LAND APPLICATION OF WASTEWATER

STATE REGULATIONS AND GUIDANCE

For the States of:

Michigan
Wisconsin
Minnesota
Illinois
Indiana

Prepared for
Environmental Research Information Center

Seminar
Land Treatment of Municipal Wastewater Effluents

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ENVIRONMENTAL RESEARCH INFORMATION CENTER
OFFICE OF RESEARCH AND DEVELOPMENT
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STATE OF MICHIGAN

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DEPARTMENT OF NATURAL RESOURCES

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SUBJECT: GROUNDWATER QUALITY RULES

TO WHOM IT MAY CONCERN:

Attached are proposed rules of the Water Resources Commission entitled PART 22. GROUND WATER QUALITY RULES, approved by the Commission at its May 18-19, 1978 meeting in Dearborn, Michigan.

It is anticipated that the proposed rules will be reviewed by the Michigan Environmental Review Board following which they will be submitted to the Legislative Services Bureau to initiate the rules making process.

Your interest and participation in the development of the proposed groundwater quality rules is sincerely appreciated.

WATER RESOURCES COMMISSION

Robert J. Courchaine

Robert J. Courchaine
Executive Secretary

DEPARTMENT OF NATURAL RESOURCES

WATER RESOURCES COMMISSION

GENERAL RULES

Filed with Secretary of State on
These rules take effect 15 days after filing with the Secretary of State

(By authority conferred on the water resources commission by sections 2 and 5 of Act No. 245 of the Public Acts of 1929, as amended, being §§323.2 and 323.5 of the Michigan Compiled Laws)

The General Rules of the water resources commission are amended by adding R 323.2201 to R 323.2211 to read as follows:

PART 22. GROUND WATER QUALITY RULES

Ground waters are waters of the state and their quality and availability are an invaluable natural resource. Ground waters in usable aquifers must be protected in their natural condition to the maximum extent possible.

R 323.2201. Purpose.

Rule 2201. (1) The purpose of the ground water quality rules is to protect the public health and welfare and maintain the quality of ground waters in all usable aquifers for individual, public, industrial and agricultural water supplies.

(2) These rules provide for the nondegradation of ground water quality in usable aquifers, define the requirements for hydrogeological study prior to permitting a discharge to ground waters, establish ground water monitoring requirements for new and existing ground water discharges and establish a procedure for obtaining variances from these rules.

R 323.2202. Definitions A to N.

Rule 2202. As used in this part:

(a) "Aquifer" means underground water-bearing earth materials through which ground water moves in sufficient quantity to serve as a source of water supply.

(b) "Aquifer system" means a single aquifer or a series of interconnected aquifers of local or regional extent.

(c) "Change in ground water quality" means a true difference in ground water quality at a site, that is considered by the commission to be real, from one point in time to another, after considering the seasonal and locational variation of quality within a site.

(d) "Commission" means the water resources commission.

(e) "Controlled application" means the proper application of the chemical for its intended purpose.

(f) "Degradation" means a deterioration of ground water quality within any portion of a usable aquifer system as identified by a change in ground water quality from local background ground water quality.

(g) "Discharge" means the addition of materials to ground waters from any facility or operation that acts as a discrete or diffuse source and which requires a permit to discharge in accordance with Act No. 245 of the Public Acts of 1929 as amended.

(h) "Diffuse source" means any facility or operation which transmits materials by seepage or percolation through the soil to the ground waters.
(i) "Discrete source" means any facility or operation which transmits materials by a discernible confined conveyance to the ground waters.
(j) "Domestic waste" means wastes generated and discharged as a result of normal household activities.
(k) "Existing ground water quality" means concentrations of the physical, biological, chemical, and radiological parameters representative of the ground water quality in usable aquifers at a site at the time of permit issuance, permit renewal, or nonpermitted discharge as determined by the hydrogeological study required by R 323.2207.
(l) "Ground water" means underground water within the zone of saturation.
(m) "Hazardous material" means those substances which singly or in combination pose an unacceptable, existing or potential risk to human health or the environment because they may be flammable, explosive, reactive, corrosive, toxic, radioactive, infectious, carcinogenic, bioconcentrative, persistent, or irritating when present in sufficient concentrations.
(n) "Hydrogeological determination" means the collection, interpretation, and presentation of hydrologic and geologic data to provide an adequate understanding of existing conditions and to determine the potential impact of a discharge from an operation or activity on the ground waters.
(o) "Industrial waste" means waste from industrial or manufacturing processes, trade, or business as distinct from domestic or sanitary waste.
(p) "Local background ground water quality" means concentrations of the physical, biological, chemical, and radiological parameters representative of the ground water quality in usable aquifers, at a site having virtually no influence from discharges as determined by the hydrogeological study required by R 323.2207.
(q) "Monitoring well" means a well specifically designed to measure the impact of a discharge on the ground waters.
(r) "Non-contact cooling water" means water used for cooling which does not come into direct contact with any raw material, intermediate product, by-product, waste product, or finished product.

R 323.2202. Definitions O to W.
Rule 2203. As used in this part:
(a) "Observation well" means a well specifically designed to determine existing hydrogeological conditions.
(b) "Parameters" means those specific characteristics describing the physical, chemical, biological, and radiological conditions of the ground water quality.
(c) "Person" means an individual, partnership, association, corporation, industry, municipality, state agency, or interstate body.
(d) "Radioactive materials" means natural or man-made materials that give off particles or rays, or both, from nuclear reactions that pose an unacceptable, existing or potential risk to human health or the environment.
(e) "Sanitary waste" means treated or untreated wastes which contain human metabolic wastes and domestic wastes.
(f) "Sludge" means concentrated residues generated or produced by industrial activities or in the treatment of industrial or sanitary wastes.
(g) "Solid waste" means refuse, garbage, rubbish, ashes, and other materials in solid form.
(h) "Toxic materials" means substances which are or may become harmful to plant life, animal life, or to food chains when present in sufficient concentrations or combinations.

(i) "Usable aquifer" means an aquifer, or that portion of an aquifer or aquifer system, which is capable of providing water in sufficient quantity of satisfactory quality, as determined from the hydrogeological study required by R 323.2207, to serve one or more protected uses. Usable aquifers do not include aquifers used for mineral, oil or gas production as regulated by Act no. 315, of the Public Acts of 1969 as amended, being §319.211 et seq., the mineral well act and Act no. 61 of the Public Acts of 1939 as amended, being §319.1 et seq., the act which regulates oil and gas in Michigan.

(j) "Well" means a properly designed and constructed hydraulic structure that permits measurement or withdrawal of ground water from an aquifer.

R 323.2204. Protected uses.

Rule 2204. All ground waters of the state, in usable aquifers, of a quality suitable for use as individual, public, industrial, or agricultural water supply shall be protected for these uses.

R 323.2205. Nondegradation of ground waters in usable aquifers.

Rule 2205. (1) The quality of ground waters in all usable aquifers shall not be degraded from local background ground water quality as the result of a discharge except as provided in R 323.2210.

(2) Discharges to ground waters may be made, provided necessary measures are taken to prevent degradation of ground waters in usable aquifers. These may include, but are not limited to one or more of the following:

(a) Proper wastewater treatment.

(b) Proper facility site selection.

(c) Controlling the zone of saturation at the site.

(d) Providing percolation and seepage barriers to prevent degradation of usable aquifers.

(e) Use of underdrainage to prevent degradation of usable aquifers.

(f) Containment of the discharge within the boundaries of the operation or activity which are defined by the hydrogeological study required by R 323.2207.

(3) No materials at concentrations which exceed maximum contaminant levels for inorganic and organic chemicals specified in "National Interim Primary Drinking Water Regulations", 40 C.F.R. §§141.11 and 141.12, promulgated pursuant to the "Safe Drinking Water Act", Public Law 93-523, as published in the FEDERAL REGISTER December 24, 1975, shall be discharged to ground waters in usable aquifers even in those cases where the local background ground water levels for these materials exceed the specified levels.

R 323.2206. Regulation of discharges.

Rule 2206. It is unlawful for any person to discharge to the ground waters any substance which is or may become injurious to the public health, safety, or welfare, or to the domestic, commercial, industrial, agricultural, recreational or other uses which are being or may be made of the ground waters. Discharges to ground waters of the state are regulated by permits issued in accordance with sections 7(1) and 8(b) of Act no. 245 of the Public Acts of 1929 as amended, being §323.7 of the compiled laws of 1970, or by approval, permit or licenses from other units of government, in accordance with established policies and rules of the commission.

R 323.2207. Determination of existing hydrogeological conditions; report.

Rule 2207. (1) A determination of existing hydrogeological conditions, or study, including existing ground water quality, shall be made in the vicinity of proposed or existing discharges.

(a) The person responsible for the discharge shall provide the hydrogeological study.

(b) At each discharge site a hydrogeological study, or equivalent, shall be required once as a minimum, in order to develop the discharge permit.

(c) For existing permitted discharges, a hydrogeological study, or equivalent, shall be required at the time of permit renewal when no approved or presently acceptable hydrogeological study is available. The continued permitting of an existing discharge shall be contingent on satisfactory hydrogeological conditions at the site, as determined by the hydrogeological study. The commission shall provide sufficient time for the hydrogeological study to be developed by the person responsible for the discharge.

(2) The purpose of a hydrogeological study is to:

(a) Establish the impact a discharge may have on ground water contained in usable aquifers.

(b) Determine through interpretation of available and collected data the acceptability of discharging at the site.

(c) Determine existing ground water quality.

(d) Determine local background ground water quality.

(e) Define engineering modifications that may make the discharge acceptable.

(f) Define a proposed ground water monitoring program.

(g) Define the usable aquifer or usable aquifers.

(h) Define the areal and vertical extent of the site earth materials that assimilate and transmit the discharge.

(3) The acceptance of a site will be determined on the basis of the hydrogeological study and consideration of proper engineering modifications.

(4) Criteria that shall be considered to determine if an aquifer is usable shall include but are not limited to the following:

(a) An aquifer presently serving a protected use is considered usable.

(b) An aquifer, as defined by the hydrogeological study, is considered usable if it can potentially serve the protected uses.

(c) An aquifer is considered usable if a well can be constructed in the aquifer meeting the requirements of Act no. 294, of the Public Acts of 1965 as amended, being §325.221 et seq., an act relating to water well drilling and Act no. 399, of the Public Acts of 1976 as amended, being §325.1001 et seq., the safe drinking water act.

(5) Hydrogeological studies shall be prepared by or under the direction of a qualified ground water or engineering geologist or registered professional engineer with assistance from experts in related fields such as land surveying, environmental science and soil science.

(6) Determination of hydrogeological conditions shall cover sufficient area to allow for a definition of the impact of the discharge on ground water in a usable aquifer or usable aquifers. The determination shall take into account the local geology and surface and ground water conditions, including water quality parameters specific to each site. The following minimum elements shall be required in determining the impact of the discharge on ground water in usable aquifers.

(a) The concentrations of the following water quality parameters shall be determined at each site:

(i) specific conductance as an indication of the dissolved solids.

(ii) determination of the concentration of the following parameters for chemical balance and indicators for comparison of water quality:

cations	anions
calcium	chloride
sodium	sulfate
magnesium	bicarbonate

(b) Additional ground water quality parameters may be required. These additional parameters shall be selected by the commission on a case by case basis and shall depend on the nature of suspected ground water contamination or on the nature of the discharge. The following categories include examples for some of the parameters that may be required in addition to those minimum parameters specified in R 323.2207 (6) (a) but are not limited to the following categories or parameters.

(i) Industrial wastewater: chemical oxygen demand, metals, organic compounds, hazardous and toxic materials.

(ii) Industrial sludge: chemical oxygen demand, metals, organic compounds, hazardous and toxic materials.

(iii) Municipal wastewater: nitrite nitrogen, nitrate nitrogen, ammonia nitrogen, total phosphorus, metals, methylene blue active substances.

(iv) Municipal sludge: nitrite nitrogen, nitrate nitrogen, ammonia nitrogen, total phosphorus, metals, methylene blue active substances.

(v) Sanitary landfills: total iron, chemical oxygen demand, nitrite nitrogen, nitrate nitrogen, ammonia nitrogen, metals, hazardous and toxic materials.

(c) A map or maps of the site and surrounding area, drawn to scale, showing distance to existing wells and properties in the surrounding area having potential for ground water supplies, existing lakes or ponds; streams, springs, and swamps; direction of surface drainage and the direction of ground water movement in the site area; locations of borings, observation wells and other well data used in the determination shall be provided. Wells used in making ground water quality determinations shall be identified.

(d) Sufficient water well records, observation wells or borings shall be required to determine composition of subsurface earth material in order to locate usable aquifers and establish the degree of connection with the discharge.

(e) Sufficient data or at least three observation wells shall be required to determine ground water flow direction and possible variations plus depth to ground water and possible variations in depth. The top of the well casings shall be referenced to a common or United States geological survey datum.

(f) Evaluation of site earth materials shall be made to determine the ability of these earth materials to assimilate by physical, chemical or biological means, the various constituents of the discharge.

(g) Evaluation of the ability of the site earth materials to percolate and transmit the volume of liquids resulting from the discharge shall be made.

(h) The nature, extent, and consequence of mounding resulting from the discharge which can be anticipated to occur above the highest naturally-occurring water table may be required.

(i) A description of the proposed engineering modifications that will ensure control of the discharge shall be provided for those discharges that could degrade water quality in usable aquifers.

(j) A determination of the horizontal and vertical flow system to properly determine the location or locations and depth or depths to be monitored, especially when mounding is superimposed on the existing system may be required.

(k) A ground water monitoring program shall be proposed, including the design, location and depth of monitoring wells and methods of sampling.

(l) Compilation and interpretation of data, maps, and charts based on site conditions to support conclusions and recommendations shall be included with the study.

(7) The commission shall decide the acceptability of the hydrogeological study or equivalent. The commission may exclude requirements of R 323.2207 on a case by case basis provided that criteria, limitations or conditions necessary to protect the usable aquifer are met.

R 323.2208. Ground water monitoring

Rule 2208. (1) Ground water monitoring shall be required for all discharges to assist in the determination of compliance under R 323.2211. Ground water monitoring shall include collection of water quality and water level data from a well or group of wells specifically designed to adequately assess the impact of any discharge on ground water. The design of the ground water monitoring system shall be based on the hydrogeological study, considering the local geology, surface water, and ground water conditions specific to each site and the type of discharge. These factors shall determine the number of locations, number of wells at each location, and depth of each well.

(2) A monitoring well or wells shall be located and completed at a depth or depths as specified in the hydrogeological study so as to intercept any discharge from the site to ground water contained in a usable aquifer.

(3) Monitoring well design and construction elements that shall be required include, but are not limited to the following criteria:

(a) The drilling method shall be specified.

(b) Monitoring wells completed in fine-textured earth materials shall require special construction, such as gravel packing around the screen.

(c) Monitoring wells shall have suitable equipment and methods for sampling ground water as specified in the hydrogeological study.

(d) Construction of monitoring wells shall be by a water well driller registered under Act 294, Public Acts of 1965, as amended, or contractor regulated by Act 315, Public Acts of 1969. Monitoring well construction shall be as specified in the approved hydrogeological study.

(e) Casings shall be installed so as to prevent vertical leakage of fluids between the casing and the drill hole and shall be capped and provided with a cap locking device. Use of a vented cap is desirable but care shall be taken to prevent introduction of contaminants through such vents.

(f) The well casing shall be protected against accidental damage and adequately marked so as to be clearly visible during winter and summer conditions.

(g) Each well shall be labeled and identified by owner, owner's address, well number, use of well, and warning.

(h) When a monitoring well is to be permanently abandoned, approved plugging procedures shall be followed as provided by Act 294, Public Acts of 1965, as amended, or Act 315, Public Acts of 1969.

(4) The person responsible for a discharge shall provide for the design, installation, and operation of the ground water monitoring system.

(5) The commission shall decide the acceptability of the ground water monitoring system. The commission may exclude requirements of R 323.2208 on a case by case basis provided that criteria, limitations or conditions necessary to protect the usable aquifer are met.

R 323.2209. Activities excluded from hydrogeological report, ground water monitoring requirements and discharge permits.

Rule 2209. (1) The following activities will not require a permit from the commission or hydrogeological report and ground water monitoring, except as may be required by the commission on a case by case basis, where such activities are or may become injurious to the protected uses of a usable aquifer.

(a) Disposal of sanitary wastes in volumes of less than 10,000 gallons per day via use of septic tank and ground disposal systems approved by local county and district health departments certified by the commission.

(b) Controlled application of dust suppressant chemicals used with normally accepted or regulated practices.

(c) Controlled application of de-icing chemicals used with normally accepted or regulated practices.

(d) Controlled chemical applications for natural resource and right-of-way programs used with normally accepted or regulated practices.

(e) Controlled application of chemicals for domestic purposes used with normally accepted or regulated practices.

(f) Controlled application of chemicals for agricultural and silvicultural use by normally accepted or regulated practices.

(g) Disposal of non-contact cooling water, not treated by the addition of chemicals, in volumes defined at the discretion of the commission.

(h) Retention of stormwater runoff in surface impoundments or surface waterways.

(2) Other activities may be excluded as determined by the commission on a case by case basis provided that such criteria, limitations or conditions the commission deems necessary are met.

R 323.2210. Variances.

Rule 2210. (1) Variances from the requirements of R 323.2205 may be granted by the commission.

(2) A variance may be granted which allows reasonable degradation of ground water in a usable aquifer, provided it can be affirmatively demonstrated to the commission that such degradation does not preclude use of the aquifer for its protected uses and will not become injurious to the public health, safety, or welfare. Permits issued in accordance with section 7(1) and section 8(b), Act 245, Public Acts of 1929, as amended, will constitute such variances.

(a) A variance shall not be granted under R 323.2210(2) for discharges containing hazardous materials in amounts or concentrations which singly or in combination pose an unacceptable, existing, or potential risk to human health or the environment.

(3) A variance may be granted which allows degradation of ground water in a usable aquifer to the extent that it precludes the use of the aquifer for its protected uses. Such variances may be granted by the commission for exceptional circumstances where it is determined by the commission that strict conformity with R 323.2205 is not economically or technically feasible and no prudent alternative exists and that such variance is consistent with the promotion of the public health, safety, and welfare in light of the state's paramount concern for the protection of its natural resources.

(a) In granting variances under R 323.2210(3) the commission shall prescribe such criteria, limitations, or conditions as the commission deems necessary to protect the public health of present or future ground water users affected by the variance. Such conditions shall include prevention of degradation of ground water in other usable aquifers, prescribing of treatment techniques, or the provision of an alternate approved water supply.

(b) All variances granted by the commission under R 323.2210(3) shall require a discharger or proposed discharger to the waters of the state to affirmatively demonstrate the need for a variance in terms of the criteria specified in R 323.2210(3).

(c) Prior to granting a variance under R 323.2210(3) the commission shall provide for adequate public notice and opportunity for public hearing.

(4) Variances granted under R 323.2210 to dischargers required to be permitted by the commission in accordance with the requirements of Act 245, Public Acts of 1929 as amended, shall be reviewed by the commission at the time of permit reissuance.

R 323.2211. Determination of compliance.

Rule 2211. (1) The commission shall determine compliance with these rules on the basis of all reports and information available.

(2) In making tests or analyses of water or waste to determine compliance with the rules, samples shall be collected in such manner that location, number and frequency are considered satisfactory by the commission. The samples shall be preserved and analyzed according to procedures outlined in 40 C.F.R. §136.1 et seq., promulgated pursuant to section 304(g) of the federal water pollution control act, as amended, Public Law 92-500, or 40 C.F.R. §141.1 et seq., promulgated pursuant to section 1401(1) of the Safe Drinking Water Act, Public Law 93-523; or other methods prescribed or approved by the Commission. Copies of 40 C.F.R. §136.1 et seq. and 40 C.F.R. §141.1 et seq. are available from the Department of Natural Resources, P.O. Box 30028, Lansing, Mi., 48909, and from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, at a cost of $2.25.

Municipal Wastewater Sludge Management

This document is intended to review the regulatory strategy of the Michigan Department of Natural Resources with respect to sludge management. The primary emphasis of this document will center upon agricultural application of sludge; however, the regulations and permit conditions discussed below will also apply to wastewater treatment plants which landfill or incinerate sludge. The regulations and permit conditions recognize the increasing emphasis at both the State and Federal level for beneficial use of the soil conditioning and nutrient value of sludge. At the same time, they recognize the responsibility of a wastewater treatment plant to utilize or dispose of sludge in a manner which will endanger neither public health nor the air, land or water resources of the State.

The Federal Water Pollution Control Act (FWPCA) of 1972 established. as a goal, the elimination of pollutants from discharges into navigable waters. Under Section 402 of this legislation, a national system of discharge permits was created, and authority to issue and enforce these permits was delegated to State environmental agencies. Separate permits for sludge disposal were authorized under Section 405 of the FWPCA, although these were never issued at any governmental level. 1977 amendments to this section placed the permitting for sludge disposal under Section 402, the National Pollutant Discharge Elimination System (NPDES). The Environmental Protection Agency will be issuing regulations regarding sludge disposal early in 1979. In any case, NPDES permits written in Michigan have specified under Section II.B.8, that substances removed during wastewater treatment not be allowed to pollute navigable or groundwaters. In addition, all permits issued since mid-1977 have included under Section I.A or Section I.C.1 a requirement for submission of a "Program for Effective Residuals Management". The latter places the NPDES permit as a key element in the strategy of the DNR to regulate sludge disposal. Ninety of the NPDES permits for municipal wastewater treatment plants are scheduled for reissuance prior to January 1, 1979, including most of the major dischargers.

The substances removed during wastewater treatment are the responsibility of the wastewater treatment plant until adequately handled. We believe the authority of the law does not allow a wastewater treatment plant to subcontract the responsibility for effective sludge management to another party. In any case, NPDES permits now clearly define the responsibility of the wastewater treatment plant for effective management of sludge and define the responsibility of MDNR for oversight of these activities.

A plan for sludge management, as required in the NPDES permits should consider the quantity and quality of the material produced. This plan should document the capability of the treatment plant to utilize or dispose of sludge as it is produced, the capability to store sludge which is seasonally in excess of quantities disposed, and the capability to utilize or dispose of sludge through a secondary method or site.

The plan should include a hydrogeological survey of the ultimate disposal site which documents protection of usable aquifers. A hydrogeological survey would be required for all disposal sites with the exception of landfills which have had previous documentation of adequate aquifer protection. In addition, agricultural disposal sites would require a less detailed groundwater study. However, the exception from a requirement for a hydrogeological survey must be documented in a sludge disposal plan which demonstrates that the application is consistent with best agricultural practice. MDNR staff have developed an example "Sludge Management Plan for Agricultural and Silvicultural Production" which may be used to demonstrate the agricultural nature of the project. Criteria defining agricultural practice will be discussed below. These plans will allow MDNR, Michigan Department of Agriculture and Michigan Department of Public Health, as well as local health departments, to comment on the proposed site, crops and application rates, and to cooperate in the monitoring of these sites.

Another part of Section I.C of NPDES permits will require periodic sampling and analysis of sludge. The frequency of this monitoring will be determined in each individual case based upon sludge quality, upon... the industrial input to the treatment plant, and upon the method of utilization or ultimate disposal. Monthly operating report sheets for sludge disposal and analysis were finalized in October, 1978. These will be required for all disposal practices.

Finally, all vehicles utilized for transport of sludge will be licensed and bonded under the Solid Waste Disposal Act. This is consistent with the Federal Resource Conservation and Recovery Act (RCRA) of 1976 which defined wastewater treatment plant sludge as a solid waste and with legislation pending in the legislature of the State of Michigan.

