WATER QUALITY MANAGEMENT GUIDANCE
WPD 11-75-01

DEMONSTRATION OF A PLANNING PERSPECTIVE FOR WASTE WATER SLUDGE DISPOSITION

Knoxville/Knox County

NOVEMBER 1975

UNITED STATES · ENVIRONMENTAL PROTECTION AGENCY ·

ENVIRONMENTAL PROTECTION AGENCY
WATER PLANNING DIVISION
WASHINGTON, D.C. 20460

DEMONSTRATION OF A DEVELOPED METHODOLOGY FOR THE ULTIMATE DISPOSAL OF RESIDUAL WASTES

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Knoxville/Knox County

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TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D)

TABLE OF CONTENTS (CONT'D)

TABLE OF CONTENTS (CONT'D)

ABSTRACT

The existing and future sludge disposal problem in Knoxville, Tennessee was investigated, and six major sludge management plans were developed. The plans were derived and evaluated by utilizing a methodology previously developed for the U.S. Environmental Protection Agency.

The plans detail the processing, transportation, and ultimate disposal sub-systems necessary to meet environmental, operational, and institutional constraints found in the study area. In addition, costs of the various sub-systems and the overall costs of the plans were determined.

This report was submitted in fulfillment of RFP No. WA75-R210, Contract No. 68-01-3225, by Engineering-Science, Inc. under sponsorship of the U.S. Environmental Protection Agency. Work was completed as of 10 September 1975.

LIST OF TABLES

LIST OF TABLES (CONT'D)

LIST OF TABLES (CONT'D)

LIST OF FIGURES

LIST OF FIGURES (CONT'D)

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Principal staff from Engineering-Science, Inc. were Mr. Michael Wyatt, Project Manager, and Mr. Richard Heil, Project Engineer.

CHAPTER I

CONCLUSIONS AND RECOMMENDATIONS

INTRODUCTION

This report addresses the sludge disposal problem currently experienced in Knoxville, Tennessee and the anticipated problem expected upon expansion and upgrading of existing wastewater treatment facilities and the construction of a regional facility. The techniques employed in the projection of the present and future sludge quantities and qualities; selection of feasible sludge handling, transportation, and ultimate disposal or resource recovery methods; and the evaluation of these methods compiled into management plans were derived from a previously developed methodology document discussed later in this report. The following sections present the conclusions and recommendations derived during this study for both the Knoxville-Knox County Study Area as they impact upon the on-going 208 planning process in this Area and the evaluation of the utility and constraints of the methodology document.

CONCLUSIONS

Study Area

- Six sludge management plans were found feasible for further in-depth consideration and final selection in the Study Area. They are (not listed in any order of priority):

  (1) truck transport and sanitary landfill disposal of a digested, dewatered sludge to a County-owned and operated site in the northeastern portion of the County;

  (2) truck transport and trench-incorporation of a digested, dewatered sludge to a City-owned and operated site in the northeastern portion of the County;

  (3) truck transport and incineration of an undigested, dewatered sludge to a City-owned and operated incinerator located on the site of the proposed regional wastewater treatment facility with truck transport and sanitary landfill disposal of a digested, dewatered sludge from two outlying treatment plants, to the landfill identified in (1) above;

(4) tank truck transport and land application (via spray irrigation) of a digested sludge to a County-owned and City-operated site in the northeastern portion of the County with truck transport of a digested, dewatered sludge from one outlying facility to the landfill site identified in (1) above;

(5) truck transport and land application (via composting and disking) of a digested, dewatered sludge to a County-owned and City-operated site [same as in (4) above] with truck transport of a digested, dewatered sludge from one outlying facility to the landfill site identified in (1) above; and

(6) tank truck and barge (from the regional facility) transport of a digested sludge to a privately-owned and operated sludge dewatering and fertilizer production facility on Pickel Island in the eastern portion of the County.

The six management plans identified above appear to present no insurmountable problems in terms of meeting environmental constraints, performance criteria, or institutional and legal feasibility. However, the land application (via spray irrigation) plan appears, at the level of cost information available in this study, to be less cost-effective than the other five plans.

Data constraints under which this study operated precluded the development of the sludge management plans at any level greater than a feasibility/representative system description. It appears at this time that in order to develop the data and its concomitant level of detail for developing site-specific alternatives for public review and selection of a final plan, 208 planning agencies must be willing to spend a larger portion of time and effort in residual waste management plan development than perhaps is currently alloted and/or allocated to them in the 208 grant monies and planning time-frame.

ogy

Cost data presented in the Methodology document were, in many instances during the conduct of this study, extrapolated from curves. Thus, the utility of the cost data for this study is limited to a first-order feasibility analysis with an unknown variability when applied to a specific area. Site specific costs were either non-existent or not made available to verify Methodology costs.

- The Methodology document, as was intended, was used as both a source for information readily obtainable within the document and as a reference to other sources of information. During future studies in which the Methodology document is utilized to develop alternative sludge management plans, the user (e.g. a 208 planning agency) should make every effort to supplement the Methodology document with the publications referenced in that document. This is particularly true when local data are lacking or incomplete.

- Care must be exercised in the utilization of sludge quantity projections by 208 planning agencies. Where local data indicate a different per capita wastewater flow, significant variations in raw sewage qualities due to industrial inputs or large infiltration and inflow contributions to the sewer system, the values presented in the Methodology document must be adjusted accordingly.

RECOMMENDATIONS

Study Area

- Additional local data, particularly with regard to the types and distribution of flora and fauna, site preparation and acquisition costs, probable users fees, and transportation costs are required as inputs before final selection of the preferred sludge management plan.

- Future long-term solutions for resource recovery appear promising and should be investigated as soon as possible. These solutions include strip-mine reclamation in areas outside the County and fuel supplementation in either a City-owned municipal solid waste incinerator or coal-fired power plants within Tennessee Valley Authority jurisdiction.

- The Knoxville-Knox County Metropolitan Planning Commission (the 208 planning agency) should, as soon as possible, obtain from local utility districts and their engineers verified or additional/corrected values for the sludge quantities present in this report. A close review and substantiation of the data and assumptions made during both the 201 Facilities planning effort and this study should be made by the agency to insure a common base of facilities and sludge production.

Methodology

- The evaluation procedures provided in the Methodology document can be taken to any level of detail desired. It is recommended that, in using the Methodology, such a feasibility level of analyses as represented by this case study, be done initially prior to detailed transportation routing and site evaluation. Undesireable alternatives, as defined by the involved institutions and general public, could then be eliminated without undue time and monetary constraints. This feasibility evaluation, in addition to identifying feasible alternatives, also identifies critical data needs requiring further and more detailed resolution and/or quantification.

- The environmental, feasibility, and performance evaluation factors in the Methodology document are rated in a subjective manner. Prior to the site-specific evaluation of the feasible alternatives, the 208 planning agency should review the factors and use local, site-specific data to provide quantitative measures or descriptions of the ratings where possible.

CHAPTER II

INTRODUCTION

BACKGROUND

A review of the Federal Water Pollution Control Act Amendments of 1972 (the Act) and the associated legislative history clearly indicates the Congressional intent to eliminate as much as possible pollutant discharges to receiving components of the environment. The basic waste treatment process consists of separating contaminants in a way that is acceptable to local, State, and Federal regulatory agencies. Proper ultimate disposal or reuse of residual wastes is essential so that usable environmental components such as surface or ground waters will not be needlessly contaminated and that pollutants are not continuously and directly recycled into water supplies, food chains, and other cycles.

At the present time, solids handling and other ultimate disposal operations are probably the most troublesome problems in treatment plant operations, partly because they have had the least attention. The problem is becoming more critical because residual waste volumes are increasing with higher treatment efficiencies and because the physical-chemical sludges and other residual wastes from tertiary treatment operations are more difficult to handle than some of the common biological sludges.

The basic approaches embodied in the Act require pragmatic and logical steps to identify and control pollution sources, including:

(1) regional planning and management of the Nation's waters which will eventually identify all point and non-point sources of pollution within a given region, and establish effluent limitations on these sources of pollution;

(2) delegation of the permit programs to approved State programs after guidelines have been prepared by the Federal Government; and

(3) control programs to determine compliance with the effluent limitations and commencement of civil and criminal proceedings against violators.

Regional planning and management processes to be undertaken by the States must be as inclusive as physically possible, both with respect to known types of pollution and the limitations of treatment processes for removing various pollutants. In addition, Sections

201(d), 201(e), 201(f) of the Act specifically encourage resource utilization and resource recycling. Within this encouragement lies the intent that planning processes carried out in fulfillment of Sections 201, 208, and 303 recognize and promote, where possible, areawide implementation concepts of residual waste management.

Under subsections (J) and (K) of Section 208(b)(2) of the Act, 208 planning and management agencies must address "a process to control the disposition of all residual waste generated in such area which could affect water quality; and a process to control the disposal of pollutants on land or in subsurface excavations within such area to protect ground and surface water quality." In addition, Section 201 (d)(4) of the Act requires in facilities planning consideration of "the ultimate disposal of sludge in a manner that will not result in environmental hazards." It therefore is also the concern of 208 planning agencies that facilities plans already made and either presently under construction or proposed for construction within the twenty-year 208 planning time framework be incorporated into the overall 208 plan which is to include residual waste disposal control.

As the United States moves toward the goals and policies described in Section 101 of the Act, publicly-owned treatment works (POTW's) are required to meet by July 1, 1977, or July 1, 1978 (for new construction), secondary treatment as defined in the Federal Register (Ref. II-1). In addition, by Sections 201(g) (2)(A) and 301(b) (2)(B) of the Act, POTW's are to provide by July 1, 1983, the application of best practicable waste treatment technology.

The application of wastewater treatment technologies to meet these requirements is anticipated to generate substantial amounts of municipal wastewater treatment plant sludges which must be handled yearly. Realizing that sludge handling absorbs 35 percent of the capital costs and 55 percent of the annual operation and maintenance costs of a wastewater treatment plant, these projected increases in sludge production will mean considerable expenditures of money (Ref. II-2). Every effort must be taken by 208 planning and management agencies to see that the expenditures necessary for sludge handling and disposal are made wisely.

Recognizing that 208 agencies may require assistance in the evaluation of residual waste management and disposal alternatives for their areas, the Environmental Protection Agency (EPA) prepared a Methodology document which considers the sources and characteristics of municipal wastewater treatment plant residual wastes, processing and transportation alternatives, and various methods of ultimate disposal and resource recovery, hereinafter referred to as the Methodology (Ref. II-2). This Methodology also considered the physical, chemical, and biological nature of the residual wastes generated and various alternate disposal/recovery methods in light of economic, environmental, social, and institutional implications in the evaluation and formulation of alternative plans and the selection of the preferred plan in the 208 planning process.

PURPOSE

The purposes of this report are threefold, namely:

(1) to demonstrate the Methodology in a specific 208 planning area;

(2) to apply and verify the Methodology and suggest improvements; and

(3) to document the results as a planning tool for considering alternatives.

This demonstration study was conducted in Knoxville, Tennessee, as a coordinated effort between the Knoxville-Knox County Metropolitan Planning Agency (MPC); the Water Planning Division of EPA, Washington, D.C.; and Engineering-Science, Inc. of McLean, Virginia. The study area is depicted in Figure II-1.

Data sources were obtained from local sources established by MPC, principally from previous local studies and 201 and 303 planning. The MPC provided an understanding of timely cooperation with local sources for technical information on the location and size of existing and proposed wastewater treatment plants, the magnitude and character of the sludges either currently generated or to be generated, pertinent land and water resource data, and socio-political conditions. During the course of this study, additional outside data sources such as State and regional planning agencies; State, county, and local agencies; and published reports were used to augment data available through MPC. Where data was unavailable, reasonable assumptions were made utilizing as necessary the information provided in the Methodology.

STUDY AREA AND GENERAL LOCATION MAP
KNOXVILLE AND KNOX COUNTY

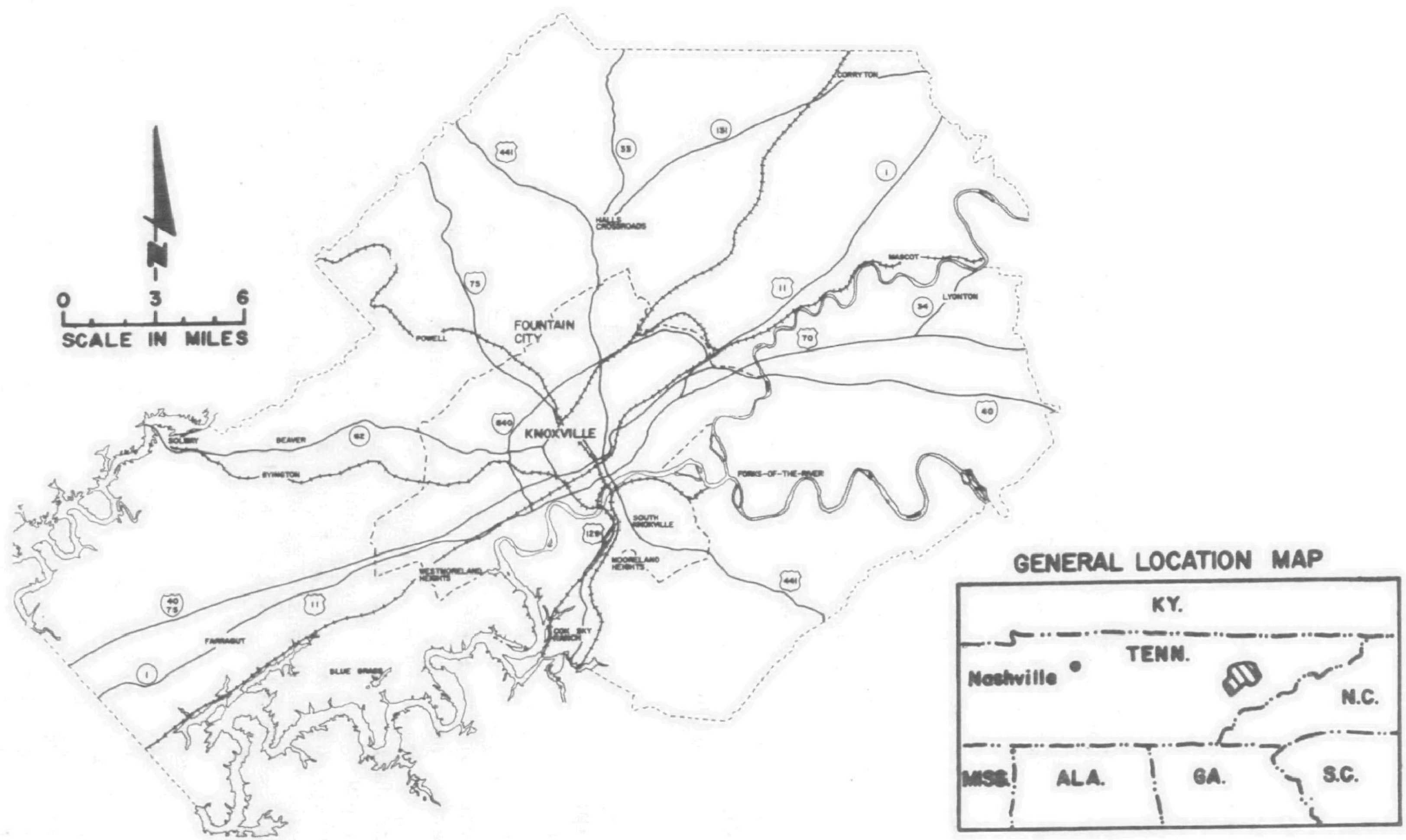


FIGURE II-1

CHAPTER II

REFERENCES

II-1 38 CFR 159 (17 August 1973).

II-2 Sludge Processing, Transportation, and Disposal/Resource Recovery: A Planning Perspective, Wyatt, J. M., and White, P. E., Jr. Engineering-Science, Inc., EPA Contract No. 68-01-3104 (April 1975).

CHAPTER III

THE PLANNING PERSPECTIVE AND THE STUDY APPROACH

THE METHODOLOGY PLANNING PERSPECTIVE

The planning perspective for municipal wastewater treatment and residual waste disposal is depicted in Figure III-1. Two major pathways of concern in the 208 planning and management process are:

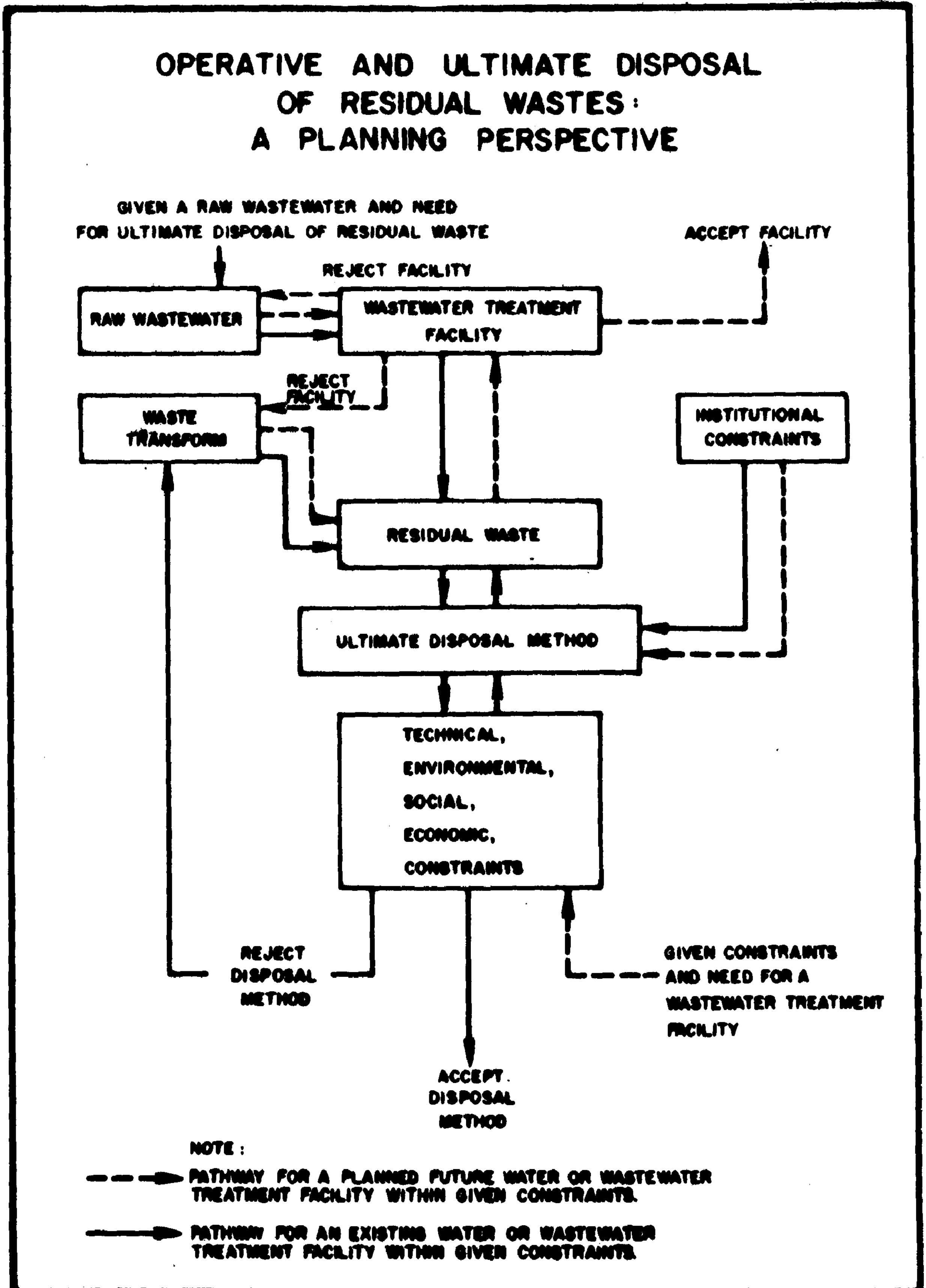
(1) Given an existing wastewater treatment facility, what is the most suitable ultimate disposal method for the residual wastes produced?

