtration and activated sludge treatment. Thirty mg/liter suspended solids and 20 mg/liter biochemical oxygen demand (BOD) in 5 days was taken as the norm for full treatment. The cost per head decreases as population increases for inlet works. Rectangular, pyramidal, and circular primary sedimentation tanks did not differ significantly with regard to costs. Since the principal cost of a biological filter is in the medium, the curve for cost per cu m follows a predictable slope showing reducing unit cost with increasing volume. Insufficient data were available upon which to base meaningful cost curves for high-rate biological filters using conventional medium, but conventional media installations are less expensive in terms of capital cost than their synthetic medium counterparts. High rate activated sludge treatment is less expensive than standard rate activated sludge treatment for all population sizes. Cost decreases as volume and population increase. Site costs vary from 25% of the aggregated unit costs for the smaller works to 10% for the larger works. Aeration package plants are cheaper than package plants using biological-disc methods of treatment. In general, cost per population equivalent decreases as unit size increases.

*Capital costs, *Waste water treatment, *Biological treatment, *Activated sludge, *Biochemical oxygen demand, *Treatment facilities, Effluents, Standards, Mathematical studies, Cost analysis

E036
EFFECT OF VARIABLE LOADING ON OXYGEN UPTAKE,

Duggan, J. B., and Cleasby, J. L.

Iowa State University,
Ames,
Department of Civil Engineering.

Journal Water Pollution Control Federation, Vol. 48, No. 3, p 540-550, March, 1976.
6 fig, 2 tab, 14 ref.

A study was conducted to determine oxygen uptake responses to influent waste loading in an activated sludge system. The study employed a package pilot plant consisting of an aeration basin and a hopper-bottom final settling basin. There were six 24 hr test runs made during the late summer and early fall. Results indicated a direct response of mixed liquor DO to influent substrate load variations when DO levels are greater than the DO concentration critical to microbial oxygen utilization. DO deficit changes were a dependable measure of oxygen transfer rate changes in the mixed liquor and an indirect measure of variations of mixed liquor oxygen demand. Measurement of mixed liquor oxygen uptake rates also proved a good indicator of microbial oxygen uptake response to influent substrate load variations. There was evidence that mixed liquor DO levels below those critical to microbial oxygen utilization contributed to lower substrate removal efficiencies in the system. It was suggested that the magnitude of endogenous respiration and the temporary substrate storage as results of aeration detention time caused a dampening of mixed liquor oxygen uptake response relative to corresponding variations in the influent substrate loading. Maintenance of mixed liquor DO above critical levels is necessary to achieve high substrate removal efficiencies.

*Activated sludge, *Pilot plants, *Settling basins, *Dissolved oxygen, *Oxygen demand, Mixing, Aeration

*Oxygen uptake, *Package plants, Waste loading

E037
RAPID DETECTION OF BACTERIAL ENDOTOXINS IN DRINKING WATER AND RENOVATED WASTE WATER,

Jorgensen, J. H., Lee, J. C., and Pahren, H. R.

Texas University Health Science Center,
San Antonio,
Department of Pathology.

Applied and Environmental Microbiology, Vol. 32, No. 3, p 347-351, September, 1976.
2 tab, 17 ref.

Experiments were conducted to determine the applicability of using the Limulus assay to measure endotoxins in potable waters and highly treated waste waters. Twenty-five samples of drinking water and Advanced Waste Treatment (AWT) process samples from around the United States were tested. The Limulus test was easily adapted to water testing without modification of the assay procedure. This investigation showed that this method could be used to test water samples for pyrogenic substances, i.e., gram-negative bacterial endotoxins. It was proven simple, relatively inexpensive, sensitive, and reliable. Other advantages determined were rapidity (total test time of less than 2 hr), no need for specialized equipment or facilities for maintaining lab animals, and it can be performed with little difficulty in any microbiology laboratory after short specialized instruction.

*Pollutant identification, *Analytical techniques, *Toxins, *Pathogenic bacteria, *Potable water, *Reclaimed water, Waste water (pollution), Tertiary treatment

*Endotoxins, *Limulus assay

E038
FACTORS AFFECTING THE ADSORPTION OF POLIO VIRUS TO MAGNETITE IN WATER AND WASTEWATER,

Bitton, G., Pancorbo, O., and Gifford, G. E.

Florida University,
Gainesville,
Department of Environmental Engineering Sciences.

Water Research, Vol. 10, No. 11, p 978-980, 1976. 5 fig, 7 tab, 22 ref.

A study was undertaken to determine the effects of cations, pH, time, and organic materials in water upon the interaction of magnetite and polio virus type 1. The virus (Sabin strain) was kept at -70 C until used and was assayed by the plaque assay technique on AV3 (human line) cells. Test results indicated that, on a concentration or molar basis, trivalent cations are more efficient than divalent cations which are more efficient than monovalent cations. The adsorption of the virus decreased with an alum concentration above 60 ppm. Decreased sorption was probably due to pH lowering by alum. Polio virus adsorption was weak below pH 5. Organic materials in waste water effluents may compete with viruses for adsorption onto solids. Dome water interfered with magnetite adsorption of viruses and filtering through activated carbon eliminated this interference. Campus activated sludge effluent showed better virus removal. The difference was that dome water had a color of 575 units versus that in campus activated sludge effluent of 35 units. Magnetite was proven a good adsorbent for polio viruses. The process has low space requirements when compared to sedimentation basins or sand filters.

*Waste water treatment, *Activated sludge, *Adsorption, *Viruses, *Waste water (pollution), Water, Cations, Hydrogen ion concentration, Organic matter

*Polio virus, *Magnetite

E039
INVESTIGATION OF OXYGEN TRANSFER TO SLIME AS A SURFACE REACTION,

Lee, E. J., De Witt, K. J., Bennett, G. F., and Brockwell, J. L.

Toledo University,
Toledo, Ohio,
Department of Chemical Engineering.

Water Research, Vol. 10, No. 11, p 1011-1017, 1976. 2 fig, 3 tab, 15 ref.

An oxygen, nutrient-laden water flow in steady laminar motion in a circular tube whose inner surface is covered with a thin layer of microorganisms was used to determine oxygen transfer to slime. Dissolved oxygen diffuses to the slime-fluid interface and is consumed in a reaction of arbitrary kinetic dependence on oxygen concentration. The first part of each experiment investigated the growth of the slime and the attainment of steady state in overall oxygen utilization. The second part was to determine if the flow-averaged oxygen concentration of the reactor effluent was a function of axial length. Controlling factors of oxygen utilization rates are the rate at which oxygen diffuses through the inert surrounding material to the microorganisms and the kinetics of reaction of the oxygen in biochemical reactions. Aerobic utilization of dissolved organic matter by a slime film depends on the availability of oxygen to act as a final electron acceptor in the final biochemical reactions. The second part of the experiment indicated that the oxygen-microorganism reaction was zero order. It is concluded that in a continuous flow, steady state system, reaction kinetics between dissolved oxygen and the attached thin layer of microorganisms generated by raw sewage do not depend on the dissolved oxygen concentration.

*Sewerage, *Analytical techniques, *Oxygen, *Slime, *Surfaces, Nutrients, Laminar flow, Tubes

E040
PHOTOLYSIS OF 5-CHLOROURACIL IN NATURAL WATERS,

Southworth, G. R., and Gehrs, C. S.

Oak Ridge National Laboratory,
Oak Ridge, Tennessee,
Environmental Sciences Division.

Water Research, Vol. 10, No. 11, p 967-971, 1976. 3 fig, 20 ref.

Investigations were made of the stability of 5-chlorouracil in dilute aqueous solution when exposed to UV radiation equal to sunlight and to determine the rate and mechanism of the photolysis process. Photolytic reduction of 5-chlorouracil concentrations in natural waters vary with seasonal changes in the aquatic environment. Absorption of UV radiation by dissolved organic matter makes photolysis insignificant at depths greater than 1 m. A decrease in photolysis occurs during winter with low light and temperature, due to the lower pH associated with less photosynthetic activity, and due to lower incident UV levels and the shift in threshold photolysis pH with lower temperatures. Acidic conditions also inhibited photolysis during any combination of temperature and illumination. Photolytic decomposition of 5-chlorouracil is most significant in relatively shallow, clear, alkaline water bodies and less in acidic, colored, or turbid waters. It was suggested that the photolysis reaction observed was basically photohydrolysis. Though natural sunlight-induced photolysis reduces 5-chlorouracil concentrations added to natural waters by chlorination, usually the rate is not fast enough to significantly reduce the quantity added to the environment. Therefore, sunlight UV radiation cannot be counted upon to reduce environmental consequences of the introduction of 5-chlorouracil into natural waters.

*Pollutant identification, *Water types, *Stability, *Chemical reactions, *Aqueous solutions, Ultraviolet radiation, Solar radiation, Kinetics

*Photolysis, *5-Chlorouracil

E041
TRANSFERABLE DRUG RESISTANCE ASSOCIATED WITH COLIFORMS ISOLATED FROM HOSPITAL AND DOMESTIC SEWAGE,

Fontaine, T. D., III, and Hoadley, A. W.

Florida University,
Gainesville,
Department of Environmental Engineering Sciences.

Health Laboratory Science, Vol. 13, No. 4, p 238-245, October, 1976. 1 fig, 4 tab, 20 ref.

A study was performed to determine the extent to which hospital wastes may serve as reservoirs for the spread of antibiotic-resistant fecal coliforms and their associated risk transfer factors in the environment. Samples of hospital, campus, and combined waste streams entering the University of Florida treatment plant were collected, as well as samples of treated effluent before chlorination and polishing pond effluent. Of 41 bacterial strains isolated from hospital wastes, 90.2% were resistant to at least one antibiotic, in contrast to 55.5% of 54 isolates from campus wastes. The proportion of resistant strains able to transfer resistance varied from 50% to 90%, depending on season and source. Transfer of as many as seven resistance determinants was demonstrated under the usual laboratory conditions. Populations of fecal coliforms were reduced by slightly more than 90% by treatment prior to chlorination, but the proportions of isolates resistant to one or more antibiotics and able to transfer resistance did not change appreciably. The proportion of multiply resistant strains isolated from hospital wastes was twice that observed in campus wastes, and remained approximately constant through the treatment plant. The emergence of a population of Salmonella choleraesuis resistant to tetracycline in a laboratory of simulation of waste treatment processes provided preliminary evidence that resistance transfer may occur in sewage.

*Waste water treatment, *Sewage treatment, *Sewerage, *Pollutant identification, Treatment facilities, Resistance, Coliforms, Hospitals

Drug resistance, Hospital wastes

E042
INFILTRATION/INFLOW - THE KANSAS CONNECTION,

Graham, M. J., Duncan, C. W., and Kirby, J. R.

Black and Veatch,
Consulting Engineers,
Kansas City, Missouri.

Water Pollution Control Federation Highlights, Vol. 13, No. 9, p D2-5, September, 1976. 1 fig, 1 tab.

The requirement of PL 92-500 that applicants for federal funds for new treatment works or system improvements must determine any excessive infiltration/inflow, has produced guidelines for such a study. There should be a preliminary infiltration/inflow study and, if an excess is found, a sewer system evaluation survey is required to determine the location, extent, and flow rate of the infiltration/inflow. A summary of several studies conducted for Kansas municipalities is reported. The analyses indicated that sewer cross-connections, broken pipes, defective joints, ill-fitting manhole lids, and manholes located in low areas with lids having holes in them that serve as area drains are probable sources. House service lines, approximately 50% of a sewer system, provide numerous potential infiltration/inflow sources. Several suggestions for improving the situation include plugging sewer lines for razed and/or abandoned buildings, requiring new service from existing sewers to new structures or major remodeling of structures in older areas, replacing broken pipes and sewer lines, and repairing leaking manholes. Increasing pipe diameter by 30% produces an 80% flow increase with little additional costs and may be a useful alternative. This investigation concludes that a substantial part of infiltration/inflow is not readily identifiable or easily corrected and providing holding facilities and treating excessive flow at treatment facilities is more cost effective, generally. It was also noted that the flows on which the studies were based were not reliable and that correction of the situation should be a part of the continuing municipal budget.

E043
COMPARISON OF TALC-CELITE AND POLYELECTROLYTE 60 IN VIRUS RECOVERY FROM SEWAGE: DEVELOPMENT OF TECHNIQUE AND EXPERIMENTS WITH POLIOVIRUS (TYPE 1, SABIN)-CONTAMINATED MULTILITRE SAMPLES,

Sattar, S. A., and Westwood, J. C. N.

Ottawa University,
Ottawa, Ontario, Canada,
Department of Microbiology and Immunology.

Canadian Journal of Microbiology, Vol. 22, No. 11, p 1620-1627, November, 1976.
1 fig, 6 tab, 29 ref.

A talc-celite mixture was tested as an economic substitute for polyelectrolyte 60 for virus recovery from sewage. Results indicated that the talc-celite combination minimized disadvantages of using polyelectrolyte 60: expense, varying virus-adsorbing efficiency, and the possibility of requiring hydrolysis to enhance adsorbance of certain viruses. Nearly 49% of poliovirus in 5-liter raw sewage samples was recovered by the mixture. Minimal amounts of high concentrations of infectious viruses remained with this mixture. Performance with the layer technique was consistently better than when the batch technique was used with the 5-liter samples. With 100 millimeter samples, both techniques were comparable. It was concluded that the availability and costs of the talc-celite mixture made it a promising alternative to polyelectrolyte 60.

*Waste water treatment, *Pollutant identification, *Sewerage, *Polyelectrolytes, Viruses, Sewage, Economics

*Talc-celite, Poliovirus, Virus recovery

E044
COLIPHAGE INTERFERENCE IN THE REOCVERY OF COLIFORM BACTERIA,

Schiemann, D. A., Manley, J. L., and Arnold, M. O.

Ministry of Health,
Toronto, Ontario, Canada,
Environmental Bacteriology.

Journal Water Pollution Control Federation, Vol. 48, No. 3, p 533-539, March, 1976.
10 tab, 17 ref.

The potential for coliphage interference in the fermentation tube technique with lactose and lauryl tryptose broths on membrane filters with m-Endo medium was examined following contact of coliphage and coliform in a buffer system. Coliphages have a greater resistance to chlorine than coliforms which suggests a higher probability of interference in chlorinated effluent. There is a greater interference after 24 hours than after 48 hours suggesting that there is a reduction of the bacterial inoculum size to a few unadsorbed cells. There is the possibility of multiplication inhibition of previously adsorbed cells but a reversal of phage adsorption and the proceeding of cell division may be caused by the ionic nature of the bacterial growth medium. The key to interference was thought to be adsorption of phage particles to the bacterial cell before introduction into the growth medium. The active metabolization of cells for successful adsorption was suggested by the lack of interference on membranes. It was concluded that coliphage interference in coliform recovery by the fermentation tube method and not with the membrane filter technique is most probable when the ratio of phage:host is increased over those usually found in raw waste water.

*Fermentation, *Tubes, *Membranes, *Membrane processes, *Filters, *Chlorination, *Waste water treatment

Fermentation tube technique, Membrane filter technique, Coliphages, Coliform bacteria

E045
BIOLOGICAL AND PHYSICAL CHARACTERIZATION OF ACTIVATED SLUDGE:
A COMPARATIVE EXPERIMENTAL STUDY AT TEN TREATMENT PLANTS,

Banks, C. J., Davies, M., Walker, L., and Ward, R. D.

York University,
York, England,
Department of Biology.

Water Pollution Control, Vol. 75, No. 4, p 492-508, 1976. 7 fig, 11 tab, 12 ref.

Bacterial population studies; respiration, viability and biochemical operations; as well as the measurement of anionic charges by alcian blue were used to determine the mechanisms of activated sludge adaptation to the environmental constraints of individual treatment works. Bacterial population studies indicated that population differences were more dependent on qualitative differences between sewages than on differences in plant design and operation. Stress favorable to selective bacterial growth was probably due to high concentrations of growth inhibitors of certain bacteria. Stress was not associated with high COD/BOD ratio values, but may have been caused by high loading with a biodegradable industrial waste. The correlation between mean respiration rate and viability suggested that they depended more on plant operation than on sewage quality. Viability was determined by the plant controlled growth rate. The tests on settling characteristics indicated that the solids concentration in returned sludge was fixed by the sludge removal rate from clarifiers and was not limited by the rate of settlement. No correlation between BOD loading rate and settling parameters was found. Concentration dependence was considered the settling parameter most characteristic of the sludge. It was also suggested that concentration dependence of settling rate changes with diurnal variations of sewage composition. Alcian blue has a great affinity for anionic matter and might replace more loosely bound cations which might overestimate the functional anionic charge of flocs.

*Biochemical oxygen demand, *Chemical oxygen demand, *Activated sludge, *Sludge treatment, *Industrial waste, Bacteria, Biodegradation, Anions

*Alcian blue, *Bacterial population studies

E046
FECAL COLIFORM AND FECAL STREPTOCOCCUS DENSITY RELATIONSHIPS
IN WASTE DISCHARGES AND RECEIVING WATERS,

Geldreich, E. E.

Environmental Protection Agency,
Municipal Environmental Research Laboratory,
Cincinnati, Ohio.

CRC Critical Reviews in Environmental Control, Vol. 6, No. 4, p 349-369, October, 1976. 4 fig, 12 tab, 130 ref.

Density differences between fecal coliform (FC) and fecal streptococcus (FS) were determined as prospective water pollution source indices. The major concern was the use of FC/FS ratios to determine if pollution was primarily due to either humans or animals. These ratios should be developed from bacterial densities in water samples from the point of discharge or within a limited distance or flow time downstream for the most meaningful correlations. This was true because of environmental effects on organisms of fecal origin after diffusion in receiving waters. These ratios were observed to shift with age to a range of 0.7 to 3.0. Tests indicated that the contrast of density relationships between man and other warm-blooded animals was revealed in analyses of domestic sewage and storm water and, in cases where storm water collections and domestic sewage are combined, ratios are more concentrated and reflect the even-flowing inputs of domestic sewage. Conditions from various food processing and animal growing enterprises were assessed as they relate to FC/FS ratios. In summary, it was concluded that the FC/FS ratios could be valuable in determining pollution origins.

*Water pollution sources, *Coliforms, *Streptococcus, *Pollutant identification, Animal wastes (wild-life), Farm wastes, Sewage effluents, Storm water

Domestic sewage

E047
VIRUS MOVEMENT IN SOIL COLUMNS FLOODED WITH SECONDARY SEWAGE EFFLUENT,

Lance, J. C., Gerba, C. P., and Melnick, J. L.

Agricultural Research Service,
Phoenix, Arizona.

Applied and Environmental Microbiology, Vol. 32, No. 4, p 520-526, October, 1976.
4 fig, 5 tab, 16 ref.

Experiments were designed to determine if soil could be saturated by viruses applied in secondary sewage effluent. Effluent containing 3 X 10 to the 4th power plaque-forming units of polio virus type 1 was applied to 250 cm long columns filled with loamy sand from basins used for infiltration of secondary sewage effluent. Average infiltration rates for the columns were 55 and 15 cm/day. Most viruses were removed from sewage in the first few centimeters of soil. Infiltration rate differences did not affect virus removal. Viruses were detected in samples from the 160 cm depth, but not from samples at 240 to 250 cm. Virus concentrations were reduced by about 2 logs during the first 2 cm, but traveled another 38 cm before being reduced by another log. Data indicated that near-surface factors other than adsorption were involved. Virus removal would be directly proportional to virus concentrations at any depth if adsorption were the only factor involved. Desorption of viruses was considerable with the application of deionized water. Desorption and virus movement were greatly decreased with the addition of $CaCl_2$ to the deionized water. Deionized water-induced desorption was prevented by drying the soil between applications of the sewage water-virus mixture. Results indicate that viruses would move through 250 cm of calcareous sand only if there were heavy rains within 1 day after stoppage of sewage application. Minimal viral movement would result from flooding with sewage soon after the rain began. Further research is suggested to determine the length of viability of adsorbed viruses.

*Viruses, *Sewage treatment, *Waste water treatment, *Pollutant identification, *Movement, Soil contamination, Adsorption

De-ionized water, Salts, Desorption

E048
MEMBRANE FILTER METHOD FOR RECOVERY OF FECAL COLIFORMS IN CHLORINATED SEWAGE EFFLUENTS,

Lin, S. D.

Illinois State Water Survey,
Water Quality Section,
Peoria, Illinois.

Applied and Environmental Microbiology, Vol. 32, No. 4, p 547-552, October, 1976.
2 fig, 5 tab, 13 ref.

Samples of secondary and tertiary effluents of five waste water treatment plants were used to develop a membrane-filter (MF) procedure for fecal coliform (FC) recovery in chlorinated effluents. The one-step M-FC broth-membrane-filter recovery method was not as effective as the multiple-tube, most probable number (MPN), technique. Recovery with the two-step M-FC agar-MF procedure had good agreement with the MPN method. Pre-enrichment, temperature acclimation, and a modified culture medium are useful in improving FC recovery in chlorinated waste water. At 44.5 C, recovery leveled off and actually decreased. A 35 C pre-enrichment incubation temperature is recommended for FC recovery by MF techniques. The pre-enrichment incubation period considered best is 4 hours. The study revealed that the two-step MF technique provides higher FC counts than the corresponding MPN bias-corrected values.

*Waste water treatment, *Pollutant identification, *Treatment facilities, *Membranes, *Filters, Chlorination, Sewage effluents

*Membrane filter methods, Chlorinated sewage effluent, Fecal coliforms

E049
CHARACTERIZATION OF SEPTIC TANK EFFLUENT - A STATISTICAL ANALYSIS,

Viraraghavan, T.

Ottawa University,
Ottawa, Canada,
Department of Civil Engineering.

Journal of the Institution of Engineers (India), Vol. 56, No. 3, p 115-117, June, 1976. 2 fig, 2 tab, 4 ref.

An analysis of twenty samples of septic tank effluent from a residence near Ottawa was used to determine its chemical and bacteriological characteristics. Observations indicated that effluent pH was 7.0 or less during 64% of the time. There was a smaller range of pH variance in the effluent than with raw sewage, probably contributable to hydraulic scouring and/or sludge gasification causing quantities of sedimented material to re-enter the effluent stream. Ratios were determined for BOD/COD (0.49), COD/SOC (7.8), and BOD/SOC (3.8). Mean phosphate levels were lower than in raw sewage, though occasionally higher. Anaerobic reactions in the septic tank caused ammonia nitrogen increases and nitrate nitrogen decreases when compared to raw sewage. Mean fecal coliforms were about 8% of mean total coliforms. Mean ratio values of fecal coliforms/fecal streptococci were 1.59, near that of raw sewage. Levels of Pseudomonas aeruginosa were less than in raw sewage.

*Pollutant identification, *Waste water treatment, *Sewage treatment, *Sewerage, *Biochemical oxygen demand, Chemical oxygen demand, Treatment facilities, Septic tanks

E050
BOD AS POLLUTIONAL PARAMETER,

Bhatia, H. S.

Delhi Engineering College,
Delhi, India.

Journal of the Institution of Engineers (India), Vol. 56, No. 3, p 87-89, June, 1976. 3 fig, 1 tab, 9 ref.

The limitations of standard BOD tests and alternatives for them were discussed. Limitations of the standard tests include: the complexity of testing more than once daily, the lack of effective process control due to the 5-day incubation period, the non-quantitative quality of the 5-day test without approximation of the ratio of 5-day to ultimate oxygen demand, the inherent deviation in BOD results, and the inaccurate determination of biological treatment processes by a 5-day analysis. Alternative approaches may be oxygen based, carbon based, or nitrogen based. The first considers most standard test limitations. Manometric techniques give a more adequate reservoir of oxygen and eliminate the necessity of high dilutions. With polarographic methods, dissolved oxygen can be measured in less than 10 minutes. Impurities are oxidized by oxygen gas. The carbon based tests measure catalytic conversion of organic carbon in the waste by a non-dispersive infrared analyzer. No presently available organic chemical can resist this oxidation. BOC/total organic carbon (TOC) ratios are based on the theoretical ratio of BOD5 to TOC. Low ratios in secondary effluent indicate a large number of organics resistant to further biochemical oxidation in the final effluent. Nitrogen based tests are still undergoing investigation. The major deterrent to the use of these new methods is the complexity of equipment and procedures.

*Pollutant identification, *Analytical techniques, *Biochemical oxygen demand, *Testing procedures, *Control, Incubation, Time, Waste water treatment

E051
EXAMINATION OF SEWAGE SLUDGE WITH SPECIAL REGARD TO PARTICLE SIZE DISTRIBUTION (Klaerschlammuntersuchung Unter Besonderer Beruecksichtigung Der Teilchengroessenverteilung),

Leschber, R., and Haacke, W.

Vom Wasser, Vol. 45, p 305-325, 1975. 10 fig, 9 ref.

Characterizing sewage sludges was studied. A method of determining sewage sludge particle size distribution has been developed that permits differentiation from 4 to 4000 microns and may be used with other characteristics to characterize sewage sludges in cases of defined treatment methods. The method has been tested using untreated sewage sludges with different origins and sludges treated using varying concentrations of flocculants. It has been proposed as an international provisional standard method.

*Waste water treatment, *Analytical techniques, *Sewage sludge, *Particle size, *Waste treatment, Sewerage, Sludge treatment, Flocculation

E052
A SIMPLE TUBE-TYPE WATER PROFILE SAMPLER,

Gilbert, R. G., and Miller, J. B.

United States Department of Agriculture,
Phoenix, Arizona,
United States Water Conservation Laboratory.

Water Resources Research, Vol. 12, No. 4, p 812-815, August, 1976. 1 fig, 3 tab, 5 ref.

Plexiglass tube-type water samplers were designed and constructed for use in small ponds. It is a plexiglass tube with holes drilled at intervals corresponding to water layers to be sampled. To obtain a water sample, the tube, open at both ends and with the side ports closed, was lowered vertically into the water. With the top stoppered, the tube was raised and its lower end stoppered just under the water surface. While the tube is held vertically, the water profile samples are obtained after removing the top stopper and successively collecting from top to bottom the water sample from each side port. Dissolved oxygen (DO) profiles of two ponds collected with the tube sampler were compared with those measured with an oxygen probe directly in the ponds and with a Van Dorn water sampler. Chemical and biological analyses of water samples obtained with the tube-type sampler and Kemmerer and Van Dorn water samplers were also compared. Dissolved oxygen profiles measured by all three methods were similar. Similar relative results were obtained from water samples collected with all three samplers, but the tube-type sampler was more desirable for obtaining water profile samples because of its simplicity of design and operation.

*Pollutant identification, *Water sampling, *Profiles, *Design, *Ponds, Tubes, Dissolved oxygen, Oxygen

E053
METHODOLOGY FOR THE STUDY OF URBAN STORM GENERATED POLLUTION AND CONTROL,

Wullschleger, R. E., Zanoni, A. E., and Hansen, C. A.

Envirex Incorporated,
Milwaukee, Wisconsin,
Environmental Sciences Division.

August, 1976. 342 p, 85 fig, 38 tab, 265 ref. Tech. Rept. EPA-600/2-76-145.

Standard procedures are recommended for assessment of storm generated discharges. Major areas of effort include recommended methods for sampling and sample preservation, monitoring instrumentation, choice of quality parameters, analytical procedures, methods for evaluating storm generated discharge pollution, and standard procedures for evaluating treatment processes treating storm generated flows. Choice of the recommended procedures was based on literature, research projects, and experience. Constant time-volume proportional to flow rate sampling is best, but constant time-volume proportional to flow increment and constant volume-time proportional to flow increment are considered acceptable. Ultrasonic level gaging equipment is suitable. The choice of quality parameters includes oxygen demand potential indicator, particulate concentration, pathogenic indicator, eutrophication potential, heavy metals, pesticide and polychlorinated biphenyls, and other characteristics. The relative merits and disadvantages of the 5-day biochemical oxygen demand (BOD), 20-day BOD, BODx, chemical oxygen demand (COD), total organic carbon, and total oxygen demand (TOD) tests are discussed; TOD is best for storm and combined sewer discharges. Fecal coliform is the best indicator of the presence of pathogens. For each quality parameter selected, the exact laboratory procedures are spelled out. The following are recommended for background data for storm generated discharges: drainage area; land usage; population density; pervious and impervious areas; street and curb miles; average daily traffic; methods and frequency of street cleaning; and lengths, sizes, and slopes of sewers. The precautions necessary to insure that true net process efficiency is determined are specified.

*Pollutant identification, *Waste water treatment, *Sewerage, *Analytical techniques, *Biochemical oxygen demand, Chemical oxygen demand, Water pollution, Sewage treatment

E054
4-AMINOBIPHENYL, 2- NAPHTHYLAMINE, AND ANALOGS: ANALYTICAL PROPERTIES AND TRACE ANALYSIS IN FIVE SUBSTRATES,

Holder, C. L., King, J. R., and Bowman, M. C.

National Center for Toxicological Research,
Jefferson, Arkansas.

Journal of Toxicology and Environmental Health, Vol. 2, No. 1, p 111-129, September, 1976. 5 fig, 10 tab, 14 ref.

Monitoring methods were described for trace levels of 4-aminobiphenyl, 2-naphthylamine, and their hydrochloride salts in waste water, microbiological growth media, potable water, human urine, and mouse blood. Spectrophotofluorometry (SPF) was used. One hundred milliliters of waste water was added to a 160 milliliter culture tube with 2 grams of NaCl, made alkaline, shaken for 2 minutes, centrifuged for 10 minutes, cleaned up, and prepared for analysis. Benzene was used for extraction. For recovery experiments, waste water was spiked at 0 and 20 ppb through the addition of milliliter of methanol (or water) with the appropriate amount of compound, held at 5 C overnight, and analyzed. Recoveries averaged 89% with good precision, and the background of unspiked samples was 0.2-0.3 ppb. The method was successfully used to evaluate laboratory-scale adsorber system performance. Average recoveries were 95% (4-aminobiphenyl), 90% (4-aminobiphenyl HCl), 90% (2-naphthylamine), and 80% (2-naphthylamine HCl).

*Pollutant identification, *Trace elements, *Analysis, *Monitoring, *Salts, Water pollution, Analytical techniques, Spectrophotometry

Carcinogens, 4-aminobiphenyl, 2-naphthylamine, Benzene

E055
DETERMINING STABILITY OF SLUDGE FROM AEROBIC DIGESTERS,

Marino, K., and Bologna, A.

Lagnese and Associates, Incorporated,
Pittsburgh, Pennsylvania.

Deeds and Data, p D1, D6-7, October, 1976. 2 fig, 1 ref.

Stability and a low odor potential are very important factors in sludge disposal because of the growing use of land application. Some methods and parameters for determining stability in sludge from aerobic digesters are discussed. One parameter used was "percent volatile reduction," a carry-over from anaerobic digestion. The major problem with this is the amount of biodegradable volatile matter remaining in the sludge. The degree of digestion can be measured by a determination of the specific oxygen uptake rate. Stabilized sludge is indicated by a limited oxygen uptake and a high specific oxygen rate indicates actively digesting sludge. A method was presented for making the determinations. A rate below 1 milligram O2/g vs/hr indicates a stable aerobically digested sludge which can be used for land application. A method which uses visual inspection of anaerobically digesting areas in a laboratory sample was also presented. Another controlled laboratory test to approximate the remaining portion of biodegradable materials was provided. Digested sludges with more than 10% biodegradable solids have proved objectionable. BOD analysis of the supernatant of the sludge can be helpful. A high BOD concentration indicates sludge instability. Consideration of information on DO, pH, temperature, volatile solids and total solids are also helpful in giving the operator a history of the digestion process.

*Pollutant identification, *Sludge treatment, *Aerobic treatment, *Stability, *Odor, Analytical techniques, Biochemical oxygen demand, Biodegradation

Specific oxygen uptake rate, Percent volatile reduction

E056
STUDY OF THE OXYGEN DEMAND IN BIOLOGICAL WASTE WATER TREATMENT AND INCINERATION PROCESSES (Valutazione dell'O2 consumato nei processi biologici di trattamento acque e nei processai di incenerimento),

Falleni, M., and Ottaviani, M.

Rassegna Chimica, Vol. 28, No. 3, p 101-105, May-June, 1976. 3 fig, 11 ref.

In a traditional biological waste water treatment plant, optimal purification is achieved when O2 is supplied to the system as fast as it is being consumed. The total consumption of O2 is equal to the quantity of BOD used to provide the reaction with energy, the quantity of BOD eliminated, the speed of endogenic respiration, and the quantity of sludge. In total oxidation systems where the sludge is incinerated, it is necessary to know the composition of the sludge in order to determine the O2 necessary for combustion. COD gives the content of biodegradable and non-biodegradable substances in the sludge as well as of all substances capable of oxidation with $K_2Cr_2O_7$ in an acid environment (H_2SO_4). As a rule, BOD is about 52% of COD.

*Biological treatment, *Waste water treament, *Oxygen, *Sludge treatment, Biodegradation, Chemical oxygen demand, Biological oxygen demand, Oxidation, Acidity, Alkalinity

E057
OPTIMIZING COSTS OF WASTE TREATMENT FACILITIES USING VALUE ANALYSIS,

Dell'Isola, A. J., and Truhan, J.

Smith, Hinchman and Grylls Associates, Incorporated,
Detroit, Michigan.

Consulting Engineer, Vol. 47, No. 6, p 55-58, December, 1976. 2 fig, 1 tab.

Value analysis is a means of determining the necessary effort and scheduling and budgeting of funds for the most effective operation of a waste treatment plant. It is designed to eliminate, as well as to identify unnecessary costs. The analytical process involves several steps. The item is selected; the owner/designer reviews results and implements approved alternatives. The review includes analysis by an interdisciplinary team to determine possible areas of significant cost savings. The designer's estimate or bidder's cost is balanced against the least cost alternative which performs the same function. The process was applied to the design of an Ocean County (N.J.) treatment facility. Areas of greatest potential savings included liquid structures, equipment structures, pumping and piping, and electrical distribution. Savings in the structures category focused on digester tanks and final clarifiers. Construction methods and materials were the object of pumping and piping evaluations. In the last category, savings in lighting, switchgear, and underground distribution were investigated. With this plant, a savings of $697,000 was effected. Value analysis proved itself to be a valuable aid in cost savings when applied to waste water treatment.

*Treatment facilities, *Cost analysis, *Cost-benefit analysis, Initial costs, Maintenance costs, Operating costs, Replacement costs, Alternative costs, Bids, Waste water treatment, Economics, Decision making

Value analysis, Life-cycle costing

E058
FACTORS INVOLVED IN BIOCHEMICAL OXIDATION OF SEWAGE,

Stones, T.

Effluent and Water Treatment Journal, Vol. 16, No. 11, p 574-575, November, 1976.
2 tab, 9 ref.

The oxidizable matter in sewage is mainly carbonaceous and nitrogenous compounds. Biochemical oxidation takes place in two stages: oxidation of carbonaceous matter and oxidation of nitrogenous matter or nitrification. Various sewages were analyzed for dissolved oxygen absorbed by settled sewage during a 50-day period at 20 C and a 1/200 dilution with a small amount of nitrified filter effluent to avoid sporatic results in the second stage of oxidation. This suggested that few nitrifying organisms are present in untreated sewage. Evidence was provided to indicate that the second stage is entirely the result of oxidation of nitrogenous matter. The presence of the second oxidation stage is suspected to be due to the activity of nitrifying organisms which prevents nitrification until carbonaceous oxidation is nearly complete. The need of oxygen is a characteristic feature of sewage and its strength is expressed in terms of the oxygen needed for oxidation. Evidence indicated that matter which is inert to biochemical oxidation is also removed during sewage treatment and that total oxygen demand of sewage and the reduction effected therein during treatment is the most realistic criteria of loading and performance of treatment plants.

*Oxidation, *Nitrification, *Biochemical oxygen demand, *Oxygen, Microorganisms, Dissolved oxygen, Sewage effluents, Oxygen demand, Sewage treatment, Waste water treatment

E059
KINETICS AND MECHANISM OF OXIDATION OF HYDROGEN SULFIDE BY HYDROGEN PEROXIDE IN ACIDIC SOLUTION,

Hoffmann, M. R.

Minnesota University,
Minneapolis,
Department of Civil and Mineral Engineering.

Environmental Science and Technology, Vol. 11, No. 1, p 61-66, January, 1977. 5 fig, 5 tab, 28 ref.

Hydrogen peroxide has recently received much backing as an odor treatment in municipal sewage treatment systems. These odor problems result from the production of H2S in treatment systems, in concrete sewer lines and other anaerobic environments where organic matter and sulfates are present. Oxidation of H2S by H2O2 is important because H2S also corrodes concrete sewer lines. Experimental results indicated that hydrogen peroxide under proper circumstances could be an effective reagent for the control of hydrogen sulfide and its odor. At a pH below 7.5, hydrogen sulfide and hydrosulfide ion are readily oxidized to a mixture of zero valent sulfur and sulfate with complete removal of the odor. A system which maximizes the production of elemental sulfur is desirable. H2S reacts in a mole ration of 1:1 and a higher mole ratio of sulfide to peroxide is needed when sulfate is produced. When the fraction of HS(-) in solution decreases, the reaction rate also decreases; thus, the optimal pH is near 7. A higher percentage of sulfate will form if excessive H2O2 is added to increase the reaction rate. A H2O2 dose that is twice the measured sulfide concentration is best for odor control. At a pH higher than 8, a greater dose of H2O2 is necessary because the predominant product is sulfate. A fourfold excess of peroxide is needed to complete the reaction. Hydrogen peroxide has the advantages of decomposition products of oxygen and water; it is a liquid and there are no toxic or corrosive fumes; and it is economically competitive with other treatment systems.

*Oxidation, *Hydrogen sulfide, *Kinetics, *Municipal wastes, *Industrial wastes, *Hydrogen ion concentration, *Sewage treatment, *Odor, Corrosion, Waste water treatment, Sewerage

Hydrogen peroxide

E060
ANALYSIS OF LEAD IN POLLUTED COASTAL SEA WATER,

Patterson, C., Settle, D., and Glover, B.

California Institute of Technology,
Pasadena, California,
Division of Geological and Planetary Sciences.

Marine Chemistry, Vol. 4, No. 4, p 305-319, December, 1976. 2 fig, 4 tab, 15 ref.

Total lead concentrations in sea water were determined in sewage-polluted coastal waters and in ordinary coastal waters. Stable isotope dilution mass spectrometric techniques, under laboratory conditions, were used to make determinations in sea water samples. Average concentrations were about 25 ng/kilogram in surface water of ordinary coastal waters and 150 ng/kilogram in highly polluted sea water samples. Filtrate lead levels (0.4 microns) were equivalent to lead extracted by dithizone in chloroform from untreated sea water. Particle lead was 39% to 56% of total lead in polluted water. The proportions increased with increased amounts of sewage. In non-polluted water, lead was associated with plankton. One-third total lead (one-half particle lead) adheres to the water container walls during the first day. After three months, the remaining particle lead can be collected from the surface of algal colonies growing on the container walls. Wall adsorption does not substantially affect concentrations of freely available lead in sea water. The 206Pb/207Pb ratio determined was considered an indication of the non-mixing of lead from two different pollution sources: rainstorm runoff and sewage lead.

*Analysis, *Lead, *Water pollution, *Water pollution sources, Sea water, Sewage effluents, Algae, Plankton, Runoff, Heavy metals

E061
VOLUMETRIC DETERMINATION OF GREASE IN WASTE WATER,

Maxcy, R. B.

Nebraska University,
Lincoln,
Department of Food Science and Technology.

Journal Water Pollution Control Federation, Vol. 48, No. 12, p 2809-2811, December, 1976. 2 tab, 6 ref.

Grease is an important factor in waste disposal problems. The effect of the contributing source and grease removal procedures were evaluated. The traditional determination methods are time-consuming. A simplified method for grease determinations that was developed involved adding ethanol and trichlorotrifluoroethane (TTE) to the sample in a separatory funnel. The TTE is removed and glass beads are added to induce a gentle boil. The TTE volume is reduced by evaporation on a hot plate and the TTE containing the grease is quantitatively transferred to a Babcock skim milk bottle by rinsing with separate TTE portions. Glass beads are added and a water bath is used to raise the bottle temperature to 100 C to evaporate the TTE to apparent dryness. The bottle is exposed to vacuum and cooled. Na_3PO_4 is added and the bottle is again warmed. The bottle is swirled to suspend the grease and cooled to room temperature. Steps are taken to bring the solution into the capillary. Then the mixture is centrifuged, warmed, and again centrifuged. A greasy column which is measurable should be formed at this point. Comparison with standard test procedures indicated that this method should provide an empirical method for routine effluent monitoring from municipal sewage treatment facilities.

*Pollutant identification, *Volumetric analysis, *Analytical techniques, *Lipids, *Oil, Laboratory tests, Evaluation, Analysis, Waste water treatment, Waste disposal

Grease

E062
DETERMINATION OF NON-IONIC SURFACE ACTIVE SUBSTANCES IN THE WATER SOLUTIONS (Oznaczanie niejonowych substancji powierzchniowo-czynnych w roztworach wodnych),

Gorzka, Z., Jozwiak, A., and Socha, A.

In: Metody Fizykochemiczne Oczyszczania Wod I Sciekow (Referaty Z Konferencji Naukowo-Technicznej), May 6-7, 1976, Lublin, Poland, Marie Curie-Sklodowska University, Lublin, Vol. 1, p 44-51. 3 fig, 2 tab.

The application of a new polarographic method for determining non-ionic surface active substances (SAS) was investigated. Tests were conducted with three commercial preparations, Roksol IT, Stremid DK, Comperlan KD, and industrial wastes with Roksol IT in 0.01 to 5% concentrations. Polarographs used were the OH 101 (Hungarian) and the LP 60 (Czechoslovakian). Colorimetric determinations of SAS were made simultaneously. The polarographic method was proved very convenient in determining non-ionic SAS in aqueous solutions of the tested preparations and industrial wastes. This is especially true when applied to serial determinations.

*Pollutant identification, *Aqueous solutions, *Colorimetry, *Analysis, Analytical techniques, Polarographic analysis, Industrial wastes

Surface active substances, Roksol IT, Stremid DK, Comperlan KD

E063
SIMULTANEOUS AUTOMATED DETERMINATION OF CHLORIDE, NITRITE, NITRATE, AND AMMONIA IN WATER AND WASTE WATER,

Canelli, E.

Environmental Health Center,
New York State Department of Health,
Albany, New York.

Water, Air, and Soil Pollution, Vol. 5, No. 3, p 339-348, April, 1976. 4 fig, 1 tab, 11 ref.

Multichannel automated analysis and optimization of automated system parameters have been combined to produce an automated system for simultaneous determination of chloride, nitrite, nitrate, and ammonia in water and waste water. Advantages of this system include optimized reaction conditions for direct application to natural and waste water samples; a 40% reduction in necessary time for analysis; a need for only 2 milliliters of sample and the inclusion of continuous filtration with minimum sensitivity loss and peak separation; total inorganic nitrogen measurement independent of interconversions with the three nitrogen forms; and the option of determining dissolved organic nitrogen as a mixture of ammonia, nitrite, and nitrate N after UV irradiation. The method is based on modifications of established colorimetric procedures. Chloride is determined by the automated mercury (II) thiocyanate method with the concentration of reagents in reaction mixture increased to maximize signal intensity and linearity and the dilution line omitted to improve precision at concentrations lower than 50 ppm Cl. The indophenol blue method of ammonia analysis was used with altered sample-to-reagent ratios. Nitrite was determined as an azo dye and nitrate was reduced and determined as nitrite. Detection limits were 1 ppm Cl for chloride and 1, 5, and 5 ppb N for nitrite, nitrate, and ammonia.

*Analysis, *Analytical techniques, *Colorimetry, *Water analysis, Chlorides, Mercury, Nitrites, Nitrates, Ammonia, Nitrogen compounds, Chemical reactions

Automated mercury (II) thiocyanate method, Indophenol blue method

E064
VIRUS-COAL SORPTION INTERACTION,

Oza, P. P., and Chaudhuri, M.

L.D. Engineering College,
Ahmedabad, India,
Department of Civil Engineering.

Journal of The Environmental Engineering Division-ASCE, Vol. 102, No. EE6, p 1255-1262, December, 1976. 6 fig, 1 tab, 24 ref, 1 append.

Investigations were performed to determine the capacity of coal to absorb viruses. The model virus used was bacterial virus MS2 (MS2 phage). Giridih bituminous coal was pulverized and sieved to 300-425 microns, washed several times to remove fines, dried at 103 C, and stored in a desiccator for use. Batch sorption tests were carried out at various pH values in 0.2 M phosphate buffer. Samples were withdrawn, filtered through a Whatman paper disk soaked in 3% beef extract, and the filtrate was enumerated for unsorbed viruses. Desorption tests were done by eluting the sorbed viruses with 0.2 M phosphate and 3% beef extract on a rotary shaker. Sorption kinetics at pH 6.5, 7.1, and 8.0 revealed a net negative charge by MS2 phage and Giridih coal. Equilibrium sorption increased linearly with ionic strength. Desorption was not evident when phosphate buffer was the eluent. With 3% beef extract, 10% desorption occurred with rapid activity during the first 10 minutes. Low desorption suggests that viruses are strongly sorbed on coal. Sorption increased with rising temperatures. Shifting absorption peaks indicated probable hydrogen bonding interactions. Sorption was studied with acetyl chloride-treated coal to determine these interactions. Coals with higher hydrogen content have a higher virus sorption. It was noted that viruses sorb only on the exterior surface of the coal. Comparisons between active carbon and coal showed that the sorptive capacity of coal was 50% that of active carbon; however, coupled with lower cost and recovery of fuel value after exhaustion, coal is a viable alternative for removing viruses from water.

*Adsorption, *Desorption, *Viruses, *Coals, Sorption, Filtration, Hydrogen ion concentration, Hydrogen bonding, Temperature, Economics, Carbon, Waste water

Bacterial virus MS2, Giridih bituminous coal

E065
PHOSPHORUS UPTAKE BY BIOLOGICAL SLIMES,

Zanoni, A. E.

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Milwaukee, Wisconsin,
Civil Engineering Department.

Journal of The Environmental Engineering Division-ASCE, Vol. 102, No. EE6, p 1229-1237, December, 1976. 2 fig, 4 tab, 14 ref.

A study was performed to determine whether there is excessive phosphorus uptake by biological slimes under normal conditions of filtration during waste treatment and to clarify the mechanism of soluble phosphorus uptake by biological slimes. A test channel apparatus with adjustable channel lengths on a channel plank with adjustable slope was used. Ultraviolet radiation was used to inactivate the surface slime to help establish the degree of physical adsorption involved. The feed substrate consisted of 25 grams dry milk solids, 75 grams glucose, 15 milliliters Na_2HPO_4 solution, and 80 milliliters NH_4Cl solution added to 80 liters softened, dechlorinated Milwaukee tap water. A substrate with a high carbon:phosphorus ratio was needed to obtain a reasonable phosphorus removal sensitivity. Testing revealed that measurable amounts of soluble phosphorus, COD, and nitrogen are removed by the slime surface and these removals are proportionate to the channel length. A slime phosphorus content of 1.62% to 2.57% shows that excessive phosphorus uptake had not occurred under a variety of operating conditions. A phosphorus removal of less than 20% can be expected in municipal waste water treatment and chemicals must be added to increase phosphorus removals. The tests involving UV treatment suggest that phosphorus uptake by a slime surface is not due to physical adsorption, and that it was totally due to a biochemical mechanism.

*Biological treatment, *Phosphorus, Slime, Adsorption, Carbon, Nitrogen, Chemical oxygen demand, Waste treatment, Ultraviolet radiation, Filtration

E066
METALS IN THE AQUEOUS EFFLUENTS FROM MUNICIPAL INCINERATORS
AND AN INCINERATOR-RESIDUE PROCESSING PLANT,

Law, S. L.

Dissertation Abstracts International B, Vol. 37, No. 6, p 2741-2742, December, 1976.

Dissolved and undissolved metals content was determined in the water systems of three incinerators and an incinerator-residue processing pilot plant. Techniques used for analysis were atomic absorption, neutron activation, and wet chemical analytical techniques. An Alexandria, Virginia, incinerator using recycled waters was used as a model for determining the maximum pollution potential of the use of municipal wastes as fuel supplements. In this incinerator, zinc concentrations harmful to biological treatment might occur in the recycled spray-chamber water. EPA drinking water standards are exceeded by a few metals in nonrecycled waters, but are continuously exceeded by cadmium, lead, zinc, manganese, and selenium in the recycled spray-chamber water. The effects of pH, $CO_3^{(2-)}$, $SO_4^{(2-)}$, and $Cl^{(-)}$ on total concentrations are estimated and compared with observed concentrations. It was noticed that pH varied with temperature. No specific time or geographic trends were established in the comparison of solids and dissolved metals in the incinerator and pilot plant effluents. The prediction of sources of metals in incinerator effluents was thought possible with the use of an enrichment factor based on aluminum concentrations and crustal abundances of elements. Noncombustible components of urban refuse seemed to be a great contributor of several elements to incinerator effluents. Separation of combustibles prior to use as a fuel supplement was suggested. Plastics, cardboard, newspapers, kraft packaging and magazines produced less than half of the total metals in the combustile fraction.

*Analysis, *Incineration, *Metals, *Heavy metals, Waste water treatment, Sewage treatment, Analytical techniques, Neutron activation analysis, Hydrogen ion concentration, Temperature, Cadmium, Lead, Zinc, Manganese, Plastics, Biological treatment, Municipal wastes, Pilot plant, Fuels

Alexandria (Va), Incinerator-residue processing, Atomic absorption, Wet chemical analysis

E067
EFFECTS OF SEWAGE SLUDGE AND SLUDGE COMPOST APPLIED TO SOIL ON SOME SOIL PHYSICAL AND CHEMICAL PROPERTIES,

Epstein, E., Taylor, J. M., and Chaney, R. L.

United States Department of Agriculture,
Agricultural Environmental Quality Institute,
Agricultural Research Service,
Beltsville, Maryland.

Journal of Environmental Quality, Vol. 5, No. 4, p 422-426, October-December, 1976.
4 fig, 8 tab, 15 ref.

A field study was conducted to determine the effects of land application of sewage sludge and sludge compost (0, 40, 80, 120, and 240 metric tons/ha) on physical and chemical soil properties and on crop growth at pH 5.5 to 6.0 and 6.5 to 7.0. The study proved that application of sludge exceeding 120 metric tons/ha were difficult and caused a cloddy seedbed, though the same rate of compost was applied easily and produced a friable seedbed. Both sludge and compost increased water content and water retention in a silt loam soil. Salinity and chloride levels were increased by both to a level which affected salt-sensitive plants. Salinity increased as application rates increased and the same results were noticed with increased chloride levels. The high increase in soil water content caused rapid decomposition of organic carbon and blocked soil pores. The compost was significantly drier and had less readily decomposable organic carbon. These conditions lead to decreased nitrification and increased denitrification and can adversely affect plant growth and root development. Heavy metals were found to be more available to plants as soil pH decreased. Nitrate-nitrogen levels were highest at the 15-20 centimeter level and sharply decreased at lower soil depths. Available phosphorus was higher than necessary for good crop growth needs.

*Soil chemical properties, *Soil physical properties, *Soil contamination effects, *Land management, *Sludge disposal, *Sewage sludge, Moisture content, Cation exchange, Nitrogen, Chlorides, Salinity

Water retention, Sludge compost

E068
EFFECTS OF TRACE ELEMENTS ON UREASE ACTIVITY IN SOILS,

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Ames,
Department of Agronomy.

Soil Biology and Biochemistry, Vol. 9, No. 1, p 9-13, 1977. 4 tab, 26 ref.

Sewage sludges and effluents are being increasingly disposed on agricultural land. A study was conducted to determine the effectiveness of trace elements in inhibiting urease activity in soils, the distribution of urease activity in agricultural soil profiles, and the relationship between urease activity and organic carbon in surface and soil profile samples. Soils were selected which had a wide range of pH, texture, organic matter content, and urease activity. Results showed that all trace elements studied, except As(5+) and W(6+), inhibited urease activity in the study soils. The inhibition ability of metal ions was found to be dependent upon soil chemical and physical properties. When 5 micro moles/gram of soil was used, the following ions produced inhibition in descending order of strength: Ag(+) and Hg(2+), Cu(2+), Cd(2+), Zn(2+), Sn(2+), and Mn(2+). Generally, Fe(3+) and Cu(2+) were more effective urease activity inhibitors than Fe(2+) and Cu(+). Inhibition was less effective when 0.5 micro moles/gram of soil were studied. Sodium arsenate and sodium tungstate had no effect on urease activity, indicating that sodium in other test compounds had no inhibitory effect at tested concentrations. Urease activity showed marked decreases with increased soil depths. Cropping history, soil amendments, and some environmental factors influence the activity of urease and other enzymes in soils. Seasonal variations were noted in Mississippi soils, and organic matter appeared to have a special effect on urease activity.

*Nitrogen compounds, *Trace elements, *Soil contamination effects, *Sludge disposal, Soil chemical properties, Soil physical properties, Soil types, Sewage effluents, Metals, Hydrogen ion concentration

E069
STUDY OF PHYSICAL, SETTLING, AND THICKENING CHARACTERISTICS OF A SLUDGE,

Greene, M. H.

Western Interstate Commission for Higher Education,
Resources Development Internship Program,
Portland, Oregon.

August, 1974. 30 p, 11 fig, 2 tab, 13 ref. Technical Report NTIS PB-241 231.

The physical characteristics of sludge from the Nassau County Bay Park Sewage Treatment Plant on Long Island, New York, were analyzed. Specific gravity of the sludge, determined by pycnometer methodology, was about 1000 grams/cu cm (liquid phase) and 1.53 and 1.62 for solids in two different samples. Total solids concentrations in the two samples were 2.20% and 1.15%. Settling studies revealed that the rate of flocculation is the limiting process for settling speed in a well mixed suspension of sludge solids. Flocculation is dependent on collision and adhesion of particles after collision. Settling time for 40% of solids in a homogeneous suspension was inversely proportional to the initial suspended solids concentration raised to the 4/3 power. The addition of several test substances did not prove especially useful in sludge thickening. However, alum was, in special cases, beneficial in increasing solids concentration. Seawater could be effective in increasing sludge bulk specific gravity, but large amounts would be required. Mechanical methods for sludge thickening should be investigated.

*Analysis, *Physical properties, *Sewage sludge, Sludge treatment, Sedimentation, Flocculation, Specific gravity, Suspended solids, Sea water, Waste water treatment

Nassau County (NY), Pycnometers, Sludge thickening, Alum

E070
A WATER QUALITY STUDY OF THE UPPER CLARK FORK RIVER AND SELECTED TRIBUTARIES,

Environmental Protection Agency,
Region VIII,
Denver, Colorado.

September, 1972. 83 p, 2 fig, 8 tab, 5 append. Technical Report NTIS PB-244 921.

A study was conducted to determine the water quality of the Clark Fork River, Montana, and to set standards for concentrations of heavy metals due to heavy mining in the area. Basic methods consisted of water quality sampling and biological evaluations in the reach from Warm Springs to Drummond, Montana, and selected tributaries. Results revealed a stretch of severe pollution indicated by a deficient and non-balanced population of benthic organisms and an almost non-existent fish population. Another area with opposite conditions was found healthy. Downstream from Drummond, the stream supports significant sportfishing activity. Most heavy metals pollution was traced to the settling tanks of one major mining, milling, and smelting operation. The high concentrations decrease downstream and these wastes caused "cementing" of a portion of the river bottom by the precipitation of gypsum and metallic hydroxides in settling pond discharges. Chemical and biological conditions indicate high water quality in tributaries. Recommendations were made for metals levels. It was suggested that the state upgrade the classification of a certain reach of the river through appropriate action. Tests are necessary to determine the degree of an indicated potential lead health hazard.

*Rivers, *Tributaries, *Water quality, *Pollutant identification, Water quality standards, Water pollution, Water pollution sources, Chemical analysis, Bioindicators, Heavy metals, Montana, Public health

Clark Fork River

E071
EFFECTS OF WASTE DISCHARGES ON WATER QUALITY OF THE SOUTH PLATTE RIVER, DENVER METROPOLITAN AREA,

National Field Investigations Center,
Denver, Colorado.

June, 1972. 118 p, 5 fig, 12 tab, 8 ref, 4 append. Technical Report NTIS PB-244 936.

A study of the South Platte River Basin was conducted to determine whether established state and federal water quality standards were being met. Fifteen treatment plants were studied to determine whether treatment meeting established requirements had been effected, to determine the extent of water quality improvement, and to determine any recommendations which might be made. Influent samples were collected and analyzed for BOD, total and suspended solids, volatile suspended solids, settleable solids, total organic carbon, chemical oxygen demand, nitrogen series, total phosphorus, and selected heavy metals. Final effluent samples from the Denver Metro facility were analyzed for total and fecal coliforms. Field measurements and residual chlorine were measured at the time of collection.

*Water quality, *Water pollution abatement, *Water treatment, Biochemical oxygen demand, Suspended solids, Chemical oxygen demand, Carbon, Nitrogen, Phosphorus, Heavy metals, Pollutant identification, Colorado, Rivers

South Platte River

E072
RAPID COLORIMETRIC ANALYSES OF CATIONIC AND ANIONIC SURFACTANTS,

Wang, L. K., and Langley, D. F.

Rensselaer Polytechnic Institute,
Troy, New York,
Department of Chemical and Environmental Engineering.

In: The 1975 New England Water Works Association Meeting, January 16, 1975, Waltham, Massachusetts. 24 p, 9 fig, 17 ref, 2 append.

A new, more rapid colorimetric method applicable to the analysis of either anionic or cationic surfactants in fresh water at low concentrations is introduced. A dye reacts with ionic surfactant and forms a chloroform-soluble, colored complex in the presence of chloroform. The color intensity of the chloroform layer is proportional to the concentration of the dye-ionic surfactant complex, and can be measured spectrophotometrically. Methyl orange is used for cationic surfactants, azure A or methylene blue for anionic surfactants. The method is stoichiometric and can be performed in a very short period of time. The advantages of the new colorimetric method over the standard methylene blue method and standard carbon adsorption method include its time-saving procedures and suitability for cationic surfactant analysis. Its advantages over a two-phase titration method include its more rapid procedure and more accurate surfactant measurement below one mg/liter. It is suitable for field analyses of ionic detergent-type impurities in water and waste water, provided that a portable colorimetric instrument is available.

*Pollutant identification, *Analytical techniques, *Colorimetry, *Surfactants, *Freshwater, Dyes, Color reactions, Spectrophotometry, Adsorption

*Cationic surfactants, *Anionic surfactants

E073
POWDERED ACTIVATED CARBON ADDITION TO BIOLOGICAL REACTORS,

Robertaccio, F. L.

Dissertation Abstracts International B, Vol. 37, No. 5, p 2463-2464, November, 1976.

The addition of powdered activated carbon to biological reactors has proven an uncomplicated way to achieve tertiary treatment water quality. The kinetics of biodegradable substrate in a pure biological system and in one with powdered activated carbon was investigated. Results indicated that the maximum utilization rate for adsorbable substrates was enhanced in direct proportion to the amount of activated carbon present. Non carbon-adsorbent substrates showed no enhancement and the effectiveness of activated carbon was lessened in a biological system. The adsorbency of a degradable substrate is a prime parameter in the determination of whether the presence of activated carbon in a biological system produces synergistic effects. The presence of activated carbon can overcome mass transfer constraints. Enhancement of substrate utilization in a carbon-biological system was independent of the assumed kinetic model. Batch system models which predicted substrate utilization could not describe gravimetrically determined biological solids growth. The presence of activated carbon was assumed to change the distribution of species in biological populations. Mass transfer at carbon-substrate-microbial interface was enhanced.

*Activated carbon, *Biological treatment, *Kinetics, *Tertiary treatment, Waste water treatment, Mass transfer, Adsorption, Models, Microorganisms

Biological reactors

E074
EFFECTS OF ANAEROBICALLY DIGESTED SEWAGE SLUDGE ON ORGANIC MATTER IN SOIL AND SOIL WATER,

Hohla, G. N.

Dissertation Abstracts International B, Vol. 37, No. 5, p 2005, November, 1976.

A six-year study was conducted to determine anaerobically digested sludge effects on soil and soil water organic matter. Lysimeters containing Blount silt loam and Plainfield loamy sand were furrow irrigated with the sludge. Lysimeter leachate waters and Blount silt loam leachate waters were also studied. Total organic carbon, carbohydrate carbon, oil and grease carbon, and organic nitrogen were determined in the soils and lysimeter leachate waters. Blount silt loam leachate waters were characterized using infrared and ultrafiltration techniques. Results indicated that the coarse textured soil (Plainfield loamy sand) had a higher oxidation rate for sludge organic carbon and a higher leaching potential than fine textured Blount silt loam. Drainage is important in controlling oxidation rate of sludge organics in soils. Long-term sludge application caused an organic compounds distribution shift in the plow layer towards that of applied sludge. Finally, long-term sludge land application by ridge and furrow irrigation produces a relatively large organic carbon loss to oxidation, and a low potential loss to leaching.

*Sludge disposal, *Sludge digestion, *Soil types, *Anaerobic treatment, *Leachate, Carbon, Nitrogen, Analysis, Organic matter, Disposal

Land application

E075
THE KINETICS OF BIOOXIDATION IN A CONTINUOUS ACTIVATED SLUDGE PROCESS (Kinetyka procesu ciaglego bioutleniania osadem czynnym),

Suschka, J.

Silesian Polytechnic Institute,
Gliwice, Poland.

Zeszyty Naukowe Politechniki Slaskiej- Inzynieria Sanitarna, Vol. 20, No. 483, p 1-69, 1976. 38 fig, 16 tab, 59 ref.

Experiments indicated a need to alter interpretations of the kinetics of substrate oxidation in a continuous activated sludge system. In such a system, the controlling factor in the biochemical reaction rate should be the rate of substrate supply. Thus, the reaction rate would be relative to the activated sludge load. A laboratory-scale pilot investigation and a full-scale test were performed with different waste waters. The k rate was observed to increase with increased activated sludge loading and was confirmed by respirometric measurements. An equation was presented to show the relationship between increased sludge activity, the biochemical reaction rate, and substrate concentrations for various waste waters. This equation was valid in conventional and high activated sludge load ranges, above 0.15 grams of BOD5/gd. equation was proven applicable in calculating substrate biochemical oxidation rates in continuous activated sludge systems.

*Sludge treatment, *Laboratory tests, *Kinetics, *Oxidation, *Activated sludge, *Biochemistry, Waste water treatment, Biochemical oxygen demand, Equations

Substrate oxidation, Continuous activated sludge process

E076
EFFECT OF WATER WORK'S SLUDGE ON WASTE WATER TREATMENT,

Zakrezewski, J.

Institute for Municipal Economy,
Warsaw, Poland.

In: Polish/U.S. Symposium on Waste Water Treatment and Sludge Disposal, February 10-12, 1976, Cincinnati, Ohio, EPA Environmental Research Center, Cincinnati, Vol. 2, p 33-41. 3 tab.

Results were presented of laboratory studies which evaluated post-coagulation sludge on municipal sewage treatment and municipal sludge disposal. Results indicated a limited effect on the mechanical treatment of municipal sewage and on activated sludge treatment of municipal sewage. The presence of post-coagulated sludge in raw sewage does not provide any important effect on mechanical-biological treatment of sewage. Addition of the study sludge slightly decreases thickening and sludge digestion. Further research is suggested to verify these conclusions.

*Waste water treatment, *Sludge treatment, *Municipal wastes, Biological treatment, Activated sludge, Sludge digestion, Laboratory tests

Post-coagulation sludge, Sludge thickening

E077
DETERMINING TOC IN WATERS,

Kehoe, T. J.

Beckman Instruments, Incorporated,
Fullerton, California.

Environmental Science and Technology, Vol. 11, No. 2, p 137-139, February, 1977.
3 tab, 5 ref.

Many considerations involved in the determination of TOC in water were reviewed. The instrumental technique of TOC determination has received great interest in the area of lowering detection limits. The practical range has been plus or minus 5% in the 0-5 milligram/liter full-scale range, which is adequate for most needs. Recent claims for minimum detectable limits have been 10-50 micrograms/liter and 0-1 milligrams/liter in the full-scale range, which would be helpful in characterizing water supplies, determining treatment process efficiencies, or monitoring for possible regulatory control purposes. Such claims must be qualified by considering the techniques and experience of the analyst; the quality of "organic-free" water used for glassware and standard preparation; pre-analysis preparation and treatment of samples; the quality of carrier gas as to CO_2 content; the capabilities and condition of the TOC analyzer; and sample/standard contamination from ambient air CO_2. It was considered improbable that TOC, TOD, or COD could be correlated to BOD unless waste water constituents remain constant. The conversion efficiency of carbonaceous materials to CO_2 has been a concern. It was concluded that 100% efficiency exists for practically all samples if they are potable waters, municipal waste waters, condensates, or cooling-tower waters. A greater concern is the potential loss of volatile organic fractions in samples where inorganic carbon must be eliminated to establish true TOC levels. Two common techniques for its removal were presented. It was concluded that the TOC method was a reliable, rapid technique which required some precautions in certain applications.

*Analytical techniques, *Carbon, *Analysis, *Carbon dioxide, Gases, Waste water treatment, Biochemical oxygen demand, Organic matter, Oxygen demand, Monitoring, Chemical oxygen demand, Analysis

Total organic carbon

E078
THE ELECTROLYTIC RESPIROMETER-II. USE IN WATER POLLUTION CONTROL PLANT LABORATORIES,

Young, J. C., and Baumann, E. R.

Iowa State University,
Ames,
Department of Civil Engineering.

Water Research, Vol. 10, No. 12, p 1141-1149, 1976. 5 fig, 5 tab, 12 ref.

A study was conducted to determine the suitability of the electrolytic respirometer for in-plant BOD measurement, to evaluate its advantages, disadvantages, and range of use beyond single-point BOD measurement, and to collect electrolytic BOD data for comparison with standard dilution method BOD measurements. The study was in three parts, coinciding with these objectives. Conclusions and recommendations developed from resultant data were that the electrolytic respirometer provides reliable and precise measurement of BOD and should be accepted by pollution control agents as a supplement to or substitute for standard dilution; that data from a 3-day, 20 C electrolytic BOD test period are equal to that of a 5-day standard 20 C dilution test; that the ease of obtaining the complete BOD curve is a major advantage and helpful in evaluating industrial waste biodegradability; and that nitrification control should be a standard practice in BOD measurements conducted by any method.

*Respiration, *Electrolysis, *Oxygen demand, *Oxygen requirements, *Biochemical oxygen demand, Evaluation, Pollution abatement, Nitrification, Waste water treatment, Industrial wastes, Biodegradation

E079
CONCENTRATION AND DETERMINATION OF TRACE ORGANIC POLLUTANTS IN WATER,

Chang, R. C-Y.

Dissertation Abstracts International B, Vol. 37, No. 7, p 3376, January, 1977.

A method was developed for concentrating and determining phenols in natural water, treated potable water and waste water. Determination was by selective sorption on a macroreticular anion-exchange resin and elution with acetone-water. Concentration was by evaporation after extraction with methylene chloride; measurements were performed by gas chromatography. The techniques used for preventing phenol loss due to chlorination, oxidation, and other reactions during determination were presented. Recovery was excellent for samples with model organic compounds of various classes added to water. Volatile and less volatile gas chromatographic compounds were determined. Removal of organic components in potable water was possible by this sorption method. A rapid method for determining and concentrating halomethanes in potable water was developed.

*Analytical techniques, *Trace elements, *Phenols, Chlorination, Oxidation, Resins, Anion exchange, Chemical reactions, Gas chromatography, Chlorides, Organic matter, Water treatment, Waste water treatment

E080
NUTRIENT REMOVAL BY WATER HYACINTHS,

Cornwell, D. A., Zoltek, J., Jr., Patrinely, C. D., Furman, T. deS., and Kim, J. I.

Florida University,
Gainesville,
Department of Environmental Engineering.

Journal Water Pollution Control Federation, Vol. 49, No. 1, p 57-65, January, 1977.
5 fig, 4 tab, 15 ref.

Hyacinths were studied as nutrient removal agents for use in combating eutrophication. Experiments on effluent from the University of Florida Waste Water Treatment Plant (Gainesville) were conducted in a 3-phase study to determine if there was a significant reduction of nitrogen and phosphorus in a plant scale operation during winter, to determine growth patterns and effectiveness, and to study effects of detention time and depth. Resultant data showed that water hyacinths' nutrient removal capacities were directly related to pond surface area; that depth and detention time must allow a given surface area per unit flow through the pond (80% nitrogen and 44% phosphorus removals were gained with 5.1 acres hyacinths per 1 mgd); and that nutrient uptake was good during the increase in area-growth phase and during the vertical-growth phase. The nitrogen removal factor may make the plants useful in eutrophication control. Nutrients which sloughed off during the death phase remained in ponds as a bottom sediment and reduced the need for hyacinth harvesting. The most profitable use of the dead hyacinths would be as compost.

*Nutrient removal, *Water hyacinth, *Waste water treatment, *Eutrophication, *Aquatic algae, *Biochemical oxygen demand, Nitrogen, Phosphorus, Water pollution effects, Water quality

E081
BACKWASHING OF GRANULAR FILTERS,

Cleasby, J. L., Arboleda, J., Burns, D. E.,
Prendiville, P. W., and Savage, E. S.

Iowa State University,
Ames,
Department of Civil Engineering.

American Water Works Association Journal, Vol. 69, No. 2, p 115-126, February, 1977.
10 fig, 3 tab, 53 ref, 1 append.

Known practices and associated concerns for the backwashing of granular filters were summarized. This has become a field of interest due to the growing variation of practices used in the United States and abroad. The use of backwash techniques requires an awareness of potable water filtration technology since some backwashing methods involve full or partial fluidization of the filter media. High-rate backwashing is with full-bed fluidization and 20-50% bed expansion. Low-rate backwashing is without full-bed fluidization and little or no bed expansion. Backwashing methods include: high-rate backwash; low-rate backwash; water backwash with surface-wash auxiliary; water backwash with air auxiliary; air scour followed by low-rate backwash with single-medium filters only; air scour followed by high-rate water backwash with single and multimedia filters; simultaneous air scour and low-rate water backwash followed by low-rate water backwash alone for single-medium filters only; and simultaneous air scour and low-rate water backwash followed by high-rate water backwash alone with single and multimedia filters. The choice of backwash method is partially dependent upon the type of filter medium selected. The various methods were described and further research was recommended.