In addition to NPDES permit requirements for sludge disposal, MDNR is developing criteria which will define irrigation water quality in terms of acceptability for high management agricultural practice. Sludge has been defined as an irrigation water within these criteria. Sludge management plans which are submitted to MDNR proposing agricultural application are being and will be evaluated within the context of these criteria. The criteria are consistent with the philosophy of the Ground Water Rules adopted by Water Resources Commission in May, 1978. As presently proposed the criteria utilized three separate tables to define concentration ranges for components of sludge, to define annual additions of these components to a field, and to define total accumulations of potential toxicants within a soil. Each of the three tables define four categories of practices ranging from supplemental irrigation through primarily disposal rates. In these tables, non-restricted use represents a quality or rate which is acceptable for continuous use on all crops and sites; slightly limited use represents a quality or rate which may affect certain crops grown on certain soils; severely limited use represents a quality or rate which will affect many or most crops grown on all but the most appropriate soils; restricted use represents a quality or rate which is disposal orientated. The ranges presented within each table are conservative estimates of the water quality required under management practices of varying intensities. That is, there is a significant safety margin in the ranges.

Applications of sludge which fall in the fourth category in any of the tables will only be acceptable with crop, soil or groundwater monitoring, or a combination of the three. In addition, site selection and investigation prior to application of sludge will be very important in these disposal practices. Crop, soil or groundwater monitoring may also be necessary under the third category, but only if high management practices are not expected; that is, the most appropriate crop and soil combinations should not require groundwater monitoring.

MDNR does not expect groundwater contamination due to potential toxicants or potential pathogens to be attributable to agricultural application of sludge. Even in situations in which sludge and soil are thoroughly mixed, research data indicate that very little water moves through the sludge particles; most of the water moves around the sludge, through and between soil particles. This means that neither potential toxicants nor potential pathogens should flush directly through a soil. Instead, they will diffuse slowly in the soil solution surrounding the sludge particle, and natural filtration of larger particles and adsorption of smaller particles, especially metallic ions and viruses, should occur. With the inorganic ions, research data indicate that the metals become available for plant uptake before they become sufficiently soluble to leach into the groundwater. Some substances, mostly nonmetallic ions such as selenium, are quite mobile in soils and may leach into groundwater as easily as they may be assimilated by plants. Fortunately, these substances are present in most sludges in low concentrations; however, MDNR will require periodic analyses for these materials. As with inorganic ions, most organic compounds found in sludge are quite insoluble in water and are strongly bound on soil particles. Soluble organics, as well as soluble inorganics, stay in a liquid during wastewater treatment, and are not expected in sludge in significant concentrations. Bacteria and viruses do not appear to leach into groundwater from most soils to which sludge has been applied. The research data indicate that this is due to a combination of very close association of bacteria and especially viruses with sludge particles, and of very little movement of water through the sludge particles. In any case, there is little danger of movement of these potentially toxic or potentially pathogenic compounds under low rates, or agricultural application of sludge.

Finally, MDNR has periodically distributed training papers and informal guidelines concerning general requirements for sludge disposal on agricultural land. The most recent of these was finalized in May, 1978. These guidelines will be formalized early in 1979 as a part of the regulatory package concerning agricultural disposal of sludge. The items which have been and will be considered include: soil conditions, such as slope and natural drainage; isolation, such as from residences, wells and natural watercourses; methods of application; methods of stabilization; and proposed cropping regimes.

RTS/clp:12-78

Municipal Wastewater Sludge Applciation to Land
General Recommendations

The following are MDNR guidelines for land application of municipal wastewater sludge. These guidelines are recommended for agronomic application rates on the basis of: potential disease vectors; potential nuisance conditions; and wholesome food production. Exceptions will be considered where a high degree of monitoring and/or supervision will be provided, or where exceptional isolation is provided.

Forage and pasture crops should not be consumed by animals while the crops are phsycially contaminated by sludge. Grazing animals should not be permitted on pastures before thorough removal of the sludge, by rain or some similar action. Dairy cattle should not be allowed to graze on pastures for two months following sludge applciation. Where there is risk of direct ingestion of sludge by grazing animals, the lead content of the sludge should not exceed 1,000 mg/kg of dry sludge, the cadmium content should not exceed 20 mg/kg of dry sludge, and the PCB content should not exceed 10 mg/kg of dry sludge.

In general, stabilized sludge should be utilized for applciation to agricultural land. Stabilization may be accomplished through aerobic or anaerobic digestion, irradiation, composting, heat treatment, chemical treatment or other appropriate means. It should be recognized that any nuisance condition or demonstrated environmental injury due to sludge application must be corrected immediately. With this in mind, the following tables correlate acceptable application methods and stabilization techniques with environmental factors, isolation distances and cropping rotations.

RTS:clp:1/79

TABLE 1: GEOLOGY, ISOLATION AND STABILIZATION

REQUIRED FOR SURFACE OR SUBSURFACE APPLICATION

	Application	
Factor	Surface	Subsurface
Slope	0-6%	0-12%
Depth to high water table	>3 feet	>3 feet
Isolation -- wells	200 feet	100 feet
-- residences	500 feet	100 feet
-- surface waters	200 feet	50 feet
-- roads	200 feet	25 feet
Stabilization		
-- unstabilized	U	M
-- aerobic digestion	A	A
-- anaerobic digestion	M	A
-- liming to pH 12	A	A
-- dry heating	M	A
-- wet air oxidation	M	A
-- composting	A	A

U - Unacceptable

M - Marginally acceptable

A - Acceptable

TABLE 2: STABILIZATION TECHNIQUES REQUIRED

FOR PRESENT OR FUTURE CROPS

Crop	Stabilization			
	None	Digestion	1. Liming 2. Dry Heating	1. Composting 2. Wet Oxidati
Present -- unprocessed fruit and vegetables	U	U	U	U
-- processed fruit and vegetables	U	M	A	A
-- grain	M	A	A	A
-- hay, haylage	U	A	A	A
-- pasture	U	M	A	A
-- non food	A	A	A	A
Future -- unprocessed fruit and vegetables	3 yrs	3 yrs	1-3 yrs	1 yr
-- processed fruit and vegetables	3 yrs	1 yr	A	A
-- grain	1 yr*	A	A	A
-- hay, haylage	1 yr	A	A	A
-- pasture	1 yr	1 yr	A	A
-- non food	A	A	A	A

U - Unacceptable

M - Marginally acceptable

A - Acceptable for present crop; no isolation period required

* less when crop will be used only for direct animal consumption

Municipal Wastewater Sludge Application to Land

Agricultural Application Rates

Annual applications of sludge from communities with primarily domestic input will normally be limited by the nitrogen required to produce the crop. We normally assume that all of the inorganic nitrogen, that is ammonia nitrogen and nitrate nitrogen, will be available to plants in the year in which the sludge is applied. In addition, a fraction of the nitrogen present in organic forms will be broken down, or mineralized to inorganic nitrogen during the first year. Smaller fractions of the organic nitrogen will be mineralized for several years following sludge application, and this is termed "residual" nitrogen. Equations which may be used to calculate the available nitrogen (AVAN) per ton of sludge are given on the back of this page. Residual nitrogen may be calculated from the table on the back of this page, and subtracted from the nitrogen required by the crop. Many municipal sludges will supply more phosphorus than crops require when sludge is applied at rates which supply adequate available nitrogen. This may be useful in increasing the fertility of the soil over a period of years. Soils have a limited capacity to adsorb phosphorus before they begin to lose this nutrient to groundwater. Now this capacity is normally large, however, at some future time it may be necessary to limit annual sludge applications to the amount which will supply the phosphorus for plant growth. Annual soil testing will indicate when phosphorus applications are limiting.

Sludges from certain communities with significant industrial input may contain high concentrations of cadmium. Many members of the scientific community have expressed concern over accumulations of cadmium in the food chain. Therefore, 2 pounds of cadmium per acre has been recommended as an annual application limit. Proposed Federal regulations would lower this to 1.25 pounds per acre in 1982, and 0.5 pounds per acre in 1986. If these annual application limits are exceeded, or if the soil pH is below 6.5, crop monitoring for cadmium will be essential.

Several methods have been proposed for determining the total sludge application based upon accumulation of certain metals in the soil. Consultation between the faculty of the Department of Crop and Soil Science, Michigan State University and MDNR has resulted in a modification of the methods suggested by the North Central Region Agricultural Experiment Stations. This system gives credit to the ability of soils to adsorb or tie-up metals based upon a chemical characteristic of the soil, the cation exchange capacity (CEC). The CEC of the soil may be multiplied by a coefficient, or "factor", to determine the total metal accumulation in the soil which should not create the problems of crop or animal toxicity. Equations which may be used to calculate these limits are on the back of this sheet. Applications of sludge should cease when accumulation of any of the metals has reached the recommended limit.

RTS:5/78

Each sludge disposal site should be reported separately. A change of crop or soils, as well as a change of landfill, constitutes a change of sludge management, and should be reported separately.

Table 4—Release of plant-available N during sludge decomposition in soil (13).

Years after sludge application	Organic N content of sludge, %						
	2.0	2.5	3.0	3.5	4.0	4.5	5.0
	lb residual N released per ton sludge added						
1	1.0	1.2	1.4	1.7	1.9	2.2	2.4
2	0.9	1.2	1.4	1.6	1.8	2.1	2.3
3	0.9	1.1	1.3	1.5	1.7	2.0	2.2

Soil Loading Rates

Nitrogen

Ni = NH_4^+-N __ __.__% + NO_3^--N __.__% = __ __. __%

No = T N __ __. __% - Ni __. __ __% = __ __. __%

Available Nitrogen (AVAN)

Ni __ __. __% x 20 = __ __. __lb/ton
No __ __. __% x 4 = __ __. __lb/ton
+

AVAN = __ __. __lb/ton
AVAN = __ __. __lb/ton x __ __. __ton/ac = __ __ __lb/ac

Report this value at the bottom of the sheet for monthly totals of AVAN.

Phosphorus and Potassium

__ __. __% (TP or K) x __ __. __tons/ac x 20 = __ __ __lb/ac

Metals

____mg/kg metal x __ __. __tons/ac x 0.002 = ____lb/ac

Crop and Soil Data - Transfer this information from soil test results. Include present ground cover as well as the projected crop, cation exchange capacity (CEC) and nutrient recommendations. Calculate and record the metal loading limits based on the following "factors" and CEC:

Metal	Factor
Pb	100
Zn	50
Cu	25
Ni	10*
Cd	1

*25 where pH control of 6.5 is assured.

CEC __ __. __meq/100g x __ __(factor) = __ __ __lb/ac

Municipal Wastewater Sludge Application to Land
Annual Monitoring

All municipal sludges contain elements which are potentially toxic or infective to plants and animals. Under a carefully designed and monitored program of application, many of the concerns regarding crop growth and quality, and public health can be minimized, if not eliminated. Land disposal of wastewater can be divided into three somewhat overlapping categories. Agricultural reuse programs are designed essentially to limit the application of potentially toxic materials to quantities which should not contaminate the crops or groundwater. Alternatively, reclamation of poor or damaged lands or high rate disposal on dedicated sites are recognized as potentially acceptable options within the context of protection of the environment and public health. Finally, give-away programs which involve public disposal may be viable in certain communities. In the latter case, care should be taken to inform the public of the hazards and benefits involved in sludge reuse.

Agricultural applications of sludge

Annual applciations of sludge on agricultural land should be limited by nitrogen requirements of the projected crops or by cadmium additions to the soil. Criteria for both of these factors have been discussed elsewhere. As currently defined, agricultural reuse of sludge will not require groundwater monitoring under most circumstances. It is assumed that applications of sludge which are consistent with nitrogen requirements of the crops will not significantly impact the groundwaters. In addition, metal loading rates consistent with those published by U.S. EPA and Regional Agricultural Experiment Stations should not result in accumulations of potentially toxic metals in the groundwater or crops.

Monitoring programs for these systems are essentially soil and sludge monitoring. Sludge should be analyzed on a monthly, quarterly, or semi-annual schedule and soils should be analyzed annually, and reported to MDNR.

Nonagricultural sludge disposal

Application of sludge to land which will result in higher rates of nitrogen application or metal accumulation than outlined for agricultural use, may result in enviornmental contamination, including degradation of groundwater or crop quality, and increased public health concerns. Such programs should be developed with more stringent monitoring considerations, and would normally occur on publicly owned land. The site selected for this disposal could be dedicated to disposal, or terrain requiring rennovation, such as former landfill areas. In addition, more stringent site selection criteria would be required, including an extensive hydrogeological survey. This study should delineate application restrictions essential for protection of the ground and surface waters. It should also indicate continuous impermeable barriers which will protect the groundwater resources of the State. As a minimum, the monitoring program should include soil and groundwater testing as well as frequent sludge monitoring. If crops are grown, these should also be analyzed for the materials of concern.

clp /RTS

LAND SLUDGE APPLICATION

This is a suggested outline for developing a land sludge application project. These are recommended considerations.

Planning

Develop a general idea for management. You need a stabilized sludge. Use Environmental Protection Agency, Ten State Standards Guidelines, and DNR handouts.

Contact the following people:

- Wastewater Treatment Plant Superintendent
- Local Government Officials
- Property Owner
- DNR Basin Engineer
- County Extension Agent
- County Health Department Sanitarian
- Consulting Engineer

Have a general information meeting with the above people to discuss the broad guidelines. Property owner should be progressive, but conscientious.

Analyze the sludge for:

- Nitrogen
- Phosphorus
- Potassium
- Volatile Solids & % V.S. Reduction
- % Total Solids
- Heavy Metals
- Other Tests if Required
- pH

Analyze the soil for:

- Phosphorus
- Potassium
- Organic Material Content
- Cation Exchange Capacity
- pH

Estimate the acceptable loading rates based on nutrient uptake for the specific crops the farmer plans to grow. Obtain a specific recommendation on crop nutrient requirements from the County Extension Agent.

Prepare a specific site plan for each field. Walk over the fields. Include:

a) Maps or aerial photos.
b) Groundwater table depth information.
c) Proposed surface and groundwater monitoring locations.
d) Application record logs to be used.
e) Planned application rates and crop rotation schedule.

(OVER)

Follow Ten State Standards and EPA Guidelines for loading rates, isolation distances, monitoring, etc.

Develop the program on paper for public response and approval by Basin Engineer. Include monitoring.

Enter an agreement between property owner and wastewater treatment plant owner.

Get monitoring wells installed, if required.

Analyze groundwater and field tile drainage for background quality. Follow the groundwater monitoring guidelines.

Acquire hauling and application equipment. Either contract out or use municipal equipment or combination.

Get a performance - safety bond on the hauling equipment.

Be sure operators, haulers, and farmer are immunized for tetanus, diptheria, polio and typhoid.

Hauling and Application

Will it be liquid, filter cake, or dried sludge.

Haul by a route away from residential areas. Start applying in center of field, not near the road.

Fill out application report log for quantity, quality, location and time data.

Apply in approved manner. Correct any problems that develop on first trial.

Have another general information meeting at the site after first application.

After Application

Continue sludge analysis on approved schedule.

Monitor groundwater quality. Follow the approved schedule.

Analyze soils for nutrients, CEC, and pH at frequency recommended by the County Extension Agent. Plan additional applications.

Analyze crops tissues for toxins or pathogens, if recommended.

Correct any nuisance problems.

Confirm farmer's crop rotation schedule for next year.

Keep municipality involved.

Chapter NR 211

PRETREATMENT STANDARDS FOR DISCHARGES TO PUBLICLY OWNED TREATMENT WORKS

Note: Pursuant to chapter 147 Wis. Stats. and under the procedure of section 227.027 Wis. Stats., the department of natural resources has promulgated interim effluent limitations which were effective February 28, 1975 and will remain in effect for one year. These interim effluent limitations will be periodically replaced by permanent effluent limitations.

NR 211.01 Purpose. The purpose of this chapter is to establish pretreatment standards for the discharge of pollutants to publicly owned treatment works pursuant to section 147.07 (2) and 147.04 (5), Wis. Stats.

History: Cr. eff. 2-28-75.

NR 211.02 Applicability. The provisions of this chapter are applicable to all non-domestic users of publicly owned treatment works.

History: Cr. eff. 2-28-75.

NR 211.03 Definitions. The following special definitions are applicable to terms used in this chapter. Definitions of other terms are set forth in Wis. Adm. Code chapter 205.

(1) "Compatible pollutant" means biochemical oxygen demand, suspended solids, pH, or fecal coliform bacteria, plus additional pollutants identified in the WPDES permit for the publicly owned treatment works receiving the pollutants if such works was designed to treat such additional pollutants, and in fact does remove such pollutants to a substantial degree.

NOTE: Examples of such additional pollutants may include chemical oxygen demand, total organic carbon, phosphorus and phosphorus compounds, nitrogen and nitrogen compounds, fats, oils and grease of animal or vegetable origin.

(2) "Incompatible pollutant" means any pollutant which is not a compatible pollutant.

(3) "Municipality" means any municipality or other agency operating a publicly owned treatment works.

(4) "Major contributing industry" means an industrial or commercial facility that is a user of a publicly owned treatment works and:

(a) Has a waste discharge flow of 50,000 gallons or more per average work day;

(b) Has a waste discharge flow greater than 5% of the flow carried by the municipal system receiving the waste;

(c) Has in its waste, a toxic pollutant in toxic amounts as defined in Wis. Adm. Code chapter NR 215; or

(d) Has a waste which the department determines has, or in the case of a new source will have, a significant impact, either singly or in combination with other wastes, on the publicly owned treatment works or on the quality of effluent from such works.

(5) "Pretreatment" means the treatment of wastewaters to remove or reduce the quantity of one or more pollutants prior to discharge to a publicly owned treatment works.

History: Cr eff. 2-28-75

NR 211.04 Compliance with limitations and standards. (1) Discharge of pollutants to a publicly owned treatment works from facilities subject to the provisions of this chapter shall comply with the prohibitions of section NR 211.10.

(2) In addition to the requirements of subsection (1) above the discharge of pollutants to a publicly owned treatment works from an existing major contributing industry shall not later than July 1, 1977 comply with pretreatment standards for incompatible pollutants for existing sources established in accordance with section NR 211.30.

(3) In addition to the requirements of subsection (1) above the discharge of pollutants to a publicly owned treatment works from a new source which will be a major contributing industry shall comply with pretreatment standards for incompatible pollutants for new sources established in accordance with section NR 211.30.

(4) Each owner or operator of an existing source which is required to provide pretreatment facilities shall commence construction of such facilities as soon as practicable but no later than 18 months after pretreatment standards for incompatible pollutants are established in accordance with section NR 211.30 for the appropriate point source category.

(5) Each owner or operator of a facility which is required to provide pretreatment facilities for incompatible pollutants shall prior to commencing construction of any such facilities submit a report to the department and to the municipality operating the publicly owned treatment works. This report shall be submitted on a form supplied by the department, shall describe the proposed pretreatment facilities and methods for disposing of removed pollutants, and shall set forth the pretreatment standards to be achieved and a schedule of compliance for achieving them. He shall thereafter submit such additional information relating to compliance and progress as the department or municipality may request.

(6) Each owner or operator of a facility which is required to provide pretreatment for incompatible pollutants shall, at the frequency the department finds necessary to assure compliance with applicable pretreatment standards,

(a) Monitor the pretreated discharge to determine quantities of incompatible pollutants discharged to the publicly owned treatment works, and

(b) At the end of each calendar quarter, report the results of such monitoring to the department and the municipality.

(7) Notwithstanding any other provisions of this chapter the department or the municipality may require that more restrictive standards be met, for either compatible or incompatible pollutants, if such standards are necessary to avoid interference with the operation of the publicly owned treatment works or to achieve water quality standards.

History: Cr. eff. 2-28-75.

NR 211.10 Prohibited wastes. No waste introduced into a publicly owned treatment works shall interfere with the operation or performance of the works. Specifically, the following wastes shall not be introduced into the publicly owned treatment works:

(1) Wastes which create a fire or explosion hazard in the publicly owned treatment works.

(2) Wastes which will cause corrosive structural damage to treatment works, but in no case wastes with a pH lower than 5.0, unless the works is designed to accommodate such wastes.

(3) Solid or viscous wastes in amounts which would cause obstruction to the flow in sewers, or other interference with the proper operation of the publicly owned treatment works.

(4) Wastes at a flow rate and/or pollutant discharge rate which is excessive over relatively short time periods so that there is a treatment process upset and subsequent loss of treatment efficiency.

(5) New wastes or increased volumes or quantities of wastes from major contributing industries in such volumes or quantities as to overload the treatment works or cause a loss of treatment efficiency.

History: Cr. eff. 2-28-75.

NR 211.20 Pretreatment for compatible pollutants. Pretreatment of discharges to a publicly owned treatment works for removal or reduction of compatible pollutants is not required except in accordance with sections NR 211.04 (7) and NR 211.10.

History: Cr. eff. 2-28-75.

NR 211.30 Pretreatment for incompatible pollutants. (1) Pretreatment for removal or reduction of incompatible pollutants is required for discharges from a major contributing industry to a publicly owned treatment works. Except in accordance with sections NR 211.04 (7) and NR 211.30 (2), such pretreatment shall achieve the pretreatment standards for existing sources or for new sources set forth for the applicable point source category or subcategory in Wis. Adm. Code chapters NR 221 through NR 299.

(2) If a publicly owned treatment works is committed in its WPDES permit to the removal of a specified percentage of any incompatible pollutant, the pretreatment standard applicable to users of such works shall, except in the case of standards specifying no discharge, be correspondingly reduced in stringency for that pollutant.

History: Cr. eff. 2-28-75.

Chapter NR 214

LAND DISPOSAL OF LIQUID WASTES

NR 214.01 Purpose. The purpose of this chapter is to establish effluent limitations and monitoring requirements applicable in permits for discharges of liquid wastes to land disposal systems. Section 147.02, Wis. Stats., requires a permit for the lawful discharge of any pollutant into the waters of the state, which include ground waters by the definition set forth in section 147.015(13), Wis. Stats. Therefore permits are required for discharges from point sources to land areas where pollutants may percolate, seep, or be leached to ground waters.

History: Cr. Register, June, 1976, No. 246, eff. 7-1-76.

NR 214.02 Applicability. (1) The discharge limitations, monitoring requirements, and other provisions of this chapter are applicable to discharges to land disposal systems of liquid wastes consisting of or resulting from:

(a) Municipal waste and domestic waste,

(b) Canned, frozen, and preserved fruit and vegetable processing,

(c) Dairy products processing,

(d) Meat and poultry products processing, and

(e) The sand, gravel, stone, and concrete products industries.

(2) The discharge limitations, monitoring requirements, and additional limitations of this chapter are applicable to discharges to a land disposal system of liquid wastes from sources other than those identified in subsection (1) and shall be applied by the department on a case by case basis in accordance with section NR 214.08.

(3) The provisions of this chapter are not applicable to discharges:

(a) From domestic sewage systems defined as plumbing in section 145.01(1)(b), Wis. Stats.,

(b) Of sludge from sewage treatment works,

(c) Of wet or semiliquid wastes at a disposal site licensed pursuant to Wis. Adm. Code chapter NR 151.

(d) Of domestic waste handled and disposed of in accordance with Wis. Adm. Code chapter NR 113.

(4) The department may on a case by case basis exempt from the requirements on this chapter the hauling and disposal of industrial wastes handled in accordance with the provisions of Wis. Adm. Code chapter NR 113 except:

(a) In cases where industrial waste is hauled from one industrial source to one disposal site; or

(b) In cases where the industrial waste from any one source exceeds a volume of 10,000 gallons on any one day.

History: Cr. Register, June, 1976, No. 246, eff. 7-1-76.