(2) Where a wastewater treatment facility is needed and planned, and given existing and anticipated physical, technological, environmental, social, and economic constraints of residual waste management and control, what is the most suitable type of wastewater treatment facility for the chosen residual waste disposal or use methodology?

In the first situation (pathway) cited above, the existing wastewater treatment facility is generating a known quantity and quality of residual wastes. Federal, State, and local guidelines and regulations help define the ultimate residual waste disposal options available to that facility. These disposal options, by virtue of regulatory and environmental, social, and economic constraints, will then have restrictions as to the quantity and quality of residual wastes they can accept. By a comparison of the disposal method's qualities and quantities of residual wastes they can handle with the known values from the wastewater treatment facility, the facility can either utilize the disposal methods available or further treat and transform the residual wastes to qualities and quantities amenable to the available disposal methods.

The second situation (pathway) is essentially the reverse process. A planning area will have acceptable ultimate disposal methods, again constrained in quantities and qualities which they can handle by virtue of regulations and environmental, social, and economic factors, acceptable for use in the area. The choice of the type of wastewater facility will then be influenced by comparing predicted quantities and qualities of residual wastes from a variety of treatment processes to those of the acceptable and available ultimate disposal methods. In this case, the quantities and qualities of residual wastes from various wastewater treatment processes can be modified by both raw wastewater modification,

FIGURE III-1



SOURCE: Reference III-1 Modified to Reflect situation in Knoxville/Knox County such as industrial pretreatment and sewer infiltration and inflow controls, and by residual waste treatment and transformation processes.

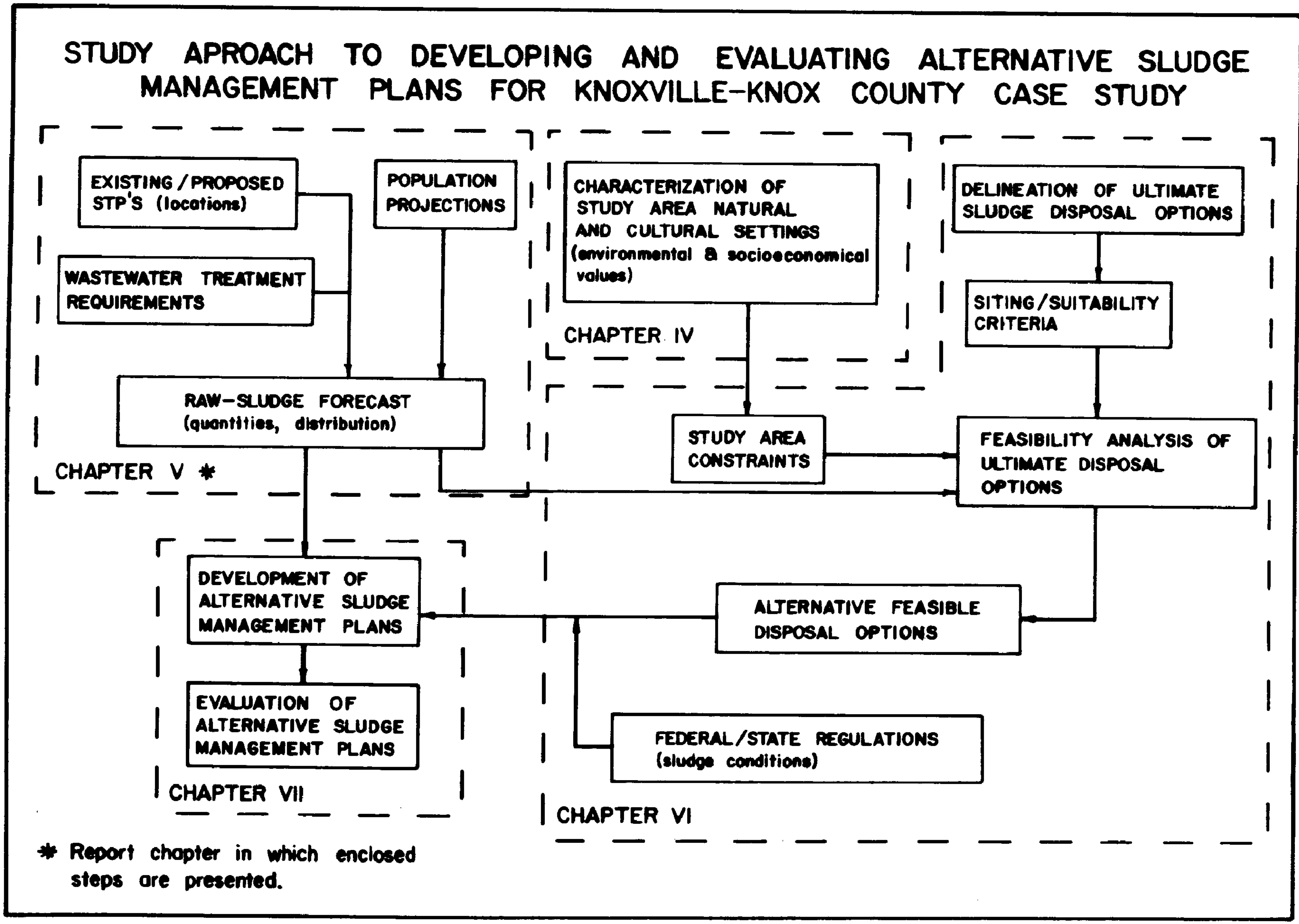
The evaluative process described above would be the same, although more complex, where more than one wastewater treatment facility either exists or is planned. However, the potential for economies of scale will require that combined treatment processes, both for wastewater and residual wastes, be investigated to insure a cost-effective plan as well as a plan that could provide for the resource recovery, recycling, and utilization encouraged in the Act.

STUDY APPROACH

The Methodology pathway (approach) used in the Knoxville-Knox County case study is not constrained by existing/proposed quantities and qualities of sludge. This approach corresponds to the second situation described in the previous section. The study approach and report organization derived from following the pathway in Figure III-1 are shown in Figure III-2.

As shown in Figure III-2, the study initially has three independent processes occurring concurrently: 1) generation of the raw-sludge forecast; 2) characterization of the study area; and 3) delineation of the ultimate disposal options. The first intersection of processes occurs in the feasibility analysis of ultimate disposal options in which the study area constraints (derived from the study area characterization) and the general siting/suitability criteria for the ultimate disposal options are compared and evaluated. Subsequently, the feasible disposal options and the required sludge conditions (i.e., digested, de-watered, etc.) are identified. A sludge management plan for the study area is then developed for each feasible disposal option incorporating the raw-sludge forecast and the required sludge condition (i.e., solids handling system). In the last step of the approach, each alternative sludge management plan is evaluated according to the criteria delineated in Chapter VII of the Methodology (i.e., economic, environmental, performance, and feasibility parameters). The general data requirements and the data sources utilized to meet them are presented in Table III-1.

The approach taken during this study and as depicted in Figure III-2 is a possible approach that may be taken by the 208 planning agencies. Existing and/or proposed wastewater treatment plants generally have either poor records of existing quantities and qualities of sludge or insufficient and unavailable



STUDY APROACH TO DEVELOPING AND EVALUATING ALTERNATIVE SLUDGE MANAGEMENT PLANS FOR KNOXVILLE-KNOX COUNTY CASE STUDY
EXISTING / PROPOSED STP'S (locations)
POPULATION PROJECTIONS
WASTEWATER TREATMENT REQUIREMENTS
RAW-SLUDGE FORECAST (quantities, distribution)
CHAPTER V ✱
CHARACTERIZATION OF STUDY AREA NATURAL AND CULTURAL SETTINGS (environmental & socioeconomical values)
CHAPTER IV
DELINEATION OF ULTIMATE SLUDGE DISPOSAL OPTIONS
SITING / SUITABILITY CRITERIA
STUDY AREA CONSTRAINTS
FEASIBILITY ANALYSIS OF ULTIMATE DISPOSAL OPTIONS
DEVELOPMENT OF ALTERNATIVE SLUDGE MANAGEMENT PLANS
EVALUATION OF ALTERNATIVE SLUDGE MANAGEMENT PLANS
CHAPTER VII
ALTERNATIVE FEASIBLE DISPOSAL OPTIONS
FEDERAL/STATE REGULATIONS (sludge conditions)
CHAPTER VI
✱ Report chapter in which enclosed steps are presented.

FIGURE III-2

TABLE III-1

DATA REQUIREMENTS AND SOURCES FOR KNOXVILLE-
KNOX COUNTY CASE STUDY

DATA REQUIRED	DATA SOURCE
Existing/Proposed STP's	201 facilities plan (draft), MPC, utility districts, Wastewater Control System (City of Knoxville)
Population Projections	201 facilities plan (draft), MPC
Wastewater Treatment Requirements	201 facilities plan (draft), utility districts, EPA Regional Office
Study Area Characteristics (e.g., geology, land use, etc.)	303(e) planning reports, 201 facilities plan (draft), MPC and TVA reports, Tennessee Department of Conservation, miscellaneous maps and reports from Federal, regional, and educational institutions
Ultimate Sludge Disposal Options/ Siting Criteria/Costs	Methodology (Chapter VI), MPC, TVA
Federal, State Sludge Disposal Regulations	Methodology (Chapter VI), Tennessee State Agencies (Air, Water, Public Health).
Alternative Solids Handling Systems/Costs	Methodology (Chapter IV and VIII)
Transportation Costs	Methodology (Chapter V)
Evaluation Criteria	Methodology (Chapter VII)

information in 201 Facilities Plans for proposed plants. Many 208 agencies will be faced, as was the case in this study, with incomplete or on-going facilities planning programs and, thus, will be required to generate sludge quantities and qualities utilizing initially local information, if available, and secondly the

Methodology. The data sources utilized during this study (see Table III-1) would therefore also be the same types of sources other 208 planning agencies would use in the development of sludge management plans.

CHAPTER III

REFERENCES

III-1 Sludge Processing, Transportation, and Disposal/ Resource Recovery: A Planning Perspective, Wyatt, J.M., and White, P.E., Jr., Engineering-Science, Inc., EPA Contract No. 68-01-3104 (April 1975).

CHAPTER IV

CHARACTERIZATION OF THE KNOXVILLE-KNOX COUNTY AREA

INTRODUCTION

The primary purpose of this chapter is to provide background data on the Knoxville-Knox County Study Area used in developing and evaluating municipal wastewater sludge disposal alternatives. Because this is a case study which will be read by persons unfamiliar with the Study Area, it is deemed necessary to include such a presentation of general background information as an aid in understanding the tailoring of the Methodology to the Knoxville-Knox County area.

The following sections are intended to provide brief but comprehensive pictures of the Study Area. The pictures to be described are the natural and cultural systems or settings. An understanding of these systems should guarantee both protection of existing and future environmental and cultural values in the region and a minimum cost for a sludge management system. Ignoring any or all of these systems might result in sludge disposal methods that impair existing and/or future uses of air, land, and water resources and lead to costly corrective or containment actions.

The natural setting includes discussions of the physiography, the geology, climatology, hydrology, soils, and other physical characteristics which provide a basis for evaluating the environmental suitability of the Study Area for various types of sludge management options and the probable environmental impact. The cultural setting describes the evolution of socioeconomic development in the Study Area and the projected level, type, and distribution of future development. This is important in delineating future sludge quantities and in locating possible sludge management facilities, particularly those having large land requirements. Included in the cultural setting is a discussion of the institutional framework (as related to wastewater sludge management) which attempts to evaluate the legal, administrative, and technical capabilities of existing agencies. Such knowledge is important for assigning agency responsibility when developing sludge management alternatives for consideration. Finally, a discussion of the legal setting highlights the existing laws under which a residual waste management agency might finance, administer, implement, and enforce a recommended management plan.

NATURAL SETTING

The natural processes dominant in the Study Area are perhaps most easily described within the context of the physiographic region. Physiographic regions are generally defined as contiguous areas having similar geologic structure and climate that have evolved the same general land forms. Inherent in this definition is the understanding that it is the interaction between geology and climate which defines the drainage pattern of streams and rivers; the topography, types and locations of soils, vegetation, and wildlife; and the distribution of ground water. These latter characteristics are directly related to the inherent environmental suitability of the region for the various sludge disposal methods.

The Study Area physiography is also dependent in certain areas on the reaction of the underlying carbonate rocks (i.e., limestone and dolomite) with the existing humid temperate climate. Carbonate and calcareous rocks are susceptible to solvation, particularly along fractures and bedding planes. Over long periods of time, the subsurface solution features begin to greatly affect landforms, surface drainage, and groundwater availability. Regions in which large-scale solution occurs are known as "karst" regions. Within the Study Area there are many areas in which karst features (Figure IV-1) are abundant along with the unique problems associated with such areas (e.g., flooding, subsidence, etc.).

The Study Area lies entirely within the Valley and Ridge physiographic province. The Valley and Ridge province is a narrow belt of faulted and folded rocks of Paleozoic age, extending 1200 miles (1931 kilometers) from central Alabama to the St. Lawrence Valley. The region is characterized by parallel ridges and valleys which are only occasionally broken by wind and water gaps. The Valley and Ridge province in Tennessee is bounded on the west by the Appalachian Plateau province, a low chain of folded mountains, and on the east by the Blue Ridge province, a belt of mountains composed primarily of metamorphic rocks.

Geology

The rocks of the Valley and Ridge province were originally deposited on the margins of the interior Paleozoic sea, the sediment originating from the erosion of highlands to the southeast and northwest. During or after their deposition, the Appalachian revolution (i.e., mountain-building period) occurred which folded and faulted the 30,000 to 40,000 feet (9100 to 12,000 meters) of stratified rock and sediment causing a substantial decrease in the basin width. The compression of these rocks resulted in parallel bands of rock extending in a southwest-to-northeast direction.

KNOXVILLE AND KNOX COUNTY
CARBONATE BEDROCK AND KARST AREAS

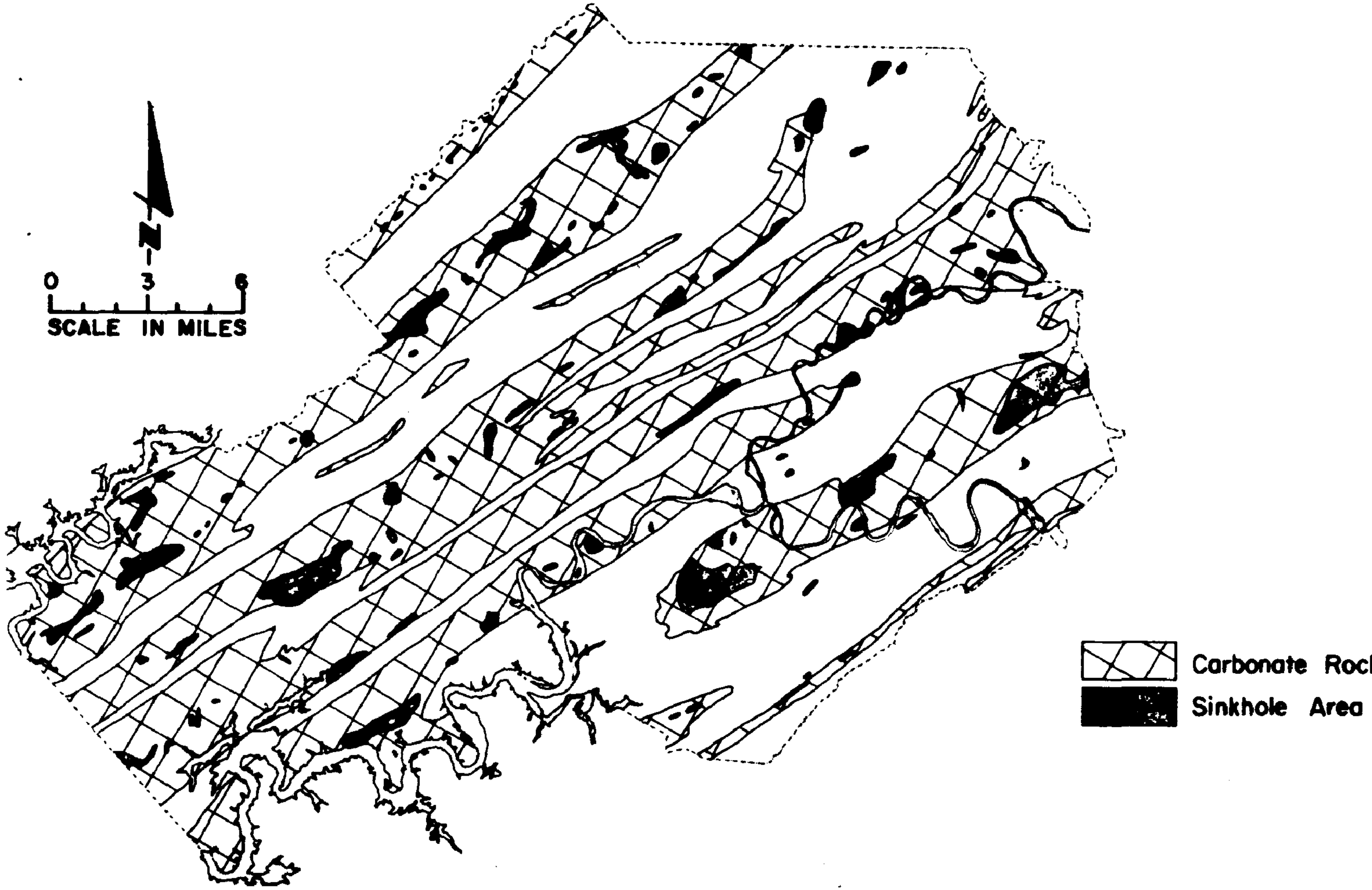


FIGURE IV-1

SOURCE: Reference IV-16

The geologic formations present in the Study Area are primarily limestones, dolomites, calcareous and sandy shales, and sandstones of early Paleozoic age. Carbonate rocks underlie approximately 55 percent of the land surface with shales and sandstones underlying 40 and five percent, respectively. These formations are generally covered by a mantle of residual soil, mostly clay, which varies in thickness up to 150 feet (46 meters) (Ref. IV-1). The residual soil or regolith is a product of the weathering of the underlying bedrock and is of a much more recent age. Alluvial deposits of gravel, sand, and clay of very recent origin have been deposited along floodplains and terraces.