*Filters, *Cleaning, Filtration, Waste water treatment, Sewage treatment, Design criteria, Soil filters, Treatment facilities, Water purification

Backwash techniques

E082
THE TOXIC EFFECTS OF SELECTED HEAVY METALS ON UNADAPTED POPULATIONS OF VORTICELLA CONVALLARIA VAR SIMILIS,

Sartory, D. P., and Lloyd, B. J.

Surry University,
Guildford, Surrey, England,
Department of Microbiology.

Water Research, Vol. 10, No. 12, p 1123-1127, 1976. 1 fig, 2 tab, 10 ref.

The effects of selected heavy metals were studied to ascertain any detrimental reactions in biological processes of sewage treatment. Mercury, lead, and zinc were tested with V. convallaria var similis, a protozoan abundant in healthy rivers, activated sludge, percolating filters and slow sand filters. Results indicated that unadapted V. convallaria var similis were sensitive to lead and mercury concentrations as low as 0.0005 milligrams/liter of free metal ion/liter and that they grow if 0.0002 milligrams/liter or less of either is present. Zinc concentrations as low as 0.075 milligrams free metal ion/liter affect the protozoans, but concentrations below 0.05 milligrams/liter or less allow their growth. The degree of adaptation determines their survival when high concentrations of heavy metals are present, but it can be assumed that much of the metals present in rivers and sewages are complexed so that they are non-toxic to the microfauna. It was recommended that metal ion concentrations be given for both total and free metal ion.

*Toxicity, *Heavy metals, *Lead, *Mercury, *Zinc, *Protozoa, *Biological treatment, Sewage treatment, Waste water treatment, Metals, Rivers, Activated sludge, Filters

V. convallaria var similis

E083
CHARACTERIZATION OF SOLUBLE ORGANIC MATTER IN LEACHATE,

Chian, E. S. K., and DeWalle, F. B.

Illinois University,
Urbana,
Department of Civil Engineering.

Environmental Science and Technology, Vol. 11, No. 2, p 158-162, February, 1977.
4 fig, 2 tab, 26 ref.

Membrane ultrafiltration, gel permeation chromatography, and specific organic analyses were used to determine the composition of unknown major organic fractions in leachate. Results indicated that a major fraction of organics permeated a 500-MW membrane in ultrafiltration and most were present as free volatile fatty acids. The second largest fraction was a fulvic-like material with relatively high carboxyl and aromatic hydroxyl group density. A high-molecular-weight, humic carbohydrate-like complex, with a significant amount of hydrolyzable amino acids, was a small percentage of the organics. In tests, 75% of organic matter was identified. Lipids associated with the high-molecular-weight humic fraction were indicated by solvent extraction. Aromatic hydroxyl compounds were extracted with butanol. Data indicated that universal bacterial processes might govern the character of naturally occurring organics.

*Leachates, *Analysis, *Physical characteristics, *Chemical characteristics, Filtration, Membranes, Organic matter, Chromatography, Lipids, Separation techniques, Water pollution, Groundwater

E084
FACTORS INFLUENCING THE DEWATERING CHARACTERISTICS OF SLUDGE,

Karr, P. R., III.

Dissertation Abstracts International B, Vol. 37, No. 7, p 3566, January, 1977.

Investigations were conducted to determine factors which influence sludge dewatering characteristics. Raw, activated, and anaerobically digested sludges were studied. Results confirmed that sludge particle size greatly affects dewatering characteristics, measured by specific resistance and capillary suction time (CST). This applied to sludges of all types. Other factors (pH, biological degradation, mixing, and conditioning) affected changes in dewaterability relative to their effects on particle size. Differences in dewatering characteristics were shown to be mainly affected by differences in particle size distributions. Supracolloidal solids in a range of 1 to 100 micrometers most affected dewatering characteristics. Particles of this size range blind sludge cake and filler medium during filtration and result in a large resistance to filtrate flow. A blinding index was developed.

*Analysis, *Dewatering, *Physical characteristics, *Sludge treatment, *Particle size, Sludge, Activated sludge, Anaerobic digestion, Biodegradation, Filtration, Waste water treatment

Dewatering characteristics, Capillary suction time, Blinding index

E085
REDUCTION OF AQUATIC TOXICITY OF LINEAR ALKYLBENZENE SULFONATE (LAS) BY BIODEGRADATION,

Kimerle, R. A., and Swisher, R. D.

Monsanto Company,
St. Louis, Missouri.

Water Research, Vol. 11, No. 1, p 31-37, 1977. 4 fig, 3 tab, 24 ref.

A study was conducted to determine acute toxicity of intact linear alkylbenzene sulfonate (LAS) components and synthesized models of biodegradation intermediates to Daphnia magna (water fleas) and Pimephales promelas (fathead minnows). The acute toxicity of intact LAS was compared to that of the methylene blue active substances (MBAS) content of effluents from a laboratory continuous flow activated sludge unit. The length of the alkyl carbon chain was the most important influence on the acute toxicity of intact LAS samples. LC50 values for Daphnia and fathead minnow was 1 to 50 milligrams/liter for C14 to the C10 pure homologs. Non-linear, dialkyl tetralin-indane sulfonate components of commercial LAS revealed about 1/2 to 1/10 the toxicity of LAS samples of the same carbon chain length. The 24 hour Daphnia LC50 concentrations for acute toxicity of synthesized models of biodegradation intermediates were 355 milligrams/liter and 12,000 milligrams/liter (C11 and C4 intermediates). Fathead minnow produced similar toxicity ranges. Desulfonation/gas chromatography revealed that the longer chain homologs and more terminal isomers were the first constituents of the LAS mixture to degrade. Fifty to eighty percent degraded samples lacked the 2-, 3-, and 4-phenyl isomers. In samples degraded above 80%, homolog distribution significantly shifted to lower chain lengths. The loss in per unit weight MBAS toxicity was attributed to the preferential faster rate of biodegradation of more toxic longer chain lengths and more terminal isomers, and to the presence of non-LAS MBAS. The non-specific nature of MBAS analytical methods precludes their use in establishing water quality criteria and standards relative to LAS.

*Linear alkylate sulfonates, *Analysis, *Toxicity, *Biodegradation, *Aquatic life, *Detergents, Surfactants, Water pollution sources, Water pollution, Degradation, Biological properties

Daphnia magna, Pimephales promelas

E086
EVALUATION OF IN-LINE AND SIDE-LINE FLOW EQUALIZATION SYSTEMS,

Foess, G. W., Meenahan, J. G., and Blough, D.

Johnson and Anderson, Incorporated,
Pontiac, Michigan.

Journal Water Pollution Control Federation, Vol. 49, No. 1, p 120-130, January, 1977. 6 fig, 6 tab, 9 ref.

Experiments were conducted to evaluate flow equalization waste water treatment systems. Flow equalization has been considered a means of improving treatment processes and potentially lowering costs. One plant studied used a side-line equalization system where only above average flow was diverted through the equalization basin; the other used an in-line system where all plant flow passes through the equalization basin. Both were very effective in smoothing influent flow variations and producing a uniform flow rate to plant processes. Their effectiveness was limited in leveling concentrations. Mass leveling was more a result of flow equalization than waste water blending. A five percent BOD reduction was noticed in the in-line basin. Operational variables such as organic loadings, intensity, mixed liquor settleability, and wind and current densities were more important to effluent quality than flow equalization. Similarly, BOD5, suspended solids, and soluble phosphorus removals resulted with and without flow equalization. Filter performance with flow equalization was superior to that with a diurnal flow. Power cost estimates indicated a less than 2% increase with flow equalization.

*Flow characteristics, *Flow control, *Flow rates, Waste water treatment, Costs, Evaluation, Biochemical oxygen demand, Suspended solids, Filters, Performance, Phosphorus, Organic loading, Sludge treatment

Flow equalization, Side-line equalization, In-line equalization

E087
SOME FACTORS AFFECTING FLOC FORMATION BY ZOOGLOEA RAMIGERA, STRAIN I-16-M,

Krul, J. M.

Agricultural University,
Wageningen, The Netherlands,
Laboratory of Microbiology.

Water Research, Vol. 11, No. 1, p 51-56, 1977. 7 fig, 1 tab, 13 ref.

Studies were conducted to determine factors which influence floc formation by Zoogloea ramigera because it was long considered the major floc-forming organism of activated sludge. Floc formation was studied after resuspending pre-cultivated cells in fresh medium. The addition of NaCl or Na_2HPO_4/NaH_2PO_4 stimulated floc formation. Flocs of highly active cells were achieved because formation occurred within 1-2 hours. Results of this study indicated that adding $CaCl_2$ or Na_2SO_4 to fresh medium with resuspended pre-cultivated cells has no effect on floc formation. No explanation was found for the stimulation differences. Stimulated cell aggregation after resuspension of pre-grown strain I-16-M cells was not generally characteristic of floc-forming bacteria. Ten floc-forming strains, isolated from activated sludge and tested in the same manner, similarly failed to exhibit strongly stimulated cell aggregation.

*Flocculation, *Activated sludge, *Salts, *Growth rates, *Bacteria, Sewage treatment, Waste water treatment, Biological treatment, Sludge treatment, Treatment

Zoogloea ramigera

E088
SIMPLIFIED METHODS OF COMPUTING THE QUANTITY OF URBAN RUNOFF,

Shubinski, R. P.

Water Resources Engineers,
Springfield, Virginia.

In: Short Course Proceedings: Applications of Storm Water Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 200-213. 7 fig, 4 tab, 2 ref. Technical Report NTIS PB 247-163.

Methods are considered for the computation of urban runoff quantities. Flow-frequency analysis involves using equations to obtain natural watershed conditions; plotting the computed discharges on probability paper and fitting a smooth curve; adjusting natural discharge for urbanization effects; and determining the required discharge. The rational method computes overland and channel travel time to obtain concentration time for watershed and design rainfall duration; it also computes the basin-wide coefficient of runoff precipitation intensity; and it determines peak discharge. The unit hydrograph method requires determining the rainfall excess available to the direct runoff process; separating baseflow from the corresponding hydrograph; determining volume of direct runoff; and dividing ordinates of the hydrograph (without baseflow) by volume of direct runoff.

*Analytical techniques, *Storm runoff, *Urban runoff, *Unit hydrographs, Peak discharge, Precipitation, Rainfall-runoff relationships, Watersheds, Design data, Drainage engineering

E089
THE EFFECT OF HIGH PURITY OXYGEN ON THE ACTIVATED SLUDGE PROCESS,

Benefield, L. D., Randall, C. W., and King, P. H.

Journal Water Pollution Control Federation, Vol. 49, No. 2, p 269-279, February, 1977.
17 fig, 1 tab, 12 ref.

An experimental design was developed to provide a valid comparison of substrate utilization and growth kinetics between air and oxygen activated sludge systems operated over a range of sludges found in normal plant operation. This design also included a biochemical analysis of sludge at various specific growth rates. Research indicated that differences in substrate utilization and cellular growth values for the two activated sludge systems occur when accepted methods are used for coefficient evaluation. The kinetic differences of the systems are due to the operational characteristics associated with small volume, high solids systems normally used with oxygen-aerated facilities. The failure of the volatile suspended solids test to distinguish between proliferating, active but non-proliferating, and inactive cellular material also contributes to this kinetic difference.

*Analytical techniques, *Model studies, *Kinetics, *Activated sludge, *Oxygen, Air, Sludge treatment, Microorganisms, Growth rates, Treatment facilities, Waste water treatment, Suspended solids, Evaluation

Biochemical analysis, Substrate utilization

E090
FORMS OF SULFUR IN SEWAGE SLUDGE,

Sommers, L. E., Tabatabai, M. A., and Nelson, D. W.

Journal of Environmental Quality, Vol. 6, No. 1, p 42-46, January-March, 1977.
7 tab, 21 ref.

An analysis was undertaken to determine the forms and amounts of organic and inorganic components of elements composing sludge. Bulk sludge samples from eleven Indiana treatment plants were subjected to gravimetric and titrimetric determinations, to a modified semimicro-Kjeldahl procedure, and to steam distillation, acidimetric titration, colorimetric determination, and various metal analyses. The samples were from plants using anaerobic digestion and either activated sludge or trickling filter secondary treatment procedures. It was found that total sulfur ranged from 0.7-2.1% and that 1-27% of this was inorganic sulfur extractable with 0.1M LiCl. Sulfur was composed of sulfide sulfur (less than 1 to 35%), inorganic nonsulfate sulfur (18-53%), carbon-bonded sulfur (18-56%), ester sulfate sulfur and inorganic sulfate sulfur (0-35%), and unidentified organic sulfur (0-42%). These forms were found to vary with time and no consistent relationships were found between the amounts of organic carbon, nitrogen, sulfur and phosphorus in the sludges. It was determined that the amounts of lead and zinc were significantly correlated with sulfide sulfur, as was cadmium with organic sulfur, ester sulfate sulfur, and 0.1M LiCl extractable sulfur. No such relationships were found for other metals and various sulfur fractions.

*Sulfur compounds, *Sludge, *Analysis, Heavy metals, Carbon, Nitrogen, Phosphorus, Cadmium, Organic wastes, Waste disposal, Inorganic compounds

E091
DRUGS AND DRUG METABOLITES AS ENVIRONMENTAL CONTAMINANTS: CHLOROPHENOXYISOBUTYRATE AND SALICYLIC ACID IN SEWAGE WATER EFFLUENT,

Hignite, C., and Azarnoff, D. L.

Kansas City Veterans Administration Hospital,
Kansas City, Missouri.

Life Sciences, Vol. 20, No. 2, p 337-342, January, 1977. 1 fig, 1 tab, 9 ref.

Effluent of the Big Blue River Sewage Treatment Plant, Kansas City, Missouri, was analyzed to determine the content of drugs or drug metabolites. Composite 24-hour samples were collected and extracted under acidic, neutral, and basic conditions with methylene chloride. The extracts were screened by gas chromatography-mass spectrometry. Results indicated the presence of 2-(4-chlorophenoxy)-2-methylpropanoic acid (CPIB), the active metabolite of clofibrate, a hypolipidemic drug; and 2-hydroxy benzoic acid (salicylic acid), a metabolite of aspirin. Average 24-hour discharges of CPIB from August, 1975 to May, 1976 were 2.1 kilograms/day and salicylic acid discharges for the same period were 8.64 kilograms/day. Concentrations in raw sewage for CPIB were 2.8 kilograms/day. Raw sewage concentrations of salicylic acid were much higher and a 90% removal of this metabolite was shown from the data. Neither compound was detected in drinking water. Further investigations for drugs in water were suggested.

*Water pollution sources, *Chemical analysis, *Analytical techniques, Pollutants, Waste identification, Sewage effluents, Potable water, Gas chromatography, Mass spectrometry, Waste water treatment

Drugs, Metabolites, Salicylic acid, 2-(4-chlorophenoxy)-2-methylpropanoic acid (CPIB)

E092
PLANT DATA ANALYSIS OF TEMPERATURE SIGNIFICANCE IN THE ACTIVATED SLUDGE PROCESS,

Lin, K-C., and Heinke, G. W.

New Brunswick University,
Fredericton, Canada,
Department of Civil Engineering.

Journal Water Pollution Control Federation, Vol. 49, No. 2, p 286-295, February, 1977. 4 fig, 3 tab, 18 ref, 1 append.

Research was conducted to determine the importance of temperature in the activated sludge process, to demonstrate the effect of temperature on activated sludge performance, and to evaluate the use of temperature data in the design and control of activated sludge. Data was gathered from plants in Chicago and Toronto. Results indicated that temperature was second to raw waste water BOD5 and suspended solids concentrations in explaining BOD5 and suspended solids removals. Analysis of 26-year plant data proved the adverse effects of low temperature on activated sludge performance. The effect of temperature on primary sedimentation alone has not been determined. A larger aeration tank volume is needed with low temperatures. Reactor volume varies inversely as the square root of reaction rate. Temperature drops may occur in process water in primary and secondary settling tanks, but a maximum temperature can be found in aeration tanks when hot compressed air is used. Raw waste water temperature should be monitored continuously, as well as mixed liquor temperature. Temperature control would increase BOD5 removal. The use of hot compressed air in diffused aeration is preferred to mechanical surface aeration for maintaining high mixed liquor temperatures.

*Temperature, *Activated sludge, Design criteria, Performance, Evaluation, Treatment facilities, Biochemical oxygen demand, Suspended solids, Sedimentation, Aeration, Waste water treatment, Monitoring

Chicago (IL), Toronto (Canada)

E093
THE CHEMICAL CHARACTERISTICS OF THE CITY OF WINNIPEG WASTE WATER,

Carroll, W. D., and Lee, P. C.

Waterworks,
Waste and Disposal Division,
Winnipeg, Manitoba, Canada.

Chemistry in Canada, Vol. 29, No. 1, p 14-17, January, 1977. 3 fig, 8 tab.

The City of Winnipeg, Canada, uses a conventional sewage treatment plant, a pure oxygen activated sludge plant, and conventional stabilization ponds to provide secondary treatment of waste water. Industrial wastes are about 35% of the 55 mgd influent volume at the conventional plant. The oxygen activated sludge plant has an inflow of 10 mgd, which is primarily domestic sewage. The lagoon system handles about 5 mgd of domestic sewage in three primary cells. The city monitors treatment by characterizing the levels and variations of organics, nutrients, and heavy metals loadings. Analyses are made of suspended solids, grease, BOD, TOC, NH3, NO3, TKN, total phosphorus, copper, nickel, zinc, chromium, lead, and cadmium. TOC was used as a tool for predicting BOD in raw waste water because it provides a close approximation of potentially oxidizable carbonaceous content of samples. Nutrient levels of sewage with a significant industrial component were about equal to that of raw waste water. Chromium, zinc, lead, and nickel levels from industrial sources probably could be reduced to levels equal to that of domestic sewage. About 50-85% of the metal content ended up in the sludge, except for nickel which is removed at much lower rates. The metal content of effluents was low when compared to drinking water criteria. These analyses provide some data needed to assess the character and extent of contaminants, and the most cost-effective approach to control them.

*Analysis, *Monitoring, *Chemical properties, Sludge treatment, Sewage treatment, Treatment facilities, Activated sludge, Oxygen, Oxidation lagoons, Heavy metals, Organic matter, Nutrients, Biochemical oxygen demand, Domestic wastes, Industrial wastes, Waste water treatment

Winnipeg (Canada)

E094
TRIALS ON THE OPERATION OF BIOLOGICAL FILTERS,

Pullen, K. G.

Water Pollution Control, Vol. 76, No. 1, p 75-85, 1977. 5 fig, 2 tab, 3 ref.

The operation of biological filters was studied to aid upgrading of treatment facilities. Three full-scale trials and one pilot-scale trial were conducted. At small and medium-sized works that pump crude sewage on-site, alternating double filtration (ADF) should be used when the design capacity on single filtration of the facility has been reached. Increased loadings can be handled with no increase in capital expenditures. Plastic media can be utilized in situations where very large loadings will be treated with single filtration systems. Partial replacement of conventional media would be advantageous. When loadings are only two to three times greater than normal, the plastic media may not perform any better than conventional filters. Further investigation was suggested for balanced flow and loading methods. It is possible that capital costs can be reduced by constructing smaller filter and primary sedimentation tank capacities if increased revenue costs are acceptable for small to medium treatment plants. Too much capital should not be invested in monolithic structures if the 'throw-away' sewage treatment works stage is reached in less than 25 years.

*Analytical techniques, *Filtration, *Biological treatment, Treatment facilities, Plastics, Capital costs, Waste water treatment, Pilot plants, Performance, Filters

Alternating double filtration (ADF), Balanced flow, Balanced loading

E095
BIOLOGICAL REGENERATION OF AMMONIUM-SATURATED CLINOPTILOLITE.
I. INITIAL OBSERVATIONS,

Semmens, M. J., and Goodrich, R. R., Jr.

Exxon Research and Engineering Company,
Florham Park, New Jersey.

Environmental Science and Technology, Vol. 11, No. 3, p 255-259, March, 1977.
5 fig, 2 tab, 12 ref.

A study was initiated to determine whether nitrifying bacteria could regenerate clinoptilolite and, if so, the degree of regeneration in different time periods with different bacterial concentrations. Known weights of ammonium saturated clinoptilolite were contacted with various concentrations of nitrifying sludge of known activity. Results indicated that regeneration was possible and that the process was very rapid. The regeneration time depended upon the nitrifying capacities of the sludges. High sludge concentrations produced as much as 80% regeneration in less than two hours of contact time. Nitrification rates during regeneration were much slower than those of free ammonium in solution. It was not clear whether the amount of available ammonium limited the rate of nitrification. However, ammonium concentrations in solution were in the range in which the nitrification rate was a function of ammonium concentration. Increasing the salt concentration in solution may improve regeneration rates if the free ammonium concentration in the solution is the controlling factor in the rate of nitrification. Clinoptilolite must be used as an ion exchanger first, and biologically regenerated, in the manner of chemical regeneration, if its exchange capacity and ammonium ion selectivity are to be fully utilized. This would produce a nitrate brine which can be denitrified in many ways, thereby representing an advantage in favor of biological regeneration.

*Analytical techniques, *Zeolites, *Ion exchange, *Ammonium compounds, *Biological treatment, Sewage effluents, Sludge treatment, Nitrification, Salts, Chemical treatment, Brines, Waste water treatment, Bacteria

Clinoptilolite regeneration

E096
BIOLOGICAL REGENERATION OF AMMONIUM-SATURATED CLINOPTILOLITE.
II. MECHANISM OF REGENERATION AND INFLUENCE OF SALT CONCENTRATION,

Semmens, M. J., Wang, J. T., and Booth, A. C.

Exxon Research and Engineering Company,
Florham Park, New Jersey.

Environmental Science and Technology, Vol. 11, No. 3, p 260-265, March, 1977.
8 fig, 1 tab, 20 ref.

The influence of salt concentrations on clinoptilolite regeneration, and the mechanism thereof, were investigated. Previous studies suggested, and this one confirms, that the solution concentration of ammonium controls nitrification rates and that this is controlled by the amount of ammonium displaced by ion exchange. Increasing ion exchange rates by decreasing clinoptilolite particle size and increasing solution salt concentrations increased the rate of regeneration. Nitrifying bacteria were significantly inhibited by salt concentrations higher than 0.6 M and, at one M salt concentration, no nitrification was observed. Salt also stimulated nitrifying bacteria in low concentrations of 0-0.4 M. It was found that salt could produce higher regeneration levels. About 99% regeneration was achieved in less than 3 hours when 400 meq/liter of sodium chloride were added to the regeneration factor. It was concluded that nitrification in concentrated salt solutions was a prerequisite to economical operation in a biological regeneration process. This produces little excess brine for disposal. Satisfactory regeneration may be attained by using a salt brine for ammonium extraction and biologically restoring the brine for reuse.

*Analytical techniques, *Zeolites, *Nitrification, *Ion exchange, *Ammonium compounds, *Salts, *Inhibition, Performance, Sodium chloride, Biological treatment, Bacteria, Economics, Brines, Waste water treatment, Brine disposal

Clinoptilolite regeneration, Nitrifying bacteria

E097
THE EFFECT OF TIME DELAY AND GROWTH RATE INHIBITION IN THE BACTERIAL TREATMENT OF WASTE WATER,

Bush, A. W., and Cook, A. E.

Teesside Polytechnic,
Cleveland, England,
Department of Mathematics and Statistics.

Journal of Theoretical Biology, Vol. 63, No. 2, p 385-395, 1976. 8 ref.

Investigations were conducted of the Monod and similar models incorporating inhibitory effects of huge nutrient concentrations on bacterial growth rates. The behavior of continuous culture systems, with and without time delay, were studied. Biological waste water treatment is an example of a system subject to failure from shock loading resulting from the inhibitory effect. Equations were presented to determine the relationship of microorganism concentrations to substrate concentrations and to determine the inhibitory effects of high substrate concentrations. Parameters of system operation failures such as shock overloading and underloading were also developed.

*Model studies, *Inhibition, *Mathematical models, *Analysis, *Growth rates, *Bacteria, *Nutrients, Biological treatment, Waste water treatment, Microorganisms

Monod model, Substrate concentrations

E098
RELATIONSHIP BETWEEN BOD5 AND FATS, OILS AND GREASE,

Schaeffer, D. J., Park, J. B., and Stock, T.

Illinois Environmental Protection Agency,
Springfield, Illinois.

Water and Sewage Works, Vol. 124, No. 3, p 82-83, March, 1977. 3 tab, 8 ref.

Fats, oils, and grease (FOG) have been investigated in Illinois effluent discharges for the purpose of setting regulations. These substances may cause clogging of sewer systems, creating maintenance problems, and they may impede treatment processes. In addition, they may cause sheens, surface and sediment deposits, and produce long term BOD which depletes dissolved oxygen in streams. It was hoped that a linear relationship could be established between FOG and BOD5. Parameters of the defining line were used to calculate the expected BOD5/FOG ratio to obtain FOG limits so that BOD5 would be the limiting factor for readily degraded wastes. FOG limits would be reached first for slowly oxidizing wastes or those which oxidize at extreme receiving stream conditions. Data resulting from investigations revealed the existence of significant relations for the parameters. The amount of BOD5 attributable to FOG could not be inferred from the results, but BOD5 did increase linearly with FOG values. There was appreciable scatter about the regression line. There was no difference between regression lines for industrial and sewage treatment plant effluents. It was concluded that neither BOD5 nor FOG would be sufficient as a single parameter. A dual standard, using BOD5 limits for degradable FOG and FOG concentrations for poorly oxidizable wastes, was suggested.

*Analysis, *Monitoring, *Oil wastes, *Lipids, *Biochemical oxygen demand, Regulation, Water quality standards, Sewage effluents, Industrial wastes, Domestic wastes, Dissolved oxygen, Mathematical models, Model studies, Treatment facilities, Waste water treatment, Sewers, Maintenance

Grease, Illinois

E099
EFFECTS OF POLYELECTROLYTES AND CLAY COLLOIDS ON CARBON ADSORPTION,

Huang, J-C., and Garrett, J. T.

Water and Sewage Works, Vol. 124, No. 3, p 64-67, March, 1977. 8 fig, 1 tab, 5 ref.

A study was conducted to investigate the effects of polyelectrolyte molecules and/or colloidal particles in waste water on the porous structure of activated carbon. How various types of activated carbon would be affected if blockage occurs which reduces activated carbon effectiveness was also investigated. Cationic, anionic and non-ionic polyelectrolyte were used and illite, montmorillonite, and kaolinite clays were employed. Phenol was used as the adsorbate. Activated carbons tested were coal-based, petroleum-based, wood-based, and lignite-based. Results indicated that almost no inhibition of carbon adsorption was caused by the colloidal materials or the polyelectrolytes used. The lack of inhibition by the polyelectrolytes studied was attributed to the lack of activated carbon affinity for them. Failure of the clays to create any inhibition was considered to be due to a lack of affinity between carbon and clay particles and to the fact that clay particles were too large to effectively block any capillary pores.

*Analytical techniques, *Activated carbon, *Polyelectrolytes, *Clays, Illite, Kaolinite, Montmorillonite, Inhibition, Particle size, Phenols, Performance, Physical properties, Chemical properties, Waste water treatment

E100
THE ACTIVATED SLUDGE PROCESS WITHOUT PRELIMINARY PURIFICATION. RESULTS OF PILOT EXPERIMENTS IN THE PURIFICATION PLANT KARLSRUHE (Das Belebungsverfahren ohne Vorreinigung. Ergebnisse der Versuche im halbtechnischen Massstab im Klaerwerk Karlsruhe),

Mueller, L.

Gas-und Wasserfach-Wasser/Abwasser, Vol. 118, No. 1, p 15-23, 1977. 10 fig, 1 tab, 9 ref.

The activated sludge process was studied in pilot experiments with waste water consisting of 45% municipal and 55% industrial waste water at the Karlsruhe waste water treatment plant. The waste water was admitted to the single-stage aeration tank without preliminary purification after the sand trap. Compared with activated sludge from the conventional process with preliminary purification, the sludge from the one-stage process had markedly improved settling properties. The sludge volume index was 51-80 mg/liter, compared with 100 mg/liter in the case of preliminary purification. The adaptation time was about half of that required in the two-stage process, which may be due to the rapid activation of bacterial colonies which would be removed during the preliminary purification. The solids content of the return sludge was surprisingly high compared with that in the two-stage process. Good purification efficiency was achieved even with high sludge loads (93.1-96.5% with an initial load of 0.19-1.27 kg BOD5/kg dry matter/day).

*Analytical techniques, *Activated sludge, *Waste water treatment, Model studies, Municipal wastes, Aeration, Bacteria

Sludge volume index, Settling properties

E101
EASIER IDENTIFICATION WITH MPN PROCEDURE,

Dornfest, A., Howard, C., and Williams, V.

Nampa Waste Water Treatment Plant,
Nampa, Idaho.

Deeds and Data, p 4, November, 1976. 2 tab, 2 ref.

The Nampa Waste Water Treatment Plant laboratory has used the MPN technique for determining fecal coliform bacteria in chlorinated secondary effluent since 1975. Problems were encountered in classifying tubes as postive or negative following the incubation period on occasions when few bubbles are present. The use of indicators to establish more definite tube results was investigated because fecal coliform bacteria produce acid in addition to gas when fermented in lactose. Brom cresol purple/1 EC (0.0125 grams) was added to tubes sterilized by autoclaving for 15 minutes at 121 C and duplicate inoculations from positive lauryl tryptose tubes were transferred to regular EC and the indicating EC. Thirty-four samples were run on dilutions of 0.01 mil to 1.0 milliliter/tube. At the end of incubation, there were 25 negative and 9 positive samples. Identical results were obtained in EC and indicating EC in all cases. Positive results changed the indicating EC from a dark purple to a yellowish green. Borderline positives changed to lavender, providing an observable determinant in addition to gas production. Small amounts of brom cresol purple indicator produced easily readable positive and borderline positive results. Tests were also conducted with EC indicators and lauryl tryptose presumptive fecal coliform tubes. These used duplicate series of nine tubes using 1.0 milliliters, 0.1 milliliters and 0.01 milliliters of sample. Results of five consecutive days showed identical numbers of fecal coliforms determined with or without brom cresol purple indicator. Interference was not caused by adding brom cresol purple to lauryl tryptose broth for more easily readable test results.

*Analytical techniques, *Water quality control, *Bioindicators, Analysis, Coliforms, E. Coli, Bacteria, Color, Laboratory tests, Waste water treatment, Chemical reactions

Brom cresol purple, Lauryl tryptose

E102
ISRAEL'S USE OF NONIONIC SURFACTANTS,

Narkis, N., and Henefeld-Furie, S.

Environmental Engineering Laboratories,
Technion, Israel Institute of Technology,
Technion City, Haifa, Israel.

Water and Sewage Works, Vol. 124, No. 3, p 69-71, March, 1977. 3 tab, 22 ref.

The use of nonionic surfactants in Israel was discussed. About 2,300 tons of these materials are used annually in Israel. They are predominantly nonyl phenol and di-nonyl phenol ethoxylates and are poorly degradable during waste water treatment. Ten to thirty percent removals are usual. Important properties of these surface active agents are that they are neutral, harmless to the skin, stable and effective in high concentrations of salts, suitable to high and low temperature applications, and are not affected by hardness or extreme pH levels. Their use as cleaners in households, and in textile, paper-making, metal, and pesticide industries has increased their presence in waste water. Detection of synthetic surfactants in water and waste water is based on the reaction of methylene blue with the anionic part of the molecule forming chloroform soluble salts. Conventional techniques cannot determine the presence of nonionic surfactants. They cause serious foaming problems and interfere with sewage treatment, as well as being toxic to fish. Research should be conducted to find effective means for their removal from waste water and sewage treatment effluents.

*Surfactants, *Foaming, *Water pollution sources, Detergents, Domestic wastes, Industrial wastes, Pulp and paper industry, Textiles, Pesticides, Chemical properties, Physical properties, Waste water treatment, Toxicity, Water pollution control

Nonionic surfactants, Israel

E103
A STUDY ON THE STRENGTH OF SEWAGE,

Stones, T.

Effluent and Water Treatment Journal, Vol. 17, No. 2, p 90-91, February, 1977.
3 tab, 11 ref.

The strength, or oxidizable matter concentration of sewage was characterized on the basis of its oxygen demand. This oxidizable matter is composed chiefly of carbonaceous and nitrogenous compounds. The absolute strength of sewage was defined as the dissolved oxygen needed for complete biochemical oxidation of the organic matter. Complete oxidation occurs in two stages: oxidation of carbonaceous matter and of nitrogenous matter. The lengthy time needed for this process required that other criteria be adopted to make the strength determinations. Carbonaceous oxygen demand can be determined by the dichromate value (DV) or COD by measuring oxygen consumption from silver catalyzed dichromate. This varies with the nature of the sewage. Nitrogenous oxygen demand can be calculated from the unoxidized nitrogen present according to a stoicheometric relationship. A formula was given for the determination of total, carbonaceous, and nitrogenous oxygen demand.

*Sewage, *Physical properties, *Chemical properties, Oxygen demand, Oxidation, Biochemical oxygen demand, Chemical oxygen demand, Industrial wastes, Domestic wastes, Chemical reactions, Analysis

E104
FACTORS AFFECTING NITRIFICATION,

Hockenbury, M. R., Daigger, G. T., and
Grady, C. P. L., Jr.

Engineering-Science, Incorporated,
Atlanta, Georgia.

Journal of the Environmental Engineering Division-ASCE, Vol. 103, No. EE1, p 9-19, February, 1977. 1 fig, 3 tab, 13 ref.

Laboratory studies were conducted to investigate factors which affect nitrification. These included the effect of heterotrophic bacteria and organic compounds on nitrifying bacteria, and the possible adverse effects created by material released in waste water during treatment in a plug flow activated sludge aeration basin. Results indicated no effects by actively metabolizing heterotrophic bacteria upon nitrate production by autotrophic nitrifiers. Domestic sewage did not affect nitrate production by nitrifying bacteria when inhibitory industrial wastes were absent. No adverse effects from treatment in plug flow activated sludge aeration basins were found when suitable pH and dissolved oxygen levels were maintained for autotrophic nitrifiers. Heterotrophic bacteria released growth factors which slightly stimulated autotrophic nitrifier activity. Many inhibitory compounds in tested sewage were apparently degraded within the first half-hour of activated sludge treatment.

*Nitrification, *Bacteria, *Organic matter, Activated sludge, Domestic wastes, Industrial wastes, Dissolved oxygen, Growth rates, Aeration, Hydrogen ion concentration, Waste water treatment

E105
MECHANISMS AND KINETIC PARAMETERS IN GRANULAR MEDIA FILTRATION,

Kavanaugh, M. C.

Dissertation Abstracts International B, Vol. 37, No. 9, p 4630, March, 1977.

Investigations were conducted to develop a process analysis methodology for particle collection in deep-bed granular media filters for optimum filter process design with minimum pilot plant experiments. Experiments indicated that straining was of small contribution to particle removal for stabilized and destabilized particles if the particle size/medium size ratio was less than .004, and the particle number flux was less than 100,000,000/sq cm/sec. Attachment was thought to be the rate limiting step under all experimental conditions. The three model parameters for a given layer of medium were the amount of solids deposited prior to the onset of effluent quality deterioration, the maximum depth-averaged single collector efficiency, and the first order proportionately constant relating head loss to specific deposit. The method was found to permit estimation of optimum process design, if the parametric dependence of the model parameters is known.

*Kinetics, *Filtration, Model studies, Design criteria, Pilot plants, Separation, Suspended solids, Performance, Waste water treatment, Analytical techniques, Filters

Granular media filters, Multi-media filters, Upflow filters

E106
STUDIES ON ADSORPTION WITH ACTIVATED CARBON,

Tebbutt, T. H. Y., and Bahiah, S. J.

University of Birmingham,
Birmingham, England,
Department of Civil Engineering.

Effluent and Water Treatment Journal, Vol. 17, No. 3, p 123-127, March, 1977.
7 fig, 1 tab, 5 ref.

Adsorption studies using activated carbon were conducted to gather information on low organic concentrations in treated waste water and polluted raw waters. Factors involved in adsorption are surface tension, capillary condensation, chemical adsorption, and physical adsorption. Test results revealed that fatty acids and lipids were adsorbed more efficiently on activated carbon than carbohydrates. Amino acids were adsorbed to an even lower degree. There is a predictable increase in adsorbability with the increase in the molecular weight of a compound class. There is also a trend towards increased adsorbability with decreased solubility for a given compound class. Designing an efficient adsorption facility rests on a knowledge of water and waste water chemical composition, and on the use of parameters such as TOC or COD. Adsorption may not always be a suitable removal process since the adsorption behavior of organic compounds varies considerably.

*Adsorption, *Activated carbon, Analysis, Chemical oxygen demand, Chemical properties, Physical properties, Separation techniques, Water purification, Toxicity, Carbon, Waste water treatment

E107
ANALYSIS OF ACTIVATED SLUDGE PROCESS PERFORMANCE,

Hovey, W. H.

Dissertation Abstracts International B, Vol. 37, No. 9, p 4630, March, 1977.

A study was conducted to collect and analyze daily data on the performance of activated sludge plants. Linear and multiple regression techniques were used to evaluate effluent quality, effluent quality variation, and effluent quality as a function of flow rate and design flow rate. The predictable variation of effluent quality, when measured by BOD and suspended solids concentrations, can allow the prediction of process performance variations and the development of discharge requirements which are realistically attainable. There were no indications of any effect of process size on process performance, suggesting no real benefit from larger regional facilities insofar as stream water quality control is concerned. The net effect of larger facilities having larger flow rates may even be negative on receiving streams.

*Activated sludge, *Performance, *Treatment facilities, Municipal wastes, Biological properties, Physical properties, Model studies, Economics, Evaluation, Flow, Sewage effluents, Biochemical oxygen demand, Water quality control, Waste water treatment

E108
BACTERIAL POPULATIONS AND END PRODUCTS DURING ANAEROBIC SLUDGE FERMENTATION OF GLUCOSE,

Chynoweth, D. P., and Mah, R. A.

Michigan University,
Ann Arbor,
Department of Environmental and
Industrial Health.

Journal Water Pollution Control Federation, Vol. 49, No. 3, p 405-412, March, 1977.
4 fig, 4 tab, 12 ref.

A study was performed to investigate changes in bacterial populations during anaerobic sludge fermentation of glucose to evaluate that substrate. No response was evident for 8 to 10 hours after the addition of glucose to unenriched digesting sludge. At that point, there was a sudden and rapid increase in gas production and accumulation of acetate, propionate, and ethanol. This resulted from a sudden selective growth of euryoxic bacteria. Isolates from the enriched sludge were characterized as the Escherichia genus and Providence group, and produced fermentation products identical to those in enriched sludge in high concentrations. These activities and growths indicate the imbalance which occurs when substrates added to anaerobic digesters are changed. Continued bacterial population imbalance in fermentation could lead to the accumulation of toxic products and the end of decomposition. Data indicated that digester sludge acclimatization to pure substrates causes a great change in the natural bacterial populations.

*Bacteria, *Fermentation, *Anaerobic conditions, *Carbohydrates, Nutrients, Sludge digestion, Waste water treatment, Gases, Metabolism, Microorganisms

Glucose

E109
CLAY ADSORPTION TREATMENT OF NON-IONIC SURFACTANTS IN WASTE WATER,

Carberry, J. G., Twardowski, C. J., and Eberhart, D. K.

Delaware University,
Newark,
Department of Civil Engineering.

Journal Water Pollution Control Federation, Vol. 49, No. 3, p 452-459, March, 1977.
11 fig, 4 tab, 11 ref.

Non-ionic surfactant adsorption studies were conducted using clays. Bentonite clays were found to adsorb 10 to 20 times better than activated carbon on a weight basis of surfactant removed per weight of adsorbent. Three clays which were able to remove non-ionics from waste water were Mineral Colloid 103, Accofloc 352, and Bentolite L. Mineral Colloid 103 had the best adsorptive capacity. Higher interaction energies were found for liquid non-ionic surfactants than those predicted for gases. Micelle formation and deposition might account for such large interactions with adsorptive surfaces. Accofloc 352 had the lowest interaction energy and might be the easiest to regenerate. A decrease in adsorptive capacity was found in continuous flow studies as compared to determinations from batch isotherm studies. This was partially due to increased bed particle size to allow gravity flow through the column. Mineral Colloid 103 had the largest adsorptive capacity in continuous flow studies. No studies of regeneration of clay surfaces, or economic comparisons of batch treatment or gravity flow through fixed columns were attempted.

*Adsorption, *Clays, *Surfactants, Separation techniques, Physical properties, Chemical properties, Analysis, Waste water treatment, Evaluation, Particle size

E110
HIGH SPEED LIQUID CHROMATOGRAPHIC ANALYSIS OF COBALAMIN PRODUCTIVITY AND DISTRIBUTION IN ACTIVATED SEWAGE SLUDGE TREATMENT,

Beck, R. A.

Dissertation Abstracts International B, Vol. 37, No. 9, p 4435, March, 1977.

A high speed liquid chromatographic technique was developed for the determination of 1-10 micrograms of total extractable cobalamins from activated sludge. Cobalamins are extracted by benzyl alcohol; spectrophotometrically interfering substances are removed by combined gel filtration and chromatography; trace extracts are concentrated by lyophilization; and total extractable cobalamins are quantified by high speed liquid chromatography. The annual productivity of cobalamins was found to average 1.87-27.08 micrograms/gram of dry sludge weight. Increases of this substance paralled increased environmental temperatures and diminished dissolved oxygen levels. Cobalamin levels were found to be 9.75 micrograms/gram in secondary stage activated sludge, 3.79 micrograms/gram in primary sludge and 4.75 micrograms/gram in tertiary sludge.

*Chromatography, *Activated sludge, Analysis, Filtration, Separation techniques, Analytical techniques, Sludge treatment, Waste water treatment, Chemical analysis

Cobalamins, Benzyl alcohol extraction

E111
FINE SCREENING OF RAW SEWAGE,

McVie, A.

The Public Health Engineer, Vol. 5, No. 2, p 38-42, March, 1977. 4 fig, 5 tab, 9 ref.

Fine screens, or strainers, were defined as those having multiple individual openings less than 10 millimeters in either face dimension. Bar screens in any form are not covered by this definition. Tests were conducted when fine mesh rotating cup screens failed to meet their hydraulic specifications because of mesh blinding. It was possible to define the strainer's effective open area by using the fabric geometry and Boucher's Law to compute the effective hydraulic capacity. Water temperature played a significant role in the calculation. For each perforation size, there is a head which cannot be exceeded without incurring malfunction and felting. This depends upon the sewage filterability index and the breakthrough point. Because sewage is expected to have a fairly constant general range for the filterability index, and thus consistent straining characteristics, strainer rotation speed should be varied for extreme cases. It was impossible to test for the filterability index with sewage under laboratory conditions. The results of this investigation led to an increased screen capacity of 250% and the cessation of felting. The general approach used here may be applied to all types of fabric including fixed bar screens. However, the Boucher hydraulic solution is limited to conditions of streamline or near streamline flow.

*Fine aggregates, *Screens, *Analysis, *Testing, Filtration, Equipment, Sewage treatment, Water quality standards, Solid wastes, Sludge treatment, Design criteria, On-site testing, Hydraulics, Waste water treatment

Fine screening

E112
RATIONAL DESIGN OF AEROBIC DIGESTION SYSTEMS,

Rich, L. G.

Water and Sewage Works, Vol. 124, No. 4, p 94-95, April, 1977. 1 fig, 1 tab, 2 ref.

Equations were presented for various aspects of the design of aerobic digestion systems. The process is used to stabilize organic solids for discharge to the environment by converting the biodegradable-solids fraction to carbon dioxide, ammonia, and water. Operation may be carried out in three modes: batch, semi-continuous, and continuous. In the first, solids are aerated for the entire stabilization period, aeration is ended, and supernatant and settled solids are discharged. Aeration is discontinued more frequently in the second method, permitting solids settling, partial solids withdrawal, and the addition of new solids. The third mode is carried out in a single or multi-stage form. The addition of a clarifier-thickener after digestion is not generally feasible with the continuous-flow, multi-stage system. Hydraulic retention time should be based on average air temperatures for the coldest month. Diffused-air aeration systems contribute to temperature stability. The equations provide means for determining the relationship of specific oxygen uptake rate, temperature, biodegradable-to-nonbiodegradable volatile suspended solids ratio in the initial suspension, and the mean solids age. These are useful for a fundamental and predictable specification of the degree of stabilization.

*Aerobic treatment, *Design criteria, Suspended solids, Biodegradation, Microorganisms, Biological treatment, Oxygen demand, Sludge digestion, Solid wastes, Temperature, Activated sludge, Waste water treatment, Analysis

E113
DETERMINATION OF BOD AFTER FREEZING WATER SAMPLES
(Bestimmung des BSB nach Einfrierung der Wasserproben),

Wachs, B.

Munchner Beitrage zur Abwasser-. Fischerei- und Flussbiologie, Vol. 27, p 179-204, 1977. 12 fig, 9 tab, 28 ref.

The effect of freezing and storing waste water samples on their biochemical and chemical parameters was studied. Waste water samples that cannot be analyzed on the site should be stored deep-frozen at -40 to -70 C. Since a high percentage of the bacteria are irreversibly damaged by deep-freezing, samples thawed after such storage should be inoculated with mechanically or biologically purified municipal waste water before BOD measurement. As freezing results in the flocculation of additional organic substance that remains in the sample, it is necessary to eliminate the settling substances before freezing. With a BOD5 range of 10-50 mg/liter, storage at -20 to -30 C can result in BOD5 losses of up to 20% compared with those of a fresh sample. The loss does not exceed 10% in a BOD5 range of 50-2,000 mg/liter. The BOD5, COD and TOC values measured in samples with BOD5 over 2,000 mg/liter, and stored at the above temperature, may be higher than those measured in fresh samples. The chemical and bacteriological parameters decrease progressively with storage time in the frozen state, especially in samples with low organic matter content, and in samples frozen and stored at relatively high subzero temperatures.

*Analytical techniques, *Freezing, *Biochemical oxygen demand, Bacteria, Flocculation, Temperature, Chemical oxygen demand, Organic matter, Carbon, Waste water treatment, Chemical properties

E114
PREDICTING PERFORMANCE OF PIPE CULVERTS BURIED IN SOIL,

Roy, M. B.

Dissertation Abstracts International B, Vol. 37, No. 8, p 4082-4083, February, 1977.

A simulation model based on the finite element method was developed to analyze the performance of culverts buried in soils. A computer program included curved bar segments with normal, tangential, and rotational degrees of freedom; triangular, isoparametric elements with a curved boundary to fit the pipe shape; three midside nodes which represented soil; and an "interaction" element to simulate interface between pipe and soil. Non-linear, anisotropic soil properties were included. Construction sequences can be simulated and "no-tension" analysis can be included. The system can be applied to questions of the influence of non-linear soil properties, relative stiffness of pipe and soil, the use of weak materials near the spring line, and construction procedures. Time-dependent soil properties, temporary soil compaction loads, and pipe cracking or yielding were not considered. Only two-dimensional problems transverse to the pipe can be analyzed. The analysis of circular corrugated metal pipe in granular soil showed that the maximum circumferential thrust in pipe depends, primarily, on the pipe diameter and height of the fill, and that it is necessary to determine the non-linear soil properties' effects on culvert performance. Neither construction sequence nor slip at soil-pipe interface were significant when the fill was loaded symmetrically. It was also found that Marston-Spangler soil modulus E' could not be used as a soil parameter for rational predictions of culvert performance.

*Analytical techniques, *Performance, *Piping, *Culverts, Soil physical properties, Model studies, Construction materials, Soil types, Computer models, Loads (forces)

E115
AN ESTIMATION OF THE EFFICIENCY OF A WASTE WATER TREATMENT PLANT, AS MEASURED BY SEVERAL PARAMETERS INCLUDING LIPID BIODEGRADATION (Essai d'evaluation de l'efficacite d'une station d'epuration a l'aide de plusieurs parametres dont la biodegradation des lipides),

Chambon, P., Pierson, M., Pattee, E., Vial, J., and Chambon-Mougenot, R.

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Faculty of Pharmacy,
Lyon, France.

La Tribune du Cebedeau, Vol. 30, No. 398, p 2-7, January, 1977. 2 fig, 2 tab, 7 ref.

Lipids, BOD, COD, detergents, and CH2 content in inflow and outflow were used to estimate the waste water treatment efficiency of a biological discs system. C12 and C18 were dominant compounds revealed by the analysis of the lipidic fraction. These compounds were eliminated to a considerable extent. It was found that the biodegradability of a chemical class is best appreciated when specific parameters are chosen. The time of sampling is more important at the inflow than at the outflow of a plant because mean values are always recorded at the outflow.

*Treatment facilities, *Evaluation, *Performance, *Biological treatment, *Lipids, Analysis, Biochemical oxygen demand, Chemical oxygen demand, Detergents, Biodegradation, Waste water treatment

E116
IMPROVED METHOD FOR THE DETERMINATION OF ETHYLENEDIAMINETETRAACETIC ACID IN AQUEOUS ENVIRONMENTAL SAMPLES BY GAS-LIQUID CHROMATOGRAPHY,

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Stevenage, Hertfordshire, England.

The Analyst, Vol. 102, No. 1211, p 120-123, February, 1977. 1 fig, 2 tab, 3 ref.

The determination of ethylenediaminetetraacetic acid (EDTA) in sewage, sewage effluents, and rivers is important because EDTA might lower the effect of adsorption and precipitation reactions in removing trace metal contaminants. Colorimetric and complexometric analytical methods were unsuccessful; gas-liquid chromatography determinations presented problems. A method was proposed using 1,6-hexanediaminetetraacetic acid (HDTA) as an internal standard. The sample is filtered and the filtrate is extracted with chloroform; it is then acidified with formic acid and the HDTA is added. After evaporation, but before precipitation, the filtrate is rinsed and further evaporated under a stream of nitrogen and in an oven. The tube is drawn in the middle in a gas-oxygen flame, and an esterifying solution is added. The tube is sealed, placed in boiling water, and cooled. After this, the tube is opened, and the contents are rinsed in chloroform and centrifuged in a tube containing a phosphate buffer solution. After separation, the chloroform layer is transferred to a small sample tube and evaporated in the solvent under a nitrogen stream. The residue is dissolved in acetone and injected on to the gas-liquid chromatographic column. The mean recovery for this method is 98.6% with a 13.1% standard deviation.

*Analytical techniques, *Chromatography, *Chemical reactions, Pollutant identification, Liquid wastes, Sewage treatment, Waste water treatment, Laboratory tests, Analysis, Water purification

E117
RAPID AGAR POUR-PLATE TECHNIQUE FOR DETECTION AND ENUMERATION OF FAECAL COLIFORMS IN SEWAGE,

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National Environmental Engineering Research Institute,
Nagpur, India.

Indian Journal of Environmental Health, Vol. 18, No. 3, p 183-190, July, 1976.
4 tab, 16 ref.

The rapid agar pour-plate technique was developed to estimate coliform populations in sewage. The technique involved the homogenization of sewage samples which were then mixed with a sterile saline solution. Appropriate dilutions were placed in separate sterile petri dishes. Rapid agar, melted and cooled to 50-55 C, was added to the petri dishes and thorough mixing followed. Incubation at 41.5 C ± 0.5 C in a water-jacketed air incubator for 7 to 8 hours followed solidification of the medium. After incubation, the yellow or orange coliform colonies were counted with a Qubec colony counter. Necessary computations were then made to adjust the results for tabulation. The technique was found to be quite sensitive and reliable. Results were consistent and reproducible with a 12.63% to 12.93% coefficient of variation. A specificity for fecal coliforms was a prime characteristic of this technique and comparisons with the MPN procedure revealed no significant differences. This method has the advantage of yielding absolute numbers as test results.

*Analytical techniques, *Pollutant identification, *Coliforms, Pollutants, Sewage treatment, Waste water treatment, Analysis, Bacteria, Sewage effluents, Water pollution control

Most-probable-number (MPN), Rapid agar pour-plate method

E118
ENTEROVIRUS TYPES IN ISRAEL SEWAGE,

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Jerusalem, Israel,
Hadassah Medical School.

Water Research, Vol. 11, No. 4, p 393-396, 1977. 1 fig, 2 tab, 16 ref.

Picked virus and neutralization test methods were described for the isolation and identification of enteroviruses in the sewage of various Israeli communities. Grab and gauze pad methods were used to collect the sewage samples. The first method resulted in the finding of 489 isolates. These included 74% polioviruses; 10% Coxsackie Type B, Coxsackie A9 or Echo 9; and 16% Echo and other strains of enteroviruses. Fifty-two samples were tested for polio and non-polio viruses with the neutralization method. An average of 37% were found to be polioviruses. These percentages were higher than those obtained with other test methods. Regular virus monitoring of sewage would give a qualitative view of the enteroviruses in sewage and of the prevalence of enteroviral diseases of the population.

*Viruses, *Pollutant identification, *Analytical techniques, Public health, Diseases, Microorganisms, Analysis, Microbiology, Water pollution sources, Waste water treatment, Sewers

Israel

E119
NITRIFICATION AND HEAVY METAL REMOVAL IN THE ACTIVATED SLUDGE TREATMENT PROCESS,

Richards, P. A.

Dissertation Abstracts International B, Vol. 37, No. 8, p 4082, February, 1977.

The relationship between nitrification and heavy metal removal was investigated in the activated sludge treatment process. Chromium was studied at 0.1-10.0 milligrams/liter, and silver was studied at 0.1-0.5 milligrams/liter in settled primary domestic sewage. The analyses covered heavy metal concentration, pH, dissolved oxygen, temperature, suspended solids, chemical oxygen demand, nitrogen species, and alkalinity. There were indications that sludge wasting rates are directly related to heavy metal removal. Nitrification indirectly affects the process because sludge wasting controls sludge age, which controls nitrification. A theory on the mechanisms of heavy metal removal was developed; sludge wasting was considered the key mechanism of this process.

*Nitrification, *Heavy metals, *Activated sludge, *Separation, Sludge treatment, Analysis, Sewage treatment, Dissolved oxygen, Temperature, Suspended solids, Chemical oxygen demand, Nitrogen, Hydrogen ion concentration, Alkalinity, Waste water treatment

E120
CONFIRMATION OF THE SINGLE-STEP MEMBRANE FILTRATION PROCEDURE FOR ESTIMATING PSEUDOMONAS AERUGINOSA DENSITIES IN WATER,

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Canada Centre for Inland Waters,
Burlington, Ontario, Canada.

Applied and Environmental Microbiology, Vol. 33, No. 2, p 240-245, February, 1977.
1 fig, 6 tab, 18 ref.

Pseudomonas aeruginosa concentrations in water have become recognized as an indicator of pollution and as a pathogen. Determination procedures have been developed including membrane filtration and most-probable-number (MPN). Two membrane filter processes and MPN were compared to determine their relative efficiencies in enumerating P. aeruginosa from Canadian water and sewage samples. The Brodsky-Nixon MacConkey agar-membrane filtration procedure was a 24-hour procedure using a commercially available medium. Density estimates were based on the presence of fluorescence. It was found that large coliform populations interfered with the development of P. aeruginosa colonies. The method was judged unsuitable for application to natural and effluent waters. The other membrane filter process employed proline and ethanol. Results indicated that the specificity of membrane filter procedures confirmed 92-99% of the organisms as P. aeruginosa, while MPN verification rates varied from 64 to 86%. For all but sewage samples, a 3-4 day incubation period at 41.5 C provides the best data results with membrane filtration. This procedure, with mPA or mPA medium B, is a simple and rapid technique which avoids the extended procedures necessitated by the MPN technique.

*Analytical techniques, *Filtration, *Membranes, *Pseudomonas, Performance, Bacteria, Coliforms, Separation techniques, Analysis, Waste water treatment

Brodsky-Nixon MacConkey agar-membrane filtration, Most-probable-number (MPN)

E121
FACTORS AFFECTING THE DENITRIFICATION RATE IN TWO WATER-SEDIMENT SYSTEMS,

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Wageningen, The Netherlands,
Laboratory of Microbiology.

Water Research, Vol. 11, No. 3, p 259-267, 1977. 9 fig, 4 tab, 32 ref.

Two water-sediment systems were studied to analyze denitrification rates, and to determine the effects of temperature, dissolved oxygen, nitrate concentrations in the water above the sediment, and the thickness of the sediment layer on these rates. Sediment A was from the top 10 centimeters of a ditch containing effluent of an activated sludge aeration treatment facility using slurry from meat production calves. Type B was from a similar layer of a ditch containing water drained from arable land. Denitrification was slightly decreased when dissolved oxygen increased from 0 to 2 milligrams/liter in overlying water. Further increases in DO concentrations had no further decreasing effect. Denitrification depended on nitrate concentrations in the overlying water when these concentrations were low. It occurred more independently as the nitrate concentrations increased. Denitrification began after an extended lag at 4 C. Denitrification, as well as nitrification, proceeded rapidly at 15 and 25 C. With nitrate-nitrogen concentrations of 25.2 milligrams/liter, a 7 millimeter layer of sediment A and a 14 millimeter layer of sediment B influenced denitrification. Added means of nitrate transport into the sediments were expected to produce lower denitrification rates in natural environments.

*Denitrification, Temperature, Dissolved oxygen, Sediments, Evaluation, Analysis, Physical properties, Chemical properties, Activated sludge, Nitrogen, Nitrates

E122
POLLUTION INDICATOR BACTERIA ASSOCIATED WITH MUNICIPAL RAW AND DRINKING WATER SUPPLIES,

Clark, J. A., and Pagel, J. E.

Laboratory Services Branch,
Ministry of the Environment,
Rexdale, Ontario, Canada.

Canadian Journal of Microbiology, Vol. 23, No. 4, p 465-470, April, 1977. 2 tab, 11 ref.

The membrane filter (MF) and presence-absence (P-A) methods were used to determine the relative frequencies of the most commonly isolated pollution indicator bacteria associated with raw and drinking waters. A total of 3819 bacterial cultures were isolated in samples from 55 Ontario municipalities. The cultures were 82% Enterobacteriaceae and 18% oxidase-positive organisms. The Enterobacteriaceae were 92% lactose fermenters; 59% of these were aerogenic at 35 C and 14% at 44.5 C. Seventy-six percent of the oxidase-positive organisms were negative for lactose fermentation. About 1% of the lactose-fermenting cultures were aerogenic and oxidase-positive at 35 C. Frequency distributions were similar for both raw and drinking water isolations, but Escherichia doubled their frequency in raw water. Klebsiella organisms were preferentially cultured from MF plates and Enterobacter were isolated about twice as frequently as other coliform genera studied. The MF technique would not detect non-lactose fermenting coliform colonies, but this could be offset by the Aeromonas colonies. Coliform isolates would be undetected by the MPN technique because at least 25% were either anaerogenic or non-lactose fermenters.

*Pollutant identification, *Bioindicators, Potable water, Municipal water, Analysis, Microorganisms, Analytical techniques, Public health, Membrane processes, Fermentation

Most probable number technique

E123
THE EFFECT OF SURCHARGING ON DISCHARGE THROUGH A PIPE,

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Wallingford, England.

Chartered Municipal Engineer, Vol. 104, No. 4, p 60-62, April, 1977. 3 fig, 4 ref.

A simple method was presented to determine the ratio of pipe discharge under surcharge and pipe-full discharge unaffected by surcharge. This information is useful for the design of drainage systems. Other applications include: determining whether an inadequate pipe should be replaced; assessing drainage system performance under rainfalls higher than design capacity; taking advantage of higher discharge capacities under surcharge in situations with difficult constructional constraints; calculating the effect on capacity of varying tailwater levels; and evaluating the comparative costs of designing for surcharged or non-surcharged conditions. The Darcy equation for flow in pipes was used as the basis of this analysis. The critical factor in increases or decreases of discharge through a surcharged pipe was the ratio of the hydraulic gradient to the pipe slope.

*Pipelines, *Flow, *Analytical techniques, Hydraulic models, Hydraulic structures, Performance, Evaluation, Hydraulic engineering, Drainage, Hydraulic design

E124
EVALUATION OF RECOVERY METHODS TO DETECT COLIFORMS IN WATER,

Bissonnette, G. K., Jezeski, J. J., McFeters, G. A., and
Stuart, D. G.

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Morgantown,
Division of Plant Sciences.

Applied and Environmental Microbiology, Vol. 33, No. 3, p 590-595, March, 1977.
2 fig, 2 tab, 19 ref.

Coliform detection in water was evaluated by several recovery methods. Methods tested were the pour plate, MPN, and membrane filtration methods. It was found that multiple-tube fermentation techniques provided better recovery than plating or membrane filtration procedures. Membrane filtration processes produced the poorest results, especially as periods of organism exposure to the stream environment increased. MPN techniques produced the best recoveries. Fecal coliform recovery by membrane filtration was enhanced by a 2-hour enrichment on a rich, non-selective medium before exposure to selective media. E. coli recoveries from pure-culture suspensions and fecal coliform recovery from raw sewage suspensions were significantly increased when compared to recoveries by direct primary exposure to selective media. The enrichment period seems to produce a non-toxic environment for gradual adjustment and repair of injured cells.

*Coliforms, *Pollutant identification, Analytical techniques, Bacteria, Sewage effluents, Evaluation, Filtration, Membrane processes, Separation techniques, Waste water treatment

E125
STEROIDS AS SEWAGE SPECIFIC INDICATORS IN NEW YORK BIGHT SEDIMENTS,

Hatcher, P. G., Keister, L. E., and McGillivary, P. A.

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Atlantic Oceanographic and Meteorological Laboratories,
Miami, Florida.

Bulletin of Environmental Contamination and Toxicology, Vol. 17, No. 4, p 491-498, April, 1977. 2 fig, 22 ref.

Steroids associated with human fecal matter were suggested as sewage pollution indicators in marine sediments. Some of these, such as coprostanol, have not been detected in unpolluted marine sediments and would be useful as indicators. An analysis of the New York Bight sediment was conducted to evaluate this theory. Steroids were determined in freeze-dried sediments and in sewage sludge. The major steroids found in two sediment samples, one taken from a near-shore site and the other from a sewage sludge dumpsite, were coprostanol, cholesterol, beta-sitosterol, and 24 beta-ethyl coprostanol. Of these, cholesterol and beta-sitosterol were present in significant quantities. These steroids are usually dominant in marine sediments. Coprostanol and 24 beta-ethyl coprostanol in the bight sediment linked the major organic component of the muds to sewage. Coprostanol concentrations in the two sediments were 4.8 and 5.2 ppm, which indicated a similar level of sewage contamination. Thus the near-shore sample indicated as much contamination as the sample from a basin heavily impacted by sewage. Analysis of a New York City treatment plant's sludge revealed large amounts of coprostanol and 24 beta-ethyl coprostanol. This confirmed the results of the sediment analysis. It was concluded that coprostanol or 24 beta-ethyl coprostanol could be used to identify sediment sewage contamination on a horizontal or vertical sedimentary profile.

*Indicators, *Water pollution sources, *Sediments, *Analysis, Sludge disposal, Waste disposal, Analytical techniques, Water quality, Pollutant identification, Human wastes

New York Bight, Steroids, Coprostanol, 24 Beta-ethyl coprostanol

E126
EFFECT OF SORBED ORGANICS ON THE EFFICIENCY OF AMMONIA REMOVAL BY CHLORAMINE-CARBON SURFACE REACTIONS,

Scaramelli, A. B., and DiGiano, F. A.

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Charleston, South Carolina.

Journal Water Pollution Control Federation, Vol. 49, No. 4, p 693-705, April, 1977. 14 fig, 4 tab, 15 ref.

There are several limitations in existing physical-chemical methods for removing ammonia from waste water. A process was developed to remove nitrogen which used chlorination followed by activated carbon contact. The stoichiometry and kinetics of mono- and dichloramine-carbon reactions were investigated to optimize the process design of this removal method. The interaction of organic adsorption and chloramine-carbon reactions was also studied. Chlorine and ammonia were mixed and the chloramine-containing solution was passed upward through a carbon column. The rate of the monochloramine-carbon reaction was of the first order. The rate decreased with increased reactor operating time up to 140 hours. Methylene blue and alum-clarified waste water reduced the monochloramine rate constant to lower steady-state values. Alkylbenzenesulfonate produced a lesser rate reduction. There was no reduction with dinitrophenol. Organics also reduced the rate of nitrogen gas production. The presence of monochloramine in the column influent reduced the organic adsorption capacity of the carbon. Both mono- and dichloramine were converted to nitrogen gas by surface reactions. Dichloramine showed a near 100% conversion to nitrogen gas. Decreases in conversion with continued operation suggested carbon surface poisoning due to surface oxide buildup. Pore diffusion rather than surface reaction controlled the dichloramine conversion rate. Several process alternatives were suggested for handling the problematic elements of this method.

*Chemical reactions, *Organic matter, *Activated carbon, *Ammonia, Kinetics, Separation techniques, Adsorption, Nitrogen, Organic compounds, Waste water treatment, Design, Hydrogen ion concentration

E127
COMPUTER APPLICATION IN WATER AND WASTE WATER MANAGEMENT:
A PANEL DISCUSSION,

Andrews, J. F., Radziul, J., Gilman, H. D., Graeser, H. J.,
and Daniels, J. E.

Houston University,
Houston, Texas,
Department of Civil Engineering.

American Water Works Association Journal, Vol. 69, No. 5, p 246-255, May, 1977. 4 fig.

A panel discussion was conducted on the application of computers in water and waste water management. The participants represented groups responsible for design engineering, installation, and computer use. Facilities in Philadelphia, Pennsylvania, and in Dallas, Texas, were described as examples of the usefulness of computers. The justifications for computer usage were the improvement of effluent water quality to meet new standards, the facilitation of data collection and subsequent evaluation of treatment processes, and cost savings. The use of automated pumping could produce a $1420/month savings in one Philadelphia district. Experience in Dallas suggested that development of computer operations should be progressive, well-planned, and held within reasonable expectations of performance. An operations system was suggested, as well as an information system at the management level. Feasibility studies should be conducted prior to the implementation of a computer program. In evaluating automated systems, it should be noted that the cost of software is rising, while hardware costs have been falling about 30% each year. Both remote and in-plant instrumentation are considered necessary, and more reliable sensors must be developed.

*Water management, *Automatic control, *Computers, Design, Automation, Waste water treatment, Personnel, Operations, Treatment facilities, Water quality control, Economics

E128
CHEMICAL COMPOSITION OF SEWAGE SLUDGES AND ANALYSIS OF
THEIR POTENTIAL USE AS FERTILIZERS,

Sommers, L. E.

Purdue University,
West Lafayette, Indiana,
Department of Agronomy.

Journal of Environmental Quality, Vol. 6, No. 2, p 225-232, April-June, 1977.
7 fig, 6 tab, 26 ref.

A regional study was conducted to determine the fertilizer values of various sludges. These values are based on sludge nitrogen, potassium, and phosphorus concentrations as well as on trace metal content. Comparisons were based on common treatment processes because of the variability in sources of treated effluent and treatment plants. Major consideration was given to sludges treated by anaerobic and aerobic processes. The study evaluated thirty chemical components of sludges. The median values of the components were used to summarize the data. Total N, NH4, and metals were the prime parameters for land application rates, and the most variable. Organic carbon was 20-30% of total carbon; 1-4% was identified as inorganic carbon. Anaerobic treatment produced lower organic carbon. Total nitrogen varied 2-4%, with a significant amount identified as NH4. Storage of anaerobic sludges may produce nitrates. Liquid sludges may contain 50-90% nitrogen in organic combinations. The sludge handling system affects the type of inorganic nitrogen in sludge. Total phosphorus was about 1.2-3.0% with 10-30% of this present as organic phosphorus. Sludge handling had no effect upon phosphorus content. Nitrogen, phosphorus, and potassium concentrations were in a narrow range, whereas that of lead, zinc, copper, nickel, and cadmium were extremely variable. It was concluded that N, P, and K were present in the approximate ratio of 11:7.6:1. About 1% of agricultural lands would be needed for sludge application at the rate of 100 kilograms of available nitrogen/hectare in most of the states evaluated. A knowledge of the chemical composition of individual sludges must be obtained before land application.

*Sludges, *Fertilizers, *Chemical properties, Carbon, Nitrogen, Phosphorus, Potassium, Metals, Sludge treatment, Waste disposal, Evaluation, Analysis

E129
AERATION: PROPER SIZING IS CRITICAL,

Sherrard, J. H.

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Blacksburg,
Department of Civil Engineering.

Water and Wastes Engineering, Vol. 14, No. 4, p 62, 66-67, 71, April, 1977. 4 fig, 4 tab, 6 ref.

The selection of low speed mechanical aerators was considered. Any aeration method must produce enough mixing to maintain activated sludge floc in suspension and supply sufficient oxygen transfer to meet the demands of microbial growth. Equations were provided to help judge a given aerator's performance. Mechanical aerators must meet two standards: power, and sufficient oxygen for microbial metabolism. The first depends upon the type of aerator and the geometry of the basin. The latter involves oxygen for organic removal and nitrification, and depends on plant operation and the BOD5/org-N + NH(+4) - N ratio. Biokinetic coefficients should be established to make quality and oxygen needs predictable as a function of treatment process operating conditions. Several examples of typical solutions were presented. It was concluded that the use of a ratio of 1 mg/liter of oxygen to 1 mg/liter of BOD5 could be misleading and result in a faulty selection. Nitrogenous oxygen demand from nitrification should be used for aerator selection if higher mean cell residence time values are used. Oxygen transfer requirements can be met in some instances by lowering process mean cell residence time to decrease oxygen needs.

*Aeration, *Treatment facilities, *Design, Performance, Activated sludge, Mechanical equipment, Oxygen, Temperature, Microorganisms, Operations, Biochemical oxygen demand, Nitrogen, Nitrification, Waste water treatment

E130
ANALYSIS OF ECONOMIC SEWAGE LIFT STATION DESIGN,

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Edmonton, Alberta, Canada.