NR 214.03 Definitions. The following definitions are applicable to terms used in this chapter. Definitions of other terms and the meanings of abbreviations are set forth in Wis. Adm. Code chapter NR 205.

(1) "Land disposal system" means a facility for disposing of liquid wastes consisting of:

(a) An absorption of seepage pond system,

(b) A ridge and furrow system,

(c) A spray irrigation system,

(d) A spray runoff system,

(e) A subsurface field absorption system, or

(f) A surface spreading system,

(g) Any other land area receiving liquid waste discharges.

(2) "Liquid waste" means the discharge in waste water of municipal waste, of domestic waste, or of processing wastes from food processing, manufacturing, and other industrial sources. Liquid manure, by product whey, and other agricultural wastes used as fertilizer by field spreading and non-contact cooling water which does not contain chemical additives are not included in this definition and are not subject to the provisions of this chapter.

(3) "Ground water monitoring" means either, as specified in the permit for a particular discharge:

(a) Measuring the ground water level in and analyzing samples taken from one or more test wells, or

(b) Analyzing samples of water in samples of soil taken at specified locations.

(4) "Hydraulic capacity" means the maximum hydraulic loading rate possible without system overload. Such rate shall be determined on the basis of any overload conditions observed in the last four years or in the absence of such conditions on the design capacity.

(5) "Hydraulic loading rate" means the average daily discharge to a land disposal system during a calendar month or other period specified in a permit for the discharge. The average is calculated by dividing the total discharge volume for such month or period by the number of days in such month or period.

(6) "Perimeter" means the boundary of a parcel of land, not intersected by any surface waters of the state, under one ownership or control on which a land disposal system is located.

(7) "Spray runoff system" means a spray irrigation system having a planned discharge to surface waters of some portion of the sprayed liquid waste.

(8) "Subsurface field absorption system" means a system of buried tile or perforated pipe for distributing liquid wastes below the soil surface.

(9) "Surface spreading system" means a system for continually distributing liquid wastes over a designated land area, as from a truck or wagon.

(10) "Ground water" means the portion of subsurface water which is within the zone of saturation.

History: Cr Register, June, 1976, No. 246, eff. 7-1-76.

NR 214.04 Compliance with discharge limitations and monitoring requirements.

(1) Discharges to a land disposal system of liquid wastes identified in section NR 214.02 (1) from sources subject to the provisions of this chapter shall comply with discharge limitations and monitoring requirements:

(a) In table 2 of this chapter for existing sources by July 1, 1977;

(b) In table 3 of this chapter for existing sources by July 1, 1983; or

(c) In table 4 of this chapter for new sources, and

(d) Any additional limitations established pursuant to sections NR 214.08 (1) and (3).

(2) Discharges to a land disposal system of liquid wastes other than identified in section NR 214.02 (1) from sources subject to the provisions of this chapter shall comply with discharge limitations and monitoring requirements established by the department on a case by case basis pursuant to section NR 214.08.

History: Cr Register, June, 1976, No. 246, eff 7-1-76.

NR 214.05 Modification procedure. The discharge limitations and monitoring requirements of this chapter may be modified by the department for a discharge subject to the provisions of this chapter if the owner or operator having the discharge can demonstrate that such limitations and requirements are more stringent than necessary to maintain adequate and satisfactory ground water quality. This demonstration may be made:

(1) By evidence submitted at a public hearing following public notice by the department of the receipt of a complete application and intent to issue or modify a permit as provided in Wis. Adm. Code chapter NR 3, subchapter II, or

(2) By evidence presented at an adjudicatory hearing on the issued permit for such discharge as provided in Wis. Adm. Code chapter NR 3, subchapter III.

History: Cr. Register, June, 1976, No 246, eff 7-1-76.

NR 214.06 Application of discharge limitations. The discharge limitations set forth in this chapter shall be used to establish the volume of liquid waste and the quantity or quality of pollutants or pollutant properties therein which may be discharged to a land disposal system, except as:

(1) They may be modified in accordance with section NR 214.05,

(2) They may be superseded by more stringent limitations necessary to achieve ground water quality standards or meet other legal requirements, or

(3) They may be supplemented or superseded by standards or prohibitions for toxic pollutants or by additional limitations required to achieve ground water quality.

History: Cr. Register, June, 1976, No. 246, eff. 7-1-76.

NR 214.07 Discharge limitations and monitoring requirements. As specified in table 2, 3, or 4 for the appropriate size class set forth in table 1, one or more of the discharge limitations and monitoring requirements of the following subsections are applicable to discharges to a land disposal system of liquid wastes of the types identified in section NR 214.02(1). Also, in accordance with section NR 214.08, these discharge limitations and monitoring requirements are applicable to discharges of other types of liquid wastes.

(1) No discharge shall exceed the maximum hydraulic loading rate specified in the permit for the discharge nor shall it have a pH or contain quantities of organic materials or suspended solids which interfere with operation of the system. In determining the maximum hydraulic loading rate for a land disposal system the department will consider the hydraulic capacity of the system, past operating performance if any, site conditions including soil and geologic characteristics, the concentration and characteristics of pollutants in the discharge, and other relevant information.

(2) There shall be no discharge to a land disposal system except after treatment in a sewage treatment system which includes a secondary treatment system approved by the department and, in the case of discharge of municipal wastes, unless industrial wastes tributary to the municipal treatment works are in compliance with pretreatment standards applicable pursuant to Wis. Adm. Code section NR 211.30.

(3) The concentration of BOD_5 in discharges to the land disposal system shall not exceed 50 mg/1 in more than 20 percent of the monitoring samples required during a calendar quarter.

(4) Discharge to a land disposal system shall be limited so that the discharge and precipitation which falls within the boundary of the disposal system during such discharge does not overflow the boundary of the system.

(5) Discharge shall be limited so that during irrigation all of the discharge and any precipitation falling or flowing onto the irrigation fields during such discharge does not overflow the perimeter of the system.

(6) The discharge shall be alternately distributed to individual sections of the disposal system in a manner to allow sufficient resting periods to maintain the absorptive capacity of the soil.

(7) The volume of discharge shall be limited to prevent ponding, except for temporary conditions following rainfall events.

(8) The discharge shall be free of material which interferes with the operation of spray nozzles or orifices.

(9) The volume of the discharge shall be limited to prevent inundation of the ridges except for temporary conditions following precipitation events.

(10) The geometric mean of the fecal coliform bacteria counts for effluent samples taken during a calendar quarter, or such other period as may be specified in the permit for the discharge, shall not exceed 200 per 100 ml. Fecal coliform bacteria shall be determined on at least one sample monthly.

(11) The volume of discharge shall be limited to prevent flow to or ponding on the ground surface.

(12) Discharges of municipal wastes and of domestic wastes to waste treatment works and from such waste treatment works to land disposal systems shall be monitored as follows:

(a) Discharges from aerated lagoons to an intermediate storage pond or directly to a land disposal system shall, as a minimum, be monitored daily for pH and weekly for BOD_5 and suspended solids using grab samples.

(b) Discharges from stabilization pond facilities which are operated on a flow through basis shall, as a minimum be monitored daily for flow, weekly for pH, and twice monthly for BOD_5 and suspended solids using grab samples.

(c) Discharges from stabilization pond facilities which are operated on a fill and draw basis shall, as a minimum, be monitored daily for total daily flow, weekly for pH, and twice monthly for BOD_5 and suspended solids using grab samples taken during periods of discharge.

(d) Discharges to an intermediate storage pond or directly to a land disposal system from waste treatment facilities other than aerated lagoons or stabilization ponds shall be monitored in accordance with appropriate Wis. Adm. Code section NR 210.11 (1), (2), or (3) except that monitoring for fecal coliform bacteria shall not be required.

(e) Discharges from intermediate storage ponds to a land disposal system shall be monitored daily for flow in addition to the monitoring required in paragraphs (a) and (d) above.

(f) Influent to all treatment facilities subject to the monitoring provisions of paragraphs (a), (b), (c), and (d) of this section shall be monitored as specified in the appropriate one of those subsections for pH, BOD_5, and suspended solids. Influent flow, and any flow bypassing the treatment facility to the land disposal system, shall be monitored continuously.

(13) The discharge to the land disposal system shall, as a minimum, be monitored for total daily flow;

(a) Monthly for systems with an hydraulic capacity of 20,000 gallons per day or less,

(b) Weekly for systems with an hydraulic capacity of more than 20,000 but less than 100,000 gallons per day, and

(c) Daily for systems with an hydraulic capacity of 100,000 gallons per day or more.

(14) Ground water shall be monitored, at locations specified in the permit, monthly for the first three months after the monitoring system is installed and twice annually thereafter except that the department may modify the twice annual requirement to once annually for land disposal systems receiving liquid wastes for a period of not more than four months annually.

(15) The department may require monitoring ground water for any or all of the following parameters; elevation, organic nitrogen, ammonia nitrogen, nitrate and nitrite nitrogen, chlorides, sulfates, dissolved solids, alkalinity, hardness, and pH.

(16) There shall be no discharge of liquid wastes from this category to this type of land disposal system.

(17) The discharge to the land disposal system shall be:

(a) Alternately distributed to individual sections of the land disposal system in a manner that allows sufficient resting periods to maintain a vegetative cover, and

(b) Limited so that it and any precipitation which falls within the area of the land disposal system is retained within the perimeter of the system except for any runoff which may be collected and discharged to a surface water in accordance with a WPDES permit for such discharge.

(18) The liquid waste shall be pretreated in a facility approved by the department prior to discharge to the land disposal system.

(19) Discharge to the land disposal system shall be limited so that during surface spreading all of the liquid waste and any precipitation falling onto or flowing onto the disposal field shall not overflow the perimeter of the system.

(20) Vehicles used for transporting and spreading the liquid wastes shall be in compliance with Wis. Adm. Code chapter NR 113.

(21) The permittee shall maintain a daily record of the volume of waste discharged.

History: Cr. Register, June, 1976, No. 246, eff. 7-1-76.

NR 214.08 Additional limitations. (1) For discharges to a land disposal system of liquid wastes containing any substances or concentrations of substances normally associated with the types of discharge identified in section NR 214.02 (1) the department may on a case by case basis impose one or more of the discharge limitations and monitoring requirements set forth in section NR 214.07.

(2) For discharges to a land disposal system of liquid wastes containing substances or concentrations of substances not normally associated with the types of discharge identified in section NR 214.02 (1) the department may on a case by case basis impose one or more of the discharge limitations and monitoring requirements set forth in section NR 214.07 and:

(a) Impose limitations on the quantity or concentration of substances discharged;

(b) Require monitoring at more frequent intervals than set forth in section NR 214.07 (13);

(c) Require monitoring for parameters in addition to those set forth in sections NR 214.07 (12) and (15);

(d) Require ground water monitoring at more frequent intervals than set forth in section NR 214.07 (14) and for parameters in addition to those set forth in section NR 214.07 (15); and

(e) Require treatment prior to discharge to the land disposal system and, for the purpose of evaluating such treatment, require monitoring;

1. Of the volume of flow before and/or after such treatment,

2. Of the concentration of critical parameters in such flow before and/or after such treatment, and

3. Of ground water in the vicinity of the system.

(3) For discharges of liquid waste to a land disposal system located on a site where soil, geologic, or other conditions may result in more rapid than normal seepage to ground water and/or an increased possibility of ground water contamination the department may require:

(a) Additional treatment beyond secondary treatment for municipal or domestic waste prior to discharge to such system, or

(b) Treatment of liquid wastes from other sources as set forth in section NR 214.08 (1) (e).

History: Cr. Register, June, 1976, No. 246, eff. 7-1-76.

NR 214.09 Sampling and analytical methods. Unless otherwise specified in the permit for a land disposal system:

(1) The procedures for measuring flow and taking samples of discharges shall be those set forth in Wis. Adm. Code chapter NR 218, and

(2) The methods of analysis for substances contained in discharges shall be those set forth in Wis. Adm. Code chapter NR 219, except that for monitoring ground water the alternate methods for certain parameters set forth in the following table may be used. The references of the table are the same as those incorporated by reference in Wis. Adm. Code chapter NR 219.

Parameter and Units	Method	Reference SM[1]	ASTM[2]	EPA[3]
Alkalinity as $CaCO_3$ (mg $CaCO_3$)	Titration, Electronic Manual or Automated Methyl Orange	52	143	6
Flouride (mg/l)	Distillation SPADNS Ion Specific Electrode	171	191	72
Surfactants (MBAS)	Methylene Blue Colorimetric	339	619	131
Iron Total (mg/1)	Colorimetric	187		
Nitrate + Nitrite (mg/l)	Cadmium Reduction Automated			175
pH (s.u.)	Glass Electrode	276	248	230
Methane (mg/l)	Combustible-Gass Volumetric	217 220		
Silica (mg/l)	Colorimetric	303	80	273

[1]*Standard Methods for the Examination of Water and Wastewater,* 13th Edition, 1971

[2]*American Society for Testing and Material, Annual Book of Standards, Part 23, Water; Atmospheric Analysis,* 1972

[3]*Methods for Chemical Analysis of Water and Wastes,* 1971

Table 1
Size Classes for Specified Types of Discharges
Hydraulic Loading Rate shown in Million gallons per day
Determines Size Class of Discharge to Disposal System

Source of Discharge	Class I	Class II	Class IIA	Class IIB	Class III	Class IV
Municipal and domestic wastes	greater than 1.0	.05-1.0	0.1-1.0	0.05-0.1	0.01-0.05	less than 0.01
Canned, Frozen, Preserved Fruits and Vegetables	greater than 1.0	0.14-1.0	0.34-1.0	0.14-0.34	0.01-0.14	less than 0.01
Dairy Products Processing	greater than 1.0	0.05-1.0	0.08-1.0	0.05-0.08	0.01-0.05	less than 0.01
Meat and Poultry Processing	greater than 1.0	0.05-1.0	0.1-1.0	0.05-0.1	0.01-0.05	less than 0.01
Sand, Gravel, Stone and Concrete Products					more than 0.01	less than 0.01

Table 2

Discharge Limitations and Monitoring Requirements Applicable no later than July 1, 1977
Numbers in this table specify applicable subsections in section NR 214.07

Type of Land Disposal System		Absorption Pond	Ridge & Furrow	Spray Irrigation	Spray Runoff	Subsurface Field Abs.	Surface Spreading
Type of Discharge	Size Class						
Municipal waste and Domestic waste	I, IIA	1, 2, 4, 12, 14, 15	1, 2, 4, 6, 9, 12, 14, 15	1, 2, 5, 6, 7, 8, 10, 12, 14, 15	1, 2, 8, 10, 12, 14, 15, 17	1, 11, 12, 14, 15, 18	
	IIB, III, IV	1, 2, 4, 12	1, 2, 4, 6, 9, 12	1, 2, 5, 6, 7, 8, 10, 12	1, 2, 8, 10, 12, 17	1, 11, 12, 18	
Canned, Frozen, Preserved Fruits and Vegetables	I, IIA	1, 4, 13, 14, 15	1, 4, 6, 9, 13, 14, 15	1, 5, 6, 7, 8, 13, 14, 15	1, 8, 13, 14, 15, 17	1, 11, 13, 14, 15, 18	1, 6, 7, 14, 15, 19, 20, 21
	IIB, III, IV	1, 4, 13	1, 4, 6, 9, 13	1, 5, 6, 7, 8, 13	1, 8, 13, 17	1, 11, 13, 18	1, 6, 7, 19, 20, 21
Dairy Products Processing	I, IIA	1, 4, 13, 14, 15	1, 4, 6, 9, 13, 14, 15	1, 5, 6, 7, 8, 13, 14, 15	1, 8, 13, 14, 15, 17	1, 11, 13, 14, 15, 18	1, 6, 7, 14, 15, 19, 20, 21
	IIB, III, IV	1, 4, 13	1, 4, 6, 9, 13	1, 5, 6, 7, 8, 13	1, 8, 13, 17	1, 11, 13, 18	1, 6, 7, 19, 20, 21
Meat and Poultry Processing	I, IIA	1, 4, 13, 14, 15	1, 4, 6, 9, 13, 14, 15	1, 5, 6, 7, 8, 10, 13, 14, 15	1, 8, 10, 13, 14, 15, 17	1, 11, 13, 14, 15, 18	1, 6, 7, 14, 15, 19, 20, 21
	IIB, III, IV	1, 4, 13	1, 4, 6, 9, 13	1, 5, 6, 7, 8, 10, 13	1, 8, 10, 13, 17	1, 11, 13, 18	1, 6, 7, 19, 20, 21
Sand, Gravel, Stone Concrete Products	III, IV	1, 4, 13	1, 4, 9, 13	1, 5, 7, 8, 13	1, 8, 13, 17	1, 11, 13, 18	1, 7, 9, 20, 21

Table 3

Discharge Limitations and Monitoring Requirements Applicable no later than July 1, 1983
Numbers in this table specify applicable subsections in section NR 214.07

Type of Land Disposal System		Absorption Pond	Ridge & Furrow	Spray Irrigation	Spray Runoff	Subsurface Field Abs.	Surface Spreading
Type of Discharge	Size Class						
Municipal waste and Domestic waste	I, II	1, 2, 3, 4, 12, 14, 15	1, 2, 3, 4, 6, 9, 12, 14, 15	1, 2, 3, 5, 6, 7, 8, 10, 12, 14, 15	1, 2, 3, 8, 10, 12, 14, 15, 17	1, 11, 12, 14, 15, 18	
	III, IV	1, 2, 3, 4, 12	1, 2, 3, 4, 6, 9, 12	1, 2, 3, 5, 6, 7, 8, 10, 12	1, 2, 3, 8, 10, 12, 17	1, 11, 12, 18	
Canned, Frozen, Preserved Fruits and Vegetables	I, II	1, 4, 13, 14, 15	1, 4, 6, 9, 13, 14, 15	1, 5, 6, 7, 8, 13, 14, 15	1, 8, 13, 14, 15, 17	1, 11, 13, 14, 15, 18	1, 6, 7, 14, 15, 19, 20, 21
	III, IV	1, 4, 13	1, 4, 6, 9, 13	1, 5, 6, 7, 8, 13	1, 8, 13, 17	1, 11, 13, 18	1, 6, 7, 19, 20, 21
Dairy Products Processing	I, II	1, 4, 13, 14, 15	1, 4, 6, 9, 13, 14, 15	1, 5, 6, 7, 8, 13, 14, 15	1, 8, 13, 14, 15, 17	1, 11, 13, 14, 15, 18	1, 6, 7, 14, 15, 19, 20, 21
	III, IV	1, 4, 13	1, 4, 6, 9, 13	1, 5, 6, 7, 8, 13	1, 8, 13, 17	1, 11, 13, 18	1, 6, 7, 19, 20, 21
Meat and Poultry Processing	I, II	1, 4, 13, 14, 15	1, 4, 6, 9, 13, 14, 15	1, 5, 6, 7, 8, 10, 13, 14, 15	1, 8, 10, 13, 14, 15, 17	1, 11, 13, 14, 15, 18	1, 6, 7, 14, 15, 19, 20, 21
	III, IV	1, 4, 13	1, 4, 6, 9, 13	1, 5, 6, 7, 8, 10, 13	1, 8, 10, 13, 17	1, 11, 13, 18	1, 6, 7, 19, 20, 21
Sand, Gravel, Stone Concrete Products	III, IV	1, 4, 13	1, 4, 9, 13	1, 5, 7, 8, 13	1, 8, 13, 17	1, 11, 13, 18	1, 7, 19, 20, 21

Table 4

Discharge Limitations and Monitoring Requirements for New Sources
Numbers in this table specify applicable subsections in section NR 214.07

Type of Land Disposal System		Absorption Pond	Ridge & Furrow	Spray Irrigation	Spray Runoff	Subsurface Field Abs.	Surface Spreading
Type of Discharge	**Size Class**						
Municipal waste and Domestic waste	I, II	1, 2, 3, 4, 6, 12, 14, 15	1, 2, 3, 4, 6, 9, 12, 14, 15	1, 2, 3, 5, 6, 7, 8, 10, 12, 14, 15	1, 2, 3, 8, 10, 12, 14, 15, 17	1, 11, 12, 14, 15, 18	
	III, IV	1, 2, 3, 4, 6, 12	1, 2, 3, 4, 6, 9, 12	1, 2, 3, 5, 6, 7, 8, 10, 12	1, 2, 3, 8, 10, 12, 17	1, 11, 12, 18	
Canned, Frozen, Preserved Fruits and Vegetables	I, II	1, 2, 3, 4, 6, 13, 14, 15	1, 4, 6, 9, 13, 14, 15	1, 5, 6, 7, 8, 13, 14, 15	1, 8, 13, 14, 15, 17	1, 11, 13, 14, 15, 18	1, 6, 7, 14, 15, 19, 20, 21
	III, IV	1, 2, 3, 4, 6, 13	1, 4, 6, 9, 13	1, 5, 6, 7, 8, 13	1, 8, 13, 17	1, 11, 13, 18	1, 6, 7, 19, 20, 21
Dairy Products Processing	I, II	1, 2, 3, 4, 6, 13, 14, 15	1, 4, 6, 9, 13, 14, 15	1, 5, 6, 7, 8, 13, 14, 15	1, 8, 13, 14, 15, 17	16	1, 6, 7, 14, 15, 19, 20, 21
	III, IV	1, 2, 3, 4, 6, 13	1, 4, 6, 9, 13	1, 5, 6, 7, 8, 13	1, 8, 13, 17	16	1, 6, 7, 19, 20, 21
Meat and Poultry Processing	I, II	1, 2, 3, 4, 6, 13, 14, 15	1, 4, 6, 9, 13, 14, 15	1, 5, 6, 7, 8, 10, 13, 14, 15	1, 8, 10, 13, 14, 15, 17	1, 11, 13, 14, 15, 18	1, 6, 7, 14, 15, 19, 20, 21
	III, IV	1, 2, 3, 4, 6, 13	1, 4, 6, 9, 13	1, 5, 6, 7, 8, 10, 13	1, 8, 10, 13, 17	1, 11, 13, 18	1, 6, 7, 19, 20, 21
Sand, Gravel, Stone Concrete Products	III, IV	1, 4, 13	1, 4, 9, 13	1, 5, 7, 8, 13	1, 8, 13, 17	16	1, 7, 19, 20, 21

History: Cr. Register, June, 1976, No. 246, eff. 7-1-76.

Chapter NR 218

METHOD AND MANNER OF SAMPLING
(INTERIM EFFLUENT LIMITATIONS)

Note: Pursuant to chapter 147 Wis. Stats. and under the procedure of section 227.027 Wis. Stats., the department of natural resources has promulgated interim effluent limitations which were effective February 28, 1975 and will remain in effect for one year. These interim effluent limitations will be periodically replaced by permanent limitations.

NR 218.01 Purpose. The purpose of this chapter is to prescribe the appropriate method and manner of obtaining samples of effluents discharged from point sources in compliance with the monitoring requirements of chapter 147, Wis. Stats., and Wisconsin pollutant discharge elimination system (WPDES) permits issued pursuant thereto.

History: Cr. eff. 2-28-75.

NR 218.03 Applicability. This chapter is applicable to and provides more explicit specification of the sampling and monitoring provisions of permits issued pursuant to chapter 147, Wis. Stats. It is also applicable, unless otherwise specifically indicated by the department, to the monitoring requirements of Wis. Adm. Code chapter NR 101 and sections 144.54 and 147.08, Wis. Stats.

History: Cr. eff. 2-28-75.

NR 218.04 Definitions. The definitions of Wis. Adm. Code Chapter NR 205, apply to terms used in this chapter and in WPDES permits not otherwise defined in this section.

(1) "Process waste" means any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, byproduct, or waste product, and is likely to contain in solution or suspension various components of such raw materials and products.