Climate and Air Quality

The climate of the Study Area is apparently moderated to a great extent by the adjacent Cumberland Plateau (a division of the Appalachian Plateau) and the Blue Ridge provinces. The Cumberland Plateau to the west has a rain-shadow effect on the Valley and Ridge province causing annual precipitation to be 10 inches (25.4 cm) less in the Study Area than that of the plateau region. The Cumberland Plateau also acts to reduce the impacts of winter and cold fronts. The Blue Ridge province to the east tends to divert hot summer winds from high-pressure systems off the South Atlantic Coast.

Precipitation in the Study Area averages about 48 inches (122 cm) annually including about 12 inches (30 cm) of snow. Rainfall is fairly evenly distributed throughout the year with the least rainfall occurring in September and October. The frost-free period for the area is 215 to 220 days.

January through March is considered the winter season with winds predominately from the west and southwest, these wind directions also occurring during the spring season. The wind speeds during these months (January-June) rarely fall below five miles per hour [224 centimeters per second (cms)]. In summer months the wind speeds are at their lowest, with speeds below five miles per hour (224 cms) occurring thirty percent of the time. During the fall (October through December), the winds are more directional than any other season, with speeds lower than five miles per hour (224 cms) from the northwest occurring 33 percent of the time (Ref. IV-2).

"In addition to seasonal fluctuations in wind speed and direction, there exists pronounced diurnal fluctuations in the wind. Daytime winds generally have a southwesterly component, while nightime winds tend to be from the northeast" (Ref. IV-2).

In accordance with 40 CFR 51.12(e) published in the Federal Register of June 18, 1973, states are to identify those areas which have the potential for exceeding any National Ambient Air Quality Standards between 1975 and 1985. The identified areas are to be known as Air Quality Maintenance Areas (AQMA's). Knoxville-Knox County was not designated as an AQMA. Within the Knoxville Standard Metropolitan Statistical Area (SMSA), the projected particulate emissions (including Anderson, Blount, Union, and Knox County) for 1975 are 21,541 tons per year (19,542 metric tons per year) and for 1985, they are projected to be 28,788 tons per year (26,166 metric tons per year) (Ref. IV-3). Pertinent Federal, State, and local air pollution standards and air quality data for Knoxville (1974) may be found in Appendix A.

Topography

The Study Area topography is classified as Open Hills surface type in the Appalachian Rough Lands Subdivision (Ref. IV-4). This type of topography is characterized by 20-50 percent of the land being in gentle slopes with over 75 percent of the gentle slopes being in lowland areas (Figure IV-2). Local relief ranges from 300-500 feet (91-152 meters).

The land surface comprises a series of narrow subparallel valleys and ridges oriented approximately N 55°E. These are a result of the folded and faulted nature of the underlying geologic formations which vary in their ability to resist weathering erosion. In general, the ridges are comprised of resistant cherty limestones and dolomites and sandstones, while the valleys are underlain by soluble carbonate rocks or shales which are easily weathered and eroded. Relief between valley floors and ridge crests is between 180-400 feet (55-122 meters), decreasing slightly from northeast to southwest.

Hydrology and Water Quality

The principle rivers draining the Study Area are the Clinch, French Broad, and the Holston Rivers. The latter two join at Knoxville to form the Tennessee. The northwestern third of the area is drained to the Clinch River (Melton Hill Lake) by Bullrun and Beaver Creeks. The remainder of the area is drained to the Holston and French Broad Rivers and, from Knoxville downstream, to the Tennessee River (Fort Loudoun Lake) by many small streams (Figure IV-3.).

The mean flow of the Tennessee River at Knoxville is 12,850 cfs (21,845 cu m/min) of which the Holston and French Broad contribute 35 and 65 percent, respectively. The flow of the Holston River is controlled by Cherokee Dam, 52 miles (84 kilometers) upstream of Knoxville, and that of the French Broad by Douglas Dam, 32 miles (51 kilometers) upstream.

KNOXVILLE AND KNOX COUNTY
PERCENT SLOPE MAP

SOURCE: U.S.G.S. Topographic Maps

FIGURE IV-2

KNOXVILLE AND KNOX COUNTY
SURFACE HYDROLOGY

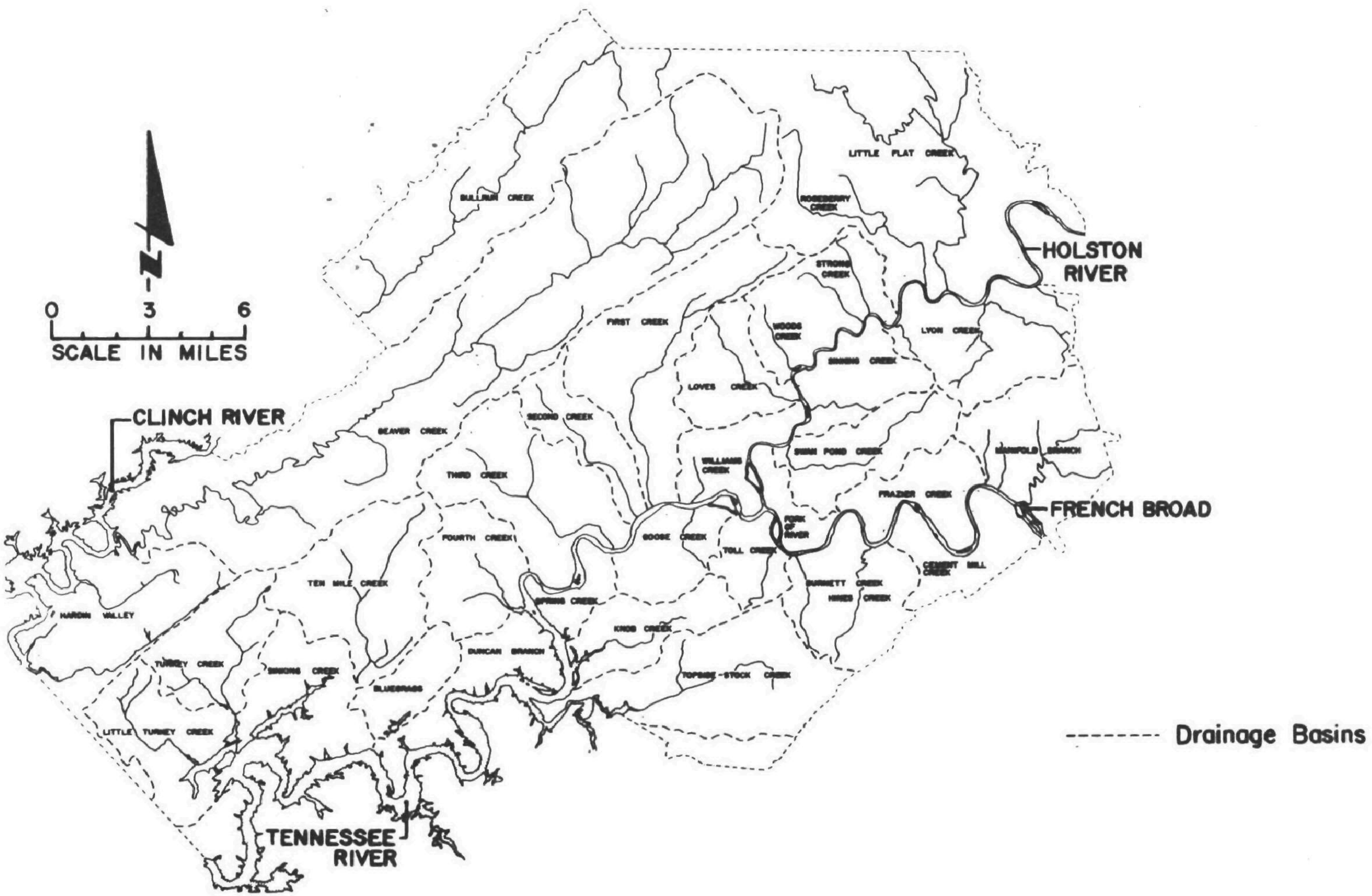


FIGURE IV-3

Major flooding of the Tennessee, Holston, and French Broad Rivers in the Study Area has not occurred since the construction of Tennessee Valley Authority (TVA) impoundments upstream and downstream. However, studies conducted by TVA indicate that such flooding is possible in the future under certain storm conditions (Ref. IV-5). Flooding is possible on many of the smaller tributary streams under many winter storm and thunderstorm conditions. Figure IV-4 shows those areas most prone to flooding and includes sinkhole areas (karst features) which, because of their importance in local drainage, could under certain circumstances contribute to flooding.

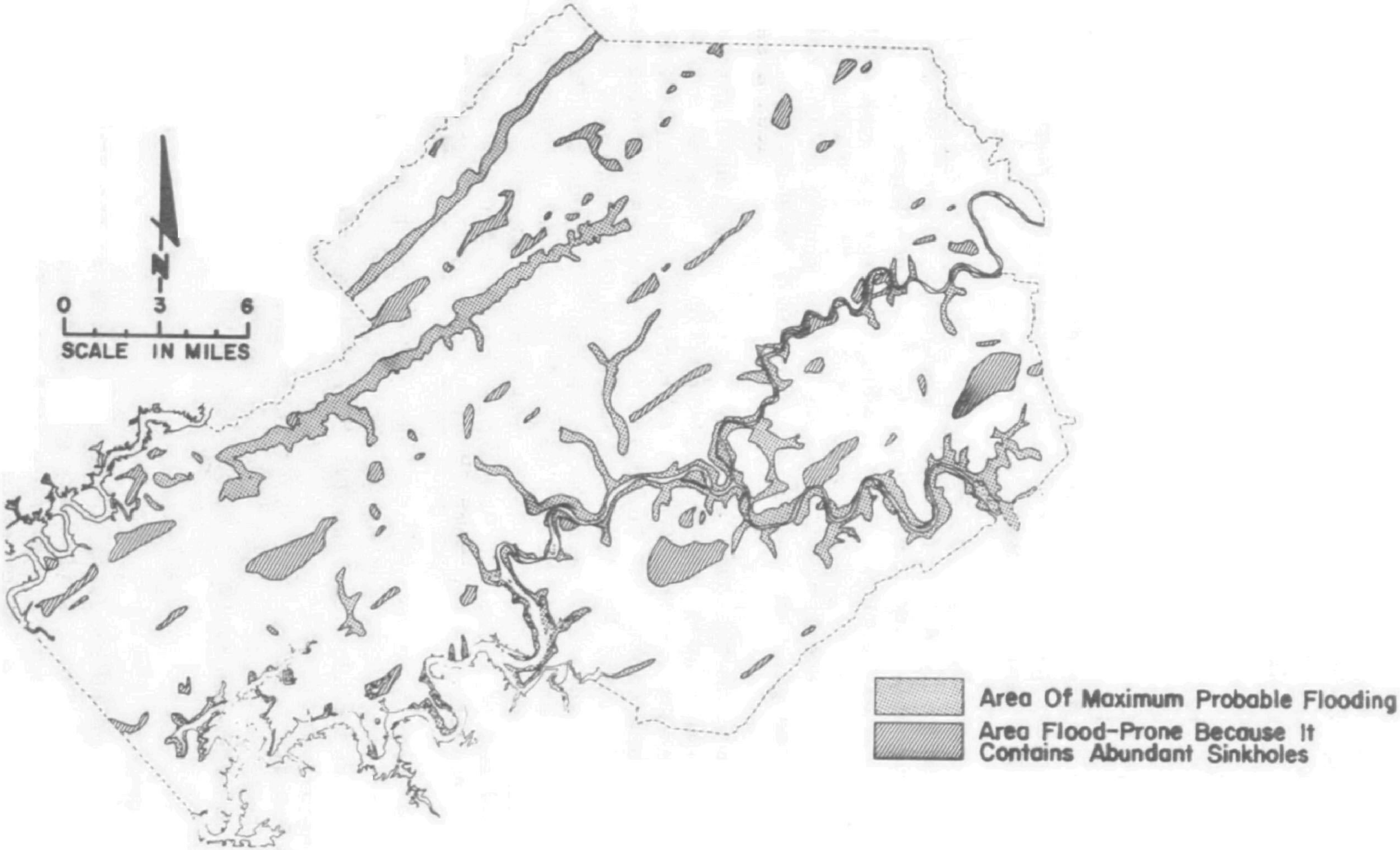
Annual runoff in Knox County averages about 19 inches (48 cm) with 7-9 inches (18-23 cm) passing through the groundwater system before discharging to streams. Evapotranspiration processes return the remaining 29 inches (74 cm) of annual precipitation to the atmosphere (Ref. IV-6).

The occurrence of ground water in the Study Area is controlled by fractures in the underlying rocks. These rocks have little primary porosity and permeability, but fracturing due to folding and faulting and solvation along bedding planes have created a secondary porosity and permeability. In carbonate and calcareous rocks the fractures are enlarged by percolating ground water which dissolves calcium carbonate from the rock. The area of active solvation within carbonate rocks is generally within 300 feet (91 meters) of the land surface. Below this depth fractures are small and precipitation of dissolved calcium carbonate occurs which decreases the secondary porosity and permeability (Ref. IV-1).

There is no area-wide aquifer underlying the Study Area which will yield predictable, large supplies of ground water to wells. In general, areas underlain by carbonate rocks have the most groundwater storage and areas underlain by shale and sandstone the least. Much of the groundwater storage in carbonate rock areas is in the residual soil overlying the bedrock, which can be as much as 150 feet (46 meters) thick. However, the permeability of this material is low causing it to act as a recharge reservoir for the bedrock system. The bedrock system has limited storage but high transmission capacities along fractures and bedding planes. The yield of springs or wells in these areas is dependent on the number and extent of fracture systems intercepted.

Domestic supplies of ground water [5-10 gallons per minute (gpm)] [0.32-0.63 liters per second (l/sec)] are available to wells in virtually all parts of the Study Area. Well yields substantially greater than that required for domestic purposes occur much less frequently for the reasons stated above.

KNOXVILLE AND KNOX COUNTY FLOOD-PRONE AREAS



SOURCE: Reference IV-5

FIGURE IV-4

A review of the 303(e) plans developed for the Study Area indicates that the majority of municipal and industrial dischargers of concern in this study are located on water-quality-limiting stream segments (Ref. IV-6, IV-7, IV-8, and IV-9). In addition the 303(e) plans all assumed that "by 1980 all persons living within an urbanized area will be served by a waste treatment facility" (Refs. IV-7, IV-8, and IV-9). Knoxville-Knox County SMSA and, in particular, the Study Area for this report being essentially in urban character (Ref. IV-10), it was assumed (see also Chapter V) that the population within the Study Area will be sewered and the wastewater treatment facilities will meet, at the minimum, discharge standards promulgated to ensure compliance with stream standards for water-quality-limiting segments.

In accordance with the Water Quality Control Act of 1971, Chapter 164 Public Acts of 1971 as Amended, Sections 70-324 through 70-342, Tennessee Code Annotated, the Tennessee Water Quality Control Board and the Division of Water Quality Control are seeking the achievement of water quality conditions necessary to meet all the reasonable and necessary water needs of the people of the basin and to provide the greatest possible net benefit to the region.

As a part of the overall water quality goal, specific water quality criteria have been established for all streams within the State of Tennessee. The "General Water Quality Criteria for the Definition and Control of Pollution in the Waters of Tennessee" were adopted on May 26, 1967 by the Tennessee Stream Pollution Control Board and were amended and readopted on October 26, 1971 by the Tennessee Water Quality Control Board with subsequent amendments on December 14, 1971, and October 30, 1973. This Board succeeded and replaced the Tennessee Stream Pollution Control Board as required by the Water Quality Control Act of 1971.

The Water Quality Criteria vary according to each of seven recognized reasonable and necessary water uses: domestic raw water supply, industrial water supply, fish and aquatic life, recreation, irrigation, livestock watering and wildlife, and navigation. The Water Quality Criteria are given in Appendix B. Tennessee's Water Quality Standards have been approved by the Water Quality Office of EPA (Refs. IV-7, IV-8, and IV-9).

Soils

There are 60 kinds of soil represented in the Study Area (Ref. IV-11). These soils vary greatly in their characteristics which are dependent to a great extent on parent material, relief, and time, and to a lesser extent, on climate and living organisms. In general, the most developed and thickest soils occur in the valleys where the rate of erosion is least and, consequently, the time for soil development the greatest. The parent material in the valley areas is chiefly residuum (the clay and silt remaining after solution of the underlying carbonate rocks) with some overlying alluvial (stream) and colluvial (gravity slope) deposits. The soils formed in the residuum are generally poorly-drained with low to moderate fertility. Those soils formed in the alluvium and colluvium are well-drained and highly fertile. The alluvial and colluvial soils are the prime agricultural soils in the Study Area; the residuum soils being more suited for hay and pasture. The locations of these soils in the Study Area are shown in Figure IV-5.

The soils formed near and along the ridges are generally thin, poorly developed, and infertile. This is primarily due to the higher rate of erosion in these steep-sloped regions which removes the soil almost as fast as it is produced.

Flora/Fauna

Information characterizing the flora and fauna of the Study Area was not found during the course of this study in detail sufficient for use in the Methodology. The existing floral and faunal systems generally found in the Valley and Ridge province today are primarily those of oak forest (Ref. IV-11). In uncut areas, red and white oak predominate on intermediate slopes and chestnut oak on higher rocky slopes and crests. The valley areas are predominately white and red oak with hickories and tulip poplars. Some of the valley areas might have been natural prairie at one time. The wildlife associated with such vegetated areas would include numerous varieties of birds and small mammals, including deer, fox, raccoon, and oppossum.