Water and Sewage Works, Reference Issue, p 58-62, April, 1977. 8 fig.

A procedure for the economical design of a sewage lift station was presented. The objective was to determine a standard type or size of station and a standard control for specific magnitudes of inflow. Design problems included wet well size and the capacity and number of pumps for a given sewage inflow. Equations were included which could aid the determination of relationships between well size, pump efficiency, and sewage inflow. Other equations were designed to specify inflow at a station with no flowmeter. Use of these steps was expected to reduce costs at the design stage and to increase efficiency of the system.

*Pumping plants, *Design, Inflow, Hydraulic engineering, Hydraulic machinery, Conveyance structures, Analytical techniques, Pumps, Performance, Equipment, Economics

Lift stations

E131
CHANGES IN INORGANIC NITROGENOUS COMPOUNDS FROM SEPTIC TANK EFFLUENT IN A SOIL WITH A FLUCTUATING WATER TABLE,

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Blacksburg,
Department of Agronomy.

Journal of Environmental Quality, Vol. 6, No. 2, p 173-178, April-June, 1977. 6 fig, 4 tab, 26 ref.

The fate of septic tank effluent inorganic nitrogenous fractions in soil was investigated. A Virginia test site had been used for nearly 15 years. The soil was a Varina sandy loam that was very slowly permeable to water and air. This resulted in a fluctuating water table. The septic tank system discharged about 700 gpd of effluent. The compounds monitored were NO3(-), NO2(-), and NH4(+), above and in the plinthic material. Redox potentials, pH, dissolved oxygen, and temperature were determined for field sub-samples. Inorganic N was found in septic tank effluent largely in the form of NH4(+). These concentrations significantly decreased with distance from the drainfield. A reduction from 23 to 4.1 micrograms/milliliter was found 12 meters from the drainfield. Nitrate and nitrite concentrations, above the plinthic material, remained at substantially the same levels for all distances. Decreased NH4(+) concentrations, as a function of distance from the drainfield, were due to the anaerobic decomposition of organic matter and to denitrification. At the 1.27-meter distance, NO2(-) accumulations probably indicated nitrification inhibition by high NH4(+) concentrations or heterotrophic conversion of NH4(+) to NO2(-). Nitrification and denitrification above the plinthic layer at this distance were possibly enhanced by the fluctuating water table. Data indicated that anaerobic conditions were sufficient to cause denitrification to a distance of 6.1 meters. Redox potentials near +200 mV (adjusted to 25 C and pH 7) were suggested in denitrification areas. Nitrite and NO3(-) in the plinthic horizon were not subjected to denitrification. Conditions for biological denitrification were not favored in this horizon.

*Nitrogen compounds, *Septic tanks, *Water table, Nitrification, Denitrification, Oxidation-reduction potential, Soil disposal fields, Water table aquifer, Perched water, Chemical properties, Chemical reactions, Adsorption, Aerobic conditions, Anaerobic conditions, Soils, Monitoring, Waste disposal

E132
COMPOUNDS OF ZINC AND COPPER IN SEWAGE SLUDGE DETERMINED BY ELECTRON SPECTROSCOPY,

Cothern, C. R., Grote, R. F., Moddeman, W. E., Ritter, C. J., and Zamicrowski, E. E.

Dayton University,
Dayton, Ohio,
Department of Physics.

Journal of Environmental Quality, Vol. 6, No. 2, p 165-168, April-June, 1977. 1 tab, 16 ref.

Chemical bonding of zinc and copper in sludge was investigated by Electron Spectroscopy for Chemical Analysis (ESCA). The Dayton, Ohio, tests were used to determine the availability of toxic metals to plants in land applications of sludge. Measurements were made in a vacuum of .0000001 Torr. A compound with a known binding energy was mixed with the samples to aid accurate calibration. Analysis revealed that the Zn2p3/2 electron had a binding energy of 1023.8 ± 0.2 eV. The Cu2p3/2 electron exhibited a binding energy of 937.2 ± 0.3 eV. These were characteristic of zinc and copper being in the positive two oxidation state. Zinc and copper in sludge were bound to a ligand with an electro-negativity of 3.5 ± 0.1 on the Pauling scale. It was concluded that oxygen in the ligand contributed to this high value. Possible compounds included oxide, carbonate, phosphate, nitrate, sulfate, silicate, and/or carboxylate. ESCA has good potential as a means of identifying chemical forms of metals in sludge, especially in combination with other techniques.

*Pollutant identification, *Spectroscopy, *Zinc, *Copper, *Bonding, Metals, Analytical techniques, Sludge disposal, Chemical properties, Chemical reactions

Electron Spectroscopy for Chemical Analysis (ESCA), Photoelectron spectroscopy, Dayton (OH)

E133
ZETA POTENTIAL MEASUREMENT,

Swope, H. G.

Water and Sewage Works, Reference Issue, p 64-67, April, 1977. 6 fig, 8 ref.

Zeta potential measurement aids the determination of proper flocculation agents and amounts to remove particulate matter and colloids for the complete clarification of water or waste water. The zeta potential describes the movement of suspended particles in water towards the anode or cathode after establishment of an electrical potential gradient. This movement is known as electrophoresis or ionic migration. The development of the Zeta-Meter has increased the usefulness of this phenomenon. Experimentation has been applied to alum coagulation to control the coagulation of raw water colloids. Colloid removal is only possible with a reduction of the zeta potential. Raw water turbidity consists of finely divided silt and clay and organic matter undergoing microbial decomposition. This turbidity is of a fine fraction and a coarse fraction. The first cannot be removed by usual alum coagulation. Both floc and colloid zeta potential should be reduced to zero ± 5 mV, by the use of an inorganic coagulant and an appropriate organic polyelectrolyte. Floc produced by minimum dosages is too electronegative to produce colloid removal. Water alkalinity depletion is a problem which can result in severe corrosion problems, especially below 6 mg/liter. Such a point may be reached before alum addition has become sufficient to achieve the proper zeta potential. The addition of unreacted aluminum sulfate can inhibit corrosion. Polyelectrolytes produce large zeta potential changes without disturbing pH or alkalinity. Jar tests should be conducted to determine the amounts of coagulants which will produce a zeta potential of -7 to -10 mV, and maintain the proper alkalinity. Various examples illustrated the applicability of zeta potential for determining treatment dosages.

*Zeta potential, *Measurement, *Flocculation, *Coagulation, Electrical properties, Colloids, Turbidity, Alkalinity, Hydrogen ion concentration, Polymers, Polyelectrolytes, Corrosion control, Waste water treatment

Alum

E134
ATOMIC ABSORPTION IN WATER AND WASTE WATER ANALYSIS,

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Lombard, Illinois.

Water and Sewage Works, Reference Issue, p 112, 115-118, April, 1977. 4 fig.

Determination of metals in waste water by atomic absorption was reviewed. Direct analysis of about 65 elements is possible with this method. Sulfate, phosphate, and chloride may be indirectly determined. Standardized techniques for either major or trace levels are available for metals of interest in water quality analysis. Atomic absorption has the advantage of little interference as compared to other techniques. Interferences which do exist are most often chemical, matrix, ionization, and background adsorption. These are relatively easy to control. Solvent extraction is usually used when concentrations below the instrument range occur. This enhances the sensitivity of atomic absorption when the proper organic solvent is used. Flame atomization is most widely used, but has several drawbacks. The sample is inefficiently used, thus reducing the opportunity of sample light adsorption. The graphite furnace method has better sensitivity and detection limits. The hydride generation system is useful in determining very low levels of arsenic, selenium, bismuth, and antimony. Drawbacks of this method include limited applicability to the elements important in water analysis; greater sample manipulation is necessary than for the flame method. Its prime advantage is a price of about $500 compared to over $4,000 for the graphite furnace. Various flameless systems have been developed for mercury analysis.

*Pollutant identification, *Analytical techniques, *Water analysis, *Metals, Instrumentation, Equipment, Sulfates, Phosphates, Chlorides, Mercury, Waste water treatment

E135
DOMESTIC AND AGRICULTURAL CONTRIBUTIONS TO THE INPUTS OF PHOSPHORUS AND NITROGEN TO LOUGH NEAGH,

Smith, R. V.

Freshwater Biological Investigations Unit,
Department of Agriculture,
Muckamore, Antrim, Northern Ireland.

Water Research, Vol. 11, No. 5, p 453-459, 1977. 4 fig, 10 tab, 15 ref.

Nitrogen and phosphorus loadings, as well as their sources and effects, were reported for river catchments contributory to Lough Neagh, Northern Ireland. The study was conducted from 1971 to 1974. No correlation was found between animal population densities and N and P loadings. There was a strong correlation between the human population and soluble ortho-P input. Land drainage was the source of about 20% of the available P input and urban sewage contributed another 62%. The remainder resulted from non-sewered rural populations. The addition of phosphorus removal to sewage works in towns with greater than 2,000 people could eliminate 50% of the available P input. This would reduce the total P input by 30%. No relationship between the use of phosphorus fertilizer and the mean annual river concentrations of soluble ortho-P and total P was found. There was such a relationship between mean nitrate-N concentrations and fertilizer usage. Phosphorus removal at treatment plants would reduce algal crops and raise the N:P ratio in the Lough. If nitrogen fertilizer use remained the same, these conditions would reduce the domination of nitrogen-fixing blue-green algae over phytoplankton.

*Water pollution sources, *Watersheds (basins), *Algal control, *Nitrogen, *Phosphorus, Rivers, Analysis, Domestic wastes, Animal populations, Human populations, Sewage disposal, Algae, Urban areas, Rural areas, Water pollution control, Drainage

Lough Neagh (Northern Ireland)

E136
PATHOGENIC AMOEBAS FROM BRACKISH AND OCEAN SEDIMENTS, WITH A DESCRIPTION OF ACANTHAMOEBA HATCHETTI, N. SP.,

Sawyer, T. K., Visvesvara, G. S., and Harke, B. A.

National Marine Fisheries Service,
U. S. Department of Commerce,
Oxford, Maryland.

Science, Vol. 196, No. 4296, p 1324-1325, June, 1977. 1 fig, 1 tab, 12 ref.

Ocean disposal of sewage wastes was considered in a study on pathogenic amoebas from brackish and ocean sediments. Sediments from various locations, including the New York Bight and the Baltimore Harbor, were examined. Acanthamoeba culbertsoni were isolated from Bight sediment and Acanthamoeba hatchetti, n. sp., were found in Baltimore Harbor sediment; both proved deadly to laboratory mice. Since Acanthamoeba are generally found in soil and freshwater, their distribution in brackish water and ocean sediment was attributed to stream and river runoff and to marine disposal of sewage and dredge spoils. The disposal of sewage in previously unaffected marine areas should be carefully considered. Amoeba-virus interactions should be further studied since amoebas feed on filamentous blue-green algae and are a reservoir for strain LPP-1 cyanophage.

*Water pollution sources, *Pathogens, *Aquatic microorganisms, Sewage disposal, Algae, Water pollution control, Water pollution effects, Diseases, Infection, Waste disposal

Acanthamoeba culbertsoni, Acanthamoeba hatchetti, n. sp., New York Bight, Baltimore Harbor (Maryland)

E137
DETERMINING CHEMICAL FEED RATE,

Fahlenbock, T.

Water and Pollution Control, Vol. 115, No. 5, p 25-27, May, 1977. 2 fig.

Methods were presented for the determination of chemical feed rates in sewage treatment. The chemical feed rate is equal to the sewage flow rate multiplied by the chemical dosage. Though measurements were expressed in British units, several general considerations were determined. Flow rates should be expressed as units/hour and chemical dosage expressed in terms of mg/liter. Dosages must be determined for specific chemicals by jar tests. Feed range of the chemical feeder should be determined by jar test, pilot plant study, or some other chemical analysis. The maximum and minimum practical dosages encountered during a year must be known for determining the feeder size. Accurate control cannot be obtained if the maximum to minimum dosage ratio is greater than 20:1. Another consideration is the use of either manual control or open-loop pacing from flow. In the latter case, the flow meter that begins feeder operation should have a maximum flow signal equal to the maximum flow treated. Equations were given for determining maximum and minimum flows. Other equations expressed the conversion of pounds of effective chemical to gallons of solution. Ferric chloride and alum were used to demonstrate these calculations. Three components of the feeder affect accuracy statements. These are the flow meter, the actuator on the metering pump accepting the flow signal, and the metering pump.

*Chemicals, *Flow rates, *Equations, Equipment, Performance, Automatic control, Chemical analysis, Chlorides, Waste water treatment, Treatment facilities

Alum, Ferric chloride

E138
OXYGEN-SAG IN A TIDAL RIVER,

Macdonald, G. J., and Weisman, R. N.

Steven and Fitzmaurice Engineers,
Christchurch, New Zealand.

Journal of the Environmental Engineering Division-ASCE, Vol. 103, No. EE3, p 473-487, June, 1977. 5 fig, 10 ref.

A study was conducted to determine BOD and dissolved oxygen deficit (DOD) in a tidal river subject to an effluent outfall. A mathematical model was developed to assess the interaction of the oscillatory flow, the fresh water streamflow, and the waste discharge in a tidal river. A choice between a constant or a time-variable coefficient of longitudinal dispersion was available. The constant value provided a higher maximum BOD concentration and a larger critical DOD than the varying term. The presentation of BOD and DOD profiles in dimensionless form allowed the abstraction of various waste discharges from the same diagram. This allowed estimation of DOD for several release rates in one computer run. Profiles of high water and low water slack times were used to determine the length of the tidal reach containing a deficit. Several limitations were found with this system. Only first stage BOD and atmospheric reaeration were included. Factors that were not included were coefficients for temperature, sunlight intensity, and turbidity. Experimental measurements should be taken to evaluate the computer programs. It should be determined if assumptions employing time-variable coefficients of dispersion would be more accurate.

*Biochemical oxygen demand, *Dissolved oxygen, *Tidal streams, *Mathematical studies, Measurement, Computers, Equations, Flow profiles, Tidal effects, Sewage disposal, River flow, Waste disposal

Dissolved oxygen deficit (DOD)

E139
WATER ANALYSIS,

Fishman, M. J., and Erdmann, D. E.

U. S. Geological Survey,
Lakewood, Colorado.

Analytical Chemistry, Vol. 49, No. 5, p 138R-158R, April, 1977. 429 ref.

A two-year literature review was presented on the application of analytical chemistry to water analysis. Continuous monitoring, automated analysis, and sampling procedures were discussed. Analyses involved included major and trace inorganics, organics, and water characteristics. Several spectrometric methods were described for determinations of alkali metals and alkaline earth metals. Techniques for analysis of copper, zinc, lead, and similar metals included several methods of simultaneous analysis. A spectrophotometric method presented for phosphate analysis in waste water involved ultrafiltration, humic acid precipitation, and its determination as the yellow vanadate-molybdate complex. Arsenic determinations by flameless atomic absorption spectrometry and sulfate analysis by gravimetric and automated spectrophotometric methylthymol blue methods were successful. Simultaneous determinations of ammonium, sodium, and potassium ions in waste water were achieved by using ion-selective electrodes. Methods applied to oxygen, ozone, and chlorine analysis included spectrophotometric, chemiluminescence, and colorimetric procedures. Organic pollutants were measured by gas chromatography-mass spectrometry. Automated and portable techniques were presented for analysis and monitoring. Other methods for organic determinations included membrane techniques, solvent extraction, and fluorometric techniques. Methods of radiochemical and isotopic analysis were presented.

*Analytical techniques, *Pollutant identification, *Monitoring, *Measurement, Organic compounds, Inorganic compounds, Gases, Metals, Water quality, Waste water treatment

E140
RECOVERY AND SUSCEPTIBILITY PATTERNS OF FAECAL STREPTOCOCCI BACTERIOPHAGES,

Saleh, F. A.

Water Pollution Control,
National Research Center,
Dokki, Cairo, Egypt.

Water Research, Vol. 11, No. 4, p 403-409, 1976. 1 fig, 5 tab, 24 ref.

A study was conducted to determine the incidence of fecal streptoccoci and their phages in fresh sewage samples. About 120 isolated strains were recovered. Nearly 18% were classified as Str. faecalis, Str. faecalis var. zymogenes, Str. faecalis var. liquefaciens, Str. durans, Str. faecium, and Str. equinus. Another 52% were designated as atypical faecalis, I, II, III, and IV. Thirty percent were unidentified. Phage sensitive cultures were 68% of the isolates, phage resistant strains 32%. For phage recovery, two primary enrichment media containing $MgSO_4$ and L-tryptophan were used. Of 20 samples, 19 yielded at least one phage type for recovery rate of 95%. Nine phages could not be isolated in the absence of $MgSO_4$ and L-tryptophan co-factors; three of these required L-tryptophan and one required $MgSO_4$. Phage typing was favorable, simple, and definitive for identification of a majority of the isolated cultures. Phage sensitivity was found to correlate with characteristics such as tellurite resistance, TTC-reduction, and mannitol fermentation. Further study of phage typing was recommended.

*Streptococcus, *Pollutant identification, Sewage bacteria, Biological properties, Chemical properties, Analytical techniques, Separation techniques, Laboratory tests, Cultures, Water water treatment

E141
A KINETIC ANALYSIS OF AMMONIA REMOVAL BY CHLORAMINE CONVERSIONS ON ACTIVATED CARBON,

Scaramelli, A. B., Jr.

Dissertation Abstracts International B, Vol. 37, No. 9, p 4565, March, 1977.

Chloramine-activated carbon reaction stoichiometry and kinetics were studied to develop design criteria for effective ammonia removal in waste water treatment. Mono- and dichloramine were converted by surface reactions to nitrogen gas. Monochloramine reacted by a parallel pathway to form ammonia and nitrogen gas, and steady-state reaction conditions did not correspond to stoichiometric conversions. Dichloramine reacted by a single pathway to produce only nitrogen gas. This pathway had a potential for 100% ammonia removal. The overall conversion of monochloramine and the parallel reactions to ammonia and nitrogen gas were described by a first-order kinetic model. Increases in pH were accompanied by decreases in the nitrogen gas production rate. The rate constant associated with nitrogen production did not measurably increase with time at any given pH. The dichloramine-carbon reaction also exhibited first-order, irreversible kinetics. The amount of dichloramine applied to the reactor as a measure of surface oxide accumulation was included in this model. Diffusional mass transfer had little effect on the monochloramine reaction rate, but was significant in relation to the dichloramine reaction. It was concluded that dichloramine-activated carbon reactions can provide effective nitrogen removal from waste water. Removals of BOD, suspended solids, phosphorus, and ammonia were expected to be greater than 95%.

*Kinetics, *Analysis, *Ammonia, *Activated carbon, Chemical reactions, Design criteria, Separation techniques, Nitrogen, Hydrogen ion concentration, Organic matter, Treatment facilities, Waste water treatment

E142
SIMPLIFIED OPTIMIZATION OF ACTIVATED SLUDGE PROCESS,

Grady, C. P. L., Jr.

Purdue University,
West Lafayette, Indiana,
School of Civil Engineering.

Journal of the Environmental Engineering Division-ASCE, Vol. 103, No. EE3, p 413-429, June, 1977. 3 fig, 6 tab, 2 append.

Dynamic programming was used to determine optimum equipment and process requirements for activated sludge treatment. Areas considered were MLSS concentration, primary settler area, aeration basin volume, air blower capacity, recycling pump capacity, and final settler area. The various steps by which optimum values are determined were presented. Dynamic programming was simple and reliable after the selection of solids retention time. Several calculations can be made with a programmable desktop calculator to avoid reliance on computer systems. Others can be performed with graphical techniques. The major consideration was the proper selection of state and decision variables to eliminate the recycling of information from the information flow diagram. The primary settler input state should be the waste strength. The efficiency should be its decision variable. This would give the primary effluent strength as the aeration basin input state. The decision and output variables for aeration basins should be the MLSS concentration. The final settler surface area can be fixed by using the MLSS concentration as its input state and the recycling ratio as the decision variable.

*Dynamic programming, *Activated sludge, *Design criteria, Equipment, Mathematical studies, Suspended solids, Computers, Aeration, Waste water treatment

E143
A METHOD FOR STUDYING MICROFAUNA OF ACTIVATED SLUDGE
(Metoda badania mikrofauny osadu czynnego),

Klimowicz, H.

Institute of Ecological Management,
Warsaw, Poland.

Gaz, Woda i Technica Sanitarna, Vol. 51, No. 2, p 46-48, 1977.

A procedure for the evaluation of sewage purification based on the microfauna in active sediment from the aeration chamber is described. Depending on the consistency of the purification process, samples were taken daily to 2x/week. To arrive at an accurate average count of microfauna, 5 small samples from different portions of the aeration chamber were taken and mixed in a 100 ml bottle 1/4 filled. The sample was aerated every 2-3 hrs and kept in a moderately cool place. The qualitative observation of individual microorganisms was performed with a stereoscopic microscope and, if of particular interest, under a research microscope. After a list of the species noticed was prepared, counting of the individuals was started in a plexiglass counting chamber of the Sedgwick-Rafter type. For the correct interpretation of microscopical analyses, a qualitative-quantitative listing of the fauna observed over a longer period of time (e.g. 1 month) was made up in order to assess changes occurring on sampling dates or of sewage purification levels. It was pointed out that physico-chemical analysis could only give exact values for a limited number of compounds. No simple detection methods were available for numerous chemical compounds able to poison the aqueous environment. Therefore, microscopic analysis of live organisms in the active sediment was essential, since most of the organisms would react to toxic compounds in the plant water which will eventually reach the city's water supply. The importance of the presence of live organisms in the active sediment as a reflection of the efficacy of the sewage purification process was emphasized.

*Microorganisms, *Activated sludge, *Aeration, *Analytical techniques, Sewage treatment, Sludge treatment, Physical properties, Chemical properties, Performance, Waste water treatment

Microfauna

E144
SCREENING METHOD FOR DETERMINATION OF THE DEGRADABILITY OF ORGANIC COMPLEXING AGENTS (Screeningverfahren zur Feststellung der Abbaubarkeit organischer Komplexbildner),

Robra, K. H.

Zeitschrift fuer Wasser- und Abwasser-Forschung, Vol. 10, No. 3, p 104-108, 1977.
3 fig, 3 tab, 22 ref.

Experiments were conducted to study the degree and rate of biological degradation of organic complex-forming compounds. The trials were based on the closed-bottle test (GF-Test). The only source of carbon for the microorganisms in the inoculum was the organic substances supplied. Degradation rates were expressed as a percentage of BOD relative to the decrease of organic substances in terms of the theoretical BOD.

*Biodegradation, *Organic compounds, Carbon, Analytical techniques, Microorganisms, Biochemical oxygen demand, Biological treatment, Analysis, Performance, Waste water treatment

Closed bottle test (GF-test)

E145
A RAPID METHOD FOR THE QUANTITATIVE ISOLATION OF VIRUSES FROM POLLUTED WATER,

Katzenelson, E.

Hebrew University-Hadassah Medical School,
Jerusalem, Israel.

1976. 16 p, 2 fig, 4 tab, 14 ref. NTIS Technical Report AD-A032 117.

A method was presented for the rapid identification and quantification of viruses in polluted water. The fluorescent antibody technique was employed to determine viruses in tissue cultures within hours of infection. Positive cells were seen after 6-8 hours, but results were not sufficiently quantitative. An interval of 18-24 hours would be adequate for most applications. Possible "false negative" or "false positive" results were considered in high-speed determinations because of reagent impurities. The method was less susceptible to bacterial contamination than those currently used. Reliability should be improved by the use of reagents with higher quality. Potable water determinations, by this method, were considered.

*Viruses, *Pollutant identification, Cultures, Analytical techniques, Water pollution control, Chemical reactions, Chemical analysis, Bioindicators, Pollutants, Bioassay, Waste water treatment

E146
HANDBOOK FOR SAMPLING AND SAMPLE PRESERVATION OF WATER AND WASTEWATER,

Huibregtse, K. R., and Moser, J. H.

Envirex, Incorporated, A Rexnord Company,
Environmental Sciences Division,
Milwaukee, Wisconsin.

1976. 276 p, 79 fig, 47 tab, 161 ref. EPA Technical Report EPA-600/4-76-049.

Sampling techniques and methods of sample protection were provided for water and waste water analysis. The information was collected from literature and a survey of field practices. General sampling and other guidelines were presented. There was a discussion of automatic samplers, flow measuring devices, and a statistical approach to sampling. The preservation of physical, chemical, biological, and radiological parameters was also considered. Sampling procedures for waters from municipal, industrial, and agricultural sources were reviewed. Information was presented concerning surface water and sludge sampling procedures. The report was not an official EPA manual.

*Water analysis, *Sampling, *Analytical techniques, Chemical analysis, Testing procedures, Measurement, Monitoring, Instrumentation, Industrial water, Municipal water, Agricultural runoff, Biological properties, Chemical properties, Laboratory tests, On-site tests, Analysis, Waste water treatment

Sample preservation

E147
EXPERIENCES WITH RECOVERY OF VIRUSES FROM STORM WATER,

Smith, J. E.

Syracuse University,
New York,
Biology Department.

IN: Proceedings of Workshop on Microorganisms in Urban Stormwaters, 1976. p 88-95, 1 fig, 5 tab. Technical Report EPA-600/2-76-244.

The Aquella virus concentrator was used to detect live animal viruses in real or simulated combined storm overflows. Storm waters from Syracuse, New York, and Baltimore, Maryland, were studied. Viruses were preferentially adsorbed to Cox epoxy fiberglass filters by two methods. Picornaviruses were able to withstand a combination of low (3.5) pH for adsorption and high (11.5) pH for elution. This eliminated adenoviruses and reoviruses which were adsorbed at pH 4.5 and eluted at pH 9.0. Picornaviruses, adsorbed under these conditions, could be eliminated by the addition of antisera. About 60+% of storm water isolates were polioviruses. These were suppressed since they quickly overgrow most other viruses. Many single-strand RNA viruses were suppressed by benzimidazoles, but DNA adenoviruses or double-strand RNA reoviruses were hardly affected. Several cell types were compared for plating efficiency. BGM cells would be the most likely cell line for most water-borne viruses of human origin. Pig kidney PK15 cells did not prove to be a broad adenovirus indicator line and were inferior to HEK cells. Operating experience with the virus concentrator indicated a likely efficiency of 30% for viral recovery from large volumes of storm overflow. This was especially true when a combination of heavy silt and high organic content was present. Enteroviruses survived experimental holding conditions very well. Data on adenoviruses and reoviruses was incomplete. Poliovirus was the most prevalent, but other viruses were detected in all raw sewage and chlorinated effluent samples. The detection frequency was similar in overflow samples from both cities.

*Viruses, *Storm water, *Separation techniques, *Equipment, Hydrogen ion concentration, Pollutant identification, Analytical techniques, Sewage treatment, Overflow, Adsorption, Runoff, Waste water treatment

Syracuse (NY), Baltimore (MD)

E148
EXPERIENCE ON THE ASSAY OF MICROORGANISMS IN URBAN RUNOFF,

Olivieri, V. P., and Riggio, S. C.

The Johns Hopkins University,
Baltimore, Maryland,
School of Hygiene and Public Health.

IN: Proceedings of Workshop on Microorganisms in Urban Stormwater, 1976. p 8-51, 12 fig, 15 tab, 31 ref. Technical Report EPA-600/2-76-244.

Techniques, methods, and procedures were evaluated for the determination of pathogenic microorganisms in urban runoff. Several factors contributed to the difficulty of standardization. Methods often produced different results in various laboratories using different samples. Microbial flora varied dramatically in water samples. Types and levels of interfering microorganisms were an important factor and varied with given analytical techniques. Clinical techniques often provided poor results when used on water samples. Procedures from Standard Methods for the Analysis of Water and Waste Water were evaluated. Alternative methods were developed in some instances. About twenty-four differential tests were used to tentatively identify isolates from microbial assays. Simultaneous analysis of water samples and data from previous studies were used to make definite selections of techniques. Multiple tube dilution techniques were chosen because they allowed most-probable-number calculations for the highly variable chemical and physical properties of urban runoff samples. Study results showed a wide variation in levels of microorganisms and the magnitude of ratios of indicator organsisms for sampling stations. This emphasized the need for a large number of samples over a reasonable time span to evaluate trends and to determine specific correlations between levels of various microorganisms.

*Pollutant identification, *Analytical techniques, *Bioassay, Microorganisms, Bioindicators, Storm water, Urban runoff, Chemical properties, Physical properties, Sampling, Waste water treatment

E149
REDUCTION OF NON-IONIC DETERGENTS IN CONNECTION WITH BASIC INDICATORS OF URBAN SEWAGE CONTAMINATION (Redukcja detergentow niejonowych w powiazaniu z podstawowymi wskaznikami zanieczyszczen sciekow miejskich),

Pastor-Rodziwanowska, J.

Medical Academy,
Gdansk, Poland,
Institute of Hygiene.

Gaz, Woda i Technika Sanitarna, Vol. 51, No. 1, p 21-22, January, 1977. 2 tab, 13 ref.

The reduction of non-ionic detergents in connection with the reduction of basic sewage pollutants in a purification plant of the mechanical-biological type was evaluated. The material examined was taken from sewage samples entering and leaving the purification plant. Seventeen tests were performed over a period of three months. To determine the level of non-ionic detergent ranging from 1-25 mg/liter, a colorimetric method using phosphorotungstic acid and a barium compound was employed. The detergents were precipitated from the solution in the form of a complex compound. The precipitate was separated and dissolved in concentrated H_2SO_4. A hydrochinone solution was added, producing red coloration. Its degree of intensity was defined by the wavelength lambda-500 mm. It was found that the concentration of non-ionic detergents was reduced by a mean 31.6%. Average level of non-ionic detergents in the sewage leaving the purification plant was 3.7 mg/liter. Reduction of BOD5 and suspended matter did not reach the intended level because the sewage flow was always higher (average 25%) than the level designed. It was concluded that a positive correlation exists between the quantity of incoming non-ionic detergents and the extent of their reduction. Reduction was adversely affected by an increased sewage flow and high level of suspended material at the entrance of the purification plant. An increased sewage flow was ascertained to have a negative effect on reduction of all components, including non-ionic detergents.

*Detergents, *Biological treatment, *Colorimetry, *Reduction, Sewage treatment, Industrial wastes, Municipal wastes, Effluents, Suspended solids, Flow, Waste water treatment

E150
EXPERIENCE WITH THE BACTERIOLOGICAL CONTROL OF WASTE WATER PURIFICATION (A szennyviztisztas bakteriologiai ellenorzesenek tapasztalatai),

Nemedi, L.

Budapesti Kozegeszsegugy, No. 4, p 113-120, 1976. 8 tab, 14 ref.

The effects of different methods of municipal waste water treatment on bacteriological characteristics were studied. Bacteria growing at 20 C on gelatin, at 37 C on agar, Clostridia, coliform bacteria, Streptococcus faecalis, Pseudomonas aeruginosa, and Salmonella were determined. Waste water treatment by means of activated sludge and percolation bodies caused no considerable improvement in the bacteria counts. Settlers, oxidation ditches, and the slow sand filtration method proved to be efficient in the reduction of the bacteria counts. Regardless of the treatment method, the reduction was most marked for bacteria growing at 20 and 37 C, P. aeruginosa, and smallest for Clostridium and Salmonella. Salmonella, coliform bacteria, and P. aeruginosa proved to be highly sensitive to gamma-irradiation, while Clostridium and S. faecalis were resistant.

*Salmonella, *Clostridium, *Coliforms, *Bacteria, Waste water treatment, Municipal wastes

E151
GUIDELINES FOR THE QUICK EVALUATION OF THE SEWAGE PURIFICATION PROCESS WITH ACTIVATED SLUDGE (Przewodnik dla szybkiej oceny przebiegu oczyszczania sciekow osadem czynnym. Czesc. III. Organizmy rzadziej spotykane),

Klimowicz, H.

Institute for Environmental Management,
Warsaw, Poland.

Gaz, Woda i Technika Sanitarna, Vol. 51, No. 3, p 73-77, March, 1977. 1 tab, 23 ref.

Guidelines for the identification of microfauna as bio-indicators for the purification process with activated sludge were presented. The microorganisms included infusoria, rotifers, flagellates, rhizopods, turbellaria, gastrotriacha, nematodes, oligochaeta, etc. They appeared at different stages of the purification process and varied in number. Flagellates were indicative of poor progress in an inadequately working purification plant or its low purification level designed beforehand. Some species were rarely encountered and only in small numbers. Other species turned up in large numbers in poorly running plants, but decreased numerically to the extent that the plant operation improved. Due to the fact that 1 liter of activated sludge averaged 27,909,000 flagellates, 15,379,000 rhizopods, 27,000 gastrotrichae, 129,000 nematodes, and 29,000 oligochaetae (levels considered to be low in activated sludge, but much higher than in rivers and lakes), the role of this microfauna in the sewage purification process has to be regarded as substantial. Determinations of species and numbers present in samples would be excellent bioindicators to assess the level of sewage purification.

*Microorganisms, *Bioindicators, *Activated sludge, *Water purification, *Sewage, Biological treatment, Analysis, Water quality standards, Sewage treatment

Microfauna

E152
EFFECTS OF NITRIFICATION IN THE ACTIVATED SLUDGE PROCESS,

Degyansky, M. E., and Sherrard, J. H.

Water and Sewage Works, Vol. 124, No. 6, p 94-96, June, 1977. 3 fig, 6 tab, 7 ref.

The removal of waste water nitrogen, or its conversion to its most oxidized form, is frequently desirable. The process of nitrification, the biologically mediated conversion of NH_4^+-N to NO_3^--N, is considered in terms of oxygen demand and depletion of alkalinity. As a model, an example situation is used in which a completely mixed activated sludge process receives waste water with a variable BOD:NH_4^+-N ratio and a variable mean cell residence time. The oxygen requirement for the nitrification process is demonstrated to be not the constant value previously believed, but rather a value dependent on the BOD:NH_4^+-N ratio and on mean cell residence time. Likewise, the alkalinity destroyed is variable. These findings must be considered in designing biological waste treatment processes.

*Nitrogen, *Nitrification, *Biological treatment, *Activated sludge, Waste water treatment, Biological oxygen demand, Oxygen, Alkalinity, Oxidation, Eutrophication, Water pollution, Water quality standards

E153
TWO-TEMPERATURE MEMBRANE FILTER METHOD FOR ENUMERATING FECAL COLIFORM BACTERIA FROM CHLORINATED EFFLUENTS,

Green, B. L., Clausen, E. M., and Litsky, W.

Massachusetts University,
Amherst,
Department of Environmental Sciences.

Applied and Environmental Microbiology, Vol. 33, No. 6, p 1259-1264, June, 1977.
5 fig, 4 tab, 11 ref.

Techniques for the recovery of fecal coliform bacteria from chlorinated sewage effluents using the standard membrane filter method (MF), the multiple-tube or most-probable-number (MPN) method, and a modified MF method were compared. Fecal coliform counts were determined for plant- and laboratory-chlorinated primary and secondary effluents. Results indicated that the MF method was much less effective than the MPN method, yielding only 14% of the recovery obtained by the MPN method. Modifications to improve recovery by the MF method were investigated by comparing counts obtained after using various preincubation periods (0, 3, 4 and 5 hours) at 35 C. It was found that the preincubation for 5 hours at 35 C prior to the standard 44.5 C incubation yielded the highest recovery, while sole use of the standard 44.5 C incubation period yielded the lowest recovery. Results obtained by the modified method (5 hours at 35 C) were comparable to those obtained by the MPN method. Statistical comparisons for the various methods were prepared using the least squares method for best fit.

*E. coli, *Coliforms, *Sewage bacteria, *Analytical techniques, *Incubation, Sewage treatment, Enteric bacteria, Microorganisms, Cultures, Sewage, Waste treatment, Waste water treatment

Multiple tube method, Membrane filter method

E154
MICROBIOLOGY OF WASTE TREATMENT,

Unz, R. F.

Pennsylvania State University,
University Park.

Journal Water Pollution Control Federation, Vol. 49, No. 6, p 1255-1268, June, 1977.
130 ref.

A literature review of various aspects of microbial contamination by waste water treatment practices has included a survey of possible sources, types, and removal procedures. Among the methods of disinfection described were chlorination and ultraviolet irradiation. Seasonal variations in viral content of raw waste water and reduction methods are also described. A survey of studies on the roles that nutrient levels, metal ions, and toxic conditions play in the destruction and inhibition of bacteria is presented. Aerobic and anaerobic biodegradation are considered under a wide variety of conditions. Possible implications of contamination by bacteria and viruses contained in sludge and waste water used for agricultural purposes, such as irrigation, are outlined.

*Microbiology, *Microbial degradation, *Activated sludge, *Viruses, *Bacteria, *Disinfection, Diseases, Environmental sanitation, Chlorination, Anaerobic digestion, Irrigation practices, Water reuse, Fertilizers, Agriculture, Metals, Nutrients, Sewage sludge, Land reclamation, Sludge disposal, Waste water disposal, Waste water treatment, Analytical techniques

E155
TRANSVERSE-GRID WATER QUALITY ANALYSES OVER THE SZOB-BUDAPEST DANUBE SECTION (Keresztmetszethalos vizminoseg vizsgalatok a Duna Szob-Budapest kozotti szakaszan),

Puskas, M.

Kozepdunavolgyi Vizugyi Igazgatosag,
Budapest, Hungary.

Hidrologiai Kozlony, Vol. 52, No. 2, p 65-70, February, 1977. 4 fig, 1 tab. 4 ref.

Analyses of water taken from a series of cross-sections along the Danube River have indicated that water quality is far from uniform along the stream. The transverse-grid system for collection was devised to insure optimal selection of sample points, representative samples, and reliable estimation of mass currents. Samples from the 7 cross-sections were collected at 4 occasions annually. Analytical results have been used to construct contour lines for flow velocity, depth, BOD5, COD (dichromate), ammonia, and ultraviolet absorption for several cross-sections. Pollutant levels were found to be higher for the left bank than for the right bank. It was suggested that the optimal number of sampling points is dependent on the component being investigated and the streamflow rate. Contoured diagrams for cross-sections can be used to determine the total amount of the component passing by any point in the river.

*Water quality, *Chemical oxygen demand, *Rivers, *Streamflow, *Sampling, Organic loading, Waste assimilative capacity, Chemical analysis, Waste water disposal, Waste water treatment, Analytical techniques

Danube River, Hungary, Transverse-grid system

E156
DISINFECTION,

Hoadley, A. W., and Gould, J. P.

Georgia Institute of Technology,
Atlanta.

Journal Water Pollution Control Federation, Vol. 49, No. 6, p 1067-1074, June, 1977. 65 ref.

A literature review on disinfection is presented. Topics covered include the chemistry of chlorination and related microbiological effects. Possible effects of harmful products formed during the process of chlorination of organic compounds are discussed. Biological factors affecting disinfection, including resistance to chlorination and to aggregation, are cited. Ozonation and irradiation of waste water effluents are described as possible alternatives to chlorination. Inactivation of viruses present in sludge by gamma irradiation, disinfection, ozonation, and heating are reported.

*Disinfection, *Chlorination, *Ozone, *Irradiation, *Bacteria, Viruses, Municipal wastes, Sewage treatment, Sludge treatment, Waste water treatment, Microorganisms, Environmental sanitation, Water Pollution Control Federation

E157
BACTERIOLOGICAL ANALYSES OVER THE RAJKA-BUDAPEST DANUBE SECTION
(Bakteriologiai vizsgalatok a Duna Rajka-Budapest kozotti szakaszan),

Deak, Z.

Orszagos Kozegeszegugyi Intezet,
Budapest, Hungary.

Hidrologiai Kozlony, Vol. 52, No. 2, p 79-83, February, 1977. 1 fig, 3 tab.

Bacteriological studies have been conducted for 11 stations on the Danube River between Rajka and Budapest, Hungary. Quantitative determinations included analyses for: coliform, fecal coliform, fecal streptocci, heterotrophic mesophilic bacteria, psychrophilic bacteria, and sulfite-reducing spore-forming anaerobic Clostridia. Bacteriophages and Salmonellae were also investigated. A gradual increase in bacterial levels was observed from Rajka to Budapest, with characteristic peaks on the profile curve where four major tributaries enter the Danube. Seasonal variations in bacterial levels were attributed to the seasonal variations in effluents discharged by the area's sugar refineries. Although bacterial levels decreased slightly during the three year study, existing levels of bacteria and the presence of pathogenic bacteria such as Salmonella still prohibited bathing in the Danube and necessitated more costly treatment of drinking water.

*Coliforms, *Pathogenic bacteria, *Salmonella, *Sampling, *Spatial distribution, Rivers, Microorganisms, Aerobic bacteria, Streptococcus, Anaerobic bacteria, Clostridia, Sulfur bacteria, Bacteriophage, Biocontrol, Potable water, Industrial wastes, Municipal wastes, Pollutant identification, Analysis, Waste water treatment

Danube River, Hungary

E158
SOLUBILITY AND AVAILABILITY OF CADMIUM IN CADMIUM-SLUDGE AMENDED SOIL,

Street, J. J.

Colorado State University,
Fort Collins.

Dissertation Abstracts International B, Vol. 37, No. 12, p 6042-6043, June, 1977.

The distribution of Cd(+2) in soils and its availability to plants have been investigated. Cadmium carbonate and cadmium phosphate were found to inhibit cadmium activity in soils, with $CdCO_3$ being the major controlling solid phase when high concentrations of Cd were added. Adsorption was found to be the controlling factor on Cd solubility when low concentrations of Cd were added. Uptake of Cd by corn seedlings which had been grown in soils amended with sewage sludge or with cadmium alone was investigated. A positive correlation was observed between cadmium concentrations in soils and in plants. Cd uptake was found to decrease with increased soil pH and phosphorus levels. Field studies showed that heavy application of Cd-bearing sludges reduced yields and increased Cd concentrations in plants. Reduced uptake, mobility, and solubility of cadmium were observed in soils that were alkaline, rich in organic matter, and heavy-textured.

*Cadmium, *Metals, *Heavy metals, *Trace elements, *Absorption, Application methods, Phosphorus, Soil chemistry, Soil contamination, Agriculture, Waste disposal, Sludge disposal, Waste water treatment

E159
WASTEWATER FLOW MEASUREMENT IN SEWERS USING ULTRASOUND,

Anderson, R. J., Bell, S. S., Vander Heyden, W. H., and
Genthe, W. K.

Sewerage Commission,
Milwaukee, Wisconsin.

1976. 100 p, 50 fig, 7 ref. 4 append. Technical Report EPA-600/2-76-243.

Accurate, reliable measurements of waste water flow are necessary to insure the efficient operation of a sewage system and to minimize outflow of raw sewage from a combined sewer system. A method for the measurement of sewage volume, depth, and velocity using ultrasonic probes has been investigated. Major elements in an ultrasonic metering system are the velocity meter, the height gauge, and an electronic signal processing unit. For the test conducted by the city of Milwaukee, costs for acquisition were considered sufficiently low for general use. Maintenance and installation requirements were not extraordinary. Depth measurements were accurate from 25% to full capacity in the sewer. Velocities were considered accurate over their full range at the test sites. Measurement interference was observed to be caused by entrained air, foam surfaces, and fluctuations in solids loading. It was suggested that existing flowmeters be used in conjunction with ultrasonic systems to further test the reliability of the ultrasonic probes. Recommendations for further investigations included the development of a portable monitoring unit, a method for operation in smaller line sizes (6-36 inch diameter), and a method for eliminating measurement interference.

*Flow measurement, *Flowmeters, *Ultrasonics, *Combined sewers, *On-site tests, Instrumentation, Sewerage, Sewers, Flow rates, Flow control, Waste water treatment

Ultrasonic flowmeter, Milwaukee (WI)

E160
BEHAVIOR OF BENZIDINE AND OTHER AROMATIC AMINES IN AEROBIC
WASTEWATER TREATMENT,

Baird, R., Carmona, L., and Jenkins, R. L.

County Sanitation Districts of Los Angeles County,
Whittier, California.

Journal Water Pollution Control Federation, Vol. 49, No. 7, p 1609-1615, July, 1977.
4 fig, 4 tab, 17 ref.

Benzidine, 1-napthylamine, and other aromatic amines have been indicated as carcinogenic, causing bladder cancer in humans occupationally exposed to them. These compounds can be contained in industrial waste waters discharged into municipal sewers. A review of the various methods to isolate and identify carcinogens from surface and waste waters is presented. An investigation was undertaken to study the effects of benzidine on activated sludge respiration, establish relative toxicities for amines, determine the effects of activated sludge treatment on amines, examine possible criteria for biological attack, and define refractory metabolic intermediates. Methods used included Warburg respirometry, gas-liquid chromatography, mass-spectrometry, colorimetric analysis, and computer analysis. Results indicated that carcinogenic amines were not immune to biologic treatment, as suggested by previous studies, but did appear to be transformed to a degree. It was suggested that the metabolic intermediates might be responsible for the toxicity and carcinogenicity. None of the suspected carcinogenic bio-oxidation products of benzidine were observed to survive the activated sludge process. In light of the results, it was suggested that sludge be analyzed for the presence of metabolic intermediates as well as for the amines themselves.

*Organic wastes, *Toxicity, *Activated sludge, *Aerobic treatment, *Human pathology, Public health, Water pollution effects, Organic compounds, Byproducts, Water Pollution Control Federation, Waste water treatment

Amines, Benzidine, Aromatic amines, Warburg respirometry

E161
METHODS FOR THE EVALUATION OF THE RESULTS OF THE SELF-CONTROL-MEASUREMENTS CARRIED OUT BY THE SEWAGE TREATMENT PLANT OPERATORS (Verfahren zur Auswertung der Betriebsergebnisse von Klaerwerken),

Groche, D.

Institut fur Siedlungswasserbau,
Wassergute- und Abfallwirtschaft,
Universitat Stuttgart,
Stuttgart, Germany.

Wasserwirtschaft, Vol. 67, No. 6, p 154-161, 1977. 8 fig, 5 tab, 24 ref.

Statistical examination is presented as a means of more efficient treatment and operations control in waste water treatment plants. Most sewage treatment plants are operated on the basis of mean values of BOD and sewage flow. A more complete evaluation of fluctuations in BOD and sewage flow is suggested, using the standard deviation, coefficient of variability, and other statistical parameters. The number of measurements required for accuracy would be determined by the degree of control desired for a particular facility. Cumulative frequency curves produced by logarithmic plotting of BOD and sewage flow on probability graph paper are used to illustrate the effect of sample size and variability on the measurement distributions.

*Statistical methods, *Mathematical studies, *Frequency analysis, *Biochemical oxygen demand, *Integrated control measures, Flow control, Sewage treatment, Sludge treatment, Model studies, Mathematical models, Forecasting, Waste water treatment

Cumulative-frequency distributions

E162
VARIATIONS IN NITROGEN AND ORGANICS IN WASTEWATERS,

Randtke, S. J., and McCarty, P. L.

Illinois University,
Urbana,
Department of Civil Engineering.

Journal of the Environmental Engineering Division, Vol. 103, No. EE4, p 539-550, August, 1977. 7 fig, 4 tab, 12 ref.

Three activated sludge plants of different size and sludge characteristics were chosen for the examination of variations in nitrogen and organics in waste water. Design data for the San Jose/Santa Clara Water Pollution Control Plant, the Palo Alto Regional Water Quality Control Plant, and the Union Sanitary District Plant No. 3 (Union City) are provided. Treatment methods employed at the three facilities include primary treatment of raw influent sewage, activated sludge aeration, final clarification, and chlorination. At each plant grab samples of raw influent sewage and primary, secondary, and chlorinated effluents were taken at 2 hour intervals. A portion of each sample was filtered and then analyzed for ammonia, soluble COD, and soluble nitrogen (SON). Composite samples prepared according to flow were also analyzed, both filtered (for ammonia, COD, SON, nitrate, nitrite, soluble total organic carbon, and BOD) and unfiltered (for organic nitrogen, COD, BOD, pH, alkalinity, and suspended solids.) Results indicated peak periods of flow in the morning and evening, possibly due to increased domestic use. As ammonia and organics loadings were observed to increase concurrently, plant designs should consider accommodation of large increases in oxygen demand and sufficient aeration to insure complete nitrification. Flow equalization, partial nitrification, denitrification, and breakpoint chlorination are also considered for the removal of excess ammonia.

*Ammonia, *Nitrification, *Diurnal distribution, *Oxygen requirements, *Design data, Nitrogen compounds, Nitrates, Nitrites, Chlorination, Aeration, Municipal wastes, Sewage treatment, Treatment facilities, Organic loading, Activated sludge, Organic wastes, Waste water treatment, Model studies

Palo Alto (CA), Santa Clara (CA), San Jose (CA), Union City (CA)

E163
MEMBRANE FILTER TECHNIQUE FOR THE QUANTIFICATION OF STRESSED FECAL COLIFORMS IN THE AQUATIC ENVIRONMENT,

Stuart, D. G., McFeters, G. A., and Schillinger, J. E.

Montana State University,
Bozeman,
Department of Microbiology.

Applied and Environmental Microbiology, Vol. 34, No. 1, p 42-46, July, 1977. 2 fig, 3 tab, 17 ref.

A method for the determination of coliform counts for fecal coliforms which have been injured by exposure to chlorine, industrial wastes, or marine waters is described. A modification of the membrane filter (MF) technique using injury-mitigating membrane filtration (IM-MF) was used for the analyses of effluents collected from several sewage treatment plant outfalls in Montana. For the IM-MF technique glycerol, acetate, and reducing agents were added to both layers and the filter was rinsed with an enriched lactose medium for resuscitation. Results obtained with the IM-MF technique were compared with the multiple-tube or most probable number (MPN) technique and the agar-membrane filter (direct M-FC) method. Fecal coliform counts in chlorinated sewage determined by the IM-MF technique were significantly higher than those obtained by the direct M-FC method in every instance. Counts determined by the IM-MF method were also reported to be as much as 1.3 to 1.9 times higher than those determined by the MPN technique. A scattergram which illustrates the relationships between values obtained for IM-MF and MPN and for direct M-FC and MPN is included. Results obtained by the various methods were similar for analyses of laboratory chlorinated sewage and mountain stream water. It is suggested that the IM-MF technique may provide a less costly, more accurate, and more easily performed alternative to the MPN technique for the quantification of fecal coliforms in chlorinated effluents.

*Coliforms, *Sewage bacteria, *Analytical techniques, *Cultures, Effluents, Microorganisms, Meus-membrane filters, Laboratory tests, Bacteria, Chlorination, Sewage treatment, Waste water treatment

*Injury-mitigating membrane filtration (IM-MF) technique, Most-probable-number (MPN) technique, Agar-membrane filter (Direct M-FC) method

E164
INACTIVATION OF VIRUSES DURING ANAEROBIC SLUDGE DIGESTION,

Bertucci, J. J., Lue-Hing, C., Zenz, D., and
Sedita, S. J.

Metropolitan Sanitary District of
Greater Chicago,
Chicago, Illinois.

Journal Water Pollution Control Federation, Vol. 49, No. 7, p 1642-1651, July, 1977. 7 fig, 4 tab, 14 ref.

Because enteric viruses may be present in waste water and sludge, the Metropolitan Sanitary District of Greater Chicago initiated an investigation of the inactivation of viruses during anaerobic sludge digestion for treated municipal sludge destined for use as fertilizer and for reclamation of strip mines. High concentrations of various viruses, including coliphage MS-2, poliovirus A-9, coxsackievirus B-4 and A-9, and echovirus 11, were seeded into pilot-scale anaerobic digesters. A comparison of virus survival and digestion time indicated that inactivation for the various viruses ranged from 54.4% to 97.6% after 24 hours and from 92.5% to 99.7% after 48 hours. Variations in measurements taken on different days were attributed to undefined sludge characteristics other than volatile solids reduction and pH, which were consistent. Linear regression curves for percent survival and time in the digester were calculated for each of the viruses examined, with correlation coefficients ranging from 0.74 to 0.93. The percent inactivation per day of anaerobic digestion, represented by the slope determined by the linear regression, ranged from 74.9% for echovirus 11 to 97.3% for coxsackievirus A-9.

*Viruses, *Epidemiology, *Anaerobic digestion, *Disinfection, *Enteric bacteria, *Sludge disposal, Sludge treatment, Microbiology, Model studies, Microorganisms, Fertilizers, Biocontrol, Sludge disposal, Activated sludge, Waste water treatment

Chicago (IL)

E165
A FUNDAMENTAL STUDY OF REMOVAL MECHANISMS OF SUSPENDED PARTICLES IN THE DEEP FILTER (III) (Kyusoku rokaroso no kyodo (III): Teijo rokaji no rihaku to sono sayo kiko no kento),

Ebie, K.

Journal of Japan Water Works Association, No. 507, p 20-34, December, 1976. 9 fig, 2 tab, 19 ref.

Microscopic examination of particles undergoing filtration has been used to better understand filtration theory. Experimental observation of deposit behaviors during direct filtration was made through the microscope by camera. It is suggested that two modes of floc particle breakdown occur. Minute suspended particle size breakdown occurs continuously during the filter run, while cluster breakdown of deposit thickness size occurs intermittently at a later stage. Mechanisms such as electrophoretic mobility which affect particle breakdown in filtration are discussed.

*Suspended particles, *Flocculation, *Filtration, *Microscopy, *Filters, Colloids, Slurries, Suspension, Waste water treatment

E166
THE USE OF A MACRORETICULAR RESIN XAD-2 FOR THE RECOVERY OF VOLATILE ORGANIC COMPOUNDS FROM MUNICIPAL SEWAGE,

Mori, B. T., and Hall, K. J.

Health and Welfare Canada,
Pesticide Laboratory,
Vancouver, British Columbia, Canada.

Journal of Environmental Science and Health, Vol. A12, No. 7, p 341-351, July, 1977. 2 fig, 2 tab, 22 ref.

The extraction ability of a macroreticular resin XAD-2 for the removal of volatile organics in municipal sewage was investigated, with special emphasis on the effects of pH and detergents, adsorption of volatiles on sewage particulates, and resin capacity. Experimental procedures for laboratory studies on the extraction of chlorinated phenols and detergent are described. Studies indicated that phenol removal was not affected by changes in pH, but decreasing the pH from 7.1 to 1.8 increased detergent recovery from 4 to 40 percent. Phenol extraction efficiencies were greater with a distilled water matrix than with municipal sewage. In addition, adsorption of phenols onto plastic surfaces was greater when sewage was the solvent. Breakthrough studies indicated that lowering the pH of the sewage from 7.2 to 2.0 lowered the breakthrough point from 133 to 120 column volumes and raised total organic carbon recovery from 19 mg/liter to 25 mg/liter. Resin capacity was 1.7 mg total organic carbon/cc of resin and was not affected by pH.

*Separation techniques, *Solvent extractions, *Phenolic pesticides, *Detergents, Chemical wastes, Sewage treatment, Organic compounds, Organic wastes, Resins, Hydrogen ion concentration, Municipal wastes, Waste water treatment

Macroreticular resin XAD-2

E167
BIOFLOCCULATION AND THE ACCUMULATION OF CHEMICALS BY FLOC-FORMING ORGANISMS,

Dugan, P. R.

Ohio State University,
Columbus,
Department of Microbiology.

1975. 148 p, 51 fig, 21 tab, 119 ref. Technical Report EPA-600/2-75-032.

Major objectives of this study were to examine the process of flocculation and to investigate biological mechanisms associated with bio-flocculation, including the formation of the zoogloeal matrix by floc-forming bacteria. Several species of floc-forming bacteria were isolated from limestone covered with zoogleal masses and effluents from organically polluted water. Isolated organisms were gram negative, polar flagellated rods which produced extracellular polymer fibrils. In studies with Zooglea ramigera, polymer extracts were observed to concentrate heavy metals such as Co, Cu, Fe, and Ni; soluble organic nutrients (BOD); soluble toxic organics; insoluble mineral particles; and insoluble organic particulates. Commercial applications of extracellular polymer are suggested for physical adsorption, metabolic reduction, and oxidation of waste water pollutants. Bioflocculation is suggested as a natural mechanism of water purification.

*Flocculation, *Bacteria, *Polymers, *Coagulation, *Absorption, *Adsorption, Sewage treatment, Activated sludge, Organic compounds, Heavy metals, Colloids, Aquatic bacteria, Chemical wastes, Slime, Waste water treatment

Bioflocculation, Zooglea ramigera, Microbial polymers

E168
NEW MICROBIAL INDICATORS OF DISINFECTION EFFICIENCY,

Engelbrecht, R. S., Severin, B. F., Masarik, M. T.,
Farooq, S., and Lee, S. H.

Illinois University,
Urbana,
Department of Civil Engineering.

1975. 88 p, 24 fig, 9 tab, 18 ref, 1 append. Technical Report AD/A-030 547.

This study attempts to define a valid indicator organism for disinfection efficiency and to establish reliable enumeration techniques. Densities of acid-fast organisms, yeasts, and fecal coliforms were examined in raw and treated waste water from the East Side Waste Water Treatment Plant of the Urbana-Champaign Sanitary District, Illinois. Raw waste water was observed to contain on the average 5,000,000 fecal coliforms, 50,000 acid-fast organisms, and 50,000 yeasts per ml. Trickling filtration and activated sludge treatment reduced fecal coliforms to 2,100,000 and 360,000, respectively; acid-fast organisms to 3,200 and 1,700; and yeasts to 15,000 and 5,200. Acid-fast organism, yeast, and fecal coliform densities were reduced by 0.5, 3.0, and 6.0 logs, respectively, during full scale chlorination. Four yeasts (Candida parapsilosis, C. krusei, Trichosporon fermentans, and Rhodotorula rubra) and three acid-fast organisms (Myobacterium fortuitum, M. phlei, and M. smegmatis) were identified in municipal wastes. Tests on organism resistance to free chlorine using mixed cultures at pH 6, 7, and 10, and at 5 C and 20 C indicated that relative resistivities were acid-fast organisms > yeasts > poliovirus > Salmonella typhimurium > E. coli. Tests on ozone disinfection indicated that E. coli was less resistant than C. parapsilosis and that the degree of inactivation was greatly affected by the initial yeast density in the feed solution. Enumeration techniques and experimental methods are described.

*Microorganisms, *Disinfection, *Yeasts, *Acid bacteria, *Chlorination, Ozone, Bioindicators, Quality control, Pollutant identification, Microbiology, Waste water treatment, Sewage treatment, Municipal wastes, Coliforms, Enteric bacteria

Microbial indicators

E169
METERING TOTAL OXYGEN DEMAND,

Voorn, G., and Marlow, J. S.

Application Laboratory, Pollution Measurement and
Industry Division, Philips NV,
Eindhoven, The Netherlands.

Effluent and Water Treatment Journal, Vol. 16, No. 6, p 301-306, June, 1977. 8 fig, 6 tab, 3 ref.

Analysis of total oxygen demand (TOD), measured by combustion at 900 C of oxidizable material in a water sample, is suggested as an alternative to traditional measurement of biochemical oxygen demand (BOD) and chemical oxygen demand (COD). A TOD meter which is based on electrochemical relationships as defined by Faraday's Law and Nernst's Law is described. In the Phillips TOD meter, zirconium oxide electrodes are used to measure oxygen-generated electrical potential with nitrogen as a carrier gas. Special features and operating procedures for the Phillips meter are described. Measured oxidation efficiencies are compared for analyses of COD, TOD, and 5-day BOD. The TOD meter is recommended for monitoring plant influents to municipal sewage treatment plants and for treating industrial waste waters.

*Dissolved oxygen analyzers, *Dissolved oxygen, *Biochemical oxygen demand, *Chemical oxygen demand, *Instrumentation, Electric potential, Electrochemistry, Electrodes, Industrial wastes, Chemical wastes, Municipal wastes, Aerobic conditions, Sewage treatment, Waste water treatment

*Total oxygen demand, Faraday's Law, Nernst's Law

E170
BIOFLOCCULATION IN THE ACTIVATED SLUDGE PROCESS,

Forster, C. F.

Wessex Water Authority,
Bristol, South Africa.

Water SA, Vol. 2, No. 3, p 119-125, July, 1976. 5 tab, 5 fig, 36 ref.

A discussion of biological processes associated with microbial flocculation which can influence sludge settling characteristics and adsorption of colloidal matter, macromolecules, and soluble substrates is presented. Literature on surface effects associated with component microbes and the sludge matrix is reviewed. Surface interaction mechanisms are discussed for several types of extracellular polymers including poly-beta-hydroxy butyric acid (PHB), nitrogenous compounds, and polysaccharides. Metal ion uptake by microbial flocculation and adsorption behavior are examined as important aspects of successful activated sludge processing. Results of an attempt to define the function of individual components of sludge surface layers by examining the sludge surface as a single unit are presented. The effects of the enzymes cellulase and lysozome on the electrophoretic mobility of sludge were measured. Although both treatments eventually resulted in decreased mobility, cellulase treatment initially increased surface charge and mobility while lysozome treatment decreased mobility, indicating that polysaccharide and non-polysaccharide polymers have separate and specific functions in bioflocculation. Field studies with plug-flow and completely-mixed activated sludge plants implied that poor sludge settling was due to high organic loading rates and alterations of the extracellular polymers.

*Activated sludge, *Flocculation, *Polymers, *Microorganisms, *Adsorption, Heavy metals, Organic compounds, Molecular structure, Nitrogen compounds, Surfaces, Enzymes, Electrophoresis, Chemical properties, Chemical analysis, Waste water treatment, Heavy metals

Extracellular polymers, Polysaccharides, Bioflocculation, Sludge characteristics, Molecular weight

E171
POLYCHLORINATED BIPHENYL CONCENTRATION IN SEWAGE AND SLUDGES OF SOME WASTE TREATMENT PLANTS IN SOUTHERN ONTARIO,

Lawrence, J., and Tosine, H. M.

Water Chemistry Section,
Canada Centre for Inland Waters,
Burlington, Ontario, Canada.

Bulletin of Environmental Contamination and Toxicology, Vol. 17, No. 1, p 49-56, January, 1977. 3 tab, 13 ref.

Polychlorinated biphenyl (PCB) levels were monitored in raw sewage at six waste treatment plants and in sludge samples from four major urban areas in Ontario, Canada. PCB levels from grab samples were analyzed by gas chromatography and identified with chromatographs of standard Arochlors. One of the treatment plants surveyed received a large proportion of industrial wastes, while the other five treated only domestic wastes. Primary and activated sludge treatment were used by all facilities. Concentrations for the 36 samples collected at the six plants ranged from 1.5 ppb to 27.3 ppb with a mean of 27.3 ppb. Projections based on an annual plant loading at a daily flow of 236 million liters/day yielded an average value of 310 kg PCB/yr. Total PCB and contributions by individual Arochlors are listed in tabular form. Sludge digestion was observed to concentrate PCB with values reported as high as 2,085 ppb. Differences in contributions by individual Arochlors between the treatment plants examined were observed. Investigations on PCB levels in corn and grass grown on sludge-treated land indicated that although concentrations of PCB in leaves were comparable with concentrations in the applied sludge, uptake of PCB was not biologically accelerated by plants as has been observed for animals. Analyses of sludge samples from urban areas revealed PCB concentrations of 100 to 200 ppb. More stringent controls on the disposal of sludge containing PCB, particularly on land application, is suggested.

*Polychlorinated biphenyls, *Arochlors, *Industrial wastes, *Sewage treatment, *Sludge disposal, Organic compounds, Sludge digestion, Gas chromatography, Chemical wastes, Chemical analysis, Water pollution sources, Absorption, Municipal wastes, Waste water treatment

Ontario (Canada), Canada

F001
WATER QUALITY SIMULATION OF TAHOE-TRUCKEE SYSTEM, NEVADA-CALIFORNIA VOLUME II APPENDICES,

Westphal, J. A., Sharp, J. V. A., and
Bateman, R. L.

Nevada University,
Reno,
Water Resources Research Center.

January, 1976. 296 p, 20 fig, 8 tab. Environmental Protection Agency Report No. EPA-600/2-76-005b.

Documentation for a digital inorganic water quality simulation model of the Tahoe-Truckee System which consists of the mainstem and tributaries of the Truckee River between Tahoe City, California and Nixon, Nevada is presented in the form of appendices. The model is based on the principle of mass-flux balance and presumes that inorganic constituents are conservative, complete mixing occurs instantaneously, and that flows are recapitulated accurately at the defunct gaging station near Truckee, California. The model was developed from 3 yr of water quality data collected monthly at about 40 sites along the mainstem and tributaries. The appendices include: predictive equations, a computer program for the model, cumulative frequency distribution curves, a derivation of complete mixing equations, and simulation model output for bicarbonate, chloride, sulfate, sodium, potassium, calcium, magnesium, silica, and total dissolved solids.

*Water quality, *Simulation analysis, *Model studies, *Rivers, *Tributaries, Surface waters, California, Nevada, Inorganic compounds, Bicarbonates, Chlorides, Sulfates, Sodium, Potassium, Calcium, Magnesium, Silica, Solid wastes, Computer models

Tahoe-Truckee system

F002
COST FUNCTIONS FOR WASTEWATER CONVEYANCE SYSTEMS,

Tyteca, D.

Louvain Catholic University,
Belgium,
Groupe de Travail en Economie de l'Environnement.

Journal Water Pollution Control Federation, Vol. 48, No. 9, p 2120-2130, September, 1976. 5 fig, 1 tab, 20 ref.

The development of cost functions for waste water conveyance systems is discussed. Waste water flow is selected as the design variable, and relationships provided by the hydraulics are used to express the cost as a function of flow only. Total cost is minimized by using preoptimization techniques which take into account the hydraulic relationships and constraints and give the optimal pipe diameter for a given pipe length, pipe slope, and waste water flow. The optimal pipe diameter is then introduced into the cost function so that the cost is a function of flow only. Although the analysis is valid only for the installation of one pipe, it can be adapted for two pipes in parallel. Also, constraints can be added for preventing abrasion and settling. Equations developed for the cost function analysis are applied to a particular region of Belgium; however, they can be applied to other countries if small adjustments in parameter values which reflect local conditions of costs are made.

*Waste water treatment, *Cost analysis, *Pipelines, *Hydraulic structures, *Transportation, Liquid wastes, Mathematical models, Optimization, Flow

F003
THEORETICAL MODEL FOR A SUBMERGED BIOLOGICAL FILTER,

Jennings, P. A., Snoeyink, V. L., and Chian, E. S. K.

Clarkson College of Technology,
Potsdam, New York,
Department of Civil and Environmental Engineering.

Biotechnology and Bioengineering, Vol. 18, No. 9, p 1249-1273, September, 1976.
12 fig, 2 tab, 16 ref.

A mathematical model for describing the biological removal of a single substrate from waste water in a porous bed of biolayer coated particles assuming plug flow and steady-state conditions is described. The model uses the nonlinear Monod expression for the substrate utilization rate. The approximation of this Monod expression by a first order rate expression yields accurate results for a much wider range of bulk concentrations than might be expected from inspection of the Monod half-velocity coefficient for a given substrate. Percent removal of substrate is a weak function of biolayer thickness when the thickness is greater than a rather small limiting value but is a strong function of particle radius (and thus biolayer surface area) for a wide range of parameter values including those of common interest.

*Waste water treatment, *Biological treatment, *Mathematical models, *Kinetics, *Liquid wastes, Waste treatment, Equations, Surfaces, Model studies

F004
DEVELOPMENT AND APPLICATION OF A WATER RESOURCE ALLOCATION MODEL,

Maddaus, W. O., and McGill, J. M.

City of Tucson,
Tucson, Arizona,
Department of Water and Sewers.

Water Resources Research, Vol. 12, No. 4, p 767-774, August, 1976. 3 fig, 8 ref.

A water resource optimization model for long-range infrastructure planning in water supply and waste water management is described. The model includes the following elements: a network analyzer to determine the least-cost allocation of available sources of water supply (including reclaimed waste water) to various demand points subject to certain physical constraints and water management policies, a recosting procedure for nonlinear cost functions, a digital groundwater model for simulating widespread changes in groundwater depth, and a salt balance model for simulating groundwater quality changes with time. The model provides costs for the optimal water resource allocation for various sets of constraints as well as for environmental changes in the groundwater reservoir. Application of the model is illustrated for the Tucson, Arizona regional area where the most cost-effective alternative was identified and used to develop a 50-year water supply and waste water management plan.

*Model studies, *Cost-benefit analysis, *Water management (applied), *Water allocation (policy), *Water supply, Waste water treatment, Groundwater, Arizona, Mathematical models, Simulation analysis, Economics, Programs, Evaluation, Optimization, Reclaimed water

Tucson

F005
THE USE OF STOCHASTIC MODELS IN THE INTERPRETATION OF HISTORICAL DATA FROM SEWAGE TREATMENT PLANTS,

Berthouex, P. M., Hunter, W. G., Pallesen, L., and Shih, C. Y.

Water Research, Vol. 10, No. 8, p 689-698, 1976. 6 fig, 5 tab, 3 ref.

Stochastic models were used to relate effluent biochemical oxygen demand for sewage treatment plants in terms of influent biochemical oxygen demand, suspended solids, temperature, and detention time. Most of the variation in effluent biochemical oxygen demand was explainable in terms of previous effluent biochemical oxygen demand values alone; the prediction was improved somewhat by taking into consideration influent biochemical oxygen demand, detention time, and mixed liquor suspended solids. The use of efficiency rather than effluent biochemical oxygen demand did not prove beneficial to the model building effort. The natural logs of influent and effluent biochemical oxygen demand proved to be better metrics than the biochemical oxygen demand values themselves, and the same appeared to hold for the suspended solids parameter. Temperature did not appear to be of significance in modeling sewage treatment plant performance.

*Model studies, *Sewage treatment, *Treatment facilities, *Mathematical models, *Performance, Biochemical oxygen demand, Temperature, Suspended solids, Efficiencies, Evaluation, Waste water treatment

F006
DYNAMIC MODELLING AND CONTROL APPLICATIONS IN WATER QUALITY MAINTENANCE,

Beck, M. B.

Cambridge University,
United Kingdom,
Engineering Department.

Water Research, Vol. 10, No. 7, p 575-595, 1976. 4 fig, 51 ref.