(2) "Domestic waste" means the type of waste normally discharged from plumbing facilities in private dwellings and includes, but is not limited to, sanitary, bath, laundry, dishwashing, garbage disposal and cleaning wastes.

(3) "Municipal waste" means the mixture of domestic, process, and other wastes tributary to any given municipal sanitary sewerage or treatment system.

(4) "Cooling water" means water which has been used primarily for cooling but which may be contaminated with process waste or airborne material, such as the discharge from barometric condensers or the blowdown from cooling towers.

(5) "Noncontact cooling water" means wastewater which has not come into contact with any raw material, intermediate or finished product, or waste and has been used in heat exchangers, air or refrigeration compressors or other cooling means where contamination with process waste is not normally expected.

(6) "Storm water" or "storm runoff" means water resulting from melting snow or rainfall, except that defined in subsection (7) below.

(7) "Contaminated storm water" means a point source discharge of storm water which the department has identified as a significant contributor of pollution in accordance with the definition of section 147.015 (8) Wis. Stats.

(8) "Continuous effluent" means a discharge which is normally continuous throughout a day or during operating hours in any facility but which may be subject to interruptions or variations in volume.

(9) "Batch effluent" means a discharge which is periodic and of relatively short duration resulting from batch operations, washup operations, or periodic discharges from tanks, ponds, and recycling systems.

(10) "Grab sample" means a single sample taken at one moment of time or a combination of several smaller samples of equal volume taken in less than a 2 minute period. Where the term is used in connection with monitoring temperature or pH it means a single measurement.

(11) "Composite sample" means a combination of individual samples of equal volume taken at approximately equal intervals not exceeding one hour over a specified period of time.

(12) "24-hour composite sample" means a combination of individual samples taken at intervals of not more than one hour such that the volumes of each of the individual samples and of the combination are proportional to the volumes of flow during each interval and during the 24-hour period respectively.

(13) "Continuous sample" means a composite of successive individual samples of equal volume taken automatically at equal intervals not exceeding 15 minutes. Where the term is used in connection with monitoring temperature or pH it means continuous in-line recording or monitoring at intervals of not more than 15 minutes.

(14) "Proportional sample" means a composite of successive individual samples taken during operating or discharge hours, whichever is longer, where the individual samples are taken at frequent intervals not exceeding 15 minutes and are either:

(a) Such that the volume of each is proportional to the rate of flow at the time it is taken, or

(b) Are of equal volume and taken at intervals such that there is a constant volume of discharge during each interval.

(15) "Estimated" used to specify the type of sample for flow measurement, means a reasonable approximation of the average daily flow based on water balance, an uncalibrated weir, or any of the

methods included in section NR 218.05 (3) (b) disregarding requirements for continuously recording flow.

(16) "Total daily" used to specify the type of sample for flow measurement, means the determination of daily flow from at least one measurement when daily frequency is specified and 3 measurements in any other specified frequency period using methods appropriate to the type of waste flow involved set forth in section NR 218.05, but disregarding requirements for continuously recording flow.

(17) "Continuous" or "continuously" used to specify the type of sample for flow measurement, means the determination of daily flow at the frequency specified using methods of sections NR 218.05 (1), 218.05 (3) (a), or 218.05 (4) appropriate to the type of waste flow involved.

History: Cr. eff. 2-28-75.

NR 218.05 Methods for measuring flow. (1) For process waste and for municipal waste at a treatment works, including any bypass, methods of flow measurement shall include continuous recording devices, preferably with integrating capabilities, and shall be one of the following:

(a) A magnetic flow meter installed in a section of pipe which is full at all rates of flow,

(b) A Parshall type flume installed in accordance with accepted design practices,

(c) A venturi meter,

(d) A sharp edged horizontal crest weir, either straight or with end contractions, installed in accordance with accepted design practices,

(e) A "V" notch weir installed in accordance with accepted design practices,

(f) Any other method approved by the department for any specific case in response to a written request for approval filed after the effective date of this chapter.

(2) For municipal wastes which are overflow or bypass flows from sewerage systems other than at a treatment works, reasonable estimates of rate of flow and duration are acceptable for short term discharges such as those caused by storm water. The department may require installation of a temporary flume or weir where the discharge is continual pending elimination by corrective construction.

(3) For noncontact cooling waters:

(a) Having a daily heat content above intake equal to or greater than one billion btu, flows are to be measured by;

1. Any of the methods specified in section NR 218.05 (1),

2. Intake water meter readings where the intake, or a specific portion of it, is used for cooling,

3. Readings of a water meter on the discharge, or

4. Computation from the operating period of one or more calibrated pumps handling the flow;

(b) Having a daily heat content above intake of less than one billion btu, flows are to be measured by;

1. Any of the methods specified in section NR 218.05 (3) (a), or

2. Calculations from the velocity and cross section of the discharge.

(4) Cooling water flows are to be measured using any of the methods specified in section NR 218.05 (3) (a).

(5) Contaminated storm water flows may be estimated from the duration and head above the crest of an installed weir. Calibration of such weirs is not necessary.

(6) Storm water flows do not require flow measurement.

History: Cr. eff. 2-28-75.

NR 218.06 Calibration of flow measuring devices. (1) Devices used for measuring flows by the methods specified in section NR 218.05 (1) shall be calibrated and the calibration rechecked at least annually using one of the following methods:

(a) A method specified by the manufacturer of the device,

(b) Calculation of rate of flow from the dilution of chloride or other ion or substance added to the effluent stream at a fixed rate sufficiently ahead of the sampling point to insure complete mixing,

(c) Measuring the volume withdrawn from or introduced into a tank or container in a known period of time, or

(d) In any specific instance by any other method approved by the department in response to a written request for approval filed after the effective date of this chapter.

(2) Records of calibration data shall be retained for a three-year period, or for a longer period on specific request by the department.

(3) The department shall be advised within 30 days of any change in reported volumes resulting from recalibration whether or not associated with replacement or change of the measuring device.

History: Cr. eff. 2-28-75.

NR 218.07 Location of sampling points. The location of sampling points shall be as specified in an applicable permit or, in the absence of such specification, at a point that is representative of the discharge. In the case of process waste effluents samples shall be taken prior to or in the absence of any dilution with cooling or storm water. The department may require relocation of a sampling point if it determines that the existing location does not provide samples representative of the discharge.

History: Cr. eff. 2-28-75.

NR 218.08 Size of samples. The samples shall be large enough to allow for the required analysis for pollutant or toxic parameters, other than pH and temperature, using the methods of analysis specified in

Wis. Adm. Code chapter NR 219, or an alternate method specified in an applicable permit.

History: Cr. eff. 2-28-75.

NR 218.09 Storage of samples. (1) Except for samples for biochemical oxygen demand (BOD) analysis, methods for preserving samples for storage prior to analysis and the limits on such storage are set forth in the standard methods specified in Wis. Adm. Code chapter NR 219.

(2) Except as provided in section NR 218.09 (3), samples collected for BOD analysis shall be preserved by refrigeration to between 32 and 40°F within 8 hours of the collection of the first portion of a composite sample and stored in that temperature range for not more than 48 hours after the composite sample has been collected before commencing analysis.

(3) For a particular discharge, the department may approve alternative preservation procedures or analytical procedures for BOD samples, provided that a written request for such approval is submitted to the department accompanied by sufficient comparative data to be statistically significant.

(a) Alternative preservation procedures for BOD samples. The following alternative preservation procedures for BOD samples may be approved by the department;

1. Refrigeration commencing within 24 hours instead of 8 hours as specified in section NR 218.09 (2),

2. Elimination of refrigeration if analysis is commenced within 3 hours of completion of the collection of a daily sample,

3. Holding the sample for not more than 120 hours in the temperature range of 32-40°F in lieu of the 48 hours specified in section NR 218.09 (2), or

4. Holding the sample for 120 hours or more using any satisfactory means of preservation such as, for example, acidification with sulfuric acid to a pH of 2.

(b) Alternative BOD analytical procedure. The department may approve modifying the incubation period for the BOD analysis procedure from 5 days to either 4 or 6 days using an appropriate conversion factor.

History: Cr. eff. 2-28-75.

NR 218.10 Frequency of sampling. Samples shall be taken at the frequencies specified in the WPDES permit authorizing discharge or as specified by the department where no permit has been issued or is required.

History: Cr. eff. 2-28-75.

NR 218.11 Method of sampling. The method of sampling shall be that specified in the WPDES permit, or by the department where no permit has been issued or is required, as defined in sections NR 218.04 (11) through (15).

History: Cr. eff. 2-28-75.

Chapter NR 219

ANALYTICAL TEST METHODS AND PROCEDURES

NR 219.01 Purpose. The purpose of this chapter is to establish analytical test methods and procedures applicable to effluent limitations for discharges from point sources as authorized by section 147.04 (5), Wis. Stats.

History: Cr. Register, August, 1976, No. 248, eff. 9-1-76.

NR 219.02 Applicability. The procedures prescribed herein shall, except as provided in NR 219.05, be used in the determination of concentrations and quantities of pollutant parameters as required for:

(1) An application submitted to the department for a permit under chapter 147, Wisconsin Statutes.

(2) Reports required to be submitted by dischargers in accordance with the conditions of issued permits.

History: Cr. Register, August, 1976, No. 248, eff. 9-1-76.

NR 219.03 Definitions. As used in this chapter:

(1) Standard Methods - means "Standard Methods for the Examination of Water and Waste Water," 14th Edition, 1976. This publication is available from the American Public Health Association, 1015 18th Street NW, Washington, D.C. 20036.

(2) ASTM - means "Annual Book of Standards, Part 31, Water, 1975." This publication is available from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

(3) EPA methods - means "Methods for Chemical Analysis of Water and Waste, 1974", Methods Development and Quality Assurance Research Laboratory, National Environmental Research Center, Cincinnati, Ohio 45268; U.S. Environmental Protection Agency, Office of Technology Transfer, Industrial Environmental Research Laboratory, Cincinnati, Ohio 45268. This publication is available from the Office of Technology Transfer.

(4) Regional Administrator - the term "Regional Administrator" means the Regional Administrator of Region V, U.S. Environmental Protection Agency.

(4m) Copies of the publications identified above, and of the publications referred to in footnotes 1 through 3, 5 through 10, 12, 13, 15 through 17, and 22 through 24 of NR 219.06 are available for inspection at the offices of the department of natural resources, the secretary of state and the revisor of statutes.

History: Cr. Register, August, 1976, No. 248, eff. 9-1-76; am. (1), (2), (3) and (4m), Register, January, 1978, No. 265, eff. 2-1-78.

NR 219.04 Application for alternate test procedures. (1) Any person may apply to the regional administrator for approval of an alternate test procedure for a specific discharge. Such application shall be made in the following manner:

(a) The applicant shall submit an application to the regional administrator through the department.

(b) The application for an alternate test procedure shall be made by letter in triplicate, and

1. Provide the name and address of the responsible person or firm making the discharge (if not the applicant), the number of the existing or pending permit, the name of the issuing agency, and the discharge serial number,

2. Identify the pollutant or parameter for which approval of an alternate testing procedure is being requested,

3. Provide justification for using testing procedures other than those specified in NR 219, and

4. Provide a detailed description of the proposed alternate test procedure, together with references to published studies on the applicability of the alternate test procedure to the effluents in question.

(2) Any person may apply to the director, environmental monitoring and support laboratory, Cincinnati, Ohio 45268 for approval of an alternate test procedure for nationwide use. Such application shall be made in the following manner:

(a) The application for an alternate test procedure shall be made by letter, in triplicate, and

1. Provide the name and address of the responsible person or firm making the request,

2. Identify the pollutant (s) or parameter (s) for which nationwide approval of an alternate testing procedure is being requested,

3. Provide a detailed description of the proposed alternate test procedure, together with references to published or other studies confirming the general applicability of the alternate test procedure to the pollutant (s) or parameter (s) in wastewater from representative or specified industrial or other categories, and

4. Provide comparability data for the performance of the proposed alternate test procedure compared to the approved test procedures.

History: Cr. Register, August, 1976, No. 248, eff. 9-1-76; r. and recr. January, 1978, No. 265, eff. 2-1-78.

NR 219.05 Approval of alternate test procedures. (1) The regional administrator has final responsibility for approval of any alternate test procedure proposed by responsible person or firm making the discharge.

(2) Within 30 days of receipt of an application, the department will forward such application proposed by responsible person or firm making the discharge, together with its recommendations, to the regional administrator. Where the director recommends rejection of the application for scientific and technical reasons which the director provides, the regional adminstrator shall deny the application.

(3) Within 90 days of the receipt of an application for an alternate test procedure proposed by responsible person or firm making the discharge, the regional administrator will notify the applicant and the department agency of approval or rejection, or shall specify the additional information which is required to determine whether to approve the proposed test procedure.

(4) Within 90 days of the receipt by the director of the environmental monitoring and support laboratory, Cincinnati, of an application for an alternate test procedure for nationwide use, the director of the environmental monitoring and support laboratory, Cincinnati, shall notify the applicant of his/her recommendation to the administrator to approve or reject the application or shall specify additional information which is required to determine whether to approve the proposed test procedure. After such notification, an alternate method determined by the administrator to satisfy the applicable requirements of this chapter shall be approved for nationwide use: alternate test procedures determined by the administrator not to meet the requirements of 40 CFR part 136 shall be rejected. Notice of these determinations shall be submitted for publication in the federal register not later than 15 days after such notification and determination is made.

History: Cr. Register, August, 1976, No. 248, eff. 9-1-76; am. (1) to (3) and cr. (4), January, 1978, No. 265, eff. 2-1-78.

NR 219.06 - LIST OF APPROVED TEST PROCEDURES

	Parameter and Units	Method	References (page numbers) EPA Methods	Standard Methods	ASTM	USGS[2] Methods	Other
General Parameters							
1.	Acidity, as $CaCO_3$, mg/1	Electrometric end point (pH of 8.2) or phenolphthalein end point.	1	273 (4d)	116	40	[3](607)
2.	Alkalinity as $CaCO_3$, mg/1	Electrometric titration (to pH 4.5) manual or automated, or equivalent automated methods.	3 5	278	111	41	[3](607)
3.	Ammonia (as N), mg/1	Manual distillation[4] (at pH 9.5), followed by nesslerization, titration electrode, automated phenolate.	 159 165 168	410 412 616	 237	 116	 [3](614)
4.	Benzidine, mg/1						
5.	Biochemical oxygen demand, five-day (BOD_5), mg/1	Oxidation - colorimetric.[5] Winkler (Azide modification) or electrode.		543		[6](50)	 [7](17)
6.	Bromide, mg/1	Titrimetric, iodine-iodate.	14		323	58	
7.	Chemical oxygen demand (COD), mg/1	Dichromate reflux.	20	550	472	124	[3](610) [7](17)
8.	Chloride, mg/1	Silver nitrate; mercuric nitrate; automated colorimetric-ferricyanide.	 29 31	303 304 613	267 265	 [8](46)	 [3](615)
9.	Chlorinated organic compounds (except pesticides), mg/1	Gas chromatography.[8]					
10.	Chlorine-total residual, mg/1	Iodometric titration, amperometric or starch-iodine endpoint; DPD colorimetric or titrimetric methods (these last two methods are interim methods pending laboratory testing).	 35	318 322 332 329	 278		
11.	Color, platinum cobalt units or dominant wavelength, hue, luminance, purity	Colorimetric; spectrophotometric; or ADMI procedure.[10]	36 39	64 66		82	
12.	Cyanide, total,[11] mg/1	Distillation followed by silver nitrate titration or pyridine pyrazolone (or barbituric acid) colorimetric.	40	361	503	85	[7](22)

	Parameter and Units	Method	References (page numbers) EPA Methods	Standard Methods	ASTM	USGS[2] Methods	Other
13.	Cyanide amenable to chlorination, mg/1	...do	49	376	505		
14.	Dissolved oxygen, mg/1	Winkler (Azide modification) or electrode method.	51 56	443 450	368	126	[3](609)
15.	Fluoride, mg/1	Distillation[4] followed by ion electrode; SPADNS; or automated complexone.	65 59 61	389 391 393 614	307 305	93	
16.	Hardness, total, as $CaCO_3$, mg/1	EDTA titration; automated colorimetric; or atomic absorption (sum of Ca and Mg as their respective carbonates).	68 70	202	161	94	[3](617)
17.	Hydrogen ion (pH), pH units	Electrometric measurement.	239	460	178	129	[3](606)
18.	Kjeldahl nitrogen (as N), mg/1	Digestion and distillation followed by nesslerization, titration or electrode; automated digestion automated phenolate.	175 165 182	437		122	[3](612)
19.	Nitrate (as N), mg/1	Cadmium reduction; brucine sulfate; automated cadmium or hydrazine reduction.[13]	201 197 207	423 427 620	358	119	[3](614)- [7](28)
20.	Nitrite (as N), mg/1	Manual or automated colorimetric (Diazotization)	215	434		121	
21.	Oil and grease, mg/1	Liquid-liquid extraction with trichloro-trifluoro-ethane-gravimetric.	229	515			
22.	Organic carbon, total (TOC) mg/1	Combustion-infrared method.[14]	236	532	467	[15](4)	
23.	Organic nitrogen (as N), mg/1	Kjeldahl nitrogen minus ammonia nitrogen.	175,159	437		122	[3](612,614)
24.	Orthophosphate (as P), mg/1	Manual or automated ascorbic acid reduction.	249 256	481 624	384	131	[3](621)
25.	Pentachlorophenol, mg/1	Gas chromatography.[9]					
26.	Pesticides, mg/1	...do[9]		555	529	[15](24)	
27.	Phenols, mg/1	Distillation followed by colorimetric (4AAP).	241	574	545		
28.	Phosphorus (elemental), mg/1	Gas chromatography.[16]					
29.	Phosphorus, total (as P), mg/1	Persulfate digestion followed by manual or automated ascorbic acid reduction.	249 256	476,481 624	384	133	[3](621)

	Parameter and Units	Method	EPA Methods	References (page numbers) Standard Methods	ASTM	USGS[2] Methods	Other
30.	Specific conductance, micromhos per centimeter at 25°C	Wheatstone bridge conductimetry.	275	71	120	148	[3](606)
31.	Sulfate (as SO_4), mg/1	Gravimetric; turbidimetric; or automated colorimetric (barium chloranilate).	 277 279	493 496	424 425		[3](624) [3](623)
32.	Sulfide (as S), mg/1	Titrimetric-iodine for levels greater than 1 mg/1; methylene blue photometric.	284	505 503		154	
33.	Sulfite (as SO_3), mg/1	Titrimetric, iodine-iodate.	285	508	435		
34.	Surfactants, mg/1	Colorimetric (methylene blue).	157	600	494	[16](11)	
35.	Temperature, degrees C	Calibrated glass or electrometric thermometer.	286	125		[17](31)	
36.	Turbidity, NTU	Nephelometric.	295	132	223	156	
Bacteria							
37.	Coliform (fecal)[18], number per 100 ml	MPN;[19] membrane filter.		922 937		 [8](45)	
38.	Coliform (fecal)[18], in presence of chlorine, number per 100 ml	...do[19],[20]		922 928,937			
39.	Coliform (total)[18], number per 100 ml	...do[19]		916 928		 [8](35)	
40.	Coliform (total)[18], in presence of chlorine, number per 100 ml	MPN;[19] membrane filter with enrichment.		916 933			
41.	Fecal streptococci,[18] number per 100 ml.	MPN;[19] membrane filter; plate count.		943 944 947		 [8](50)	
Metals[21]							
42.	Aluminum, total, mg/1	Digestion[22] followed by atomic absorption[23] or by colorimetric (Eriochrome Cyanide R).	92	152 171		[8](19)	
43.	Antimony, total, mg/1	Digestion[22] followed by atomic absorption[23].	94				
44.	Arsenic, total, mg/1	Digestion followed by silver diethyldithio-carbamate; or atomic absorption.[23],[24]	 9 95	285 283 159		 [8](31) [8](37)	
45.	Barium, total, mg/1	Digestion[22] followed by atomic absorption.[23]	97	152			52

	Parameter and Units	Method	References (page numbers) EPA Methods	Standard Methods	ASTM	USGS[2] Methods	Other
46.	Beryllium, total, mg/1	Digestion[22] followed by atomic absorption[22] or by colorimetric (aluminon)	99	152 177		53	
47.	Boron, total, mg/1	Colorimetric (Curcumin).	13	287			
48.	Cadmium, total, mg/1	Digestion[23] followed by atomic absorption[23] or by colorimetric (Dithizone).	101	148	345	62	[3](619) - [7](37)
49.	Calcium, total; mg/1	Digestion[22] followed by atomic absorption; or EDTA titration.	103	182 148 189	345	66	
50.	Chromium VI, mg/1	Extraction and atomic absorption; colorimetric (Diphenylcarbazide).	89,105	192		76 75	
51.	Chromium, total, mg/1	Digestion[22] followed by atomic absorption[23] or by colorimetric (Diphenylcarbazide).	105	148 192	345 286	78 77	[3](619)
52.	Cobalt, total, mg/1	Digestion[22] followed by atomic absorption.[23]	107	148	345	80	[7](37)
53.	Copper, total, mg/1	Digestion[22] followed by atomic absorption[23] or by colorimetric (Neocuproine).	108	148 196	345 243	83	[3](619) - [7](37)
54.	Gold, total, mg/1	Digestion[22] followed by atomic absorption.[22]					
55.	Iridium, total, mg/1	Digestion[22] followed by atomic absorption.[22]					
56.	Iron, total, mg/1	Digestion[22] followed by atomic absorption[23] or by colorimetric (Phenanthroline).	110	148 208	345 326	102	[3](619)
57.	Lead, total, mg/1	Digestion[22] followed by atomic absorption[23] or by colorimetric (Dithizone).	112	148 215	345	105	[3](619)
58.	Magnesium, total, mg/1	Digestion[22] followed by atomic absorption; or gravimetric.	114	148 221	345	109	[3](619)
59.	Manganese, total, mg/1	Digestion[22] followed by atomic absorption[23] or by colorimetric (Persulfate or periodate).	116	148 225,227	345	111	[3](619)
60.	Mercury, total, mg/1	Flameless atomic absorption.	118	156	338	[8](51)	
61.	Molybdenum, total, mg/1	Digestion[22] followed by atomic absorption.[23]	139		350		
62.	Nickel, total, mg/1	Digestion[22] followed by atomic absorption[23] or by colorimetric (Heptoxime).	141	148	345	115	

	Parameter and Units	Method	References (page numbers) EPA Methods	Standard Methods	ASTM	USGS[2] Methods	Other
63.	Osmium, total, mg/1	Digestion[22] followed by atomic absorption[12].					
64.	Palladium, total, mg/1	Digestion[22] followed by atomic absorption[12].					
65.	Platinum, total, mg/1	Digestion[22] followed by atomic absorption[12].					
66.	Potassium, total, mg/1	Digestion[22] followed by atomic absorption, colorimetric (Cobaltinitrite), or by flame photometric.	143	 235 234	 403	134	[3](620)
67.	Rhodium, total, mg/1	Digestion[22] followed by atomic absorption.[12]					
68.	Ruthenium, total, mg/1	Digestion[22] followed by atomic absorption.[12]					
69.	Selenium, total, mg/1	Digestion[22] followed by atomic absorption.[12],[24]	145	159			
70.	Silica, dissolved, mg/1	0.45 micron filtration[21] followed by colorimetric (Molybdosilicate).	274	487	398	139	
71.	Silver, total[28], mg/1	Digestion[22] followed by atomic absorption[23] or by colorimetric (Dithizone).	146	148 243		142	[3](619)- [7](37)
72.	Sodium, total, mg/1	Digestion[22] followed by atomic absorption or by flame photometric.	147	 250	 403	143	[3](621)
73.	Thallim, total, mg/1	Digestion[22] followed by atomic absorption.[23]	149				
74.	Tin, total, mg/1	Digestion[22] followed by atomic absorption.[23]	150			[8](65)	
75.	Titanium, total, mg/1	Digestion[22] followed by atomic absorption.[23]	151				
76.	Vanadium, total, mg/1	Digestion[22] followed by atomic absorption[23] or by colorimetric (Gallic acid).	153	152 260	 441	 [8](67)	
77.	Zinc, total, mg/1	Digestion[22] followed by atomic absorption[23] or by colorimetric (Dithizone).	155	148 265	345	159	[3](619)- [7](37)
Radiological							
78.	Alpha, total, pCi/1	Proportional or scintillation counter		648	591		[8, 26](75+78)
79.	Alpha, Counting Error, pCi/1	...do		648	594		[8](79)
80.	Beta, total, pCi/1	Proportional counter.		648	601		[8, 26](75+78)
81.	Beta, counting error, pCi/1	...do		648	606		[8](79)

	Parameter and Units	Method	EPA Methods	References (page numbers) Standard Methods	ASTM	USGS[2] Methods	Other
82.	Radium, total, pCi/1	...do		661	661		•(81)
83.	226 Radium, pCi/1	Scintillation counter.		667			
Residue							
84.	Total, mg/1	Gravimetric, 103 to 105°C.	270	91			
85.	Total dissolved (filterable), mg/1	Glass fiber filtration, 180°C.	266	92			
86.	Total suspended (nonfilterable), mg/1	Glass fiber filtration, 103 to 105°C.	268	94			
87.	Settleable, ml/1 or mg/1.	Volumetric or gravimetric.		95			
88.	Total volatile, mg/1	Gravimetric, 550°C.	272	95			

[1]Recommendation for sampling and preservation of samples according to parameter measured may be found in "Methods for Chemical Analysis of Water and Wastes, 1974" U.S. Environmental Protection Agency, table 2, pp. vii-xii.