Mineral Resources

The mineral resources of the Study Area are related primarily to the carbonate rocks. Carbonate rocks are important as sources of crushed stone, agricultural limestone, lime, cement, and dimension stone. Carbonate rocks near the town of Mascot are the host for zinc deposits which are mined primarily as sphalerite concentrates. Shale is also quarried for brick and lightweight aggregate manufacture. The locations of active quarries and mines are shown in Figure IV-6. On a regional basis, the Study Area is located only several tens of miles east of extensive coal strip-mining operations which could provide feasible reclamation alternatives for sludge disposal.

CULTURAL SETTING

Just as it is unwise to plan sludge disposal management ignorant of the natural setting, so is it equally unwise to develop

KNOXVILLE AND KNOX COUNTY
PRIME AND SECONDARY AGRICULTURAL SOIL AREAS

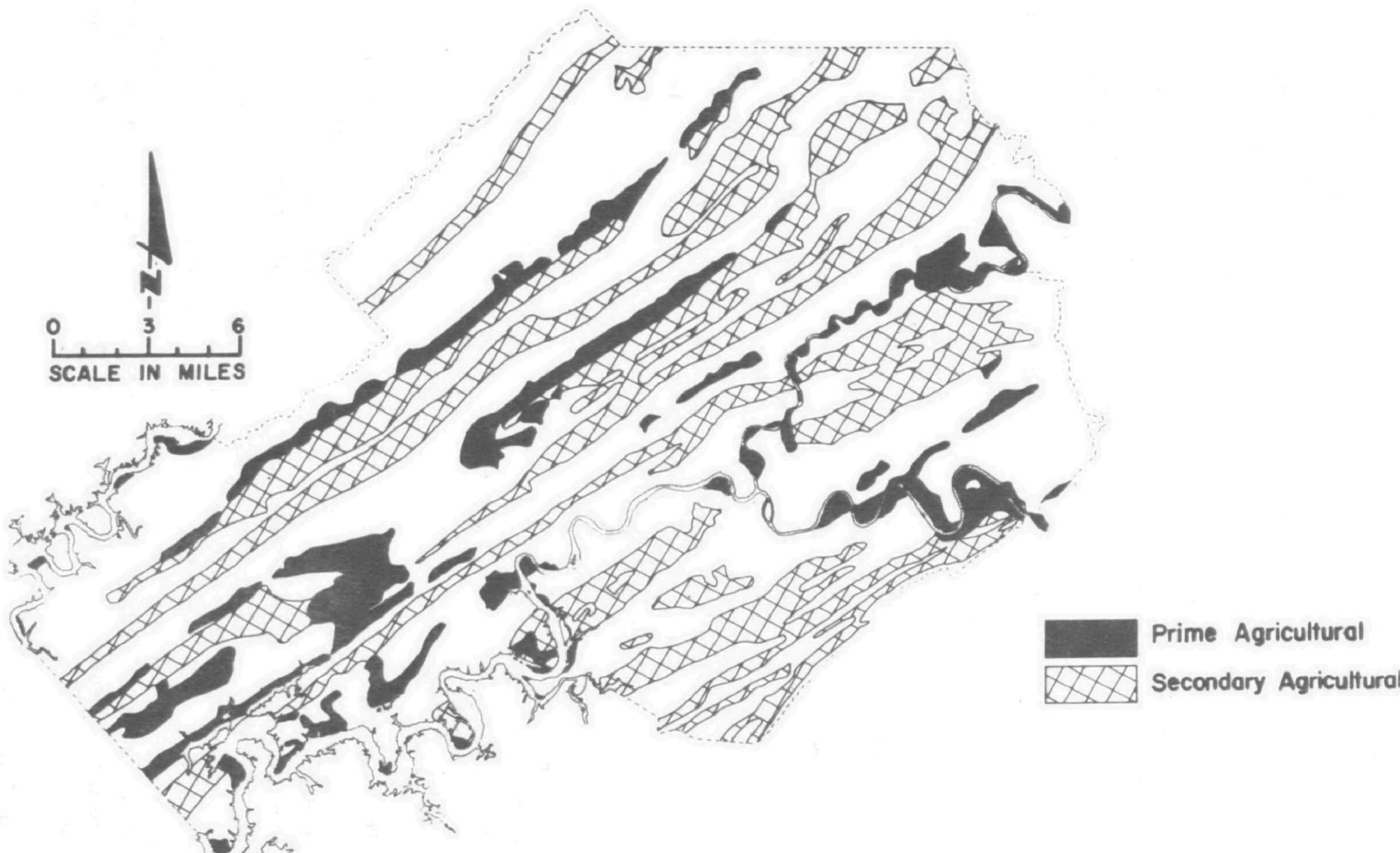
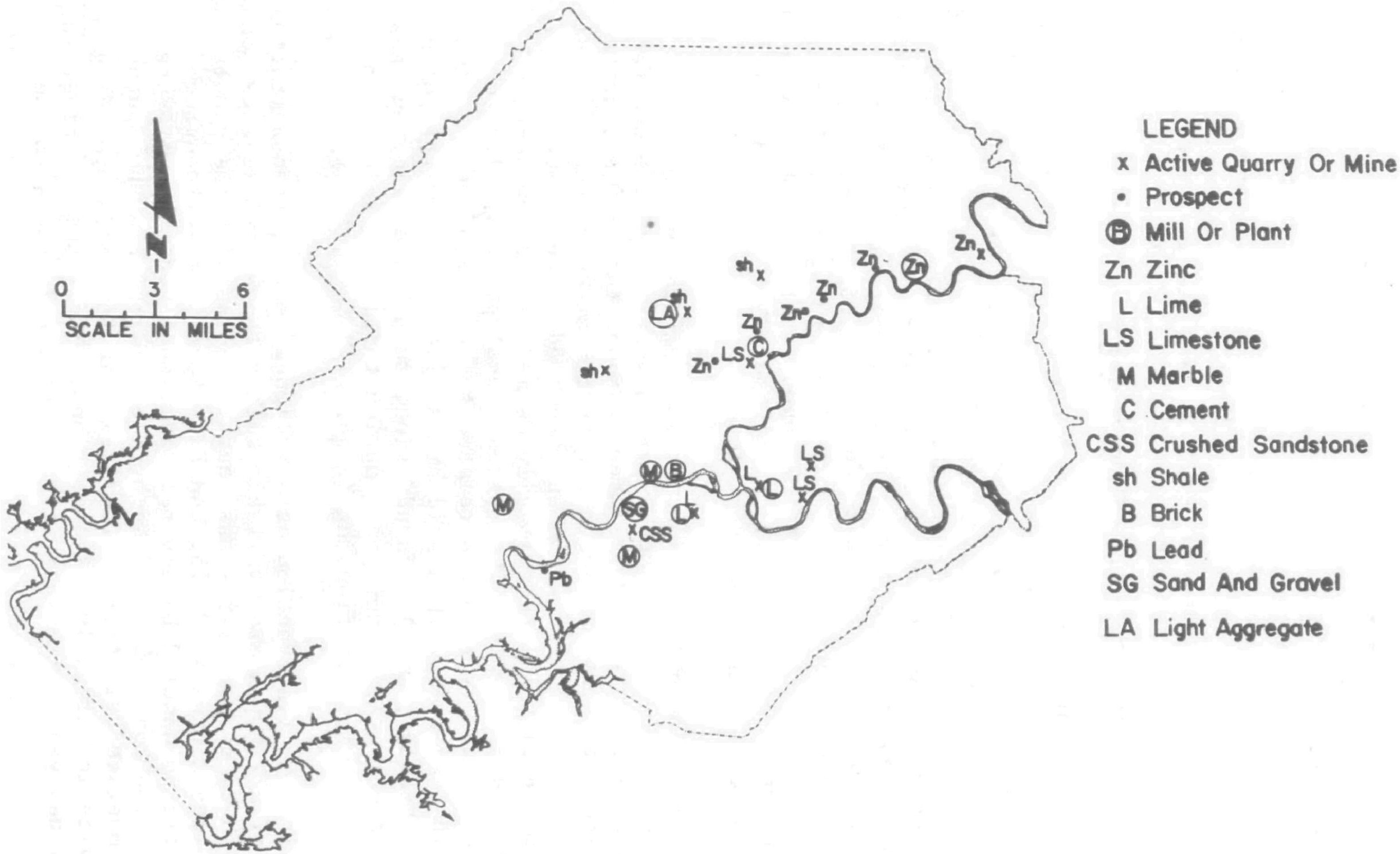


FIGURE IV-5

SOURCE: Reference IV-11

KNOXVILLE AND KNOX COUNTY MINERAL RESOURCES



SOURCE: Reference IV-17

FIGURE IV-6

and evaluate disposal alternatives without considering the existing and projected cultural setting and values. Sludge disposal alternatives compete with other public and private interests for economic and environmental resources, whether it be for space in a sanitary landfill or the money for building and operating an incinerator. The following sections are intended to present in brief form the cultural setting as it exists now and, possibly more important, what it is desired/projected to be.

Evolution of the Knoxville-Knox County Area

The primary driving force in the socioeconimic development of the Study Area has been its location at the navigable headwaters of the Tennessee River. This natural access to cheap bulk transportation has led to a concentration of wholesale, retail, banking, transportation, and manufacturing services, (primarily located in and adjacent to Knoxville) which serve eastern Tennessee and parts of Virginia, Kentucky, and North Carolina. With its evolution from an area primarily devoted to developing local agricultural, forest, and mineral resources to one of providing regional services (not dependent, to any great extent, upon local natural resources), a different set of environmental needs and values related to urbanization developed within the Study Area.

Initially, the urbanization process occurred north of and adjacent to the upper Tennessee River in what is now the central core of Knoxville. Urban development through the 1950's occurred in areas adjacent to past development with the steep ridge areas left undeveloped. Post-1960 development occurred in rural areas several miles from the city limits primarily as medium and low density residential developments. This recent development has led to environmental quality problems related to the use of septic tank disposal in clay and/or thin soil areas (i.e., groundwater pollution, drainfield seepage, etc.). In addition, suburban development has resulted in competition for prime agricultural land which in many cases is susceptible to flooding (Figures IV-4 and IV-5).

Critical to its function as a regional center, transportation networks of all types are available within the Knoxville-Knox County area. Highway accessibility has been increased with the completion of Interstate Highways 40, 75, and 81. Local and surrounding area traffic is handled by several additional Federal and State highways. The Louisville and Nashville Railroad and the Southern Railroad operate rail freight facilities in Knoxville providing rail service in virtually all directions. The Tennessee River is presently navigable from Knoxville to its confluence with the Ohio River.

The economy of the Study Area is diversified with manufacturing the largest single employment category. Trades, government, and services are also significant economic factors. The agricultural economy is characterized by numerous small farms [about 1800 farms with an average size of 73 acres (30 hectares) in 1969] with a long-term decreasing trend in the number of farms and the acreage farmed (Refs. IV-7, IV-8, and IV-9).

The population of the Study Area has grown from 74,000 in 1900 to 276,000 in 1970. The growth rate per decade has been fairly constant. A current population estimate made by the Metropolitan Planning Commission (MPC) in July, 1974 is 303,379 of which 59 percent live within the city limits of Knoxville. Figure V-4 shows the distribution of the estimated 1975 and 1995 populations per drainage area. Primary population centers outside Knoxville are to the north, west, and southwest of the city limits.

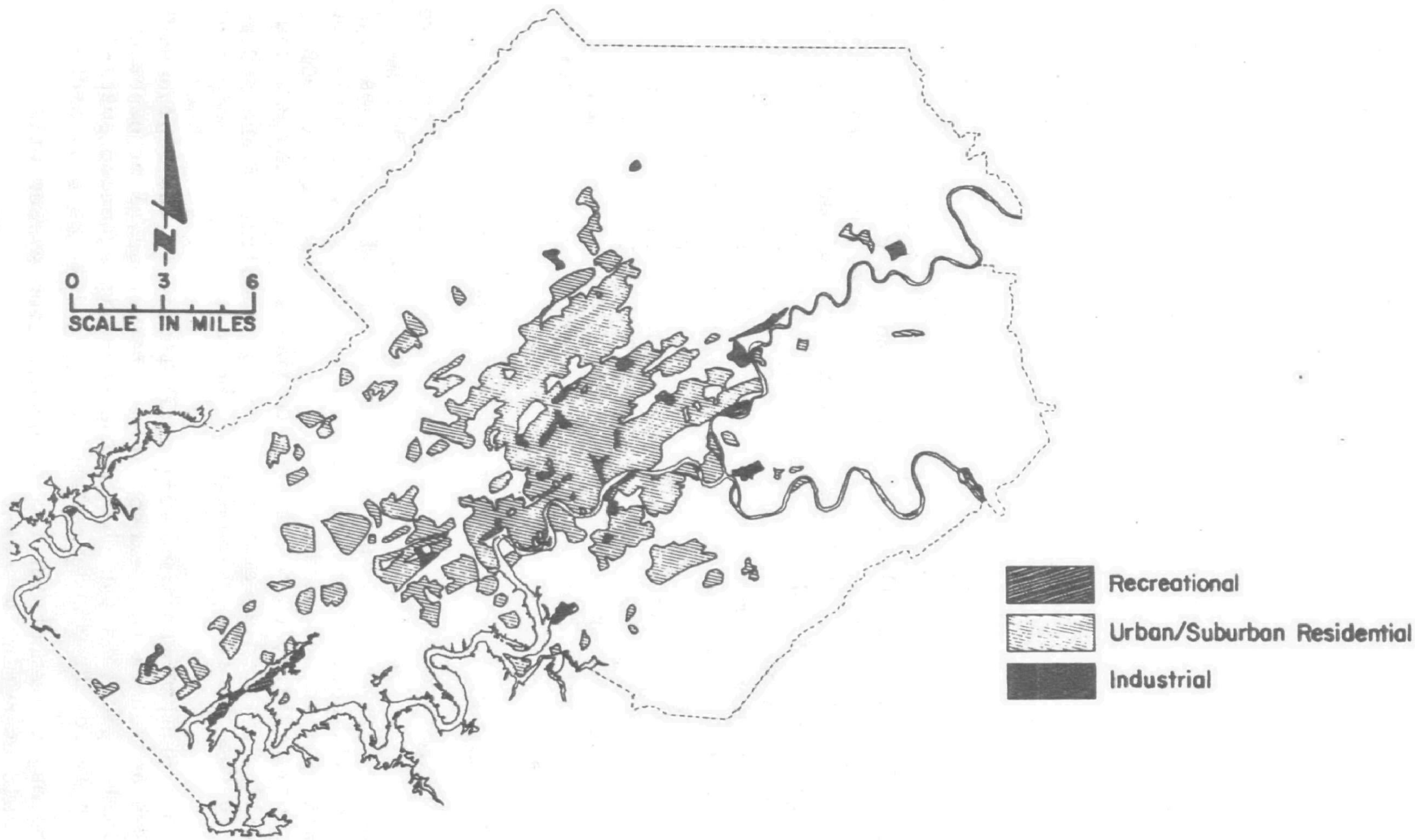
The existing land use (Figure IV-7) for the Study Area outside Knoxville has major residential developments west and north of the city limits adjacent to major highways. Industrial areas are located primarily within Knoxville and adjacent to railroad lines. Pre-1960 development, particularly residential, occurred in a ring-like pattern centered around the central core-area of Knoxville. Post-1960 residential and industrial development has occurred in a much more dispersed manner. Many medium and low density residential projects and large commerical and office parks have been built in formerly rural areas, particularly in west Knox County. The northern portion of Knox County has had additional suburban residential development on a smaller scale. East Knox County has not experienced much development since 1960 with the exception of the Forks-of-the-River industrial area. Recent development in southern Knox County has been limited to some low density residential developments.

The 1990 General Plan for Knoxville-Knox County

The primary goal of the 1990 General Plan for the Study Area as delineated by the MPC is to provide the greatest number of people with public services and facilities on a cost-effective basis. This is most easily accomplished by filling in currently sparsely populated areas with future new development. Figure IV-8 shows the 1990 land use plan which, when compared to the existing land use map (Figure IV-7), reveals several assumptions/desires of the MPC in regard to the future development of the area:

> "Most of the urbanized areas will remain in their present uses and character, except where urban renewal or other similar programs can change the economic equation sufficiently to allow redevelopment.
>
> The major elements of the transportation system will remain essentially intact.
>
> Location of additional development will be greatly influenced by topography and transportation corridors.