A unified systematic approach to considering the problems of water quality management is presented. The systems analysis approach defines four major subsystems: the water abstraction plant and distribution network providing potable supplies, the urban land surface (rainfall runoff) and sewer network, the waste water treatment plant, and a stretch of the river. Biological process modeling is shown to be the major challenge to dynamic water quality management. For example, increased understanding of the substrate/microorganism relationships of activated sludge and anaerobic digestion and of nitrification and the nitrogen cycle as they apply to activated sludge operations and river water quality is required. The quality dynamics of potable abstraction treatment and a combined dissolved oxygen-biochemical oxygen demand-algae-nitrogen model also need further investigation. Dynamic models and control theory are cited as playing a fundamental part in the systematic analysis of water quality systems where standards must be maintained in the river by an operational control.

*Water quality, *Model studies, *Waste water treatment, *Drainage systems, *Systems analysis, Rivers, Sewers, Analytical techniques, Mathematical models, Water pollution control, Biological treatment, Activated sludge, Microorganisms, Algae, Nitrogen, Dissolved oxygen, Biochemical oxygen demand, Nitrification, Anaerobic conditions, Runoff, Potable water, Surface waters

F007
ESTIMATING FLOW CONDITIONS FOR RIVER MODELS,

Grenney, W. J., and Bowles, D. S.

Utah State University,
Logan,
Civil and Environmental Engineering.

Journal of the Environmental Engineering Division-ASCE, Vol. 102, No. EE4, p 693-707, August, 1976. 9 fig, 4 tab, 1 ref.

A "man in the loop" computer model which utilizes available historical streamflow data and user judgment to estimate flow boundary conditions for a water quality model is described along with its application to the Weber River Basin in northeastern Utah. The model requires four types of data: system geometry representing the stream system layout, typical flow data for the boundary conditions, known flows, and initial boundary conditions. Output from the model contains the estimated boundary conditions and corresponding values of streamflow (balance flows). The model has been applied to the Weber River Basin to produce a consistent set of flows at sampling points where flow estimates had been made at the time of sampling and where measured flows are available at gaging stations. A second application involved the estimation of 7-day, 10-year low flows at sampling points given 7-day 10-year low flows at gaging stations. The model is not limited to flows and can also be used to perform mass balance on any conservative substance such as salinity.

*Rivers, *Flow, *Mathematical models, *Water quality, *Computer models, Model studies, Surface waters, Flow characteristics, River flow, River systems, Utah, Salinity

Weber River Basin

F008
DEVELOPMENT OF MATHEMATICAL MODELS FOR THE WATER QUALITY MANAGEMENT OF THE PEARL RIVER, JACKSON, MISSISSIPPI,

Sun, P. T-C.

Dissertation Abstracts International B, Vol. 36, No. 9, p 4615-4616, March, 1976.

A mathematical model was developed to evaluate the waste treatment practice of organic removal and/or ammonia oxidation to avoid extreme dissolved oxygen deficits in the receiving stream. Two systems were studied. The first was a completely mixed activated sludge treatment plant which discharged into a hypothetical stream. The second involved the Jackson Mississippi Wastewater Treatment Plant, with a "contact stabilization" activated sludge system, and the Pearl River, its receiving stream. Models were developed for organic removal, nitrification, and solids separation processes. Nitrification models were developed for the two types of activated sludge systems. A model was worked out for predicting effects of effluent on receiving streams. This employed Monod growth kinetics for heterotrophic carbon oxidation and autotrophic nitrification to determine stream dissolved oxygen resources. The combined models of the treatment plant and its receiving stream can further aid evaluation of the total operation. Results of studies showed that complete nitrification in the treatment system best protected oxygen resources for a stream receiving effluent from a completely mixed activated sludge treatment plant. For a contact stabilization system, partial nitrification may cause a more severe dissolved oxygen deficit than a non-nitrified effluent (short sludge age). Dissolved oxygen resources can be improved by chlorinating a partially nitrified effluent from a waste water treatment plant.

*Sewage treatment, *Activated sludge, *Dissolved oxygen analyzers, *Rivers, *Chlorination, *Nitrification, *Oxidation, *Mathematical models, Treatment facilities, Waste water treatment, Kinetics, Ammonia, Water quality control

Jackson (Miss), Contact stabilization

F009
A STUDY OF SUBSTRATE REMOVAL IN A MICROBIAL FILM REACTOR,

Harris, N. P., and Hansford, G. S.

Cape Town University,
Rondebosch, Cape, South Africa,
Department of Chemical Engineering.

Water Research, Vol. 10, No. 11, p 935-943, 1976. 12 fig, 1 tab, 43 ref.

A mathematical model was proposed to predict the quantity of substrate removable by slime when it is subjected to various hydraulic and organic loadings. It was, also, to determine if performance of the slime was limited by either a lack of organic carbon or oxygen, or both. Supportive data was obtained by measuring substrate removals on a vertical experimental biofilm reactor over a range of hydraulic and organic loadings similar to an industrial type operation. The model is based on basic chemical engineering principles of interfacial mass transfer, diffusion, and biochemical reaction and, using kinetic parameters which fell within variations reported in literature, predicted the reactor's COD removal capacity when subjected to organic and hydraulic loadings. It also showed whether the operation of the film was limited by substrate, oxygen, or both together. It indicated that change from one to the other occurred between organic loadings of 300 to 500 mg/liter COD. There was poor correlation between model predictions and experimental results pertaining to hydraulic loadings approaching minimum wetting rate. The model becomes unreliable in predicting results of conditions of low hydraulic load.

*Mathematical models, *Chemical oxygen demand, *Microorganisms, *Slime, *Model studies, *Organic loading, Carbon, Oxygen, Kinetics

Biofilm reactors, Hydraulic loading

F010
A MATHEMATICAL MODEL FOR PREDICTING WATER DEMAND, WASTE WATER DISPOSAL AND COST OF WATER AND WASTE WATER TREATMENT SYSTEMS IN DEVELOPING COUNTRIES,

Muiga, M. I.

Dissertation Abstracts International B, Vol. 37, No. 1, p 372, July, 1976.

Mathematical models were developed for various inputs and costs of water and waste water treatment for Africa, Asia, and Latin America. Such factors as water demand, waste water amounts, and construction, operation and maintenance costs of slow sand filter, rapid sand filter, stabilization lagoon, aerated lagoon, activated sludge, and trickling filter processes were considered. Analysis indicated that water demand is a function of population, income, and the percentage of households connected to water supply. Waste water disposal was shown to be a function of water demand, the percentage of homes connected to public sewage systems and the percentage of household systems. Equations for predicting water treatment costs were a function of the percentage cost of imported water supply materials, population, and design capacity. These variables gave the best correlation for waste water treatment costs.

*Mathematical models, *Cost analysis, *Water treatment, Waste water treatment, Filters, Lagoons, Activated sludge, Trickling filters, Water supply, Waste water disposal, Foreign countries

Sand filters

F011
CHEMICAL DYNAMICS OF A POLLUTED WATERSHED, THE MERRIMACK RIVER IN NORTHERN NEW ENGLAND,

Ceasar, J., Collier, R., Edmond, J., Frey, F., and Matisoff, G.

Colorado University,
Boulder,
Department of Geology.

Environmental Science and Technology, Vol. 10, No. 7, p 697-704, July, 1976.
4 fig, 10 tab, 21 ref.

The flux of various chemical and geochemical components of the Merrimack River were determined and analyzed to develop a hydrochemical model of an urban, polluted stream. Monitoring stations were located at such points as tributaries, dams, and towns to determine their influences on the river. Sampling stations were not always possible in the ideal mid-stream location. One model was developed to identify sources in the river system, and another dealt with concentration versus flow. The three major sources of chemicals are atmospheric, weathering, and anthropogenic conditions. A significant input of sodium, calcium, magnesium, and potassium from anthropogenic sources was found. The flow model was based on apparent background flow which included groundwaters with long and short residence times and sewage flow, and on "runoff" events. Results were reasonable for the northern portion where inputs were practically entirely natural and from morphologically homogeneous drainage region and for the southern region where anthropogenic inputs are predominant. The flow model was not totally applicable to the central area because morphology was complex and human inputs were significant.

*Monitoring, *Rivers, *Model studies, *Sampling, Water pollution sources, Flow, Runoff, Pollutant identification, Groundwater, Chemical analysis

F012
LEAST COST CONTROL STRATEGIES IN URBAN DRAINAGE DESIGN: A DYNAMIC PROGRAMMING APPROACH,

Froise, S.

Dissertation Abstracts International B, Vol. 37, No. 2, p 889, August, 1976.

An approach to determine least cost control strategies was developed for urban drainage network design. Networks were defined as combined conveyance (circular cross-section conduits, junction and diversion structures, and pump stations) and storage (ponds and retention basins) elements. A dynamic programming approach and hydraulic simulation and cost-estimation models were used for evaluations. The hydraulic model consisted of a design and a simulation module. The system proved valuable and may represent a 30% cost reduction over conventionally designed drainage networks.

*Control systems, *Urban drainage, Cost analysis, Conduits, Conveyance structures, Hydraulic models, Simulation, Design, Networks

F013
ENGINEERING, SANITARY AND MUNICIPAL MODELING, IDENTIFICATION AND CONTROL OF A DYNAMIC AND STOCHASTIC CHEMICAL BIOLOGICAL PROCESS,

Adeyemi, S. O.

Dissertation Abstracts International B, Vol. 37, No. 2, p 939, August, 1976.

The proposal that chemical costs savings and reduced effluent phosphorus variability may result from optimal control of a chemical-biological process was investigated. Phosphorus removal involves simultaneous physical, chemical, and biological mechanisms. In this study, the operating data suggest the model form. The Dynamic Data System (DDS) which uses time series techniques to determine models is used. The DDS approach involves two model classes: scalar and vector. The objective was to develop models to aid performance improvement. Individual operating parameters which provide information on phosphorus removal performance were modeled. An input-output model was developed to define the functional relationships of these parameters. An optimal control strategy and sampling program based on the DDS models was developed. From these models, control equations were delineated for calculating the rate of iron addition. The total phosphorus system and total soluble phosphorus systems were defined. It was found that a significant amount of useful information is contained in the operating data from treatment facilities when proper techniques are used and that the DDS approach is a valuable tool for systems analysis and control.

*Model studies, *Systems analysis, *Phosphorus, Chemical precipitation, Biological treatment, Operating costs, Mathematical models, Treatment facilties

Phosphorus removal, Dynamic Data System (DDS)

F014
A DYNAMIC MODEL AND COMPUTER COMPATIBLE CONTROL STRATEGIES FOR WASTE WATER TREATMENT PLANTS,

Stenstrom, M. K.

Clemson University,
Clemson, South Carolina.

Dissertation Abstracts International B, Vol. 37, No. 4, p 1860, 1976.

A model was developed for the use of automatic controls as a method for instituting economies in the operation of treatment plants. Automatic controls could improve the efficiency and performance of most components of a treatment system. Six process models were developed: primary clarification, activated sludge with secondary clarification-thickening, waste sludge thickening, anaerobic digestion, and chlorine disinfection. The latter two models were used to predict end products and the liquid and solids processing trains. Controls were developed for all processes and the total plant was simulated using time-varying deterministic and stochastic inputs. Definite economic optimum sludge ages were indicated which depend upon costs for energy and ultimate sludge disposal.

*Automatic control, *Activated sludge, *Analytical techniques, *Treatment facilities, *Model studies, Waste water treatment, Sludge treatment, Economics

F015
PREDICTION OF VINYL CHLORIDE MONOMER MIGRATION FROM RIGID PVC PIPE,

Berens, A. R., and Daniels, C. A.

The B. F. Goodrich Company Research and Development Center,
Brecksville, Ohio.

Polymer Engineering and Science, Vol. 16, No. 8, p 552-558, August, 1976. 7 fig, 2 tab, 8 ref.

A predictive model was developed using data on the solubility and diffusion of vinyl chloride monomer (VCM) in PVC resin powders and Fick's diffusion equation solutions to determine the amount and rate of loss of residual VCM (RVCM) of rigid PVC pipe in service and storage. Good agreement between predictions and observation of RVCM from PVC pipe to water indicates that the diffusion coefficient of pure PVC resins is applicable to rigid PVC pipe compounds, and little change in VCM diffusivity is produced by PVC contact with water when compared to measurement by vapor sorption/desorption methods. The model can be used to estimate VCM concentrations in water resulting from actual use of PVC water pipe systems. The calculations presented may also be used in model dynamic flowing systems. Highest VCM concentrations are expected from new installations of recently manufactured small diameter PVC pipe after long periods of stagnation. In actuality, PVC pipe containing 1 mg/kg or less residual VCM produces VCM concentrations undetectable with present analytical methods.

*Analytical techniques, *Forecasting, *Migration, *Plastic pipes, *Model studies, Solubility, Diffusion, Resins

*Vinyl chloride

F016
DESIGNING REGIONALIZED WASTE WATER TREATMENT SYSTEMS,

Whitlatch, E. E., Jr., and ReVelle, C. S.

Ohio State University,
Columbus,
Department of Civil Engineering.

Water Resources Research, Vol. 12, No. 4, p 581-591, August, 1976. 13 fig, 1 tab, 22 ref.

Research was directed towards adding to the mathematical methodology being developed to aid the design of regionalized treatment schemes. It was assumed that activated sludge treatment to remove 85% of waste BOD will be used to meet conditions of many state laws requiring secondary treatment of waste water sources. Dynamic programming, linear programming, and heuristic location techniques were used to develop a step procedure to progressively improve solutions to the problems of treatment and transport. The proposed procedure is relatively simple to learn and computer costs involved are not expected to be excessive. It was developed, also, to resolve problems inherent with existing solution procedures proposed for regional sewage treatment plants and has the advantage of providing alternative near-optimal solutions for given situations. This proposal was expected to be a valuable tool in providing maximum economies in regional treatment facility design and operation.

*Waste water treatment, *Sewage treatment, *Activated sludge, *Analytical techniques, *Biochemical oxygen demand, Treatment facilities, Design, Dynamic programming, Linear programming

F017
HOW TO CONTROL BIOLOGICAL WASTE-TREATMENT PROCESSES,

Harbold, H. S.

Chemical Engineering, Vol. 83, No. 26, p 157-160, December, 1976. 5 fig, 6 ref.

Much money has been spent for new water pollution control equipment or for upgrading existing treatment plants to meet the requirements of Public Law 92-500. Because biological waste treatment is now most widely used to remove organic pollutants from industrial wastes, optimizing its control procedures is the object of this discussion. In this category, activated sludge systems are the most versatile and efficient of available processes. Controlling the solids level in biological treatment systems is one of the most important issues. The net production of biological solids is equal to the mass of new biological solids produced by food substrate utilization minus the loss of biological solids by endogenous respiration. Control of the activated sludge process may be accomplished by use of the food-to-microorganism ratio (F/M), the quantity of mixed-liquor suspended solids (MLSS) or mixed-liquor volatile suspended solids (MLVSS), or solids retention time (SRT). The SRT method was proven to be one of the most successful controls of an activated sludge system. With the automation of future treatment plants, this method may be used as the basis for design.

*Waste water treatment, *Biological treatment, *Activated sludge, *Treatment facilities, *Water pollution control, Equipment, Industrial wastes, Organic matter

F018
FLOOD DAMAGE MITIGATION,

Simultation Network Newsletter, Vol. 8, No. 6, p 1-187, October, 1976. 3 fig, 5 ref.

Methods and techniques for assessing flood damage probability and constructing flood control structures and procedures are reviewed. Structural techniques such as reservoirs, levees, and diversions to reroute flood waters away from the flood area were used. Flood proofing is a recent development. Minimizing total costs of flooding is the best criteria for determining control means in a given situation. Evaluation of the flood area and probability and magnitude of flooding is the first consideration. An analysis of a hundred year flood record requires a 115 year study for a ± 10% accuracy. Because most streamflow records are shorter than 48 years, simulation must be used to project conditions further back. A relationship should be developed between flood damage and river stage or flow to determine the relationship of flood damage and frequency. Flood plain mapping is another tool which is necessary to develop the most adequate and pertinent flood control plan. This helps to ensure the most economic and beneficial flood control measures. Flood forecasting is valuable in providing time to issue warnings to populations as well as allowing for adequate preparation for the most efficient use of flood control plans. Such forecasts must include data collection of current information on rainfall and upstream river stages, hydrologic techniques which translate this data to streamflow at downstream points where warnings are necessary, and a program for disseminating the forecasts and warnings. Forecasting is also an aid in the development of control measures which must handle a particular flood period. The Hydrocomp company has several services, including simulation programming, to assist these developments.

*Analytical techniques, *Floods, *Flood damage, *Flood protection, *Flood control, Probability, Diversion structures, Reservoirs

F019
A BENEFIT/COST EVALUATION OF DRINKING WATER HYGIENE PROGRAMS,

Singley, J. E., Hoadley, A. W., and Hudson, H. E., Jr.

Florida University,
Gainesville,
College of Engineering and
Institute of Food and Agricultural Science.

November, 1975. 136 p, 3 fig, 27 tab, 101 ref, 5 append. Tech. Rept. NTIS PB-249 891.

A methodology has been developed to evaluate the benefit/cost ratio of water hygiene programs. It is based upon regression models. The number of water-related disease cases is estimated by estimating regression equations relating the rate of reported cases of infectious disease to the quality of drinking water and other factors and estimating how changes in water quality will change the number of cases reported. This methodology has been used to evaluate the benefit/cost ratio for water quality improvements affecting the incidence of salmonellosis, shigellosis, and hepatitis. First, the total disease and cost per incidence of disease was measured. A regression equation was then estimated to explain the reported rate of disease and water quality. Costs of a given water quality improvement program were then estimated. The benefits of improvement programs were then determined in terms of infectious disease using the cost per incidence of disease and estimated regression equation. Cost/benefit ratios were then determined. The regression methodology could be used for other water programs if appropriate data is available.

*Analytical techniques, *Cost-benefit ratio, *Water treatment, *Mathematical models, *Regression analysis, Salmonella, Shigella, Human diseases

*Water hygiene, Salmonellosis, Shigellosis, Hepatitis

F020
ASSESSMENT OF MATHEMATICAL MODELS FOR STORM AND COMBINED SEWER MANAGEMENT,

Bradstetter, A.

Battelle Pacific Northwest Laboratories,
Richland, Washington,
Water and Land Resources Department.

August, 1976. 530 p, 122 fig, 76 tab, 139 ref, 6 append. Tech. Rept. EPA-600/2-76-175a.

Mathematical models for the nonsteady simulation of urban runoff were evaluated for engineering assessment, planning, design, and control of storm and combined sewerage systems. They were evaluated on the basis of information provided by the model builders and users. Most include nonsteady simulation of the rainfall-runoff process and flow routing in sewers; a few include simulation of waste water quality, options for dimensioning sewerage system components, and features for real-time control of overflows during rainstorms. The models evaluated were: British Road Research Laboratory Model, Chicago Hydrograph Method, Colorado State University Urban Runoff Modeling, Corps of Engineers Hydrologic Engineering Center STORM Model, Hydrocomp Simulation Program, Minneapolis-St. Paul Urban Runoff Model, Municipality of Metropolitan Seattle Computer Augmented Treatment and Disposal System, University of Cincinnati Urban Runoff Model, University of Illinois Storm Sewer System Simulation Model, University of Massachusetts Urban Runoff Model, Wilsey and Ham Urban Watershed Model, Battelle Urban Waste Water Management Model, Dorsch Hydrograph-Volume Method, Environmental Protection Agency Storm Water Management Model, Massachusetts Institute of Technology Urban Watershed Model, Metropolitan Sanitary District of Greater Chicago Flow Simulation Program, SOGREAH Looped Sewer Model, and Water Resources Engineers Storm Water Management Model. The last seven were also treated by computer runs using hypothetical and real catchment data. Testing with hypothetical data showed that computer running time is governed more by efficient formulations of the overall model logic than by the basic equations used for specific phenomena.

*Sewerage, *Analytical techniques, *Combined sewers, *Hydraulics, *Hydrology, Mathematical models, Sewers, Water pollution

F021
DEVELOPMENT AND APPLICATION OF A SIMPLIFIED STORMWATER MANAGEMENT MODEL,

Lager, J. A., Didriksson, T., and Otte, G. B.

Metcalf and Eddy, Incorporated,
Palo Alto, California.

August, 1976. 153 p, 30 fig, 47 tab, 12 ref, 4 append. Tech. Rept. EPA-600/2-76-218.

A simplified, inexpensive, flexible stormwater management model for planning and preliminary sizing of storm water facilities has been created. The model delineates a methodology for storm water management and consists of a series of interrelated tasks combining small computer programs and hand computations that can be used either singly or together. It introduces time and probability into storm water analysis, promotes total system consciousness, and assists in establishing size-effectiveness relationships for facilities. Five tasks are included: data preparation, rainfall characterization, storage-treatment balance, overflow-quality assessment, and receiving water response. A system of combined sewers is analyzed using Rochester, New York, as a working example. A schematic of the existing storm water facilities, outlining major conduits and overflow discharge locations and sizes, is essential to data preparation. Overflow quantities and qualities must be measured for calibrating the model. It is easy to generate frequency of occurrence curves from the ranking of storm parameters. The storage-treatment computer program allows quick review of the interrelationship between containment of runoff in storage and the capacity of treatment plants or interceptors. This program, which uses rainfall records for a long period as the data source, can accurately tabulate the quantity, frequency, and duration of overflows. Overflow quality can be predicted based on storm characteristics using linear regression techniques. Gross averages of the quality data by subarea can indicate overflow quality and areal trends. The receiving water analysis provides the final test of a control alternative.

*Waste water treatment, *Analytical techniques, *Treatment facilities, *Combined sewers, *Mathematical models, Storm water, Overflow, Runoff, Water quality

F022
SHORT COURSE PROCEEDINGS: APPLICATIONS OF STORMWATER MANAGEMENT MODELS,

DiGiano, F. A., and Mangarella, P. A.

Massachusetts University,
Amherst,
Department of Civil Engineering.

August, 1974. 435 p, 129 fig, 53 tab, 386 ref. Tech. Rept. EPA-670/2-75-065.

Instructional papers have been compiled to encourage consultants to use storm water models in dealing with combined and storm sewer overflows and make state pollution control agencies aware of this tool in their pollution abatement efforts. Emphasis was placed on presentations of various types of models, their data requirements, and case studies in which they were used. The Environmental Protection Agency Storm Management Model (SWMM) is highlighted.

*Sewerage, *Analytical techniques, *Storm drains, *Combined sewers, *Rainfall intensity, Waste treatment, Water quality, Computer programs

*Peak storm flow

F023
ENVIRONMENTAL IMPACT OF URBAN STORMWATER RUNOFF,

McPherson, M. B.

In: Short Course Proceedings: Applications of Stormwater Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 11-82.
4 fig, 4 tab, 198 ref.

Urban storm water runoff and mathematical models describing it are discussed. Peak drainage runoff rates can be reduced by means of proper land-development design. The bulk of storm drainage systems convey very modest flow rates, substantiating the surmise that the majority of catchments replace mainly fringe tributary natural channels. The most dramatic hydrologic impact of urban development is that on peak flows, where the basin lag time is reduced as an area becomes urbanized. Structural means for mitigating flood-plain inundation are designed to provide a much higher level of protection than that for storm drainage systems. Pollution from storm sewer discharges can be almost as severe as that from combined sewer overflows. Substantial departures from traditional underground systems that remove storm water as rapidly as possible are required for enhancement of urban environment, conservation of water resources, and reducing water pollution. The rational method of sewer design involves numerous artificialities. For preliminary analysis and design of specific projects, the use of the simplest models is recommended. Ad hoc temporary rainfall-runoff-quality measurements to calibrate and verify the crude models used are recommended. Opportunities for design application of more detailed modeling techniques may arise if actual field data is available. Use of more detailed models is mainly justified to give a better insight into the underlying processes and develop more rational understanding of the simpler models. Exploration of metropolitan-wide pollution-control alternatives should employ the simplest mass-balance and mass-routing techniques. Most models require a computer for efficient calculation.

*Sewerage, *Analytical techniques, *Storm drains, *Combined sewers, *Water quality, Computer programs, Runoff, Urban runoff

Peak storm flow

F024
INTRODUCTION TO URBAN STORMWATER RUNOFF MODELS,

Shubinski, R. F.

Water Resources Engineers,
Springfield, Virginia.

In: Short Course Proceedings: Applications of Stormwater Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 177-199.
15 fig, 4 tab, 6 ref.

The urban drainage system can be viewed as an assemblage of subsystems dealing with surface runoff, transport of flow and quality, and the receiving water. Each drainage subarea is characterized by its area, degree of imperviousness, slope, and production of quality constituents. Overland flow modifies the rainfall hyetograph by infiltration, surface retention, and transient storage. The transport subsystem conveys storm waters and associated pollutants from the inlets through an underground conduit network to disposal points. The receiving water may be a stream, lake, estuary, or coast. The impact will probably be assessed in terms of the concentration of a particular pollutant. Increased imperviousness is associated with urbanization. Location of impervious areas in the watershed, proximity and geometry of drainage systems, and building practices should be considered in analyzing runoff from impervious areas. The dominant hydrologic factors in the rainfall-runoff process are rainfall, infiltration, storage, and detention. Land use profoundly influences urban runoff quantity through its effects on imperviousness and surface cover. Storm discharge from an urban watershed can best be analyzed by dividing the total basin into smaller homogeneous units. A stormwater model was applied to a watershed to determine the influence on storm water quality and quantity that might be expected with a land use change. Storage reservoirs and detention ponds which increase runoff travel time in selected reaches of a watershed can reduce peak flows during storm water runoff. Other storage concepts include in-line storage in existing main sewers.

*Rainfall intensity, *Water quality, *Runoff, *Urban runoff, *Storm water, Storm runoff, Mathematical models, Cities, Peak discharge

Peak storm flow

F025
THE WRE STORM MODEL,

Shubinski, R. P.

Water Resources Engineers,
Springfield, Virginia.

In: Short Course Proceedings: Applications of Stormwater Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 214-241. 8 fig, 5 tab, 9 ref.

The present and expected future magnitude of pollution loads carried by urban runoff from a given watershed must be determined before developing a pollution control plan. A computer program, STORM, is presented that estimates the quantity and quality of runoff from small, primarily urban, watersheds. Land surface erosion, suspended and settleable solids, biochemical oxygen demand (BOD), total nitrogen, and orthophosphate are calculated. The model considers the interaction of precipitation; air temperature for snowmelt; runoff, pollutant accumulation on the land surface, and land surface erosion; treatment rates; storage; and overflows. The program requires about 35,000 words of core storage and a FORTRAN IV compiler that accepts multiple ENTRY statements.

*Waste water treatment, *Analytical techniques, *Biochemical oxygen demand, *Water quality, *Rainfall intensity, Waste treatment, Computer programs, Runoff, Urban runoff

F026
THE EPA STORMWATER MANAGEMENT MODEL,

Huber, W. C., and Heaney, J. P.

In: Short Course Proceedings: Applications of Stormwater Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 242-246. 1 fig, 4 ref.

A comprehensive mathematical computer simulation program was developed to model flow and quality during the total urban rainfall-runoff process. It provides an accurate representation of the physical system and an opportunity to determine the effect of proposed pollution abatement procedures. The Storm Water Management Model (SWMM) was developed, demonstrated, and verified. It has been documented and is currently in use. The SWMM is descriptive and models most urban configurations encompassing rainfall, runoff, drainage, storage/treatment, and receiving waters. Program segments correspond to physical components of the urban runoff process, and it has preliminary decision-making capabilities. Many changes have been made in details of the original program, input/output requirements, and data descriptions.

*Waste water treatment, *Analytical techniques, *Mathematical models, *Rainfall intensity, *Waste treatment, Water quality, Computer programs, Runoff

*Storm Water Management Model (SWMM)

F027
DECISION-MAKING FOR WATER QUANTITY AND QUALITY CONTROL,

Heaney, J. P.

In: Short Course Proceedings: Applications of Stormwater Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 247-249. 4 refs.

Results of analyses into alternative procedures for selecting optimal overall storm water control strategy are presented. A linear programming model is used to determine sizes and operating policies for sewer pipes, storage reservoirs, and treatment plants; the Storm Water Management Model (SWMM) generates boundary conditions and provides more detailed information on performance. Because many storm water quality control alternatives serve other functions, the urban water quality problem seems to fit well into a more general framework of urban water resources management. Traditionally, waste water disposal, water supply, recreation and open space have been considered as separate problems. An 800 acre planned urban development with overall density of four units/acre was able to satisfy the following constraints: water use less than or equal to safe recharge of the aquifer, on-site control of storm water from a 50 yr storm, no structures in the flood-plain, no direct discharge of storm water into on-site recreational lakes, and disposal of treated sewage effluent onto a golf course. About 86% of the total land is in open space. Development costs for the mix of detached houses, townhouses, apartments, and condominiums appear competitive or lower than for existing practices.

*Waste water treatment, *Sewage treatment, *Sewerage, *Analytical techniques, *Treatment facilities, Mathematical models, Waste treatment, Water quality

Storm Water Management Model (SWMM)

F028
SELECTED CASE STUDIES USING STORMWATER MANAGEMENT MODELS -- QUANTITY ASPECTS,

Orlob, G. T.

G. T. Orlob and Associates,
Orinda, California.

In: Short Course Proceedings: Applications of Stormwater Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 250-268. 15 fig, 6 ref.

Investigations of Northwood Tract, Baltimore, Maryland; Pegel T1/T2, Hamburg, Germany; View Ridge, Seattle, Washington; Vine Street, Melbourne, Australia; and a special study of stability problems are used to illustrate application of the Storm Water Management Models. Observed and simulated runoff peaks were not coincident in time. Watershed yields disagreed. The simulated runoff pattern tended to be smoother and more attenuated than that observed. Simulated runoff was discontinuous. Sometimes initial peaks were not well simulated although subsequent peaks were, and vice versa. The simulations were generally excellent for the Northwood Tract. The computer runoff for Hamburg compared well with the measured flow for a storm with two distinct precipitation peaks. The model gave a good account of the peak flow for the View Ridge catchment, but was a bit too low in the trailing portion of the storm. The SWMM proved superior in a comparison with models developed by England's Road Research Laboratory and the University of Cincinnati for Melbourne. Often it is difficult to distinguish numerically induced oscillations from hydraulic behavior that sometimes produces real fluctuations. Numerically induced oscillations can often be eliminated by changes in time step, averaging, or computational techniques.

*Analytical techniques, *Rainfall intensity, *Computer programs, *Runoff, *Urban runoff, Peak discharge, Storm water, Storm runoff

Peak storm flow, Storm Water Management Model (SWMM)

F029
PLANNING A STUDY USING STORMWATER MANAGEMENT MODELS,

Orlob, G. T.

G. T. Orlob and Associates,
Orinda, California.

In: Short Course Proceedings: Applications of Stormwater Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 269-279.
5 fig, 1 ref.

Mathematical modeling makes it possible to expeditiously examine large numbers of complex alternatives. It may serve to study designs, sizing system elements, alternative routings, impact of off-line storage, control measures, and land and water use planning schemes. If the model is well conceived and tested the user may anticipate a productive effort with only the normal computer problems. However, things seldom run smoothly with computer models. The Storm Water Management Model package is briefly described. Points where trouble may arise and ways to avoid it, if possible, are discussed. The planning process is examined, including the technique for bringing the models up to speed and to bear on the real problems to be solved. This includes the model development process, calibration, and application. Once the Storm Water Management Models are calibrated and verified, providing the user with some appreciation of their reliabilities and fallibilities, they can be employed best to discriminate between alternative choices.

*Analytical techniques, *Computer programs, *Storm water, *Design, *Mathematical models, Planning, Water management (applied), Computer models

*Storm Water Management Model (SWMM)

F030
THREE CASE STUDIES ON THE APPLICATION OF THE STORM WATER MANAGEMENT MODEL,

Vittands, J. P.

Metcalf and Eddy Engineers,
Boston, Massachusetts.

In: Short Course Proceedings: Applications of Stormwater Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 280-332.
19 fig, 13 tab, 5 ref.

A program was started for the systematic evaluation of the existing system, and preparation of a plan and program for the reconstruction of the inadequate segments of the sewer system in the Easterly District of Cleveland, Ohio. The flooding conditions and transport capabilities in the existing system were determined by computer simulation. Based on these results, the necessary sewer sizes were estimated to eliminate flooding under the design storm conditions. Computer simulation was used to test the selected improvements. A comprehensive engineering evaluation was also conducted with respect to abatement of pollution from combined sewer overflows to the Great Miami River in Middletown, Ohio. All combined sewer outfalls connect to an interceptor by junction chambers designed to regulate flows so that the major portion of flow during storm runoff passes to the river. Records sometimes show reduced flow to the treatment plant during rainfall periods, indicating that the regulators, as presently operated, perform a negative function for water pollution control. The biggest pollution problem confronting Boston Harbor was identified as the combined sewer discharge problem which has been causing bacterial contamination and visual pollution of beaches and shellfish areas. The Storm Water Management Model (SWMM) is being used to model approximately 24,000 acres of combined and separate sewered areas in metropolitan Boston. Measurements at a Cambridge overflow were compared favorably with hydrographs generated by the SWMM under similar conditions.

*Waste water treatment, *Sewerage, *Analytical techniques, *Treatment facilities, *Combined sewers, Storm drains, Rainfall intensity, Computer programs

F031
COMPARATIVE ANALYSIS OF URBAN STORMWATER MODELS,

Brandstetter, A.

Battelle Pacific Northwest Laboratories,
Richland, Washington.

In: Short Course Proceedings: Applications of Stormwater Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 333-420. 26 fig, 5 tab, 60 ref.

Eighteen mathematical models for the nonsteady simulation of runoff in urban storm and combined sewerage systems were reviewed based on information from model builders and users. The seven most promising models were also tested by computer runs using hypothetical and real catchment data. Most include nonsteady simulation of the rainfall-runoff process and flow routing in sewers; a few also include waste water quality simulation, options for dimensioning sewerage system components, and features for realtime control of overflows during rainstorms. The models vary greatly in scope and purpose, mathematical detail, system elements and hydrologic phenomena being modeled, size of the system that can be handled, data input requirements, and computer output. Their state of development also varies significantly. Evaluations considered model accuracy, cost of model use, computer requirements, data requirements, input data preparation requirements, and output options available. All eighteen are suitable for simulation of storm and combined sewerage systems or incorporation in comprehensive simulation models. Considerable differences exist in the types of phenomena modeled and mathematical formulations for each phenomenon. If only a few physical phenomena need to be modeled, the simplest model simulating them with adequately accurate mathematical formulations should be selected.

*Sewerage, *Analytical techniques, *Storm drains, *Combined sewers, *Rainfall intensity, Water quality, Computer programs, Runoff

F032
EFFECTS OF DOSING RATES ON TRICKLING FILTER PERFORMANCE,

Cook, E. E., and Crame, L.

Southern Illinois University,
Carbondale,
Department of Thermal and Environmental Engineering.

Journal Water Pollution Control Federation, Vol. 48, No. 12, p 2723-2730, December, 1976. 3 fig, 1 tab, 19 ref.

The performance of trickling filters is examined to determine the effects of the frequency with which waste is distributed over the filter media. A model fixed bed reactor was used with a prepared synthetic waste with sucrose as the limiting substrate for bacterial growth. Nutrients were added to provide a balanced growth medium. The pH of the synthetic waste at the distributor nozzle was 7.0 to 7.5. Results indicated that increasing the rest periods between dosing caused an increase in the instantaneous hydraulic load to the filter and altered COD removal kinetics. The higher instantaneous loadings changed COD removal from two first-order rates to a single rate throughout the filter. Continuous dosing provided a great COD removal in the upper filter regions, but retarded COD removal in the lower levels. A 5-minute dosing period with a 5-minute rest period was considered best for a deep trickling filter. These results were not applicable to a circular trickling filter with rotating distributors due to the difference in filter geometry. A change in detention time by increased instantaneous hydraulic loading caused no substantial difference in effluent quality. It was thought that increased rest periods between dosings caused the biomass to grow downward toward the lower filter levels. Ponding is prevented by this more even distribution of biomass in the trickling filter. It was concluded that continuous dosing was best for shallow trickling filters and that the above dosing plan was best for deep trickling filters.

*Trickling filters, *Biological treatment, *Physical properties, Waste treatment, Chemical oxygen demand, Biochemical oxygen demand, Microorganisms, Kinetics, Biomass, Waste water treatment, Filters

F033
PROCESS CONTROL AND DATA PROCESSING IN SEWAGE TREATMENT PLANTS,

Lenschow, J.

Brown Boveri Review, Vol. 63, No. 10, p 643-650, October, 1976. 12 fig, 8 ref.

Automated control and data processing have recently been used to reduce costs and personnel work loads, as well as to increase safety and sewage purification levels. Examples were given to illustrate the beneficial use of data processing and automated control on mechanical purification, biological purification and sludge treatment. The combination of purification processes and the growing development of reliable measurement instrumentation have made this a viable part of waste water treatment. Automated process control makes it possible to optimize purification performance and increase the flexibility of plant operations.

*Automatic control, *Data processing, *Treatment facilities, *Instrumentation, Biological treatment, Sludge treatment, Measurement, Waste water treatment, Operating costs, Treatment, Computers

F034
OPTIMAL CONTROL OF AN UNSTEADY STATE CONTINUOUS ACTIVATED SLUDGE SYSTEM: A COMPARISON OF DIGITAL COMPUTER SIMULATION VS PILOT PLANT RESULTS,

Shahalam, A. B.

Dissertation Abstracts International B, Vol. 37, No. 5, p 2412, November, 1976.

A dynamic model of the activated sludge process was developed. This involved an aerator, a thickener and sludge recycle. System variables were the microorganism and substrate concentrations. System control was by detention time in the aerator and the sludge wastage rate. Analysis was made of continuous sinusoidal variations in influent substrate and microorganism levels. A digital computer simulation was used to illustrate the effects of variable waste quality on effluent quality with and without optimal system control. A laboratory scale pilot activated sludge system employing synthetic glucose waste was studied to determine the unsteady state system responses. Comparisons of the pilot system and the model indicated a close correlation. It was determined that optimal control techniques would help to produce substantial effluent quality improvements.

*Model studies, *Sludge treatment, *Activated sludge, *Computer models, *Pilot plant, Sewage effluent, Performance, Control, Aeration, Waste water treatment

Sludge thickening

F035
DESIGN PRINCIPLES OF ACTIVATED CARBON-FILLED ADSORPTION COLUMNS FOR WASTE WATER TREATMENT (Zasady projektowania kolumn sorpcyjnych z weglem aktywnym do oczyszczania sciekow),

Adamski, W., and Przewlocki, J.

In: Metody Fizykochemiczne Oczyszczania Wod I Sciekow (Referaty Z Konferencii Naukowo-Technicznej), May 6-7, 1976, Lublin, Poland, Marie Curie-Sklodowska University, Lublin, Vol. 1, p 105-119, 5 fig, 1 tab, 8 ref.

A formula was derived as an adsorber designing method. It was based on a mathematical model of sorbate balance. The parameters involved include the necessary adsorbent mass, waste water flow, mass transfer coefficient, surface area of adsorbent, and sorbate effluent and equilibrium concentrations. Activated carbon(s) surface area was determined from BET adsorption isotherms of p-cresol. A solution was developed to assess adsorption driving force and operating line COD, BOD, and TOC adsorption isotherms by use of the batch procedure. The mass transfer coefficient was determined through dynamic adsorption tests using column adsorbers filled with granular activated carbon. The extent of the adsorption front was derived from column breakthrough curves based on Michaels' formula. The linear Bohart-Adams equation was used to determine the k-value.

*Model studies, *Waste water treatment, *Adsorption, Activated carbon, Biochemical oxygen demand, Chemical oxygen demand, Flow, Carbon, Mathematical models

Michaels' formula, Linear Bohart-Adams equation, Total organic carbon

F036
COMPUTER CONTROLS 55,000 CU M/DAY OF SEWAGE,

Control and Instrumentation, Vol. 8, No. 8, p 10, September, 1976.

Computer controls have been installed at the Anglian Water Authority's Whitlingham, England, sewage treatment plant. The system allows remote automatic control of most of the treatment process, traditional biological filter treatment, and the activated sludge processes. The control loops for the activated sludge process are a good example of the sophistication provided by the system. A controlled flow of settled sewage is passed through a series of aeration tanks where air is blown into the mixed liquor to speed the oxidation process. The balance of flow rate, sludge return and oxygen level is maintained automatically and involves measurement and control of flow rate and dissolved oxygen levels. A semi-high level sequencing language was used to develop override capability in instances of electrical or mechanical failures or storms. The inlet screen, flow splitting, aeration channels, sequence switching of pumps for recirculation or double filtration, batch feeding, and monitoring of anaerobic sludge digestion are controlled. Operators can up-date set points, retrieve data on demand and initiate various control strategies while the system is functioning. There is also a provision for manual control.

*Automatic control, *Computers, Waste water treatment, Biological treatment, Sludge digestion, Treatment facilities, Aeration, Oxidation, Flow, Activated sludge

Whitlingham (UK)

F037
AN EXAMINATION OF THE VALIDITY OF THE MATHEMATICAL FORMULAE FOR EXPRESSING THE RATE OF BIOCHEMICAL OXIDATION OF SEWAGE,

Stones, T.

Water Pollution Control, Vol. 75, No. 4, p 527-529, 1976. 4 tab, 8 ref.

Conclusions based on results of investigations by Streeter and Phelps indicate that the rate of biochemical oxidation of carbonaceous matter in sewage is proportional to the remaining concentration of carbonaceous matter measured by its unsatisfied BOD, and that the process is in accord with a first-order reaction previously postulated by Phelps. Various aspects of this conclusion were evaluated. Several investigations have shown that biochemical oxidation of carbonaceous matter did not conform to the postulated reaction. This discrepancy has been ascribed to the heterogeneous nature of sewage that causes more readily oxidized constituents to be attached first so that the proportion of constituents resistant to oxidation increases and the velocity coefficient decreases as oxidation continues. If Phelps' Law is modified to assume a retardation factor so that the velocity coefficient is not constant but decreases progressively with time, constant figures should be obtainable. Values for initial velocity coefficient and the retardation factor could then be calculated. These figures were not constant and it was shown that the reaction did not proceed in accordance with the retarded exponential equation. Further calculations, assuming that oxidation is governed by unsatisfied BOD and the residual concentration of DO, resulted in a process which conformed to a second order reaction. It was concluded that the oxidation rate at any time in a period of 10 days is governed jointly by residual concentrations of DO and the unsatisfied BOD.

*Mathematical models, *Oxidation, *Analysis, *Biochemical oxygen demand, Waste water treatment, Sewage treatment, Dissolved oxygen, Domestic wastes, Chemical reactions, Evaluation

Phelps' Law

F038
PHYSICAL AND ECONOMIC PARAMETERS FOR PLANNING REGIONAL WASTE WATER TREATMENT SYSTEMS,

Klemetson, S. L., and Grenney, W. J.

North Dakota State University,
Fargo,
Department of Civil Engineering.

Journal Water Pollution Control Federation, Vol. 48, No. 12, p 2690-2699, December, 1976. 6 fig, 7 tab, 27 ref.

Parameters were developed for the operation of a mathematical model to be used in regional planning for treatment systems. Parameters considered were: population projections, waste water quality and quantity, stream and effluent standards, pollution removal efficiencies, treatment level classifications, cost indices, interest rates, economies of scale and cost coefficients for capital and operation, and maintenance costs. Data was calculated or obtained from available literature and summarized in the desired formats.

*Model studies, *Mathematical models, *Computer models, Treatment facilities, Waste water treatment, Treatment, Water quality, Community development, Human population, Economics

F039
DIGESTED SLUDGE: DELINEATION AND MODELING FOR OCEAN DISPOSAL,

Faisst, W. K.

Dissertation Abstracts International B, Vol. 37, No. 5, p 2462-2463, November, 1976.

A study was conducted to gather data on digested sludge particles and related trace metals to develop a model of digested sludge discharge in ocean disposal. Digested sludge particles in the test area, Los Angeles County (California) Sanitation Districts, were measured for size. Ninety percent of these had diameters of less than 10 microns. Of nine trace metals studied, only manganese had a dissolved fraction greater than 1% of the total metal. Sedimentation velocities of this sludge decreased as the dilution factor increased. Sedimentation of chromium, copper, iron, nickel, lead, and zinc was approximately the same as that of sludge particles. About 10% of filterable solids dissolved or oxidized in oxic mixtures. A hydraulic computer simulation indicated that sludge effluent discharges at depths of 730 m rise no more than 120 m. Analysis showed that solids reach the sediments within 10 kilometers of the discharge point. Other data revealed that nearly anoxic waters would become wholly anoxic from the sludge discharges. Chemical-equilibrium models showed that trace metals, except chromium and manganese, would be controlled by metal sulfide solids precipitation at dilutions up to 3000. It was concluded that trace metals in sludge would be immobilized in anaerobic bottom sediments of the basins and no life forms higher than bacteria were in the area to be disrupted. Ocean discharge would eliminate potentially expensive land disposal alternatives. Ocean surface waters would also be protected.

*Computer models, *Sewage disposal, *Sludge digestion, *Sludge disposal, Ultimate disposal, Sedimentation, Metals, Trace elements, Analysis, Model studies, Sulfides

Los Angeles County (Calif), Land disposal, Ocean disposal

F040
A SCREENING MODEL FOR FLOOD CONTROL PLANNING,

Mokashi, A. R.

Dissertation Abstracts International B, Vol. 37, No. 5, p 2409, November, 1976.

In order to reduce damages, a screening model was developed to aid determination of the number, location, and size of reservoirs at sites of potential flooding. Plans are judged by this model and then subjected to detailed simulation analysis for final selection. The model is a mathematical programming optimization model. The deterministic model uses the most severe historical floods as hydrologic input. Capacities of potential reservoirs are chosen by balancing annual damage against annual average costs of reservoir storage to prevent damage. For large basins, the system is divided into subsystems which are separately subjected to modeling. Design parameters employed by the screening model serve as input data for detailed simulation analysis. The chosen system must produce the maximum reduction in average annual damage.

*Model studies, *Mathematical models, *Reservoirs, *Flood control, Flood protection, Flood data, Planning, River regulation, Reservoir design, Reservoir sites

Screening model

F041
A NONLINEAR MULTILEVEL TRANSPORTATION MODEL FOR WATER RESOURCE-WATER QUALITY MANAGEMENT,

Pratishthananda, S.

Dissertation Abstracts International B, Vol. 37, No. 5, p 2410, November, 1976.

A nonlinear multilevel transportation model was developed for the study of large scale water resources systems. This included allocation to multiple users and effluent treatment to meet required water quality standards. The basic framework is a modified transportation matrix. Included are cost functions for treatment and water transport. Salt Lake County, Utah, was used as a case study area. It was divided into four subregions with the water supplies as the interconnecting variables. Surface water, groundwater and import water were allocated to municipal, industrial and agricultural users for projected 1985 median needs. Effluent from treatment facilities were required to meet goals of Public Law 92-500. Management alternatives considered were allocations with no reuse of treated effluent and allocations with effluent reuse allowed for industrial and agricultural users. The reuse of effluents proved to be least costly. The model was considered as efficient as or better than nonlinear formulations.

*Model studies, *Water resources, Comprehensive planning, Water reuse, Water quality, Effluents, Water users, Costs, Groundwater, Water resources

F042
STUDY ON SEWAGE FLOW DYNAMICS THROUGH DORR TYPE CLARIFIER ON STREAM,

Selecki, A., Zwolinski, K., Chmielewski, A. G.,
Babczynski, S., and Wild, K.

Warsaw Technical University,
Warsaw, Poland,
Institute of Chemical Engineering.

Chemie Ingenieur Technik, Vol. 49, No. 1, p 67, 1977. 2 fig, 3 ref.

Results were presented from flow dynamics research with a Dorr type clarifier. With this apparatus, sewage enters a middle column under the liquid surface, sludge exits via outlets at the column bottom, and clear fluid reaches the sewer through the overflow. Radioactive tracers were added to the stream by an impulse method. Dynamic characteristics were studied by observations of residence time distribution function in response to the introduced pulse. Flow models were developed for an overcharged clarifier and for a normally charged clarifier. With an overall sewage flow rate of 750 cu m/hour, the clear liquid flow is nearly equal to plug flow with the occurrence of a sludge short circuit. No short circuiting occurred in the overcharged flow model. This may be due to the fact that, at the given flow rate, streams outflowing from the diffusion cells in the column have significantly greater energy when compared to that at a flow rate of 451 cu m/hour. Experiments were conducted under severe conditions with results which were debatable. However, they may be considered a useful diagnostic method.

*Flow characteristics, *Dynamics, *Flow separation, *Sewage treatment, Tracers, Separation techniques, Waste water treatment, Model studies, Effluents

Dorr type clarifier

F043
WATER QUALITY INVESTIGATIONS IN THE SOUTH PLATTE RIVER BASIN, COLORADO, 1971-72,

National Field Investigations Center,
Denver Colorado.

1972. 266 p, 30 fig, 17 ref, 9 append. Technical Report NTIS PB 244-912.

Stream surveys were conducted of the South Platte River Basin (Colorado) to determine water quality changes since a survey in 1964-65. Surveys were made of Bear Creek, Clem Creek, Boulder Creek, St. Vrain Creek, the Big and Little Thompson Rivers, Cache la Poudre River, and the South Platte River. Twenty-three municipal waste treatment facilities were evaluated, as were industrial pollution sources. Developments in the control of industrial wastes since the earlier survey were evaluated as well.

*Water quality, *Analysis, *Rivers, *Streams, Water pollution sources, Pollution abatement, Treatment facilities, Municipal wastes, Industrial wastes, Evaluation

South Platte River Basin (Colo)

F044
WATER QUALITY SIMULATION OF TAHOE-TRUCKEE SYSTEM, NEVADA-CALIFORNIA-VOLUME I,

Westphal, J. A., Sharp, J. V. A., and Bateman, R. L.

Nevada University,
Reno,
Desert Research Institute.

1976. 67 p, 19 fig, 15 tab, 54 ref. Technical Report NTIS PB 247-798.

A model was developed to aid inorganic water quality control in the Tahoe-Truckee water system of Nevada and California. In this system impoundments, diversions for and returns from industrial, agricultural, and municipal uses, and groundwater returns influence inorganic quality and surface water flows. Mass-flux-balance is the basis of the model. Assumptions used relative to the model include: a conservative nature for inorganic constituents, instantaneous, complete mixing, and the accurate recapitulation of flows at an unused gaging station. The model is based on data collected over three years at 40 sites. Calcium, sodium, potassium, chloride, sulfate bicarbonate, silica, magnesium, and total dissolved solids (less silica) were modeled. The model simulates concentrations at selected points and quality of dispersed flows.

*Model studies, *Inorganic compounds, *Water quality, *Water quality control, *Rivers, *Streams, *Estuaries, Flows, Industrial wastes, Municipal wastes, Agricultural runoff, Surface waters

Tahoe-Truckee water system (Nev and Calif)

F045
SHORT COURSE PROCEEDINGS: APPLICATIONS OF STORMWATER MANAGEMENT MODELS,

Massachusetts University,
Amherst,
Department of Civil Engineering.

June, 1975. 426 p, 137 fig, 56 tab. Technical Report NTIS PB-247-163.

Presentations are made of various storm water models to solve the problem of storm and combined sewer overflows and to make state pollution control agencies aware of these resources for pollution abatement. Discussed in the proceedings are such problems as the environmental effects of urban storm water runoff, the quantity and quality aspects of this runoff, the effects of runoff on the quality of receiving waters, and decision-making regarding quantity and quality control of water. The papers presented include data requirements and case studies of the different models, along with comparative analyses. Amongst the various models, the EPA Stormwater Management Model (SWMM) was highlighted.

*Model studies, *Water management (applied), *Storm water, *Storm runoff, *Combined sewers, Hydrologic data, Water pollution, Pollution abatement, Simulation analysis, Mathematical models

*EPA Stormwater Management Model (SWMM)

F046
THE WRE STORM MODEL,

Shubinski, R. P.

Water Resources Engineers,
Springfield, Virginia.

In: Short Course Proceedings: Applications of Storm Water Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 214-242. 8 fig, 5 tab, 9 ref. Technical Report NTIS PB 247-163.

The WRE STORM model was developed to help determine future magnitudes of urban runoff pollution loads from a given watershed, to help determine the pollution load for average and extreme events, and to determine the occurrence of a given extreme event. The STORM (storage, treatment, overflow, and runoff model) considers interactions of precipitation, air temperature for snowpack accumulation and snowmelt, runoff, pollutant accumulation on land surface, land surface erosion, treatment rates, storage, and overflows from the storage/treatment system. Land uses considered in this model include: single family residential, multiple family residential, commercial, industrial, parks, and non-urban or undeveloped areas. It is used with many years of continuous hourly precipitation records and may be used for selected single events as well as for continuous simulation.

*Model studies, *Water pollution sources, *Storm runoff, *Urban runoff, Precipitation (atmospheric), Land use, Erosion, Urban hydrology, Analysis, Water quality

F047
THREE CASE STUDIES ON THE APPLICATION OF THE STORM WATER MANAGEMENT MODEL,

Vittands, J. P.

Metcalf and Eddy Engineers,
Boston, Massachusetts.

In: Short Course Proceedings: Applications of Storm Water Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 280-332. 19 fig, 12 tab. Technical Report NTIS PB 247-163.

Three case studies are presented which employ the Storm Water Management Model. These involved sewer system modeling and improvements in Cleveland, Ohio; combined sewer overflow regulation in Middletown, Ohio; and combined sewer overflow regulation in metropolitan Boston, Massachusetts. For the purposes of the first study, only parameters for the quantification of pollutants needed to be added in order to use the model as an aid in determining alternative remedies for combined sewer overflows. The technique used was design by analysis with computer simulation employed to determine conditions in a sewer system during a storm. For the second study, dry-weather flows, wet-weather flows, and other data were combined to conduct a comprehensive engineering evaluation of pollution abatement relative to combined sewer overflows to the Great Miami River within Middletown. The model was used in the metropolitan Boston area to assess the combined sewer overflow problem and to determine possible means for pollution abatement during the planning process for sewer development during the next 80 years. About 24,000 acres of combined and separate sewered areas were modeled to quantify combined sewer overflow pollution in terms of quality of discharge and amount of pollutants represented by BOD, suspended solids, and coliform bacteria.

*Model studies, *Water management (applied), Analysis, Evaluation, Overflow, Water pollution sources, Pollution abatement, Sewerage, Combined sewers, Planning, Cities

Storm Water Management Model, Cleveland (Oh), Middleton (Oh), Boston (Mass)

F048
BIOLOGICAL PHOSPHATE ELIMINATION OF PRELIMINARILY CLEANED COMMUNAL WASTE WATER BY USE OF IRON BACTERIA (Biologische Entphosphatung vorgereinigten kommunalen Abwassers unter Mitwirkung von Eisenbakterian),

Bringmann, G.

Zeitschrift fuer Wasser und Abwasser Forschung, Vol. 9, No. 6, p 195-196, 1976. 1 fig.

A report was presented of a model plant for the removal of biological phosphate from the phosphate-rich effluent of a sewage treatment plant after biological pretreatment. It was found that autotrophic microorganisms, gaining their chemoenergy from oxidation of Fe(2+) to Fe(3+) as they assimilated carbon dioxide, provided an effective means of phosphate removal.

*Phosphates, *Biological treatment, *Oxidation, *Microorganisms, Carbon dioxide, Iron, Sewage treatment, Pilot plants, Treatment facilities, Waste water treatment

F049
PROCESS TECHNOLOGICAL BACKGROUND REGARDING NEW PROTECTIVE REGULATIONS FOR WATER BODIES-RESULTS OF EXPERIMENTS ON NITRIFICATION AND PHOSPHORUS ELIMINATION IN ZURICH AND BERN. II. PROCESS TECHNOLOGICAL BACKGROUND OF NITRIFICATION IN ACTIVATED SLUDGE PLANTS (Verfahrenstechnische Unterlagen im Hinblick auf die neuen Gewaesserschutz-Anforderungen-Ergebnisse der Versuche ueber die Nitrifikation und Phosphorelimination in Zuerich und Bern. II. Verfahrenstechnische Grundlagen der Nitrifikation in Belebtschlammanlagen),

Gujer, W.

Gas-Wasser-Abwasser, Vol. 56, No. 11, p 609-614, 1976. 10 fig, 3 tab, 6 ref.

Results of pilot and laboratory experiments with activated sludge were evaluated with theoretical explanations. The effects of temperature and digester supernatant on nitrification were explored. A dynamic simulation model was used to describe performance in nitrifying activated sludge plants, with good accuracy, by the hour and for longer time periods.

*Treatment facilities, *Model studies, *Activated sludge, *Nitrification, Evaluation, Pilot plants, Laboratory tests, On-site tests, Temperature, Theoretical analysis, Waste water treatment

F050
PROCESS STABILITY OF ACTIVATED SLUDGE PROCESSES,

Chiang, C. H.

Malcolm Pirnie, Incorporated,
White Plains, New York.

Journal of the Environmental Engineering Division-ASCE, Vol. 103, No. EE2, p 259-271, April, 1977. 3 fig, 3 tab, 2 append.

Process stability indicators were developed and their importance considered for completely mixed activated sludge processes. Kinetic and mathematical models were used to determine the relationship of stability indicators. Process response and the transient concentration of soluble effluent substrate characterized process stability. Solids retention time and hydraulic detention time were found to be very important in the determination of process response. Transient soluble effluent substrate was found to be a function of solids retention time and influent substrate concentration. Hydraulic detention time in this case was unimportant.

*Model studies, *Stability, *Kinetics, *Mathematical models, *Activated sludge, Chemical properties, Physical properties, Waste water treatment, Sludge treatment, Sewage effluents

Retention times, Substrate concentrations

F051
STUDY OF THE RIO GRANDE, BOLIVIA HIGHLIGHTS SOME BASIC QUESTIONS ABOUT SIMULATION,

Johanson, R. C.

Simulation Network Newsletter, Vol. 8, No. 8, p 1-8, December, 1976. 7 fig, 3 ref.

A simulation study of the Rio Grande River, Bolivia, was performed which highlighted questions on the validity of simulation studies where data was incomplete. It was pointed out that there was no hourly continuous precipitation data available for use with Hydrocomp Simulation Programming (HSP). Opinion was presented on the need for this type of data to reduce errors in results and the relative importance of the number of gauges in simulation studies was stressed. Data on the Rio Grande was from five recording rain gauges covering a period of 1.5 years, including 81 daily records. A 30-year simulation was achieved by obtaining representative temporal distributions of daily precipitation. The calendar year was divided into rainfall seasons in which classes are identified based on quantity of daily precipitation. These formed a matrix of seasons and daily precipitation classes which made a two-way scheme for classifying any day's precipitation. Available hourly data was tallied into daily totals. Each value in the daily data record was disaggregated by random choice of a 24-hour sequence. After disaggregation of precipitation data, the HSP model was calibrated against observed streamflow in the usual way. The 30-year simulation for the river was calculated with and without a proposed dam. Results were shown to have good agreement with earlier findings and most error was very small.

*Model studies, *Rio Grande River, *Hydrologic data, Rivers, Precipitation (atmospheric), Rainfall intensity, Computer models, Evaluation, Flow, Data collections

Hydrocomp Simulation Programming (HSP)

F052
MANAGEMENT MODEL FOR WASTE WATER DISPOSAL ON LAND,

Koenig, A., and Loucks, D. P.

Cornell University,
Ithaca, New York,
Department of Environmental Engineering.

Journal of the Environmental Engineering Division-ASCE, Vol. 103, No. EE2, p 181-196, April, 1977. 3 fig, 1 tab, 2 append.

A model was proposed to assist in the evaluation of land disposal schemes, under varying climatic conditions, for pretreated municipal waste water. Models for storage lagoons and for land assimilative capacity were developed. Considerations in the lagoon model included the relationship between nitrogen removal efficiencies and effluent detention times, complex nitrogen reactions, incomplete mixing, and various temperatures and storage volumes. The second model included soil-water balance, drainage, and soil-nitrogen balance. Design policy should provide good drainage for a maximum throughput of waste water effluent in a way that does not limit storage lagoon nitrogen removal efficiency, if the nitrogen concentration of the drainage effluent is the limiting constraint.

*Model studies, *Oxidation lagoons, *Soil chemical properties, *Waste water disposal, Design criteria, Nitrogen, Drainage, Waste water treatment, Evaluation, Analytical techniques

Land disposal, Management model

F053
CONCEPTUAL MODEL FOR ACTIVATED SLUDGE PROCESSES,

Gaudy, A. F., Jr., Srinivasaraghavan, R., and
Saleh, M.

Oklahoma State University,
Stillwater,
Bioenvironmental Engineering Program.

Journal of the Environmental Engineering Division-ASCE, Vol. 103, No. EE1, p 71-86, February, 1977. 8 fig, 2 tab, 2 append.

A conceptual model was developed for activated sludge processes, using the recycled sludge concentrations and biomass concentration in the reactor as design and/or operational parameters. Engineering parameters were related to biological constants. Selectable engineering parameters such as dilution rates, the mean hydraulic retention time, and the hydraulic sludge recycle ratio had an overriding effect, indicating good engineering control over the biological process. The model can be confirmed by reconciliation with other design approaches, such as the "food to organism ratio". The model was found to be very useful in determining functional inadequacies in plant design and in aiding designers to create a facility which will deliver a reliable, high quality effluent.

*Model studies, *Activated sludge, Sludge treatment, Mathematical models, Design criteria, Biological properties, Chemical properties, Physical properties, Suspended solids, Waste water treatment, Sanitary engineering

F054
KINETICS OF BREAKPOINT CHLORINATION AND DISINFECTION,

Saunier, B. M.

Dissertation Abstracts International B, Vol. 37, No. 9, p 4631-4632, March, 1977.

A continuous flow pilot plant study was conducted to determine the kinetics of chlorine-ammonia reactions with chlorine added in excess (breakpoint chlorination) and of bacterial disinfection. Significant results were: reaction end products containing nitrogen and a lesser quantity of nitrate; nitrate production which increased directly with initial chlorine/nitrogen dose ratio; trichloride production which was less pH-dependent; and nitrate formation which was slow and not strongly pH-dependent. Nitrogen released from nitrogen trichloride was converted mainly to nitrate in the presence of free chlorine. The initial reacting stream segregation had no substantial effect on breakpoint reaction rates, but had a small effect on nitrate production. HOCl was approximately 30 times more bactericidal than OCl(-). NHCl2 was as bactericidal as HOCl. NH2Cl was practically inert in comparison. The mathematical model developed in this research can compute water pH immediately following chlorine and other chemical application, as well as the production of the aforementioned compounds, and total chlorine, free chlorine, mono-, di-, and trichloramines. Model predictions vary from reality when chlorine/ammonia dose ratio is relatively small or the contact time is short.

*Kinetics, *Chlorination, *Disinfection, Model studies, Chemical reactions, Chlorine, Lime, Municipal wastes, Nitrogen, Coliforms, Waste water treatment, Mathematical models

F055
INVESTIGATION OF DYNAMIC PERFORMANCE OF WASTE WATER TREATMENT PLANTS,

Shih, C-Y.

Dissertation Abstracts International B, Vol. 37, No. 9, p 4632, March, 1977.

A study was conducted to determine the time-dependent performance of waste water treatment plants. The stochastic time series approach used here is based on the analysis of large amounts of collected data. Two treatment systems in Wisconsin were studied. Although existing models cannot explain such situations as internal compensating mechanisms for damping out normal diurnal variations in organic loading, this model is able to explain 42-82% of data variations. Comparing the results from simplistic mechanistic models and stochastic models indicated the importance of this comparison in understanding the advantages and disadvantages of each model type. The performance of final clarifiers was also studied. Indications were that improved solids removal in final clarifiers, rather than improved soluble BOD5 removal in aeration basins, was more important for a higher degree of total system performance. Solids removal efficiency could be upgraded by expanding final clarifiers, adding coagulant aids, or filtering the final effluent.

*Treatment facilities, *Performance, *Operation and maintenance, Pollution abatement, Model studies, Sewage treatment, Effluents, Separation, Coagulation, Filtration, Waste water treatment

F056
PREDICTION OF NITROGEN TRANSFORMATIONS IN THE STORAGE LAGOON OF A LAND TREATMENT SYSTEM,

Su, Y-S.

Dissertation Abstracts International B, Vol. 37, No. 9, p 4565, March, 1977.

The influence of storage lagoons on the nitrogen balance in a land treatment system was studied. The lagoon functions as a biological reactor where algae and bacteria transform input nitrogen. A simulation model was developed to predict yearly concentrations of ammonium, nitrate, organic nitrogen and algae in the lagoon. Ammonification, nitrification, and algal uptake were considered, as were the effects of temperature, solar radiation, and rate-limiting nutrients. Data were taken from a storage lagoon with a three-month winter storage followed by a nine-month empty period. There was a great reduction of obtainable inorganic nitrogen during a substantial portion of the irrigation period; algal uptake of nitrogen was indicated as the most important factor in the lagoon's dynamic behavior. Algal growth and death rate constants had the greatest effect on ammonium-N and nitrate-N-profiles. Nitrification and ammonification were much less important. Reductions in the required irrigation land area resulted from the decrease in nitrate due to storage lagoon transformations. Lagoon effluent should be blended with secondary effluent in varying ratios during the growing season in order to design a system with a nitrogen supply equal to crop demand.

*Storage, *Lagoons, Biological treatment, Algae, Bacteria, Nitrogen, Model studies, Nitrification, Ammonification, Pilot plant, Sewage effluents, Irrigation, Waste water treatment

Land treatment system

F057
STATE OF THE ART IN SEWAGE TREATMENT PLANT CONTROL,

Olsson, G.

Lund Institute of Technology,
Lund, Sweden.

In: Chemical Process Control, Foss, A. S., and Denn, M. M., Editors, AIChE Symposium Series, Vol. 72, No. 159, p 52-77, 1976. 5 fig, 126 ref.

Waste water treatment is a non-profit industry where there is little incentive for designing an optimal cost-effective system. For this reason and because of inherent difficulties in treatment methods, there is a lack of information on the benefits and costs of automatically controlled treatment. Sewage treatment plants are centered on the removal of contaminants which are vastly varied and of such small concentrations that few have measurable levels. This is the major obstacle to designing instrumentation for control purposes. Influent and effluent qualities are measured by BOD, COD, TOC, total phosphorus, nitrogen, suspended solids, trace metals, trace organics, pesticides, and viruses. Selection of relevant information for control and instrumentation is a must, but the lack of dynamic models to determine essential variables places a real limitation on sensors and equipment. Temperature variations from seasonal changes also affect control efforts. The spatial distribution of sedimentation basin concentrates, and the changes in character of biological reactor processes also present control problems. Process design and control system design should therefore be integrated for optimum effects. Related sewer systems should be considered in treatment system design; collection systems should be operated so that flow rate or water quality changes can be predicted early and flow to the plant can be controlled. The application of various models for design, flow prediction, and routing were explored, as were current operational practices. Control and monitoring were illustrated through descriptions of the activated sludge process, settler dynamics, dissolved oxygen control, biological systems, water quality systems, phosphorus removal by chemical precipitation, and in-plant computer use.

*Waste water treatment, *Treatment facilities, *Automatic controls, Instrumentation, Chemical treatment, Analytical treatment, Monitoring, Computers, Performance, Tertiary treatment, Design criteria, Model studies, Biological treatment, Sludge treatment, Chemical properties, Biological properties, Physical properties, Flow, Biochemical oxygen demand, Dissolved oxygen

F058
DESIGN AND OPERATION OF RAIN RETENTION BASINS
(Entwurf und Betrieb von Regenruckhaltebecken),

Malpricht, E.

Berichte der Abwassertechnischen Vereinigung e. V., No. 29, p 147-162, 1976. 12 fig, 6 ref.

Design calculations and operation of rain retention basins are described. The value of the design rainfall frequency can be reduced for canals having a small slope within the sewer system. The feed canal should be as high as possible to prevent settling. The longitudinal slope of the retention basin should not be greater than 0.5%; the transversal slope should be 3-5%. The dry-weather runoff can pass through the retention basin. The calculation of rainwater retention basins according to Specification A 117 is described.

*Water storage, *Basins, *Design criteria, *Storm runoff, *Model studies, Sewers, Canals, Construction, Canal construction, Engineering, Flow, Operations

Rain retention basins

F059
GET READY FOR DUAL WATER SYSTEMS,

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Weston Environmental Consultants-Designers,
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Water and Wastes Engineering, Vol. 14, No. 4, p 88-89, 91-92, April, 1977. 3 fig, 2 tab, 5 ref.

Technological advances are increasing the probability of dual water systems and mathematical models have been developed for the costs involved in these systems. If the current rate of increased water demand, population growth, and development of chemicals which enter natural waters continue, the quality of water will decline and high quality supplies of domestic water will not remain at present levels. It is important to understand that a majority of water uses do not require the quality levels of potable water. It was suggested that a hierarchy of water use and relative quality levels be established. The supply of two or more water grades should be considered. Separate systems could be used to supply potable water and non-potable water. A higher quality level of water treatment, including disinfection, would be necessary for potable water, but non-potable water would receive treatment somewhat similar to present levels. Benefits would include lowered public health risks and water conservation. Dual systems are being used in various locales at present. An English system separates domestic (potable) and industrial (non-potable) water and, in Singapore, part of filtered waste water is used for industry and toilet flushing. A plan for St. Petersburg, Florida, would use reclaimed municipal water for lawn sprinkling. Non-potable water in dual systems should nevertheless be of such quality that accidental or inadvertent ingestion would not cause harm.

*Water supply, *Domestic water, Water quality control, Municipal water, Water consumption (except consumptive use), Industrial water, Cities, Water use, Water purification, Water demand, Treatment facilities, Model studies, Costs, Recycling

Dual water supply systems

F060
DESIGN EFFICIENCY OF STORM WATER DETENTION BASINS,

Curtis, D. C., and McCuen, R. H.

National Weather Service,
National Oceanic and Atmospheric Administration,
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Journal of the Water Resources Planning and Management Division-ASCE, Vol. 103, No. WR1, p 125-140, May, 1977. 5 fig, 6 tab, 15 ref.