[2]All page references for USGS methods, unless otherwise noted, are to Brown, E., Skougstad, M.W., and Fishman, M.J., "Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases," U.S. Geological Survey Techniques of Water-Resources Inv., book 5, ch. Al, (1970).

[3]EPA comparable method may be found on indicated page of "Official Methods of Analysis of the Association of Official Analytical Chemists" methods manual, 12th ed. (1975).

[4]Manual distillation is not required if comparability data on representative effluent samples are on company file to show that this preliminary distillation step is not necessary; however, manual distillation will be required to resolve any controversies.

[5]Adequately tested methods for benzidine are not available. Until approved methods are available, the following interim method can be used for the estimation of benzidine: "Method for Benzidine and its Salts in Wastewaters," available from Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

[6]Slack, K.V., and others, "Methods for Collection and Analysis of Aquatic Biological and Microbiological Samples," U.S. Geological Survey Techniques of Water-Resources Inv., book 5, ch. A4, (1973).

[7]American National Standard on Photographic Processing Effluents, April 2, 1975. Available from NASI, 1430 Broadway, New York, New York 10018.

[8]Fishman, M.J. and Brown, Eugene, "Selected Methods of the U.S. Geological Survey for Analysis of Wastewaters," (1976) open-file report, 76-117.

[9]Procedures for pentachlorophenol, chlorinated organic compounds and pesticides can be obtained from the Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

[10]Color method (ADMI procedure) available from the Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

[11]For samples suspected of having thiocyanate interference, magnesium chloride is used as the digestion catalyst. In the approved test procedure for cyanides, the recommended catalysts are replaced with 20 ml of a solution of 510 g/1 magnesium chloride ($MgC1.6H_2O$). This substitution will eliminate thiocyanate interference for both total cyanide and cyanide amenable to chlorination measurements.

[12]Method available from the Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

[13]An authomated hydrazine reduction method is available from the Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

[14]A number of such systems manufactured by various companies are considered to be comparable in their performance. In addition, another technique, based on combustion-methane detection is also acceptable.

[15]Goerlitz, D., Brown, E., "Methods for Analysis of Organic Substances in Water," U.S. Geological Survey Techniques of Water-Resources Inv., book 5, ch. A3 (1972).

[16]Addison, R.F., and Ackman, R.G., "Direct Determination of Elemental Phosphorus by Gas-Liquid Chromatography," "Journal of Chromatography," vol. 47, No. 3, pp. 421-426, 1970.

[17]Stevens, H.H., Ficke, J.F., and Smoot, G.F., "Water Temperature-Influential Factors, Field Measurement and Data Presentation," U.S. Geological Survey *Techniques of Water Resources Inv., book 1 (1975).*

[18]The method used must be specified.

[19]The 5 tube MPN is used.

[20]Since the membrane filter technique usually yields low and variable recovery from chlorinated wastewaters, the MPN method will be required to resolve any controversies.

[21]Dissolved metals are defined as those constituents which will pass through a 0.45 micron filter. A prefiltration is permissable to free the sample from larger suspended solids. Filter the sample as soon as practical after collection using the first 50 to 100 ml to rinse the filter flask. (Glass or plastic filtering apparatus are recommended to avoid possible contamination). Discard the portion used to rinse the flask and collect the required volume of filtrate. Acidify the filtrate with 1:1 redistilled HNO_3 *to a pH of 2. Normally, 3 ml of (1:1) acid per liter should be sufficient to preserve the samples.*

[22]For the determination of total metals the sample is not filtered before processing. Because vigorous digestion procedures may result in a loss of certain metals through precipitation, a less vigorous treatment is recommended as given on page 83 (4.1.4) of "Methods for Chemical Analysis of Water and Wastes" (1974). In those instances where a more vigorous digestion is desired, the procedure on page 82 (4.1.3) should be followed. For the measurement of the noble metal series (gold, iridium, osmium, palladium, platinum, rhodium and ruthenium), an aqua regia digestion is to be substituted as follows: Transfer a representative aliquot of the well-mixed sample to a Griffin beaker and add 3 ml of concentrated redistilled HNO_3. Place the beaker on a stream bath and evaporate to dryness. Cool the beaker and cautiously add a 5 ml portion of aqua regia. (Agua regia is prepared immediately before use by carefully adding 3 volumes of concentrated HC1 to one volume of concentrated HNO_3). Cover the beaker with a watch glass and return to the steam bath. Continue heating the covered beaker for 50 minutes. Remove cover and evaporate to dryness. Cool and take up the residue in a small quantity of 1:1 HC1. Wash down the beaker and watch glass with distilled water and filter the sample to remove silicates and other insoluble material that could clog the atomizer. Adjust the volume to some predetermined volume based on the expected metal concentration. The sample is now ready for analysis.

[23]As the various furnace devices (flameless A.A.) are essentially atomic absorption techniques, they are considered to be approved test methods. Methods of standard addition are to be followed as noted in p. 78 of "Methods for Chemical Analysis of Water and Wastes," 1974.

[24]See "Atomic Absorption Newsletter," vol. 13,75 (1974). Avaiable from Perkin-Elmer Corp., Main Ave., Norwalk, Conn. 06852.

[25]Recommended methods for the analysis of silver in industrial wastewaters at concentrations of 1 mg/1 and above are inadequate where silver exists as inorganic halide. Silver halides such as the bromide and chloride are relatively insoluble in reagents such as nitric acid but are readily soluble in an aqueous buffer of sodium thiosulfate and sodium hydroxide to a pH of 12. Therefore, for levels of silver above 1 mg/1, 20 ml of sample should be diluted to 100 ml by adding 40 ml each of 2M $Na_2S_2O_3$ and 2M NaOH. Standards should be prepared in the same manner. For levels of silver below 1 mg/1 the recommended procedure is satisfactory.

[26]The method found on page 75 measures only the dissolved portion while the method on page 78 measures only suspended. Therefore the two results must be added together to obtain "total."

History: Cr. Register, August, 1976, No. 248, eff. 9-1-76; r. and recr. Register, January, 1978, No. 265, eff. 2-1-78.

GUIDELINE DOCUMENT
FOR THE
DESIGN, CONSTRUCTION, AND OPERATION
OF
LAND DISPOSAL SYSTEMS FOR LIQUID WASTES

PREPARED BY THE
WISCONSIN DEPARTMENT OF NATURAL RESOURCES
BOX 7921
MADISON, WISCONSIN 53707

NOVEMBER 1975

(PRELIMINARY DRAFT - SUBJECT TO CHANGE AFTER COMMENT PERIOD)

CHAPTER TWENTY-TWO: WPC 22

CLASSIFICATION OF UNDERGROUND WATERS OF THE STATE AND STANDARDS FOR WASTE DISPOSAL

WPC 22: It is the purpose of this regulation to preserve and protect the underground waters of the state by: (a) Preventing any new pollution, and (b) Abating existing pollution. It is the policy of the Agency to consider the actual or potential use of the underground waters for potable water supply as constituting the highest priority use and as such to provide maximum protection to all underground waters. The ready availability nearly statewide of underground water constitutes a natural resource of immeasurable value which must be protected as nearly as possible in its natural condition. For the conservation of underground water supplies for present and future generations and prevention of possible health hazards, it is necessary and proper that the Agency employ a non-degradation policy to prevent pollution of the underground waters of the State.

Regulation WPC 14 also applies to underground waters. Where differences exist between regulation WPC 14 and this regulation, the more stringent of the conditions shall be construed to apply.

(a) **Definitions**

(1) **Underground Water** means the water contained below the surface of the earth in the saturated zone including, without limitation, all waters whether under confined, unconfined or perched conditions, in near surface unconsolidated sediment or regolith, or in rock formations deeper underground. The term ground water shall be synonymous with underground water.

(2) **Confined ground water** means the water which is under pressure greater than atmospheric, and its upper limit is the bottom of a bed of distinctly lower hydraulic conductivity than that of the material in which the confined water occurs.

(3) **Unconfined ground water** is water in a formation that has a water table.

(4) **Perched ground water is** unconfined ground water separated from an underlying body of ground water by an unsaturated zone. Perched ground water may be either permanent where recharge is frequent enough to maintain a saturated zone above the perching bed, or temporary where intermittent recharge is not great or frequent enough to prevent the perched water from disappearing from time to time as a result of drainage over the edge or through the perching bed.

(5) **Saturated zone** is that part of the earth's crust in which all the voids, large and small, are ideally filled with water under pressure greater than atmospheric.

(6) **Unsaturated zone** is the zone between the land surface and the water table. It includes the capillary fringe. Generally, the water is under less than atmospheric pressure.

(7) **Water table** is the surface of the ground water at which the pressure is atmospheric. Generally this is the top of the saturated zone.

(8) **Toxic pollutant** means those pollutants, or combination of pollutants, including disease-causing agents, which after discharge and upon exposure, ingestion, inhalation or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will, on the basis of information available, cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction) or physical deformations, in such organisms or their offspring.

Other terms used herein which are defined in Minnesota Statutes, Chapters 115 and 116, shall be given the meaning ascribed to them therein. Terms not defined in this regulation or in Chapters 115 and 116 shall be construed in accordance with accepted professional usage and practice.

(b) **Uses of Underground Waters.** The waters of the state are classified according to their highest priority use, which for underground waters of suitable natural quality is their use now or in the future as a source of drinking, culinary, or food processing water. Suitability is to be construed as meaning that the waters in their natural state can be used for such purposes after such purification or treatment processes as may be prescribed by the Minnesota Department of Health or the Minnesota Department of Agriculture. This classification is established to protect the underground waters as potable water supplies by preventing and abating pollution. In making this classification, the Agency recognizes that the underground waters of the state are contained in a series of related and often interconnected aquifers, such that if sewage, industrial waste, other waste, or other pollutants enter the underground water system, they may spread both vertically and horizontally. Thus, all underground waters are best classified for use as potable water supply in order to preserve high quality waters by minimizing spreading of pollutants, by prohibiting further discharges of wastes thereto, and to maximize the possibility of rehabilitating degraded waters for their priority use.

(c) **Non-Degradation.** It is the policy of the Agency that the disposal of sewage, industrial waste and other wastes shall be controlled as may be necessary to ensure that to the maximum practicable extent the underground waters of the state are maintained at their natural quality unless a determination is made by the Agency that a change is justifiable by reason of necessary economic or social development and will not preclude appropriate beneficial present and future uses of the waters.

(d) **Standards**

(1) No sewage, industrial waste, or other wastes shall be discharged directly into the zone of saturation by such means as injection wells or other devices used for the purpose of injecting materials into the zone of saturation, except that the discharge of cooling water under existing permits of the Agency may be continued, subject to review of the permit by the Agency for conformance with section (d)(3).

(2) No sewage, industrial waste, other waste, or other pollutants shall be allowed to be discharged to the unsaturated zone or deposited in such place, manner or quantity that the effluent or residue therefrom, upon reaching the water table, may actually or potentially preclude or limit the use of the underground waters as a potable water supply, nor shall any such discharge or deposit be allowed which may pollute the underground waters. All such possible sources of pollutants shall be monitored at the discharger's expense as directed by the Agency.

(3) Treatment, safeguards or other control measures shall be provided by the person responsible for any sewage, industrial waste, other waste, or other pollutants which are to be or have been discharged to the unsaturated zone or deposited there, or which have been discharged to the zone of saturation, to the extent necessary to ensure that the same will not constitute or continue to be a source of pollution of the underground waters or impair the natural quality thereof.

(4) Toxic pollutants including, but not limited to, radioactive substances, chemicals, metals, solvents, petroleum products, plating wastes, and acids and bases, shall not be discharged or deposited in any manner such as to endanger the quality or uses of the underground waters.

(5) This regulation shall not be construed as prohibiting the use of septic tank systems or holding tanks for disposal or storage of sewage or other acceptable organic wastes where public or other sewage or other waste disposal systems with surface discharge of effluent are not available or cannot reasonably be made available (except as Agency regulations may in the future apply to the construction, location, maintenance or use of such disposal systems), nor shall it be construed as prohibiting land disposal of acceptable organic wastes or the use of chemicals and fertilizers for the production or protection of agricultural crops or products, nor the recharge of ground waters under controlled conditions, provided that such practices do not pose a significant pollution hazard.

(6) All persons operating or responsible for sewage, industrial waste or other waste disposal systems, except septic tanks and related soil adsorption systems, which discharge effluent to the unsaturated zone, or deposits of pollutants or other operations from which residues may reach the underground waters, shall submit regularly every month a report to the Agency on the operation of the disposal system, the waste flow, and the characteristics of the influent, effluent and underground waters of the vicinity. Sufficient data on measurements, observations, sampling and analyses, and other pertinent information shall be furnished as may be required by the Agency to, in its judgment, adequately reflect the condition of the disposal system, raw wastes, deposited material, effluent, residues, and the receiving or affected soils and underground waters. These data shall be collected under the supervision and direction of the Agency.

(7) The long term storage underground for later treatment of sewage, industrial waste or other wastes, except solid wastes under permit of the Agency, is prohibited. Liquids or other substances not sewage or industrial waste which may pollute or tend to pollute the underground waters of the state shall not be stored underground without safeguards adequate to reasonably assure proper retention against entry into the underground waters. The use of sewer systems for purposes of conveyance or control of the flow to outlets or treatment works, including temporary storage for such purposes, shall not be construed to be long term storage within the meaning of this regulation.

(8) The ground water may in its natural state have some characteristics or properties exceeding the standards for potable water supplies. Where the background level of natural origin is reasonably definable and is higher than the accepted standard for potable water and the hydrology and extent of the aquifer are known, the natural level may be used as the standard.

(e) **Severability.** If any provision of this regulation or the application thereof to any person or circumstances is held to be invalid, such invalidity shall not affect other provisions of the regulation or application of any other part of this regulation which can be given effect without application of the invalid provision. To this end the provisions of all sections, subsections or subdivisions herein and the various applications thereof are declared to be severable.

(f) **Determination of Compliance.** In making tests or analyses of the underground waters of the state, or of sewage, industrial wastes or other wastes. to determine compliance with the standards, samples shall be collected in such manner and place and of such type, number and frequency as may be considered satisfactory by the Agency from the viewpoint of adequately reflecting the condition of the underground water and the effects of the pollutants upon the specified water uses. The samples shall be preserved and analyzed in accordance with procedures described in the 13th edition of Standard Methods for the Examination of Water and Wastewater, 1971, by the American Public Health Association, American Water Works Association, and the Water Pollution Control Federation, and any revisions or amendments thereto, or other methods acceptable to the Agency.

(g) **Variance.** In any cases where, upon application of the responsible person or persons, the Agency finds that by reason of exceptional circumstances the strict enforcement of any provision of these standards would cause undue hardship, that disposal of the sewage, industrial waste or other waste is necessary for the public health, safety or welfare, or that strict conformity with the standards would be unreasonable, impractical or not feasible under the circumstances, the Agency in its discretion may permit a variance therefrom upon such conditions as it may prescribe for prevention, control or abatement of pollution in harmony with the general purpose of these standards and the intent of the applicable state and federal laws.

Filed August 14, 1973.

MINNESOTA POLLUTION CONTROL AGENCY
Division of Water Quality

Recommended Design Criteria for Disposal of
Effluent by Land Application

May 1, 1972

Effluent for final disposal by land application shall first be treated by adequate and well-operated secondary treatment works, including disinfection, to produce an effluent quality with a five day biochemical oxygen demand of 25 mg/l or less, total suspended solids concentration not in excess of 30 mg/l and fecal coliform organisms not exceeding 200 Most Probable Number per 100 milliliters.

1. Supplement to Preliminary Engineering Report

The engineering report shall contain pertinent information on location, geology, soil conditions, area for expansion, groundwater conditions and any other factors which may affect the feasibility and acceptability of the proposal.

The following specific information is to be submitted in addition to that required by the latest edition of Recommended Standards for Sewage Works of the Great Lakes-Upper Mississippi River Board of State Sanitary Engineers and the Federal Guidelines on Design, Operation, and Maintenance of Wastewater Treatment Facilities of the U. S. Environmental Protection Agency:

1.1 Supplementary Field Information

1.11 Legal description of the disposal site.

1.12 The location of all existing and proposed residences, commercial or industrial developments, roads, and ground or surface water supplies within one half mile of the proposed site.

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1.13 When industrial wastes are involved, analytical data showing the constituents of the waste.

1.14 Representative percolation and infiltration data on the topsoil, and the subsoil layers between the surface and groundwater table.

1.15 Representative data on the chemical and bacteriological quality of the groundwater as well as its elevation and the rate and direction of flow under existing and proposed conditions of use.

1.16 A description, including maps showing elevations and contours, of the site and adjacent areas which may be suitable for expansion.

1.17 Pertinent (as a minimum temperature, rainfall, evaporation, runoff, and wind speed and direction) climatological data for the area on a yearly basis, and specific data for the proposed on-land effluent disposal period.

1.18 Location, depth and outlet of field drain tiles on the site.

1.19 A summary describing the existing vegetation and wildlife of the area.

1.2 Geological Information

1.21 The depth, nature and type of the deeper formations at the site and the general area.

1.22 The degree of weathering of any shallow bedrock.

1.23 The local bedrock structure, including the presence of faults, fractures, and joints.

1.24 The character and thickness of the residual soils and glacial deposits.

1.25 In limestone terrain, additional information about sinkholes and solution openings.

1.26 Representative soil boring data to a depth of at least 25 feet or to bedrock. The information should include a detailed description of the properties of the major soil types present and any soil survey information available from the Soil Conservation Service of the U.S. Department of Agriculture.

1.27 The source should be given for any information not developed originally by the consultant.

2. Storage

2.1 An effluent storage pond system shall be provided having a minimum of 210 days capacity without consideration for evaporation and seepage looses.

2.2 The pond shall be designed and constructed in accordance with the applicable criteria for waste stabilization ponds.

3. Location of Disposal Site

3.1 At least one mile from any municipal water supply and one fourth of a mile from any private domestic water supply, except that in limestone or other unusual geological areas a greater distance may be required.

3.2 At least one fourth of a mile from any human habitation or area which is likely to be developed for the same within the proposed use period of the project.

3.3 At least one fourth of a mile from state parks, recreation areas, and lakes or rivers which are useable for recreation or crop irrigation.

3.4 A statement from the regional clearinghouse or local planning and zoning agency on the planned uses of the disposal site and adjacent land.

4. Design of Irrigation Area

4.1 The vertical distance between the surface of the irrigation field and the maximum height of the groundwater table should be a minimum of ten feet or more if possible, except where the site is to be underlain by field tile and the percolate intercepted for discharge to surface waters in which case the vertical distance between the surface of the irrigation field and the field tile should be a minimum of four feet.

4.2 The spray irrigation season for design purposes shall not exceed a maximum of 18 weeks.

4.3 For the purpose of designing the pumping, flow measuring and irrigation equipment necessary to handle the effluent volume, the maximum application rate before evaporation shall be two inches per acre per week, except for eight weeks in July and August when the maximim allowable rate may be four inches per acre per week, but the overall rate shall not exceed 52 inches per acre per year. Rates above two inches per week in July and August will be allowed on a permanent basis only after submission of operational data showing that the system can effectively accept such larger volumes of effluent. The effluent shall not be applied at a rate to exceed one-half inch per hour, with the maximum application per hour not to exceed one-fourth of an inch.

4.4 For the purpose of determining land requirements the maximum application shall be limited to two inches per acre per week, or a total of 36 inches per acre per year, to insure that sufficient land will be available if rates greater than two inches cannot be utilized.

4.5 To the extent possible a buffer zone around the land disposal site shall be provided through purchase of additional land and/or control of the land use through zoning ordinances.

4.6 The effluent shall be applied so as not to have an adverse effect on vegetation. In the absence of suitable natural vegetation, provision shall be made for developing and maintaining an acceptable vegetative cover on the site.

4.7 Computation of the area required for irrigation shall be based on representative percolation and infiltration data, available rainfall data, the maximum irrigation season and application rates, plus an allowance for system maintenance and for drying and harvesting cover crops, where applicable.

4.8 The irrigation area shall be diked to prevent any surface runoff of effluent, and/or provision made for its recapture by a system of ditches, storage and pumping facilities or other acceptable means.

4.9 Extraneous surface water shall be prevented from entering the irrigation area.

4.10 Spray irrigation systems shall be designed or operated such that no parts of the irrigation field remain in operation for longer than six days at a time. The spray equipment used shall to the extent feasible be such as to minimize wind drift of effluent and formation of aerosols.

4.11 The slope of broad field or ridge and furrow irrigation sites shall not exceed two percent.

4.12 The depth of the trench in a ridge and furrow field shall not exceed one foot.

4.13 The minimum permissible horizontal distance between any two trenches shall be eight feet.

5. Design of Seepage Basins

5.1 Seepage basins shall be preceded by tertiary treatment works designed to remove nitrates and other potentially detrimental soluble chemical constituents except where the site is to be underlain by field tile and the percolate intercepted for discharge to surface waters.

5.2 Seepage basins shall be designed to dispose of the entire annual wastewater flow in a period of not more than six months during warm weather.

5.3 The vertical distance between the basin bottom and the maximum height of the groundwater table should be a minimum of ten feet, except where the site is to be underlain by field tile and the percolate intercepted for discharge to surface waters in which case the vertical distance between the surface of the irrigation field and the field tile should be a minimum of four feet.

5.4 Computation of the area required for the seepage basin shall be based on representative percolation and infiltration data and available rainfall data.

5.5 The seepage basin shall be diked or ditched to prevent surface runoff of the effluent, and/or provision made for its recapture by a system of ditches, storage and pumping facilities or other acceptable means.

5.6 Extraneous surface water shall be prevented from entering the irrigation area.

6. Safeguards and Monitoring

6.1 The site shall be enclosed with a fence capable of discouraging the entrance of unauthorized persons and wild animals, and preventing the entry of livestock.