KNOXVILLE AND KNOX COUNTY
EXISTING LAND USE



SOURCE: Knoxville-Knox County Metropolitan Planning Commission

FIGURE IV-7

KNOXVILLE AND KNOX COUNTY 1990 LAND USE PLAN

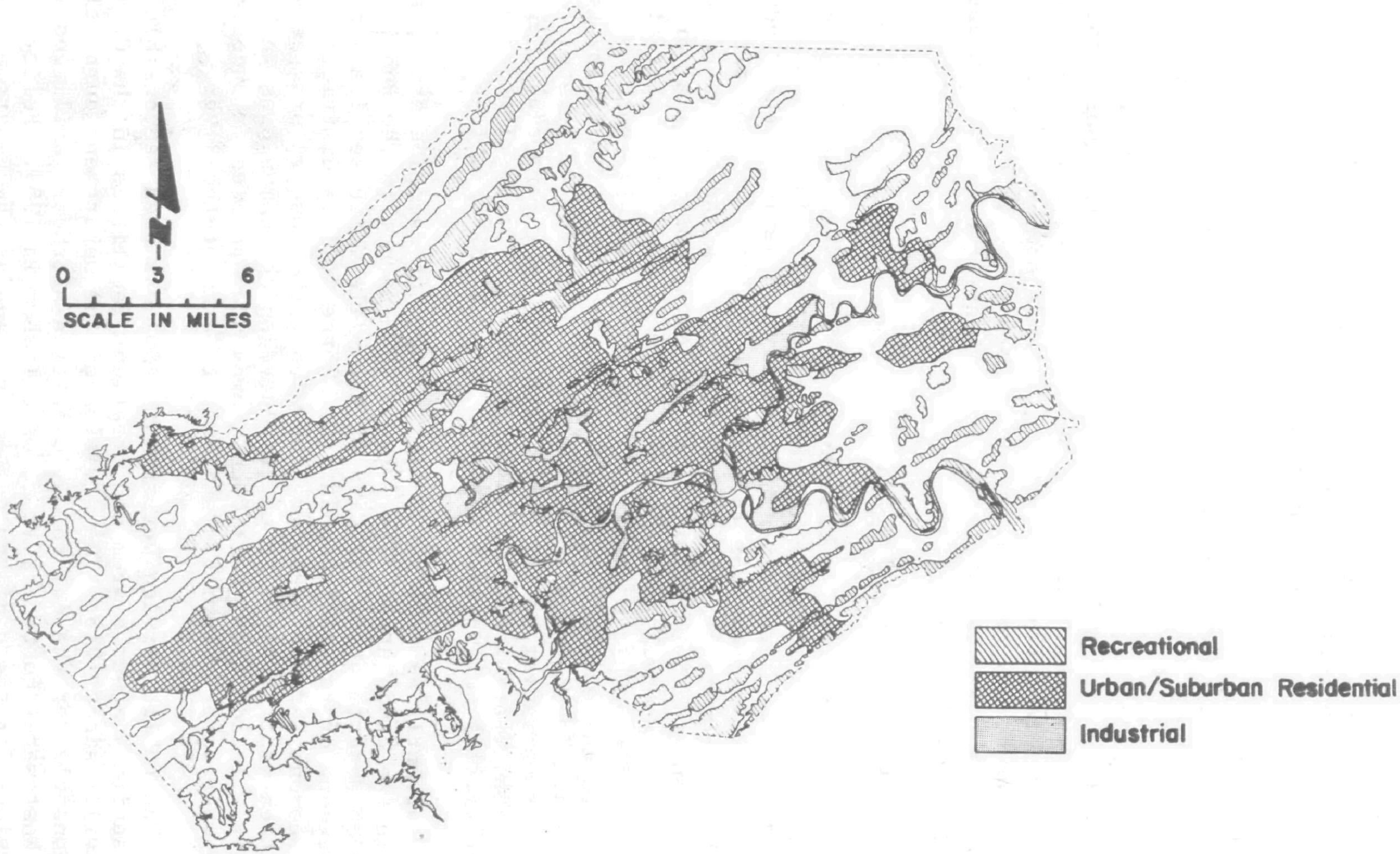


FIGURE IV-8

SOURCE: Knoxville-Knox County Metropolitan Planning Commission

Some manufacturing uses will be located outside of the city with regional services and distribution facilities concentrated within the city." (Ref. IV-13).

In addition to allowing for more extensive and cost-effective public services, increasing the density of development would preserve land for other uses such as agriculture and recreation.

Population projections (Figure V-4) indicate three general areas within the Study Area which are expected to absorb most of the new development through 1990. West Knox County is expected to accommodate the greatest amount of development. North and south Knox County are expected to absorb the bulk of the remaining development potential with new development in north Knox County being a greater certainty.

Institutional Characterization

Another important parameter to be considered in the general feasibility of a sludge management alternative is the number of implementation alternatives practically available in the Study Area. It would show poor foresight to develop disposal alternatives which are compatible with the environment and the projected land uses of an area but infeasible to implement for political or financial reasons. And, although there are a large number of possible financial, operational, and political alternatives, only a limited number would apply to any given area. The following discussion is intended to delineate the existing wastewater agencies operating in the Study Area and their financial, legal, and administrative capabilities, and assess the institutional possibilities for various types of disposal alternatives.

Currently several wastewater management agencies are operating within the Study Area. The largest such agency is the Public Service Department of the City of Knoxville which services about 70 percent of the city population. Three utility districts (autonomous service areas created within the county) provide sewer and treatment services to certain developing communities in Knox County. In addition, Knox County owns and operates an industrial park wastewater treatment facility at Forks-of-the-River.

The Public Service Department (PSD) has been responsible for the sanitary sewer system and treatment facilities in the City of Knoxville since 1923. The division of the Department currently responsible for the day-to-day operation of these facilities is the Wastewater Control System, established in 1953. Policy decisions for the sanitary system are made at the Department level. The Department has all the legal powers necessary to perform its functions (which would include sludge disposal) as provided in the Tennessee Annotated Code and Knoxville city charter (Ref. IV-10). Among its legal prerogatives are the ability to enter into contracts with other municipalities or private corporations outside its jurisdiction in order to provide adequate service and the power of eminent domain, which under certain circumstances can extend beyond the corporate limits of the city. The Department has the power to issue general obligation bonds and can determine sewer rates (subject to City Council approval). It has received Federal and State funds in the past and, owing to inadequate and malfunctioning treatment plants, is ranked high on the priority list for Federal funding. Revenues to repay bonded indebtedness and system operating costs are generated through user charges, improvement fees, and industrial surcharges. If these revenues are not enough to meet expenses, funds can be obtained from the general tax fund of the city, although this has never been required in the past. Because city taxes guarantee the bonds, the Department has an "A" bond rating. The Department has an established record for providing diverse public services and would have some of the technical expertise in-house required to design and operate a sludge management program.

The three utility districts providing sewer service and treatment to areas of Knox County are West Knox, Hallsdale-Powell, and First Utility (Figure V-2). The sewered populations served by these districts are small although they are expected to increase substantially in the future (see previous section Hydrology and Water Quality). In the past, the utility districts have operated relatively autonomously, although they are participating in recent "201" and "208" planning. Two of the utility districts are currently coordinating with the PSD in order to sewer parts of their districts to the city system. Utility districts do not have the power to levy taxes and must rely on revenue bonds, short-term loans, and Federal assistance for financing capital improvements. Because of their small size and inability to tax, utility district bond ratings are low (BBB or less) which means high interest rates. Utility districts do have most of the other legal powers given to municipalities, such as eminent domain and entering into contracts as stated in the Utility District Act of 1937 of the State of Tennessee (Ref. IV-10). The technical and administrative capabilities of the districts are limited, such services being normally provided by outside consultants.

Knox County has only recently (1967) provided sewer service and treatment with the Forks-of-the-River industrial park facility. Traditionally, most counties in Tennessee have avoided providing such services, hence the creation of the utility districts. This has been in accordance with legislative and constitutional limitations upon the power and nature of county government. In 1961, however, a public act of the legislature specifically gave the counties the right to provide certain urban services including sanitary sewer service (Tennessee Code Annotated, Sec. 3-1612). There are tentative indications that the County is evolving a more responsible County-wide awareness which could lead to greater County participation in services and planning in the future. For example, the Knox County Court, in 1971, created the Knox County Environmental Commission with a goal of bringing County-wide water services, sewage disposal, and solid waste disposal under a single agency (presumably the County). Currently the county is limited in its ability to administer any of these functions. Although it has MPC to perform technical planning duties, the County does not have a large technical staff available.

From an institutional perspective, then, the Study Area can be described as a large municipal agency (PSD) surrounded by several small utility districts within a county matrix. Traditionally, these agencies have operated independently with little or no interaction. In recent years, however, the PSD (City of Knoxville) and the First Utility and West Knox utility districts have cooperated in providing sewer service to portions of west Knox County, thus establishing a precedent for interagency cooperation. At the same time, a metropolitan attitude has been evolving within the Study Area via various civic groups, planning agencies, and City and County officials. An initial step in this perspective change is the growing awareness within Knox County of the need for the County to participate more extensively in the provision of public services and in the planning and direction of future development. These functions could, however, be usurped by individual developers and the utility districts which do not and could not have an area-wide perspective or concern for their impacts on County development. As a result two desirable but conflicting institutional processes are evolving within the Study Area: (1) greater interagency cooperation among existing agencies; and (2) growing pressure for the County to enlarge its responsibilities and participation in the future development of the area. The latter increase in power by the County would be at the expense of the utility districts.

From a sludge management perspective, the institutional setting is currently limiting in regards to metropolitan-level solutions. The utility districts can not be required to participate in a metropolitan solution. The financial instability and inherent limited financial capabilities of the utility districts (i.e., small size, no taxation power) would almost certainly deter their participation in an <u>expensive</u> but environmentally-and socially-sound alternative. Moreover, it is conceivable that a utility district would become a principal adversary in the implementation of a large land application system within its jurisdiction, not necessarily for environmental or cost reasons, but based on its need/desire to encourage residential development within its area in order to finance the existing system and future improvements. As a result, a sludge management alternative incorporating a metropolitan solution would need to be both economically advantageous to a utility district and noninterfering with regard to its development needs in order to expect the utility district's cooperation.

LEGAL SETTING

The setting in which residual waste management [including both solid waste and municipal wastewater treatment plant sludges, which are considered a "special" solid waste (see following discussion under The Solid Waste Disposal Act, TCA 53-4302 et seq.)] could be addresses from a legal standpoint is also a concern in the planning and management of any disposal or resource recovery plan. The following information has been provided by the East Tennessee Development District (ETDD) which covers 26 counties of east Tennessee and 3 counties of north Georgia (Ref. IV-14).

In order to determine the available options for regional waste management it is necessary to examine the laws of Tennessee pertaining to solid waste, intergovernmental cooperation, and the formation of other corporate and municipal type entities capable of waste management. Solid waste collection and disposal is covered under a number of different sections of the Tennessee Code Annotated (TCA). The two most significant Acts which relate to the institutional arrangements for a resource and energy recovery system are the Garbage and Rubbish Collection and Disposal Services Act, TCA 5-1901 et seq., which authorizes governmental bodies and joint efforts of the same to collect and dispose of solid wastes; and the Tennessee Solid Waste Disposal Act, TCA 53-4302 et seq., which provides for grants to governmental bodies to aid in the proper disposal of solid waste and loans for the construction of resource and energy recovery systems.

In addition to these Acts, the Utility District Act, TCA 6-2601 et seq.; the Industrial Development Corporation Act, TCA 6-2501 et seq.; and the Corporations laws at TCA 48 have potential use in the development of management possibilities for a resource and energy recovery system and related industrial development. A brief discussion of each of these laws follows.

The Garbage and Rubbish Collection and Disposal Services Act (TCA 5-1901 et seq.)

Under this Act, the counties of the State of Tennessee are authorized to provide garbage and rubbish collection services and to provide disposal services to the entire county or to special districts within the county. The Act contains an interlocal agreement section which gives counties the option of entering into cooperative agreements for either the collection or the disposal of solid waste. (TCA 5-1901). This section of the Act is broad in that it allows counties to enter into such agreements with other counties or with any other governmental unit or agency, Federal, State, or local. It includes municipalities, towns, utility districts, and improvement districts within the County, and also allows contracting with private contractors for collection and/or disposal, or any other entity which provides either or both services.

The interlocal agreement section of the Garbage and Rubbish Collection and Disposal Services Act specifically gives the cooperative management entity the power to raise revenues in any and all ways that the county can raise revenues, such as by revenue bonds, by taxes levied in specific districts, by combinations of revenue bonds and income from facilities operated by the several jurisdictions, etc. For the purposes of the institutional arrangements of a resource recovery facility in the Study area, this section could be used to form either one entity to oversee the entire operation or groups of cooperative entities to construct and manage transfer stations, to operate regional sanitary landfills, and to coordinate collection.

The interlocal agreement section of the Act would give a stronger basis for such cooperative efforts than would the Interlocal Cooperation Act, TCA 12-801 et seq. The Interlocal Cooperation Act is vague about power to raise revenues for the operation of a cooperative effort. This vagueness could result in delays while an agency formed under it is tested in court action. The Des Moines Solid Waste Agency was formed under an Interlocal Agreement Act very similar to that of the Tennessee Code Annotated, and the Supreme Court of Iowa found that additional legislation would be required to give that agency the power to raise revenues (Goreham V. Des Moines, 188 NW 2nd 860).

At least two possible arrangements exist and would be workable under TCA 5-1901 et seq. (1) The local government could contract with the provider of the recovery facility on an individual basis for disposal of solid waste. Where the amount of waste generated by a specific local government is insufficient to make the transportation from that county alone economically feasible, a cooperative unit of several local governments could be formed. That unit could contract in turn with TVA, the City of Knoxville, or any other provider of a resource/energy recovery facility for disposal of solid waste. (2) Another possibility would be for the entire Study Area to form an agency for the construction and management of transfer stations necessary to store and prepare waste for transportation to a resource/energy recovery facility, and for the acquisition and management of regional sanitary landfills for waste unsuitable for recovery and as alternative disposal sites in the event of facility snutdown. (A private corportation could also participate at any of the stages of the operation; that is, it could do the collection, construct and manage the transfer facilities, handle the transportation, or construct and operate the recovery facility.)

Solid Waste Disposal Act, (TCA 53-4302 et seq.)

This Act as amended in 1974 will also be very beneficial in developing the institutional arrangements for a solid waste system with resource/energy recovery. Grants of up to one dollar ($1.00) per capita are available from the State for each incorporated city or town or for each county to be used in operating and maintaining state approved disposal facilities. Cooperative efforts are encouraged as part of the specific legislative intent of the grant section of TCA 53-4302 et seq. "It is the further intent of this section to reduce the number of these optimum feasible solid waste disposal facilities or systems to the absolute minimum by vesting in the department (of Health) the authority to insist upon maximum cooperation among local instrumentalities as a prerequisite to receiving these special minimum-level grants" (TCA 53-4318).

The grant funds are available for the purposes of "Acquiring, establishing, constructing, altering or operating solid waste disposal facilities or systems or for the purpose of purchasing equipment therefor, or for the service of debt incurred therefor" (TCA 53-4317). These funds may be provided either directly to the cities, towns, and counties involved or they may be provided by contract with one or more other political subdivisions of the State as authorized by the Interlocal Agreement Act. They may also go to an approved private solid waste disposal system or facility that is certified as eligible by the Department of Health.

The Solid Waste Disposal Act also gives the Tennessee Department of Public Health authority to approve grants and loans from the Federal government or other sources to local governments (TCA 53-4309).

The 1974 amendment to the Act provides for resource/energy recovery facility loans from the State. (TCA 53-4322 et seq.). This section provides that the "State of Tennessee is hereby authorized to make loans to any municipal corporation or county for the construction of energy recovery facilities and/or solid waste resource recovery facilities. Such loans shall be made from the proceeds of State bond sales authorized pursuant to implementing acts of the State of Tennessee" (TCA 53-4323). Limits of indebtedness imposed by other laws of the State are not applicable to loans under this Act (TCA 53-4336).

Loans under this section of the Act can be supplementary to grants made under the other provisions of the Act. Loans are available to special districts of the State empowered to provide solid waste disposal service as well as to municipal corporations and counties.

Pertinent sections of the regulations governing solid waste processing and disposal in Tennessee may be found in Appendix D.

The Utility District Act, (TCA 6-2601 et seq.)

Solid waste collection and disposal are among the services that can be performed by utility districts in Tennessee (TCA 6-2603). The potential for using utility districts for the purpose of coordinating local governments in solid waste collection and disposal has not been adequately explored in Tennessee. A factor that supports utility districts in waste management is their ability to charge customers for actual services. This would allow local governments to remove solid waste collection and/or disposal from their ordinary expenses and actual costs could be billed to the customer-user in the same manner as other utilities are now billed.

The Urban Type Public Facilities Act, (TCA 5-1601 et seq.)

This Act used with the Interlocal Cooperation Act, supra, created the Tellico Area Service System in Monroe and Loudon Counties for development of the Tellico Area and the Timberlake Community. It gives the system utility functions including the incineration or other disposal of solid waste. However special authorization is necessary for the addition of each new service. It is limited to the two counties but could be expanded or other counties could form similar service systems if necessary.

The Industrial Development Corporation Act, (TCA 6-2801 et seq.)

This Act provides for the issuance of bonds to raise revenue for industrial development. The revenues can fund nonprofit corporations established to increase industry. Its purpose is to develop job potential through industrialization. It also seems to provide for loans to existing industry for acquisition of pollution control devices necessary to meet State standards. It might prove useful in developing resource recovery related industry and in ultimately financing pollution control equipment for a resource/energy recovery facility. Its use for the latter appears somewhat dubious because of the lack of clarity of those provisions of the Act.

Corporations, (TCA 48-102 et seq.)

The Corporation Act of the State of Tennessee has been used at all stages of solid waste collection and disposal, and corporations chartered by this State and others are engaged in each area of activity at this time. Two landfills in the ETDD area are owned and operated by private for-profit corporations. Transfer stations are operated in conjunction with one of the landfills. Collection is carried on by large numbers of corporations in the grant area, ranging from the largest corporation in the Nation involved in the solid waste industry, Browning Ferris Industries, Inc., to small family corporations operating one or two trucks for collection.

In Nashville, Tennessee, the Nashville Thermal Transfer Corporation is chartered by the State of Tennessee as a not-for-profit corporation whose purpose is to provide low-cost district cooling and heating services for downtown Nashville. The Nashville Electric Service and the Nashville Gas Company were initially approached with the idea of providing a central heating and cooling plant for the area, but because a referendum would have been required to give them the authority to do this, the not-for-profit corporation was formed so that the work on the system could be begun within a necessary time frame.

The system proposed by I.C. Thomasson and Associates for Knoxville (see also Chapter V) is similar in design to the Nashville Thermal Transfer Facility. While it could be established as a not-for-profit corporation, the proposal calls for it to be owned by the city and financed through either revenue or general obligation bonds.

Additional Legal Considerations

In additional to the laws discussed above and earlier sections of this chapter (see Climate and Air Quality and Hydrology and Water Quality), there are two legal considerations that impact on sludge management for Knoxville-Knox County. Ordinance No. 5819 of the City of Knoxville, effective 8 November, 1974, established rules and regulations governing the wastewater control system of the city. Normal domestic wastewater, as defined in Article III of the ordinance is as follows:

> "Normal Domestic Wastewater" shall be regarded as "normal" for Knoxville. Normal domestic wastewater shall contain a daily average of not more than 2,500 pounds (300 Milligrams per liter) of suspended solids; not more than 2,000 pounds (240 Milligrams per liter) of B.O.D.; and not more than 471 pounds (50 Milligrams per liter) of grease and oil, each, per million gallons.

Industrial discharges to the City sewer system must either pretreat their wastes to domestic wastewater quality levels prior to discharge or pay an extra strength surcharge (Articles IV, Section 8, Paragraph G-1 and Article IV, Section 6, Paragraph C). In addition, Article IV, Section 8, Paragraph H establishes wastewater discharge criteria which include heavy metals such as cadmium, iron, chromium, copper, zinc, and nickel.