A linked-system hydrograph simulation model (LSHS) was used to aid in the design of storm water detention basins. Questions concerning detention basins include the effect of these basins on watershed hydrologic response, their effectiveness in sediment removal, design parameters which affect their performance, and the sensitivity of watershed response to their design. The basic model was assumed to be rectangular with sloping sides and a horizontal bottom. The Universal Soil Loss equation (USL) was used for erosion or soil loss estimation; a settling component was developed within the LSHS model. Formulation of the detention component, stating that detention basin change rates equalled the differences between inflow and outflow, was based on the Law of Continuity. Basin location was found to affect peaking and time-to-peak. Basin effectiveness in sediment removal depended upon the shape of particle size and on weight distribution. Basin depth and orifice diameter affected peak discharge and trap efficiency. The combination of these mathematical models allows a quick evaluation of the importance of various design parameters and the determination of the impact of urbanization on the environment.

*Storm runoff, *Water storage, *Basins, *Design criteria, *Model studies, Urban runoff, Engineering structures, Mathematical models, Watersheds, Sedimentation, Watersheds (basins)

Storm water detention basins

F061
WATER QUALITY IMPACTS OF URBANIZATION—A METHODOLOGY,

Jalal, K. F.

Division of Industry, Housing, and Technology,
U. N. Economic and Social Commission for Asia and the Pacific,
Bangkok, Thailand.

Journal of the Environmental Engineering Division-ASCE, Vol. 103, No. EE1, p 49-57, February, 1977. 2 fig, 4 tab, 2 append.

The STORM (Storage Treatment Overflow Runoff Model) model was used in Canada to investigate the effects of urbanization on water quality. Three steps are involved in the application of the model for this purpose: long-term simulation of runoff quantity and quality for all planning alternatives; comparison of alternatives; and determination of the storage-treatment relationship and the optimum storage-treatment combination for the preferred alternative. Using the model can produce the optimum storage-treatment combinations for meeting a given water quality objective at minimum cost.

*Model studies, *Urban runoff, Water quality, Design, Planning, Pollutant identification, Cities, Urban areas, Water quality control, Economics

STORM runoff model

F062
A MATHEMATICAL MODEL FOR WATER QUALITY IN A COASTAL REGION IN TERMS OF SEA BOTTOM WASTE DEPOSITS (Kaitei osenbusshitsu nado no eikyo o koryo shita kaiiki no suishitsu no yosokumoderu no kaihatsu ni kansuru kenkyu),

Hashimoto, H., and Uda, T.

Public Works Research Institute,
Ministry of Construction,
Tokyo, Japan.

Kankocho Kogai Semnon Shiryo, Vol. 12, No. 1, p 66-81, 1977. 7 ref.

A mathematical model was developed to evaluate the effect of waste water treatment levels, the establishment of sewage systems, and the control of land use for estuarine water quality control. Physical, chemical, and biological processes were investigated. Field data were analyzed in the Seto Inland Sea. Three-fourths of the total influent COD was removed by sedimentation, absorption, or decay. The remainder was dispersed to the Pacific Ocean. Seasonal variations of COD in summer and in winter were clear. Organic matter reproduction was active in summer and had an effect on water quality. Thermocline developed in water at depths of 5-10 meters. Convection and dispersion by tidal currents and the decay and reproduction of organic matter should be included in the model. Analyses of density effects were carried out by two layer tidal computation. Inclusion of tidal flow dispersion in the diffusion equation is advantageous, although it is difficult to calculate the diffusion coefficient. Consumption of dissolved oxygen, organic matter suspension due to tidal flow, and dissolution of bed nutrients determine the effect of waste deposits on water quality. The importance of waste deposits is not clearly understood due to the lack of data. A mechanical turbulence generator was developed to analyze mechanisms involved in waste deposit suspension.

*Water quality, *Model studies, *Estuaries, Water quality control, Mathematical models, Analysis, Chemical oxygen demand, Sedimentation, Adsorption, Organic matter, Waste disposal, Tidal effects, Dissolved oxygen, Suspended solids, Coasts

F063
GRAVITY THICKENING OF WATER-TREATMENT-PLANT SLUDGES,

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Stamford, Connecticut.

American Water Works Association Journal, Vol. 69, No. 5, p 272-282, May, 1977.
10 fig, 30 ref, 2 append.

Conclusions from previous studies of gravity thickening prefaced this report of a study on sludge behavior during steady-state continuous thickening. Steady state conditions were established, and contraction and pressure distribution measurements were made relative to thickening zone depth. Equations were developed to analyze solids-handling capacity and the movement of planes of constant concentration in the thickening of nonflocculant suspensions. The major difference between these and flocculant suspensions is that larger concentrations of the latter occur in channeling and compression processes which do not occur in nonflocculant suspensions. The developed channeling and compression study methods were too simple for the complete description of continuous gravity thickening. A model of flocculant porous medium was constructed to describe water treatment plant sludges during gravity thickening. The mathematical description of flocculant porous medium was based on intrinsic conductivity, or the filtration characteristic of sludge, and the modulus of linear compressibility, which is its consolidation characteristic. Equations for determining the effective pressure changes with time were used to describe the batch and unsteady continuous thickening processes. The coefficient of linear compressibility was revealed to be a function of the suspended solids concentration. Filtration characteristics were dependent upon flocculant porous medium flow conditions, in addition to being concentration dependent. Channeling was described as a non-Darcian flow. A computer simulation of steady-state continuous gravity thickening was used to establish design parameters.

*Sludge treatment, *Model studies, *Flocculation, Pressure, Physical properties, Suspended solids, Loads (forces), Treatment facilities, Performance, Design, Evaluation, Waste water treatment

Gravity thickening, Water treatment wastes

F064
TWO-STAGE SETTLING IMPROVES SLUDGE REMOVAL EFFICIENCY,

Lee, C. R., Fan, L. T., Kuo, M. C., and Takamatsu, T.

Water and Sewage Works, Vol. 124, No. 5, p 41-44, May, 1977. 6 fig, 2 tab, 16 ref.

Flow patterns and geometric design have a great effect on sludge removal in sedimentation basins. A theoretical approach which divides basins into two or more stages was developed to improve removal efficiency. Modeling and simulation studies have indicated better performance in multi-stage settling tanks. Experiments were conducted to verify these results. One set of experiments was designed to identify axial dispersion from oscillating nets which generated different flow patterns and the second was to confirm performance of a two-stage tank. Results indicated that a two-stage settling tank was superior in performance, especially when axial dispersion was great. Every degree of dispersion was found to have an optimal first and second stage volume allocation. Well-designed weir troughs could improve overflow effluent quality from the first stage. Circular tanks could be used for both stages because weir loadings were smaller than those of rectangular tanks with similar capacities. Sludge spreading in single-stage rectangular settling tanks creates a long travel distance to the hopper in the sludge collector. This allowed a greater probability of sludge re-suspension in the tank. Long sludge residence times in the tank could create a septic or anaerobic state. In a two-stage tank, the first could be used as a thickener to produce fresher and denser sludge for recirculation and later dewatering.

*Sedimentation, *Settling basins, *Design criteria, Suspended solids, Flow, Model studies, Separation techniques, Sludge, Performance, Waste water treatment

F065
OPTIMAL STORAGE CONTROL IN A COMBINED SEWER SYSTEM,

Bradford, B. H.

Georgia Institute of Technology,
Atlanta,
Department of Civil Engineering.

Journal of the Water Resources Planning and Management Division-ASCE, Vol. 103, No. WR1, p 1-15, May, 1977. 8 fig, 4 tab, 7 ref.

Combined sewer overflows and storm water discharges were considered as they affect flow to treatment facilities. In-line storage or temporary flow diversion were suggested to relieve these conditions. Automatic control has become a viable alternative to static control of storage facilities. A control algorithm was used to establish computerized control criteria. The concept was applied to the planning of a San Francisco combined sewer system. Considerations involved development of storage in the total areas and in each subdistrict. Static and automatic control of overflows, street flooding, and flow to treatment plants were compared. Automatic control eliminated overflow and flooding, while maximizing treatment plant throughflow in the overall, or aggregate situation. Static control did not maximize throughflow in this situation. The second example, using a lower level of aggregation, eliminated two detention reservoirs and reduced the remaining reservoir capacity by 50%. Overflow and flooding were unavoidable. Static control produced 28% less throughflow and 229% more overflow. Automatic control maximized throughflow and produced 95% of maximum storage utilization in this instance. Further evaluation of computer control was suggested.

*Storage, *Automatic control, *Combined sewers, Computers, Flood control, Reservoirs, Basins, Model studies, Planning, Overflow, Waste water treatment, Evaluation

Static control, Control algorithm

F066
BOD5 REMOVAL FROM AERATED LAGOON SYSTEMS,

Rich, L. G., and White, S. C.

Clemson University,
Clemson, South Carolina,
Environmental Engineering System.

Water and Sewage Works, Reference Issue, p 21-23, April, 1977. 6 fig, 7 ref.

Design and operation criteria were suggested for BOD removal in aerated lagoon systems. A four-cell, dual-power system could achieve effluent quality with a lower retention time than a two-cell, dual-power level system. Lagoons presently used are of two types. Completely suspended lagoons maintain all settleable solids in suspension. Partially suspended systems hold only a portion of settleable solids in suspension. Power levels depend upon lagoon geometry and size, as well as the type of aerator involved. A completely suspended cell followed by a partially suspended cell uses less lagoon volume to attain a desired soluble BOD5 effluent concentration than either type used individually. Various equations were used to determine total retention times for both systems. An infinite retention time was calculated for both systems, but the four-cell system produced shorter retention times. This system would not produce any significant algal growth with retention times under 2 or 3 days. Algal growth at any retention time would be greatly reduced by the system. It was found that the system showed greatest enhancement when the cell number was increased from one to three. Multicellular construction resulted in much smaller cells. Flow variations could create some system instability. The dynamic behavior of the two systems was studied, at various flows, with the aid of a modeling program. The four-cell system was slightly more sensitive to flow variations, but recovery time could be twice as long. This system's surface-overflow rate in the last cell would help to maintain a stability in its effluent suspended solids. Results of the model study and laboratory studies produced several design criteria which related settling characteristics of biomass solids, hydraulic retention times, and flow rates to BOD removal.

*Oxidation lagoons, *Biochemical oxygen demand, Suspended solids, Aeration, Dissolved oxygen, Treatment facilities, Algae, Model studies, Flow rates, Hydraulic properties, Waste water treatment

F067
NATIONWIDE EVALUATION OF COMBINED SEWER OVERFLOWS AND URBAN STORMWATER DISCHARGES. VOLUME II: COST ASSESSMENT AND IMPACTS,

Heaney, J. P., Huber, W. C., Medina, M. A., Jr., Murphy, M. P., and Nix, S. J.

Florida University,
Gainesville,
Department of Environmental Engineering Sciences.

1977. 380 p, 62 fig, 73 tab, 109 ref. Technical Report EPA-600/2-77-064.

Costs associated with various degrees of wet-weather pollution control were determined as part of a nationwide study. The quality and quantity of urban storm flow was assessed in nearly 248 American urban areas. Continuous simulation runs were used to determine pollution control levels for specified storage volumes and treatment rates in Atlanta, Denver, Minneapolis, San Francisco, and Washington, D. C. Equations derived from the collected data were combined into a optimization model that could determine the best mix of storage and treatment for any viable level of control in any city. Determinations suggested that annual costs would be about $297 million for 25% pollution control and $5,029 million for 85% control. Corresponding capital costs would be $2,476 million and $41,968 million. Potential savings were indicated if wet-weather quality control were integrated with dry-weather sewage treatment plants and/or storage facilities for storm water quantity control. The use of best management practices (BMP) was suggested as an alternative means for reducing control costs.

*Combined sewers, *Overflow, *Storm water, Urban runoff, Pollution abatement, Treatment facilities, Costs, Model studies, Sewage treatment, Waste water treatment, Economics

F068
THE IDENTIFICATION AND ADAPTIVE PREDICTION OF URBAN SEWER FLOWS,

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Cambridge University,
Cambridge, England,
Department of Engineering.

International Journal of Control, Vol. 25, No. 3, p 425-440, March, 1977. 7 fig, 21 ref.

Studies were conducted to develop models for the identification and prediction of urban sewer input flows to treatment plants. Plant operations would be enhanced by a more precise knowledge of input material, which varies with time. Such knowledge would also minimize storm water overflows from sewers. Results were presented for identification of a stochastic input-output, time-series model using the maximum likelihood method. Two steps were involved in the prediction problem: black-box model predictions estimated recursively with a least squares technique, and plant inflow prediction by a newly updated model and parameter estimates. The identification problem involved the determination of a dynamic model which related given rainfall measurements to the flow component. Adaptive prediction should identify the process equation by maximum likelihood methods; compute optimal, minimum variance, predictor; and compare the adaptive predictor for the unknown process with the optimal predictor for the known process. The major limitation of adaptive prediction was the poor quality of the data.

*Model studies, *Flow, *Sewers, *Treatment facilities, Hydrologic data, Overflows, Urban areas, Rainfall, Theoretical analysis, Waste water treatment

F069
THE PREDICTION OF THE RAINFALL-RUNOFF BEHAVIOR IN URBAN AREAS
(Zur Prognose des Niederschlag-Abflussverhaltens in urbanen Einzugsgebieten),

Neumann, W.

Wasserwirtschaft, Vol. 67, No. 4, p 89-93, April, 1977. 9 fig, 10 ref.

A model for the prediction of urban rainfall-runoff relationships was presented. A division into surface and channel systems was necessary, and an overland flow model was especially important regarding the transfer of areal characteristics. A single linear reservoir model suffices if the parameter is based on specific area characteristic values. Variables considered included length of flow, roughness of area surface, and slope. Rainfall intensity influences were necessarily considered in the nonlinear rainfall-runoff process. The model provided practical solutions to this problem.

*Rainfall-runoff relationships, *Model studies, *Urban areas, Flow, Surface runoff, Precipitation (atmospheric), Urban runoff, Slopes, Overland flow, Physical properties

F070
BEST PRACTICABLE WASTE TREATMENT SCREENING MODEL,

Haith, D. A., and Chapman, D. C.

Cornell University,
Ithaca, New York,
Department of Civil Engineering.

Journal of the Environmental Engineering Division-ASCE, Vol. 103, No. EE3, p 397-412, June, 1977. 1 fig, 8 tab, 2 append.

A model was developed to identify cost-effective waste water management that satisfies the "best practicable waste treatment" requirement of P.L. 92-500. The model incorporated comparisons of costs and performance of water discharge, land application, and reuse options. Combinations of these items were also evaluated by the model. The model's accuracy was consistent with preliminary planning guidelines. Simulation and dynamic programming were able to provide solutions to the model. Some cases could be solved by using only dynamic programming. When dynamic programming was insufficient, it could be used to focus cost-effective combinations that were then judged by simulation.

*Model studies, *Dynamic programming, *Cost-benefit analysis, Treatment facilities, Evaluation, Costs, Performance, Regulations, Waste water treatment

Screening models

F071
THE PERSISTENCE OF POLIOVIRUS IN ACTIVATED SLUDGE TREATMENT,

Balluz, S. A., Jones, H. H., and Butler, M.

Journal of Hygiene, Cambridge, Vol. 78, No. 2, p 165-173, 1977.

Poliovirus persistence during activated sludge treatment was studied in a model activated sludge treatment facility. Poliovirus was inoculated either continuously or by single dose. Viral distribution in influent, mixed liquor, and effluent was regularly monitored. Observations of viral decline during sewage treatment were confirmed. It was concluded that virus removal efficiencies were related to suspended solids removal capacities, and that an effluent with low solids content would likely contain low viral counts. Careless disposal of untreated sludge may be the cause of pathogenic virus transmission in sewage whose effluent was apparently virus-free. It was not possible to determine reasons for differences in viral decline rates after cessation of inoculation of the two experimental systems. It was suspected that a relationship existed with solids loading. The viral inactivation mechanism was not understood, although direct or indirect biological activity was considered the most important factor.

*Viruses, *Persistence, *Activated sludge, Temperature, Suspended solids, Operations, Performance, Separation, Model studies, Treatment facilities, Waste water treatment

F072
A MODEL FOR ALUMINUM PHOSPHATE PRECIPITATION,

Ferguson, J. F., and King, T.

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Journal Water Pollution Control Federal, Vol. 49, No. 4, p 646-568, April 1977.
11 fig, 1 tab, 20 ref, 1 append.

A conceptual and numerical model for orthophosphate precipitation was described. The model accounted for many experimental and field studies on aluminum addition. The process was modeled as an equilibrium precipitation process. Phosphate removal was approximately stoichiometric at an Al:P mole ratio of 1.4 until a residual of nearly 1 mg/liter at a final pH of 5.2-6.9. Aluminum and phosphate mass balances could be used to compute residuals from aluminum phosphate solubility at doses near the stoichiometric requirement. Overdosing above 60 mg/liter only changes the final pH. Intense initial mixing and uniform chemical addition are necesary for efficient use of alum in the stoichiometric zone. Phosphate reduction usually causes a reduction in chemical costs if done in the stoichiometric zone, except when alkalinity is high or low. Qualitative reproductions of the effects of alum dosage and pH seen in experimental studies can help estimation of the potential applicability of alum for a particular waste water and the needed chemical dosages.

*Model studies, *Separation techniques, Phosphate, Aluminum, Hydrogen ion concentration, Sewage effluents, Physical properties, Chemical properties, Design criteria, Waste water treatment

F073
NETWORK APPROACH TO OPTIMAL WASTE WATER TREATMENT SYSTEM DESIGN,

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Department of Civil Engineering.

Journal Water Pollution Control Federation, Vol. 49, No. 4, p 623-632, April, 1977.
4 fig, 4 tab, 6 ref.

Optimal process selection in the design of waste water treatment systems can be facilitated by using the network approach. Considerations in selection include recognitions of several facts. Each process' cost per unit of flow is a function of the treatment level and the inflow level. Optimization of all parameters, such as BOD and suspended solids, must be determined. The fact that each process may create new waste streams should be considered. Existing fixed capacity facilities and disposal considerations should also be incorporated. The network approach can handle multiple waste parameters and can determine costs sensitivity of various effluent quality levels. The similarity of the network approach to the flow-chart of a treatment plant allows simple translation from the physical problem to the network format and then to the computer code. The network approach would be most useful as a decision-making aid.

*Treatment facilities, *Model studies, *Design, Biological treatment, Chemical treatment, Physical properties, Sewage effluents, Sludge, Waste water treatment, Waste disposal

F074
GREAT LAKES EUTROPHICATION: THE EFFECT OF POINT SOURCE CONTROL OF TOTAL PHOSPHORUS,

Chapra, S. C., and Robertson, A.

Great Lakes Environmental Research Laboratory,
National Oceanic and Atmospheric Administration,
Ann Arbor, Michigan.

Science, Vol. 196, No. 4297, p 1448-1450, June, 1977. 1 fig, 13 ref.

A mathematical model was developed to describe phosphorus-induced eutrophication in the Great Lakes. The model of the total phosphorus budgets for the Great Lakes was based on the assumption that a lake's trophic state is predominantly determined by its phosphorus levels. Basic forcing functions of the model were variables which represented human activities in each drainage basin. These variables were translated into phosphorus loadings by a waste source submodel. Three groups of waste sources were considered: domestic sources, land runoff, and atmospheric inputs. The model acknowledges exchange between lakes and in-lake losses. The latter was a first-order loss whose basic parameter was the apparent settling velocity of total phosphorus. The model was a set of ordinary differential equations. The model revealed that a 1 mg/liter effluent restriction would provide significant water quality improvements. Phosphorus levels in central and eastern basins of Lakes Erie and Ontario would fall from over 20 micrograms/liter to about 10 micrograms/liter. Even lower concentrations would be achieved in Lake Michigan. Minor improvements would be effected in Lakes Superior and Huron. The western basin of Lake Erie, Saginaw Bay, and lower Green Bay have naturally higher phosphorus concentrations. The proposed restriction would not reduce total phosphorus in these areas below 20 micrograms/liter.

*Eutrophication, *Mathematical models, *Phosphorus, *Great Lakes, Water quality standards, Loads (forces), Domestic wastes, Surface runoff, Waste water treatment

F075
SOLVING STREAM POLLUTION CONTROL PROBLEMS WITH DIGITAL COMPUTER AND MODELLING TECHNIQUES,

Wang, L. K., Wang, M. H., and Bergenthal, J. F.

Proceedings of the Institute of Environmental Sciences, 23rd Annual Technical Meeting, April 25-27, 1977, Los Angeles, California, p 29-31. 1 fig, 1 tab, 7 ref.

Procedures were described for modelling and controlling stream pollution. A mathematical model was developed by means of the multiple linear correlation method. This model calculated dissolved oxygen (DO) concentrations in fresh water at various temperatures. The DO-drop was determined to be a function of combined BOD loads of upstream, the temperature of stream water, and the stream flow. The model was used to calculate allowable BOD discharges in the upstream. A different DO-drop model should be developed for different streams or different sections in the same stream.

*Dissolved oxygen, *Biochemical oxygen demand, *Mathematical models, Water pollution control, Temperature, Streamflow, Loads (forces), Model studies, Computers, Waste water treatment, Analytical techniques

DO-drop

F076
BIOKINETICS OF LOW TEMPERATURE WASTE ASSIMILATION,

Topnik, B. H.

Dissertation Abstracts International B, Vol. 37, No. 11, p 5801-5802, May, 1977.

The biokinetics of low temperature waste assimilation were studied. Investigations were performed with a 20 liter/day continuous-flow extended aeration unit at temperatures of 20-0 C. Raw domestic sewage was used as the feed. Data on kinetic growth and substrate utilization were analyzed after steady state operation at a given temperature. Temperature and substrate concentration effects on growth and substrate utilization were unobservable after 261 days of testing. Average kinetic constants were given and overall BOD5 removals followed a zero-order relationship. Nitrification was evident at all temperatures. About 18% of feed ammonia nitrogen was oxidized to nitrate at 0 C. The oxygen uptake rate was temperature-dependent. High BOD5 and COD removal efficiencies at low temperatures were attributed to cellular food storage rather than to cell replication. Other test parameters supported this conclusion.

*Kinetics, *Aeration, *Waste water treatment, *Temperature, Domestic wastes, Biochemical oxygen demand, Chemical oxygen demand, Nitrification, Oxygen, Ammonia, Nitrogen, Separation techniques, Model studies, Waste water treatment

Biokinetics, Kinetic growth, Substrate utilization, Laboratory studies

F077
TRANSPORT OF NITRATE ION IN UNSTEADY, UNSATURATED FLOW IN POROUS MEDIA,

Hildebrand, M. A., and Himmelblau, D. M.

Texas University,
Austin,
Department of Chemical Engineering.

AIChE Journal, Vol. 23, No. 3, p 326-335, May, 1977. 8 fig, 1 tab, 39 ref.

A simplified model of nitrate ion transport was described for unsteady, unsaturated flow in porous media. The model was used to gain information on the pollution of ground and surface waters, especially through leaching and infiltration. The water content of the sand and the nitrate ion concentrations in the water phase were important variables. They had to be measured for less than saturated flow. Model-based predictions were compared to data on nitrate movement in sand columns. Profiles of nitrate concentrations as a function of time and distance showed good agreement with model-based data. The nitrate dispersion front velocity and the nitrate dispersion coefficient proved to be functions of time and flow rate. A correlation was developed between the nitrate dispersion coefficient and cumulative average seepage velocity. This allowed application of the model to media other than sand. The agreement between predicted values of the nitrate concentration and the experimental values was found satisfactory when subjected to an F test.

*Ion transport, *Nitrates, *Leaching, *Infiltration, *Mathematical models, Water pollution sources, Time, Flow rates, Chemical properties, Waste disposal, Movement, Waste water treatment

F078
DIRECT DIGITAL CONTROL AT THE IOWA CITY WATER-TREATMENT PLANT,

Manning, A. W.

EMA, Incorporated,
Consulting Engineers,
St. Paul, Minnesota.

American Water Works Association Journal, Vol. 69, No. 6, p 317-324, June, 1977.
10 fig.

A report was presented on computer control of the water treatment plant in Iowa City, Iowa. Because of plant expansion and the variability of conditions in the Iowa River, a digital system was chosen over the more expensive and complex analog system. Although the plant was designed to be run automatically, an operator could assume control of plant operations at any of five control panels, and could run the plant by computer or manually. Processes discussed included: skimming-gate control, low-lift-pump sequencing, flow split, sludge-blanket control, filter control and washing, chemical feed control, clear-well control, distribution, and high service control. Computerization of low-lift-pump sequencing saved on power, due to programming for minimum horsepower, and on equipment wear, due to more efficient and less frequent starts and stops. Filters could be washed automatically, thus increasing effluent quality. The devices were constantly monitored; an alarm would sound and be printed out if any device was operating in alarm condition, and must be acknowledged and shut off by the operator. A digital system provided data-handling capabilities which would be unavailable with an analog system. Data were supplied and managed by an operator control panel, a graphic panel, an alarm logger, and a report logger. Logs could be made up continuously and at any set time interval daily, monthly, and yearly. The digital control system proved to have increased quality of effluent and efficiency of operation; lowered costs in power and chemicals; and improved control of distribution.

*Computers, *Digital computers, *Municipal water, *Water quality control, Automatic control, Filtration, Costs, Waste water treatment, Data storage and retrieval, Pumps, Effluents

Iowa City (IA)

F079
THE EFFECT OF URBAN SEWAGE AND INDUSTRIAL WASTES OF BIALYSTOK ON THE PURITY AND BIOCOENOSIS OF THE SUPRASL AND NAREW RIVERS (Wplyw sciekow miejskich i przemyslowych m. Bialegostoku na czystosc i biocenoze rzeki Suprasli i Narwi),

Januszko, T., and Malyszko, E.

Institute of Social Medicine,
Academy of Medicine, Bialystok, Poland,
Division of Hygiene.

Gaz, Woda i Technika Sanitarna, Vol. 51, No. 2, p 48-51, 1977. 22 ref.

The effect of a tributary river, Biala, carrying urban sewage and industrial waste material, on the purity and biocoenosis of the downstream sections of the Suprasl and Narew Rivers is evaluated. Five water-testing positions at varying distances from the pollution source were selected. Water samples for physico-chemical, bacteriological, and hydrobiological tests were taken, as were plankton samples. Physico-chemical properties were determined by domestically developed methods. Differentiation of microorganisms was undertaken by routine processes. It was determined by standard methods that the pollution of the downstream section of the sewage and waste-carrying Biala River was very high. Wastes in the Biala caused high water pollution of the lower segment of the Suprasl River, as indicated by higher water turbidity, specific odor, high oxidizability, and much higher ammonia, nitrite, and chloride levels. However, by physico-chemical standards, Suprasl River contaminants did not significantly affect the Narew River. This phenomenon could be explained by the considerable dilution of the pollutants entering the Narew River. Microbiologically, the Biala River exhibited a superiority of rods over cocci; the Suprasl had at first a low bacterial index, and downstream had an increase of rods. In the Narew, cocci at first slightly dominated over rods; in its lower part, affected by the water of the Suprasl, rods numerically equalled cocci. The downstream portions of the Suprasl and Narew Rivers polluted by the waters of the Biala were characterized by the disappearance of pollution-sensible hydrobiological species and domination of saprobic species.

*Water pollution effects, *Municipal wastes, *Industrial wastes, Water pollution control, Rivers, Turbidity, Odor, Oxidation, Ammonia, Nitrites, Chlorides, Bacteria, Waste disposal, Waste water treatment

Bialystok (Poland), Suprasl River, Narew River

F080
IDENTIFICATION OF STRUCTURE AND PARAMETERS OF HYDROLOGIC RUNOFF-MODELS (Identifikation von Struktur und Parametern hydrologischer Abflussmodelle),

Marr, G.

Wasserwirtschaft, Vol. 67, No. 4, p 94-97, April, 1977. 2 fig, 1 tab, 6 ref.

A study of hydrologic models was presented. The identification of their structure and relevant parameters was reviewed. Mathematical equations were used to define the parameters by hydraulic values. The models were approximations of the differential equations developed for non-steady runoff. The validity of the results was checked by the use of a transfer function which was derived from measured data.

*Model studies, *Runoff, *Hydrologic data, Equations, Mathematical models, Surface runoff, Urban runoff, Physical properties, Waste water treatment

F081
THE TECHNICAL-ECONOMIC MODEL OF WATER QUALITY IN THE SAJO RIVER
(A sajo vizminosegi muszaki-kozgazdasagi modellje),

Bora, G., Hock, B., Mucsy, G., Pinter, J., and
Reczey, G.

Karl Marx University of Economics,
Budapest, Hungary.

Hidrologiai Kozlony, Vol. 57, No. 1, p 27-37, January, 1977. 3 fig, 9 tab, 36 ref.

A technical-economic model was developed as an aid in planning construction of sewage treatment facilities for the Sajo River area of Hungary. COD, characterized by dichromate oxygen consumption, was used as the basis for modelling oxidizable substances. The effluent discharge to the river was mainly toxic industrial wastes. It was assumed that the decrease of the COD mass current in the direction of flow was proportionate to the existing COD. Nine major streams represented 98% of the COD mass current. These were considered in the model formulation. The model set COD standards for the receiving waters to aid optimization of construction and operating costs. Alternative technologies were developed for individual pollution sources and related costs were computed. Allowances were made for future industrial development. The final choices were determined by the achievement of COD standards at the lowest cost.

*Water quality standards, *Model studies, *Chemical oxygen demand, *Water pollution control, Treatment facilities, Industrial wastes, Water pollution sources, Planning, Rivers, Economics, Costs, Waste water treatment

Hungary

F082
MATHEMATICAL MODELING OF HETEROGENEOUS SORPTION IN MATHEMATICAL CONTACTORS FOR WASTEWATER DECONTAMINATION: INFLUENCE OF REVERSIBILITY AND CHROMATOGRAPHIC EFFECTS ON SYSTEM DESIGN AND OPERATION,

Keinath, T. M., Karesh, H., Lowry, S., and Abdo, M. S.

Clemson University,
South Carolina,
Environmental Systems Engineering.

1976. 169 p, 69 fig, 5 tab, 55 ref. NTIS Technical Report AD-A031 179.

A predictive mathematical model was developed to aid various studies of activated carbon adsorption. The major objective was to model multiple solute adsorption onto activated carbon from solution by a differential contacting system. Present multisolute adsorption equilibria models were evaluated. The influence of adsorption reversibility and chromatographic effects on the operation of prototype adsorbers was also determined. Bi-solute combinations of o-phenylphenol (OPP), dinitro-o-sec-butylphenol (DNOSBP), and 2,4-dichlorophenol (2,4-DCP) were used in several adsorption equilibria studies. The Longmuir Competitive Adsorption Model and the Longmuir Semi-Competitive Ideal Solution Theory and Graphical Models were evaluated. Although neither method sufficiently described competitive adsorption effects, the graphical method produced the best estimates. Mathematical model simulations produced several observations. Fluidized bed operation minimized the elution of adsorbed contaminants from adsorbers much better than packed-bed operation. All contaminants of industrial production should be discharged simultaneously. Waste waters with the highest energy-adsorbing contaminants should be introduced first to a column of fresh adsorbent, with the lowest energy-adsorbing contaminants entered last. Minimization of displacement and subsequent elution of adsorbed contaminants resulted from using concentration equilization before the adsorbers. These conclusions were generally supported by columnar laboratory studies.

*Sorption, *Mathematical models, *Activated carbon, Chemical reactions, Separation techniques, Model studies, Equipment, Treatment facilities, Evaluation, Kinetics, Waste water treatment

Longmuir Competitive Adsorption Model, Longmuir Semi-Competitive Ideal Solution Theory and Graphical Models

F083
DESCRIPTIVE WATER QUALITY (DISPERSION) MODEL FOR THE DANUBE SECTION BETWEEN SZOB AND BUDAPEST (A Duna, Szob es Budapest kozotti vonatkozo, leiro jellegu visminosegi (diszperzios) modell),

Somlyody, L.

Vizgazdalkodasi Tudomanyos Kutato Kozpont,
Budapest, Hungary.

Hidrologiai Kozlony, Vol. 52, No. 2, p 71-78, February, 1977. 10 fig, 22 ref.

A linear descriptive model for representation of water quality along the Danube proved inadequate, since transverse changes were observed to be greater than longitudinal variations. A dispersion model was investigated as the basis for a mathematical model for water quality which would correspond to the Hungarian filing system of river data. In this model, curvilinear relations are used to determine variations in background pollution as well as to examine individual discharges. The language used in programming the dispersion model is FORTRAN IV. Additional data required include: distributions of velocity, initial conditions, and dispersion coefficients. The dispersion model has been used for the Szob-Nagymaros section of the Danube. It was found that closely spaced cross-sections are necessary for accurate descriptions. Only very slow mixing does occur, and differences between actual and computed input parameters may affect computed mixing intensities.

*Water quality, *Dispersion, *Mathematical models, *Computer models, *Sampling, Model studies, Curves, Streamflow, Mixing, Flow characteristics, Statistical methods, Spatial distribution, Simulation analysis, Systems analysis, Waste water treatment

Danube River, Hungary, Dispersion models

F084
STORM WATER MANAGEMENT MODEL: LEVEL I - PRELIMINARY SCREENING PROCEDURES,

Heaney, J. P., Huber, W. C., and Nix, S. J.

Florida University,
Gainesville,
Department of Environmental Engineering Sciences.

1976. 77 p, 23 fig, 24 tab, 26 ref. Technical Report EPA-600/2-76-275.

The need for a more simplified user-oriented alternative to the USEPA Storm Water Management Model has prefaced the preparation of a four-level series of storm water management models. The Level I model emphasizes a nationwide assessment of storm water pollution control costs and quantity and quality estimates for urban runoff. For this model, the country is divided into five zones based on precipitation patterns. Each urban area is partitioned according to land use and type of sewer system. Results from runs of the Corps of Engineers' STORM model on a representative city in each of the regions were used to develop the assessment method and calibrate the run-off prediction technique. Population density, depression storage, and a runoff coefficient were used to generate annual wet-weather runoff and dry-weather flow estimates. Using limited available data, pollutant loadings for wet weather were estimated with respect to precipitation, land use, and population density. Annual dry- and wet-weather pollutant loadings were calculated. A method for determining the optimal combination of mixing and storage of runoff for various degrees of pollutant control has been developed for use in any U. S. city. Costs were assessed according to type of sewer system. Multipurpose planning using flow equalization between wet- and dry-weather treatment facilities, possibly incorporating storage during peak flow, was suggested as a means of reducing costs of adequate storm water pollution control.

*Runoff forecasting, *Storm runoff, *Storm water, *Urban runoff, *Mathematical models, Average runoff, Sewerage, Urban drainage, Forecasting, Urban hydrology, Storm drains, Combined sewers, Cities, Waste water treatment, Costs, Cost allocation, Water pollution sources

Storm Water Management Model (SWMM)

F085
ROLE OF MODELS IN URBAN STORMWATER MANAGEMENT PLANNING,

Heaney, J. P.

Florida University,
Gainesville,
Department of Environmental Engineering Sciences.

In: Applications of Stormwater Management Models 1976, 1977. p 4-13, 1 fig, 10 ref. Technical Report EPA-600/2-77-065.

An outline is presented which examines possible uses for mathematical models or simulations in storm water management, in compliance with Section 208 of the Federal Water Pollution Control Act Amendments which require plans to abate and control point and non-point waste sources in urban areas. Areas evaluated for model use in Section 208 implementation include: public participation and local government involvement; organization; data collection; natural and physical systems analysis; social, economic, and land use analysis; waste water source analysis; waste water treatment systems, non-point sources, and water quality analysis; groundwater protection and enhancement; development of non-point source control strategies; land use/water quality relationship; public works/water quality relationship; and institutional analysis. The report also considered waste water management techniques; evaluation and comparison of alternative plans; selection of waste treatment management program; environmental, social, and economic impact assessment; plan preparation and completion; and coordination activities. Specific models suggested for use include STORM, FILTH, and the Universal Soil Loss Equation (USLE).

*Rainfall-runoff relationships, *Model studies, *Computer models, *Mathematical models, *Federal Water Pollution Control Act, Water management (applied), Urban runoff, Storm runoff, Storm water, Planning, Management, Waste water treatment

STORM, FILTH, SWMM, USLE, Storm water management

F086
INTRODUCTION TO THE EPA STORM WATER MANAGEMENT MODEL (SWMM),

Huber, W. C., and Heaney, J. P.

Florida University,
Gainesville,
Department of Environmental Engineering Sciences.

In: Applications of Stormwater Management Models - 1976, 1977. p 34-73, 14 fig, 2 tab, 26 ref. Technical Report EPA-600/2-77-065.

The EPA Storm Water Management Model (SWMM) was developed to aid municipalities in decision-making for urban runoff treatment by providing accurate quantitative and qualitative descriptions of the total urban rainfall-runoff process. A general description of SWMM's overall design and capabilities is presented. Using a high speed digital computer, SWMM simulates single storm events and long-term trends in storm runoff using input data for rainfall, catchment, conveyance, storage/treatment, and receiving data. Input sources, a central core, correctional devices, and the effect on receiving waters comprise the model structure. Included in the input sources are: RUNOFF, a subroutine to estimate surface runoff, COD, settleable solids, total nitrogen, phosphate, and grease; FILTH for generation of dry-weather flow; and INFIL to assess infiltration/inflow. The central core is used to integrate the data generated for the input sources. Correctional devices are used to modify input according to retention time, treatment cost and efficiency, and other parameters. RECEIV is used to evaluate the effects of input data on receiving waters. Other parameters which can be estimated by the model include 5-day BOD, total suspended solids, and total coliform. The program itself is divided into individually accessible blocks for qualitative and quantitative estimates of runoff, transport, and storage and treatment. A sample simulation for the city of Lancaster, Pennsylvania is presented.

*Computer models, *Mathematical models, *Urban runoff, *Storm water, Sewer systems, Planning, Water management (applied), Combined sewers, Precipitation, Hydrographs, Hydrologic systems, Urban hydrology, Costs, Infiltration, Inflow, Forecasting, Cost analysis, Storm drains, Sewage treatment, Waste water treatment, Rainfall-runoff relationships

Storm water management, Storm Water Management Model (SWMM)

F087
SWMM APPLICATION STUDY GUIDE,

Jewell, T. K., Mangarella, P. A., DiGiano, F. A., and
Adrian, D. D.

Massachusetts University,
Amherst,
Department of Civil Engineering.

In: Applications of Stormwater Management 1976, 1977. p 91-231, 25 fig, 20 tab, 13 ref. Technical Report EPA-600/2-77-065.

A series of study guides as an aid to the use of the computerized EPA Storm Water Management Model (SWMM) is presented. Sample data and program output, as well as suggestions for data collection, are presented for the Runoff and Transport program blocks within SWMM. To illustrate design limitations and capabilities, case studies are presented for an urban drainage basin of approximately 300 acres. Job control parameters and deck setups to access SWMM are described.

*Computer programs, *Mathematical models, *Urban runoff, *Storm water, *Data processing, Urban hydrology, Model studies, Water management (applied), Precipitation, Hydrologic systems, Waste water treatment, Data collections, Computer models, Urban drainage, Rainfall-runoff relationships

Storm water management, Storm Water Management Model (SWMM)

F088
PERFORMANCE OF STORM DRAINAGE SIMULATION MODELS,

Colyer, P. J.

Proceedings of the Institution of Civil Engineers, Part 2, Vol. 63, p 293-309, June, 1977. 3 fig, 3 tab, 33 ref.

Various storm drainage models were evaluated for accuracy in simulated observed storm events. Models examined included: rational (Lloyd-Davies) method; direct method; inlet method; lumped hydrologic methods; Transport and Road Research (TRRL) method; East African modification of TRRL (TRRL(EA)); Illinois urban drainage area simulator (ILLUDAS); Massachusetts Institute of Technology (MIT) method; University of Cincinnati urban runoff (UCUR) method; hydrograph volume method (HVM); EPA storm water management model (SWMM); and the Illinois storm sewer system simulation (ISS) model. Numerical parameters were used to determine accuracy in performance using observed and calculated values for hydrologic variables such as peak discharge, time to peak, and total runoff volume. Among the numerical parameters used were: lambda, the ratio between calculated and observed values; epsilon, the absolute error between individual calculated and observed values; and epsilon calculated for groups of positive and negative errors. Calculations indicated that storm sewer models can predict peak discharge and runoff volume within 10-20%. The TRRL method was capable of the most accurate overall performance of the models examined. Suggestions for improvement in storm drainage models include closer examination and field studies to better determine the limitations of simulation models, more efficient programming to reduce costs to the user, and the addition of other parameters such as surcharging, backwater effects, and surface flooding.

*Computer programs, *Mathematical models, *Simulation analysis, *Storm runoff, *Water management (applied), Sewerage, Urban hydrology, Drainage systems, Hydrograph analysis, Sewers, Analytical techniques, Storm water, Waste water treatment

Storm drainage simulation models, TRRL

F089
EVALUATION OF A COMPREHENSIVE KINETIC MODEL FOR THE ACTIVATED SLUDGE PROCESS,

Benefield, L. D., and Randall, C. W.

Colorado University,
Boulder,
Department of Environmental and Civil Engineering.

Journal Water Pollution Control Federation, Vol. 49, No. 7, p 1636-1641, July, 1977.
6 fig, 12 ref.

Mathematical models have been used to predict steady-state biomass and effluent substrate concentrations for completely-mixed, suspended growth, biological processes with and without cellular growth. Limitations of previously used models are discussed, and a model to adequately describe process kinetics under conditions outside the limits of other models is presented. Previous models have assumed that effluent and influent substrate concentrations are independent, whereas investigations of the treatment of organic substrates by mixed microbial cultures have indicated otherwise. This relationship, if valid, would necessitate changing mean cell residence times to compensate for variations in influent substrate concentration. It is suggested that mean cell residence time may not be useful as a control parameter for plant operation where the influent substrate varies.

*Mathematical models, *Activated sludge, *Biomass, *Forecasting, *Effluents, Operations research, Mathematical studies, Sludge treatment, Kinetics, Model studies, Water Pollution Control Federation, Waste water treatment

Grau-Dohanyos model

F090
CONTROL STRATEGIES FOR THE ACTIVATED SLUDGE PROCESS,

Flanagan, M. J.

Flanagan and Associates,
San Francisco, California.

Instrumentation Technology, Vol. 24, No. 7, p 35-43, July, 1977. 5 fig, 5 ref.

Improved automatic control of the activated sludge process has been suggested to increase process performance and efficiency, particularly in the treatment of wastes with large diurnal and seasonal variations. In order to maintain the food-to-microorganism ratio within the acceptable operating limits, increases in plant flow and solids loading must be controlled to prevent overburdening of the oxidation and sedimentation tanks. A suggested solution to the oxidation-sedimentation interaction is to provide storage during peak flow, larger sedimentation tanks to accommodate diurnal fluctuations, and separate oxidation and sedimentation processes. Since many facilities are not equipped with return activated sludge facilities or sufficient storage space in sedimentation tanks, three additional control strategies are described: return activated sludge storage facilities, and variable-speed pumping between storage and oxidation tanks with optional step-feed control gates; oxidation tanks equipped with power-actuated step-feed control gates; and sedimentation tanks equipped with power-actuated step-feed control gates. All three contain a feedforward-feedback air supply control system which is activated by on-line measurements of dissolved oxygen levels and oxygen demand, as determined by dissolved oxygen probes and a respirometer.

*Activated sludge, *Automatic control, *Oxidation, *Biodegradation, *Settling basins, Sludge treatment, Oxygen requirements, Sewage treatment, Sewage effluents, Biochemical oxygen demand, Fluctuations, Equipment, Remote control, Waste water treatment

Activated sludge process control

F091
INITIAL DILUTION WITH DEEPWATER DIFFUSERS,

Wallis, I. G.

Caldwell Connell Engineers,
Melbourne, Australia.

Journal Water Pollution Control Federation, Vol. 49, No. 7, p 1621-1626, July, 1977.
3 fig, 3 tab, 3 ref, 2 append.

The dynamics of ocean-discharged effluent from deep water diffusers are examined in an effort to better predict the thickness, width, location, and strength of the effluent field in relation to diffuser design and other factors. Factors considered include grit and sludge deposition near the outfall, vertical distribution of the effluent, fluctuations in effluent discharge rate, ocean currents, vertical density profiles, and effluent characteristics such as initial dilution and coliform level. The degree of buoyancy, which is determined by the relative densities of the effluent and seawater, is the major controlling factor in the dilution and motion of the effluent. A series of simulations was carried out to determine the effect of diffuser design on the behavior of the effluent field. Using diffusers with different combinations of port spacing, port diameter, and discharge velocity, it was determined that the effect of initial momentum on dilution was relatively insignificant compared with buoyancy. Initial dilution could be predicted on the basis of unit length discharge of the diffuser and diffuser depth if greater than 40 meters. A diagram relating discharge per unit length, diffusion depth, and initial dilution was presented as a means of evaluating diffuser efficiency and design. Various factors which influence the thickness of the surface effluent field are discussed, including: diffuser depth, ocean currents, stratification, vertical mixing, and effluent strength.

*Deep water, *Design criteria, *Discharge (water), *Waste dilution, Buoyancy, Density, Waste disposal, Currents (water), Diffusion, Waste water disposal, Effluents, Water Pollution Control Federation, Waste water treatment

*Deep water diffusers

F092
ACTIVATED SLUDGE PROCESS DESIGN,

Lauria, D. T., Uunk, J. B., and Schaefer, J. K.

Journal of the Environmental Engineering Division, Vol. 103, No. EE4, p 625-645, August, 1977. 6 fig, 2 tab, 12 ref.

Various considerations for the mathematical evaluation and empirical modelling of activated sludge process design are described, with emphasis on the completely mixed steady-state activated sludge process. A series of biological process equations is presented for the determination of BOD removal rates, net excess sludge production, and process efficiency. Oxygen requirements are then related to demand and rate of use as determined by previous calculations. The required settling tank area for adequate thickening is calculated on the basis of solids loading and underflow concentration. Process variables and parameters are defined and listed in tabular form. Process efficiency ratings are considered for the amount of sludge under aeration and the net excess solids, including other variables such as BOD loading, sludge age, and a waste sludge factor. Because the process is defined by six decision variables and four equations, the number of degrees of freedom available to the process designer and the effect of fixing variables such as aeration tank volume and mixed liquor solids concentration are discussed. Formulas for construction and operation costs are derived on the basis of decision variables. Examples of numerical values of decision variables (BOD removed, net excess sludge, sludge under aeration, oxygen, BOD loading factor, BOD utilization factor, sludge, and waste sludge factor) calculated for various process efficiencies are given. Practical limitations on empirical modelling of the activated sludge process for maximum efficiency are discussed.

*Mathematical models, *Activated sludge, *Efficiencies, *Optimization, *Design criteria, Costs, Aeration, Sludge treatment, Biochemical oxygen demand, Dewatering, Settling basins, Waste water treatment

Activated sludge process efficiency

F093
DEVELOPMENT AND TESTING OF A WASTEWATER RECYCLER AND HEATER,

Guarino, V. J., and Bambenek, R. A.

CHEMTRIC Incorporated,
Rosemont, Illinois.

1976. 92 p, 24 fig, 20 tab, 1 append. Technical Report EPA-600/2-76-289.

The major objective of this study was to produce and evaluate a device for the recovery of usable hot water from room-temperature waste water. The prototype examined was to use no more than 1800 watts of electrical power to produce 6 gallons of 165 F water per hour. Flash evaporation and vapor compression processes were used for distillation. Design data for the prototype unit are presented. Tests using laundry water showed that the prototype unit was capable of producing sterile hot water with neutral pH as well as low suspended solids, COD, and turbidity, at a rate of 6 gallons per hour with an energy use of 229 watt-hours per gallon. Pretreatment was suggested for the reuse of hospital waste water, since ammonia and alcohols may be present in the distillation product. Annual operating costs for the unit, which is reported to conserve approximately 44,000 gallons of potable water per year, were estimated at $717.

*Water reuse, *Distillation, *Vapor compression distillation, *Flash distillation, *Design data, Heated water, Laundering, Hospitals, Waste water treatment, Electric power demand, Water conservation, Model studies, Research and development

Water heaters

F094
A MODEL TO PREDICT CONCENTRATION AND HEAD-LOSS PROFILES IN FILTRATION,

Adin, A., and Rebhun, M.

Iowa State University,
Ames,
Department of Civil Engineering.

Journal of the American Water Works Association, Vol. 69, No. 8, p 444-453, August, 1977. 17 fig, 2 tab, 22 ref.

A mathematical model has been developed for the study, evaluation, and prediction of contact filter performance. A material-balance relationship and an equation for filtration kinetics were derived. A computer program was developed to predict concentration-filtrate volume profiles for different filtration parameters. Model performance was tested against experimental data from filtration of a kaolinite suspension through deep granular beds where alum or a cationic polyelectrolyte was applied as a flocculant. Breakthrough curves were examined for different bed depths under various conditions with a small pilot filter, and then related to an accumulation-detachment model. Parameters used in the model include filter capacity, hydraulic conductivity, and accumulation and detachment coefficients. The predictive mathematical model can be used for various waters, filter beds, and flocculants to estimate concentration and head-loss profiles for engineering design.

*Filtration, *Mathematical studies, *Computer models, *Separation techniques, *Forecasting, Filters, Flocculation, Packed beds, Porous media, Design, Flocculation, Waste water treatment

Contact filtration, High-rate filtration, Filter performance, Filter head-loss

F095
REDUCTION OF AQUEOUS FREE CHLORINE WITH GRANULAR ACTIVATED CARBON--PH AND TEMPERATURE EFFECTS,

Suidan, M. T., Snoeyink, V. L., and Schmitz, R. A.

Georgia Institute of Technology,
Atlanta,
School of Civil Engineering.

Environmental Science and Technology, Vol. 11, No. 8, p 785-789, August, 1977.
5 fig, 12 ref.

The effects of pH and temperature on HOCL and OCL(-) reactions with activated carbon were examined with the aid of a mathematical model previously developed by the authors. The behavior of packed carbon beds was examined at various pH and temperature values. Chemical and mathematical relationships were described. Experimental methods and materials for batch tests and packed bed experiments were outlined. A determination of rate constants for the disappearance of free chlorine from blank reactors indicated that disappearance of chlorine followed first order kinetics. Equilibrium constants and speciation for HOCL and OCL(-) were examined at pH values of 4.0, 7.6, and 10.0. The pH was observed to affect the distribution of free chlorine between HOCL and OCL(-) but did not appreciably affect reaction rates. A dissociation constant for free chlorine on the carbon surface of 10.5 kcal/mole was calculated on the basis of temperature data. The values of constants in the mathematical model were suggested as useful in the prediction of behavior for packed bed reactors with respect to pH, temperature, influent concentration, particle size, and flow rate.

*Activated carbon, *Packed beds, *Chlorine, *Mathematical models, *Kinetics, Chemical reactions, Adsorption, Thermodynamic behavior, Equilibrium, Chlorination, Hydrogen ion concentration, Temperature, Water treatment, Waste water treatment

Granular activated carbon

F096
SCIENTIFIC AND TECHNICAL EVALUATION OF THE ENVIRONMENTAL PROTECTION AGENCY'S WASTEWATER FACILITIES PLANNING, BOSTON CASE STUDY, PHASE I: WATER QUALITY CONSIDERATIONS,

Noss, R., Najarian, T., and Marks, D. H.

Resource Analysis Incorporated,
Cambridge, Massachusetts.

1976. 324 p, 52 fig, 23 tab, 8 append.

The Boston area was chosen for an investigation into planning effectiveness for municipal treatment facilities construction grants under the Federal Water Pollution Control Act Amendments of 1972. The two-phase study will ultimately include data collection in the initial phase of the study and data evaluation in the second phase. Data collections included analyses of existing waste sources and water quality in the basins of Boston Harbor, Charles River, Mystic River, Neponset River, Sudbury-Assabet-Concord Rivers, and North River. Current plans and priorities for construction of waste water facilities by surrounding municipalities are discussed. Major issues and reviews of cost effectiveness of decisions to improve water quality are examined for each basin in the study area. Appendices include descriptions of water quality standards, classifications, and segmentation as well as the results of qualitative and quantitative water analyses conducted for each of the basins.

*Treatment facilities, *Federal Water Pollution Control Act, *Planning, *Massachusetts, Water management (applied), Water quality, Water pollution sources, Treatment facilities, River basins, Harbors, Regional planning, Legal aspects, Construction, Regulation, Waste water treatment

*Boston (MA), Boston Harbor, Charles River, Mystic River, Neponset River, Sudbury River, Assabet River, Concord River, North River, Construction grants

F097
THE EFFECTS OF NTA ON THE CHLORINE DEMAND OF VARIOUS TYPES OF WATER,

Katz, E. L.

1971. 28 p, 12 tab. Technical Report PB-256 363.

The effects of NTA (tri-sodium salt of nitrilotriacetic acid, N-(CH2COONa)3) on chlorine demand of potable and surface waters were examined. Chlorine demand was also examined for different chlorine concentrations, NTA concentrations, NTA types, temperature, pH, and contact time. Increases in chlorine demand caused by the presence of NTA were higher at higher temperatures in tests from 4 C to 23 C. NTA also increased chlorine demand more effectively at lower pH's. An increase in NTA concentration from 1 to 25 ppm increased chlorine demand by a factor of 2 or more. Studies indicated that the effect of NTA was increased with chlorine contact time, increasing by up to 6% in 0 to 4 hours contact time. No discernible difference in increased chlorine was observed between commercial NTA and re-crystallized NTA. The report concluded that at high temperatures, high NTA concentrations, and acidic pH, NTA may increase chlorine demand by as much as 50%.

*Chlorination, *Nitrilotriacetic acid, *Chemical wastes, *Model studies, Potable water, Surface waters, Temperature, Hydrogen ion concentration, Chemical reactions, Disinfection, Water treatment, Waste water treatment

F098
THE ACTIVATED SLUDGE PROCESS: PART I--STEADY STATE BEHAVIOR,

Marais, G. v. R., and Ekama, G. A.

Capetown University,
South Africa,
Department of Water Resources and Public Health Engineering.

Water SA, Vol. 2, No. 4, p 163-200, October, 1976. 29 fig, 2 tab, 34 ref, 2 append.

Equations relating active endogenous residue, inert volatile material, and oxygen demand are presented as part of a discussion of activated sludge process theory for steady state behavior and sludge age. Previous literature on activated sludge process kinetics is reviewed. Oxygen demand tests and method accuracy are examined for biochemical oxygen demand and chemical oxygen demand. Biological growth kinetics are considered with respect to endogenous respiration, COD removal, and COD utilization and yield. The degree of mixing and flow regime are discussed with respect to reactor or process kinetics in the completely-mixed and plug-flow activated sludge systems. Oxygen requirements, mass parameters, steady state design charts, COD fractions, functional inter-relationships, and nutrient requirements for biological synthesis are mathematically derived. Active and inert solids concentrations are related to active mass, endogenous residue, inert mass, volatile mass, and oxygen demand of sludge entering an aerobic digester. Equations for nitrification kinetics relating sludge age, nitrification, and organism growth are presented. Experimental investigations to determine the yield constant Y, the endogenous respiration constant b, and the substrate conversion rate constant K are described. A stepwise analysis of kinetic response of settled waste is presented. Loading rate, sludge age, and oxidation are related to process design and control.

*Activated sludge, *Mathematical models, *Kinetics, *Aerobic treatment, *Design criteria, Nitrification, Oxygen requirements, Chemical oxygen demand, Model studies, Sludge treatment, Oxidation, Waste water treatment

Steady state behavior, Activated sludge process theory

F099
EFFECTS OF TREATED MUNICIPAL WASTE WATER ON GROWTH, FIBER, PROTEIN, AND AMINO ACID CONTENT OF SORGHUM GRAIN,

Day, A. D., and Tucker, T. C.

Arizona University,
Tucson,
Department of Plant Sciences.

Journal of Environmental Quality, Vol. 6, No. 3, p 325-327, July-September, 1977.
2 tab, 15 ref.

The effect of treated municipal waste water on growth, fiber, protein, and amino acid content of grain from sorghum was investigated in Tucson, Arizona, for grain growth in two soil types. Comoro sandy loam and Grabe silt loam were used in experiments with treated municipal waste water, well irrigation water, and commercial inorganic fertilizer. For grain grown in Comoro sandy loam, average number of days from planting to maturity, leaf length, and grain yield were lower for plots that received well water with appropriate amounts of N, P, and K than for plots irrigated with waste water. Sorghum growth relationships were similar in Grabe silt loam soils, although more tillers were produced per plant with well water than with waste water. Analyses of fiber, protein, and amino acid for sorghum grain grown with different irrigation and fertilizer treatments indicated that total protein contents, leucine, methionine, threonine, and tyrosine were similar for all treatments and soil types. Cystine, glycine, and histidine were lower for grain irrigated with waste water, or with simulated waste water produced by the addition of appropriate amounts of N, P, and K to well water, than for grain grown with simple well water irrigation. Municipal waste water is suggested as an effective source of irrigation water and plant fertilizer to increase yields for grain crops in the southwestern United States.

*Soil-water-plant relationships, *Irrigation practices, *Grain sorghum, *Fertilizers, Plant growth, Soil types, Southwest U. S., Arizona, Grains (crops), Waste water disposal, Municipal wastes, Activated sludge, Water supply development, Water reuse

Tucson (AZ)

H001
THE IMPACT OF INTENSIVE APPLICATION OF PESTICIDES AND FERTILIZERS ON UNDERGROUND WATER RECHARGE AREAS WHICH MAY CONTRIBUTE TO DRINKING WATER PROBLEMS,

Garrett, D., Maxey, F. P., and Katz, H.

Environmental Protection Agency,
Washington, D. C.,
Office of Toxic Substances.

January, 1976. 110 p, 12 fig, 6 tab, 103 ref. Technical Report No. EPA 560/3-75-006.

An assessment of the impact of intensive application of pesticides and fertilizers on underground water recharge areas is presented, with particular emphasis on agricultural feedlot operations. Pesticides appear to offer only a marginal threat to groundwater quality because of their adsorptive properties in the soil structure and/or their short-lived persistence. Exceptions to this include the improper application of pesticides or the existence of sandy soils or thin soils overlaying fissured rocks. With regard to fertilizer application, more information on the amount of nitrate reaching the groundwater is required. Septic tanks on farms present an insignificant source of pollution to groundwater in terms of public drinking water supplies. However, well water supplies on a particular farm may be susceptible to contamination from septic tanks. Cesspools represent a significantly greater groundwater pollution source, although such installations are now widely prohibited. More information on the processes of nitrification and denitrification in various soils and subsoils as a function of soil temperature, climate, and biochemistry is needed in relation to animal waste applications and fertilizer and crop cover sources of nitrogen.

*Water pollution, *Groundwater recharge, *Farms, *Fertilizers, *Pesticides, Waste disposal, Septic tanks, Cesspools, Soil types, Soil water movement, Potable water, Groundwater, Nitrates, Nitrification, Denitrification, Chemical wastes, Farm wastes, Nitrogen compounds

H002
FACTORS AFFECTING DECLINING WATER LEVELS IN A SEWERED AREA OF NASSAU COUNTY, NEW YORK,

Garber, M. S., and Sulam, D. J.

Journal of Research of the United States Geological Survey, Vol. 4, No. 3, p 255-265, May-June, 1976. 12 fig, 1 tab, 15 ref.

A double-mass-curve analysis of groundwater levels in Nassau County, Long Island, New York reveals that the average-weighted groundwater levels in a 32 sq mi segment of a sewered area declined 11.8 ft relative to an adjacent unsewered area to the east during the period 1953-1972. An electric analog model analysis indicated that 4.9 ft of the decline was due to pumping in nearby Queens County, west of the sewered area. Most of the remaining 6.9 ft of the decline is due to sewering. Streamflow within the sewered area has also declined because of the lowered groundwater levels. Double mass curve analysis of previous and present declines provides a useful means of evaluating the various factors responsible for changes in water levels and aquifer storage.

*Sewers, *Groundwater, *Water levels, *Water loss, *New York, Surface waters, Aquifers, Pumping, Analytical techniques, Cities, Drainage systems

Long Island, Nassau County

H003
SURVIVAL OF COLIFORM BACTERIA IN SEWAGE SLUDGE APPLIED TO A FOREST CLEARCUT AND POTENTIAL MOVEMENT INTO GROUND WATER,

Edmonds, R. L.

Washington University,
Seattle,
College of Forest Resources.

Applied and Environmental Microbiology, Vol. 32, No. 4, p 537-546, October, 1976.
4 fig, 8 tab, 12 ref.

A 3-year study was undertaken to determine the environmental soundness of using dewatered sludge on clearcut areas in forests on gravelly glacial outwash soils, the survival of total and fecal coliform bacteria in sludge and soil systems relative to environmental conditions and time of year of application, and if fecal coliform bacteria in the sludge are capable of moving into soil and groundwater systems and into streams. Results indicated that few viable fecal coliforms penetrated greater than 5 cm into soil and that practically none entered the groundwater system. Though there was little movement of viable coliforms from sludge to soil, many moved to the 5 cm depth. The low fecal coliform count may result from filtration and sedimentation as well as poor competitive ability in soil. A total coliform maximum of 370/100 milliliters was detected in the lysimeter leachate at 180 cm. Seasonally, total coliform counts in groundwater revealed high numbers in the fall and low numbers in the winter. Most water movement through the soil profile occurred during winter when rainfall was high and the bacterial activity was low. It was concluded that, though fecal and total coliforms survive in sludge for long time periods, very little movement of either into groundwater systems occurs through the gravelly outwash soil. The soil is effective as a biological filter for hazardous pathogens. There is little danger of contamination of groundwater and streams from vertical bacterial movement. They can, however, remain viable in surface layers, and stormwater runoff and direct contact with contaminated soil is still a problem.

*Pollutant identification, *Coliforms, *Sewage sludge, *Clear-cutting, *Movement, Groundwater, Environmental effects, Forest soils

H004
WHY SIMULATION?,

Linsley, R. K.

Simulation Network Newsletter, Vol. 8, No. 5, p 1-4, September, 1976.

The advantages of simulation techniques were discussed as applied to hydrology. Beginning in 1960, it was found that simulation programs could, with past data as background, allow the extrapolation of conditions beyond the range of observed data in storm runoff studies. Previous "pencil" calculations were only approximations which were time consuming as well as being unable to use time intervals of less than 6 hours which would more accurately deal with infiltration and hydrograph characteristics of small watersheds. Simulation produces a more complete answer; allows adjustments for change which are not effective with conventional methods; has, generally, a time and cost advantage over conventional methods; and data is easily obtained on magnetic tape from the Climatic Data Service or the Geological Survey. Simulation, however, is not competitive with the use of empirical formulae for design flow computations.

*Analytical techniques, *Model studies, *Hydrology, *Storm runoff, *Time, Infiltration, Hydrographs, Watersheds (basins)

H005
GROUND-WATER POLLUTION NEAR A LANDFILL,

Kelly, W. E.

Rhode Island University,
Kingston.

Journal of the Environmental Engineering Division-ASCE, Vol. 102, No. EE6, p 1189-1199, December, 1976. 10 fig, 2 tab, 23 ref.

A study was implemented to determine the effects of an existing landfill on groundwater. A landfill was chosen in Rhode Island which has been used for disposal of appliances, building rubble, leaves, and brush. No garbage or hazardous materials were disposed of at the site. Water quality at the tested aquifer is generally good, with some high nitrate levels reported in some shallow wells and high manganese concentrations in high yield wells. Water sampling was by bailing at the landfill site and by pumping at test borings. A connection between the landfill and nearby Hundred Acre Pond was well established, though a connection between it and nearby Thirty Acre Pond is only suggested by chloride data. There is a measurable effect on ground water quality in the aquifer, with overall mineralization, especially increased manganese, being the greatest effect. Specific conductance was a good indicator of the degree of mineralization. Groundwater specific conductances were determined by surface measurement of electrical resistivity. Digital or analog computer models may quantitatively evaluate the effects of landfills and gravel pits on groundwater flow patterns.

*Pollutant identification, *Groundwater, *Landfills, *Environmental effects, *Water pollution effects, Rhode Island, Leaves, Brush

Appliances, Building rubble

H006
PENNSYLVANIA USES LINERS TO CONTROL GROUND WATER CONTAMINATION FROM LANDFILL OPERATIONS,

Bucciarelli, W. C.

Journal of Environmental Health, Vol. 39, No. 3, p 184-185, November-December, 1976. 1 tab.

The increasing use of landfills for waste disposal has necessitated the use of poorer soils and more sophisticated technology. Liners are used in Pennsylvania landfill operations. Various liners such as clays, asphaltics, rock dykes and manmade materials have been applied to ponds and canals. Sealants have been used to create barriers against fluids and water. Recent applications are variations of conventional construction techniques. Site characteristics, usually groundwater systems, must be used to evaluate the need for liners. The degree of impermeability required determines the type of liner to be used, as well as the economic considerations. Area characteristics must be considered in the decision process. The landfill liner collects leachate to prevent water pollution. In Pennsylvania, all facilities must assure operation of the treatment facility for 10 years after landfilling ceases. There must be an adequate monitoring system to substantiate the integrity of the liner. This can involve subdrains, collection and channelization or mechanical monitoring. Groundwater monitoring wells are a necessity. The natural clays used must be evaluated for their chemical compatibility with the wastes and leachates they will contact. With proper installation and use, the liner concept approaches zero environmental degradation. So far, there has been no evidence of liner failures in Pennsylvania.

*Linings, *Landfills, *Groundwater, *Water pollution, Waste disposal, Construction, Leachate, Ponds, Canals, Treatment facilities, Economics, Pennsylvania

Construction techniques

H007
EFFECT OF A SECONDARY TREATED EFFLUENT ON THE MOVEMENT OF VIRUSES THROUGH A CYPRESS DOME SOIL,

Bitton, G., Masterson, N., and Gilford, G. E.

Florida University,
Gainesville,
Department of Environmental Engineering.

Journal of Environmental Quality, Vol. 5, No. 4, p 370-375, October-December, 1976.
6 fig, 2 tab, 17 ref.

A study was performed to determine the movement of viruses through a sandy soil in a cypress dome. The study was designed to aid disposal of sewage effluents by land applications. Bacteriophage T2 was used as well as the animal virus, Sabin vaccine strain type 1 poliovirus. Results of column experiments indicated that the cypress dome soil had a potentially good retention capacity for the test viruses. A binding of the viruses to soil particles was promoted when tap water was used in the column experiments. The low pH of the soil also promoted viral adsorption, though adsorption was greatly decreased when the secondary effluent (dome water) was used. Organic substances in the water hindered adsorption. These interfering substances prevent viral adsorption to clays, microcline, membrane filters and polyelectrolytes, as well as magnetite. High molecular weight substances also reduced the interaction between bacterial phage MS2 and polyelectrolytes. Further experimentation was suggested to determine the reasons for virus breakthrough into wells 305 centimeters deep under the cypress dome.

*Viruses, *Movement, *Soil types, *Soil properties, *Sewage treatment, Sewage disposal, Sewage effluents, Adsorption, Polyelectrolytes, Waste water treatment

Type 1 poliovirus, Bacteriophage T2, Bacterial phage MS2

H008
SEPTIC TANK POLLUTION CUT,

Crops and Soils, Vol. 29, No. 3, p 14, December, 1976.

Design elements of a denitrification unit for nitrates from septic systems were considered. These nitrates are contributors to groundwater pollution. The nitrates are changed into nitrogen gas by the process. Necessary components of the system are the absence of oxygen and the presence of an energy source. In this system, sewage effluent with nitrates flow continuously through limestone-filled columns, simulating the continuous flow in a field septic system and creating anaerobic conditions. Methanol is used for the energy source and is used in the bacteria's biochemical process to change nitrates into nitrogen gas. Sludge from paper mills was suggested as a cheap energy source if it were not proved to be a pollution source. The nitrogen gas produced is discharged into the air. Initial tests of a field unit indicate efficiencies near that produced in the laboratory.

*Septic tanks, *Water pollution, *Denitrification, *Groundwater, Nitrates, Nitrogen, Laboratory tests, On-site tests, Prototype tests, Anaerobic conditions, Pulp wastes

Limestone columns, Methanol

H009
PHYSICAL, CHEMICAL, AND BIOLOGICAL ASPECTS OF SUBSURFACE ORGANIC WASTE INJECTION NEAR WILMINGTON, NORTH CAROLINA. GEOLOGICAL SURVEY PROFESSIONAL PAPER 987,

Leenheer, J. A., Malcolm, R. L., and White, W. R.

51 p, 34 fig, 36 tab, 29 ref. United States Government Printing Office Stock Number 024-001-02915-4.

A four-year field and laboratory study was conducted to determine the physical, chemical, and biological effects of the Hercules waste injection system on the subsurface near Wilmington, North Carolina. In addition, a case history of this system was provided. A two-part site study involved the determination of hydrogeologic conditions, characterization of industrial waste, and analysis of native groundwater, as well as the observation of waste-aquifer interactions at various wells. The concurrent laboratory study involved the injection of waste into cores of aquifer material from the injection area. A conceptual model was devised, combining results of both studies, to detail the stages of injected waste reactivity and movement in the subsurface from the injection well to the edge of the waste front. Results indicated several waste-aquifer interactions: dissolution of carbonate minerals, sesquioxide coatings on primary minerals and on primary aluminosilicate minerals, and dissolution and complexation of iron and manganese oxides by waste organic acids; reprecipitation of complexed dissolved iron during waste neutralization; coprecipitation of phthalic acid complexed with iron during iron hydroxide precipitation; methane gas production from anaerobic microbial waste degradation; microbial reduction of sulfates to sulfides; reduction of ferric to ferrous iron from decreases in Eh and pH; and retention of organic waste acids by adsorption and anion exchange on mineral constituents at low pH values. The importance of compatibility tests of the injected waste with aquifer material before waste injection was proven. The laboratory simulation quantitatively better defined waste-aquifer interaction than did the site study.

*Injection, *Injection wells, *Industrial wastes, *Aquifer characteristics, *Waste disposal, *Waste water disposal, *Analysis, *Model studies, Environmental effects, Physical properties, Chemical properties, Biological properties

Wilmington (NC)

H010
INTRODUCTION TO URBAN STORM WATER RUNOFF MODELS,

Shubinski, R. F.

Water Resources Engineers,
Springfield, Virginia.