6.2 Appropriate warning signs shall be provided on the fence around the site to inform the public of the nature of the facility and advise against trespassing. At least one sign shall be provided on each side of the site and one for every 500 feet of its perimeter.

6.3 Shallow wells shall be placed in all directions of major groundwater flow from the site. The wells shall be not more than 200 feet outside of the site perimeter, spaced not more than 500 feet apart, and extending into the groundwater table. The shallow wells shall be no deeper than 5 feet below the seasonal low watertable. Additional wells shall be provided on-site which draw from the waters of the underlying deep strata. Wells or spacings may be varied in any particular situation depending upon circumstances.

6.4 Consideration shall be given to providing automatic irrigation or flow shut-off equipment during periods of precipitation.

6.5 Provision shall be made for measurement of the quantity and quality of the effluent discharged to the irrigation field, and measurement of the static water level of the observation wells.

7. <u>Operation and Reporting</u>

Any or all of the following tests may be required routinely every month on samples from all observation wells and the flow from field drain tile outlets:

Conductivity
Chlorides
Dissolved Solids
Nitrates
Nitrites
Ammonia
Methylene Blue Active Substance
Fecal Coliform Group Organisms
5-day Biochemical Oxygen Demand
Phosphorus

7.2 Other tests on samples from the observation wells or tile outlets also may be required as recommended by the staff of the Division of Water Quality, such tests to be made and reported to the Agency before, during and after periods of use of the site.

7.3 The groundwater sample shall be taken after the well has been pumped a minimum of 15 minutes.

7.4 Pertinent operational information shall be submitted monthly to the Agency.

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7.5 The aerial or leafy shoot portion of the vegetative cover of grasses or forbs, if such are the main cover, shall be harvested at least annually and disposed of off-site in a satisfactory manner.

8. Other

8.1 The quality of the treated wastewater effluent to be disposed of in this manner shall insofar as it is reasonably possible conform with the current mandatory and recommended Drinking Water Standards published by the Public Health Service, U.S. Department of Health, Education and Welfare, and the standards for class 1B waters as set forth in Agency regulations WPC 14, 15, and 23. Any expected departure therefrom shall be noted in the engineering report together with proposed means for conforming, or justification therefor if remedial measures are not proposed.

8.2 Any significant detrimental change in the groundwater and/or irrigation field effluent quality at or near the site shall constitute grounds for requiring additional treatment works and/or abandonment of the disposal site.

8.3 Adequate pre-operational baseline data on the groundwater quality, and other environmental aspects as may be requested, shall be obtained and submitted for review before the site is placed in operation.

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DRAFT
Date________

Evaluating Land Application in Facilities Planning

The construction grants program requires that cities investigate land treatment systems during Facilities Planning. Because the feasibility and costs of land treatment systems are very dependent upon the characteristics of potential application sites, unique problems are encountered in evaluating land treatment in Facilities Planning. Because of this, the Agency has developed a recommended procedure for evaluating land treatment alternatives. This procedure segments the necessary site investigation work into two phases. The grant for Facilities Planning should be sufficient to complete work in both phases, but no second phase work should be initiated until after phase one work has been completed and reviewed and approval for phase two has been obtained from the Agency.

Phase 1 work should assess general area suitability and, where appropriate, present a site or sites exhibiting substantial probability as a land treatment system. This phase should generally use the existing data bank, possibly supplemented by limited, reconnaissance field data.

Phase 2 involves substantial field investigations and generation of detailed data specific for the proposed site and conditions.

Typical data to be generated and provided in each of these phases is outlined below:

Typical Data Requirements For Phase 1

1. Legal Description of the Application Site(s)
2. U. S. Geological Survey Quadrangle Maps

3. Location of all existing and proposed residences, commercial developments, roads, and water supplies within 1/2 mile delineated on appropriate maps
4. Existing land use, vegetation, and wildlife
5. Climatological data to include pertinent information on wind speed and direction, precipitation, evapotranspiration, and temperature.
6. Wastewater volumes and where industrial wastes are involved, wastewater analytical data.
7. Geologic and ground water information as available from geologic maps, hydrologic atlases, soil maps, nearby well logs and pumping data.
8. Soil information as available from soil survey maps, soil atlases, and Soil Conservation Service, Soil and Water Conservation District, and County Extension Service personnel.
9. Presence and location of field drainage systems and outlets.
10. Reconnaissance soil borings to six feet to identify soil types where existing soil survey data is insufficient.

Typical Data Requirements For Phase 2

1. Infiltration and percolation rate data for surface and subsurface soil.
2. Ground water depth, flow direction, gradient, aquifer thickness at existing conditions and as estimated for proposed operational conditions.
3. Soil boring data to at least 25 feet or bedrock, whichever is least.

4. If encountered in borings, a description of local bedrock conditions, including faults, fractures, joints.
5. Detail on the presence of or formation of sink holes or solution channeling.
6. Detailed site contours at present and a discussion of any topographic modifications.
7. Preliminary design for application rates, acreages, application methods, drainage, runoff, storage, vegetation, monitoring.

RECOMMENDATIONS FOR APPLICATION
OF MUNICIPAL WASTEWATER SLUDGES ON LAND

August 1978

MINNESOTA POLLUTION CONTROL AGENCY
1935 West County Road B-2
Roseville, Minnesota 55113

RECOMMENDATIONS FOR APPLICATION
OF MUNICIPAL WASTEWATER SLUDGES ON LAND

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(08/15/78)

RECOMMENDATIONS FOR APPLICATION OF MUNICIPAL WASTEWATER SLUDGES ON LAND

A. INTENT

Improper disposal of municipal wastewater sludges on land can adversely affect surface and ground waters, soil, vegetation, public health, and the general public welfare. It is the purpose of this document to set forth recommendations of the Minnesota Pollution Control Agency pertaining to land application of municipal wastewater sludges.

In the application of sludge on land, priority consideration should be given to alternatives such as landspreading which beneficially use or recycle the materials in the sludge. The recommendations contained herein represent generally accepted and used engineering and operational practices for landspreading of municipal wastewater sludges. As further data becomes available or changes in statutes and regulations take place, modification of these recommendations may be necessary. Also, landspreading practices other than those outlined herein and determined by the Director to be acceptable for protecting the environment and public welfare may be used. Practices involving sludge burial or landfilling must be done in accordance with all applicable regulations and criteria of the Agency.

B. DEFINITIONS

For the intent and purpose of these recommendations, the following definitions should be used. Terms not here defined should be construed in accordance with acceptable professional usage.

"AGENCY" - The Minnesota Pollution Control Agency

"AGRICULTURAL LAND" - Land intensively managed for production of crops used for human or animal consumption.

"AVAILABLE NITROGEN" - Nitrogen which can be readily absorbed by growing plants or leached by percolating water.

"DEDICATED APPLICATION SITE" - Site devoted to and managed for the primary function of sludge disposal. Such sites may or may not be used for growth of food chain crops, but generally do receive high cumulative sludge and potential pollutant loadings and are, therefore, intensely managed and monitored during and after the application program.

"DEWATERED SLUDGE" - Sludge with sufficient solids content such that it has no free water and can be transported and handled as a solid material.

"DIRECTOR" - The Executive Director or other designated representative of the Minnesota Pollution Control Agency.

"GROUND WATER" - Water contained below the surface of the earth in a saturated zone, including, without limitation, all waters whether under confined, unconfined, or perched conditions, in near surface unconsolidated sediment or regolith, or in rock formations deeper underground.

"HEAVY METALS" - Metals having a high specific gravity; including but not limited to, cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni) and zinc (Zn).

"INCORPORATION" - The mixing of sludge with topsoil, concurrent with application or within 48 hours thereafter, by means such as discing, mold-board plowing, chisel plowing or rototilling.

"LANDSPREADING" - Placement of sludge in or on soil at rates where the quantity of nutrient and non-nutrient elements and soil conditioning materials is consistent with the biochemical assimilative capacity of the soil-plant system.

"LEACHATE" - Liquid which has percolated through sludge amended soil and has dissolved and extracted variable concentrations of materials from it.

"MUNICIPALITY" - A city, sanitary district, or other governmental subdivision or public corporation.

"NON-DEDICATED AGRICULTURAL SITE" - Site intensely managed for production of crops used as human or animal food, around which sludge application is scheduled and managed. Such sites receive low cumulative sludge and potential pollutant loadings and generally are not intensely managed and monitored because of sludge additions.

"NON-DEDICATED NON-AGRICULTURAL SITE" - Site not currently used in agricultural production, but which otherwise meets the definition of a "non-dedicated agricultural site."

"ORGANIC NITROGEN" - Nitrogen combined with, and part of, organic compounds. In sludge, organic nitrogen generally equals Kjeldahl nitrogen minus ammonium and nitrate nitrogen.

"PCB's" - Total polychlorinated biphenyls, persistent organic chemicals.

"RESIDENTIAL DEVELOPMENT" - A concentration of human residences equaling or exceeding 10 residences within 10 acres.

"SLUDGE" - The various solids and associated liquid encountered and concentrated during wastewater treatment; not inclusive of grit, scum or screenings where such materials are removed from other solids during treatment.

"SLUDGE SOLIDS" - The total, oven-dry (105°C) solids in sludge.

"SOIL CATION EXCHANGE CAPACITY" - A measure of the potential quantity of readily exchangeable positive ions that the soil can attract and retain, expressed in milliequivalents per 100 grams of soil.

"SOIL TEXTURE" - The relative proportion of the soil separates sand, silt and clay.

Coarse Texture - USDA textural classification sands and loamy sands

Medium Texture - USDA textural classification sandy loams, loams, silt loams, and silts

Fine Texture - USDA textural classification clay loams, and clays

"STABILIZED SLUDGE" - Sludge which has been treated to provide pathogen reduction and odor control.

"SURFACE APPLICATION" - Sludge spread on the surface of the land and not incorporated into the soil within 48 hours of application.

"TISSUE ANALYSIS OR MONITORING" - Analytical determination of vegetative composition; to include, but not limited to, major inorganic constituents, heavy metals, and as necessary, persistent organics. The stage of development and sampling tissue varies with plant species and use.

"USDA" - United States Department of Agriculture.

C. RECOMMENDATIONS FOR LANDSPREADING

Landspreading of sludge for utilization as a fertilizer and soil conditioner is considered in most cases to be preferable to disposal oriented practices such as landfilling, and landspreading should be practiced wherever feasible. The following recommendations indicate application site location factors, application rates and management practices which provide a feasible opportunity for landspreading of sludge while minimizing associated potential environmental and public health problems.

1. Stabilization of Sludge

a. Sludge should be adequately stabilized prior to landspreading to avoid undue nuisance and potential public health problems.

b. Alternative methods of stabilization include:

(1) High rate, heated anaerobic digestion with a minimum solids retention time of 10 to 15 days.

(2) Low rate, unheated anaerobic digestion with a minimum solids retention time of 30 to 60 days, depending upon sludge temperature.

(3) Aerobic digestion, a minimum solids retention time of 15 to 20 days at sludge temperatures higher than 60°F. Retention time should be increased at least 25% for each 10°F decrease in sludge temperature below 60°F.

(4) Lime stabilization; sludge pH must be maintained at 11.5 or greater for at least one hour.

(5) Chemical and physical stabilization. Other methods may be acceptable provided an adequate degree of stabilization is achieved and the acceptability for land application is not impaired.

(6) Composting the sludge at temperatures above 130°F which are the result of oxidative bacterial action, and further stockpile curing for 30 days. If sludge is composted, the process shall consider all applicable regulations and should be done using proven sludge composting methods.

2. Storage of Sludge

a. The need for, type, and size of sludge storage facilities should be evaluated on a case-by-case basis. Storage facilities should be included in any landspreading program where year-round application may be restricted by such things as soil conditions, topography, road weight restrictions, snow depths, wet periods, cropping seasons, or periods of conflicting land use.

b. Storage facility location and design should consider geologic and hydrologic conditions, prevailing winds, vegetative barriers, topography, residence locations, leachate and runoff generation, and facility operation and maintenance.

c. Storage facilities should not be located within a 100 year flood plain.

d. Permanent open storage facilities should be at least 1/4 mile from occupied residences and areas of concentrated human activity and should be enclosed by adequate fencing and access gates equipped with locks.

e. Storage facilities should be designed such that the maximum seepage loss is less than 500 gallons/acre/day (0.018 inches per day). Facility design should consider removal of solids from the facility and integrity of the seal.

f. Facilities should be diked as necessary to retain sludge and divert extraneous surface runoff.

3. Sludge Composition Data

a. Chemical analyses of sludge is necessary for all projects. The data should characterize the sludge which is actually land applied (direct from digester, stored, chemically treated, dewatered, liquid, etc.) and be reported on a dry weight (105°C) basis.

b. Minimum analytical requirements for different class treatment facilities are provided in Table I. Increased sampling frequency or additional parameters may be necessary on a case-by-case basis as determined by the Director.

c. Design for new or upgraded facilities and landspreading practices should be based on a minimum of two separate samples taken a minimum of three weeks apart.

d. The following concentrations of heavy metals (dry weight basis) are median values found in numerous sludges throughout the upper midwest. Concentrations substantially above these levels probably result from point source discharges and pretreatment of such discharges is recommended.

Zinc	1750 mg/kg	Nickel	100 mg/kg
Chromium	900 mg/kg	Cadmium	20 mg/kg
Copper	850 mg/kg	Mercury	5 mg/kg
Lead	500 mg/kg		

TABLE I

Required Sludge Analyses*

Parameter	Treatment Facility Classification		
	A	B	C and D
pH	quarterly	semi-annually	annually
Total solids (%)	"	"	"
Total Volatile Solids (% of total solids)	"	"	"
NH_3-N (%)	"	"	"
NO_3-N (%)****	"	"	"
Kjeldahl-N (%)	"	"	"
Total Zinc (mg/kg)***	"	"	"
Total Copper (mg/kg)***	"	"	"
Total Nickel (mg/kg)***	"	"	"
Total Lead (mg/kg)***	"	"	"
Total Cadmium (mg/kg)***	"	"	"
Total Mercury (mg/kg)***	annually	annually	**
Total Chromium (mg/kg)***	"	"	**
Total PCB's (mg/kg)***	"	"	**

* Analyses performed in accordance with Standard Methods, 1977 or Methods for Chemical Analysis, EPA, 1974 and results reported on a dry weight (105°C) basis

** Not required unless specifically requested by the Director

*** Upon establishment of relatively consistent concentrations and data base, a reduction in required parameters and/or monitoring frequency may be requested

**** Necessary for aerobically digested or composted sludges only

4. Application Methods

a. Liquid sludge may be applied in several ways:

   (1) Tank trucks and wagons - vehicles should be equipped with deflector plates or equivalent to promote uniform application.

   (2) Subsurface injection.

   (3) Pressurized spray - sludge must be highly stabilized; for upward directed spray nozzles, application should be limited to wind speeds less than 10 miles per hour; special consideration must be given to aerosol drift and aesthetics.

b. Dewatered sludge may be applied like solid animal manures.

c. Sludge should be incorporated into the soil as necessary to prevent runoff and nuisance conditions. This is an especially important consideration for chemically stabilized sludges.

d. Transport of sludge should be performed without spillage, undue odors or unsightliness.

5. Location of Application Sites

a. Separation from human dwellings, water wells and public transportation facilities are as shown in Table II.

TABLE II

Separation Distances (feet)

Feature	Method of Application: Immediate Incorporation or Injection	Surface Spreading	Pressurized Spray
Individual Dwelling*	100	200	1300
Residential Development*	300	600	2600
Water Wells	200	200	200
Major Road Rights-of-Way	10	25	300
Airports**			

* Distances may be reduced upon consent of occupants

** Regulations and criteria of the Federal Aviation Administration and Division of Aeronautics, Minnesota Department of Transportation must be observed with regard to sludge application on airport land. Approval of these agencies should be submitted where application on airports is desired.

b. Separation from surface water (including streams and waterways)

(1) Sludge should not be surface applied within a 10-year floodplain or within any wetland area.

(2) Care shall be taken to prevent direct runoff into any drainage ditch or waterway.

(3) Where sludge is injected or immediately incorporated into the soil, or where the site is enclosed by adequate diking to retain runoff and sediment, the recommended separation from surface water is 100 feet.

(4) Where sludge is applied by pressurized spray, the minimum recommended separation from surface water is 300 feet.

(5) Where sludge is surface applied by tank truck, wagon or similar method, the recommended separation from surface waters is given in Table III.

TABLE III

Separation from Surface Waters for Surface Applications

Slope (%)	Texture of Surface Soil	Months of Application	Minimum Separation (feet)
0 - 6	Coarse	May - October	200
		November - April	400
	Medium and Fine	May - October	300
		November - April*	600
Greater than 6	All	All year	No surface application without runoff retention terraces or berms

* Winter spreading on medium and fine textured soil should be limited to 0 - 2% slopes wherever possible and in no case should the slope exceed 6%.

c. Separation from ground water and bedrock is listed below:

Soil Texture	Minimum Separation (feet)
Coarse	6
Medium and Fine	4

d. Soil Considerations:

(1) Whenever available from local Soil and Water Conservation District or Soil Conservation Service offices, a detailed soil map of a scale equaling four inches per mile or larger should be obtained to determine soil types at application sites.

(2) Sludge should not be applied to very coarse sands or gravel soils.

(3) Organic soils (peat) should not be utilized for sludge application unless adequately drained.

(4) Application sites should be tested to determine specific soil characteristics. Generally, land receiving sludge should be divided into areas not exceeding 40 acres for composite sampling and testing. Areas differing in soil type, crop yield and management practices should be sampled separately. For each designated sampling area, individual samples should be taken to a depth of one foot from about 10 locations, the samples placed in a clean container, mixed together, and a sample of the composite soil taken for analysis.

(5) Required soil test data is listed in Table IV.

TABLE IV

Parameter
Texture (USDA Classification)
Organic matter (%)
Extractable phosphorus (Bray's No. 1 Extractant)
Exchangeable potassium (Ammonium Acetate Extractant)
pH (1:1 soil-water suspension)
Lime requirement to pH 6.5
Soluble salts (electrical conductance - mmhos/cm)

6. Site Usage Agreements

a. The municipality is responsible to achieve proper sludge disposal. Reliable access to and proper management of application sites are vital factors in any successful landspreading program. Therefore, appropriate agreements between application site owners and the municipality should be made to reasonably ensure reliable access and site management plans. Wherever such agreements are verbal or otherwise non-binding in nature, agreements should be obtained for acreages equaling or exceeding 150% of the required application acreage. At least two separate owners should be included in obtaining the necessary site acreages with agreements.

b. Small scale sludge giveaway, individual sludge pickup, and sludge marketing programs must be closely supervised by the municipality. The following is a minimal recommended program for such control:

(1) Individuals may receive or pick up 10 cubic yards or less of dried or dewatered stabilized sludge without furnishing specific site or management information. However, these individuals should sign a criteria-agreement sheet which states their agreement to adhere to minimum sludge usage criteria outlined on the sheet. Copies of the signed criteria-agreement sheet should be retained by both the individuals and the municipality.

(2) The municipality should obtain, submit, and receive approval of all information pertaining to application site location, description, and management prior to delivering or allowing individual pickup of more than 10 cubic yards of dried or dewatered sludge or any quantity of liquid sludge.

(3) Marketed sludge products should at a minimum have a label containing directions for use. These directions should include recommended and non-recommended uses and recommended rates for various acceptable uses.

7. Utilization on Non-Dedicated Agricultural Sites

a. Nitrogen Limitations. The rate of sludge applied per year must be controlled so as to avoid excess nitrogen additions and the resulting potential for nitrogen pollution of ground water. Annual limitations based on nitrogen additions are described below:

(1) Existing treatment facilities - Calculations in this section to determine annual application rates based on available nitrogen additions need not be performed if sludge application rates do not exceed five tons of solids per acre per year. Rates greater than five tons of solids per acre per year may be used if the calculations in this section are performed and indicate such rates would be acceptable.

(2) New and upgraded facilities - Design application rates should be calculated in accordance with the following discussion or other methods acceptable to the Director. Design application rates must consider appropriate available nitrogen levels for various crops, yields and soils and the amount of available nitrogen supplied by the sludge and any other added nitrogen containing materials.

(a) Maximum allowable available nitrogen levels for various crops and yields and soil types are provided in Table V.

TABLE V

Maximum Allowable Available Nitrogen Levels for Various Crops, Yields and Soil Textures

Crop	Yield/Acre	Maximum Available Nitrogen Level (lbs./acre) ------ Soil Texture ------ Coarse	Medium	Fine
Alfalfa*	4 ton	180	210	230
	6 ton	280	340	370
Barley	80 bushel	100	110	120
Bluegrass	3 ton	180	210	230
Corn	75 bushel	100	120	130
	100 bushel	130	150	160
	125 bushel	150	180	190
	150 bushel	180	210	230
	175 bushel	210	250	270
Oats	75 bushel	80	90	100
	100 bushel	130	150	160
Soybeans*	30 bushel	120	140	150
	40 bushel	180	210	230
	50 bushel	230	270	300
	60 bushel	280	340	370
Wheat	50 bushel	100	120	130
	75 bushel	160	180	190

* Legumes can usually obtain their nitrogen from the atmosphere, so addition of fertilizer nitrogen is not normally needed. However, since fertilizer nitrogen reduces use of atmospheric nitrogen, sludge may be applied.

(b) Where crops are not harvested from the site each year, maximum allowable available nitrogen application during years of non-harvest are provided in Table VI.

TABLE VI

Degree of Vegetative Cover	Maximum Allowable Available N Application Level (lbs./acre) ------- Soil Texture ------ Coarse	Medium	Fine
high density	75	100	125
low density	50	75	100

(c) Where application sites are used in consecutive years, carryover nitrogen from sludge applied the previous year must be subtracted from the maximum allowable nitrogen level (Tables V or VI) to determine ongoing application rates. An approximation of carryover nitrogen from sludge applied the previous year is as follows:

Carryover N (lbs./acre) =

(% organic sludge N) x (tons sludge solids/acre)

(d) Available nitrogen added in fertilizers or animal manures must be subtracted from the maximum allowable nitrogen level (Tables V or VII) to determine sludge application rates.

(e) The amount of available nitrogen added with sludge is dependent upon type of stabilization, application method and sludge composition and can be estimated using the proper formula in Table VII.

TABLE VII

Formulas for Determination of Available Nitrogen in Sludge
(pounds of available nitrogen per ton of sludge solids)

Type of Stabilization	Application Method	Formula
Digested	Surface . . .	(% organic---N x 4) + (% NH_3---N x 10)
	Incorporated or Injected .	(% organic---N x 4) + (% NH_3---N x 15)
Chemically or Physically Stabilized or Unstabilized	Surface . . .	(% organic---N x 6) + (% NH_3---N x 10)
	Incorporated or Injected .	(% organic---N x 6) + (% NH_3---N x 15)

(f) Necessary nitrogen limit determinations are as follows:

(i) Based on cropping practices and soil type, determine maximum allowable available nitrogen levels (Tables V and VI).

(ii) Determine and subtract carryover nitrogen and other added nitrogen from the maximum allowable available level (Section C.7.a.(2)(c) and (d)).

(iii) Determine available nitrogen in sludge (Table VII).

(iv) Divide maximum allowable available nitrogen level (lbs./acre) by available nitrogen in sludge (lbs./ton) to obtain sludge application rate in tons of solids per acre per year.

b. Heavy Metal Limitations. The total quantity of sludge applied to a site over the duration of site usage should be limited to prevent excessive heavy metal accumulation in the soil and subsequent potential plant and food chain toxicity.