As also noted in Chapter V of this study, it was assumed, due to a lack of data, that future industrial discharges to the City sewer system would be comparable, in terms of strength, to domestic sewage. It should be pointed out that the present extra strength surcharge rates appear both low in terms of dollars charged for pounds in excess and lacking in ability to consider excess heavy metals in the surcharge. Thus, the industries may not presently have a sufficient economic incentive to provide pretreatment facilities capable of heavy metal removal. If sludge disposal options are selected which are sensitive to heavy metal inputs (e.g., land application systems), the City may be required, for operational concerns in these options, to provide stricter heavy metals discharge standards and extra strength surcharges based also upon heavy metals. This can be done by Article IV, Section 8, Paragraph H as cited below.

> "No statement in this ordinance is intended or may be construed to prohibit the Director from establishing specific wastewater discharge criteria more restrictive where wastes are determined to be harmful or destructive to the facilities of the Waste Water Control System, or to create a public nuisance, or to cause the discharge of any treatment facility operated by the Waste Water Control System to violate effluent or stream quality standards imposed or as may be imposed by the Tennessee Department of Public Health and/or the United States Environmental

Protection Agency, or to exceed industrial effluent standards for discharge to minicipal wastewater treatment systems as imposed or as may be imposed by the Tennessee Department of Public Health and/or the United States Environmental Protection Agency."

Zoning ordinances for both the City of Knoxville and Knox County provide restrictions as to the uses of various types of lands within their respective boundaries. The existing and proposed land maps for the Study Area as noted earlier in this chapter were developed by MPC and considered the various applicable zoning ordinances. The evaluation of potential disposal options utilized these maps and thus, indirectly, zoning ordinances (see Chapter VI, Table VI-2 of this report).

The issue of eminent domain (see under Institutional Characterization) has been addressed in a recent publication (Ref. IV-15). As noted in this publication, Article 1, Section 21 of the Tennessee Constitution allows the taking of private property for public use only upon payment of just compensation to the owner thereof. Just compensation is satisfied by the payment of the fair market value of the property actually taken. To determine the fair market value, the Circuit Courts (under which jurisdiction over eminent domain proceedings is vested by statute unless the Chancery Courts acquire jurisdiction over a matter pecurlarly cognizable such as to assess damages in a suit originally brought to avoid a contract or to reform a deed) must assess all available uses and capacities to which the property is adaptable and all the available uses to which it might be applied given its size, zoning, location, and condition.

If only partial taking of a landowner's tract is involved, the landowner is entitled to recover the fair market value of the property actually taken, to which will be added by statute (TCA, Title 23, Sections 1414 and 1537), damages incidentally done to the residue by reason of the taking, less the value of any benefits accruing thereto by reasons of the proposed improvement. By definition, incidental damages to the residue are allowable only to a property owner some part of whose land was actually taken, and do not cover compensation for ajoining or abutting owners no part of whose land is actually taken for the improvement. The following have been held compensable as incidental damage to the residue of property taken: noise, soot, and inconvenience created by the operation of a railroad; obstruction of view by a highway embankment within the right-of-way; change of grade in a municipal street, reasonable apprehension of danger from inherent and unavoidable defects in the improvement; and loss of access to abutting street. In addition, reasonable expenses of removing and reinstalling fixtures, moving expenses for a distance not to exceed ten miles, cost of amortizing the remaining principal of a mortgage or deed of trust at a rate not to exceed nine percent are also included as incidental damages that may be recovered.

The condemnor is entitled to off-set against incidental damages the value of any benefits accruing to the residue by reason of the improvement, but is not entitled to offset any general increase or advance in the value of the residue occasioned by the construction of the improvement.

Following proper procedure (i.e., determination of jurisdiction, petition, filing of notice, and deposit of amount of damages the condemnor determines as due the owner for which he can seek legal remedy under equity), the City of Knoxville of Knox County can proceed under its powers of eminent domain (specifically, water works and sewers TCA 6-1701, et seq.) to obtain lands necessary for ultimate disposal of sludges derived from such works. As discussed above, it would appear that the least costly means of acquiring such property would be the acquisition of whole property and not leaving in an owner's possession residue property which is part of a disposal site.

The City of Knoxville/Knox County might also wish to consider leasing rather than purchasing the land. The City currently is under a lease agreement for the sanitary landfill located near Rutledge Pike and therefore has prior experience and legal capabilities in such arrangements (Ref. IV-18).

The disadvantage of utilizing a lease arrangement for land application systems is that, unlike purchase and outright land ownership where the purchase price can be shared 75 percent by Federal funding with State and local share of only 25 percent, the lease payments would be considered an operating expense to be borne totally by the local area. Thus, prior to evaluation of a land-oriented sludge management plan, the true costs of leasing versus amortization of the 25 percent capital expense of purchase must be compared to determine the most cost-effective financial arrangement.

In addition, care must be excerised in drawing up the lease arrangement to protect the legal interests of the lessor from possible suits brought against the lessee for improper operation of the land site leading to off-site environmental degradation.

Land application programs require site preparation and design features (contouring, dikes, berms, underground collection systems) to prevent run-off from entering nearby water courses. The design and construction costs of these features are quite high, generally greater than the purchase costs of the land itself. In the development of sludge management plans for Greater Chicago, the Metropolitan Sanitation District looked at purchase versus leasing of suburban lands south of the city. It was noted that "since the investment in site preparation is large relative to the purchase price of the land, it is generally preferable to purchase, rather than lease, land in order to be able to recover development costs in the event of a later sale of the property" (Ref. IV-19).

CHAPTER IV

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CHAPTER IV

REFERENCES

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CHAPTER V

THE SLUDGE DISPOSAL PROBLEM

INTRODUCTION

Evaluation of the planning perspective figure in Chapter III indicates that one of the investigations necessary in the development of residual waste management options is the review of existing and proposed wastewater treatment facilities in the 208 Study Area and the projection of sludge quantities from these facilities. This review and projection would be facilitated by having completed 201 Facilities Plans available such that the actual quantities could be ascertained and utilized. However, the 201 Facilities Plan for Knoxville-Knox County was not completed during the course of this investigation, thus making it necessary to utilize the Methodology to develop sludge projections. It should be recognized that in a great many cases this lack of completed 201 Facilities Plans for use in a 208 planning study would likely be the rule. Therefore, the following portions of this chapter are intended to: 1) characterize the existing situation in terms of wastewater treatment facilities and current disposal practices; and 2) describe the future anticipated facilities and project for these facilities raw sludge production.

Due to the lack of sufficient or complete data within the 201 Facilities Plan as noted above, the following procedure was utilized such that the characterization of the Study Area in terms of existing municipal wastewater treatment facilities (and the drainage areas served by them) and their respective sludge quantities and existing disposal practices could be described. The goals of the procedure were to: 1) identify the extent of the present service area served by each existing facility; 2) identify the responsible agencies providing the sewerage and treatment facilities; and 3) the existing treatment facilities (their present average dry weather flows and operational difficulties which impact upon current and/or proposed sludge handling and disposal).

The procedure was as follows:

(1) review the 201 Facilities Plan and, to the extent possible, abstract and synthesize data from the Plan;

(2) describe in some manner common to the Plan the existing situation (thus providing some commonality between 201 and 208 planning);

(3) contact local agencies, utility districts, and consulting engineering firms such that missing or incomplete data could be filled in; and

(4) from the first three steps above summarize the existing facilities, their current sludge quantities produced and the current disposal practices.

The same procedural format was also utilized in the development of information necessary to describe the anticipated facilities. During the course of this phase (i.e., description of the anticipated facilities), it became necessary to make reasonable assumptions as to the extent of future service areas and population served such that projected future raw sludge quantities could be made. These assumptions, required because of a lack of data supplied in the 201 Facilities Plan regarding future sludge quantities, were made in order to facilitate the use of the per capita sludge generation numbers found in the Methodology. The method and the necessary assumptions used to describe future sludge quantities are described in a latter portion of this chapter.

EXISTING FACILITIES

As shown on Figure V-1, there are thirty-one distinct and separate drainage basins within the Study Area. These thirty-one drainage basins were combined during the preparation of the 201 Facilities Plan into the eleven major drainage areas described below and utilized during this study (Ref. V-1). The major wastewater facilities are presented and industrial discharges to the system discussed. Figure V-2 indicates the boundaries of the utility districts and the City of Knoxville discussed in the following text.

Third Creek Drainage Area

The Third Creek Drainage Area encompasses approximately 64 square miles (166 square kilometers) of which 50 square miles (129 square kilometers) are in the City of Knoxville. It consists of the central, northern, and southern portions of the City of Knoxville and includes eight drainage basins. These drainage basins are First Creek; Second Creek; Goose Creek; Toll Creek; and portions of Third Creek, Knob Creek, Williams Creek and Loves Creek. Sewerage service within the basins is provided by the City of Knoxville.

KNOXVILLE AND KNOX COUNTY
DRAINAGE BASINS AND PUBLIC WATER SUPPLY LOCATIONS

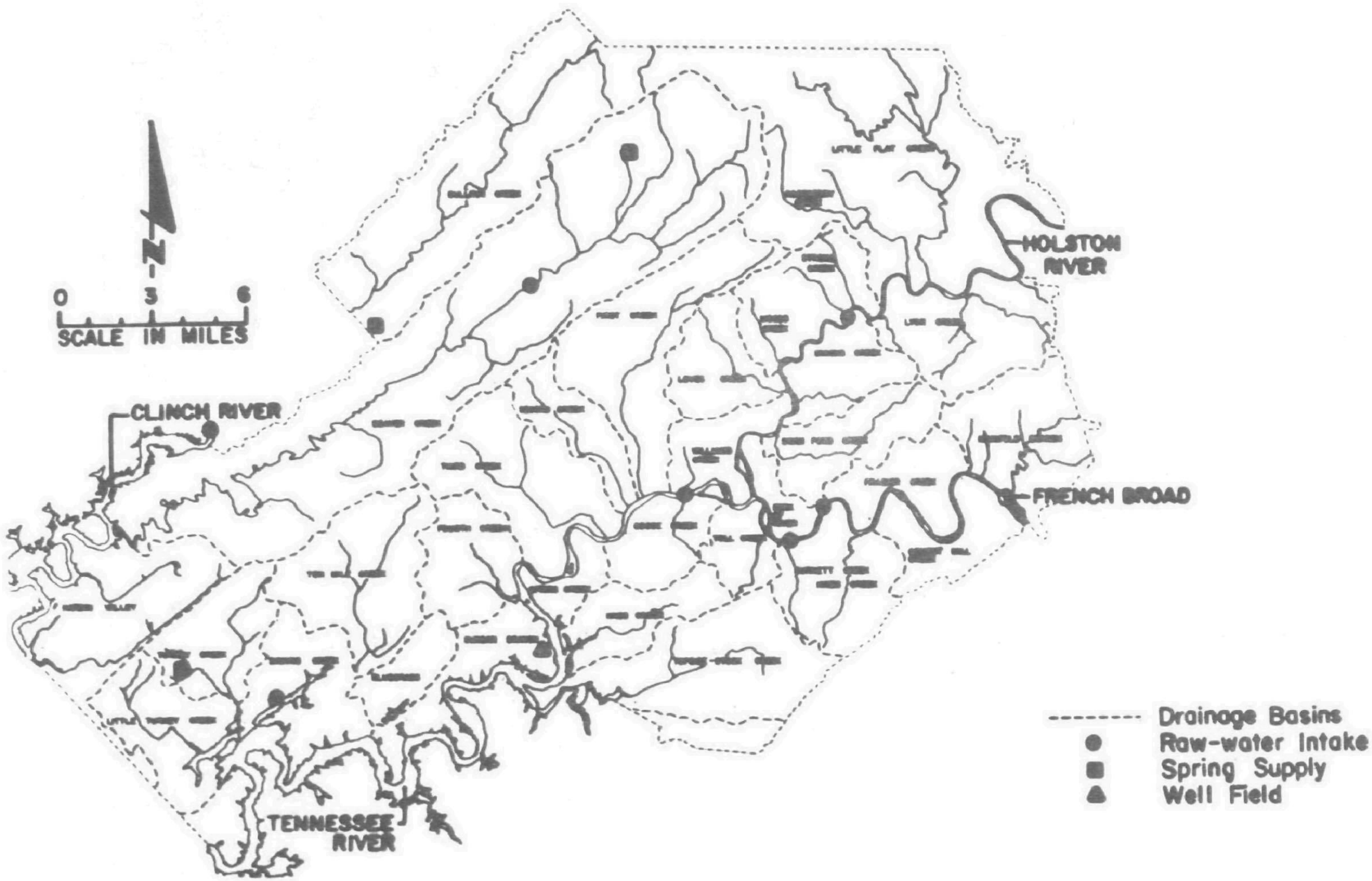


FIGURE V-1

UTILITY DISTRICTS LOCATED IN KNOX COUNTY

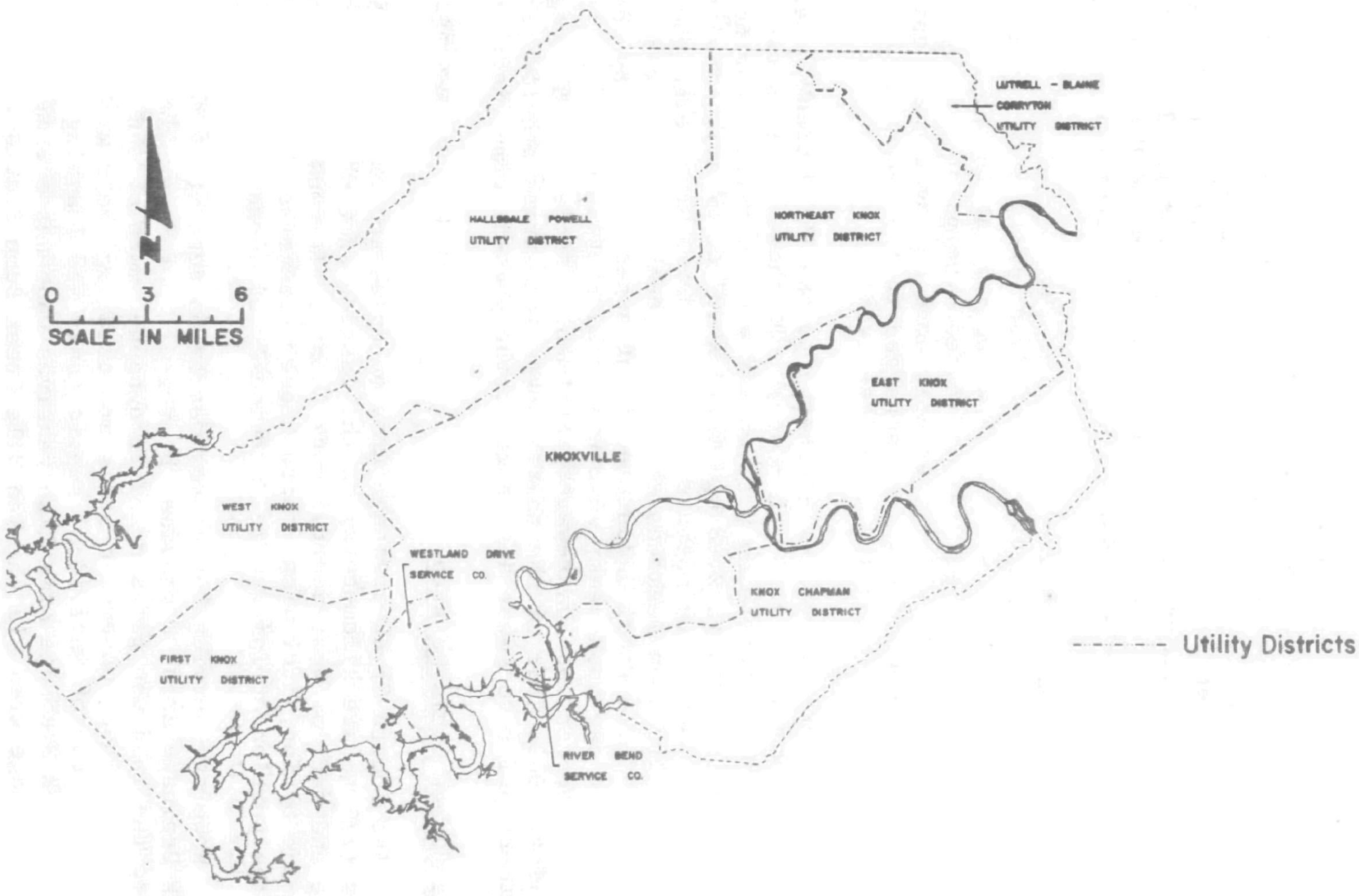


FIGURE V-2

The largest existing waste treatment facility located in this drainage area, as well as in the Study Area, is the Third Creek Treatment Plant. It is owned and operated by the City of Knoxville. The plant provides primary treatment for the entire wastewater flow entering the plant, secondary activated sludge treatment for a portion of the flow, and effluent chlorination for the entire flow. Its sewage collection system serves the entire area within the City limits of this drainage area and serves approximately 132,400 people (1970 figure).

The existing effective capacity of the Third Creek Treatment Plant is 18.0 million gallons per day (mgd) (6.81×10^4 cu m/day). However, the average dry weather flow received at the plant is 26.8 mgd (10.14×10^4 cu m/day). As indicated, the plant is severely overloaded. The effluent, which presently does not meet the requirements of the regulatory agencies, is discharged to the Tennessee River (Fort Loudoun Lake) at River Mile 646.3 (Ref. V-1).

Thirty-seven industries discharge to the Third Creek sewerage system 6.52 mgd (2.47×10^4 cu m/day). Of these thirty-seven industries, nine operate on a seven day a week, twenty-four hour a day basis and discharge 2.98 mgd (1.13×10^4 cu m/day). The other twenty-eight industries operate on a five day a week, eight hour a day basis. Thus, on weekends the Third Creek plant receives only 46 percent of the total industrial input experienced during the earlier five day work week; an operational problem which may adversely impact upon wastewater treatment efficiency and sludge handling. Only four of the thirty-seven industries provide pre-treatment prior to sewer discharge at the present time (Ref. V-1).

Fourth Creek Drainage Area

The Fourth Creek Drainage Area occupies approximately 43 square miles (111 square kilometers) in the western part of the City of Knoxville and part of west-central Knox County. It consists of four drainage basins, including Fourth Creek, Bluegrass, Duncan Branch, and the portion of Third Creek previously discussed.

Sewerage service for approximately 65 percent of the Fourth Creek Drainage Area is provided by the City of Knoxville. However, due to the land use pattern and topography, much of the area is unsewered. These unsewered areas are treating their wastewaters through the use of individual septic tanks and leaching fields. The Fourth Creek Drainage Area also receives wastewater from the Ten Mile Creek Drainage Area via the Ten Mile Creek Pump Station.