In: Short Course Proceedings: Applications of Storm Water Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 177-199. 15 fig, 4 tab, 6 ref. Technical Report NTIS PB 247-163.

Storm water runoff models were applied to a simplified urban drainage system. This system was composed of subsystems dealing with surface runoff, transport and quality of flow, and receiving waters. The surface runoff subsystem was a drainage area tributary to a sewer inlet--a system of surface elements, gutters, and drainage ditches. The transport system is the physical works which carry storm waters and their pollutant load from inlets through underground conduits to a point of disposal. Receiving systems could be streams, lakes, estuaries, or coasts. The hydrologic effects of urbanization and the characteristics of the urban watershed were considered. Factors controlling urban runoff include rainfall, infiltration, depression storage, surface detention and gutter detention, and storage in house drains, catch basins and major sewage elements. Land use influences imperviousness and surface cover which regulate surface depression, detention, and infiltration. A storm drainage model should analyze storm discharge from urban runoff by dividing the total basin into smaller homogeneous units to calculate individual runoff contributions. Collection of individual sub-basin outflows and their routing through main storm sewers allow determination of total watershed outflow at the basin outlet.

*Model studies, *Storm runoff, Water quality, Sewerage, Watersheds, Hydrologic aspects, Urban runoff, Infiltration, Sewage effluents, Drainage, Flow

H011
QUANTITY ASPECTS OF URBAN STORM WATER RUNOFF,

Espey, W. H., and Winslow, D. E.

Espey, Huston and Associates, Incorporated,
Austin, Texas.

In: Short Course Proceedings: Applications of Storm Water Management Models, August 19-23, 1974, Amherst, Massachusetts, University of Massachusetts, Amherst, p 83-137. 13 fig, 7 tab, 73 ref. Technical Report NTIS PB 247-163.

In designing urban drainage facilities one must consider rainfall-runoff relationships and the effects of the surface and geometric characteristics of the watershed. The system should be adequate for all surface runoff disposal and disposal of excess runoff with minimal damage to physical facilities. There should be a maximum reliability of operation with a minimum need for maintenance. Costs should be reasonable in relationship to the benefits derived and economically viable means for future expansion should be built into the system. Models relative to design features and considerations, such as excess rainfall determination, were reviewed. These included infiltration, API, graphical, numerical coaxial regression, and functional models. Overland flow and open channel flow analysis were considered, as well as flood frequency analysis, routing methods, and simulation analysis.

*Storm drainage, *Design criteria, *Model studies, Storm runoff, Drainage engineering, Costs, Infiltration, Economics, Precipitation (atmospheric), Analysis, Evaluation, Urban hydrology

H012
LEACHING CHARACTERISTICS OF POLLUTED DREDGINGS,

Jin, J. S., Krizek, R. J., and Roderick, G. L.

Hayward Baker Company,
Odenton, Maryland.

Journal of the Environmental Engineering Division-ASCE, Vol. 103, No. EE2, p 197-215, April, 1977. 5 tab, 1 append.

Laboratory leaching tests were conducted to evaluate the pollution potential of leachates from freshwater dredgings and the effect of additives on leachate quality improvement. Results indicated that there was not a serious pollution problem because leachate quality improved quickly with subsequent leaching. The average permeability of dredged material decreases to as little as one-half of its initial value after leaching with water of a volume five times that of the sediment volume. Leachates from well-graded, coarser dredged material had a higher total solids content at the beginning of leaching, a higher total solids declination rate, and a lower total solids content at the end of leaching than finer, more cohesive materials. All quantities measured in leachates decreased with an increase in the volume of leachate drained. Slightly basic pH values did not significantly change during leaching. Sodium and iron ions had a higher declination rate than total solids. Calcium ions had a lower one. Calcium in lime-treated materials satisfied the exchange capacity and complex formation needed by organics, and reduced gas bubble formation. The volatile solids content was higher in leachates from lime-treated sediments than in those from untreated samples. There was no significant change in the water quality of leachates when dredged materials were treated with additives. These leachates produce no serious pollution problems when placed in diked containment areas.

*Leachates, *Physical properties, *Chemical properties, Water pollution sources, Lime, Water quality control, Hydrogen ion concentration, Calcium, Organic matter, Pollution abatement

Freshwater dredgings

H013
NONPOINT SOURCE EFFECTS ON WATER QUALITY,

Wanielista, M. P., Yousaf, Y. A., and
McLellon, W. M.

Florida Technical University,
Orlando,
Environmental Systems Engineering Institute.

Journal Water Pollution Control Federation, Vol. 49, No. 3, p 441-451, March, 1977.
5 fig, 11 tab, 24 ref.

Effects of nonpoint sources of pollution on water quality were investigated. They can be studied by measuring water quality relative to precipitation/runoff/infiltration events and by calculating potential water quality degradation relative to loading rates of land uses. Sources are generally classified as rural or urban. Rural sources include agricultural chemicals, animal wastes, and human wastes. Urban sources are primarily from runoff consisting of solid waste litter, chemicals, air deposited substances, and vehicle pollutants. Heavy metals are also a part of this pollution source. Site-specific studies may be necessary because of the variability of nonpoint source effects on water quality. Site conditions, receiving water conditions and regulatory requirements affect the extent of the studies. Sampling procedures should follow the hydrograph. Composite samples for small, well-defined urban areas should be taken every few minutes. Non-urban basins may be analyzed by the use of grab samples or longer time composite samples of 3 to 12 hours. A "pollutograph" similar to the pattern of a hydrograph can be developed for small basins, and a relationship between mass loadings and flow can be developed for larger basins. Mass loading curves and the suggested methods may be used to separate the effects of point and nonpoint pollution sources. Nonpoint source constitutents may decrease in concentration while the total pollutant mass is likely to increase. Sometimes an increase in the mass of pollution accompanied by a decrease in concentration may be quite harmful. It was suggested that mass loading standards and concentrations be developed and used together to determine the extent of pollution effects in receiving waters.

*Water pollution effects, *Analytical techniques, *Water pollution sources, *Runoff, Rural areas, Urban areas, Urban runoff, Agricultural chemicals, Animal wastes (wildlife), Heavy metals, Domestic wastes, Industrial wastes, Oil wastes, Hydrologic aspects, Water quality control, Water quality

H014
THE FATE OF POLLUTANTS IN SUBSURFACE ENVIRONMENTS,

Metry, A. A.

Roy F. Weston, Incorporated,
West Chester, Pennsylvania.

Journal of Environmental Sciences, Vol. 20, No. 2, p 27-31, March/April, 1977.
8 fig.

Groundwater will continue to be a growing source of water supply and aquifers may become alternatives for direct and indirect disposal of liquid and solid wastes. Groundwater pollution can develop from several sources: waste water disposal on land, seepage from waste water holding basins, deep well injection, and leachates from solid waste disposal. Two models were developed to predict leachate/pollutant migration and fate in subsurface environments. The first was a one-dimensional model for pollutant attenuation prediction in subsaturated media (soils), and the second was a two-dimensional model for pollutant migration and fate prediction in saturated media (aquifers). The models include the mass-transport mechanisms of molecular diffusion, convective dispersion, and chemical reaction. These models are flexible and practical, accurate, and have a sound mathematical basis.

*Water pollution sources, *Pollutant identification, *Groundwater, *Model studies, Aquifers, Waste disposal, Seepage, Deep wells, Solid wastes, Leachates, Analysis, Water quality

H015
REMOVAL OF NUTRIENTS FROM TREATED MUNICIPAL WASTE WATER BY WETLAND VEGETATION,

Boyt, F. L., Bayley, S. E., and Zoltek, J., Jr.

Water and Waste Water Technical School,
Neosho, Missouri.

Journal Water Pollution Control Federation, Vol. 49, No. 5, p 789-799, May, 1977.
9 fig, 7 tab, 17 ref, 2 append.

A study was conducted, in Florida, to determine the ability of wetland vegetation to remove nutrients from treated municipal waste water. Effluent from a 0.25 mgd secondary treatment trickling filter plant was discharged into a mixed hardwood swamp. Poor plant operation has produced only primarily treated effluent for the past few years. The study involved monthly water chemistry sampling, coliform and fecal streptococci sampling, sediment analysis, and recording of tree growth data. Hydrologic data were used to develop a nutrient budget. Study results revealed 98.1% total phosphorus reductions and 89.5% total nitrogen reductions. Heavy metal concentrations were low due to the absence of industrial wastes; the amounts of lead were 0.03 mg/liter, and of copper, 0.02 mg/liter. Dissolved oxygen in the experimental swamp averaged 2.8 mg/liter in a range of 0.3-6.3 mg/liter. The control swamp averaged 2.4 mg/liter in a range of 2.0-4.0 mg/liter. Sediments were normally anoxic. Anoxic conditions were best for nutrient uptake by plants. The sediment nutrient levels were similar in both experimental and control swamps. A layer of clay in the sediment prevented exchange between waste water-containing surface water and groundwater. The dominant soil allowed little filtration, and groundwater recharge was slight. The fecal coliform count in the control area was 200 per 100 millimeters, which was above national potable and recreational water standards. The fecal coliform/fecal streptococci ratio was less than 1, suggesting that high fecal bacterial counts were of livestock origin. Human fecal bacteria were removed in the wetlands after the effluent travelled less than a mile. Tree growth indicated quicker nutrient uptake in the experimental area. It was concluded that the wetland system could be substituted for tertiary treatment and save area residents the $79,500/year costs for a new treatment facility.

*Nutrients, *Municipal wastes, *Filtration, *Vegetation, *Wetlands, Water quality, Bacteria, Sediments, Hydrologic aspects, Economics, Waste disposal

H016
CARBON ISOTOPIC STUDY OF THE FATE OF LANDFILL LEACHATE IN GROUNDWATER,

Games, L. M., and Hayes, J. M.

Indiana University, Bloomington, Department of Chemistry.

Journal Water Pollution Control Federation, Vol. 49, No. 4, p 668-677, April, 1977.
7 fig, 6 tab, 22 ref.

An isotopic study was conducted to gain information on carbon movement in groundwater and on the effects of a landfill on the presence of different carbon molecular forms. Oversimplification was avoided by the simultaneous study of four carbon fractions - inorganic carbon, volatile organic carbon, non-volatile organic carbon, and CO and CH4. It was concluded that soil microorganisms quickly modified the bulk of mobile carbon entering the groundwater system from the landfill. Non-volatile organic carbon was effectively immobilized. Though the landfill did not significantly alter the bulk carbon budget, it is possible that trace amounts of unusually mobile materials could have entered the aquifer. These might be highly toxic with a negative effect on water quality, even in small quantities. Large variations of amounts and isotope ratios with time suggested the need for a longer study period. The isotopic method made available direct bulk carbon information for organic chemical aspects. It was also a good data source for the effects of soil microorganisms on groundwater carbon.

*Isotope studies, *Carbon, *Leachate, *Groundwater, *Landfills, Analytical techniques, Water pollution, Water pollution effects, Waste disposal, Chemical properties, Waste water treatment

H017
HYDROLOGICAL STUDIES ON SOME RIVER CATCHMENTS IN GREATER LONDON,

Butters, K., and Vairavamoorthy, A.

Proceedings of the Institution of Civil Engineers, Part 2, Vol. 63, p 331-361, June, 1977. 18 fig, 3 tab, 9 ref.

Hydrologic studies were prepared by the Department of Public Health Engineering of the Greater London Council for several catchments of the Thames River in the Greater London area. A system for the collection of rainfall and runoff was developed to better predict storm runoff and flooding and to determine hydrologic trends. Using flood hydrographs and other hydrologic data, an equation was developed to predict flood damage on the basis of flood water volume. The effects of catchment area, travel time of excess rainfall, climatological influences, and catchment topography were considered in hydrologic analysis. Duration and intensity were examined for individual storms, and 30-year trends were examined. A series of 250 storms, said to represent a 100-year period, were simulated. Analytical methods and parameters considered in the study were: time of equilibrium, the Wandle study for the preparation of flood hydrographs, peak discharges for rainfall and runoff probabilities, the unit hydrograph, synthetic unit hydrograph, and simulated point rainfall. A flow network for the digitization of rainfall data was presented. An examination of parameters taken into account by the various methods for calculating rainfall indicated that the synthetic hydrograph was the most complete analytical method, accounting for catchment area, slope, storage, and shape; rainfall intensity and profile; storm pattern; and runoff coefficient.

*Hydrologic data, *Floods, *Analytical techniques, *Model studies, *Watersheds (basins), Hydrographs, Storms, Computer models, Rainfall-runoff relationships, Unit hydrographs, Data collections, Precipitation (atmospheric), Storm runoff, Urban drainage, Urban runoff, Storm water, Waste water treatment

Thames River, London, England

MISCELLANEOUS

J001
NATIONAL SAFE DRINKING WATER STRATEGY ONE STEP AT A TIME,

Environmental Protection Agency,
Washington, D. C.,
Office of Planning and Evaluation.

May, 1975. 77 p, 2 fig, 5 tab. Report No. P.L. 93-523.

A safe drinking water strategy which has been developed to clarify the Environmental Protection Agency's policy with respect to implementing the Safe Drinking Water Act is described. The strategy proposes the following principles for implementing the Act: a commitment to give highest priority to public health matters; the involvement of states, local governments, and consumers in all aspects of the program; the consideration of worst problems first; a consideration of the costs involved in all phases of the program; maximum utilization of existing state and local water supply control programs; decentralization of decision-making to Environmental Protection Agency regional offices; a consideration of the environmental side effects of actions taken under the Act; and the minimization of 'red-tape' in all actions. The Environmental Protection Agency also plans to implement an underground injection control program prescribed by the Act with the same step-by-step approach.

*Legislation, *Potable water, *Public health, *Water quality control, *Water policy, Groundwater, Underground, Injection, Programs, Federal project policy, Federal government

Safe Drinking Water Act

J002
RESIDUAL WASTE MANAGEMENT RESEARCH AND
PLANNING PROJECT,

Environmental Protection Agency,
Washington, D. C.,
Water Planning Division.

September, 1975. 363 p, 102 ref. Technical Report No. EPA-440/9-76-003.

Approximately 100 abstracts of documents dealing with the subject of residual wastes and their impact on ground and surface waters are presented. The abstracts provide project or publication identification, a brief summary of the document, the status of the project, information sources, and acquisition details. The abstracts are arranged by types of residual wastes and are cross-referenced where necessary. Some basic topics covered include: urban planning, regional planning, sludge disposal, water pollution, material recovery, cost-benefit analysis, residual waste reclamation, residual waste disposal, and socio-economic and intergovernmental aspects of the impact of residual wastes.

*Waste disposal, *Reclamation, *Water pollution, *Social aspects, *Economics, Governmental interrelations, Cost-benefit analysis, Sludge disposal, Regional development, Urbanization, Groundwater, Surface waters

J003
REACTIONS OF HEAVY METALS WITH SOILS WITH SPECIAL REGARD TO THEIR APPLICATION IN SEWAGE WASTES,

Leeper, G. W.

Melbourne University,
Melbourne, Australia,
Agricultural Chemistry.

November, 1972. 77 p, 5 tab, 66 ref. Department of the Army Contract No. DACW73-73-C-0026.

Reactions of heavy metals with soils are reviewed, with particular emphasis on their application during the irrigation of crop lands with liquid sewage. Topics discussed include: the fate of heavy metals in soils, the mechanisms of removal of individual or grouped heavy metals, and the uptake and tolerance of heavy metals by plants. The use of specialists crops for harvesting unwanted accumulations of heavy metals does not appear to be feasible. As an alternative, the removal of metal-laden top soil is suggested so that the subsoil rich in nutrients from previous applications of nitrogen and phosphorus can be utilized.

*Heavy metals, *Soil chemical properties, *Sewage, *Irrigation, *Plant growth, Nutrients, Metals, Sewage disposal, Toxicity, Nitrogen, Phosphorus

J004
PRELIMINARY ASSESSMENT OF SUSPECTED CARCINOGENS IN DRINKING WATER: REPORT TO CONGRESS,

Environmental Protection Agency,
Washington, D. C.,
Office of Toxic Substances.

December, 1975. 115 p, 16 tab, 89 ref. Technical Report No. EPA 560/4-75-005.

A compilation of efforts by the Environmental Protection Agency to identify and control suspected carcinogens in drinking water is presented. Topics covered include: studies dealing with the nature and extent of drinking water, including analyses for polychlorinated biphenyls, polyvinyl chloride, nitrosamines, trihalomethanes, pesticides, suspected inorganic carcinogens, asbestos, and radioactivity; evaluations of the risks associated with contaminant levels in drinking water; the identification of drinking water contaminant sources (industrial sources, chlorination, municipal waste treatment discharges, agricultural chemicals); treatment techniques for controlling drinking water contaminants; and projected costs for removing carcinogenic contaminants from drinking water. Byproducts from chlorination (chloroform and other trihalomethanes) appear to be more easily prevented than removed. Two techniques currently being considered for avoiding trihalomethane formation are the use of an alternative to chlorine as the disinfectant and the removal of precursors that react with chlorine.

*Potable water, *Water pollution, *Public health, *Water pollution effects, *Pollutant identification, Water purification, Chlorination, Asbestos, Inorganic compounds, Organic compounds, Polychlorinated biphenyls, Polymers, Pesticides, Hydrocarbons, Economics, Water pollution control, Disinfection, Radioactivity

Carcinogens, Polyvinyl chloride, Chlorinated hydrocarbons, Trihalomethanes, Chloroform, Nitrosamines

J005
THE EFFECTS OF SEWAGE EFFLUENT ON WETLAND ECOSYSTEMS,

Kadlec, R. H., Richardson, C. J., and
Kadlec, J. A.

Michigan University,
Ann Arbor.

December, 1975. 203 p, 27 fig, 59 tab, 50 ref. Semi-Annual Report No. 4.

Ongoing studies of the effects of sewage effluents in wetland ecosystems are reported, with particular emphasis on the nutrient status of the surface and interstitial waters of peatlands in Michigan. Specific topics covered include: the effects of simulated sewage effluent on the decomposition, nutrient status, and litterfall in a central Michigan peatland, the effects of simulated sewage effluents on the growth and productivity of peatland plants, pilot scale irrigation experiments, a statistical analysis of seasonal changes in biomass (standing crop new growth) of selected wetland species as influenced by nutrient additions, and studies of dissolved nutrients in Michigan peatland.

*Wetlands, *Sewage disposal, *Irrigation, *Nutrients, *Ecosystems, Biomass, Simulation analysis, Plant growth, Sewage effluents, Statistical methods, Michigan

J006
THE IMPACT OF FARGO, NORTH DAKOTA'S WASTE DISCHARGES ON THE INTERSTATE WATERS OF THE RED RIVER OF THE NORTH, SEPTEMBER 1969-APRIL 1970,

Federal Water Quality Administration,
Kansas City, Missouri,

July, 1970. 31 p, 4 fig, 8 tab. Publication No. PB-245 755.

The impact of waste discharges from Fargo, North Dakota's sewage treatment plant on the Red River of the North was evaluated during field study conducted from September 1969 to April 1970. The total pounds of biochemical oxygen demand (5-day) discharged from the Fargo-Moorhead area during the survey period ranged from 4203/day in March to a high of 44,241/day in October. The quantity of wastes from Fargo steadily increased as the efficiency of the Fargo sewage treatment plant declined during the winter months, with Fargo contributing a maximum of 82% of the total organic waste load discharged from the Fargo-Moorhead area in March. The combined waste discharges from the Fargo-Moorhead area had an adverse effect on the water quality of the Red River of the North as evidenced by numerous violations of dissolved oxygen and bacterial criteria and violations of the state effluent requirements. Monthly averages of dissolved oxygen concentrations less than 5 milligrams/liter were observed for samples collected during the winter months. Monthly average effluent concentrations for samples taken from the Fargo sewage treatment plant always exceeded North Dakota's effluent criteria of 25 milligrams/liter biochemical oxygen demand and 30 milligrams/liter total suspended solids.

*Water pollution, *Rivers, *Sewage treatment, *Treatment facilities, *Water pollution effects, Monitoring, On-site investigations, Dissolved oxygen, Biochemical oxygen demand, Suspended solids, Surface waters, North Dakota, Efficiencies, Performance, Waste treatment, Effluents, Bacteria, Organic compounds

J007
ASSESSMENT OF OFFSHORE DUMPING IN THE NEW YORK BIGHT, TECHNICAL BACKGROUND: PHYSICAL OCEANOGRAPHY, GEOLOGICAL OCEANOGRAPHY, AND CHEMICAL OCEANOGRAPHY,

Charnell, R. L.

Atlantic Oceanographic and
Meteorological Laboratories,
Miami, Florida.

April, 1975. 92 p, 57 fig, 5 tab, 35 ref. National Oceanic and Atmospheric Administration Report No. ERL 332-MESA 3.

An assessment of the effects of offshore dumping in the New York Bight is presented. Fine-grained waste dumped in New York Bight is entrained in a clockwise circulation pattern and is dispersed to the north. A significant portion is deposited in the low area immediately northwest of the dumpsites. Christiaensen Basin, a natural zone of mud deposition, is significantly contaminated with sewage sludge. Water sampling data show that nutrient (nitrates, nitrites, silicates, and phosphates) distributions are dominated by the lower New York Bay outflow, with dumped sewage sludge contributing very small amounts. The carbohydrate/total organic carbon ratio of samples taken from the bight indicates that the whole bight contains some sewage-derived materials, with the greatest concentration occurring in the Hudson Shelf Valley, the Christiaensen Basin, and north of the geographical sewage sludge dumpsites. Although the presence of sewage-derived material is suggested by carbohydrate/total organic carbon ratios in sediments throughout the area close to Long Island, low total organic carbon values found in all but isolated pockets demonstrate that contaminant material comprises only a small fraction of the sediments.

*Waste disposal, *Sewage sludge, *Bays, *Circulation, *Water pollution, Sludge disposal, Water circulation, Solid wastes, Nutrients, Nitrates, Nitrites, Silicates, Phosphates, Organic compounds, Carbon, Sediments, New York, Water sampling

Offshore dumping, New York bight, Nutrient distributions, Bight waters

J008
CROP RESPONSE TO TANK TRUCK APPLICATION OF LIQUID SLUDGE,

Kelling, K. A., Walsh, L. M., and Peterson, A. E.

Ball State University,
Muncie, Indiana,
Natural Resources Department.

Journal Water Pollution Control Federation, Vol. 48, No. 9, p 2190-2197, September, 1976. 3 tab, 22 ref.

The effects of repeated tank truck applications of liquid sludge on experimental plots of alfalfa, corn, and sorghum-sudan were investigated. Sludge applications of 5 cm usually provided yields of corn and sorghum-sudan which were equivalent to those obtained with a moderately high rate of commercial fertilizer when these crops were planted in the growing season following sludge application. Sludge applications of up to 15 cm did not reduce crop yields and in fact generally resulted in maximum yields and nitrogen uptake. Substantial residual benefits from sludge were observed at sludge applications as low as 5 cm for sorghum-sudan and 10 cm for corn, whereas no such residual response was observed when commercial fertilizer was applied. Repeated tank truck traffic on established alfalfa plots severely reduced crown survival and subsequent yields, and liquid sludge application by this method is not recommended for such plots. Nitrogen and phosphorus recoveries by corn and sorghum-sudan were relatively low in sludge-treated plots.

*Sludge, *Soil amendments, *Crop response, *Sludge disposal, *Fertilizers, Nitrogen, Phosphorus, Waste disposal, Symbiosis, Liquid wastes, Plant growth

J009
ENVIRONMENTAL IMPACTS OF LAND APPLICATION OF SLUDGE,

Zenz, D. R., Peterson, J. R., Brooman, D. L., and
Lue-Hing, C.

Metropolitan Sanitary District of Greater Chicago,
Chicago, Illinois,
Department of Research and Development.

Journal Water Pollution Control Federation, Vol. 48, No. 10, p 2332-2342,
October, 1976. 2 fig, 8 tab, 6 ref.

The results of a 4-year environmental monitoring program conducted by the Metropolitan Sanitary District of Greater Chicago to determine the effects of land application of sludge in Fulton County are reported. Surface discharges from fields receiving digested sludge averaged suspended solids, biochemical oxygen demand, and fecal coliform levels of 60 milligrams/liter, 6.0 milligrams/liter, and 36 counts/100 milliliters (geometric means), respectively. The water quality of a major stream which drains the digested sludge application project was unaffected by surface water discharges, and groundwater monitoring wells showed no evidence of groundwater contamination. After 3 years of sludge application, metal levels in corn grain grown on digested sludge amended soils showed no significant increase. Virus levels monitored over a 2-year period at three surface water monitoring points were not influenced by sludge application to the surrounding watershed. Fish living in several reservoirs which receive discharges from fields to which digested sludge has been applied were not influenced by such applications.

*Sludge disposal, *Soil amendments, *Reclamation, *Illinois, *Monitoring, Biochemical oxygen demand, Suspended solids, Coliforms, Surface water, Groundwater, Water quality, On-site investigations, Waste water treatment, Viruses, Fish, Metals, Recycling

Land application, Fulton county

J010
A STUDY OF BACTERIAL AEROSOLS AT A WASTEWATER
IRRIGATION SITE,

Sorber, C. A., Bausum, H. T., Schaub, S. A., and
Small, M. J.

United States Army Medical Bioengineering
Research and Development Laboratory,
Fort Detrick,
Frederick, Maryland.

Journal Water Pollution Control Federation, Vol. 48, No. 10, p 2367-2379, October,
1976. 7 fig, 7 tab, 13 ref.

A 4-week field study at a golf course irrigated with chlorinated secondary effluent was conducted to obtain data for a model designed to predict pathogen levels downwind from the spray source. Bacterial aerosols significantly above background were demonstrated at 198 m downwind from the nozzle, the greatest distance tested. At 152 m from the source, total aerobic counts of about 100/cu m and coliform-like counts of about 30/cu m were recorded. Among the isolates confirmed as coliforms biochemically, 58% were assigned to the genus Klebsiella; this is of public health significance since these bacteria are capable of producing respiratory and other infections in man. In two runs where chlorination was practiced, the mean reduction in total aerobic count observed at the irrigation spray nozzle was 99.6%, illustrating the effectiveness of this treatment for controlling the microbial aerosol problem.

*Irrigation, *Air pollution, *Aerosols, *Bacteria, *Waste water treatment, Water reuse, Recreation facilities, On-site investigations, Sprays, Chlorination, Microorganisms, Efficiencies, Coliforms, Public health

Klebsiella

J011
OCEAN DUMPING PHASE-OUT IN EPA REGION II,

Hadeed, S. J.

Journal Water Pollution Control Federation, Vol. 48, No. 10, p 2246-2248, October, 1976.

Environmental Protection Agency plans for phasing out ocean dumping of sewage sludge in Region II are described. Provisions to end ocean dumping by December 31, 1981 will be written into the interim dumping permits which will also prohibit nighttime dumping and recommend an expanded monitoring program. A comprehensive study of land-based alternatives to ocean dumping in Region II contracted by the Environmental Protection Agency indicates that air pollution rules must be waived in the New York and New Jersey metropolitan areas and recommends that regional pyrolysis facilities be constructed in the New York-New Jersey area. Land application or composting is recommended for sludge produced in outlying areas. Senate bill S 3147 which extends the Marine Protection, Research and Sanctuaries Act through fiscal 1977 appropriates $4.8 million for ocean dumping regulation, $5.6 million for ocean dumping research, and $0.5 million for marine sanctuaries. It also requires that the Secretary of the Army, Coast Guard, and Administrator of the Environmental Protection Agency submit annual reports on their respective activities in carrying out the ocean dumping title of the Act.

*Sewage sludge, *Sludge disposal, *Oceans, *Legislation, *Coasts, Legal aspects, Monitoring, Cities, Waste disposal, New York, New Jersey

Land application, Composting, Environmental Protection Agency, Pyrolysis

J012
GAS AND LEACHATE FROM LANDFILLS: FORMATION, COLLECTION, AND TREATMENT. PROCEEDINGS OF A RESEARCH SYMPOSIUM,

Genetelli, E. J., and Cirello, J.

Rutgers University,
New Brunswick, New Jersey,
Department of Environmental Science.

March 25-26, 1975, 196 p. 104 fig, 47 tab, 102 ref. Report EPA-600/9-76-004.

Topics dealing with the formation, collection, and treatment of gas and leachate from landfills are presented. Specific subjects discussed include: current Environmental Protection Agency activities in solid waste management research; solid waste management research in New York State, Puerto Rico, and the United Kingdom; a theoretical analysis of gas movement through soils; analytical methodologies for leachate and gas analysis; leachate attenuation in undisturbed and remoulded soils; variations in gas and leachate production from baled and non-baled municipal refuse; gas and leachate generation in various solid waste environments; leachate migration through selected clays; the pollution of groundwater by organic compounds generated by landfill activities; attenuation mechanisms of pollutants through soils; the monitoring of toxic chemicals at land disposal sites; an assessment of synthetic and admixed materials for lining landfills; landfill management with leachate recycle and treatment; the effect of shredding and sludge addition on solid waste decomposition; and a case history of landfill gas movement through soils.

*Landfills, *Leachate, *Gases, *Waste disposal, *Solid wastes, Soil types, Migration, Attenuation, Monitoring, Analytical techniques, Research priorities, Toxicity, Hazards, Liners, Recycling, Sludge, Clay minerals, Soil mechanics, Groundwater, Water pollution, Organic compounds

J013
INTRODUCTION TO SYMPOSIUM ON GAS AND LEACHATE FROM LANDFILLS: FORMATION, COLLECTION, AND TREATMENT,

Kaplovsky, A. J.

Rutgers University,
New Brunswick, New Jersey,
Department of Environmental Science.

In: Symposium on Gas and Leachate from Landfills: Formation, Collection, and Treatment, March 25-26, 1975, New Brunswick, New Jersey, Department of Environmental Science, Rutgers University, p 1-2.

Problems associated with assessing the impact of solid waste disposal in landfills are discussed, with particular emphasis on the importance of considering all of the environmental interactions involved. Constituent concentrations of pollutants found during landfill investigations should be carefully qualified by reporting fully the environmental conditions under which the decomposition occurred. For example, simply reporting the constitutent level at a given distance from the source without including the type of soil or medium through which the leachate traveled, the time of transit, or vegetative cover can lead to a misrepresentation of the findings. At the current pace of new legislation and enforcement, it is especially important to appropriately identify findings and to delineate limitations on conclusions.

*Landfills, *Waste disposal, *Leachate, *Soil types, *Solid wastes, Environmental effects, Environmental sanitation

J014
CURRENT EPA RESEARCH ACTIVITIES IN SOLID WASTE MANAGEMENT,

Schomaker, N. B., and Roulier, M. H.

Environmental Protection Agency,
Cincinnati, Ohio,
National Environmental Research Center.

In: Symposium on Gas and Leachate from Landfills: Formation, Collection, and Treatment, March 25-26, 1975, New Brunswick, New Jersey, Department of Environmental Science, Rutgers University, p 3-11. 1 tab.

Environmental Protection Agency research activities dealing with the management and disposal of solid wastes are outlined. The Agency's research efforts in this area include: establishing the basis for a solid waste management regulatory program for hazardous and nonhazardous wastes; determining the human health and environmental effects resulting from the land disposal of selected substances; investigating the migration of hazardous materials through soils and in water transport; establishing the role of soil in controlling or reducing harmful substances reaching water or air; assessing technology for the control of hazardous solid wastes; and evaluating the potential of source reduction, recycling, and energy conversion of solid waste materials.

*Waste disposal, *Solid wastes, *Reclamation, *Research priorities, *Federal government, Programs, Energy conversion, Land use, Recycling, Regulation

J015
CURRENT OFFICE OF SOLID WASTE MANAGEMENT PROGRAMS
LANDFILL ACTIVITIES,

DeGeare, T. V., Jr.

Environmental Protection Agency,
Washington, D. C.,
Office of Solid Waste Management Programs.

In: Symposium on Gas and Leachate from Landfills: Formation, Collection, and Treatment, March 25-26, 1975, New Brunswick, New Jersey, Department of Environmental Science, Rutgers University, p 12-15.

Research programs currently being conducted by the Environmental Protection Agency's Office of Solid Waste Management which deal with problems related to leachate and gas generation during landfill activities are outlined. These programs include: field monitoring activities to learn about leachate generation and movement under various field conditions; an assessment of the economic impact resulting from the effect of poor waste disposal practices on ground water contamination; studies on the extent to which soil attenuation acts as a mechanism for reducing the harmful effects of leachate; an evaluation of various leachate treatment methods (anaerobic filtration, spray irrigation, activated sludge treatment); and studies on the nature of landfill-generated gas both in terms of its potential as a hazard and as an energy source.

*Landfills, *Waste disposal, *Research priorities, *Leachate, *Gases, Federal government, Programs, Waste treatment, Solid wastes, Monitoring, On-site investigations, Toxicity, Economics, Groundwater, Soil tests, Soil mechanics, Filtration, Irrigation, Activated sludge

J016
CURRENT SOLID WASTE RESEARCH ACTIVITIES IN NEW YORK STATE,

Goddard, C. N.

New York State Department of Environmental Conservation,
New York,
Division of Solid Waste Management.

In: Symposium on Gas and Leachate from Landfills: Formation, Collection, and Treatment, March 25-26, 1975, New Brunswick, New Jersey, Department of Environmental Science, Rutgers University, p 16-17.

Solid waste research being sponsored by the State of New York is described. Leachate from two landfills in the central part of the state is being extensively sampled at a series of surface sample points in springs and streams below the disposal sites to learn more about the conservative nature of various pollutants. Flow measurements are being performed in the streams to provide information on the influence of dilution. This information will then be used to select a set of leachate indices. Another project funded by the Environmental Protection Agency is being conducted concurrently with the above research to investigate various ways of detecting the presence of leachate during the daytime and at night. Various types of films and thermal scanners are being evaluated.

*Landfills, *Leachate, *Research priorities, *Waste disposal, *Solid wastes, Monitoring, Streams, Springs, Surface waters, Flow, Analytical techniques, Water pollution, Pollutant identification, New York, Programs

J017
CURRENT SOLID WASTE MANAGEMENT ACTIVITIES IN PUERTO RICO,

Robena, S., Jr.

Environmental Quality Board,
San Juan, Puerto Rico.

In: Symposium on Gas and Leachate from Landfills: Formation, Collection, and Treatment, March 25-26, 1975, New Brunswick, New Jersey, Department of Environmental Science, Rutgers University, p 18-25. 1 fig, 2 tab, 8 ref.

Research activities on solid waste management in Puerto Rico are reviewed. Studies on leachate formation at different sanitary landfill sites have been initiated in coordination with the United States Geological Survey. A long-range plan for a continuous monitoring program at solid waste disposal sites has been proposed to assess the quality of groundwater near landfill sites. Advanced resource recovery studies are being conducted to investigate the feasibility of using metropolitan solid waste as an auxiliary fuel and to evaluate existing markets for segregated solid wastes, paper, glass, and metals. Community information programs are also being conducted. An island-wide survey of industrial hazardous and toxic wastes is being performed so that a state plan for the management of these wastes can be formulated. Detailed physical and chemical data from an analysis of leachate sampled at one of the landfill sites investigated are tabulated.

*Solid wastes, *Waste disposal, *Landfills, *Leachate, *Research priorities, *Energy conversion, Monitoring, Pollutant identification, Reclamation, Economics, Feasibility studies, Physical properties, Chemical properties, Surveys, Information exchange, Groundwater, Toxicity, Puerto Rico

J018
LANDFILL RESEARCH WORK IN PROGRESS AT HARWELLS HAZARDOUS MATERIALS SERVICE,

Bromley, J.

Harwell Laboratory,
Oxfordshire, United Kingdom,
Toxic and Hazardous Materials Group.

In: Symposium on Gas and Leachate from Landfills: Formation, Collection, and Treatment, March 25-26, 1975, New Brunswick, New Jersey, Department of Environmental Science, Rutgers University, p 27-32.

Research on solid waste management in the United Kingdom is reviewed, with particular emphasis on landfill site studies. The research activities include: the reclamation of landfill sites; the development of a data bank on potentially hazardous materials deposited into landfills; on-site investigations of different types of landfills; supporting lysimeter programs; studies on the behavior of selected toxic wastes associated with landfill leachate; studies of the movement of toxic leachate through sandstone, chalk, and gravel; experiments involving the exposure of different rock cores to synthetic leachate mixtures; studies on the relative rates at which various toxic materials are leached from actual wastes; and evaluations of encapsulation procedures for preventing the release of toxic wastes to landfills under different conditions.

*Solid wastes, *Waste disposal, *Leachate, *Landfills, *Research priorities, Reclamation, On-site investigations, Leaching, Movement, Rock properties, Chemical wastes, Toxicity

United Kingdom

J019
THEORETICAL APPROACH TO GAS MOVEMENT THROUGH SOILS,

Moore, C. A.

Ohio State University,
Columbus,
Department of Civil Engineering.

In: Symposium on Gas and Leachate from Landfills: Formation, Collection, and Treatment, March 25-26, 1975, New Brunswick, New Jersey, Department of Environmental Science, Rutgers University, p 33-43. 22 fig, 2 ref.

A mathematical model for predicting the flow of gases around sanitary landfills is presented along with some preliminary results. The mathematical analogue decouples the physical characteristics of the gases, the porous medium, and the areal geology. Interactions between the gas and the liquid or solid phases can be incorporated into the analogue through equilibrium equations. A solution to the analogue, assuming a 70% methane level in the landfill for 5 years and no excess total pressure, yields the following information: the maximum radial extent of the 5% methane level above the elevation of the landfill base extends for 1.28-2.25 times the radius of the landfill, depending on the perviousness of the ground surface; decay to below 5% methane requires from 1 to over 150 years; decomposition times in excess of 5 years result in further excursion of the 5% methane level; as the porosity of the soil increases, the 5% methane excursion distance increases; a small degree of perviousness of the ground surface is very effective in reducing the 5% methane excursion; vents are effective in reducing methane concentrations along a radial line passing through the vent but are essentially useless in reducing methane along radial lines a few degrees away from the line through the vent; and circumferential trenching can significantly reduce methane concentrations.

*Landfills, *Gases, *Methane, *Mathematical models, *Waste disposal, Solid wastes, Physical properties, Chemical properties, Soil physical properties

J020
ANALYTICAL METHODOLOGIES FOR LEACHATE AND GAS ANALYSIS,

Chian, E. S. K., and DeWalle, F. B.

Illinois University,
Urbana,
Department of Civil Engineering.

In: Symposium on Gas and Leachate from Landfills: Formation, Collection, and Treatment, March 25-26, 1975, New Brunswick, New Jersey, Department of Environmental Science, Rutgers University, p 44-53. 4 fig. 15 ref.

Techniques for sampling and analyzing leachate samples from landfills are discussed. Strict anaerobic sampling and storage conditions are necessary to prevent extensive changes from occurring in the leachate sample prior to analysis. Samples should be stored in glass bottles for organic analysis and in plastic bottles for heavy metal analysis. The sequence of parameter analysis should be: oxidation-reduction potential, color, turbidity, suspended solids, pH, and conductivity. Other parameters such as chemical oxygen demand and organic nitrogen may also change directly after sampling, but these changes can be reduced by acidifying the sample. Chemical analysis using colorimetric methods is strongly interfered with by color, suspended solids, and high salt concentrations in the leachate. These interfering effects can be reduced by using a standard addition method or by diluting the leachate sample with increasing amounts of water to determine whether the interfering effect can be sufficiently reduced.

*Leachate, *Landfills, *Analytical techniques, *Sampling, *Chemical analysis, Conductivity, Color, Turbidity, Suspended solids, Nitrogen, Chemical oxygen demand, Physical properties, Chemical properties, Colorimetry, Heavy metals, Organic compounds

J021
LEACHATE ATTENUATION IN UNDISTURBED AND REMOULDED SOILS,

Farquhar, G. J., and Rovers, F. A.

Waterloo University,
Waterloo, Ontario, Canada,
Department of Civil Engineering.

In: Symposium on Gas and Leachate from Landfills: Formation, Collection, and Treatment, March 25-26, 1975, New Brunswick, New Jersey, Department of Environmental Science, Rutgers University, p 54-70. 14 fig, 8 tab, 15 ref.

Soil attenuation of landfill leachate was studied by comparing the flow and contaminant removal patterns in columns containing both undisturbed and remoulded samples of the same soil. A significant degree of attenuation by dilution was provided by the water retained in the soil below the field capacity. Remoulded soils provided more attenuation by dilution than did undisturbed soils. When flow conditions were intergranular, the use of remoulded soil columns for estimating attenuation was acceptable; thus, the estimation of attenuation using dispersed soil reactors corrected for the degree of dilution appears to be acceptable. Removal isotherms constructed from dispersed soil studies can be used to predict the breakthrough curves for some contaminants. This can be accomplished for contaminants where the isotherms constructed from dispersed soil studies are linear.

*Attenuation, *Leachate, *Soils, *Landfills, *Analytical techniques, Solid wastes, Soil types, Soil tests, Soil water

Dilution

J022
VARIATIONS IN GAS AND LEACHATE PRODUCTION FROM BALED AND NON-BALED MUNICIPAL REFUSE,

Eifert, M. C.

Systems Technology Corporation,
Dayton, Ohio.

In: Symposium on Gas and Leachate from Landfills: Formation, Collection, and Treatment, March 25-26, 1975, New Brunswick, New Jersey, Department of Environmental Science, Rutgers University, p 71-82. 10 fig, 3 tab.

Experiments involving the use of five landfill simulators filled with municipal refuse were performed to investigate gas and leachate production. Although insufficient gas was generated for analysis, leachate was collected several times. The first leachate collected appeared to be the squeezings from the solid waste during loading. Further leachates gathered reflected leachate generated from moisture additions. The experiments are still underway, and no conclusions can be drawn because of the limited amount of data thus far generated. Leachate analytical data for color, pH, conductivity, chemical oxygen demand, hardness, total organic carbon, volume, iron, copper, zinc, and nickel are tabulated.

*Leachate, *Gases, *Landfills, *Municipal wastes, *Waste disposal, Color, Conductivity, Chemical oxygen demand, Hardness (water), Carbon, Iron, Copper, Zinc, Nickel, Chemical analysis, Solid wastes

J023
GAS AND LEACHATE GENERATION IN VARIOUS SOLID WASTE ENVIRONMENTS,

Jackson, A. G., and Streng, D. R.

Systems Technology Corporation,
Dayton, Ohio.

In: Symposium on Gas and Leachate from Landfills: Formation, Collection, and Treatment, March 25-26, 1975, New Brunswick, New Jersey, Department of Environmental Science, Rutgers University, p 83-91. 2 fig, 5 tab.

Ongoing experiments to investigate gas and leachate generation in different solid waste environments are reported. Landfill simulations with test cells containing solid waste and selected other wastes have been in progress for about 4 months. The cells are in the early stages of methane generation and have just completed the change from aerobic to anaerobic condition. Microbiological assay of the leachate revealed high levels (generally 100,000 colonies/100 milliliters) of fecal coliforms and fecal streptococcus in the initial leachate collected. Analysis of the leachates that followed revealed an increasing dieoff of coliforms in the leachate as the cell aged. Streptococcus remained quite high for several months but is now beginning to decrease. Detailed chemical data for the leachate and gas collected thus far are tabulated.

*Landfills, *Leachate, *Gases, *Chemical analysis, *Microbiology, Waste disposal, Coliforms, Streptococcus, Methane, Chemical properties, Solid wastes, Simulation analysis

J024
LEACHATE MIGRATION THROUGH SELECTED CLAYS,

Griffin, R. A., and Shimp, N. F.

Illinois State Geological Society,
Urbana, Illinois.

In: Symposium on Gas and Leachate from Landfills: Formation, Collection, and Treatment, March 25-26, 1975, New Brunswick, New Jersey, Department of Environmental Science, Rutgers University, p 92-95.

Leachate migration through three different clay minerals was investigated as part of an effort to evaluate the potential use of clay as a liner for landfills. Montmorillonite clay exhibited the strongest attenuation, being about four times more effective than illite and five times more effective than kaolinite. Mercury, lead, zinc, and cadmium were the components most strongly attenuated by the clays. Calcium, iron, and manganese showed no attenuation. Chemical oxygen demand showed a relatively low attenuation. Adsorption studies revealed that the most important factors affecting the prediction of a given metal ion's migration under a solid waste disposal site are the pH of the solution, the cation exchange capacity of the clay, and the ionic composition of the solution matrix. A computer simulation model was written to predict metal ion migration through clay columns.

*Migration, *Leachate, *Attenuation, *Landfills, *Clay minerals, *Chemical analysis, Mercury, Lead, Zinc, Cadmium, Calcium, Iron, Manganese, Chemical oxygen demand, Waste disposal, Solid wastes, Ion exchange, Ions, Metals, Montmorillonite, Kaolinite, Illite

J025
ORGANIC POLLUTANTS CONTRIBUTED TO GROUNDWATER
BY A LANDFILL,

Dunlap, W. J., Shew, D. C., Robertson, J. M.,
and Toussaint, C. R.

Environmental Protection Agency,
Ada, Oklahoma,
Robert S. Kerr Environmental Research Laboratory.

In: Symposium on Gas and Leachate from Landfills: Formation, Collection, and Treatment, March 25-26, 1975, New Brunswick, New Jersey, Department of Environmental Science, Rutgers University, p 96-110. 7 fig, 4 tab, 21 ref.

Groundwater from a well within a landfill and from a control well was sampled using a modified low-flow carbon adsorption procedure to determine the contribution of organic compounds to groundwater resulting from the disposal of refuse. Column chromatography, solubility separation, and gas chromatography/mass spectrometry measurements revealed low levels of many undesirable organic chemicals in the groundwater which were apparently leached from the landfill. More than 40 compounds were identified, most of which were chemicals commonly employed in industry for the manufacture of domestic and commercial products. The source of these compounds was apparently manufactured products which were discarded in the landfill since it had not received appreciable wastes from industrial operations. The results demonstrated the potential for long-term pollution of groundwater as a result of solid waste disposal in landfills.

*Groundwater, *Landfills, *Leachate, *Waste disposal, *Water pollution, Chemical analysis, Organic compounds, Domestic wastes, Solid wastes, Leaching, On-site investigations

J026
ATTENUATION MECHANISMS OF POLLUTANTS THROUGH SOILS,

Fuller, W. H., and Korte, N.

Arizona University,
Tucson,
College of Agriculture.

In: Symposium on Gas and Leachate from Landfills: Formation, Collection, and Treatment, March 25-26, 1975, New Brunswick, New Jersey, Department of Environmental Science, Rutgers University, p 111-122. 4 fig, 7 tab, 6 ref.

Soil columns were leached with a landfill leachate spiked with selected potentially hazardous elements to investigate soil attenuation mechanisms. The relative mobility of 11 trace elements in landfill leachate was ranked for 11 soils representing seven soil orders. The most generally mobile elements were chromium, mercury, and nickel; whereas the least mobile elements were lead and copper. The mobility varied with conditions for arsenic, beryllium, cadmium, selenium, vanadium, and zinc. The soil that was most effective in attenuating trace elements was Molokai, and Oxisol from Hawaii. Davidson, an Ultisol from North Carolina, ranked second in its immobilization effectiveness. Both soils are high in clay and extractable free iron oxides. The attenuation of other soils varied but generally ranked according to the amount of clay-sized particles in the soil.

*Attenuation, *Soil types, *Leachate, *Landfills, *Clay minerals, Chromium, Mercury, Nickel, Lead, Copper, Arsenic compounds, Beryllium, Cadmium, Zinc, Chemical analysis

Vanadium, Selenium, Oxisols, Ultisols

J027
MONITORING TOXIC CHEMICALS IN LAND DISPOSAL SITES,

Walker, W. H.

Illinois State Water Survey,
Urbana, Illinois.

In: Symposium on Gas and Leachate from Landfills: Formation, Collection, and Treatment, March 25-26, 1975, New Brunswick, New Jersey, Department of Environmental Science, Rutgers University, p 123-129. 3 fig, 1 ref.

Toxic chemical monitoring at landfill sites is discussed. Recent studies indicate that well monitoring systems may not be the most effective means to trace chemical pollutant flow paths or to determine groundwater chemical concentrations at any time or depth. Instead, chemical analyses of core samples from the underlying earth material profile may be preferred since these allow for a positive definition of any chemical constituent within the profile at any given location. This is true regardless of whether the chemicals are present in precipitated form in the zone of aeration, are held by retention on soil particles in the semisaturated fringe, or are dissolved in groundwater within the zone of saturation. Core sample monitoring is also faster and more economical than well monitoring. The number of sampling points required is primarily controlled by the expected variability of each parameter and the degree of monitoring accuracy desired. Initial soil core test probes which are made to obtain background data should be placed at the center of each sampling station.

*Monitoring, *Landfills, *Groundwater, *Sampling, *Cores, Chemical analysis, Soil tests, Water pollution, Waste disposal, Solid wastes

J028
ASSESSING SYNTHETIC AND ADMIXED MATERIALS FOR
LINING LANDFILLS,

Haxo, H. E., Jr.

Matrecon, Incorporated,
Oakland, California.

In: Symposium on Gas and Leachate from Landfills: Formation, Collection, and Treatment, March 25-26, 1975, New Brunswick, New Jersey, Department of Environmental Science, Rutgers University, p 130-158. 8 fig, 14 tab, 26 ref.

Experiments involving the use of various polymeric and admixed materials for landfill liners are reported. The liners are mounted as barriers in the bases of 24 simulated sanitary landfills which are uniformly filled with a shredded municipal refuse with a moisture content of 30%. In addition, 42 small membrane specimens are being exposed to leachate by being placed in the sand above the barriers. To date, only a soil-asphalt liner appears to be inadequate. Leachate is seeping through one specimen of this type, and indications are that a second liner of this type will also leak. Sealing the liners into the generator bases with a cast epoxy ring has worked out satisfactorily except for the soil-asphalt liner. Polyethylene film appears to be sensitive to creasing and puncturing, although it has not failed as a barrier. Laboratory tests of unexposed membrane liners of the same polymer indicate that there can be considerable liner-to-liner variation in liners of the same polymer type. These variations probably reflect differences in compounding and in fabrication of the liner materials.

*Linings, *Landfills, *Leachate, *Waste disposal, *Simulation analysis, Materials, Polymers, Asphalt, Soils, Physical properties, Performance, Evaluation

J029
LANDFILL MANAGEMENT WITH LEACHATE RECYCLE AND TREATMENT: AN OVERVIEW,

Pohland, F. G.

In: Symposium on Gas and Leachate from Landfills: Formation, Collection, and Treatment, March 25-26, 1975, New Brunswick, New Jersey, Department of Environmental Science, Rutgers University, p 159-167. 9 fig, 2 tab, 3 ref.

An overview of a leachate recycle/treatment concept is presented based on experiments with a simulated landfill constructed so that leachate could be recycled back in a manner analogous to the operation of an anaerobic trickling filter. Recirculation of the leachate through the landfill promotes a more rapid development of anaerobic activity and methane fermentation, an increase in the rate and predictability of biological stabilization of organic pollutants in the waste, a significant decrease in the time required for stabilization, and a reduction of the potential for environmental impairment. Leachate recirculation with pH control and initial sludge seeding further enhances treatment efficiency so that the time required for biological stabilization of readily available organic pollutants in the leachate is reduced to months rather than years. The application of separate anaerobic and aerobic biological processes has also proven satisfactory for leachate treatment. Carbon adsorption is effective in removing residual organics and inorganics in the effluent when it is followed by mixed resin ion exchange.

*Leachate, *Landfills, *Waste disposal, *Waste treatment, *Recycling, Organic compounds, Methane, Biological treatment, Adsorption, Ion exchange, Inorganic compounds, Simulation analysis, Efficiencies

J030
SOLID WASTE DEGRADATION DUE TO SHREDDING AND SLUDGE ADDITION,

Ham, R. K.

Wisconsin University,
Madison,
Department of Civil and Environmental Engineering.

In: Symposium on Gas and Leachate from Landfills: Formation, Collection, and Treatment, March 25-26, 1975, New Brunswick, New Jersey, Department of Environmental Science, Rutgers University, p 168-176. 6 fig, 1 tab, 5 ref.

Experiments investigating the effects of shredding and sludge addition on refuse decomposition in landfills are reported. The shredding of refuse promoted decomposition, resulting in rapid oxygen use and methane production as well as stabilization of leachate contaminant production. Cover prolonged the period of acidic leachate production and postponed methane production. The addition of sludge to shredded refuse resulted in odors, and a 70% water mixture was not workable. Flies were attracted to the refuse-sludge cells, whereas no flies were observed in cells without sludge. Rodent activity developed on noncompacted cells but was not observed on the compacted cells. The production of leachate per ton of dry refuse increased markedly with initial percent water and was not a strong function of compaction or depth. It appears that environmental and operational problems associated with the incorporation of sludge with refuse may negate any advantages of the process.

*Landfills, *Solid wastes, *Sludge, *Waste disposal, *Waste treatment, Leachate, Methane, Biological treatment, Chemical reactions, Evaluation, Performance, Odor

J031
CASE HISTORY OF LANDFILL GAS MOVEMENT THROUGH SOILS,

Flower, F. B.

Rutgers University,
New Brunswick, New Jersey,
Cook College.

In: Symposium on Gas and Leachate from Landfills: Formation, Collection, and Treatment, March 25-26, 1975, New Brunswick, New Jersey, Department of Environmental Science, Rutgers University, p 177-189. 14 fig.

Three cases of landfill gas migration problems are reviewed. Each case involved the disposal of commercial refuse in old sand and gravel pits. Problems resulting from the migration of gas generated from the landfills included the death of peach trees, the death of ornamental vegetation, and the demise of commercial farm crops. One case also involved the entrance of combustible gases into private residences adjacent to the landfill. The studies demonstrated that injury and death of vegetation can be used as indicators of the presence of landfill gases in the surface soil layers; however, the gases can travel laterally below vegetation without injuring it and appear at the surface at a greater distance from the landfill. The studies also demonstrated that sand and gravel pits are not good places for refuse disposal if lateral gas migration is to be prevented. If old sand and gravel pits are used as refuse landfills, gas vents and seals should be placed at the outer edge of the landfill prior to refuse deposition.

*Landfills, *Waste disposal, *Gases, *Migration, *Phytotoxicity, Vegetation, Hazards, Solid wastes, On-site investigations

J032
TREATMENT OF LEACHATES FROM SANITARY LANDFILLS,

Johansen, O. J. G.

Dissertation Abstracts International B, Vol. 37, No. 2, p 940, August, 1976.

The fate of organics, heavy metals, and other inorganic compounds was evaluated in leachates from eight landfills. Leachates from two landfills were treated anaerobically and four aerobically to study biological treatability. Results from anaerobic tests indicated that treatment could be successful with organic loadings less than 0.7 kg COD/cu m/day and temperatures higher than 22 C. The activated sludge process gave the best results of the aerobic systems. High strength leachates gave higher organic removals than low strength leachates. Treatment efficiencies were the same in treating both chemically precipitated or raw leachate. Phosphorus did not limit biodegradation. Concentrations of 50 milligrams per liter of zinc and copper proved inhibitory to COD removal. At temperatures below 18 C, COD removals and nitrification dropped sharply. Chemical precipitation at high pH efficiently removed heavy metals from raw leachate. Activated carbon adsorption of biologically treated plus precipitated leachate produced much lower residual organics than carbon adsorption of precipitated leachate.

*Organic compounds, *Leachate, *Landfills, *Inorganic compounds, *Waste treatment, Aerobic treatment, Anaerobic digestion, Activated sludge, Activated carbon, Biodegradation

J033
INNOVATION IS AN OLD IDEA--WITH A BIG FUTURE,

Culver, R. H., Kalinske, A. A., and Woodward, R. L.

Camp Dresser and McKee,
Boston, Massachusetts.

Water and Wastes Engineering, Vol. 13, No. 7, p 43-48, 112, July, 1976. 1 tab.

An historical perspective of developments in treating water and sewage was used to project the types of future developments in the field. Advances in this area have traditionally been evolutionary rather than radically advanced by leaps and bounds. Most techniques presently used were developed during the past fifty years and the processes and materials involved were refined with the passage of time. Systems are being designed and developed which will have a probable lifetime of fifty to seventy-five years. There is no expectation of radical advances and the water treatment and sewage disposal systems of the next one hundred years will be quite recognizable. Considerations are cost effective systems and energy efficiency, as well as resource recovery and recycling of clarified water for uses other than drinking water. Computerization will also become a more important part of systems design in the future.

*Waste water treatment, *Sewage treatment, *Sewage disposal, *Water treatment, *Reviews, Computers, Recycling, Design, Potable water, Energy

J034
GRANT AID FOR PLANT OPERATIONS: AN EVALUATION,

Hetling, L. J., Caracich, I. G., Mack, P. J., and
Klimek, J. C.

New York State Department of Environmental Conservation,
Environmental Quality Research Unit.

Journal Water Pollution Control Federation, Vol. 48, No. 11, p 2529-2540, November, 1976. 2 fig, 4 tab, 1 ref.

A New York State Legislature study on its program of financial assistance in the construction, operation, and maintenance of waste water treatment plants was reported. The main goal of the program was to prevent deterioration of new treatment plants and to upgrade existing ones where feasible. In evaluating administrative costs, it was found that the program cost $720 thousand annually or $1 in administrative overhead for each $25 given in grant. Rising expenditures were considered the result of an increase in eligible facilities, the greater costs of more efficient and complex plants, and general economic inflation. Most rejections under the program were due to removals less than design or deteriorating removals; lack of action on study and/or correction of flow measurements, hydrologic overloading, infiltration or storm water problems; raw waste water discharges or bypassing; and inadequate or no sampling and/or laboratory testing. The program was very helpful in improving secondary considerations such as plant performance, increasing inspection and repair operations, maintaining qualified personnel without political overstaffing, inspiring community sewer use ordinances, improving safety standards, and aiding compliance with pollution abatement orders. There are problems with this system which have hindered full participation by New York communities. Some were complicated by community dislike of outside inspections and supervision. Others were financial. In some cases the possible state funds would not be of sufficient benefit in improving treatment facilities and, often, costs involved in application for grants were detrimental inhibitors.

J035
AEROSOL PRODUCTION BY IRRIGATION EQUIPMENT USED
FOR LAND APPLICATION OF WASTE WATER,

Raynor, G. S., and Hayes, J. V.

Brookhaven National Laboratory,
Upton, New York.

American Industrial Hygiene Association Journal, Vol. 37, No. 9, p 526-536, September, 1976. 9 fig, 4 tab, 8 ref.

Experiments were conducted to determine the size distribution and concentration of aerosols and drops from dilute untreated sewage sprayed through agricultural irrigation systems. Experiments were conducted at specified pressures for each nozzle system over a wide range of wind speed, temperature, and relative humidity. Output rate, flow rate through each sampler and meteorological conditions were measured during testing. Testing was done with four nozzle systems used for upland recharge of waste water. A small part of the liquid output was lost to drift droplets, but large quantities of small aerosols were produced, especially in the respirable size range. The typical system produced from 10 to the 13th power to 10 to the 14th power particles per spray acre with a rate of 50,000 gallons per acre per day. Fewer aerosols were produced at low wind speeds from low spraying nozzles. A shorter operating time and exposure to wind may result in fewer aerosols at greater flow rates if fixed amounts of liquids must be emitted. Under typical atmospheric conditions, centerline concentrations decrease from one to two orders of magnitude in a travel distance of 1 km near ground level.

*Pollutant identification, *Sewerage, *Aerosols, *Irrigation practices, *Irrigation systems, Application equipment, Land use, Waste water (pollution)

J036
RISK OF COMMUNICABLE DISEASE INFECTION ASSOCIATED WITH
WASTE WATER IRRIGATION IN AGRICULTURAL SETTLEMENTS,

Katzenelson, E., Buium, I., and Shuval, H. I.

Hebrew University-Hadassah Medical School,
Jerusalem, Israel,
Environmental Health Laboratory.

Science, Vol. 194, No. 4268, p 944-946, November, 1976. 1 fig, 1 tab, 7 ref.

Statistics from 207 kibbutzim (population 82,825) were used to compare morbidity rates between users and nonusers of waste water for irrigation. Data was collected primarily for waterborne diseases such as shigellosis, salmonellosis (not including typhoid fever which was considered separately), infectious hepatitis, and influenza. Streptococcal infections (including scarlet fiver) and tuberculosis were chosen as controls. Disease incidence was two to four times higher in settlements using sewage effluent as irrigation water. Though the incidence of clinical influenza was twice as high in sewage-irrigated settlements, there was no difference in the incidence of laboratory diagnosed influenza cases. There was no significant difference in the incidence of the diseases not associated with sewage. Since sewage irrigation is not used during the winter, the similarity of mortality rates supports the hypothesis that there is a link between sewage irrigation and enteric disease incidence. Geographical differences and pathogen transmission by sewage-irrigated crops have been discounted. It was suggested that pathogens from waste water irrigation areas could reach kibbutz populations through alternate pathways, on bodies and clothes of irrigation workers returning to the community. The precaution of waste water treatment, including bacterial and viral disinfection of all waste water used in the vicinity of settlements or residential areas, is urged.

*Waste water treatment, *Sewerage, *Pollutant identification, *Infection, *Human diseases, Waste water (pollution), Irrigation practices, Irrigation water

J037
IS THERE A 'SLUDGE MARKET'?,

Ettlich, W. F., and Lewis, A. K.

Culp/Wesner/Culp,
Clean Water Consultants,
Santa Ana, California.

Water and Wastes Engineering, Vol. 13, No. 12, p 40-44, 47, December, 1976. 1 fig, 6 tab.

A marketing study, including a literature search, telephone survey, and user survey, was conducted to determine the practicality and desirability of marketing composted waste water sludge. Six metropolitan areas were chosen, three of which presently have such an operation. The literature search revealed that prices for air-dried sludge ($0-20/ton unbagged; $20-60/ton bagged) were higher than competitive products at West Coast prices. Comparison of this to heat-dried sludge was found to be difficult. The telephone and user surveys revealed that most people were willing to use sludge compost if it were competitively priced and if they could have a sample for testing. Some would use it instead of fertilizer, but it was felt that compost might not meet their needs. Users accept the product, have few complaints, and many become repeat customers. Demand has remained high. It was found that no significant surveys had been made in present market areas. The study proved that, in these areas, the operation's success depended on: favorable local publicity, ease of pick-up or delivery, guidelines or suggestions for use, free or low-cost products, and a trade name for the product. It was felt that a demonstration project would speed public acceptance and use of sludge compost.

*Waste water treatment, *Sludge, *Marketing, *Publications, *Surveys, Sludge disposal, Economics, Prices, Drying

Composting, Marketing survey, Air-dried sludge, Heat-dried sludge

J038
HUMAN ENTERIC VIRUSES IN A WASTE-RECYCLING AQUACULTURE SYSTEM,

Metcalf, T. G.

New Hampshire University,
Durham,
Department of Microbiology.

August, 1975. 32 p, 4 fig, 3 tab, 3 ref. Tech. Rept. NTIS PB-245 909.

Potential public health hazards from the use of the aquaculture waste recycling system were evaluated. The treatment system consisted of algal ponds, in which secondary non-chlorinated sewage was mixed with seawater, and raceways stocked with shellfish. Test viruses were Poliovirus II, Echovirus 5, Coxsackievirus B-3, Reovirus 1, and type 5 Adenovirus. Results of the two-year study indicated that the system is unacceptable, if a virus-free effluent is desired, without a second virus inactivating process. If virus-free shellfish were to be the parameter of public health acceptance, the full-grown shellfish could be depurated to remove viruses or the sewage effluent could be treated to remove viruses. The system was judged unsafe for use as a means of providing a growth medium for commercially valuable marine life. Further research was recommended.

*Waste water treatment, *Public health, *Pollutant identification, *Sewerage, *Treatment facilities, Sewage treatment, Viruses, Aquaculture, Recycling

Waste-recycling aquaculture system

J039
AN EVALUATION OF LAND TREATMENT OF MUNICIPAL WASTE WATER AND PHYSICAL SITING OF FACILITY INSTALLATIONS,

Hartman, W. J., Jr.

Office of the Chief of Engineers
James Forrestal Building,
Washington, D.C.

May 16, 1975. 65 p, 31 fig, 16 tab, 127 ref. Tech Rept. NTIS AD-A016 118.

A study of historical and current literature on land treatment was conducted to help policy and decision making relative to treating or disposing municipal waste water. Information is given to aid designers in siting treatment facilities. Evaluations were made of environmental factors and characteristics of potential and current areas served. These characteristics included population size, soils, crops, health hazards, aesthetics, and the rate and quantity of application. Several concerns in siting facilities were farm unit density, crop production, present non-farm land uses, topography, animals and vegetation, meteorology, soil moisture, and public involvement. Planning goals cited were consideration of buffer areas, isolation, preservation of natural resources and farm-municipal cooperation. Land treatment was considered useful for waste water where environmental factors are favorable and area economics can be improved. Scientific teams from varying backgrounds were suggested as designers of treatment systems.

*Waste water treatment, *Land management, *Treatment facilities, *Evaluation, *Land use, Environmental effects, Sites

J040
AN EXPERIMENTAL AND SIMULATION STUDY OF WASTE EFFLUENT FILTRATION THROUGH SOIL,

Lo, K. V.

Dissertation Abstracts International B, Vol. 36, No. 9, p 4592, 1976.

The effects of waste water effluent application rates and frequencies on waste water renovation through soil media was studied with soil columns. Chemical analyses were made of soil, waste water and filtrate samples, and bench tests were conducted to determine nutrients adsorption properties of various soils. Mathematical models were made of waste water movement in soil columns for infiltration and redistribution and moisture profiles were determined. Tests revealed that all columns achieved a 99% or better phosphorus removal. Phosphorus from applied secondary effluent accumulated in the top 1.0-2.5 inches of the columns, depending on loading. At the end of the study, nitrogen levels were below the recommended limit of 10 ppm for drinking water. Denitrification was significant in nitrogen removal.

*Waste water treatment, *Filtration, Soil water movement, Model studies, Phosphorus, Nitrogen, Soil types, Denitrification

J041
GROUNDWATER POLLUTION FROM A SEPTIC TILE FIELD,

Viraraghavan, T., and Warnock, R. G.

Ottawa University,
Ottawa, Canada,
Department of Civil Engineering.

Water, Air, and Soil Pollution, Vol. 5, No. 3, p 281-287, April, 1976. 1 fig, 4 tab, 5 ref.

The characteristics of groundwater pollution below a septic tile field were studied. Soil in the test area was a combination of Piedmont (sandy loam) and Pontiac (silt loam to clay loam) and the topography was undulating with steeply sloping banks, stone- and outcrop-free. Grain-size analysis, percolation, and permeability tests were performed. The subsurface tile field system, operated for three years, treated effluent from a 5625 liter capacity septic tank. Groundwater samples were taken at four locations near three of the ten laterals in the system. Analysis was done for pH, total suspended solids (TSS), 5-day biochemical oxygen demand (BOD), chemical oxygen demand (COD), soluble organic carbon (SOC), total phosphates, ammonia nitrogen, nitrate nitrogen, total soluble iron, chloride, indicator organisms (coliforms, fecal coliforms and streptococci), and Pseudomonas aeruginosa. Observations showed that groundwater pollutant concentrations were significantly lower than in septic tank effluent due to dilution and passage through soil. Compared to background levels, concentrations were higher, especially COD, SOC, total phosphates, ammonia, and chlorides. Total phosphate levels of 21.6 milligrams/liter and ammonia nitrogen levels of 50-75 milligrams/liter were observed under one lateral. Chlorides were seen to increase by 20-30 milligrams/liter under two laterals. Soil removed much of the pollutants from septic tank effluent, but concentrations in groundwater varied substantially due to variations in the depth to groundwater table and the non-uniform loadings resulting from the hydraulics of the system.

*Water pollution, *Water pollution sources, *Soil disposal fields, *Septic tanks, *Percolation, Permeability, Groundwater, Biochemical oxygen demand, Chemical oxygen demand, Carbon, Phosphates, Nitrogen, Chlorides, Microorganisms, Coliforms, Streptococcus, Pseudonomas

J042
EFFECT OF MUNICIPAL LANDFILL LEACHATE ON MERCURY MOVEMENT THROUGH SOILS,

Niebla, E. E., Korte, N. E., Alesii, B. A., and Fuller, W. H.

Arizona University,
Tucson,
Department of Soils, Water and Engineering.

Water, Air, and Soil Pollution, Vol. 5, No. 4, p 399-401, June, 1976. 2 tab, 8 ref.

The effect of sanitary landfill effluent on mercury attenuation by soils was evaluated. Test soils (Anthony sandy loam, Davidson clay, Fanno clay, and Chalmers sity clay loam) were packed in PVC pipe, 5 centimeters in diameter and 10 centimeters long. Three columns of each were subjected to leaching solutions of simulated landfill leachate (75 ppm Hg), de-ionized water with HgCl2 (90 ppm Hg), and de-ionized water with 0.25 mM Na2 EDTA (90 ppm Hg). The high concentrations minimize vaporization loss and compensate for container adsorption. Solutions were adjusted to pH 5. Results showed that mercury in landfill leachate was more mobile than that in de-ionized water. The similar data for Chalmers and Fanno soils indicated that leachate composition was more important than soil properties. Mercury in EDTA and leachate solutions were alike for Anthony and Chalmers soils, but mercury in the EDTA solution was most mobile in Anthony soil. The assumption is that chelation is not the only factor involved in mercury mobility. Several other organic compounds and complexes may play a part in mercury mobility. It was concluded that mercury adsorption in soils is more effective from water than the simulated sanitary landfill leachate. The composition of the leaching solution should be adequately characterized in order to predict mercury mobility.

*Pollutant identification, *Municipal wastes, *Landfills, *Waste disposal, Soil chemistry, Leachate, Mercury, Adsorption

J043
EFFECTS OF SEWAGE SLUDGE COMPOSITION, APPLICATION RATE, AND LIME REGIME ON PLANT AVAILABILITY OF HEAVY METALS,

John, M. K., and Van Laerhoven, C. J.

Office of the Science Advisor,
Environment Canada,
Ottawa, Ontario, Canada.

Journal of Environmental Quality, Vol. 5, No. 3, p 246-251, July-September, 1976.
8 tab, 15 ref.