(1) The metals of greatest concern for most sludges are cadmium, zinc, copper, nickel and lead. The recommended total cumulative addition of these metals to agricultural land are found in Table VIII.

TABLE VIII

	TOTAL RECOMMENDED METAL ADDITIONS (lbs./acre) ------- Soil Cation Exchange Capacity ------- (milliequivalents/100 grams)		
METAL	0-5	5-15	>15
Lead	500	1000	2000
Zinc	250	500	1000
Copper	125	250	500
Nickel	50	100	200
Cadmium	5	10	20

(2) No more than two pounds of cadmium should be applied per acre per year.

(3) Sludge application to non-dedicated agricultural sites should be terminated when the sum addition of any one metal equals the recommended total for that particular metal and soil. Metal additions above those levels listed in Table VIII or above two pounds of cadmium per acre per year will require crop tissue monitoring and specific approval of the Director.

(4) In particular situations, metals other than those listed in Table VIII may be of concern and additional specific limitations may be imposed.

(5) The Soil Cation Exchange Capacities used to determine metal addition limits can be estimated using Table IX. As considered necessary by the Director, direct analytical measurement of cation exchange capacities may be required instead of using estimations.

TABLE IX

Cation Exchange Capacity
(milliequivalents/100 gms)

	------------ Soil Organic Matter Level ------------		
Texture	Low (<2%)	Medium (2-4%)	High (>4%)
Coarse	0 - 5	5 - 15	5 - 15
Medium	5 - 15	5 - 15	>15
Fine	>15	>15	>15

(6) Necessary heavy metal limit calculations are as follows:

(a) Pounds of metal per ton of sludge solids = concentration in ppm (mg/kg) x 0.002.

(b) Design cumulative sludge loading = metal addition limit (Table VIII) divided by pounds of metal per ton of sludge solids (should be calculated for each metal with the lowest value being maximum design cumulative sludge loading).

(c) Metal addition per sludge application = pounds of metal per ton of sludge solids x tons sludge solids applied.

(d) A running total or summation of the pounds of each metal applied from sludge applications should be kept and when the sum addition of any one metal equals the total addition limit for that metal, sludge applications should be ceased.

(e) Accurate records must be kept for each site on the quantity of sludge applied per year and cumulatively, and the quantity of metals applied per year and cumulatively.

c. Persistent Organic Limitations. In some instances persistent organics may be found in sludges at concentrations to be of concern for vegetative and food chain toxicity and ground water quality. There currently is insufficient data to set specific criteria for allowable concentrations in sludge or for annual or cumulative additions of sludge-borne persistent organics. There is, however, enough data to conclude that special precautions, site management, and monitoring may be necessary where sludges are found to contain significant concentrations of persistent organics. The specific precautions and monitoring necessary for such projects will have to be determined on a case-by-case basis.

d. Soluble Salt Limitations

(1) Sludge application should be suspended whenever the electrical conductivity of a saturation extract of site soil exceeds 4 millimhos/cm (soluble salt test).

(2) Long term application of sludges high in sodium can cause a deterioration of soil structure and result in increased erosion and runoff. The Director should be notified if

field observations indicate reduced water infiltration rates or deteriorating soil structure.

e. Management Practices. Proper utilization of sludge on land requires good site management, much of which is commonly recommended cropland management.

(1) Runoff Control

(a) Where necessary, appropriate tillage operations should be performed to promote infiltration of sludge liquid and rainfall, i.e., crusted soil should be tilled before application.

(b) To avoid prolonged ponding and runoff, individual surface applications of liquid sludge should generally not exceed:

Coarse textured soil --- 25,000 gallons per acre
Medium textured soil --- 15,000 gallons per acre
Fine textured soil ----- 10,000 gallons per acre

(c) Soil conservation measures such as contour tillage, strip cropping and terracing should be practiced at application sites as necessary to minimize soil erosion losses.

(d) Diking of application sites must be provided where site conditions or management practices fail to prevent polluted runoff and eroded sediments from reaching surface waters or, as necessary, adjoining property.

(2) Cropping Practices

(a) To apply sludge at maximum nitrogen application rates (i.e., in accordance with Table V) it will be necessary for a crop to be grown and appropriately harvested each year. If crops are not harvested each year, application rates should be restricted to levels consistent with Table VI.

(b) Sludges having concentrations exceeding 1000 mg/kg lead, 25 mg/kg cadmium, 10 mg/kg mercury or 5 mg/kg total PCB's should not be applied on forage crops or pastures where surface contamination of the foliage and direct ingestion by feeding animals is possible. This is especially important for dairy cattle. An allowable exception to this criteria is that the above sludges may be applied on forage crops during the period immediately following cutting and harvest when there is minimal vegetative surface area. Application under this exception should be made within seven days of forage cutting.

(c) Harvesting of forage crops or grazing of pastures should be delayed for at least two weeks following application.

(d) Sludge amended soils should generally not be used for growth of leafy vegetables to be consumed by humans unless crop tissue analyses indicate such practices are acceptable. This is especially pertinent during the year the sludge was applied and for sludges having cadmium concentrations greater than 25 mg/kg.

(e) Vegetable crops consumed raw by humans should not be grown on sludge amended soils for at least one year and preferably two years following the last sludge application.

(3) pH Control

(a) The pH of sludge amended soils should be maintained between 6.5 and 8.0 throughout the application program.

(b) After the cessation of sludge application to a site, the soil pH should be maintained at 6.2 or greater for five years.

(4) Potassium Fertilization. Supplemental potassium fertilization consistent with agronomic production is recommended as necessary to assure desired crop yield and nitrogen uptake.

(5) Public Access. Unless the sludge has undergone treatment for reduction of potential pathogens beyond normal stabilization processes, public access to application sites should be restricted for at least two weeks after the last application

f. Monitoring

(1) Except as specifically exempted for small scale giveaway and individual pickup programs, routine monitoring will be necessary of all sludge disposal programs. All necessary monitoring is the responsibility of the municipality.

(2) The following is a list of minimum monitoring requirements:

Sites and acreages used for application

Amount of sludge spread per site

Sludge composition data (Table I)

Soil test data (Table IV)

Cropping practices

Problems encountered

(3) Monitoring of runoff, leachate, ground water, soil and vegetation may be required where project size; sludge, soil, site properties; or management practices could adversely impact water, soil or vegetative resources.

8. Utilization on Non-Dedicated, Non-Agricultural Sites

a. Nitrogen Limitations. Annual sludge application rates should be limited such that available nitrogen additions are consistent with Table VI and Section C.7.a., or as otherwise specifically approved by the Director.

b. Heavy Metal Limitations. The total quantity of sludge applied to non-dedicated, non-agricultural sites over the duration of site usage should be limited such that the total cumulative addition of metals is limited to levels provided in Table VIII. The acceptability of metal additions above those levels must be determined on a case-by-case basis and have the specific approval of the Director.

c. Further Limitations

(1) Limitations for application of sludges containing significant concentrations of persistent organics must be determined on a case-by-case basis.

(2) Sludge application should be suspended whenever the electrical conductivity of a saturation extract of site soil exceeds 4 millimhos per centimeter (soluble salt test), except as otherwise specifically approved by the Director.

d. Management Practices

(1) Runoff Control - See Section C.7.e.(1).

(2) pH Control - See Section C.7.e.(3).

(3) Vegetation. A vegetative cover should be established and maintained on all non-agricultural sites.

(4) Public access - See Section C.7.e.(5).

e. Monitoring Requirements - See Section C.7.f.

9. Utilization on Dedicated Application Sites

Classification of application sites as dedicated sites requires demonstration of the capability for acceptable long term and intensive site management and monitoring.

a. Nitrogen Limitations. Annual sludge application rates should be limited such that available nitrogen additions are consistent with Table V or VI, whichever is appropriate, and Section C.7.a., or as otherwise specifically approved by the Director.

b. Heavy Metal Limitations. The quantity of sludge applied to dedicated sites must be controlled to prevent excessive heavy metal accumulation in the soil or vegetation. It is not possible at this time to set precise maximum metal addition levels that would provide appropriate protection of soil, vegetative or water resources at dedicated sites. However, addition of metals beyond those levels provided in Table VIII and Section C.7.b. will necessitate site monitoring, including but not limited to, appropriate vegetative tissue analysis, soil analysis, and leachate and/or ground water analysis.

c. Further Limitations

(1) Limitations for application of sludges containing significant concentrations of persistent organics must be determined on a case-by-case basis.

(2) Soluble Salts - See Section C.8.c.(2).

c. Management Practices

(1) Runoff Control - See Section C.7.e.(1)

(2) pH Control. The soil pH of dedicated application sites should be maintained above 6.5 throughout the application program and thereafter as long as necessary to ensure protection of ground water and soil and vegetative resources consistent with future land uses.

(3) Vegetation. An appropriate vegetative cover should be established and maintained on all dedicated sites.

(4) Public Access. Access to dedicated sites should be restricted by a fence or other appropriate means.

e. Monitoring Requirements

(1) See Section C.7.f.

(2) Monitoring of leachate and/or ground water and appropriate vegetative tissues is necessary for dedicated application sites. The specific program must be determined on a case-by-case basis.

10. Utilization in Reclamation of Unproductive Land

Application should be controlled so that there is environmental improvement at the site without pollution of ground water, surface water, or land resources.

a. Application rates must be determined on an individual basis with consideration of the fate of added nitrogen, heavy metals and organics.

b. When high amounts of sludge are to be applied to alter adverse soil conditions, the sludge should be dewatered and the amount of inorganic nitrogen decreased to prevent ground water pollution.

c. Sludge should be incorporated if possible to increase the effectiveness of the application for reclamation.

d. The soil pH should be maintained between 6.2 and 8.5.

e. The same monitoring program prescribed in Section C.7.f. should be followed for reclamation projects. Projects of greater environmental concern, as determined by the Director, will also be required to monitor runoff, leachate, ground water and vegetation on a case-by-case basis.

f. Sludge application must be modified or suspended when, as determined by the Director, there is or is pending net environmental degradation due to sludge application.

D. PLANS AND REPORTS

1. Plan for Solids Disposal

In accordance with the general condition of National Pollutant Discharge Elimination System (NPDES) - State Disposal System Permits regarding "Removed Substances," all permittees will be requested to develop and submit a Solids Disposal Plan to the Agency for review and approval. As new or upgraded wastewater treatment facilities are planned and designed, the new Solids Disposal Plan should be incorporated into or accompany the facilities plans or appropriate engineering plans and reports.

a. Solids Disposal Plan for Landspreading. The following specific information should be provided in the Solids Disposal Plan where landspreading of the sludge is practiced:

(1) Data on the sludge, to include:

(a) quantity of sludge generated and disposed of;

(b) treatment provided for stabilization of the sludge;

(c) composition data as prescribed in Table I or as otherwise specifically requested.

(2) Detailed description of practices and facilities used in storage of sludge.

(3) A Soil Survey map delineating the specific location of storage facilities other than regular digesters and all landspreading sites. Each landspreading site should be numbered for easy reference during correspondence. Where Soil Survey maps are not available, the locations should be delineated on U. S. Geological Survey or county maps.

(4) Names and addresses of the owners of privately owned application sites.

(5) Type of agreement obtained for application on private land, i.e., informal written, lease, verbal, and what provisions are provided or available for alternate disposal should sites normally used become unavailable or inaccessible.

(6) Application acreage at each site.

(7) Detailed description of each application site which provides the information outlined below. The information on slopes, depths to ground water and bedrock, and soil types can be obtained from Soil Survey maps and reports, or where such reports are not available, assistance in obtaining this data may be available through local Soil and Water Conservation District, Soil Conservation Service, and Agricultural Extension personnel.

    (a) Approximate separation distances from nearest individual dwellings, residential developments, water wells, major road rights-of-way, airports, and surface waters, including drainage ditches and waterways.

    (b) Approximate degree (percent) and direction of slope(s) at site.

    (c) Approximate depth to ground water, including seasonal water tables, and bedrock.

    (d) Soils information and data as prescribed in Section C.5.d.

(8) Duration and approximate quantity of past sludge applications on proposed sites.

(9) Annual application rates to be used.

(10) Methods of application to be used.

(11) Site management practices to be used, i.e., cropping practices, crop use, etc.

(12) Description of any program for small scale sludge giveaway, individual pickup, or marketing.

(13) Discussion of how and where grit, screenings and scum are disposed of.

(14) Indication that any necessary local and county approvals have been obtained.

2. Routine Monitoring Reports

Monitoring/operational reports which provide monitoring data and summarize application and site management practices is necessary on a routine basis.

a. Annual Report for Landspreading (due by March 1 of the following year).

(1) Required sludge composition data.

(2) Application sites and acreage at each site used during the year.

(3) Soil test data for application areas used during the year.

(4) Annual application rates at each site.

(5) Vegetation grown on each site used during the year.

(6) Complaints, management problems, or other difficulties encountered during the year.

(7) A map showing the location of, and a description of any new application sites.

(8) Results of any other required monitoring, i.e., ground water, soils, vegetative tissues, etc.

(9) Quantity of sludge disposed of through small scale give-away, individual pickup and sludge marketing, and the number of participants in small scale giveaway and individual pickup programs.

E. EXAMPLE CALCULATIONS

1. Conversion of Concentrations on Wet Weight Basis (mg/l) to Concentrations on Dry Weight Basis (mg/kg).

a. Concentrations expressed on wet weight basis (mg/l) can be converted to dry weight basis (mg/kg) by dividing concentration wet weight basis by the fraction of total solids in sample.

b. Example. Given: 5% total solids

50 mg/l zinc

Concentration dry weight basis =

50 ÷ 0.05 = 1000 mg/kg

2. Conversion of Tons of Solids per Acre to Gallons of Liquid Sludge per Acre.

a. Application rate in tons of solids per acre can be converted to gallons of liquid sludge per acre by using the following procedure:

(1) tons solids per acre ÷ fraction total solids in liquid sludge = tons of liquid sludge per acre.

(2) tons of liquid sludge per acre ÷ 0.0042 tons/gallon = gallons of liquid sludge per acre.

b. Example

(1) Given : Application rate of 5 tons solids per acre, 5% total solids

(2) Solution: 5 tons solids/acre ÷ .05 = 100 wet tons/acre

100 wet tons/acre ÷ 0.0042 = 24,000 gallons liquid sludge/acre

3. Determination of Annual Application Rates Based on Nitrogen Addition

a. Given:

(1) Anaerobically digested sludge with following composition: organic nitrogen 3.0%, ammonium nitrogen 2.0%.

(2) Surface application by tank truck.

(3) Soil type is medium texture.

(4) Corn crop with 125 bushel/acre expected yield.

(5) Site received 5 tons sludge solids/acre last year.

b. Solution:

(1) Determine maximum allowable available nitrogen level for medium texture soil and 125 bushel/acre corn.

(a) Using Table V answer is 180 lbs/acre.

(2) Derive adjusted available soil nitrogen level by determining and subtracting carryover nitrogen from last year's sludge application (C.7.a.(2)(c)).

(a) Carryover nitrogen = (% organic nitrogen) x (tons solids/acre)
= 3.0 x 5
= 15 lbs/acre

(b) 180 lbs/acre - 15 lbs/acre = 165 lbs/acre

(3) Determine the available nitrogen in the sludge (Table VII).

(a) For digested sludge and surface application, the proper formula is:

(% organic-N x 4) + (% ammonia-N x 10) = lbs available N/ton

(3.0 x 4) + (2.0 x 10) = lbs available N/ton

12 + 20 = 32 lbs available N/ton

(4) Derive sludge application rate by dividing adjusted available soil nitrogen level by available nitrogen in sludge.

(a) From Step 2 of solution adjusted available soil nitrogen level equals 165 lbs/acre; from Step 3 of solution available nitrogen in sludge equals 32 lbs/ton.

165 lbs/acre ÷ 32 lbs/ton = 5.2 tons of sludge solids per acre

4. Determination of Annual Application Rate Based on Cadmium Addition

a. Given: :

(1) Cadmium concentration equals 25 mg/kg.

b. Solution:

(1) Derive pounds of cadmium per ton of sludge solids by multiplying cadmium concentration by 0.002.

(a) 25 mg/kg x 0.002 = 0.05 lbs Cd/ton

(2) Derive sludge application rate by dividing annual cadmium addition limit of 2 lbs/acre (Section C.7.b.(2)) by pounds of cadmium per ton of sludge solids.

(a) 2 lbs/acre/year ÷ 0.05 lbs/ton = 40 tons of sludge solids per acre

5. Determination of Allowable Cumulative Sludge Loadings Based on Heavy Metals

a. Given:

(1) Metal concentrations in sludge of:

1750 mg/kg zinc
850 mg/kg copper
500 mg/kg lead
100 mg/kg nickel
20 mg/kg cadmium

(2) Agricultural land with medium texture soil (loam) with 3% organic matter content.

b. Solution:

(1) Derive pounds of each metal per ton of sludge solids by multiplying concentration of each by 0.002.

(a) 1750 mg/kg Zn x 0.002 = 3.5 lbs Zn/ton
850 mg/kg Cu x 0.002 = 1.7 lbs Cu/ton
500 mg/kg Pb x 0.002 = 1.0 lbs Pb/ton
100 mg/kg Ni x 0.002 = 0.2 lbs Ni/ton
20 mg/kg Cd x 0.002 = 0.04 lbs Cd/ton

(2) Determine cation exchange capacity range for soil (Table IX).

(a) For medium texture soil with 3% organic matter, cation exchange capacity range is 5-15 (Table IX).

(3) Determine allowable metal additions for agricultural soil with cation exchange capacity of 5-15.

(a) Using Table VIII, allowable metal additions are:
1000 lbs/acre lead
500 lbs/acre zinc
250 lbs/acre copper
100 lbs/acre nickel
10 lbs/acre cadmium

(4) Derive allowable cumulative sludge loading on site by dividing allowable metal additions in pounds per acre (Step 3 of solution) by metal concentration in sludge in pounds per ton of solids (Step 1 of solution) and use lowest derived value.

(a) Zinc : 500 lbs/acre ÷ 3.5 lbs Zn/ton = 143 tons/acre

Copper : 250 lbs/acre ÷ 1.7 lbs Cu/ton = 147 tons/acre

Lead : 1000 lbs/acre ÷ 1.0 lbs Pb/ton = 1000 tons/acre

Nickel : 100 lbs/acre ÷ 0.2 lbs Ni/ton = 500 tons/acre

Cadmium: 10 lbs/acre ÷ 0.04 lbs Cd/ton = 250 tons/acre

(b) Lowest derived value is 143 tons/acre so that is the recommended allowable cumulative sludge loading to the site.

Chapter 120

LAND APPLICATION OF WASTEWATER EFFLUENT

121. Site Considerations

121.1 Site Location

The location of the site, relationship to the overall land use plan, proximity to surface waters, the number and size of available land parcels and the location and use of potable water supply wells are of prime importance. A topographic map of the proposed project area will be required, as a part of the engineering design, locating all buildings, treatment units, land disposal field boundaries including buffer zones, water supply wells and abandoned wells and shafts within a mile of project boundary.

121.2 Buffer Zones

121.21 Low Pressure Systems

Spray irrigation systems using low pressure sprayers (less than 50 p.s.i.) must maintain a distance of 200 feet between the outer boundary of the spray and occupied dwellings, surface waters and the closest edge of the traveled portion of any public road.

121.22 High Pressure Systems

Spray irrigation systems using high pressure sprayers (greater than 50 p.s.i.) must maintain a distance of 1000 feet between the outer boundary of the spray and occupied dwellings, surface waters and the closest edge of the traveled portion of any public road.

121.23 Overland Flows Systems

Overland flow systems and rapid infiltration/percolation systems must provide distances of: 200 feet from occupied dwellings, 200 feet from surface waters, 75 feet from the closest edge of traveled portion of any primary or secondary public roads or 50 feet from closest edge of lesser utilized public roads or within fence.

All application methods must maintain a minimum distance of 500 feet from the disposal site to potable water supply wells. When overland flow or rapid infiltration/percolation systems use spray irrigation for distributing the wastewater, the minimum separation distances required for low or high pressure sprayers should be provided.

121.3 Geology

Geological conditions present at the land disposal site and their potential effects must be described. This description should include the structure of the bedrock, depth to bedrock, degree and thickness of surficial deposits, and the presence of any special conditions such as limestone terrain with solution openings or sinkholes.

For projects greater than 1000 PE, an evaluation by a geologist or geohydrologist shall be provided.

121.4 Hydrology and Groundwater

An investigation of the groundwater at a proposed site must be conducted, with particular detail given to the effect of groundwater levels on renovation capabilities, existing groundwater quality, the effects of the applied wastewater on groundwater movement and quality with respect to groundwater quality standards.

The depth to the seasonal high water table must be given including a description of seasonal variations. Static water levels must be determined at each depth for each aquifer under concern.

The direction of groundwater movement and the point(s) of discharge must be located on the topographic map.

Chemical analysis of the existing groundwater quality at the site must be provided for those parameters that could be affected by the application of wastewater. A groundwater mount will develop below the site and must be taken into account in the groundwater analysis.

121.41 Depth to Groundwater

Depth to groundwater is important because it is a measure of the aeration zone where purification will take place. An aerated zone of at least five feet shall be maintained.

The minimum depth of earth cover to the mean annual water table will vary with the type of system used and the soil conditions. A minimum of 10 feet of earth cover to the water table for rapid permeable soils (2.0 to 20.0 inches per hour), and 5 feet of earth cover for moderate to slow permeable soils (less than 2.0 inches per hour) must be provided.

Underdrains shall be provided as required to maintain a zone of aeration, to prevent surface waterlogging and to reduce the groundwater mount. If such drainage will result in a surface discharge, additional precautions may be necessary to meet required effluent and/or water quality standards.

121.5 Soil Characteristics

The soil at a proposed site must be evaluated for: chemical characteristics soil types and texture classifications, soil mantle thickness, pH, nutrient levels, adsorptive capabilities and infiltration/percolation potential. The infiltration rate should be determined under conditions similar to those expected during operation. The double-ring infiltrometer method, as developed by USDA-ARS, is recommended for measuring infiltration. The method is described in the appendix.

121.6 Topography

For system other than overland flow, slopes shall be limited to 4% or less on cultivated fields and 8% or less on sodded fields. Forrested areas with slopes up to 14% are acceptable for some seasonal operations.

Slopes for overland flow systems should range from 2 to 4%.

121.7 Loading Factors

121.71 General

To size the land disposal field, it will be necessary to determine which characteristics of the wastewater will be limiting. Balances should be conducted for water, nitrogen, phosphorus, and organic matter.

Loading rates must be established from these balances for each parameter, and the critical loading rate must be identified as the one requiring the largest field area.

121.72 Water Balance

The design shall be based upon a water balance that takes into account the applied effluent, precipitation, evaportranspiration, infiltration and percolation and runoff.

For spray irrigation and rapid infiltraton/percolation systems, surface runoff must be prevented from entering or leaving the site. Provisions may be necessary in the preliminary treatment system or storage basin for holding this runoff water.

Hydraulic equipment and the spray field shall be sized and designed to allow alternate wetting and drying periods in order to maintain aerobic conditions in the top soil, as well as to maintain a viable cover crop.

121.73 Nitrogen Balance

On an annual basis, the total nitrogen applied in the wastewater must be accounted for in crop uptake, denitrification, volatilization, percolation into the groundwater, runoff into surface waters or storage in the soil.

Total annual nitrogen crop uptake will depend upon the type of crop, and is a function of crop yield. Harvesting and physical removal of the crop is required.

Typical values for fertilizer requirements for Illinois crops and typical nitrogen uptake rates can be found in the Appendix.

Denitrification and volitilization are dependent upon the loading rate, wastewater characteristics and conditions in the active zones of the soil.