The sewered area is served by Fourth Creek Treatment Plant, the City's second largest wastewater treatment facility. It is an activated sludge plant with an effective capacity of 5 mgd (1.89 x 10^4 cu m/day). It is presently receiving an average dry weather flow of 5.7 mgd (2.16 x 10^4 cu m/day) (Ref. V-1).

Five industries discharge to the Fourth Creek sewerage system 1.08 mgd (0.41 x 10^4 cu m/day). Of these five industries, two operate on a seven day a week, twenty-four hour a day basis and discharge 0.43 mgd (0.16 x 10^4 cu m/day). The other three industries operate on a five day a week, eight hour a day basis. Thus on weekends the Fourth Creek plant receives only 40 percent of the total industrial input experienced during the earlier five day work week; again with operational problems as noted for Third Creek above. Only one of the five industries currently provides pretreatment prior to sewer discharge (Ref V-1).

Loves Creek Drainage Area

The Loves Creek Drainage Area is located in the eastern part of the City of Knoxville. It occupies an area of approximately 14 square miles (36 square kilometers) and encompasses the Woods Creek Drainage Basin, as well as portions of Loves Creek and Williams Creek Drainage Basins. Portions of the Loves Creek Drainage Area lie within the area served by the Northeast Knox Utility District and portions lie within the county and are not served by any utility district. The portions not served by any utility district were considered a part of the City of Knoxville for planning purposes.

Sewerage services in the Loves Creek Drainage Area are provided only by the City of Knoxville. The area within the City limits and the majority of the area within the county are presently sewered. The wastewater is collected and treated at the City's Loves Creek Wastewater Treatment Plant which employs trickling filters, designed to treat an average dry weather flow of 3.0 mgd (1.14 x 10^4 cu m/day). It is presently receiving an average dry weather flow of 1.2 mgd (0.45 x 10^4 cu.m/day). The effluent is discharged at River Mile 5.0 of the Holston River. The sludge generated at this treatment plant is pumped to the gravity collection system for the Third Creek Treatment Plant and becomes a part of the raw wastewater flow to this treatment facility (Ref V-1).

No industries contribute to the sewer system in this drainage area.

Ten Mile Creek Drainage Area

The Ten Mile Creek Drainage Area is in the west-central portion of Knox County. It encompasses an area of approximately 19 square miles (49 square kilometers) and contains only the Ten Mile Creek Drainage Basin.

West Knox Utility District serves approximately 49 percent of the area, First Utility District serves 31 percent, the City of Knoxville serves 3 percent, and approximately 17 percent of the drainage area is not served by any utility district. For planning purposes this latter portion was considered a part of the City. Approximately 62 miles (100 kilometers) of sanitary sewer serve 3,600 customers in the West Knox and First Utility Districts. Wastewater service to the Ten Mile Creek Drainage Basin is jointly contracted by West Knox Utility District, First Utility District, and the City of Knoxville. Each utility district maintains its sewerage collection system and the City of Knoxville owns and operates the pump stations that transmit the waste to the City of Knoxville's Fourth Creek Treatment Plant (Ref. V-1).

No industrial discharges in this drainage area were identified.

East Knoxville Drainage Area

The East Knoxville Drainage Area is located in the eastern portion of Knox County. It is bounded on the north and west by the Holston River, on the east by the Knox County limits, and on the south by the French Broad River. It encompasses an area of approximately 67 square miles (174 square kilometers) and includes five drainage basins. These drainage basins are Lyon Creek, Sinking Creek, Swanpond Creek, Frazier Branch, and Tuckahoe Creek.

Most of the domestic residential wastewaters are treated by individual septic tanks and leaching fields. The Eastwood Subdivision is served by a prefabricated wastewater treatment plant which is operated by the City of Knoxville.

In the Forks-of-the-River Industrial Park, an existing sewerage system treats the domestic waste from eighteen industries in the area. The wastewater is treated in a 1 mgd (0.38×10^4 cu m/day) design capacity secondary activated sludge treatment plant operated by Knox County and the effluent is discharged to the French Broad River at River Mile 1.9. The plant also receives process wastewater estimated at 0.21 mgd (0.08×10^4 cu m/day) all on a five day a week, approximately eight hour a day basis from five industries located in the Forks-of-the-River Industrial Park. The plant is receiving 0.26 mgd (0.10 x 10^4 cu m/day) average flow and is discharging an unsatisfactory effluent, due to heavy metals discharge by one of the industries (Ref. V-1).

Knox-Chapman Drainage Area

The Knox-Chapman Drainage Area is located in the southern portion of Knox County. It includes six drainage basins and occupies approximately 61 square miles (158 square kilometers). These drainage basins are Spring Creek, Knob Creek, Burnett-Hines, Cement Mill, Stock Creek, and Roddy Branch. A portion of this area within Knox County is not served by a utility district. For purposes of planning, it was considered a part of the City of Knoxville. The remainder of the area is served by the Knox-Chapman Utility District.

At present, no sewage collection and treatment system is serving this area. All residential wastewater generated in the area is treated by individual systems. The University of Tennessee Hospital, located near the City limits, discharges approximately 0.26 mgd (1.10 x 10^4 cu m/day) on a seven day a week basis to the City sewer system. No industrial discharges were noted (Ref. V-1).

Little Flat Creek Drainage Area

The little Flat Creek Drainage Area is situated in the northeastern portion of Knox County and occupies an approximate area of 64 square miles (166 square kilometers). It consists of two drainage basins, Strong Creek and Little Flat Creek Drainage Basins, both tributary to the Holston River.

At present, two utility districts are serving this drainage area. These are the Luttrell-Blaine-Corryton Utility District and the Northeast Knox Utility District. The former serves three communities in three counties. These are Luttrell in Union County, Blaine in Grainger County, and Corryton in Knox County. Only the Corryton area, which occupies approximately 17.5 square miles (45 square kilometers) is included in this study. The Northeast Knox Utility District serves the remainder of this drainage area.

The area is sparsely populated due to topography. There are no existing sewage collection and treatment systems in the area (Ref. V-1). Small package treatment plants are currently used to serve some commercial establishments while septic tanks are employed by individual residences. No industrial discharges were noted.

Bullrun Creek Drainage Area

This drainage area is located in the northern part of Knox County. It occupies approximately 41 square miles (106 square kilometers) and consists of one drainage basin, Bullrun Creek. This area is separated from the remainder of Knox County by three parallel ridges forming Brushy, Bullrun, and Raccoon Valley.

This area is presently served by the Hallsdale-Powell Utility District. However, no sewage collection and treatment system is existing in this area, although a 150,000 gallon per day (0.06×10^4 cu m/day) extended aeration type process is being proposed for completion in 1975. The proposed location is at Interstate 75 and Raccoon Valley Drive (Ref. V-1).

Beaver Creek Drainage Area

The Beaver Creek Drainage Area encompasses approximately 92 square miles (238 square kilometers). It lies in the north-central part of Knox County parallel to and south of Bullrun Creek Drainage Area. It contains only one drainage basin, Beaver Creek, which is tributary to the Clinch River.

Of the total area enclosed by Beaver Creek Drainage Area, approximately 32.3 percent [30 square miles (78 square kilometers)] in the southwestern portion of the drainage area is presently served by the West Knox Utility District. This includes the communities of Karnes, Solway, and Ball Camp, and the 550-acre (223 hectare) Byington Industrial Park.

A sewage treatment and collection system is in operation near Byington and has a total design capacity of 100,000 gallons per day (0.04×10^4 cu m/day). It is a prefabricated extended aeration type process (Ref. V-1). This plant will be known as the Karns facility and referred to as such in the remainder of this report.

Another utility district that serves the Beaver Creek Drainage Area is the Hallsdale-Powell Utility District. It serves approximately 54.7 percent [50 square miles (129 square kilometers)] of the total area. Two major communities are in this utility district, each being served by a separate sewage and collection system. The Hallsdale Community Treatment Plant, an extended aeration facility owned and operated by the District, has a design capacity of 400,000 gallons per day (0.2×10^4 cu m/day) (Ref. V-1). After chlorination, the effluent is discharged to Beaver Creek.

The other treatment facility owned and operated by the Hallsdale-Powell Utility District serves the Powell Community. This wastewater is treated by a contact stabilization treatment plant with a design capacity of 400,000 gallons per day (0.2 x 10^4 cu m/day). At present, this treatment facility is receiving approximately 200,000 gallons per day (0.1 x 10^4 cu m/day). The effluent from the treatment plant is discharged to an aerated lagoon, chlorinated, and then discharged to Beaver Creek (Ref. V-1).

The northeastern portion of this drainage area is served by the Northeast Knox Utility District. It occupies about 10.2 percent [9.4 square miles (24 square kilometers)] of the total drainage area. No existing sewage collection and treatment system is presently serving this part of the drainage area (Ref. V-1).

The remainder of the drainage area, which occupies 2.8 percent [2.7 square miles (7 square kilometers)], lies within a portion of the county not served by any utility district. For purposes of planning, this portion was considered part of the City of Knoxville.

Industrial discharges to the sewer systems of the Hallsdale-Powell Utility District are approximately 50,890 gallons per day (0.02 x 10^4 cu m/day) on a five day a week basis (Ref. V-1).

Hardin Valley Drainage Area

This drainage area is located in the west-northwest part of Knox County adjacent to the Clinch River. It occupies approximately 21 square miles (54 square kilometers) and is served by the West Knox and First Utility Districts. Only one drainage basin, Hardin Valley Drainage Basin, lies within this area.

There are no wastewater collection or treatment facilities in the drainage area; domestic wastes being treated by individual septic tanks. No industrial discharges were noted (Ref. V-1).

Turkey Creek Drainage Area

The Turkey Creek Drainage Area lies in the southwestern section of Knox County. It contains three drainage basins, Turkey Creek, Little Turkey Creek and Choto Basin, and occupies approximately 42 square miles (109 square kilometers). It is served by the First Utility District, with the exception of the extreme northeast tip which is within the jurisdiction of the West Knox Utility District. There are four existing wastewater collection systems owned and operated by the First Utility District. Three of these are located in the Turkey Creek Drainage Basin and the fourth is in the Ten Mile Creek Drainage Basin which was discussed previously.

The three collection systems are Stonecrest, Village Green, and Fox Den. The Stonecrest system collects the wastewater which is then hauled by tank truck to the Ten Mile Creek collection system. The Village Green collection system discharges into a small contact stabilization and tertiary nitrification plant, currently operating at a flow of 75,000 gallons per day (0.03×10^4 cu m/day). The Fox Den collection system discharges into a small contact stabilization and filtration plant. The plant is operating at less than 10,000 gallons per day (0.004×10^4 cu m/day). A new wastewater treatment facility (Turkey Creek), at 1 mgd (0.38×10^4 cu m/day) is designed to treat the wastewater collected at all three of the above collection systems as well as a large segment of the Turkey Creek Drainage Area. The wastes from all three collection systems are strictly domestic with no industrial discharges noted (Ref. V-1).

EXISTING SLUDGE DISPOSAL PROCESSES

Data in the 201 Facilities Plan, at least those portions of the plan available during the course of this study, were lacking with regard to current sludge disposal processes or quantities and qualities. It therefore became necessary to contact the utility districts, local consulting engineering firms, and City/County personnel to obtain such information if available. Table V-1 is the best available information that could be developed during this specific contact investigation phase. The estimation for Turkey Creek was based upon a scaling up from information provided on the Powell plant facility. It should be recognized that the accuracy of the sludge quantity numbers may be questionable, however the overall relative quantities between plants is felt to be a reasonable approximation of the current picture. It should also be noted that the low values for the Third Creek facility are due to operational problems at the overloaded facility which during 1974 had removal efficiences of 32 percent for biochemical oxygen demand (BOD) and 43 percent for suspended solids (SS) (Ref. V-2).

The existing sludge disposal practices for Knoxville-Knox County involve (1) allowing private individuals to pick up a dewatered sludge, (2) on-site disposal of a dewatered sludge or, (3) trucking to a landfill either all of the dewatered sludge or the remaining portion from (1) above.

There appears to be, at least noted by personnel at the Third Creek facility, a decline in the amount of dewatered sludge taken by private individuals, possibly due to a saturation of the area within an economical and convenient distance to the plant. Whether a decline could be anticipated in the long run for this disposal option for such outlying facilities as Powell, where access to larger agricultural interests may be found, is unknown at this time. However, due to the urbanization process within the County and the

TABLE V-1

PRESENT SLUDGE QUANTITIES

Plant	Type	Size mgd	Status	Sludge Handling	Sludge Quantities
Third Creek	Activated Sludge	26.80	Existing	Anaerobic Digestion, Vacuum Filter to Private individuals or landfill	6721 lbs/day dry solids (this low value is due to operational problems of the Third Creek plant)
Fourth Creek	Activated Sludge	5.70	Existing	Anaerobic & Aerobic Digestion, Vacuum Filter, Landfill	7988 lbs/day dry solids
Loves Creek	Trickling Filter	1.20	Existing	Raw, Pumped to Third Creek	Included in Third Creek
Forks-of-the-River	Activated Sludge	0.26	Existing	Aerobic Digestion, Sand Bed Dewatering On-site disposal	
Raccoon Valley	Extended Aeration	0.15	Under Construction	None, hauled to Powell when needed monthly - 2000 gallons at 3% solids	100 lbs/day dry solids
Karns	Extended Aeration	0.10	Existing. To be expanded		Negligible
Hallsdale	Extended Aeration	0.40	To be abandoned in 1977	Sand Drying Beds Applied once a week	374 lbs/day dry solids
Powell	Contact Stabilization	0.20	Existing. To be expanded	Sand Drying Beds	286 lbs/day dry solids
Turkey Creek	Contact Stabilization	1.00	Under construction and to be expanded	Aerobic Digestion, Sand Drying Beds, On-site Disposal	Estimated 1430 lbs/day dry solids

decline in both size and numbers of farms in the County, as noted in Chapter IV, it is unlikely that either partial or total reliance upon private individuals to truck away sludge would be a feasible means of sludge disposal in the short or long run.

On-site disposal, again for the processes of urbanization occurring within the county and the expansion plans for several of the existing facilities which would require site acreage, is unlikely to provide either a short-or long-range disposal option. Although this is an existing practice at the Forks-of-the-River and Turkey Creek plants, these plants are located in areas subject to expansion of surrounding industrial activities, such as at Forks-of-the-River, or urbanization such as at Turkey Creek. Avoidance of potential problems such as complaints from neighbors and restrictions in usable on-site land, particularly at Turkey Creek, would thus render on-site disposal less likely to occur in the relatively near future.

Utilization of sanitary landfills for disposal of a dewatered sludge thus appears to be both the current and possible near-term disposal program and as such was considered to represent the "base case" in this study. However, the future of sanitary landfills in Knoxville-Knox County is open to question. Studies currently in progress by the Tennessee Valley Authority (TVA) are investigating the possibility of collecting and transporting municipal solid waste to regional processing centers for separation of metals, glass, and combustible fractions (Ref. V-3). The metals and glass fraction would be sold and the combustible fraction remaining would then be transported to TVA steam power plants to augment coal supplies. One of the regional processing centers under investigation would be located in Knoxville-Knox County. Concurrently, the City of Knoxville is conducting an investigation of the feasibility of solid waste collection and burning in a municipal incinerator which would also generate power and steam for use in the downtown area.

It thus appears that solid waste disposal and hence sanitary landfilling, is a problem recognized in the Knoxville-Knox County area as being sufficiently serious to warrant consideration of other alternatives. In addition, all open dumps have been closed in the County, and only one sanitary landfill in the northeast portion of the County (Rutledge Pike) is presently in operation.

Thus, the long-term viability of the "base case", i.e. sludge disposal into a sanitary landfill, is questionable, recognizing however the probable lag time of implementation of the solid waste alternatives mentioned above.

As existing wastewater treatment facilities are expanded, wastewater treatment levels are increased to meet more stringent discharge standards, and proposed facilities come on-line, the increased amounts of sludge generated that must be disposed will increase substantially. Disposal to sanitary landfills, which may be of questionable viability in the near future, is therefore a problem of significant concern to Knoxville-Knox County. As stated earlier in this report, it is one of the intended purposes of this study, by utilizing the Methodology, to develop alternative residual waste (in this case municipal wastewater treatment plant sludges) handling and ultimate disposal alternatives for Knoxville-Knox County. The following sections of this chapter discuss the wastewater treatment facilities anticipated in Knoxville-Knox County for inclusion in this study and the projected raw sludge productions at these facilities.

ANTICIPATED KNOXVILLE-KNOX COUNTY MUNICIPAL WASTEWATER TREATMENT FACILITIES

As noted in the contract for this study, the alternatives evaluated were to meet disposal requirements for a 20-year period (Ref. V-4). This also corresponds to the planning timeframe required under 208 planning (Ref. V-5). The facilities described below are those anticipated to be operable in Knoxville-Knox County during this 20-year period (Ref. V-1). It is assumed in this study that these facilities as designed or proposed meet applicable discharge standards required under the 1983 goals of the Federal Water Pollution Control Act Amendments of 1972. The solids handling systems are as proposed currently and do not necessarily reflect the alternatives discussed in Chapter VII of this report.

Knob Creek

Because of current operational problems at the Third Creek facility, the City of Knoxville has been in the process of completing a 201 Facilities Plan which investigated for the Study Area the facilities needed to meet applicable standards and to serve the present and anticipated growth in the Area (Ref. V-1). One major finding of this Plan has been to abandon the Third and Fourth Creek facilities and construct a biological (activated sludge) regional facility in the southern portion of the area serving the majority of the urban portion of the Area. A tentative site location (Cox Sky Ranch) has been selected. This site, although meeting some local opposition, has been evaluated by MPC in conjunction with other alternative sites and tentatively approved (Ref. V-6).

The Knox Creek facility will be an air activated sludge process employing mechanical screening, grit removal, primary settling, activated sludge, nitrification (if needed), multi-media filtration, chlorination, and post aeration prior to discharge to the Tennessee River.

Proposed sludge handling includes sludge thickening, two-stage anaerobic digestion, and filter press dewatering with the filter cake trucked to a sanitary landfill.

Powell

The present Powell plant, located in the northwest portion of the Study Area, is currently under expansion proceedings (construction bids). The Hallsdale plant is to be abandoned following the completion of the Powell construction program (sometime in 1977) and for the purposes of this study will not be considered as a separate facility but as having contributed its flow to Powell.

The Powell plant after expansion will include bar screens, grit removal, contact stabilization, aerated lagoons, air flotation (for removal and return of algae to the lagoons), multi-media filtration, chlorination, and post aeration prior to discharge to Beaver Creek.