Milorganite and air-dried primary digested sludge were applied to unlimed and limed soil to determine the effects of heavy metals on romaine lettuce and beets grown on these soils. The lettuce yield after 6 weeks was immensely improved when Iona sludge (10 grams/kilogram) or Milorganite (5 or 10 grams/kilogram) was applied. When Milorganite increased above 10 grams/kilogram, lettuce dry markedly decreased. A larger lettuce yield was obtained from limed than unlimed soil. Beet top growth was greatly enhanced when Milorganite was applied to unlimed soil (10 or 25 grams/kilogram) and to limed soil (25 to 100 grams/kilogram). Various application rates of Iona sludge did not produce results very different from that of control treatment. Addition of sludge to limed soil increased Cd concentrations in lettuce, whereas additions to unlimed soil did not affect those concentrations. Concentrations in beets did not significantly change from controls when sludge was applied to limed soil. Milorganite-borne Cd was also less available to plants from limed soil than from unlimed soil. Zinc available to plants was enhanced by sludge applications of 100 grams/kilogram, but not lower concentrations, in both soil types. Milorganite application (5 to 25 grams/kilogram) in limed soil increased Zn, but decreased Zn in unlimed soils. Data was provided on experiments with other metals. Soil pH was not significantly affected by sludge applications, but massive declines were found with milorganite applications. Higher pH values were found in limed than unlimed soil for all sludge treatments. An inverse relationship was found between soil pH and zinc and cadmium.

*Soil amendments, *Soil treatment, *Heavy metals, *Lime, *Phytotoxicity, Vegetation, Sludge disposal, Sludge digestion, Waste disposal, Cadmium, Lead, Copper, Iron, Manganese, Nickel, Zinc

Milorganite

J044
THE OPERATION OF THE DUMPING AT SEA ACT 1974,

Norton, M. G.

Ministry of Agriculture,
Fisheries and Food Fisheries Laboratory,
Burnham-on-Crouch,
Essex, England.

Chemistry and Industry, No. 19, p 829-834, October, 1976. 4 tab, 8 ref.

Various aspects and effects of the Dumping at Sea Act 1974 in Britain, are discussed. The Ministry of Agriculture, Fisheries and Food (MAFF), under this Act, is a licensing authority responsible for the protection of the marine environment and the life it supports from pollution. The agency must assess short and long term effects of ocean dumping of wastes and approve the location of dumping areas. In addition, the agency must consider the effects of dumping wastes on other interests and activities in the area, such as fishing, navigation, and mineral extraction. Sewage sludges have been disposed by ocean dumping in greater quantities, largely due to difficulties with other disposal means. Ocean disposal of industrial wastes releases land disposal facilities for more toxic or difficult waste disposal. A reduction in applications for ocean dumping of these wastes may be due to economic factors and to the fee charged for any tests necessary to evaluate effects of ocean dumping. The MAFF is also involved in international schemes to manage ocean dumping through agreements such as the Oslo and London conventions. Various requirements and effects of these agreements are discussed.

*Waste disposal, *Administration, *Legislation, *Standards, Administrative agencies, Adoption of practices, Decision making, Industrial wastes, Ultimate disposal, Water pollution, Oceans

Ocean dumping, Ministry of Agriculture Fisheries and Food, Dumping at Sea Act 1974

J045
CONSEQUENCES TO INDUSTRY OF THE RECENT WATER LEGISLATION:
THE ROLE OF THE REGIONAL WATER AUTHORITY,

Bailey, D. A.

Yorkshire Water Authority,
Leeds, Yorkshire, England.

Chemistry and Industry, No. 19, p 808-818, October, 1976. 7 fig, 3 tab, 13 ref.

The functions of British Regional Water Authorities in water supply and management, river pollution prevention, waste treatment and disposal are surveyed. There are 10 Water Authorities which are divided into several divisions. The major purpose of these Authorities is to provide "pure and wholesome" water for domestic and industrial use. They must also reduce pollution to acceptable levels. Formed by the Water Act of 1973, they are responsible for the collection, treatment, and disposal of water-borne wastes, drainage, and maintenance, improvement and development of fisheries. Problems of economics are the most difficult to overcome. Additional concerns are the degree of "cleanness" and time involved in achieving relevant goals. In order to set standards for treated effluents, one must consider the effects upon receiving sewers, the influence on treatment processes, and the effects of sewage effluents on rivers and implications for sludge disposal. The Water Act of 1973 and the Control of Pollution Act of 1974 delineate most of the responsibilities and control factors given to the Authorities. Alternatives available to industries include options of disposal methods, pretreatment of wastes, minimization of costs, reduction of water use, and reductions in pollutant loading.

*Administration, *Administrative agencies, *Decision making, Legal aspects, Regulation, Governments, Waste water treatment, Industrial wastes, Municipal wastes, Sewage effluents, Management, Disposal, Economics

*Regional Water Authorities, *Water Act 1973, *Control of Pollution Act 1974

J046
CADMIUM DISTRIBUTION IN FOREST ECOSYSTEMS IRRIGATED WITH
TREATED MUNICIPAL WASTE WATER AND SLUDGE,

Sidle, R. C., and Sopper, W. E.

Pennsylvania State University,
University Park,
Department of Forestry.

Journal of Environmental Quality, Vol. 5, No. 4, p 419-422, October-December, 1976.
6 tab, 12 ref.

The introduction of heavy metals into natural biological systems relative to waste water applications on land was studied for 10 years by irrigating treated municipal waste water in an abandoned field area and in a mixed hardwood area (old gamelands). The major metal under study was cadmium. Concentrations in soil and plant samples were determined to evaluate accumulation and recycling of cadmium in forest ecosystems. Waste water, soil, and plant samples were analyzed for zinc to extrapolate cadmium/zinc ratios. Results indicated that cadmium (in the old field area) did not increase in spruce and wild strawberry and was lower in goldenrod in the effluent irrigated area than in the control area due to the greater biomass resulting from irrigation. Under conditions of low cadmium application in a waste water disposal system, cadmium concentrations in some herbaceous vegetation may decrease. No samples from the gamelands revealed increased cadmium levels from the waste water irrigation. Goldenrod had higher cadmium levels than white spruce or wild strawberry in the old field area. Red maple had higher cadmium levels than white oak or sarsaparilla in the old gamelands area. This indicated that a single species, rather than a composite of several species, should be sampled when determining the effect of waste water irrigation on the cadmium content of forest vegetation. Cadmium in soil was not significantly affected by the waste water irrigation in either area. However, there was an increase at the 0-5 centimeter depth in the old gamelands area. It decreased with depth in the soil profile in both treated and control areas. Cadmium/zinc ratios between the areas were not substantially different either.

*Soil contamination effects, *Analysis, *Cadmium, *Toxicity, *Irrigation effects, *Return flow, Municipal wastes, Zinc, Forests, Ecosystems, Metals, Sewage effluent

Cadmium/zinc ratio

J047
ENERGY REQUIREMENTS FOR WASTE WATER TREATMENT. PART 2,

Hagan, R. M., and Roberts, E. B.

California University,
Davis,
Water Science Department.

Water and Sewage Works, Vol. 123, No. 12, p 52-57, December, 1976. 4 fig, 17 tab.

Because of the concern over the availability and cost of energy sources, costs for treatment facilities have been determined. Public Law 92-500 has influenced this subject by its requirement that treatment plants provide a minimum of secondary treatment by July 1, 1977. Activated sludge is commonly used to provide this treatment level and direct electrical power required for a typical activated sludge plant is about 71,000 kwh/day for a 100 mgd plant with gravity discharge of effluents. Sludge treatment for the same size plant (digestion and landfill disposal) would use 56,000 kwh/day. Miscellaneous power needs account for another 24,000 kwh/day. The use of digester gas could recover nearly 69,000 kwh/day of energy, producing a net direct energy requirement of 61,462 kwh/day. Other energy needs are for manufacture and transport of chlorine and other input chemicals, construction needs, and advanced treatment (such as phosphorus and nitrogen removal). Another factor is the possible need of activated carbon adsorption for refractory organics removal from waste water. If land treatment is available, it can replace advanced waste treatment processes. Energy requirements for most common uses of treatment products and effluents are also estimated.

*Energy, *Waste water treatment, Treatment facilities, Activated sludge, Treatment, Sludge treatment, Waste disposal, Electrical equipment, Electrical engineering

J048
WATER TREATMENT PLANT PROCESSES AND OPERATIONS,

Manwaring, J. F., and Lee, R. G.

U.S. Environmental Protection Agency,
Water Supply Branch, Region III,
Philadelphia, Pennsylvania.

May, 1974. 74 p, 27 fig, 12 tab. Technical Report NTIS-PB-248-137, EPA 903/9-75-021.

A training manual for plant operators and regulatory personnel of drinking water treatment facilities was developed by the Environmental Protection Agency. Information, data, and various calculations are presented to aid treatment plant operation. Various aspects of treatment covered include: coagulation-flocculation, sedimentation, filtration, iron and manganese removal, taste and odor control, softening, fluoridation, disinfection, desalination, nitrate removal, corrosion control, and disposal of water treatment plant wastes. A problem set relating to practical problems of operation is also included.

*Engineering education, *Training, *Potable water, Publications, Technical writing, Sanitary engineering, Waste water treatment, Sewage treatment, Treatment facilities, Sewage effluents

J049
REMOVAL OF Cr(+6) FROM POTABLE WATER BY ION EXCHANGE
(Usuwanie zwiazkow Cr(+6) z wody pitnej za pomoca wymiany jonowej),

Barcicki, J., Pawlowski, L., Kyhnke, T., and Cichocki, A.

In: Metody Fizykochemiczne Oczyszczczania Wod I Sciekow (Referaty Z Konferencii Naukowo-Technicznej), May 6-7, 1976, Lublin, Poland, Marie Curie-Sklodowska University, Lublin, Vol. 1, p 69-84, 6 fig, 3 tab.

Results of investigations elaborating the ion exchange method for CrO4(--) ion removal from potable water are reported. The technique is based on filtration of water containing 1-3 milligrams of Cr(+6)/cu dm through a column charged with Amberlite IRA-900 and regenerated to the chloride form. Purification of 5,150 bed volumes of water of the concentration of CrO4(--) was done at the single operation cycle. Regeneration was a two-stage process. The first portion of the post-regeneration solution (1.10-1.3 bed volumes) were collected into a tank. Post-regeneration solution from the first operation was passed through the column first, at the second regeneration, and the total effluent was drained to sewage. The fresh solution of 10% NaCl (1.3 bed volumes) was then passed through the column with complete collection in order to use it in the next regeneration cycle. Consumption of 10% NaCl was minimized to 1.3 bed volumes and the NaCl consumption for 1000 cubic meters of treated water amounted to 25 kilograms.

*Ion exchange, *Separation techniques, *Filtration, Potable water, Chlorides, Water treatment, Tanks, Sodium compounds

Regeneration, Amberlite IRA-900

J050
HOW MUCH POLLUTION CONTROL FOR WHAT PRICE?,

Luken, R. A., and Pechan, E. H.

Energy Research and Development Administration,
Washington, D. C.

Journal of Soil and Water Conservation, Vol. 31, No. 6, p 252-253, 260-263, November/December, 1976. 4 tab, 2 ref.

The Federal Water Pollution Control Act Amendments (P.L. 92-500) instituted a shift in the American approach to pollution control. Effluent limitations became the control factor with the law. The use of pollution control technology as it became available was required, as well as quality standards. Factors of this law were uniformity, finality, and enforceability. For uniformity, each discharger class, regardless of location, had to meet stipulated effluent limitations. "Best practicable control technology now available" became the rule of thumb for effluent treatment with target dates set for implementation. Finality involved requiring municipal and industrial sources to meet more stringent limitations at required time intervals. New enforcement powers were granted to control agencies; action could be taken against violators. A commission was established to investigate all technological, economic, social, and environmental aspects of the situation. Costs of treatment for industrial complexes were estimated and cost-effectiveness of treatment was considered. It was shown that national capital costs savings could have amounted to about 50% of a projected $57 billion in 1975 under a cost-effective, rather than uniform, control policy.

*Pollution abatement, *Legislation, *Costs, *Water quality, *Waste water treatment, Water quality management, Municipal wastes, Industrial wastes, Environmental control

Public Law 92-500

J051
MOLYBDENUM HAZARD IN LAND DISPOSAL OF SEWAGE SLUDGE,

Lahann, R. W.

New York State University,
Binghamton,
Department of Geological Sciences.

Water, Air, and Soil Pollution, Vol. 6, No. 1, p 3-8, August, 1976. 2 fig, 1 tab, 20 ref.

Increasing costs of treatment and incineration of sludge have incited investigations for alternate disposal means. One alternative is land disposal. Accumulation of toxic substances is a great problem of land disposal techniques. A study was conducted on the effects of molybdenum (Mo). The substance is mobile in neutral to alkaline systems, readily concentrated by plants, and in excess, can cause metabolic disorders in animals. Results of field studies indicated Mo concentrations in strip mine spoil materials discharge water were 300 micrograms/liter, excessive of the world-wide fresh water average (1.2 micrograms/liter). Dissolved Mo was adsorbed by the precipitate when acid water encountered water with a more normal pH. Oxidation and adsorption were extensive and resulted in Mo-rich oxides and hydroxides within the spoils. Oxygen free conditions should be maintained to prevent oxidation of pyritic spoil materials. Soil pH increases or the dissolution of Fe or Mn oxides can cause introduction of large amounts of Mo into groundwater. The molybdenum release rate following sludge release should decline as exchangeable Mo is flushed, and as soluble phases are removed, from the system. The short-term magnitude of concentration increase is probably a function of the length of oxidizing exposure, sludge application rate, and groundwater movement rate. Increased soil pH should increase Mo solubility.

*Sludge treatment, *Sludge disposal, *Molybdenum, Physical properties, Chemical properties, Oxidation, Adsorption, Soil contamination, Hydrogen ion concentration, Metals, Water pollution sources, Disposal, Soil chemical properties, Incineration

Land disposal

J052
EFFECTS OF ANNUAL AND ACCUMULATIVE APPLICATIONS OF SEWAGE SLUDGE ON ASSIMILATION OF ZINC AND CADMIUM BY CORN (ZEA MAYS L.),

Hinesly, T. D., Jones, R. L., Ziegler, E. L., and
Tyler, J. J.

Illinois University,
Urbana,
Department of Agronomy.

Environmental Science and Technology, Vol. 11, No. 2, p 182-188, February, 1977. 5 fig, 5 tab, 15 ref.

Field studies were conducted to determine the applicability of heated anaerobically digested sludge as a fertilizer and a soil amendment. Sixteen chemical elements were monitored, but only zinc and cadmium results were reported because they are always present in municipal waste water sludges at levels higher than in agricultural soils and in forms which can readily be assimilated and deposited in plant tissues. They also present the most obvious phytotoxic and animal health hazard. The tests revealed that the organic portions of sludge mixed with soil were not a great factor in the protection of plants against excessive soil concentrations of zinc and cadmium. Annual application of these elements as sludge components varied depending upon the depth of sludge applied during the growing season and the concentration of solids in the digested sludge. Application of digested sludge at just adequate rates for nitrogen supplementation for corn would not present a hazardous Zn or Cd concentration. Most favorable responses to sludge application were at those times when the weather was unfavorable for corn growth. Results suggest that organic components or decompositional products of soil-incorporated sludge organic matter can temporarily maintain applied Zn and Cd in forms available for absorption by plant roots. Conditions were maximized for the absorption and translocation of cadmium to grain, but no concentrations of cadmium in one-fourth maximum-treated plots ever exceeded those of more normal environments.

*Phytotoxicity, *Zinc, *Cadmium, *Corn, Sludge disposal, Chemical properties, Metals, Sludge digestion, Anaerobic digestion, Fertilizers, Soil chemistry, Nitrogen

J053
PROCESS TECHNOLOGICAL BACKGROUND REGARDING NEW PROTECTIVE REGULATIONS OF WATER BODIES-RESULTS OF NITRIFICATION AND PHOSPHORUS ELIMINATION EXPERIMENTS IN ZURICH AND BERN. I. INTRODUCTION AND FUTURE PROSPECTS OF PROTECTIVE PLANNING (Verfahrenstechnische Unterlagen im Hinblick auf die neuen Gewaesserschutzanforderungen-Ergebnisse der Versuche ueber die Nitrifikation und Phosphorelimination in Zuerich und Bern. I. Einfuehrung und Perspektive im Hinblick auf die Gewaesserschutzplanung),

Roberts, P.

Gas-Wasser-Abwasser, Vol. 56, No. 11, p 604-608, 1976. 5 fig, 4 tab.

Swiss waste water discharge regulations of December, 1975, require new measures in waste water treatment practices. Older criteria for design which rely heavily upon BOD removal and suspended solids must be adapted to new effluent standards, and parameters, such as ammonia, phosphorus, and dissolved carbon, must be considered when designing new treatment facilities. The critical parameters from the viewpoint of maintaining the desired status of the body of water differ depending on the type of water (running water or lake) and the type of impairment expected, given the intended use of the water. Residual concentrations of DOC (dissolved organic carbon) are reduced 10% by simulation precipitation and filtration, 20% by additional contact filtration, and 30% by preliminary precipitation. Activated carbon adsorption affords a possibility of attaining an effluent concentration of 2 milligrams/liter, or less, of DOC. Problems involving metals generally arise from local industrial sources and should be eliminated there. Necessary design principles can be derived from pilot and full-scale investigations of modern processes or combinations of processes.

*Regulation, *Design criteria, *Treatment facilities, Evaluation, Water quality, Effluents, Water pollution sources, Waste water treatment, Industrial wastes, Water quality standards, Adsorption, Activated carbon, Filtration, Precipitation, Ammonia, Phosphorus

Swiss regulations

J054
EVALUATION OF GAUZE PAD METHOD TO RECOVER VIRUSES FROM WATER,

Fattal, B., and Katzenelson, E.

Hebrew University-Hadassah Medical School,
Jerusalem, Israel,
Environmental Health Laboratory.

Water Research, Vol. 10, No. 12, p 1135-1140, 1976. 9 tab, 12 ref.

The gauze pad method was evaluated as a means of virus recovery from water. This method was compared with the grab sample method for concentration and detection of viruses from sewage. Laboratory and field studies were conducted for the two methods. The tests compared virus detection by the two methods; compared the number of viruses in gauze pads in sewage for 24 hours against those kept 3, 4, and 7 days at the same time; determined the effect of repeated elutions and the effect of calf serum on elution recovery efficiency from gauze pads; studied the recovery efficiency of gauze for viruses in water; and determined the effect of a sample volume on virus recovery efficiency. Results indicated that gauze left in sewage for 24 hours contained 90 times the viruses found in the sewage, suggesting some concentrating ability. The grab sample method was selective in the concentration of all enteroviruses and had low recovery efficiencies for sewage-contained enteroviruses. The gauze pad was advantageous for continuous, long-term sampling, but is limited by being qualitative, and only about 1% of the viruses in water can be recovered by this method. No advantage was found in immersing the pad for more than 24 hours. Recovery efficiency using gauze pads for viral concentrations from tap water is very low and dependent upon sample volumes. The larger pads have lower efficiencies. Adding calf serum to the wash fluid did not affect elution of viruses from pads immersed in tap water. Two washings of the pad removes more than 70% of the total virus recoverable after 5 elutions in either tap water or sewage.

*Evaluation, *Analysis, *Viruses, *Separation techniques, Sewage effluents, Water quality, Laboratory tests, On-site investigations, Water pollution sources, Waste water treatment

Gauze pad method, Grab sample method

J055
ALGAE SEPARATION FROM OXIDATION POND EFFLUENTS,

Friedman, A. A., Peaks, D. A., and Nichols, R. L.

Tennessee Technological University,
Cookesville,
Department of Civil Engineering.

Journal Water Pollution Control Federation, Vol. 49, No. 1, p 111-119, January, 1977.
8 fig, 2 tab, 12 ref.

Analysis of maturation and facultative lagoon effluents have indicated that algae in effluents produce a great oxygen demand on receiving waters. A study was conducted to evaluate and characterize methods of algae removal from waste water treatment systems. A laboratory-grown algae sample was studied using coagulants, pH values, and algal concentrations for bench-scale batch flotation and sedimentation tests. Field studies were also conducted. Data resulting from these studies indicated that magnesium must be present if lime was to become an effective algae removal agent and lime raises pH which allowed the precipitation of magnesium hydroxide. The addition of 10 milligrams/liter of magnesium at pH 11 was sufficient to remove waste water grown algae by sedimentation or dissolved-air flotation processes. In a pH range of 5 to 9, alum was an effective coagulant for algae removal in these experiments. Synthetic organic polyelectrolytes were not effective algae coagulants either with or without lime or alum treatment. Because supernatant COD quality is not degraded for periods longer than 90 days, periodic in-pond separation of algae by chemical coagulation and sedimentation seems viable.

*Algal control, *Oxidation lagoons, *Oxygen demand, *Chemical oxygen demand, Water purification, Waste water treatment, Sewage effluents, Sedimentation, Flotation, Lime, Polyelectrolytes, Magnesium hydroxide, Coagulation, Separation techniques

Alum

J056
CONTROL AND TREATMENT OF WASTE WATER,

Cross, F. L., Jr.

Pollution Engineering, Vol. 9, No. 1, p 99-105, January, 1977. 2 tab, 3 ref.

Changes in water quality legislation and waste water treatment concepts indicate the status of public concern about these matters. Public Law 92-500 of 1972 is the most consequential legislation in this area so far and was conceived due to public pressure for environmental protection. This legislation provided the mechanisms for involving citizens in the decision-making process in meaningful ways. The EPA was required to establish definite and uniform effluent controls for industrial and municipal waste water treatment on a national basis. The Water Pollution Control Act delineated a two-level program for industrial waste treatment. One was the "best practicable technology", or B.P.T., category comprising the best existing performance methods; the other was the "best available technology", or B.A.T., category which includes the best economically viable control and treatment measures. The best pollution controls are those performed at the source of the problem. A method of determining pollution probems was suggested. First, there is on-site sampling and laboratory testing and analysis; this is followed by pilot- or bench-scale treatment studies. The data is used to determine the most efficient and economical means of treatment. Primary, secondary, and tertiary treatment processes are described, and tables indicate standards for the various industries delineated in PL 92-500 along with the applications, advantages and disadvantages of the various treatment systems. The probable legislative measures to be taken concerning pollution control by the present Congress are explored and considered in terms of future trends in pollution control.

*Legislation, *Federal Water Pollution Control Act, *Regulation, *Water pollution sources, Waste water treatment, Performance, Evaluation, Analysis, Water quality, Environmental control, Government, Treatment facilities

PL 92-500

J057
ACCUMULATION OF HEAVY METALS IN SOILS FROM EXTENDED WASTE WATER IRRIGATION,

Sidle, R. C., Hook, J. E., and Kardos, L. T.

Pennsylvania State University,
University Park,
Department of Agronomy.

Journal Water Pollution Control Federation, Vol. 49, No. 2, p 311-318, February, 1977.
9 tab, 21 ref.

Accumulation and distribution of heavy metals due to waste water irrgiation were investigated in soil profiles of a reed canarygrass and a corn rotation area. The soils were irrigated year-found with chlorinated secondary treated waste water effluent. Copper, zinc, cadmium, lead, nickel, and cobalt were studied. Effluent concentrations of these metals were in the lower range for heavy metals in waste water effluents given in previous studies. Extractable soil copper and zinc accumulated substantially at a depth of 0 to 30 centimeters in the reed canarygrass area, but cadmium levels in the surface foot of soil increased to a lesser degree. Copper was the only metal with a significant accumulation rate over time in the same depth range of the corn areas, and less than the copper concentration in the reed canarygrass areas. No definite indications were found that the heavy metals moved from this depth range in either area and there were no definite accumulation trends with time for lead, nickel, or cobalt in either area. No serious soil contamination by these metals was indicated in either study area. Cadmium:zinc ratios approached that of the waste water applied in both cases, which was 0.68 to 1%. Further monitoring of heavy metal levels in the surface foot of soil and in vegetation would avoid possible food chain contamination.

*Heavy metals, *Irrigation, *Soil contamination, Sewage effluents, Sewage disposal, Soil types, Waste water treatment, Copper, Zinc, Cadmium, Lead, Nickel, Cobalt, Metals, Vegetation, Food chains

J058
PERSISTENCE OF POLIOVIRUS 1 IN SOIL AND ON VEGETABLES GROWN IN SOIL PREVIOUSLY FLOODED WITH INOCULATED SEWAGE SLUDGE OR EFFLUENT,

Tierney, J. T., Sullivan, R., and Larkin, E. P.

Virology Branch, Bureau of Foods,
Food and Drug Administration,
Cincinnati, Ohio.

Applied and Environmental Microbiology, Vol. 33, No. 1, p 109-113, January, 1977.
3 fig, 3 tab, 23 ref.

Studies were conducted to determine viral persistence in soil and on lettuce and radishes grown naturally in soil flooded with poliovirus-inoculated sewage. The results were compared with those from spray irrigation studies to investigate land disposal of sewage sludge and effluent. The average recovery of poliovirus from 100-gram soil samples was 82%. Plot runoff was periodically collected and monitored for virus. Data indicated that low virus levels were not detected. Laboratory studies indicated effective recovery efficiency until less than 100 PFU/100 grams were added to soil samples. No viruses were recovered at levels less than 10 PFU/100 grams of soil. A two week period was necessary before virus levels became undetectable and virus survival times determined in this study were probably minimum values. Recovery values would be different if sand or sandy soils were used at disposal sites. Other studies indicated that viruses percolate below the soil surface and that they are protected from the destructive effects of solar radiation and temperature. Results indicated that viruses may be present in soil and on crops harvested from land flooded with sewage sludge or effluent. It is possible that viruses are mechanically transmitted when these crops are harvested or consumed. Use of this method of sludge disposal might lead to contamination of the food chain but, if drainage could be controlled, use on vegetation other than that in the food chain would be a beneficial disposal method.

*Viruses, *Sludge disposal, *Vegetable crops, *Vegetation, Sewage effluents, Drainage, Lettuce, Irrigation, Irrigation effects, Runoff, Soil types, Food chains

J059
WHAT'S NEW IN LANDFILL LINERS,

The American City and County, Vol. 92, No. 2, p 54-56, February, 1977. 2 tab.

Landfill linings have been used to control ground and surface water pollution resulting from landfill operations. Linings suitable for the disposal of various fluids or wastes were described. These include polyethylene (PE), plasticized polyvinyl chloride (PVC), butyl rubber sheeting, chlorosulfonated polyethylene sheeting (Hypalon), ethylene propylene rubber (EPDM), chlorinated polyethylene (CPE), admix liners, asphalt concrete, hydraulic asphalt concrete, soil asphalt, bituminous seal-catalytically blown asphalt, and bituminous seal-fabric plus asphalt emulsion. Selection often depends upon the economics of usage and the length of time the liner will be in service. Combinations of linings are sometimes preferable to single ones. Seaming is important with liners because they are usually manufactured in narrow sheets. Factory seaming usually employs electronic sealing, "solvent welding", or heat curing adhesives. The use of adhesives is restricted by the specific polymer and specific compounding recipe for which they are designed. Environmental conditions often affect the usefulness of these liners. Anaerobic conditions, normally found at the bottom of landfills, prevent oxidation of liner materials. The liners should be placed on surfaces graded to allow drainage; objects that could cause cracking of hard liners should be removed. Polymeric materials should be protected from light which degrades the materials. Wet-humid conditions should be reduced, especially when leachate is regularly produced, to prevent leaching from a liner, and temperatures should be in the 40-70 F range. Acidic conditions and high leachate ion concentrations should also be avoided.

*Linings, *Landfills, *Water pollution, Groundwater, Surface waters, Plastics, Asphalts, Cements, Rubber, Impervious membranes, Adhesives, Films, Polymers, Leachates, Economics, Oxidation, Temperatures, Anaerobic conditions, Environment

J060
APPLICATION OF MUNICIPAL REFUSE AND LIQUID SEWAGE SLUDGE
TO AGRICULTURAL LAND: II. LYSIMETER STUDY,

King, L. D., Leyshon, A. J., and Webber, L. R.

North Carolina State University,
Raleigh,
Department of Soil Science.

Journal of Environmental Quality, Vol. 6, No. 1, p 67-71, January-March, 1977.
1 fig, 6 tab, 6 ref.

A lysimeter study was conducted to determine whether agricultural land could be simultaneously used for waste disposal-utilization and crop production. Liquid sewage sludge and unsorted, pulverized municipal refuse was used. Refuse was applied at 188 metric tons/hectare and a 2.3 centimeter depth of sewage sludge was applied separately and in combination. A double refuse-sludge rate and a control treatment were also studied. Results partially confirmed the assumption that the addition of refuse to sludge would create a C/N ratio which would allow enough N mineralization for crop growth but prevent excess leaching loss of NO3-N. Compared to the sludge treatment, the combined treatment reduced NO3-N by 33% and the refuse treatment caused leaching of NO3-N equal to that of the control situation. Refuse treatment produced 43% more total corn yield than the control and released more nitrogen than the leachate data suggested. There was no significant difference between refuse and control treatment soil nitrate levels. The soil environment limited NO3-N formation and favored denitrification in the combined treatment area, explaining the lack of significant NO3-N leaching in the test. COD levels were high and the leachate had a septic odor, indicating anaerobic conditions in the lysimeters from the high oxygen demand of decomposing organic material. The amount of NH4-N leached also supported this conclusion. Though the combined treatment is not a short term pollution problem relative to NO3-N, high leachate COD and high Zn and Cd levels in plant material suggest this application rate to be a pollution problem. These and other results indicate that land application of refuse alone or in combination with sludge is an acceptable utilization/disposal method.

*Waste disposal, *Sludge, *Liquid wastes, *Wastes, *Lysimeters, Nitrogen compounds, Municipal wastes, Nitrogen compounds, Leachates, Denitrification, Chemical oxygen demand, Oxygen demand, Waste water treatment, Anaerobic conditions

Land disposal

J061
LAND APPLICATION OF SEWAGE SLUDGE: IV. WHEAT GROWTH, N CONTENT, N FERTILIZER VALUE, AND N USE EFFICIENCY AS INFLUENCED BY SEWAGE SLUDGE AND WOOD WASTE MIXTURES,

Sabey, B. R., Agbim, N. N., and Markstorm, D. C.

Colorado State University,
Fort Collins,
Agronomy Department.

Journal of Environmental Quality, Vol. 6, No. 1, p 52-58, January-March, 1977.
3 fig, 4 tab, 18 ref.

A study was conducted to measure several parameters involving digested sewage sludge and wood waste materials and land application. These included total N and NO3-N in wheat and total N, NH4-N, and NO3-N in the soil after wheat harvesting. Inorganic fertilizer was added, with and without the organic matter, to aid evaluation of fertilizer potential of various rates and mixtures of organic materials on greenhouse-grown wheat. Four rates of sewage sludge and wood wastes, ranging from 22.4 to 224 metric tons/hectare, were used. Every mixture but 50% bark-50% sludge increased wheat growth. Greatest growth occurred at the 224 metric ton rate with 50% wood-50% sludge, 25% bark-75% sludge, and 25% wood and bark-75% sludge. Highest application rates of 100% sludge, 25% wood-75% sludge and 50% bark-50% sludge caused less growth than the next lower application rates. Equations were derived to express the relationship between wheat growth and N content in the plant tissue. Amounts of total N, NH4-N, and NO3-N remaining in greenhouse pots after harvest usually increased as the application rates of treatment increased. Care was suggested for application of 112 and 224 metric tons/hectare of 100% sludge and 25% wood-75% sludge, and 224 metric tons/hectare of 25% wood and bark-75% sludge due to possible NO3-N accumulation and groundwater pollution. Ammonium N did not accumulate excessively. Estimations were that 2 to 22.7% initial N was taken up by plants during the study period of 50 days.

*Sewage disposal, *Wheat, *Wood wastes, *Nitrogen compounds, Soil contamination, Water pollution, Growth rates, Organic matter, Inorganic compounds, Sludge disposal, Waste water treatment, Fertilizers

Land disposal

J062
PHOSPHATES IN SOILS TREATED WITH SEWAGE WATER: 1. GENERAL INFORMATION ON SEWAGE FARM, SOIL, AND TREATMENT RESULTS,

Beek, J., de Haan, F. A. M., and van Riemsdijk, W. H.

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Wageningen,
The Netherlands.

Journal of Environmental Quality, Vol. 6, No. 1, p 4-7, January-March, 1977.
1 fig, 3 tab, 7 ref.

Research conducted at a sewage farm used for 50 years was described. The 247 acre area was reclaimed from uncultivated woodland on sandy soil. A comparison of the composition of the added waste water and the drainage water can be indicative of the effectiveness of this treatment method. Water analysis results can be supported with soil analysis data. Analysis of sodium, potassium, cadmium, manganese, silica dioxide, iron, and chlorine did not reveal any significant differences, indicating a degree of soil system equilibrium relative to these compounds. Data indicated that the soil is an active filter for organic carbon compounds, as well as for organic and inorganic phosphorus compounds. These and other collected data showed land disposal of raw sewage water is still effective in reducing BOD and removing phosphates, even after 45 years of use. The use of this land as permanent pasture can be combined with waste water treatment up to a waste water level thickness of 2.5 meters on an annual basis. This treatment raises soil pH and increases organic matter content. Nitrogenous compounds are transformed into nitrate nitrogen and nitrogen removal by soil treatment is relatively low. Both adsorption and precipitation reactions play a role in phosphate bonding by soil and phosphate accumulation is mostly limited to the top 50 centimeters.

*Phosphates, *Soil, Sewage treatment, Sewage effluents, Sewage disposal, Organic matter, Inorganic compounds, Biochemical oxygen demand, Waste water treatment, Waste water disposal

Sewage farms

J063
PHOSPHATES IN SOILS TREATED WITH SEWAGE WATER: II. FRACTIONATION OF ACCUMULATED PHOSPHATES,

Beck, J., de Haan, F. A. M., and van Riemsdijk, W. H.

Agricultural State University,
Wageningen,
The Netherlands.

Journal of Environmental Quality, Vol. 6, No. 1, p 7-12, January-March, 1977.
2 fig, 4 tab, 24 ref.

Investigations, using phosphate fractionation methods, were conducted on sewage farm soils to determine whether the chemical forms of phosphate accumulation in soil change with prolonged sewage water addition. Phosphate accumulation in soils flooded with sewage water for 30 and 50 years is mostly restricted to the upper 50 centimeters of soil. Phosphorus fractionation methods revealed that 15-20% accumulated in organic form. Most of the inorganic fraction was found in combination with aluminum or iron, and solubility relationship determinations indicated a possible precipitation of apatite-like compounds in soils with a nearly neutral pH. Aluminum combined phosphates were found to be prevalent. It was thought that phosphate retention is mostly governed by reactions with aluminum since the phosphate fractions distribution pattern remained practically the same during the lifetime of the sewage farm. Ultimate storage capacity of the soil for phosphate bonding is mainly determined by the presence of active aluminum compounds.

*Phosphates, *Sewage disposal, Soil contamination, Sewage effluents, Organic matter, Inorganic compounds, Aluminum, Hydrogen ion concentration, Waste water treatment
Storage

Sewage farms

J064
PHOSPHATES IN SOILS TREATED WITH SEWAGE WATER: III. KINETIC STUDIES ON THE REACTION OF PHOSPHATES WITH ALUMINUM COMPOUNDS,

van Riemsdijk, W. H., Westrate, F. A., and Beek, J.

Agricultural State University,
Wageningen,
The Netherlands.

Journal of Environmental Quality, Vol. 6, No. 1, p 26-29, January-March, 1977.
3 fig, 4 tab, 8 ref.

The reaction of phosphate and aluminum hydroxide and alpha Al2O3 was studied in order to understand the kinetics of phosphate precipitation reactions in land disposal of raw sewage water. An initial phosphate concentration of 0.35 millimoles/liter at 20 C was used. Sources of the phosphate were solutions of KH2PO4 and synthetic inorganic sewage water. Highest values of removed phosphate occurred when KH2PO4 solutions were used; this was attributed to the lack of competitive anions for adsorption. The ionic strength of this solution was lower and phosphate activities were much higher than in synthetic waste water. The mechanism of the reaction kinetics was similar with both adsorbent types used and was, possibly, influenced by the surface structure of the adsorbent. Characteristics of phosphate removal reactions were a first, fast adsorption on the surface of the adsorbent, and the formation of a solid aluminum phosphate phase. After 40 days, the reaction rate does not fit the presented first order equation.

*Adsorption, *Phosphate, *Kinetics, Chemical reactions, Sewage effluents, Sewage disposal, Waste water disposal, Soil contamination, Chemical properties, Disposal

Aluminum hydroxide

J065
SOLUBILITY AND PLANT UPTAKE OF CADMIUM IN SOILS AMENDED WITH CADMIUM AND SEWAGE SLUDGE,

Street, J. J., Lindsay, W. L., and Sabey, B. R.

Journal of Environmental Quality, Vol. 6, No. 1, p 72-77, January-March, 1977.
8 fig, 4 tab, 34 ref.

Adsorption and precipitation are investigated as controlling factors in cadmium concentration in soils. Factors studied, in addition to adsorption and precipitation, were plant uptake and chemical extraction of cadmium. The addition of soluble cadmium to soil produced a rapid removal of cadmium from solution by adsorption on to soil constituents and by the possible formation of solid phases of cadmium compounds. Solutions containing less than 50 micrograms of Cd(2+)/milliliter produced data which fit the empirical Freundlich equation in all soils. In alkaline sandy soils, high concentration cadmium precipitated, perhaps, as CdCO3 and Cd3(PO4)2. When added to soil, either alone or with sludge, cadmium was taken up by corn seedlings. Cadmium alone was more readily taken up by soil than the combination of cadmium and sludge. Organic matter in one test soil depressed cadmium uptake, possibly indicating a reduced availability of cadmium sorbed to organic matter. High levels of cadmium can be accumulated by corn seedlings without visual toxicity symptoms. The DTPA soil test method was useful in estimating the cadmium uptake by corn seedlings grown on cadmium-contaminated soils.

*Cadmium, *Adsorption, *Solubility, *Soils, Physical properties, Chemical properties, Sludge, Alkalinity, Corn, Organic matter, Toxicity

Precipitation, Freundlich equation

J066
INTEGRATED APPROACH TO URBAN WASTE WATER MANAGEMENT,

Hasan, S. M.

Dissertation Abstracts International B, Vol. 37, No. 7, p 3565, January, 1977.

An approach was developed for urban waste water management which integrates considerations for urban storm drainage, dry-weather sewage treatment, and wet-weather quality control. There has been a change from "least-cost" to "cost-effective" approaches and solutions. This approach presents procedures for formulation of control strategies and their cost evaluation. Integration of these evaluations would take advantage of overlap areas which could combine several functions, and procedures are also presented for this type of evaluation. The question of cost allocation was also considered and methods for cost determinations were presented. Concepts of cost sharing/cost allocation for evaluation of multipurpose plans were reviewed in light of the N-person cooperative game theory.

*Water management (applied), *Urban drainage, *Storm water, *Water quality control, Cost analysis, Flow, Sewage treatment, Cost sharing, Cost allocation, Evaluation, Urban hydrology

N-person cooperative game theory

J067
UNDERFLOW FROM SLUDGE-IRRIGATED CROPLAND,

Andrew, R. C., and Troemper, A. P.

Springfield Sanitary District,
Springfield, Illinois.

Journal Water Pollution Control Federation, Vol. 49, No. 1, p 161-168, January, 1977.
1 fig, 10 tab.

The Springfield Sanitary District, Illinois, has instituted the use of cropland spray irrigation for liquid disposal of aerobically digested sludge. Two sites totaling 66 acres are used. They have permanent underdrainage systems which collect and pump the underflow back to the aeration tanks at the treatment plant. Data indicated underdrain water volumes were more parallel to rainfall than to applied sludge volumes. Soil filtration produced a 99.96% average BOD5 reduction and an 99.98% average suspended solids reduction. Average component levels were 0.9 milligrams/liter of BOD5, 5.6 milligrams/liter of suspended solids, and 1,179/100 milliliters of fecal coliform. The median pH was 7.1 for applied sludge and 7.0 for underdrain water; soil pH was basically unaffected. Small amounts of phosphates leached to underdrain water and phosphate removal averaged 98.5%. Enough iron, aluminum, and calcium were present to react with phosphates and make insoluble products which were held in the upper soil layers. Nitrogen was almost completely oxidized to nitrate nitrogen. Under normal conditions, the cations calcium, magnesium, potassium, and sodium will not be likely to leach to underdrain water. Chromium, lead, cadmium, and nickel did not appreciably collect in the soil. This method was the most economical of all tested and irrigation proved a viable disposal means for waste water sludge. It is simple, needs a minimum of operation attention, and does not create an odor nuisance if sludge is well digested before application.

*Irrigation, *Underflow, *Liquid wastes, Sludge digestion, Sludge disposal, Aerobic treatment, Drainage, Suspended solids, Biochemical oxygen demand, Leachates, Soil disposal fields, Soil contamination, Metals, Inorganic compounds, Organic matter, Nitrogen, Oxidation, Economics

Springfield Sanitary District (IL)

J068
AGRICULTURAL DISPOSAL OF AEROBIC WASTE WATER SLUDGES
IN AN URBAN COUNTY,

Clark, A. B.

Clermont County Sewer District,
Batavia, Ohio.

Deeds and Data, p D1, 8, 9, January, 1977.

Agricultural disposal of aerobic sludges in Clermont County, Ohio, was reviewed. The county is rapidly developing from a rural area to a suburban one, mainly in the western portion. The eastern area is still largely agricultural. Gaining the acceptance of farmers for the use of their lands is a major obstacle. Once their concern for their property is allayed, the economics of commercial fertilizer use makes sludge application an attractive alternative. Any odor problem with this sludge type is relatively negligible, but application near the farmhouse is generally avoided. It is suggested that application be made first to grass crops because of the high nitrogen and water content which produces rather dramatic improvements. The most satisfactory application system developed involved using a rain gun designed for agricultural irrigation. It is mounted on a two wheel trailer and fitted with a 3.2 centimeter orifice. The gun throws a full or part circle and the sludge is evenly distributed. Four to twelve 7.5 cu m loads may be discharged in one setting. The system has been used on dry frozen fields after crop removal, wet fields in the process of thawing, soggy pasture land, dry plowed fields, and fields of growing corn. No indication of herbicide failure has been noticed.

*Sludge disposal, *Fertilizers, Odor, Agricultural chemicals, Crops, Farms, Equipment, Waste water treatment, Sludge treatment, Aerobic treatment

Clermont County (OH)

J069
CONDITIONING AND LAND APPLICATION OF AEROBICALLY DIGESTED SLUDGE,

Yates, T.

Montgomery County Sanitary Department,
Dayton, Ohio.

Deeds and Data, p D2-3, January, 1977.

Many consider sludge conditioning and disposal to be the most difficult phases of waste water treatment. This is especially true of aerobically digested sludge. More efficient plants and increased industrial sludges add to the problem, as does the refusal of farmers and land owners to allow sludge application because of concern over metals and other sludge components. It is usually the most expensive portion of treatment, involving collection, transportation, processing, and final disposal. Gravity thickening of sludge is the most common process used in treatment plants. It is simple and inexpensive, unless there is a great distance to be traveled to the disposal site. The sludge produced is not as highly concentrated as that from other processes, causing more sludge to be transported. Most of the conditioning is done by wasting sludge gravity flow or pumping to aerobic digesters. The operation at the Montgomery County, Dayton, Ohio, plant was described. Because the plant has no sludge thickening equipment, polymers were added to a secondary settling tank to concentrate waste sludge. Methods of land application for sludge were discussed. Tank trucks may be used for transporting the sludge and spreading it on plowed farm land and pasture land, or it may be pumped from the side through a hose onto the land, if the area is not too wet to drive upon. A tractor with a vane-type vacuum-pressure pump can be used if disposal land is located near the treatment plant. More research was proposed to develop improved methods and equipment for sludge disposal.

*Sludge disposal, *Sludge digestion, *Aerobic treatment, Metals, Liquid wastes, Economics, Equipment, Soil disposal fields, Waste water treatment

Montgomery County (OH)

J070
ESTIMATING COSTS OF WASTE WATER SLUDGE DISPOSAL,

Helle, S. C.

Boyle Engineering Corporation,
Orlando, Florida.

Public Works, Vol. 108, No. 3, p 56-58, March, 1977. 5 fig.

A procedure for cost estimation of waste water sludge disposal was presented. The analysis was broken down according to the three phases of sludge disposal: digestion, dewatering, and hauling. Digestion costs included capital investment, power, labor, and maintenance costs. Dewatering expenses consisted of capital, power, labor and maintenance, and chemical costs. Hauling costs were truck purchase and operation, labor costs, and dumping fees. If changes in the sludge disposal operation occur, estimates need be reanalyzed for only that phase which is affected. Estimated parameters for various phase components were input into a series of simple equations to illustrate the computational format for arriving at costs.

*Cost analysis, *Costs, *Sludge disposal, Sludge digestion, Dewatering, Transportation, Capital costs, Maintenance costs, Electric power costs, Operating costs, Wages, Comparative costs, Equipment, Estimated costs

J071
NITRIFICATION IN SOIL TREATED WITH DOMESTIC AND INDUSTRIAL SEWAGE SLUDGE,

Wilson, D. O.

Georgia University,
Experiment,
Department of Agronomy.

Environmental Pollution, Vol. 12, p 73-82, 1977. 3 fig, 5 tab, 15 ref.

Experiments were conducted to determine the effects of two sewage sludges, varying in metal content, on nitrification of NH4 (+) -N added to soil. Dried domestic or industrial sewage sludge was applied to soil at rates of 0, 1, 4, or 16 milligrams/gram and the soils were incubated with or without added NH4(+) -N at 30 C. Data was not corrected for nitrification occurring in untreated soil. Domestic sludge had no great effect on (NO3(-) + NO2(-)) -N, except at 16 milligram/gram applications. Industrial sludge at 4 and 16 milligrams/gram substantially reduced the same values when compared to control values during the first few weeks. High application rates of both sludges produced appreciable amounts of NH4(+) -N accumulated at the end of the first week. Industrial sludge reduced nitrification at the two highest rates and, at the highest rate, completely inhibited nitrification during the first two weeks. Domestic sludge had a slight effect on nitrification reduction at the highest rate. The reduced nitrification at high rates of industrial sludge was thought to be caused by zinc, cadmium, and lead. It was concluded that high rates of sewage sludge containing high metals concentrations temporarily inhibit nitrification and that extended use of such sludges may seriously interfere with important microbial nitrogen transformation in soil.

*Nitrification, *Sludge disposal, Domestic wastes, Industrial wastes, Soil contamination effects, Heavy metals, Lead, Zinc, Cadmium, Sewage disposal, Waste water treatment

J072
REDUCTION IN SEWAGE CONTAMINATION IN SYDNEY ROCK OYSTERS,

Qadri, R. B., Buckle, K. A., and Edwards, R. A.

Fish Technology Division, Karachi Laboratories,
Pakistan Council for Scientific and Industrial Research,
Karachi, Pakistan.

Food Technology in Australia, Vol. 28, No. 11, p 411, 413-416, November, 1976.
4 tab, 7 ref.

Results were presented of a depuration study involving oysters in the Georges River and Botany Bay area of Sydney, Australia. The depuration process investigated involves the immersion of oysters in tanks of water to allow natural elimination processes of the oysters to occur. Oyster gills act as filters of particulate matter; ingested sewage and fecal microorganisms are trapped in the gill mucus and transferred to the alimentary tract. Shellfish growing in sewage polluted waters digest, retain, and discharge microorganisms. In unpolluted waters, they should reduce the gut flora of sewage bacteria due to the change in the microbial status of the water. Depuration depends on economic factors such as the implied double handling operation for growers, the cost of tanks which would be very large, installation and operation costs, and costs of land to locate the tanks and auxiliary facilities. Results indicated that a significant fecal coliform MPN reduction occurred after one week and that this period is sufficient to clean polluted oysters if water quality, temperature, water salinity, and the season are conducive to active feeding of oysters. Oysters can be purified of heavy E. coli contamination in a short time if they are placed in unpolluted waters. Excessive pollution may require additional time for purification. The area used for depuration should not be subject to sewage or industrial pollution from weather or seasonal effects. It was noted that each species reacts a little differently to depuration processes. Freezing at -23.3 C in an air blast or at -12.2 C in still air produces significant reductions of coliforms. Both depuration in uncontaminated water and freezing and frozen storage can be used to reduce bacterial contamination of Sydney rock oysters.

*Oysters, *Pollution abatement, Water pollution, Sewage effluents, Bacteria, Water quality, Temperature, Salinity, E. coli, Costs, Economics

Depuration, Georges River (Australia), Botany Bay (Australia)

J073
GERMAN POLLUTION CONTROL,

Environmental Science and Technology, Vol. 11, No. 2, p 134-136, February, 1977.
1 tab.

A review was presented of West German efforts in water pollution control. The nation enacted a Water Resources Act in 1957, but there is no national standard for surface water quality. The government is able to establish effluent discharge standards and, in the next few years, German industry will have to produce more effective effluent treatment. Sewage treatment mainly consists of the mechanical removal of suspended solids and the oxidization of dissolved solids by bacteria and other organisms. Presently, 50% of all waste water is receiving inadequate treatment or is not being purified at all. Only about 30% receives full biological treatment, but by 1985, 90% of all households are expected to be connected to biological treatment plants. There are nearly 6,000 treatment plants for about 40% of the population. If the proposed programs are instituted by 1985, 38-40 million cubic meters of sludge will have to be disposed of annually. Dewatering, drying, incineration, and pyrolysis are being considered and developed for disposal purposes. Advanced treatment processes, including physical-chemical treatment and combinations of these with biological treatment, are being included in treatment schemes to handle industrial wastes. The government is also progressing in matters of air, noise, and thermal pollution, as well as resource recycling and recovery.

*Water pollution control, *Water quality control, Water quality, Industrial wastes, Domestic wastes, Municipal wastes, Waste water treatment, Sewage treatment, Sludge treatment, Water purification, Treatment facilities, Waste disposal, Planning, Legislation

West Germany

J074
TREATING URBAN DRAINAGE AS A UTILITY,

Warren, R. E.

Public Works, Vol. 108, No. 3, p 85, March, 1977.

Water supply, domestic and industrial waste treatment, and solid waste management have attained highly effective levels. The treatment and control of urban drainage and runoff have not been so effectively handled. It was suggested that drainage be considered like a utility, and handled in the same manner as waste water treatment and quality control. Suggestions included the establishment of a separate department which would be responsible for drainage and runoff water quality. Among its responsibilities would be street sweeping/cleaning, catch basin and storm sewer cleaning, and open stream preservation. It would also play a part in solid waste disposal and other departments to assure that these wastes would not enter drainage systems because of poor storage practices. It would handle the issuing of permits relative to development; the enforcement of rules and regulations on construction; runoff control; water quality and related issues; and inspection and monitoring. The final consideration in establishing this kind of department would be financing, which could be provided by assessing service charges.

*Water management, *Drainage systems, *Urban runoff, Water quality control, Construction, Government, Monitoring, Inspection, Cleaning, Storm sewers, Streams

J075
EFFECTS OF TRACE ELEMENTS ON NITROGEN MINERALIZATION IN SOILS,

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Iowa State University,
Ames,
Department of Agronomy.

Environmental Pollution, Vol. 12, No. 2, p 141-147, February, 1977. 3 tab, 18 ref.

Soil trace element content was studied to determine the effects on nitrogen mineralization. Soils studied were surface soils at depths of 0-15 centimeters with a pH range of 5.8-7.8; an organic matter content of 2.58-5.45% organic carbon; and textures of 23-45% clay, 39-54% silt, and 1-38% sand. Results were obtained after a 20-day incubation period. Nineteen trace elements were studied, showing Ag(I) and Hg(II) to be the most effective inhibitors, and Co(II), As(III), Se(IV), and W(VI) to be the least effective inhibitors of nitrogen mineralization in the soils. Chemical and physical characteristics of the soils as well as the nature of nitrogen in them have a great effect on the inhibition of nitrogen mineralization by trace elements. The degree of effectiveness of the remaining elements varied. The toxicity of Ag(I), Hg(II), Cu(II), and Cd(III) might have been caused by an ionic reaction with sulphydryl groups of the enzyme systems of the microorganisms involved in nitrogen mineralization. No nitrite nitrogen was detected and this suggested that there was no inhibition of Nitrobacter under the conditions of the experiment. Small amounts of chloride and sulfate ions associated with trace elements were not likely to stimulate or depress nitrogen mineralization in these experiments. It was concluded that the accumulation of trace elements in soils could cause a reduction of the nitrogen available to plants in soil organic matter.

*Trace elements, *Metals, *Soil types, *Mineralization, Sludge disposal, Organic matter, Toxicity, Chemical properties, Physical properties, Microorganisms, Nitrogen

J076
COMMUNITY WATER SUPPLY AND EXCRETA DISPOSAL IN THE DEVELOPING COUNTRIES,

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Community Water Supply and Sanitation,
Division of Environmental Health,
World Health Organization,
Geneva, Switzerland.

Ambio, Vol. 6, No. 1, p 51-54, 1977. 2 fig, 2 tab, 8 ref.

The provision of a safe water supply and hygienic waste disposal for developing nations was considered. HABITAT, the United Nations Conference on Human Settlements, proposed that each nation set reasonable standards for achieving these goals. Fifty-seven percent of the urban population had a community water supply to house connections and an added 20% had access to piped water from public standposts. As of 1970, about 50% of these piped supplies were intermittent, causing the associated health hazards. For rural areas about 22% of the population had access to safe water. Nearly 75% of urban dwellers had access to public sewerage systems and only 15% of rural residents had similar provisions. The social and economic aspects of the problem were not covered by this WHO survey. One reason was the lack of definitive information, itself a product of underdevelopment. WHO set target goals for 1980 and HABITAT set goals for 1990. Water supply goals would call for more than a 150% increase in spending; WHO disposal goals would require a 200% increase; HABITAT's plan would require a 400% increase over 1975 cost levels. Development strategies for developing countries would include national commitment, manpower development, appropriate design criteria and technology, consultation with and participation of communities; and appropriate institutional mechanisms.

*Water quality control, *Planning, *Disposal, Rural areas, Urban areas, Costs, Social change, Social aspects, Waste disposal, Sewerage, Design criteria

World Health Organization (WHO), United Nations Conference on Human Settlements (HABITAT)

J077
SEWAGE SLUDGE DISPOSAL: A STICKY PROBLEM WITH NO FAIL-SAFE ANSWER,

Fluet, C. V.

Solid Wastes Management, Vol. 20, No. 2, p 38, 58-59, February, 1977.

Methods for the disposal of sewage sludge were considered. A well and properly designed landfill can accept sludge. The usual procedure involves combining dewatered sludge, containing no more than 20-30% solids, with solid wastes or soil for bulking. Landfilling is a reasonable alternative disposal method if land is available and is environmentally acceptable. It is also economical but is only a stop-gap solution. Contaminant, leachate, and heavy metals movement present problems with landfilling. Discing, plowing or injecting digested, dewatered sludge on the soil surface and subsurface is another disposal alternative. This allows sludge to be used as an added resource. Using sludge on food crops for humans or animals is problematic because of the heavy metals pollution of the food chain. Bacteria, viruses, and persistent pesticides raise other questions regarding this disposal method, particularly because of the potential danger to groundwaters. Entrenchment of raw sewage requires substantial land areas and is very costly. Small-scale composting has received some acceptance as a disposal method. Ocean dumping is ruled out because it produces many more pollution and contamination problems. Incineration is another alternative, but produces problems of ash residues with a high metals concentration and it usually involves some land disposal. Choosing one disposal method over another will depend on the relative importance of all factors involved.

*Sludge disposal, *Sewage disposal, Landfills, Solid wastes, Sludge digestion, Heavy metals, Soil contamination, Food chains, Incineration, Economics, Costs, Waste water treatment

Land disposal, Ocean dumping, Soil injection, Composting

J078
DIRECT AND INDIRECT WASTE WATER REUSE FOR MUNICIPAL PURPOSES,

Shuval, H. I.

Hebrew University-Hadassah Medical School,
Jerusalem, Israel,
Environmental Health Laboratory.

Ambio, Vol. 6, No. 1, p 63-65, 1977. 11 ref.

The reuse of waste water in Israel was discussed. It is hoped that eventually waste water will be reusable for unlimited domestic purposes, and that it will provide a source of potable water. Limited municipal uses now include firefighting, irrigation of parks and recreational areas, and street cleaning. Highly treated water can be used in public buildings, and in homes for toilet flushing. Even for these applications, purification would have to assure freedom from microbiological hazards. One problem is that there are inadequate standards for pollutants and contaminants in drinking water. Many bacterial pathogens are effectively countered by chlorination but others are resistant. There should be an established maximum allowable concentration or limit for each potentially hazardous chemical found in renovated waste water. Tolerance levels to known toxicants should also be established. If waste water is to be reused domestically, a full-scale epidemiological evaluation of such reuse should be conducted. Regardless of these problems, the reuse of waste water for agricultural, industrial, and non-potable municipal purposes should be considered until more complete answers to these questions are provided.

*Water reuse, *Water purification, Domestic water, Irrigation, Municipal water, Potable water, Pathogens, Toxicity, Waste water treatment, Treatment facilities, Water quality control, Planning

Israel

J079
THE USE OF SEWAGE EFFLUENT AS POWER STATION COOLING WATER,

Humphris, T. H.

Water Research, Vol. 11, No. 2, p 217-223, 1977. 4 fig, 1 tab, 1 ref, 1 append.

Various aspects of the use of sewage effluent as cooling water in power stations were discussed. The Croydon Power Station has used sewage effluents for this purpose for twenty years. One problem encountered was that condenser tubes were fouled with calcium phosphate along with smaller amounts of calcium carbonate, silica, and organic matter. This produces a heat transfer loss and reduces station efficiency. Manual cleaning reduced soft sludge, and acid washing was used to remove carbonate scale. Calcium phosphate was the major source of fouling and could be controlled by limiting the concentration of calcium and/or total phosphate ions in solution, or by lowering the pH of circulating water to decrease available HPO4 ions by conversion to H2PO4. At power stations other than Croydon, oxidation of ammonia salts occurred in the cooling water, probably through the action of nitrifying bacteria. The production of acid waters following ammonia oxidation was also noticed. The introduction of nitrification at Croydon could provide a means of conditioning circulating water at reduced cost. Control processes have exchanged the former sludge problem for one caused by an organic film contamination. The use of hypochlorite solution overnight did not produce consistent good results. Cleaning is now accomplished by draining the water side of the condenser and opening access doors, running hot condensate from the feed system to the steam side, and drying overnight. Flaked deposit then washes out as the water circulation is restored.

*Condensers, *Cooling water, *Sewage effluents, Water reuse, Powerplants, Cleaning, Sludge, Heat transfer, Calcium, Phosphate, Nitrification, Bacteria, Ammonia, Performance, Oxidation

Croydon Power Station (England)

J080
STATUS OF OCEAN DUMPING RESEARCH IN NEW YORK BIGHT,

Swanson, R. L.

Stony Brook State University,
Stony Brook, New York,
New York Bight Project.

Journal of the Waterway Port Coastal and Ocean Division-ASCE, Vol. 103, No. WW1, p 9-24, February, 1977. 7 fig, 3 tab, 34 ref.

The New York Bight extends from Long Island and New Jersey to the edge of the continental shelf. Evaluations have indicated that this marine region has been placed in a condition of ecosystem imbalance by human activity. Ocean dumping of sludge has been a great concern in this situation. The EPA investigated three alternatives for control of this problem: continuing the present practice, moving the sewage sludge dump farther from the coast, and using land-based alternative for disposal. Contaminating substances include dredge spoil, clean earth, and fly ash from electric power generating stations; waste acid; construction industry nonflotable debris and earth from excavations; and sludge. Results of investigations indicated that, though land disposal alternatives are attractive, better management practices would be of more use. There is no present public health danger from sludge dumping in the area and there is no indication that sludge is moving towards the coastal areas. Other contamination sources far outweigh the input of waste water sludge pollutants and no advantage can be found in removing sludge dumping at the present time.

*Environmental control, *Waste disposal, *Sludge disposal, Urban areas, Water quality control, Waste water treatment, Toxicity, Metals, Evaluation, Pollution abatement, Water pollution sources

Atlantic Ocean, New York Bight

J081
WATERSHED MANAGEMENT AND WATER QUALITY,

Karalekas, P. C., Jr.

Journal of the New England Water Works Association, Vol. 91, No. 1, p 1-11, March, 1977. 9 ref.

The relationship of watershed management to water quality was evaluated. Two objectives of watershed management for municipal water supplies are: to maintain or enhance water quality through the control or elimination of contamination sources, and to maintain or improve total water yields from watersheds. The former receives the greater attention. Physical contaminants, chemical contaminants, and microbiological contaminants are the major pollutants. There should be adequate control of turbidity, color, temperature, setteable solids, taste, and odor. Measures should be taken against municipal and industrial wastes discharges, and other chemical contaminant sources such as agricultural runoff and roadway runoff. Diversion of storm runoff can be helpful in these instances. Recreational uses of watersheds could be prohibited or limited to prevent contamination from all classes of pollutants. Primarily, frequent analysis and inspections and a knowledge of contamination sources are needed to ensure watershed water quality.

*Watershed management, *Water quality control, *Water supply, *Water yield improvement, Water utilization, Surface runoff, Pollutants, Pollution abatement, Water pollution sources, Environmental control

J082
SILK FROM SOWS' EARS,

Engineering News-Record, Vol. 198, No. 15, p 52, April, 1977.

Various projects being developed for refuse and sludge recycling were described. A solid waste and sludge recycling plant will be constructed in Wilmington, Delaware. The operation combines metal and gas recovery with a process to provide fuel for a powerplant and compost production. It will cost about $30 million for the plant to process 1,000 tons/day of refuse and 50 tons/day of dry sludge. Another facility for Monroe County, New York, will process 2,000 tons/day of solid wastes at a cost of nearly $20 million. An electric company in St. Louis dismissed a proposed facility because of difficulty in obtaining collection sites. Increased transportation costs, the inability of boilers to accept the material, and possible damage to boilers from waste combustion, eliminated Tennessee Valley Authority plans to burn refuse from its fossil-fueled plants. Seattle, Washington, is considering a pyrolysis plant similar to the one in South Charleston, West Virginia, which is experimenting with sludge disposal.

*Recycling, *Sludge treatment, *Waste disposal, Fuels, Metals, Treatment facilities, Planning, Costs, Waste water treatment, Combustion

J083
SAVE SLUDGE HANDLING COSTS BY LEVEL CONTROL,

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Markland Specialty Engineering, Limited,
Toronto, Ontario, Canada.

Modern Power and Engineering, Vol. 71, No. 3, p 34, March, 1977.

Reductions can be made in sludge treatment and handling costs by the use of an automatic sludge level control. Significant savings result from the removal of excess water, which is nearly 90% of sludge composition. The process involves pumping sludge from clarifiers or settling tanks at the highest suspended solids level possible with the minimum of water possible. To institute automatic control, the optimum sludge blanket level for each clarifier and/or settling tank must be known. The level should not be allowed to vary more than a few inches from this optimum. A sludge blanket detection probe is needed, and one has been developed which works on the principle of ultrasonic adsorption. This system operates accurately even in opaque slurries and resists fouling in slimy wastes. Pumping solids only on demand and maintaining an optimum sludge blanket level reduces the amount of gallons discharged from the sludge pump for added handling. Potential savings are high and equipment costs would be quickly repaid.

*Sludge treatment, *Costs, *Automatic controls, *Sludge disposal, Slurries, Suspended solids, Pumps, Treatment facilities, Flow, Performance, Equipment, Waste water treatment

J084
APPLICATION OF SEWAGE SLUDGE TO CROPLAND,

Crops and Soils, Vol. 29, No. 7, p 5-7, April/May, 1977.

A summary was presented of an EPA report, by the Council of Agricultural Science and Technology, on the application of sewage sludge to cropland. Sludge may be a good source of plant nutrients and a good soil conditioner, but the problem of possible heavy metal contamination must be considered. About 25% of sludge is applied to land, but future economic and environmental considerations may increase its application to croplands. With increasing sludge production, industrial pretreatment of waste water could substantially reduce heavy metals in sludge. It has been suggested that the sludge quantity applied be determined by nitrogen, phosphorus, or heavy metal content. Where metal content is low, the nutrient needs of the crops could be the deciding factors. Various recommendations were made for the use of sludges containing cadmium, copper, molybdenum, nickel, and zinc. Parameters of usage included soil pH; metal residence time in soils; and effects on crops, animals, and humans.

*Sludge disposal, *Soil amendements, Heavy metals, Nutrients, Toxicity, Fertilizers, Vegetation, Phosphorus, Cadmium, Crops, Soil disposal fields

J085
ORGANIC MATTER AND HEAVY METAL UPTAKE,

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Stillwater,
Department of Agronomy.

Compost Science, Vol. 18, No. 1, p 18-21, January-February, 1977. 57 ref.

The uptake of the organic matter and heavy metal content of sludge has become increasingly important due to the economically beneficial disposal of sludge for agricultural purposes. The greater portion of heavy metals combined with soil organic matter are in insoluble, stable combination with humic substances. The presence of humus in soil is beneficial because it holds heavy elements needed for plant growth for long periods of time and releases them as needed. Deficiencies of these heavy metals are most consistently found in plants grown on peat and muck soils. Low pH causes reduced availability from organic matter relative to the same soil without organic matter; high pH causes this availability to increase. The organic matter degradation rate in soil is dependent on microbial activity. Incubation studies indicated that metal release by sludge decomposition in an alkaline soil did not make these metals available for plant uptake. Other studies indicated that plants grown on soils composted with sludge had much lower cadmium and zinc contents than those grown on plots with digested sludge. Radioisotope studies indicated that organic matter reduces plant uptake of radioisotopes. Sludge was found effective in increasing the organic matter content of soil. Research indicated that the maintenance of a high organic matter content in soil reduces plant uptake of metals added to soils treated with sludge.

*Organic matter, *Heavy metals, Soil chemical properties, Sludge disposal, Fulvic acids, Humic acids, Hydrogen ion concentration, Copper, Iron, Zinc, Manganese, Molybdenum, Toxicity

J086
"HYDIG"-ONE EXAMPLE OF CONTROLLED SLUDGE USE,

Compost Science, Vol. 18, No. 1, p 30, January-February, 1977.

A sewage treatment plant at Rickmansworth, England, has developed a liquid fertilizer from treated sludge called "Hydig." It is distributed to farms in a 300 square mile area around the plant. The treated sludge becomes a fertilizer rich in humus, nitrogen, and phosphate, and it has some potassium. Instructions are provided with the product which emphasize the possible toxicity of heavy metals contained in it. It contains 60.1% of organic and volatile matter, 39.9% mineral matter, 7.84% total nitrogen, and 5.13% phosphorus. Metal content averages 0.0032% for cadmium, 0.0117% for nickel, 0.0392% for chromium, 0.1337% for zinc, and 0.0437% for lead. Various controls are used for the distributed sludge. Each field at every farm is recorded and every dressing and quantity delivered is noted. Soil samples are analyzed before each dressing and sludge is sampled daily from the delivery tanker.

*Sludge disposal, *Fertilizer, Humus, Nitrogen, Phosphate, Soils, Metals, Trace metals, Organic matter, Soil disposal fields, Waste disposal, Waste water treatment

"Hydig", Liquid fertilizer

J087
WATERSHED ORGANIZATIONS—IMPACT ON WATER QUALITY MANAGEMENT: AN ANALYSIS OF SELECTED MICHIGAN WATERSHED COUNCILS,

Hood, E. J.

Dissertation Abstracts International B, Vol. 37, No. 9, p 4379-4380, March, 1977.

A case study approach was used to examine the effectiveness of Michigan watershed councils in watershed management and water quality control. The study was designed to reveal problems and make recommendations for more effective activities. It was revealed that effective water quality management planning was limited to advisory, planning and information-educational functions. Effectiveness of the councils depended on variations in enabling legislation; character of the watershed (urban or rural); level and type of participating membership; continuity in leadership; executive committee direction and perception; ability to seek financial and other aids from other groups; level of communication with constituents, state government, and other councils; and on whether the approach taken was a service or an issue approach. The weaknesses found were primarily due to statutory deficiencies, and to structural and operational difficulties of internal organization, orientation, and approach. These were not uniform but varied among the councils in type and degree. Recommendations were suggested to alleviate the problems associated with the above factors.

*Watershed management, *Evaluation, *Watersheds (basins), Rural areas, Urban areas, Legislation, Environmental control, Water quality control, Planning, Water management (applied)

Michigan

J088
THE DEVELOPMENT OF COSTS RECOVERY SCHEME: SUGGESTED APPROACHES FOR MUNICIPAL OR REGIONAL WASTE WATER TREATMENT PLANTS,

Thomopulos, A. A.

Dissertation Abstracts International B, Vol. 37, No. 8, p 3847, February, 1977.

An approach to costs recovery for financing waste water treatment plants was developed using some guidelines of the 1972 Federal Water Pollution Control Act Amendments. The study was based on an examination of existing cost allocation and user charge methods for waste water treatment. A charge method based on treatment costs provides a readily understandable basis for levying charges without punitive implications. The identification of recoverable costs is difficult with current methods and, in most cases, the costs of future expansion are not considered. The concept of costs recovery from industrial waste dischargers only contradicts the principle of distributing cost amongst all dischargers. The costs to be recovered should appreciably exceed the costs of borrowed money in order to avoid future borrowing. Recoverable costs should include total capital and interest costs, as well as the operation, maintenance, and replacement costs of present facilities. An incremental scheme will allow for a proportional increase in annual recoverable costs as users and waste water flows increase over time.

*Cost repayment, *Cost allocation, Reimbursable costs, Non-reimbursable costs, Capital costs, Operating costs, Maintenance costs, Replacement costs, Interest rates, Annual costs, Treatment facilities, Use rates, Water rates

Cost recovery

J089
SOME REFLECTIONS OF A SEWAGE WORKS MANAGER,

Batters, W.