For irrigation systems, these mechanisms are not significant, but for overland flow and rapid infiltration/percolation systems, denitrification plays a major role.

Nitrogen cannot be held in the soil indefinitely. Ammonia and organic nitrogen will be converted to nitrate nitrogen which will leach into groundwater, denitrify or be washed into surface waters through runoff.

The design loading must provide for adequate nitrogen removal by crop uptake with subsequent physical removal and/or denitrification of nitrates to nitrogen gas to ensure that the nitrogen groundwater quality standards are not violated.

121.74 Phosphorus Balance

Phosphorus applied to land will be removed by fixation and chemical precipitation as well as by plant uptake. Generally, the phosphorus levels in municipal effluents will be well below the capacity of the soil to fix and/or precipitate the phosphorus.

Plant uptake is normally less than 20% of the applied phosphorus with the remaining phosphorus staying in the upper several feet of the topsoil.

121.75 Organic Balance

Organic loadings in the range of 10 to 25 pounds/acre/day should be adequate to maintain the tilth of soil, replenish carbon oxidized by soil microorganisms and not cause a clogging problem.

Treated municipal wastewater will add much less organic matter than this to the disposal field and will normally not be the critical loading factor in the design.

122. Preapplication Treatment and Storage

122.1 *Lagoons*

Land application treatment systems which will employ waste stabilization ponds or aerated lagoons for preliminary treatment shall be required to have a minimum of two cells. Systems employing overland flow as the application technique shall be required to have three cells.

122.11 Design

Lagoon cells must be designed in accordance with criteria listed in Chapter 80. Systems utilizing spray irrigation shall be provided with screening devices.

122.2 *Mechanical Plants*

When preliminary treatment is to be accomplished by a mechanical treatment system, the system should contain the equivalent of secondary processes. Secondary treatment processes can be various combinations of units such as a primary clarifier with trickling filter, Imhoff tank with intermittent sand filter, or an activated sludge process. Other combinations of units will be reviewed individually.

122.21 Design

The design of all preliminary treatment systems must conform to this document for such processes.

122.3 *Disinfection*

The requirement for disinfection depends upon itended land use. Systems using fodder, fiber or seed cover crops, not for human consumption, and are sufficiently isolated will not require disinfection. Systems that will grow produce for human consumption and systems which will use public access areas for land disposal will be required to provide disinfection. Disinfection will, however, be required for <u>all</u> systems utilizing mechanical type treatment processes in combination with overland flow land application.

PROPOSED

122.4 Storage

Storage shall be provided for all land application systems. The volume provided shall be sufficient to hold flows received during the following periods:

a. When mean air temperature is less than 32°F;

b. When the ground is frozen;

c. When the ground is saturated (as from late winter snowmelt and spring rains);

d. During days when precipitation exceeds 0.1 inch;

e. During field or crop maintenance and harvest days;

f. During days set aside for equipment maintenance.

122.5 Fencing

The entire project area must be enclosed with fencing to preclude livestock and prevent access by the general public. Warning signs shall be posted at 100 yard intervals on exterior fences identifying the area as a sewage disposal area.

123. <u>Application Systems</u>

123.1 General

The three most widely used systems for applying wastewater to land are spray irrigation, overland flow and rapid infiltration/percolation.

123.11 Spray Irrigation

Spray irrigation applies large amounts of wastewater to land using standard irrigation equipment in combination with a cover crop to utilize the nutrients and moisture for growth. This method uses percolation as well as evapotranspiration to dispose of wastewater.

123.12 Overland Flow

Overland flow applies a thin film of wastewater over a soil surface covered with close growing vegetation where filtering action and soil micro-organisms reduce contaminants. Overland flow is appropriate where the infiltration/percolation capacity of the soil is low, and generally results in a surface discharge.

123.13 Rapid Infiltration/Percolation

Rapid infiltration/percolation applies wastewater to basins at high rate therefore requiring deep, permeable soils. The wastewater is renovated as it passes through the soil matrix and is removed mainly by infiltration/percolation and evaporation, with no surface discharge occurring.

123.2 Equipment Design

123.21 General Requirements

The design of all application techniques must provide for even distribution of the wastewater over the disposal area.

Sufficient spare equipment and parts must be available to assure uninterrupted irrigation.

Provision for draining all pipes and equipment must be provided to prevent freeze damage.

Equipment for measuring and recording the following flows shall be provided:

a. Raw waste to treatment facilities

b. Treated wastes to storage;

c. Wastes applied to land;

d. Volume of wastes in storage.

123.22 Spray Equipment

Stationary systems are acceptable. Moveable systems must be provided with one main header having individual connections for each field.

Application of wastewater by spray irrigation should be ceased when wind velocities exceed 22 MPH.

124 Effluent and Groundwater Standards

124.1 Surface Discharges

All surface discharges from land application sites must comply with regulations set forth by the Illinois Pollution Control Board in Chapter 3: Water Pollution, Part II: Water Quality and Part IV: Effluent Standards.

124.2 Groundwater Discharges

Groundwater quality requirements as set forth in Rule 207 of Chapter 3: Water Pollution state that groundwaters shall meet the General Use Standards (Rule 203) and Public and Food Processing Water Supply Standards (Rule 204) except due to natural causes.

124.21 Groundwater Monitoring

Groundwater monitoring shall be provided for all land application systems except overland flow.

A minimum of one groundwater monitoring well must be provided in each dominant direction of groundwater movement and between the project site and public well(s) and/or high capacity private wells.

One additional well shall be provided for determining background concentrations.

The monitoring wells should be constructed with provisions for sampling at the surface of the waterable and at five (5) feet below the water table at each monitoring site.

Monitoring equipment shall be provided to run tests for nitrates, ammonia-nitrogen, chlorides, sulphates, pH, total dissolved solids, phosphates, and fecal coliform bacteria.

This list of parameters may be decreased or increased depending upon the site situation and the wastewater constituent make-up.

AGRONOMIC FERTILIZATION AND NITROGEN UPTAKE RATES
FOR VARIOUS ILLINOIS CROPS
POUNDS OF NUTRIENT

CROP	NITROGEN UPTAKE lbs/acre/year	Available N	P_2O_5	K_2O
Corn for grain		1.3/bu.	.55/bu.	0.28/bu.
Corn silage		7.5/T	3.1/T	9.4/T
Wheat (1)	50-76	2.3/bu.	0.68/bu.	2.0/bu.
Oats (1)		1.1/bu.	0.40/by.	1.5/bu.
Barley (1)		1.5/bu.	0.55/bu.	1.0/bu.
Rye (1)		2.2/bu.	0.69/bu.	1.8/bu.
Grain sorghum for grain		2.0/100 lbs.	0.75/100 lbs.	0.38/100 lbs.
Grain sorghum for silage		7.5/T	3.1/T	9.4/T
Tall fescue	275	39/T	19/T	53/T
Bromegrass		33/T	13/T	51/T
Sorghum-Sundan		40/T	15/T	59/T
Orchard Grass		50/T	17/T	63/T
Timothy		38/T	14/T	63/T
Reed Canary Grass	226-359	55/T	13/T	50/T
Alfalfa	155-220	(2)	10/T	60/T
Clovers	77-158	(2)	15/T	60/T
Soybeans	94-113	(2)	1.1/bu.	2.4/bu.

1. If straw is removed

2. Legumes can obtain most of their N from the air and are normally not fertilized with N. However, if included in a crop rotation with nitrogen using crops, they will use the available N in the soil and not fix N from the air. Therefore, it can be assumed that they will remove as much N as corn for grain would in the same rotation.

   This information is general in nature and may not reflect an accurate recommendation for all areas or soil types of the State. Any recognized fertility recommendation for Illinois crops, climate and soils is acceptable in lieu of these general figures. In order to obtain more accurate recommendations for phosphorus and potassium, soil testing should be done.

Double-ring Infiltrometer Method*

The double-ring Infiltrometer method involves driving a 6 to 14 inch diameter metal ring, about 10 inches in length into the soil to a depth of 6 inches to prevent lateral flow of water from the ring. Divergent flow is additionally reduced by using a buffer zone surrounding the central ring. The buffer zone is usually another ring from 16 to 30 inches in diameter, driven to a depth of 2 to 4 inches and then kept partially full of water during the time of infiltration measurement of the inner ring.

* For further information, consult: Haise, H.R., et al. "The Use of Cylinder Infiltrometers to Determine the Intake Characteristics of irrigated Soils." U.S. Dept. of Agriculture, Agricultural Research Service 41-7 (1956).

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Technical Release No. 8
Recommended Design Guidelines for Surface Application of Wastewater

Land application of wastewater (not sludge) is being recognized as one of the viable methods of wastewater treatment. It is the intent of this technical release to delineate the necessary design criteria so that a design consultant and the regulatory agency will have a common ground in implementing such a project.

This release is aimed at the land application of wastewater originating from municipal and industrial sources which is amenable for bio-degradation. Wastewater from confined animal feeding operations is not addressed as its disposal is covered in a separate publication (ID 88). This release, also, does not cover sludge application on land as this subject will be covered by separate guidelines.

It is generally recognized that there are three methods of wastewater application on land; irrigation, overland flow, and infiltration-percolation ponds. Each will be discussed separately.

I. Irrigation

This process involves application of wastewater on land by either ridge and furrow irrigation or surface spraying. The applied wastewater is removed mostly by evapotranspiration with no point source discharge of wastewater.

A) Site Requirements

1) Buffer zone

In order to prevent nuisance complaints originating from the irrigation operation due to aerosol and/or odor, it is recommended that at least 500 feet separation between the edge of a irrigation field (or lagoon) and a nearest residence be provided when a high pressure sprinkling system (more than 50 psi) is utilized. For the lower pressure sprinkling and ridge and furrow irrigation, the minimum separation distance should be 200 feet. A minimum separation distance between an edge of irrigation field and a water supply well should be 300 feet. The spray irrigation site should be at least ½ mile away from a built-up area.

2) Ground water level

The average ground water table should be no less than five feet and the seasonal highwater table should be no less than three feet from the land surface. When the soil is drained by under-drain pipes, this requirement may be waived. However, flow from the under-drain tile shall be collected and recycled. Otherwise, the dischargers will be subject to requirement of point source discharges.

3) Topography

The maximum allowable slope of the disposal site is 5%. When the site has a slope in excess of 5% average, runoff control and recycling facilities, or reduced hourly application rate should be considered.

4) Soil depth

The minimum depth of permeable agricultural soil should be 20 inches to bedrock or hardpan. Soil borings and percolation tests should be performed to confirm this.

B) Pretreatment Requirements

Pretreatment of wastewater prior to irrigation is usually required to prevent nuisance conditions and/or public health hazards. Depending on the type os wastewater, solids reduction, disinfection, heavy metal reduction and/or other pretreatment may be required.

1) Removal of settleable, floatable, and large solids

In order to prevent clogging of irrigation equipment and soil, the wastewater should not contain excessive quantities of settleable, floatable and large solids. This may be attained during storage of wastewater by installing screens and scum baffles.

2) Disinfection

Domestic wastewater contains high counts of bacteria, and spray irrigation could cause propagation of pathogens through drift of spray mist. Also, ridge and furrow irrigation of wastewater could cause public health hazard to the operators of the systems and bacterial contamination of ground water. Therefore, disinfection of the domestic wastewater will be required prior to irrigation. If chlorine is used, the design shall provide a minimum contact time of 15 minutes with equipment to introduce sufficient chlorine to maintain a minimum residual chlorine level of 0.5 mg/l. For chlorination, the use of chlorine gas, hypochlorite solutions, or chlorine pellets may be considered. Industrial wastewater may not need to be disinfected if sanitary sewage is excluded from wastewater. However, certain industrial wastewater, such as that from a slaughter house operation, may contain high bacterial concentration, and the bacterial quality may have to be ascertained for the determination of disinfection requirements. Disinfection should be considered if the fecal coliform concentration exceeds 1,000 per 100 ml before surface application.

C) Storage Requirement

A storage capacity should be provided for periods when wastewater cannot be applied on land. As a guide to estimating the detention time required, storage should be provided for the days with more than 0.5 inch/day rainfall, more than 1.0 inch snow on the ground, and less than 32°F average daily atmospheric temperature (adjustment should be made for the overlapping days). Also, the expected duration of mechanical failure should be included in the consideration (two weeks as a minimum is recommended). These data and the expected average flow of wastewater will give the necessary storage requirement.

If local climatic information is not available, it is recommended that a minimum of 90 days storage in northern Indiana and 60 days in southern Indiana be provided; U.S. 36 West and U.S. 40 East of Indianapolis may be considered as the demarcation line.

In general, the construction of a storage lagoon should follow the "10-State Sewage Works Standards" in order to assure proper construction and maintenance. The lagoon bottom should be relatively impermeable to prevent groundwater contamination. The depth of lagoon, however, could be up to 20 feet. It is expected that a storage lagoon could serve as the unit to remove floatable, settleable, and large solids. On the other hand, the storage of wastewater may cause the onset of a septic condition and odor nuisance. Therefore, a storage lagoon may have to be provided with aeration facilities sufficient to keep the lagoon aerobic at the peak organic loading. Considerable reduction of organic strength of the wastewater can be expected during the storage and aeration.

Facilities to control the water levels in the lagoon should be provided so that sufficient storage will be available at the onset of wet seasons.

D) Loading Criteria

In order to prevent pollution of ground and surface water, the following loading criteria are recommended. The least value of the loading rates computed from each criterion should be used in the design.

1) Hydraulic loading rate

Two different approaches are suggested. The first is the water-balance approach in which the effective water storage capacity of soil is balanced against the water-loss due to evapotraspiration. The duration of wastewater application, time interval between irrigation, and the intensity of application are computed based on the soil characteristics, climatic conditions, and the cover crops. Detailed method of computation can be found in the publication by P.E. Brisbin titled "Design of Spray Irrigation system -April 1975." A copy of the paper will be made available upon request.

The second approach is somewhat more empirical based on the generally accepted practices in the country. The maximum weekly rate of application should be no more than 2.0 inch/week, and the average interval of irrigation should be approximately one week between irrigation cycles when the ground is amenable for land application. Wastewater should not be applied on land when precipitation on the day or preceding day exceeded 0.5 inch/day, ground has more than 1 inch cover of snow, or when the gound is frozen. Also, the maximum intensity of irrigation should not exceed the value shown on Table I which takes into consideration the soil type and crop cover.

Table I Maximum Design Application Rates

Textural Class	Application Rate in Inches per Hour	
	Grass Sod	Cultivated
Sand	1.5	0.8
Loamy sand	1.3	0.7
Sandy loam	0.9	0.5
Fine sandy loam	0.8	0.5
Loam	0.7	0.4
Silt loam	0.7	0.4
Clay loam	0.6	0.3
Clay	0.5	0.2
Organic soils (muck)	1.0	1.0

Either approach (water-balance or empirical approach) will be considered if sufficient supportive information is attached.

2) Nitrogen loading

The total nitrogen loading from wastewater, commercial fertilizer or any other source should be balanced against the expected nitrogen demand of the crop. This is to prevent pollution of ground water which is a potential source of drinking water. The maximum allowable nitrate nitrogen in drinking water is 10 mg/l. The total poundage of nitrogen loading should be calculated from the total volume of wastewater applied per year and the concentration of nitrogen in the wastewater; the concentration of nitrogen should include Kjeldahl nitrogen (organic and ammonia nitrogen) and nitrate-nitrite nitrogen. Under most conditions, volatilization of ammonia into atmosphere is not a major mechanism of removal. Therefore, the ammonia loss to the atmosphere during and after irrigation should be neglected in the nitrogen balance computation, However, the loss of nitrogen due to denitrification in soil is expected in the range of 15 to 25% of the applied nitrogen. The nitrogen demand of specific crops is shown in Table II. The expected annual loading of nitrogen from wastewater and commercial fertilizer, minus 20% of the applied nitrogen due to denitrification, should not exceed the expected utilization of nitrogen by the specific crop.

Table II. N, P, and K Utilization* of Specific Crops

Crop	Yield/Acre	N	P	K
			lbs per acre	
Corn	150 bu.	185	35	178
	180 bu.	240	44	199
Corn Silage	32 tons	200	35	203
Soybeans	50 bu.	257**	21	100
	60 bu.	336**	29	120
Grain Sorghum	8,000 bu	250	40	166
Wheat	60 bu.	125	22	91
	80 bu.	186	24	134
Oats	100 bu.	150	24	125
Barley	100 bu.	150	24	125
Alfalfa	8 tons	450**	35	398
Orchard Grass	6 tons	300	44	311
Brome Grass	5 tons	166	29	211
Tall Fescue	3.5 tons	135	29	154
Bluegrass	3 tons	200	24	149
Canary Grass		350	38	280

*Values reported above are from Reports by the Potash Institute of America except that on canary grass and are for the total above-ground portion of the plants. Where only grain is removed from the field a significant proportion of nutrients are left in the residues. However, since most of these nutrients are temporarily tied up in the residues they are not readily available for crop use. Therefore, for the purpose of estimating nutrient requirements for any particular crop year, one can assume complete crop removal.

**Legumes get most of their N from the air so additional N sources in the forms of livestock wastes or inorganic N fertilizer are not normally needed.

3) Heavy Metal Loading

Some industrial wastewater may contain relatively hign concentration of metals. Excessive application of metals can impair crop productivity and the quality of food. The data on the long-term effect of heavy metals on soil are very scarce. However, if soil pH is maintained above 6.5 by proper soil management, the following total accumulated loading (including the existing metal concentration in soil) shown in Table III could be considered safe.

Table III indicates the total metal loading allowed for the life of the land. Annual application rate should not exceed one-tenth of the values shown in the table. The total duration (years) of irrigation should be calculated from the maximum allowable metal loading. The cation exchange capacity of the soil may be estimated by the soil type as follows:

Soil type	cation exchange capacity (meq/100 gr)*
sand, loamy sand - - - - - - - - - - - - - - - - - -	less then 5.0
sandy loam, loam - - - - - - - - - - - - - - - - - -	5.0 - 15.0
silty loam, clay loam, clay - - - - - - - - - - - -	greater than 15.0

* meq.-- milliequivalent

Since domestic wastewaters and some industrial wastewaters are low in metal contents, the application rate is unlikely to be dictated by metal loading criteria. Therefore, the need for metal loading analysis on domestic wastewaters and some industrial wastewaters may be omitted if allowed by the State.

Table III

Maximum Metal Applications for Farmland

	Soil Cation Exchange Capacity (meq/100 gr)*		
	< 5	5 ~ 15.0	15 <
	Maximum Metal addition, kg/ha**		
Lead	500	1,000	2,000
Zinc	250	500	1,000
Copper	125	250	500
Nickel	50	100	200
Cadmium	5	10	20

*Cation exchange capacity determined on soil prior to application by pH 7 ammonium acetate procedure. Estimation of CEC by the soil type is acceptable.

**1.0 kg/ha = 0.893 lb/acre

Computation should be made for each of the five metal ions on Table III, and the least number should be used.

4) Organic loading

Excess application of organic matter, dissolved or suspended, can cause a septic condition, pore plugging, reduction of percolation rates, and odor problems. Therefore, the organic loading should not exceed 1,400 lb/acre/week as violatile solids or 933 lb/acre/week as 5-day BOD. An exception could be considered if supporting document is submitted to substantiate an effective operation at the higher organic loading.

E) Other Requirements

1) Distribution System

The system should be designed to deliver the design hydraulic flow.

Provisions should be made for draining the pipe to prevent freezing if pipes are located above frost line.

The irrigation system should be designed to assure uniform distribution of wastewater.

2) Total Dissolved Solids(TDS)

TDS concentration of the wastewater should not exceed 1,000 mg/l. Specific conductivity of wastewater could be substituted for the TDS measurement, and it should not exceed 1,600 micromhos/cm at 25°C.

3) Manpower requirement

The applicant should estimate the necessary manpower for proper operation, maintenance, and monitoring of the irrigation operation; availability of such manpower should also be established.

4) Irrigation of truck-farm

The use of wastewater for irrigation of truck farms growing vegetables is prohibited.

F) Monitoring and reporting

Since there would not be a point source discharge from the irrigation process, no NPDES discharge permit would be required. However, such an operation would be subject to an SPC 15 operation permit. The pertinent operational parameters should be measured and reported to the ISBH according to the following schedule:

1) Reporting frequency - Every three months for less than 0.5 mgd design

Every two months for 0.5 - 2.0 mgd design

Every month for greater than 2.0 mgd design

2) Operation information required (weekly records)

- location of area and acreage used for the week
- volume of wastewater sprayed
- duration of spraying for each cycle
- precipitation, snow cover, and temperature on the day of application
- date of spraying
- type of crop grown
- harvesting of crop
- ultimate use of the crop

3) Quality information

a) Sampling frequency: Every three months for less than 0.5 mgd

Every two months for 0.5 - 2.0 mgd

Every month for greater then 2.0 mgd

b) Type of information:

- TKN (nitrogen content) before and after the storage
- Nitrate and Nitrite before and after the storage
- BOD_5 before and after the storage
- Ground water table
- Soil pH
- Heavy metal content (where required)
- Fecal coliform before and after disinfection (where required)
- Residual chlorine (where required)

4) Other information - as requred by the regulatory agency

II. Overland flow

In this process the wastewater is treated mainly during flow over gently sloped land surface.

Part of the flow percolates into ground while the remaining is collected and discharged to a natural water course as a point source or is collected and reapplied on land.

All of the design requirements indicated for an irrigation process will apply except:

1) The maximum hydraulic application rate will be 3 inch/week instead of 2 inch/week.

2) The minimum length of travel on land surface should be 200 feet.

3) The discharger should obtain an NPDES discharge permit and comply with its requirements instead of the SPC 15 operation permit.

4) The land slope should be relatively uniform and be in the range of 2 - 8%.

III. Infiltration-Percolation Pond

This is a process utilizing percolating capacity of soil. Wastewater is disposed of underground at a relatively higher rate compared to irrigation or overland flow. For reason of potential nitrate contamination of ground water, the method of infiltration-percolation is not recommended on municipal wastewater.

On industrial wastewater, this method will be considered only when the following conditions are met:

1) The applicant submits a detailed document prepared by a qualified person to establish the movement of quality of existing ground water.

2) The applicant delineates the effect of proposed wastewater percolation on the quality of ground water, and assures compliance with the primary drinking water limits on inorganic, organic and bacterial levels.

3) The concentration of TDS, chloride, and sulfate in the wastewater are less than 1,000, 250, and 250 mg/l, respectively.

4) The applicant extablished a detailed ground water monitoring program, and submits a feasible alternate and plan of wastewater treatment if and when the contaminant levels of the ground water exceed the maximum allowable concentration.

IV. <u>Information Needed in the Design Report for Irrigation and Overland Flow Proposals</u>

1) Location of disposal site - map and layout

2) Climatic data - days of freezing weather, rainy days of more then 0.5 inch/day, weeks available for surface application, and direction of prevailing wind during irrigation season

3) Soil classification, soil maps, and percolation tests

4) Soil borings to a minimum depth of ten feet

5) Ground water table elevation - average and maximum

6) Soil property - pH, CEC (if needed)

7) Land use, location of buildings, built-up areas, road, highways, and environmentally sensitive areas such as parks, historical sites, and endangered species

8) Depth to bedrock, sink-hole location, limestone area

9) Surface slope

10) Flood plain information

11) Location of stream and stream flow as 7-day average, 1-in-10-year low flow (applicable only to overland flow process)

12) Crop type, crop management plan, and planned crop usage

13) Buffer zones

14) Computations for the four application parameters

15) Application area needed and available

16) Storage requirement - needed and available

17) Construction method of the storage lagoon

18) Requirements for surface irrigation piping and pump layout, pumping