The Public Health Engineer, Vol. 5, No. 2, p 51, March, 1977.

Observations on sewage treatment at the Coleshill Works, Birmingham, England, were made by its manager. Communication between designers and operators of sewage treatment facilities was a prime concern. The difficulties in reacting to flow variations and in synchronizing treatment processes were considered. It was suggested that sampling should be followed through on a time basis, and not as a sequence of numbers or sampling points. The air supply to aeration tanks should be regulated based on the influent flow to and the sedimented effluent strength of the aeration tanks. It was also suggested that tank performance should not be gauged totally by the meters, and that experience was the best basis for creating a proper atmosphere for biological activity. Heated sludge digestion should be considered because it utilizes anaerobic bacteria and provides a reliable gas source for power generation, if kept under control. Chemical treatment was considered, but it has the drawback of making treatment costs dependent upon material costs rather than on plant and operator efficiency. Fear was expressed that inflation and the scarcity of chemical supplies would create a crisis similar to that in the oil industry.

*Treatment facilities, *Operations, *Maintenance, *Monitoring, Equipment, Design criteria, Activated sludge, Flow, Aeration, Anaerobic bacteria, Sludge digestion, Chemical treatment, Biological treatment, Performance, Costs, Waste water treatment

Coleshill Works (Birmingham, England)

J090
WASTE WATER PLANTS USE LESS INSTRUMENTATION THAN RELATED INDUSTRIES,

Molvar, A. E., Roesler, J. F., Wise, R. H., and Babcock, R. H.

Raytheon Company,
Portsmouth, Rhode Island.

Water and Wastes Engineering, Vol. 14, No. 4, p 58, 60-61, April, 1977. 2 fig, 1 tab.

Waste water treatment plants were found to use less instruments and automatic controls than related water supply and chemical processing plants. The average secondary plant allocates about 3% of construction costs for installed instruments, although related industries allocate from 6 to 8% for this purpose. About 2% was allotted for remote satellite, wet-weather treatment plants. Only central, computerized, storm water-routing and in-line storage systems had an apparently adequate number of instruments and automatic controls. Reasons for this included the lack of a profit motive to produce high quality effluent; no legal penalties for low quality effluent and poor enforcement of effluent standards and guidelines; lack of commercially available, reliable instruments for process parameter measurement; oversized plant capacity that allows for less controlled operations; and a lack of familiarity with instrumentation practices and needs. Unreliable sensors were a major problem. They created more maintenance problems than their industrial counterparts. Successful controls were used for automatic liquid-level, liquid-flow rate, and air-flow rate control. Systems for controlling chemical addition, residual chlorine feedback, and digester temperature worked well. Computers were used for data aquisition in 20% of the facilities studied; only two facilities had process control computers. Storm water control with computer supervision was seen in three facilities. Research on and the development of reliable instruments was highly recommended.

*Treatment facilities, *Automation, *Instrumentation, Costs, Equipment, Automatic control, Operations, Maintenance, Water quality standards, Measurement, Computers, Waste water treatment

J091
FINANCING: THERE MUST BE A BETTER WAY,

Lubetkin, S. A.

Passaic Valley Sewerage Commissioners,
Newark, New Jersey.

Water and Wastes Engineering, Vol. 14, No. 4, p 80, 82, 85, April, 1977.

Ideas were presented for better financing arrangements by the government for the construction of waste water systems. An Environmental Financing Authority was created in 1972 when P.L. 92-500 was enacted. Rates were very high and borrowing was low or nonexistent. When money was "tight" and the New York City crisis made municipal borrowing difficult, legislation was enacted which granted agencies the right to borrow from the Federal Financing Bank when they could not fund their share of eligible grants. The Bank coordinated loan programs with the government's economic and fiscal policies to reduce the costs of federally assisted borrowing. The EPA was required to guarantee payment to the FFB. Rates were the prime issue of discussion. Recommendations were suggested which would tie rate charges to the status of Treasury Securities, the Moody ratings of municipalities, and Standard and Poor ratings. It was also stated that the arrangement of temporary financing should not make a borrower ineligible for Federal loans.

*Financing, *Legislation, Loans, Government finance, Interest, Costs, Bond issues, Credit, Grants, Treatment facilities, Waste water treatment

Federal Financing Bank, Municipal bonds

J092
APPRAISAL OF AREAWIDE WASTE WATER PLANNING,

Shubinski, R. P., and Fitch, W. N.

Water Resources Engineers, Incorporated,
Springfield, Virginia.

Journal of the Water Resources Planning and Management Division-ASCE, Vol. 103, No. WR1, p 63-72, May, 1977. 2 fig.

Basic water and planning demands created by P.L. 92-500 were discussed. Three areas were provided for: basin planning (Section 308), facilities planning (Section 201), and area-wide planning (Section 208). This study concerns area-wide planning which has multiple purposes. Municipal and industrial treatment needs, including storm runoff systems can be identified, and construction priorities can be developed. Regulatory programs can be established and the responsible agencies can be identified, along with the requirements for implementation. Plans and controls for agricultural and forestry nonpoint pollution sources, for mining-related sources, construction-related sources, and for saltwater intrusion can be identified, and residuals and land and subsurface dispositions can be controlled. Carrying out the planning process has encountered some difficulties which have altered the actual sequence of planning from that of the enabling legislation. The goals which were set for 1977, 1983, and 1985 require sharp departures from past attitudes and vast advances in technology. Technical limitations include an insufficient data base, inadequate analytical techniques, shortages of qualified manpower, and a restricted understanding of side effects. Management limitations center on the identification of public goals, jurisdictional conflicts, cost distribution equity, and problems of present institutional structures and the distribution of new powers. The program was judged quite valuable, with all the various conflicts and problems, in advancing water quality planning and may be viewed as a valid approach.

*Planning, *Water resources, *Legislation, *Coordination, Water resources development, Water quality control, Water quality standards, Institutional constraints, Administration, Long-term planning, Pollutant identification, Regulation, Construction, Analysis, Data collection, Construction, Waste water treatment, Costs, Project planning

P.L. 92-500 (Section 208), Environmental Protection Agency

J093
WASTE WATER RECLAMATION IN ST. CROIX,

Buros, O. K.

Black, Crow and Eidsness,
Gainesville, Florida.

Journal Water Pollution Control Federation, Vol. 49, No. 3, p 429-435, March, 1977.
5 fig, 2 tab, 3 ref.

A report was presented on waste water reclamation in St. Croix, U. S. Virgin Islands. The advent of tourism and industrial and economic development has greatly increased water demand on the island while depleting groundwater supplies. Various water reuse schemes have been investigated. Groundwater recharge received much attention in preventing deterioration of well field and augmenting water supplies. Interceptors and pumping stations are being constructed to deliver waste water to a central treatment plant. The quality, quantity, and movement of surface and groundwaters were studied intensely to determine placement of these facilities for the best advantage. The reclamation plant is a completely mixed, activated sludge plant with aeration tanks, clarifiers, solids removal by coagulation and flocculation with aluminum sulfate, filtration, and chlorination. Artificial recharge began in 1974 and studies indicated that expansion of the program was economical and technically feasible. The program is expensive, but much cheaper than the desalination programs which were tried.

*Groundwater recharge, *Groundwater resources, *Water reuse, Artificial recharge, Groundwater availability, Sewers, Water use, Water conservation, Treatment facilities, Desalination

St. Croix (U. S. Virgin Islands)

J094
COST OF HIGH QUALITY WASTE WATER TREATMENT FOR REUSE,

Anand, A. S., Albertson, O. E., and Fox, R. D.

Effluent and Water Treatment Journal, Vol. 17, No. 2, p 67-73, February, 1977.
9 fig, 4 tab, 14 ref.

A study was conducted to determine the cost of waste water treatment as a function of plant size, waste characteristics, and degree of treatment. The analysis was based on flow sheet combinations of the following factors: three plant sizes, two waste water strengths, and three levels of effluent quality. Cost analysis included construction costs, operational costs, equipment costs, and chemical costs. The relative costs of primary, secondary, and tertiary treatment processes were given, as were costs for dewatering and disposal methods.

*Costs, *Water reuse, Waste water treatment, Design criteria, Water quality, Treatment facilities, Filtration, Activated carbon, Tertiary treatment, Industrial wastes, Water quality control

J095
COMPOSTING--AN APPROACH TO USING SEWAGE WASTE,

Heaman, J. D.

Bird and Hale Limited,
Toronto, Ontario, Canada.

Compost Science, Vol. 18, No. 1, p 28-29, January-February, 1977.

Composting was considered as a means of using sewage wastes. The City of Windsor, Canada, has contracted with a composting firm to process sludge produced from treatment plants. Water is first removed until there is approximately 30% solids. The sludge is mixed with sawdust, inoculated with starting material, and the blend may then be oxidized to produce a stable humus. The sludge/sawdust ratio is about 80:20 by weight. Bacterial action begins at this point; the mixture is turned to prevent anaerobic conditions. After three months of this treatment, the compost is suitable for farm use. Care must be taken to provide an environment which allows the biochemical processes to continue. Temperatures of nearly 165 F destroy pathogenic bacteria and other unwanted materials. The product is odor-free, non-hazardous to health, and sterile. It is marketed in 10, 25, 50, and 80-pound bags. Blends are marketed as a potting soil, a mixture to improve aeration, and a greenhouse aid. They are also used to improve plant growth and soil fertility. The method is applicable to any waste matter with a substantial organic character for stabilization.

*Sludge disposal, *Fertilizers, Sludge digestion, Dewatering, Bacteria, Biological treatment, Temperature, Equipment, Anaerobic conditions, Storage, Organic compounds, Oxidation, Odor, Public health, Nutrients, Nitrogen, Phosphorus, Waste disposal

Composting

J096
SURVEY PREDICTS 33 PERCENT MUNICIPAL COMPLIANCE WITH
1977 DEADLINE,

Hadeed, S. J.

Journal Water Pollution Control Federation, Vol. 49, No. 3, p 360-362, March, 1977.
1 fig, 2 tab.

A survey was undertaken to determine the number of municipal treatment facilities which would meet the secondary treatment requirements of Public Law 92-500 by the 1977 deadline. It was indicated that only 33% of the municipal facilities would be able to comply with the standards, as compared to a nearly 90% industrial compliance. A regional analysis of 12,806 facilities found only 4,244 which are either providing this level of treatment or are capable of meeting the deadline. Parameters of the analysis were facilities, sewered flow, and population served which would have the secondary treatment by the deadline date. In order to provide some impetus without penalty, the EPA will issue Enforcement Compliance Schedule Letters which will forego penalties if certain goals are met by specified dates. However, no extension would last beyond 24 months after the deadline. Municipal dischargers will have to document their need for extensions and provide schemes for compliance within the shortest possible time. Congress is considering legislation to cope with this problem.

*Treatment facilities, *Cities, *Water quality standards, Environmental sanitation, Municipal wastes, Water purification, Pollution abatement, Regional analysis, Sewage effluents, Law enforcement, Waste water treatment

Public law 92-500

J097
1976 NEEDS SURVEY MARKEDLY LOWER,

Kendrick, P. J.

Journal Water Pollution Control Federation, Vol. 49, No. 3, p 365-368, March, 1977.
2 tab.

The EPA released its 1976 Needs Survey in February, 1977. Contained in this report was an estimate that $96 billion would be needed to build facilities in Categories I to V which would meet 1983 municipal effluent standards of the 1972 Federal Water Pollution Control Act. This is $55 billion lower than the 1974 estimate and reflects improved estimation processes. Costs for storm water pollution control were not included. This would add another $54 billion. Other reasons for this difference in estimates include: varied assumptions and less structured methodology in 1974, improved guidance procedures in 1976, more accurate 1976 estimates, completion of infiltration/inflow studies, the elimination of needs for controls of infiltration/inflow pollution into combined sewers, the elimination of non-documented state costs, more accurate reporting techniques, and reductions in sewer construction cost estimates for completed work. Independent surveys were conducted in some categories and a section on backlog costs was included. The 1978 survey will include further revisions.

*Treatment facilities, *Federal Water Pollution Control Act, *Water quality standards, Regional analysis, Construction, Municipal wastes, Cities, Law enforcement, Water purification, Costs, Waste water treatment

J098
SOIL TESTING FOR SLUDGE DISPOSAL,

Compost Science, Vol. 18, No. 1, p 16-17, January-February, 1977.

Graduate and undergraduate students at the Penn State School of Agronomy are investigating sludge disposal for agricultural use. Soil testing is part of their research. The method developed uses an ideal solution of macro elements in combination with a soil sample. The solution adds to the soil or adsorbs from it the basic elements needed for plant growth; excesses or deficiencies of these elements can be pinpointed by examination of the solution after it interacts with the soil. The type and amount of fertilizer needed to promote optimum growth can be determined, as can the presence of heavy metals in sludge fertilizer. Monitoring the use of sludge as compost will be much easier with these test methods.

*Sludge disposal, *Soil tests, Heavy metals, Fertilizers, Soil properties, Monitoring, Ultimate disposal, Soil disposal fields, Soil analysis, Waste water treatment

J099
NEOPLASTIC AND POSSIBLY RELATED SKIN LESIONS IN NEOTENIC TIGER SALAMANDERS FROM A SEWAGE LAGOON,

Rose, F. L., and Harshbarger, J. C.

Texas Tech University,
Lubbock,
Department of Biological Sciences.

Science, Vol. 196, No. 4287, p 315-317, April, 1977. 1 fig, 8 ref.

Neoplastic and other skin lesions were studied in neotenic tiger salamanders growing in a lagoon with high concentrations of secondary domestic sewage. Thirty to fifty percent of a 28,000 population developed skin lesions of which 84% were neoplasms. Salamanders in uncontaminated area lagoons developed normally with no neoplasms. Non-neoplastic lesions found were ascites, serous cysts, and epidermal inclusion cysts. Ascites were common to both test populations. The neoplastic lesions developed from skin epithelium, dermal fibroblasts, or dermal melanocytes. Water analyses were negative for 14 nitrosamines, but sediment analyses revealed 300 ppm of perylene, from jet fuel, and trace amounts of benzpyrene. Perylene has caused low tumorigenic activity in mice when combined with other polycyclic aromatic hydrocarbons. Tests should be conducted to determine its effects on salamanders. Metamorphic failure was determined to be a factor in tumorigenesis. Tiger salamanders were considered to be sensitive indicators for certain environmental carcinogens and could possibly monitor sewage ponds. Other vertebrate and invertebrate larval forms could be developed for such purposes by hormonally prolonging the length of the immature stages.

*Cytological studies, *Salamanders, *Growth stages, *Lagoons, *Monitoring, Water pollution effects, Chemical reactions, Biochemistry, Diseases, Water pollution, Waste water treatment, Settling basins

Neoplasms, Carcinogens, Tiger salamanders, Skin lesions

J100
MAKE MONEY BY COMPUTER,

Watkins, E., and Burger, J.

The American City and County, Vol. 92, No. 4, p 57-58, April, 1977.

Computerization was the solution to sewage collection problems created by the merger of Eau Gallie and Melbourne, Florida. Difficulties included meeting EPA regulations, conveying sewage in a level terrain to two treatment plants, and monitoring sealed overflow pipes on lift station wet wells. The computer used remote terminals at lift stations and distant treatment plants, and telemetric reports on operational and emergency conditions. Lift station terminals monitor water levels and control pump activity. Power failures and maintenance operations are also monitored. Infiltration/inflow data are collected to aid evaluation of future expansion needs. Operation and maintenance costs have been reduced and rate increases have been avoided by the installation of this system. A computerized billing system also reduced cost and billing errors.

*Computers, *Costs, *Monitoring, Operating costs, Maintenance costs, Evaluation, Equipment, Cities, Water districts, Water quality control, Treatment facilities, Water rates, Waste water treatment

Melbourne (FL)

J101
CONTROL OF NON-POINT SOURCES OF WATER POLLUTION WITHIN AN ECOLOGICAL FRAMEWORK: THE CASE OF THE TRI-COUNTY REGION, MICHIGAN,

Nortey, P. A.

Dissertation Abstracts International B, Vol. 37, No. 9, p 4380-4381, March, 1977.

A study was conducted on the control of non-point water pollution sources within an ecological framework. A second objective was the evaluation of institutions and institutional planning arrangements for pollution control under Section 208 of the 1972 amendments to the Federal Water Pollution Control Act. Four principles were derived from a conceptual ecosystems model, which involved regional considerations, environmental quality, carrying capacities and tolerances, and sound management practices. The Tri-County Region of Michigan was the study area chosen. The Tri-County Planning Commission's approach was judged to be basically sound. It was suggested that the Commission be made coordinator of all citizen participation activities relative to water pollution. Ecosystem relationships were suggested as a basis for the identification of water pollution control strategies. A close functional relationship was recommended between the planning agency and the implementing agency. Further investigation is necessary to identify the best combination of incentives for public adoption of compatible water management practices. The Section 208 program was judged to be an effective means of solving Tri-County water pollution problems and aiding better land use and economic community growth. Continuance and improvement of the program was seen as the major challenge.

*Water pollution control, *Water pollution sources, Public health, Ecosystems, Model studies, Legislation, Planning, Water quality control, Environmental control, Administration

Water Pollution Control Act Amendments (1972)

J102
PLANASA--A NATIONAL PLAN FOR WATER SUPPLY AND SEWERAGE IN BRAZIL,

Klumb, A.

Banco Nacional da Habitacao,
Rio de Janeiro, Brazil.

Journal of the American Water Works Association, Vol. 69, No. 4, p 186-187, April, 1977.

PLANASA (Brazilian National Sanitation Plan) was developed to mobilize national resources in the quickest time possible for the economical provision of basic sanitation to all Brazilian urban areas. All federal agencies involved with social development have been directed to support the effort. The United States and the Pan American Health Organization are making technical assistance available. The plan calls for a rate structure consistent with the consumer's ability to pay and reduction of operational costs by economies of scale to create a permanent balance between revenues and expenditures. A target date of 1980 has been set for the provision of drinking water to more than 80% of the urban population and for adequate sewerage facilities in major metropolitan regions. At the same time, simpler and more basic services are to be provided for towns and villages of lesser size. Meeting these goals will require a vast improvement of water qualtiy for three-fourths of the municipalities and the expansion and construction of sewage systems. Pooling of resources on a national and state basis will be necessary, as will the training of qualified personnel and the strengthening of sanitation authorities. Means for the development and transfer of technology for the provision of the best possible systems must be devised. The major problem of the future will be to provide an impetus for the population to connect to the systems after their completion.

*Planning, *Sanitary engineering, *Water supply development, *Sewerage, Public health, Water quality, Sewage treatment, Waste disposal, Construction, Economics, Research and development, Costs, Urban areas, Rural areas, Governments, Foreign countries

Brazilian National Sanitation Plan (PLANASA), Brazil

J103
HEALTH CONSIDERATIONS IN USE OF TERTIARY EFFLUENTS,

Cooper, R. C.

California University,
Berkeley,
Department of Biomedical and Environmental
Health Sciences.

Journal of the Environmental Engineering Division-ASCE, Vol. 103, No. EE1, p 37-47, February, 1977. 2 tab, 45 ref.

Hazards to human health which might result from the reuse of highly treated waste effluents have two major sources, biological agents and chemical agents. These biological agents may be bacterial, viral, or parasitical in nature. Salmonella and Shigella are the most important enteric pathogenic bacteria encountered. Enteroviruses, adenoviruses, reoviruses, and the agent of infectious hepatitis are potentially the most important viruses involved. Many intestinal parasites are associated with waste water but the incidence of their occurrence is not well established. Inorganic or organic chemical agents may be either acutely or chronically toxic to populations. The analysis of chemical agents is more difficult, and they arise from a wider range of sources than biological agents. They are both natural and man-made. Another problem is the uncertainty concerning the fate of chemicals in water, which depends upon their stability and their biotransformation to more toxic forms. Other concerns involve the effects of water hardness and the impact of trace organics. Developments in analysis, epidemiologic studies, and treatment must become more definitive before extensive waste water reuse can be applied with guarantees of health safety.

*Water reuse, *Public health, Toxicity, Bacteria, Viruses, Animal parasites, Chemical wastes, Inorganic compounds, Organic compounds, Tertiary treatment, Waste water treatment

J104
OPTIONS FOR SLUDGE—TO LAND, SEA OR FIRE,

Pullin, J.

Surveyor, Vol. 149, No. 4423, p 7-9, March, 1977.

For many years, sludge disposal has been a neglected step in sewage treatment processes. Increased sewage flows and stricter pollution standards have resulted in more efficient treatment methods, and consequently in more sludge. Four basic options for sludge disposal are using the sludge as landfill, using it as fertilizer, disposing of it in oceans, and incinerating it. The type of sludge produced and the geographical characteristics of a given area limit the choices. A 1970 report estimated that England and Wales produced about 1.1 million tons of sludge per year and that nearly 40% was used as fertilizer. It should be noted that the fertilizing benefits of sludge nitrogen and phosphorus can be offset by the presence of toxic substances, such as heavy metals, which may enter the food chain. Cadmium concentrations in British sewage sludges may be as high as 50 milligrams/kilogram of dry solids. Though ocean disposal has been prominent in the past, incineration has become popular. The use of incineration is basically an economic decision. It was thought that sludge and domestic refuse could be incinerated together, but this was not very successful in Britain. Where sludges are not suitable for land application, incineration has a definite advantage. Land requirements are less, and the ash volume is much lower than the volume of sludge dried on beds. It appears that British practice will be to use incineration and ocean dumping in urban areas, for sludges which contain much industrial waste. Agricultural disposal will be used in areas where land is easily accessible and for sludge which is low in toxic materials.

*Sludge disposal, Landfill, Fertilizers, Incineration, Pollution abatement, Sewage effluents, Sludge treatment, Nitrogen, Phosphorus, Cadmium, Public health, Trace elements, Waste water treatment, Metals, Economics, Treatment facilities

Ocean disposal

J105
SOUTH BEND'S INDUSTRIAL SURVEILLANCE WASTE WATER MONITORING PROGRAM,

Jeter, J. M., and Liggett, R. S.

Bureau of Waste Water,
South Bend, Indiana.

Water and Sewage Works, Vol. 124, No. 5, p 74-80, May, 1977. 6 fig, 2 tab, 10 ref.

The South Bend, Indiana, program for industrial surveillance and waste water monitoring was examined. The program consisted of industrial waste water characterization and treatment facility monitoring. Its objective was to develop a suitable management program. Program personnel and equipment requirements were discussed. A chemist and two technicians were employed full-time, with another chemist and technician available as needed. Automated sampling units, analytical equipment and glassware, as well as a vehicle and traffic equipment were requisitioned as essentials. The quality and quantity of industrial effluents were monitored. Treatment facilities were monitored to determine the impact of the added industrial loads on performance. Evaluation criteria for treatment plants were pH, suspended solids, BOD5, COD, phosphate-phosphorus, fecal and total coliforms, and metals. Water quality parameters for river monitoring were pH, BOD5, COD, DO, phosphate-phosphorus, temperature, fecal coliform, total metals, total cyanides, oil, and greases. The city has expanded its analytical capabilities. Carbon rod atomization and atomic absorption techniques were being refined to increase sensitivity for certain total metal parameters. Phenolics determination and oil fingerprinting by gas chromatography were also being developed. Various required reporting procedures were described.

*Monitoring, *Industrial wastes, Water pollution sources, Regulation, Legislation, Water quality standards, Personnel, Cities, Treatment facilities, Equipment, Analysis, Waste water treatment

South Bend (IN)

J106
CONSTRUCTION MANAGEMENT FOR WASTE WATER TREATMENT PLANTS,

Strang, W.

CM Associates, Incorporated,
Houston, Texas.

Public Works, Vol. 108, No. 5, p 82-84, May, 1977. 2 fig.

The construction management approach was applied to waste water treatment facilities. This approach was found to alleviate several problems of past decision making processes. Problems such as selecting designers and subcontractors, procuring equipment, and funding cost overruns, can be more efficiently handled. Under this management process, a construction manager and designer are hired at about the same time. The manager does cost estimation, cost consulting, and scheduling in the early stages. He provides contract management, field supervision, and scheduling during construction. Fast-tracking may then be used for permit bidding and for some construction before the later phases are completely designed. This considerably reduces construction time. The approach facilitates communications between users and subcontractors. Cost reductions can be achieved through bid selection by the owner rather than by a general contractor. Direct negotiations between the manager and the lowest bidder may result in additional savings. General managers, who would include allowances for contingencies in their bids, are avoided. The owner, however, accepts the responsibility for risks. There is also the liability of extending funds, as a result of fast-tracking, before a final cost is known. Construction management has so far been applied mainly for schools and health facilities. While general contractors or designers may be hired as construction managers, there are some organizations which will provide this management as their sole function.

*Construction, *Treatment facilities, *Management, Decision making, Personnel, Structural engineering, Design, Equipment, Contract administration, Costs

Construction management

J107
IMPACT OF MUNICIPAL WATER AND SEWAGE CHARGES ON INDUSTRY,

Schaffer, R. J., Jr., and Pickard, B. L.

Packard and Anderson Engineers,
Auburn, New York.

Water and Sewage Works, Reference Issue, p 107-109, April, 1977. 4 tab.

The economics of municipal waste water treatment can be staggering. One aspect of the issue is that of charges to industrial users of the systems. Increased costs for power, labor, and chemicals, in addition to federal stipulations for cost appropriation, have increased the financial responsibility of industrial customers. Minimizing such costs would necessitate a detailed analysis of water uses and waste water generation by each facility. Determination of the best means to monitor the strengths and quantity of waste water disposed to municipal systems would follow. Pretreatment of specific wastes or separate waste water treatment facilities may be justified. Alternate solutions include water metering by uses to separate water used and disposed to the system from that used and disposed by other means. The total flow of municipal water used and that of waste water discharged to sewers could be metered. Fixed charges could be negotiated, based on accurate flow data. These choices involve several considerations. The type of metering device chosen would depend on the selected solution. Reduction of municipal water usage and the development of a private additional water source should be investigated. Industries should not overlook the possibility of reducing waste water flows to municipal sewers. A case study proved that even a small plant could benefit from improvements and recover costs.

*Water costs, *Cost allocation, Water policy, Water rates, Water consumption (except consumptive use), Water resources, Waste treatment, Industrial water, Industrial wastes, Water users, Waste water treatment, Municipal water, Waste water treatment

J108
PRODUCTIVITY OF CLARIAS BATRACHUS IN THE SEWAGE FERTILIZED FISH PONDS,

Krishnamoorthi, K. P., Abdulappa, M. K., and
Rap, A. V. J.

National Environmental Engineering Research
Institute,
Nagpur, India.

Indian Journal of Environmental Health, Vol. 18, No. 4, p 292-298, October, 1976.
6 fig, 5 ref.

Two fish ponds, fertilized with stabilization pond effluent, were stocked with Clarias batrachus to reduce fishkill from seasonal algal blooming. A study was conducted to determine C. batrachus growth, as well as related chemical and biological parameters. Over a two-year period the fish ponds were compared to a control pond and the stabilization pond. Pond temperatures were 20-30 C, and pH ranged from 7 to 9.5. Observed pH fluctuations resulted from high photosynthetic activity and community respiration. C. batrachus were able to survive extreme environmental conditions and ammonia toxicity created at high pH values. The BOD, nitrogen, and phosphate ratio was 60:30:4 indicating excessive nitrogen and adequate phosphate concentrations to support a blooming proportion of algae. Indian catfish culture is quite young and there is no regular source of supply. It was concluded that large-scale catfish culture in ponds and swamps receiving sullage, sewage and treatment plant effluent could enhance the production of catfish as a food source.

*Fish management, *Catfishes, *Sewage effluents, Fishkill, Algae, Oxidation lagoons, Fish stocking, Fish populations, Fish farming, Carp

J109
STUDY ON ECONOMIC AND POLICY INSTRUMENTS FOR WATER MANAGEMENT.
WATER MANAGEMENT IN JAPAN,

1976. 49 p, 26 append. Technical Report of the Organization for Economic Co-operation and Development (Paris).

This report deals with Japanese water management programs. No comprehensive system of water management has been developed in Japan. The nation's water management efforts have resulted from the requirements of various water supply, water pollution control, and waste treatment laws and from the regulation of surface water usage. Such laws include the River Law, the Water Pollution Law, and the Sewerage Law. Many laws regarding industrial regulation have also been influential. Institutional structures of these programs are bi-level. Nationwide administration is the responsibility of the Ministry of Construction. Prefectural Governors are empowered to determine prefectural standards for effluent and area environmental quality and to control water areas under their jurisdiction. Physical data on Japanese water resources and the economics of financing management programs are reviewed.

*Water management (applied), *Administration, *Legislation, *Water pollution control, Water policy, Water supply development, Industrial wastes, Municipal wastes, Project planning, Water resources, Waste water treatment, Financing

Japan

J110
STUDY ON ECONOMIC AND POLICY INSTRUMENTS FOR WATER MANAGEMENT.
WATER MANAGEMENT IN FINLAND,

1976. 34 p, 3 append. Technical Report of the Organization for Economic Co-operation and Development (Paris).

An overview of the Finnish water management program is presented. The system has been based on a regulatory approach. The 1961 Water Act applies to all water functions except ownership. The administrative network is composed of the National Water Board, the Water Court, thirteen Water Districts, and three hundred Municipal Water Boards. A licensing program governs water discharge and withdrawal. The Water Court, the only source of licenses, is the technical inspection branch of the management program. Its main purpose is the integration of water management by different functions. It also encompasses water protection, water main and sewerage expansion, expansion of recreational water uses, and water and water use supervision. Water districts have the responsibility of inspecting and measuring waterway flow rates and quality, inspecting local communities, and offering planning assistance. Municipal Water Boards, independent of national authorities, are empowered to grant licenses for small local operations and to settle simple disputes. Several sources are available for financing water management programs. Loans from the state Post Office Savings' Bank are provided for water supply and sewer systems. Water pollution control subsidies have been set aside for community assistance. The state also operates several water pollution facilities of its own. Investment loans available from the state can be applied to industrial programs. Municipalities have been able to collect sewer connection and operation charges since 1974. Their effects have not been evaluated.

*Water management (applied), *Administration, *Legislation, *Regulation, *Water policy, Water pollution control, Financing, Project planning, Water resources, Industrial wastes, Municipal wastes

Finland

J111
STUDY ON ECONOMIC AND POLICY INSTRUMENTS FOR WATER MANAGEMENT.
WATER MANAGEMENT IN THE UNITED STATES,

1976. 127 p, 17 fig, 27 tab, 15 ref. Technical Report of the Organization for Economic Co-operation and Development (Paris).

Water management in the United States is handled by hundreds of organizations. No defined form, channel of communication, or co-ordination has been established. Federal participation has resulted from various legislative imperatives such as the Water Resources Planning Act of 1965, the Clean Waters Restoration Act of 1966, the 1961 Federal Water Pollution Control Acts, and the 1972 Federal Water Pollution Control Act Amendments. This legislation has established institutions such as the Water Resources Council and the state-federal River Basin Commissions. In other instances, federal agencies have been given control or influence over water quality standards, pollution control, and waste treatment facilities. Among these agencies are the EPA, Army Corps of Engineers, and the Bureau of Reclamation. The states have their own version of several of these federal laws and agencies. Interstate regional commissions or agencies also play an important part in the planning process. Federal standards have been used as guidelines for the establishment of state standards. Since most water projects require partial or total federal funding, there is an economic impetus for state and local authorities, as well as industrial establishments, to comply with federal guidelines or standards. Industrial compliance can be controlled by fines for polluters. On an international level, the United States participates in joint commissions with Canada and Mexico.

*Water management (applied), *Administration, *Legislation, *Regulation, *Water policy, Water pollution control, Water quality standards, Project planning, Water resources, Financing, Industrial wastes, Municipal wastes, Sewage treatment, United States

J112
STUDY ON ECONOMIC AND POLICY INSTRUMENTS FOR WATER MANAGEMENT.
WATER MANAGEMENT IN THE UNITED KINGDOM,

1976. 41 p, 3 fig, 3 tab, 16 ref. Technical Report of the Organization for Economic Co-operation and Development (Paris).

Water management in England, Wales, and Scotland is reviewed. Scottish organization and practices often vary from those of England and Wales. The English and Welsh system was reorganized in 1974 to consolidate administrative and control practices. Nine English Water Authorities and the Welsh National Water Authority were formed. These agencies have separate divisions responsible for water resources conservation and development, sewerage, sewage disposal, and pollution control. Other structures of this program include the Water Research Centre, National Water Council, Water Space Amenity Commission, Central Water Planning Unit, and Water Data Unit. Scotland has developed nine regional and three island water councils. Seven river purification boards handle water pollution matters. Abstraction of surface or ground water in England and Wales is licensed, but there is no such provision under the Scottish system. English and Welsh financing results from water charges levied on licensed abstractors; payments from municipal, individual, and industrial sewer usage; and government supports. Scottish operations are funded from government grants, metered supplies, and domestic or industrial water rate charges. Nearly 100% of the total population is supplied with piped water and about 80% of English and Welsh populations are connected to public sewer systems. Data are supplied on the progress of the application of water and waste effluent standards.

*Water management (applied), *Administration, *Legislation, *Regulation, *Water policy, Water pollution control, Financing, Water rates, Water quality standards, Water resources, Industrial wastes, Municipal wastes, Sewage treatment

England, Wales, Scotland

J113
CROSS CANADA REPORT,

Overment, M.

Water and Pollution Control, Vol. 115, No. 3, p 14-19, 21, March, 1977. 2 fig, 1 tab.

A review was made of the water and sewage activities in Canada, as well as pollution control efforts. Spending on various programs reached $2.5 billion in 1976 due to an emphasis on cleanup and prevention. Spending for sewage treatment was as high as $1.2 billion. The Fisheries Act and the Canadian Waters Act were the basic enabling legislation for programs in water pollution control. The Ocean Dumping Control Act and the Environmental Contaminants Act, passed in the 1975-76 fiscal year, have affected flood control, sewage treatment, ocean dumping, and pollution control. Various activities in each Province were described with a financial breakdown for water and sewage treatment.

*Environmental control, *Pollution abatement, *Water pollution control, *Legislation, Waste treatment, Waste disposal, Costs, Treatment facilities, Flood control, Economics, Planning, Waste water treatment

Canada

J114
SYNTHETIC AGGREGATES MADE FROM SEWAGE PLANT SLUDGE,

Engineering News-Record, Vol. 199, No. 18, p 13, May, 1977.

A method was devised to produce lightweight synthetic aggregates from sewage sludge for use in concrete. Ash of incinerated sludge was mixed with crushed shale, water, and binding materials. This mixture was heated to 2,200 F and molded into 0.4-inch diameter balls having a porous interior and a nonporous, compact surface layer. Their specific gravity was 1.2 compared to an average of 1.5 for other synthetic aggregates. Only laboratory production has been successful, but the size and shape of the balls could be adjusted for commercial usage.

*Aggregates, *Concrete technology, Sludge disposal, Incineration, Particle size, Construction materials, Shales, Physical properties, Specific gravity, Waste disposal, Recycling, Water water treatment

J115
ACTIVITY OF INTESTINAL ARYL HYDROCARBON HYDROXYLASE IN
GUINEA PIGS FED HIGH ELEMENT CONTAINING SLUDGE-GROWN CABBAGE,

Stoewsand, G. S., Babish, J. G., and Lisk, D. J.

Institute of Food Science,
Geneva, New York.

Federation Proceedings, Federation of American Societies for Experimental Biology,
Vol. 36, No. 3, p 4626, March, 1977.

The high levels of heavy metals present in municipal sewage sludge and industrial wastes represent a barrier to agricultural application of these products. A study was performed to examine the potential toxic effects of this application by feeding young male guinea pigs for 100 days on a diet, of which 45% was cabbage grown in municipal sewage sludge. This sludge-grown cabbage contained Al, As, Ba, Cd, Cr, Co, Cu, Eu, Na, Mo, Sr, Th, and Yb at levels 100% more than those in soil-grown cabbage. No adverse effects were apparent in the animals. The guinea pigs fed sludge-grown cabbage had a slighcly elevated growth. Aryl hydrocarbon hydroxylase activity in the test animals was 130% of controls. This finding correlates with increased enzyme (hepatic and tissue microsomal mixed-function oxidase) levels observed in prior studies on animals fed high trace-metal, waste-amended diets.

*Heavy metals, *Toxicity, *Enzymes, *Growth rates, *Vegetable crops, Sludge disposal, Industrial wastes, Municipal wastes, Diets, Waste disposal, Waste water treatment

Aryl hydrocarbon hydroxylase, Sludge-grown cabbage

J116
MANAGEMENT ALTERNATIVES FOR LAND TREATMENT SYSTEMS,

Culp, G. L., and Hinrichs, D. J.

Culp/Wesner/Culp, Consulting Engineers,
El Dorado Hills, California.

Public Works, Vol. 108, No. 6, p 78-79, June, 1977.

Alternative solutions were suggested for management problems related to land treatment systems. The problems considered were operation of the irrigation system; planting, cultivating, and harvesting of crops; and ownership of the land. One method involved ownership of the land and operation of the irrigated-agriculture project by one agency. Its main advantage was complete agency control of the treatment and irrigation systems. Problems included staffing, equipment costs, and maintenance costs. Maximized crop revenues could offset operating costs. A perennial crop would require less tillage and save equipment and personnel costs. A solid-set or a center pivot type system requires less labor. The crop should be compatible with local crops to utilize local knowledge and markets. Agency ownership of the land and contracted farming activities was another choice. This relieves some equipment and labor costs, but creates problems of priority. Is waste water treatment or maximization of crop revenues more important? A compromise solution would be agency ownership and irrigation operation, with only crop planting and harvesting activities contracted. This provides complete control of the entire system and avoidance of farm labor and equipment charges. Timing harvest to maximize crop yield may become a problem. There was also the option of leasing the lands for irrigation operations. Another prospect was the provision of water to a farmer or group of farmers who need water and may already possess irrigation equipment. The choice of management approach should depend upon local agency constraints and concerns.

*Waste water management (applied), *Irrigation, Waste disposal, Equipment, Maintenance, Costs, Crops, Administration, Waste water treatment

J117
MULTIFUNCTIONAL APPROACH TO POLLUTION PREVENTION,

Raven, T. W.

Water Pollution Control, Vol. 76, p 222-231, 1977.

The reorganization of the Yorkshire Water Authority, with an emphasis on pollution prevention, was described. The major concern was to reconcile the Authority's position as pollution control overseer with its creation of pollution as a byproduct of water treatment. Emphasis was placed on making the scientific services multifunctional. The objective was to combine responsibility for analysis of water; trade effluents to sewer, surface, and groundwater; treatment facilities; and river samples. This would effectively eliminate large scientific staffs at individual facilities. Pollution prevention was divided into the areas of inspection, monitoring, examining waste treatment planning applications, developing procedures for emergency pollutions, keeping the public informed, and establishing effluent standards.

*Water pollution control, *Water districts, *Administration, Analysis, Inspection, Monitoring, Planning, Treatment facilities, Standards, Waste water treatment

J118
A NEW APPROACH TO SUBDIVISION PLANNING,

Kumar, I. J., and Eustance, A. W.

Eustance and Horowitz, P. C.,
Circleville, New York.

Public Works, Vol. 108, No. 6, p 75-76, June, 1977. 1 fig.

The town of Waywayanda, New York, developed an approach for planning sewage collection and treatment for new subdivisions. The objective was to establish a sewage system which would assure systematic community growth and reduce the future addition of several small collection systems and treatment facilities to the municipal lines. Two plans were investigated. One plan would have the developers form a corporation to build a joint sewerage system which would be financed by them. The town would allow the formation of a sewer district; control design and construction; and help obtain rights-of-way. The plan finally chosen called for the town to establish the sewer district and to design, finance, and build the collection system and treatment plants. Repayment of municipal bonds would be the responsibility of the developers. Securities would be accepted from them to guarantee construction, payment of finance costs, and repayment of bonds. This would be in lieu of a sufficient number of ratables on the properties. The securities would be held by the town until the bond was paid or until the latter condition was fulfilled. The first plan could be possibly quicker and less expensive, but was also riskier for the developers. Less immediate cash outlay was required by the second plan, which also offered complete control by one agency (i.e. the town). The districts formed would be more flexible and more easily expanded.

*Land development, *Planning, *Sewers, Treatment facilities, *Financing, Cities, Cost sharing, Bond issues, Government finance, Economics, Waste water treatment

Waywayanda (NY)

J119
WASTEWATER MANAGEMENT PROGRAM, JAMAICA BAY, NEW YORK,
VOLUME I: SUMMARY REPORT,

Feuerstein, D. L., and Maddaus, W. O.

H. F. Ludwig and Associates,
Engineering-Science, Incorporated,
Berkeley, California.

1976. 182 p, 85 fig, 37 tab, 14 ref, 3 append. EPA Technical Report EPA-600/2-76-222a.

A three-year study was conducted to develop management criteria and procedures for the Jamaica Bay, New York, ecosystem. Management of combined sewer overflow was important to water contact recreation in the bay. Four municipal treatment facilities discharged their organic and nutrient materials into the bay. Significant quantities of solids and coliforms resulted from combined sewer overflows. The treatment facilities were being upgraded for better removals of suspended solids and organic, oxygen-demanding materials. A construction plan was instituted to build treatment facilities for the eight major combined sewer overflows to reduce bacterial densities. Three facilities were upgraded to full step-aeration processes. An auxiliary plant was built to treat combined sewer overflows from two basins. Reduction of oxygen-demanding materials to near natural background levels could be accomplished by routing most of the dry- and wet-weather treated effluents and combined sewer overflows from the bay to the New York Bight. The planned upgrading program was expected to produce levels of these materials which would not be detrimental to the ecosystem. Cost-effectiveness studies were implemented to determine the most reasonable development of a waste water management program for the bay.

*Water management (applied), *Water pollution control, *Water quality, *Combined sewers, *Treatment facilities, Overflows, Oxygen demand, Suspended solids, Organic matter, Aeration, Nutrients, Costs, Waste water treatment

Jamaica Bay (NY), New York Bight

J120
TRACE ELEMENTS IN WASTEWATER,

Chang, A. C., and Page, A. L.

California University,
Riverside,
Department of Agricultural Engineering.

California Agriculture, Vol. 31, No. 5, p 32-33, May, 1977. 4 tab.

A study was done on the effects of trace element concentrations on the reuse of waste water effluents and sewage sludge for agricultural and municipal purposes. Elements studied included B, Cd, Cr, Cu, Pb, Hg, Ni, and Zn. Most waste effluents could meet criteria for trace element concentrations established by the National Academy of Science and National Academy of Engineering Joint Committee in 1972. Because the actual concentrations of trace elements may vary considerably with the nature of the community, its related industries, and its treatment system, direct reuse of waste water for public water supply is not recommended by regulatory agencies at the present time. Agricultural use of sludge with nominal trace element concentrations has been found to be not generally detrimental to plants, but it does present a potential danger to human consumers if accumulation in edible plant tissues is significant. Proper selection of crop species, soil type, and sludge composition may minimize accumulation of trace elements in plant tissue. Use of sludge that is unusually high in trace element concentrations is discouraged.

*Trace elements, *Metals, *Water reuse, Phytotoxicity, Effluents, Waste disposal, Sludge disposal, Fertilizers, Industrial wastes, Food chains, Waste water treatment

J121
$885 MILLION-PLUS PLAN IS RECOMMENDED FOR BOSTON AREA,

Weiss, M., and Vittands, J. P.

Water and Wastes Engineering, Vol. 14, No. 6, p 30-34, June, 1977. 2 fig, 1 tab.

A study was done on possibilities for improving municipal waste water treatment capacity for the Boston Metropolitan Sewerage District. Five concepts for waste water management were considered, including various degrees of expansion of service, decentralization, and waste water disposal through land application. Capital costs for the various concepts, with the exception of land application, were approximately equal. After evaluation of the five plans presented, moderate decentralization was recommended. The recommended plan includes upgrading existing facilities and constructing two new AWT satellite plants. Costs will be apportioned among member municipalities.

*Sludge disposal, *Sludge treatment, *Municipal wastes, *Regional development, *Comprehensive planning, Overflow, Feasibility studies, Waste water treatment, Waste water disposal

Boston (MA)

J122
CAN IRRIGATION WITH MUNICIPAL WASTE WATER CONSERVE ENERGY?,

Roberts, E. B., and Hagan, R. M.

California University,
Davis,
Department of Land, Air, and Water Resources.

California Agriculture, Vol. 31, No. 5, p 45, May, 1977.

The State Water Resources Control Board of California has evaluated energy costs for the reuse of waste water for agricultural purposes in comparison to costs for alternative importation of fresh water and ocean dumping of waste water. Since waste water discharged to the Pacific requires secondary treatment and outfall pumping, while waste water reused for irrigation of fodder, fiber, and seed crops requires only primary treatment, reuse instead of ocean disposal would save about 200 KWH in direct energy requirements. Reuse for pasture irrigation and surface irrigation of food crops also requires secondary treatment, therefore saving only approximately 50 KWH over ocean disposal. Waste water used for sprinkler irrigation requires additional coagulation and filtration, using slightly more energy (10 KWH/AF) than ocean disposal. Energy savings produced by reuse of waste water, however, are often offset by water quality and geographic considerations. When additional treatment processes are already indicated, as for a "water quality limited stream segment", reuse of waste water for fodder, fiber, and seed crops becomes advantageous.

*Water reuse, *Irrigation water, *Irrigation efficiency, *Energy, *Water costs, Irrigation practices, Waste disposal, Water sources, Water distribution, Waste water disposal, Waste water treatment, California

J123
MARYLAND RESEARCH FINDING GUIDELINES FOR SLUDGE USE,

Water and Wastes Engineering, Vol. 14, No. 6, p 42, June, 1977.

Researchers at the University of Maryland have been investigating the use of sewage sludge as fertilizer for home lawns and food crops. Until now, widespread use of municipal sewage sludge as fertilizer has been hindered by the possibility that heavy metals and disease-causing organisms may infiltrate the food chain and adversely affect human populations. A prepared compost mix which is acceptable under federal guidelines for nonfood crops has been developed. An examination of the effects of sewage sludge application on crop yields, soil nutrient status, and soil structure has yielded favorable results. It was found that soil temperature and pH affect the rate of uptake by plants of heavy metals. Elevated temperatures can increase the rate of uptake, but maintenance of pH conditions of about 6.5 can lessen uptake. It was found that leafy vegetables absorbed heavy metals at a much higher rate than grasses or grass-type crops such as corn. Use of composted sludge on turf grass is suggested.

*Sludge disposal, *Trace elements, *Fertilizers, *Crop production, *Soil chemical properties, Soil contamination effects, Diseases, Solid wastes, Soil science, Grasses, Turf grasses, Municipal wastes, Waste water treatment, Food chains, Lawns, Path of pollutants

J124
RENOVATED WASTE WATER AS A SUPPLEMENTARY SOURCE FOR MUNICIPAL WATER SUPPLY: AN ECONOMIC EVALUATION,

Clark, R. M., Gillean, J. I., and Adams, K.

Municipal Environmental Research Laboratory,
Office of Research and Development,
Environmental Protection Agency,
Cincinnati, Ohio.

1976. 113 p, 58 fig, 25 tab, 7 ref, 3 append. EPA Technical Report EPA-600/1-76-033.

Growing concern and awareness about maintaining an adequate water supply for the future has led to an investigation into the feasibility of waste water reclamation and reuse for drinking water. Three alternatives for obtaining additional water were considered: (1) expansion of the existing water supply source; (2) treatment of processed waste water by an add-on reservoir renovated treatment system, dilution in existing reservoirs, and subsequent transport to the water treatment plant; and (3) treatment of processed waste water by an additional waste water treatment plant and subsequent transport to the headworks of the existing water treatment facility, bypassing the reservoir. The San Diego and Dallas Water Utilities, in areas where water supplies are needed, were chosen for consideration. Standardized costs were developed and comparisons were made between existing facilities and the three alternatives. Costs for acquisition, treatment, distribution, and other associated costs for the current water supply system were calculated. For both utilities, acquisition produced the greatest increase in cost over the existing system. Expansion of the existing water supply source was the most economical alternative for obtaining additional water. Reuse of waste water for drinking purposes may become advantageous when additional sources of potable water are limited. Reuse for agricultural purposes could be used to conserve existing supplies of drinking water.

*Water reuse, *Water reclamation, *Cost comparisons, *Potable water, *Water management, Reclaimed water, Water supply, Dependable supply, Water quality, Waste water treatment, Water conservation, Municipal wastes

San Diego (CA), Dallas (TX)

J125
PROBLEMS RELATED TO WATER QUALITY OVER THE DANUBE SECTION BETWEEN RAJKA AND ESZTERGOM (A Rajka-Esztergom kozotti Duna-szakasz vizminosegi problemai),

Abraham, M., and Varday, N.

Eszakdunantuli Vizugyi Igazgatosag,
Gyor, Hungary.

Hidrologiai Kozlony, Vol. 52, No. 2, p 60-64, February, 1977. 6 fig, 1 ref.

The North Hungary District Water Authority has examined water quality for a section of the Danube between Rajka and Esztergom for the past 15 years. Records showed that the mineral content of the Danube water was related to the rate of streamflow alone, while the organic pollutant load was also related to temperature. A deteriorating trend in water quality as indicated by COD-streamflow measurements was attributed to increasing effluent discharges into the Danube by area industries and communities. It was found that O2 consumption was not uniform throughout the river's cross-section but was a function of depth and prevailing current. Water quality was observed to improve from Rajka downstream to Komarom, but increased effluent discharges were observed below that point.

*Water quality, *Chemical oxygen demand, *Oxygen demand, Streamflow, *Rivers Organic loading, Waste assimilative capcity, Effluents, Waste water disposal, Waste water treatment

Hungary, Danube River

J126
SELECTED APPLICATIONS OF INSTRUMENTATION AND AUTOMATION IN WASTEWATER-TREATMENT FACILITIES,

Molvar, A. E.

Raytheon Company,
Portsmouth, Rhode Island.

1976. 312 p, 91 fig, 60 tab, 67 ref, 2 append. Technical Report EPA-600/2-76-276.

Automatic controls in waste treatment facilities are considered as a means of maximizing efficiency, reducing energy and labor costs, and maintaining consistent effluent quality under variable loading. Various applications for automatic monitoring are discussed, as well as possible sources of error. Among the dry-weather processes considered for automation are: influent pumping and pretreatment control, primary sludge pumping, aeration, biodegradation, filtration, secondary sludge pumping, disinfection, anaerobic digestion, sludge conditioning, dewatering, incineration, neutralization of acids and bases, and removal of phosphorus. Controls on wet-weather treatment processes and collection systems are considered for three hypothetical catchment areas as a means of alleviating overflow pollution in combined sewer systems. A survey of 50 treatment facilities indicated that far less automatic equipment was in use than was commercially available and reliable. Cost/benefit analyses showed that automatic control of certain processes is feasible for smaller plants (1 to 5 mgd). Processes recommended for automatic control include: prechlorination, aeration, digestion, disinfection, phosphorus removal, and pH adjustment.

*Automation, *Automatic control, *Instrumentation, *Combined sewers, *Waste treatment, Activated sludge, Cost-benefit analysis, Sewage treatment, Waste water treatment

J127
INSTRUMENTATION AND AUTOMATION EXPERIENCES IN WASTEWATER-TREATMENT FACILITIES,

Molvar, A. E., Roesler, J. F., and Babcock, R. H.

Raytheon Company,
Portsmouth, Rhode Island.

1976. 371 p, 18 fig, 11 tab, 24 ref, 3 append. Technical Report EPA-600/2-76-198.

A comprehensive nationwide survey of current and potential instrumentation and automation applications in 50 waste water treatment facilities was conducted to evaluate existing and prospective water treatment practices. The survey revealed that most waste water treatment facilities employ fewer instruments and automatic control devices than similar water supply and chemical processing plants. Flow and level measuring devices comprised much of the instrumentation present in the surveyed facilities. Based on operational experiences, the following parameters were considered reliably measurable by commercially available instruments: level, flow, temperature, pressure, speed, weight, position, conductivity, rainfall, turbidity, pH, free and residual chlorine, and free flammable gases. Other sensors and measuring devices were subject to fouling and required more frequent calibration and maintenance. It was observed that although most facilities used automatic devices to control liquid level, liquid flowrate, and air flowrate, other applications of automatic control were limited. Further research into the development of more successful sensors for organic contaminants, suspended solids, storm water, phosphates, and ammonia is suggested. Research into control loops for organic load equalization, food-to-microorganism ratio, breakpoint chlorination, phosphate removal, and feed-forward DO control is recommended. Computer hardware and software requirements are outlined.

*Automation, *Automatic control, *Instrumentation, *Data processing, *Waste water treatment, Surveys, Control systems, Monitoring, Waste treatment, Storm water

Control loops, Sensors

J128
PROBLEMS IN IMPLEMENTING U. S. WATER QUALITY GOALS,

Westman, W. E.

California University,
Los Angeles,
Department of Geography.

American Scientist, Vol. 65, No. 2, p 197-203, March-April, 1977. 21 ref.

Key elements and goals of the 1972 Federal Water Pollution Control Act Amendments (FWPCA), the degree to which these goals are reflected by the National Commission on Water Quality (NCWQ), and possible future strategies for implementation are evaluated. Factors which are thought to reduce the cost-effectiveness of implementation policies are: assigning higher priority to the treatment of municipal and industrial wastes than to nonpoint sources of wastes, discouraging treatment of urban runoff, lacking optimal strategies for storm water treatment, and failing to rank pollution sources by severity. Criticisms were leveled at the current monitoring program for the lack of enforcement, lack of distinction between point and nonpoint sources of pollution, inadequate storm water and groundwater monitoring, and insufficient staff to insure accurate reporting by dischargers. Technologies available for land application as an alternate means of ultimate disposal of sewage wastes are examined. Hindrances to the reclamation and reuse of waste water are summarized as public health uncertainties, historical or legal uncertainties, and revenue requirements. Regulations for the protection of coastal waters are considered inadequate from an ecological standpoint in not considering the food chain paths of various pollutants being dumped into the ocean. Suggestions for the future include the development of more cost-effective routes toward attaining the goals set forth by the FWPCA and NCWQ.

*Planning, *Federal Water Pollution Control Act, *Legislation, *Water pollution control, *Water quality, *Water policy, Water pollution, Urban runoff, Storm water, Water pollution sources, Water pollution effects, Reclaimed water, Monitoring, Sea water, Trace elements, Metals, Fertilizer, Treatment, Costs, Water management (applied), Waste water treatment, Waste water disposal

National Commission on Water Quality

J129
STANDING COMMITTEE ON THE DISPOSAL OF SEWAGE SLUDGE,

Water Services, Vol. 81, No. 976, p 335, 338, June, 1977.

The Standing Committee on the Disposal of Sewage Sludge was set up in 1975 by the Department of the Environment and the National Water Council of the United Kingdom as part of a set of six standing technical committees. Because of the wide range of interests involved in the ultimate disposal of sewage sludge, four subcommittees were formed covering the areas of land disposal, sea disposal, air disposal (i.e. incineration), and economic aspects. The subcommittee on the disposal of sewage sludge to land initiated a survey on the means of disposal for different parts of England, Scotland, Wales, and Northern Ireland and determined that 75 percent of disposal was to land, 22 percent to sea, and 3 percent to incineration. The committee is examining the effects of land application of sludge on soil, crops, humans, and the environment through field studies. It is also conducting a literature survey on land disposal. The sea disposal subcommittee reviewed the effects of sludge disposal by ocean dumping, existing methods of monitoring, and current research into ocean disposal. The incineration subcommittee surveyed existing sludge treatment plants using incineration as a means of disposal and suggested that the constituents of ash and emissions be examined more closely. The economics subcommittee is collecting information on the economic constraints on disposal and is identifying networks of processes for treating and disposing of sewage sludge. The findings of each of the subcommittees will be evaluated with respect to all possible solutions before final recommendations are made.

*Sludge disposal, *Sludge treatment, *Incineration, *Waste disposal, Oceans, Water pollution, Land management, Fertilizers, Planning, Waste water treatment, Sewage disposal

*Standing Committee on the Disposal of Sewage Sludge (UK)

J130
DUAL WATER SYSTEMS -- DESIGN,

Haney, P. D., and Beatty, F. K.

American Water Works Association Journal, Vol. 69, No. 7, p 389-398, July, 1977.
5 fig, 14 tab, 25 ref.

Various aspects of dual water systems, separate facilities designed to provide potable and nonpotable water, are presented. An historical review of the concept of dual water systems and their role in maintaining adequate water supplies in the future are discussed. The possibility of accidental cross-connection of potable and nonpotable water is considered. Water quality standards dependent upon planned use are evaluated. Adverse effects of substandard water caused by pathogenic organisms or trace elements are discussed. Cost estimates for dual and conventional systems employing demineralization by electrodialysis, activated carbon filtration, and chlorination of groundwater are compared, including amortization, operation, and maintenance costs. It is suggested that dual systems are advantageous in areas where expensive treatment methods such as demineralization are indicated or where water resources are limited. Comparative installation costs and service are given for seven midwestern utilities. The average daily use of nonpotable water ranged from 0.37 cu m/capita per day to 0.916 cu m/capita per day. Reclaimed waste water is suggested as a source of nonpotable water, provided that other sources are available to supplement the average daily waste water flow of 0.38 cu m/capita per day.

*Water reuse, *Impaired water reuse, *Water sources, *Water treatment, *Dual system, Waste water treatment, Costs, Cost comparisons, Design criteria, Water pollution, Water quality, Demineralization

J131
WATER QUALITY MANAGEMENT QUALITY PLANNING,

Casapieri, P.

HQ Scientific Services,
Thames Water Authority,
London, England.

The Public Health Engineer, Vol. 5, No. 3, p 76-79, May, 1977. 1 tab, 5 ref, 1 append.

An historical background for water quality standards in the United Kingdom is presented as part of a general overview on river quality classification as a means of controlling effluent discharge. A new river classification system is compared with a 1969 version prepared by the Department of the Environment. The new system includes subdivisions based on quality criteria such as dissolved oxygen, ammonia, biochemical oxygen demand, potability, and toxicity to fish. Additional guidelines and potential uses are given for each subdivision. In order to maintain membership in a particular class, a given stream may not exceed class-limiting criteria more than 5% of the time. The levels of the river classification system also provide target levels for stream quality improvement.

*Water quality, *Rivers, *Water pollution control, *Classification, Water utilization, Water quality standards, Effluents, Water management (applied)

*River classification systems, Thames River (UK)

J132
REGIONALIZING WASTEWATER FACILITIES ON THE OREGON COAST,

Jackson, R. F., Hackworth, W., and Barrett, F. H., Jr.

Depoe Bay Sanitary District,
Depoe Bay, Oregon.

Public Works, Vol. 108, No. 8, p 68-71, August, 1977. 2 fig.

The coastal communities of Depoe Bay and Gleneden Beach, Oregon have investigated alternatives to ocean discharge of untreated wastes. The Gleneden Beach and Depoe Sanitary Districts adopted a master plan for sewage treatment and disposal which provided for interconnection of the two systems and a common treatment facility. The treatment facility in Depoe Bay was designed to accommodate fluctuations in loading caused by the area's tourist industry, and uses a two-part complete-mix activated sludge processing system which can be partially shut down during periods of low flow. The Gleneden District is serviced by 750,000 feet of sewer lines and nine pumping stations which direct sewage to the Depoe plant via a common interceptor system. The Depoe collection system includes 35,000 feet of sewer lines and three pumping stations. Construction costs for the regional facilities included $1.6 million for the Depoe project and $1.3 million for the Gleneden collection and interceptor systems.

*Sewerage, *Regional development, *Interceptor sewers, *Activated sludge, *Treatment facilities, Sewage treatment, Sewage disposal, Municipal wastes, Waste water treatment

Depoe Bay (OR), Gleneden Beach (OR)

J133
NEW OXYGEN METERS,

Effluent and Water Treatment Journal, Vol. 17, No. 6, p 299, June, 1977.

A series of Lovibond dissolved oxygen meters are being marketed by The Tintometer Limited of Salisbury, England. The instruments utilize a Messtronik electrode which contains a large gold cathode, a liquid electrolyte, and a pressure-compensating diaphragm for measurements at greater depths. Bench and portable models with a wide variety of optional features are available, including measurements of dissolved oxygen and temperature, automatic agitation, multi-probe measurements, and data recorders. Dissolved oxygen meters may be used in monitoring sludge digestion in sewage treatment facilities.

*Equipment, *Monitoring, *Dissolved oxygen analyzers, *Electrodes, *Dissolved oxygen, Instrumentation, Water quality, Sewage treatment, Waste water treatment

J134
INVENTORY OF SEWAGE TREATMENT PLANTS FOR CHESAPEAKE BAY,

Brush, L. M.

1974. 62 p, 29 fig, 1 tab. Technical Report PB-241 005.

A survey of sewage treatment facilities in operation on Chesapeake Bay as of 1973 is presented. Municipal treatment plant locations are illustrated for 27 tidal tributaries which empty into the Chesapeake. The Chesapeake Bay area itself has been divided into 5 major basins. Data provided for each plant include: plant, state, plant number as defined by the resident state, flow, treatment level, and basin code. A plot, illustrating sewage treatment plants handling more than 5 mgd and cumulative effluent input along major segments of the bay, is presented.

*Treatment facilities, *Sewage treatment, *Municipal wastes, *Chesapeake Bay, Bays, Estuaries, Effluents, Treatment, Flow, Waste water treatment

J135
A SURVEY OF COMMERCIALLY AVAILABLE AUTOMATIC WASTEWATER SAMPLERS,

Lauch, R. P.

Environmental Monitoring and Support Laboratory,
Office of Research and Monitoring,
U.S. Environmental Protection Agency,
Cincinnati, Ohio.

1976. 38 p, 1 tab, 16 ref. Technical Report EPA-600/4-76-051.

A survey of commercially available automatic waste water samplers is presented. Data presented in tabular form include manufacturer name and location, approximate cost, dimensions and weight, sample bottles, cooling type, materials exposed to samples, velocity in sample line, maximum lift, intake internal diameter, type of pump, controls, and power requirements. Short descriptions of available equipment are provided in an alphabetical listing of manufacturers.

*Sampling, *Water sampling, *Design data, *On-site data collections, *Automation, Electronic equipment, Instrumentation, Monitoring, Waste water treatment

Waste water samplers, Equipment manufacturers

J136
WATER QUALITY MANAGEMENT IN THE SOVIET UNION,

Loucks, D. P.

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Journal Water Pollution Control Federation, Vol. 49, No. 8, p 1767-1778, August, 1977.

Water quality management practices in the Soviet Union were examined as part of a 1972 U. S. U. S. S. R. Agreement on Cooperation in the Field of Environmental Protection. The All-Union Scientific Research Institute of Water Protection (VNIIVO) and the basic water law (Principles of Water Legislation of the U. S. S. R. and the Union Republics) govern water quality management in the Soviet Union. Water quality standards are based on three criteria: organoleptic characteristics, damage to the self-purification capacity of the water body, and toxicity to animals or plants. Stream standards and water quality monitoring programs vary with intended water use and only apply to waters where fish are raised or drinking water is drawn. A network of basin inspectorates is used to enforce municipal and industrial effluent standards. Protection of groundwater quality from pollution by industrial effluent lagoon seepage and infiltration is minimal, implemented only where direct contamination of drinking water is possible. Polluted urban runoff waters in the Soviet Union are usually treated in separate or dual treatment systems. Riparian Water Protection Zones in agricultural areas were designated to prevent erosion products from entering surface waters, prevent soil and stream bank erosion, maintain quality of water used for recreation, and prevent contamination from construction or other temporary activities. Multipurpose water quality planning was implemented in the U. S. S. R. at the All-Union level in 1965 with primary emphasis on BOD control.

*Water management (applied), *Water quality control, *Water resources development, *Regulation, *Water policy, Water quality standards, Biochemical oxygen demand, Potable water, Waste water treatment, Water pollution control

All-Union Scientific Research Institute (U.S.S.R.), U.S.S.R.

J137
REGIONAL MANAGEMENT OF URBAN AND AGRICULTURAL POLLUTION,

Lashkari, R. S., Hwang, C. L., and Fan, L. T.

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Department of Industrial Engineering.

Journal Water Pollution Control Federation, Vol. 49, No. 8, p 1877-1888, August, 1977. 6 fig, 6 tab, 13 ref.

A regional approach to water quality management in areas characterized by both agricultural and urban activities is presented for the Utah Valley, as a typical situation where such an approach may be applied. A basic description of the Utah Lake drainage area and of the water demands of its four districts is provided. A system for urban-agricultural salinity-BOD control is presented for achieving acceptable concentrations in district return flows at minimum total annual costs. Data on optimal total costs for each district in the Utah Valley model are broken down to desalting and primary, secondary, and tertiary treatment for the urban sector, and to structural and practical improvements in the agricultural sector. Optimal costs and policies were determined under the assumption that each district would be required to maintain certain levels of BOD and salt concentration in its effluents. Mathematical equations for calculation of total, operation, and maintenance costs based on BOD and salt removal requirements are derived. Total costs are compared for aggregate and independent operation of districts for agricultural and urban sectors. Costs for independent operation of districts were approximately 7.2 percent more than for aggregate operation.

*Planning, *Financial feasibility, *Water management (applied), *Mathematical models, *Regional analysis, Regional economics, Water quality standards, Biochemical oxygen demand, Desalination, Water requirements, Water reuse, Return flow, Feasibility studies, Waste water treatment

Utah Valley (UT)

J138
A COMMUNITY DEVELOPER'S ROLE IN ENVIRONMENTAL PLANNING AND MONITORING,

Alverson, K. A., and Wilcox, W. H.

Journal of Soil and Water Conservation, Vol. 32, No. 4, p 183-185, July-August, 1977.

Operations of the Environmental Quality Laboratory Incorporated, a private environmental consulting laboratory in Port Charlotte, Florida, are described. Federal and state regulations have required potential developers to submit environmental impact statements in advance of new projects and to design developments which meet environmental criteria. The Environmental Quality Laboratory was established in 1975 by the General Development Corporation to aid developers and planners in meeting these requirements. Laboratory facilities include two chemistry labs, a biology lab, a bacteriology lab, a library, and a computer room. The services provided by Environmental Quality Laboratory include compliance monitoring, environmental planning of new community developments, and redesigning of older plans for residential communities. The laboratory also conducts a monitoring program of Charlotte Harbor, Florida, which includes regular evaluations of water quality and biota. The laboratory is currently testing new methods of waste disposal and treatment for the Port Charlotte area.

*Environmental effects, *Planning, *Water quality, *Monitoring, Water quality standards, Environmental control, Waste water treatment, Waste disposal, Estuaries

Port Charlotte (FL), Environmental consulting agencies

J139
POTABLE WATER FROM WASTEWATER--DENVER'S PROGRAM,

Hadeed, S. J.

Journal Water Pollution Control Federation, Vol. 49, No. 8, p 1757-1758, August, 1977.

Although the reuse of waste water has been examined extensively for applications in irrigation, industry, recreation, and groundwater recharge, the reuse of waste water for drinking purposes has not often been considered. Plans for a pilot study in Denver, Colorado, using a 1 mgd potable quality demonstration plant are discussed. The program, which may eventually lead to a full-scale 100 mgd plant scheduled for operation in the early 1990's, will include extensive water quality monitoring and health and toxicological studies. As water supplies must be transported to Denver and demands may exceed existing supplies by 1980, the use of high-quality effluents as a source of potable water may be more cost-effective than importation. Pilot operations will include constant monitoring of effluent quality over a 5 to 15 year period during which reclaimed waste water will be used for industrial and recreational purposes. Construction costs for the pilot plant are estimated at $8.3 million, and $95 to $150 million for the full-scale facility. A public opinion survey on the reuse of waste water for drinking purposes revealed that 63% of the respondents did not object to water reuse, 25% were against the concept, and 12% were undecided.

*Water reuse, *Return flow, *Water supply development, *Cost comparisons, *Tertiary treatment, Water treatment, Water sources, Waste water treatment, Potable water, Pilot plants, Environmental effects

Denver (CO)

J140
WATER QUALITY MANAGEMENT--THE MANAGEMENT INFORMATION REQUIREMENT,

Guiver, K.

The Public Health Engineer, Vol. 5, No. 4, p 97-99, July, 1977.

Water quality management practices in the United Kingdom and methods for obtaining water quality information are discussed. Sampling programs may be instituted to provide general background information on water quality, assess environmental effects of sewage and water treatment facilities, and provide data for input to mathematical models. Specific aspects of sampling examined include location and number of sampling points, sample transport and laboratory handling, sampling frequency, sampling equipment, and the choice of parameters for analysis. Automatic sampling equipment and remote sensors are considered for use in water quality management. Coordination in sampling programs is suggested to enhance water quality data. Precautions in sampling to insure sample integrity and occupational safety are discussed. Accuracy in sample and data analyses is considered necessary to insure reliable and cost-beneficial sampling programs.

*Sampling, *Monitoring, *Water quality management (applied), *Water pollution control, *Water sampling, Hydrologic data, Water analysis, Mathematical studies, On-site data collections, On-site tests, Laboratory tests, Waste water treatment

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The Franklin Institute Research Laboratories, Science Information Services Department, prepared for the Environmental Protection Agency Volume 4 of the *Municipal Technology Bulletin*, a current-awareness abstracting bulletin covering methods of municipal waste water treatment, problems of water quality, and water pollution control. Volume 4 of the *Bulletin* contained abstracts of technologically significant literature appearing in print during 1976 and 1977. Under the same grant the Science Information Services Department, as a center of competence on municipal waste water, provided 1320 abstracts, including those appearing in the *Bulletin*, to the Water Resources Scientific Information Center (WRSIC). The *Municipal Technology Bulletin* informs researchers, consultants, engineers, and government officials of current developments described in more than 4000 English and non-English language scientific and technical publications. Topics covered in the *Bulletin* and in the abstracts submitted to WRSIC include: analytical techniques for water quality measurements; biological, chemical, and physical methods of waste water treatment, disposal, and recycling; construction and equipment for pollution control; model studies; storm runoff; tunneling technology and sewer systems; and treatment plant operation and automation. This report is a compilation of the 1320 abstracts arranged consecutively by accession number within subject categories. The report is completed by a journal list and subject and author indices.

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