Sludge handling includes, for the contact stabilization process sludge, aerobic digestion, thickening, and vacuum press dewatering. The filter cake would then be trucked to a sanitary landfill. Excess algae from the aerobic lagoons recycle would be dried on sand drying beds for on-site disposal. Sludge from the Raccoon Valley plant will be trucked to Powell for handling in the thickening and vacuum press processes.

Turkey Creek

The Turkey Creek facility, located in the southwestern portion of the Study Area, is currently finishing a construction and start-up phase as a contact stabilization facility. Before 1995 flows come on line, the plant would be modified as an oxygen activated sludge plant with nitrification facilities. The exact flow process was not made available for this study.

Proposed sludge handling processes include aerobic digestion followed by sand drying beds with on-site disposal.

Karns

The Karns facility will be expanded as a contact stabilization facility followed by sand filtration until 1990. At that time the plant will be modified and expanded to provide air activated sludge treatment.

The modified plant will provide primary clarification, air activated sludge with carbon addition for nitrification, secondary clarification, rapid sand filtration, chlorination and dechlorination, prior to effluent discharge to Beaver Creek.

Primary sludge would be mechanically dewatered and disposed into a sanitary landfill. Secondary sludge containing carbon would be reprocessed for carbon recovery and reused with the sludge ash going to sanitary landfill. It is unclear at this time the rational used by the local consulting firm as to its suggested disposition of primary dewatered sludge into a sanitary landfill. This sludge handling process would not come on-line until 1990.

Up to 1990 the solids handling includes aerobic digestion of the waste activated sludge, vacuum filtration, and trucking to sanitary landfill.

Lyon Creek

A proposed modified extended aeration plant at Lyon Creek in the eastern portion of the County would serve the Little Flat Creek drainage basin in the Luttrell-Blaine-Corryton and Northeast Knox Utility Districts and Lyon Creek drainage basin in the East Knoxville Utility District.

This plant would provide grit removal, primary settling, extended aeration, secondary-clarification, chlorination, and post aeration prior to effluent discharge to the Holston River.

Proposed sludge handling includes sludge thickening, two-stage anaerobic digestion, sand bed dewatering, and trucking the cake to a sanitary landfill.

Loves Creek

Serving the Loves Creek drainage basin in the eastern portion of the County, the existing Loves Creek facility, a trickling filter plant, has a design capacity expected to be sufficient for projected 1995 flows. The facility is anticipated to undergo expansion after 1995.

Sludge generated at Loves Creek is currently pumped to the gravity collection system for the Third Creek treatment plant. Upon abandonment of Third Creek and flow diversion to the regional Knob Creek plant, the sludge from Loves Creek then becomes part of the raw wastewater flow to Knob Creek.

Forks-of-the-River

This facility presently serves the domestic wastes from the industries located in the Forks-of-the-River Industrial Park as well as some process wastewater from five industries located in the park. The current hydraulic capacity is expected to serve as the ultimate capacity expected in the year 2005.

The plant is an activated sludge facility utilizing trickling filters prior to the aeration basins. Primary and secondary sludge is aerobically digested, dewatered on drying beds, and disposed on-site.

PROJECTED SLUDGE QUANTITIES

With the exception of the Forks-of-the-River Plant, all other anticipated plants will be discharging to water quality limited stream segments (Refs. V-7, 8, and 9). Thus, the wastewater treatment efficiencies required will translate directly to large quantities of sludge to be processed and disposed.

Information made available during the course of this study was incomplete with regards to both the anticipated wastewater flows in the year 1995 and the resultant projected sludge quantities for these anticipated facilities. Therefore, the Methodology was utilized to develop these quantities. The technique utilized is described below.

The anticipated facilities and their service areas are shown on Figure V-3. The eleven drainage areas discussed earlier for the existing facilities and their respective 1975 and 1995 population estimates are shown in Figure V-4. A comparison was made of these two figures and assuming the total population to be sewered as anticipated by the various river basin plans in the area (Refs. V-7, 8, and 9) (see also Chapter IV of this report), the following breakdown of population served by the anticipated facilities by drainage areas was utilized for this study:

(1) Knob Creek - serves all of the Third Creek, Fourth Creek, and Ten Mile Creek drainage and two-thirds of the Knox Chapman drainage area;

(2) Loves Creek - serves all of the Loves Creek drainage area and one-half of the East Knoxville drainage area;

(3) Powell - serves all of Bullrun Creek drainage area and four-fifths of the Beaver Creek drainage area;

(4) Turkey Creek - serves all of the Turkey Creek and Hardin Valley drainage areas;

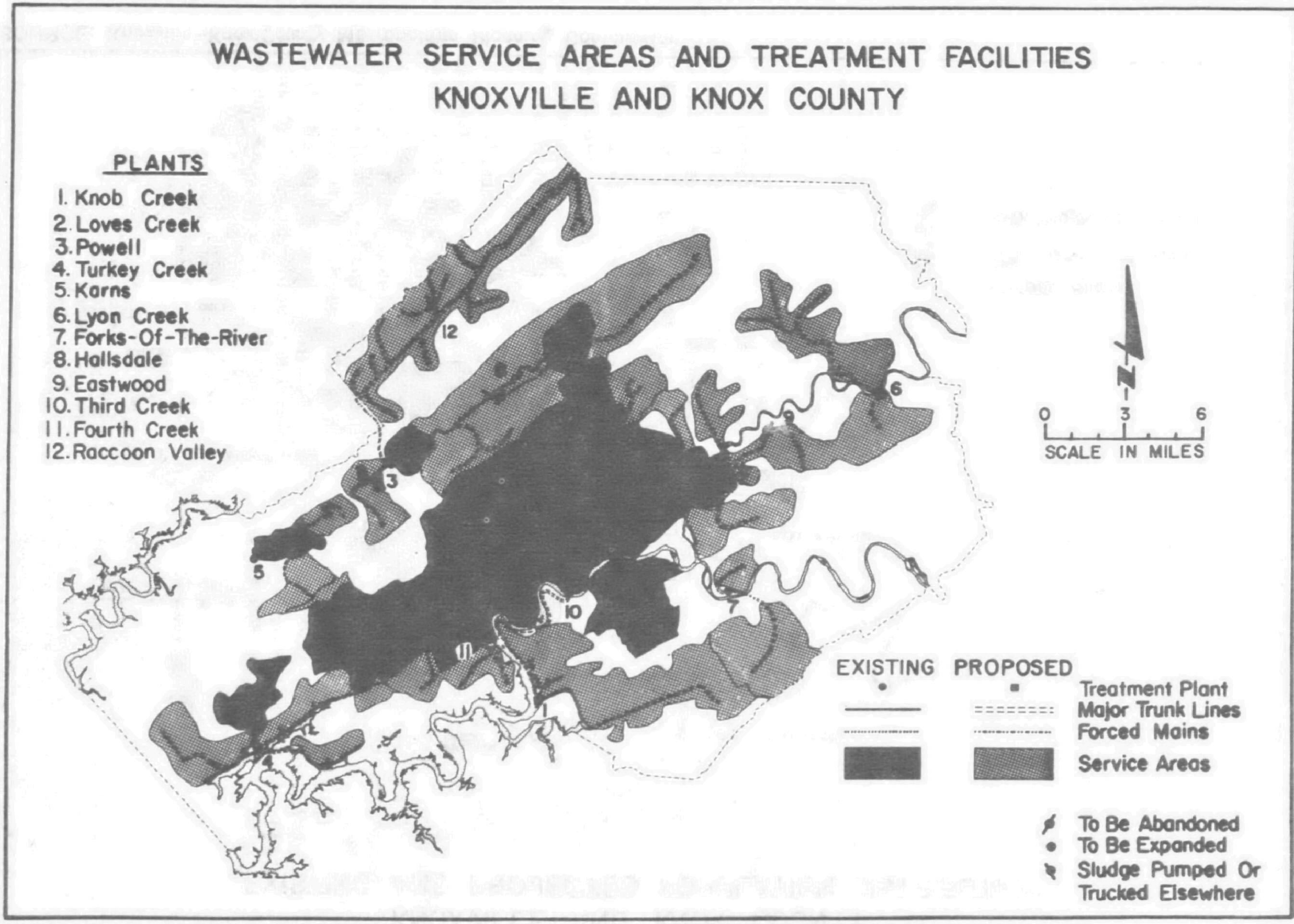


FIGURE V-3

SOURCE: Knoxville-Knox County Metropolitan Planning Commisson

KNOXVILLE AND KNOX COUNTY EXISTING AND PROJECTED POPULATION DISTRIBUTION

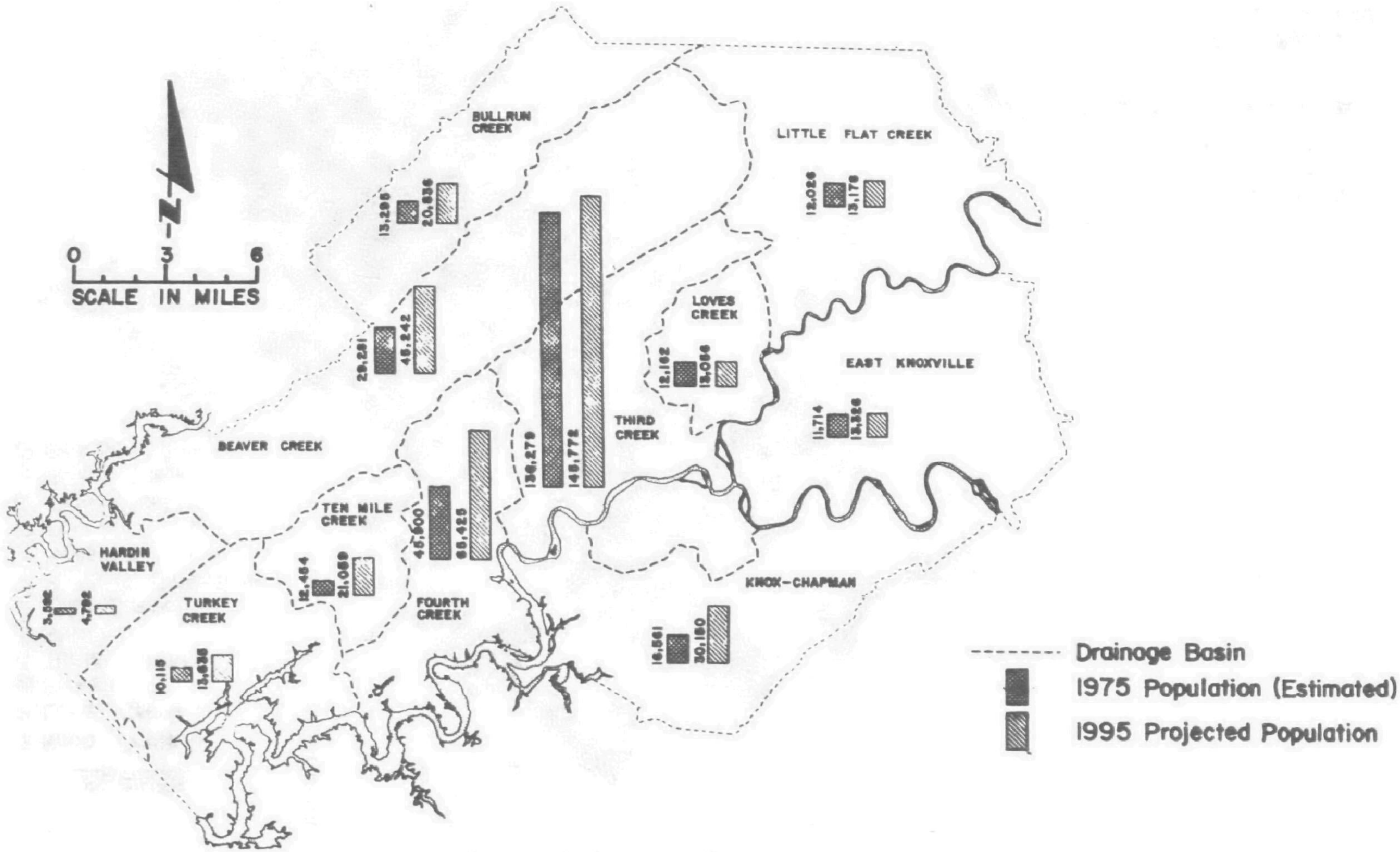


FIGURE V-4

SOURCE: Knoxville-Knox County Metropolitan Planning Commission

(5) Karns - serves one-fifth of the Beaver Creek drainage area;

(6) Lyon Creek - serves all of the Little Flat Creek drainage area and one-fourth of the East Knoxville drainage area; and

(7) Forks-of-the-River - serves one-third of the Knox Chapman drainage area and one-fourth of the East Knoxville drainage area.

Population forecasts provided by MPC (Ref. V-1) were aggregated according to the above breakdowns, and the projected domestic populations served by the anticipated facilities shown in Table V-2.

The industrial and commercial discharges within the drainage areas noted earlier were converted first to a seven day a week basis and then to population equivalents and are shown in Table V-3. The combined domestic, industrial, and commercial populations used during this study are shown in Table V-4.

Utilizing the Methodology (Ref. V-10), the projections of raw sludge quantities were determined and are given in Table V-5. The applicable factors used in projecting the sludge quantities are noted in this table.

Implicit in the utilization of the per capita sludge projection values in the Methodology is the fact that these values are those to be used when the per capita wastewater flows are 100 gallons per day. A report prepared in 1972 projected for the Knoxville area a per capita value of approximately 100 gallons per day based upon projected water requirements and usage (Ref. V-11). Therefore, the values in the Methodology were used directly. However, it should be noted that if local situations (e.g. heavy industrial input or specific flow and quality of sewage on a per capita basis) warrent in other study areas, the values in the Methodology should be adjusted accordingly.

TABLE V-2

POPULATION PROJECTION FOR THE ANTICIPATED FACILITIES

Facility	1975	1980	1985	1990	1995
1. Knob Creek	205,729	224,523	238,422	245,927	252,457
2. Loves Creek	18,019	18,300	18,582	18,792	19,719
Sub Total	223,748	242,823	257,004	264,719	272,176
3. Powell	36,720	43,581	49,790	55,018	57,030
4. Turkey Creek	13,707	15,901	17,014	18,127	18,384
5. Karns	5,856	6,951	7,938	8,776	9,048
Sub Total	56,283	66,433	74,742	81,921	84,462
6. Lyon Creek	14,955	15,597	15,996	16,136	16,510
7. Forks-of-the-River	8,394	10,426	12,356	12,656	13,281
GRAND TOTAL Knoxville-Knox County	303,380	335,279	360,098	375,432	386,429

TABLE V-3

POPULATION PROJECTIONS FOR THE ANTICIPATED FACILITIES
INDUSTRIAL AND COMMERCIAL POPULATION EQUIVALENTS

Facility	1975	1980	1985	1990	1995
1. Knob Creek	55,466	56,398	57,346	58,309	59,289
2. Loves Creek	0	0	0	0	0
Sub Total	55,466	56,398	57,346	58,309	59,289
3. Powell	291	296	301	306	311
4. Turkey Creek	0	0	0	0	0
5. Karns	73	74	75	77	78
Sub Total	364	370	376	383	389
6. Lyon Creek	0	0	0	0	0
7. Forks-of-the-River	2,107	2,142	2,178	2,215	2,252
GRAND TOTAL Knoxville-Knox County	57,937	58,910	59,900	60,907	61,930

Assumptions:

1. Industry flows to sewers specified in 201 facilities adjusted from 5-day to 7-day flows.
2. With pretreatment standards in effect and large clean (cooling) water input, quality of industrial waste assumed essentially equivalent in strength to domestic waste, this total industry flow divided by 100 gallons per capita per day (gpd) gives population equivalents (see also Chapter V).
3. Industry growth projected at rate of 1.68 percent per five year period as specified in the 201 facilities plan.

TABLE V-4

POPULATION PROJECTIONS FOR THE ANTICIPATED FACILITIES-
DOMESTIC, INDUSTRIAL, AND COMMERCIAL POPULATION EQUIVALENTS

Facility	1975	1980	1985	1990	1995
1. Knob Creek	261,195	280.921	295,768	304,236	311,746
2. Loves Creek	18,019	18,300	18,582	18,792	19,719
Sub Total	279,214	299,221	314,350	323,028	331,465
3. Powell	37,011	43,877	50,091	55,324	57,341
4. Turkey Creek	13,707	15,901	17,014	18,127	18,384
5. Karns	5,929	7,025	8,013	8,853	9,126
Sub Total	56,647	66,803	75,118	82,304	84,851
6. Lyon Creek	14,955	15,597	15,996	16,136	16,510
7. Forks-of-the-River	10,501	12,568	14,534	14,871	15,533
GRAND TOTAL Knoxville-Knox County	361,317	394,189	419,998	436,339	448,359

TABLE V-5

SLUDGE PROJECTIONS FOR THE ANTICIPATED FACILITIES
RAW SLUDGE
(in tons)[6]

Facility	1975	1980	1985	1990	1995	Process Description
1. Knob Creek[4]	764.00/30.56[1]	821.75/32.87	865.00/34.60	890.00/35.60	911.75/36.47	Primary Sedimentation & Activated Sludge
2. Loves Creek	21.50/ 0.43	22.00/ 0.44	22.00/ 0.44	22.50/ 0.45	23.50/ 0.47	Trickling Filter to Knob Creek[5]
Sub Total	785.50/30.99	843.75/33.31	887.00/35.04	912.50/36.05	935.25/36.94	At Knob Creek
3. Powell	176.67/ 2.65	209.33/ 3.14	238.67/ 3.58	264.00/ 3.96	273.33/ 4.10	Contract Stabilization[2]
4. Turkey Creek	65.33/ 0.98	76.00/ 1.14	81.33/ 1.22	53.00/ 2.12	53.75/ 2.15	<1990 contact sta.,>1990 prim. & act. sludge
5. Karns	28.00/ 0.42	33.33/ 0.50	38.00/ 0.57	26.00/ 1.04	26.75/ 1.07	Same as Turkey Creek
Sub Total	270.00/ 4.05	318.66/ 4.78	358.00/ 5.37	343.00/ 7.12	353.83/ 7.32	
6. Lyon Creek	30.00/ 0.60	31.00/ 0.62	32.00/ 0.64	32.50/ 0.65	33.00/ 0.66	Extended Aeration Modified[3]
7. Forks-of-the-River[4]	30.75/ 1.23	36.75/ 1.47	42.50/ 1.70	43.50/ 1.74	45.50/ 1.82	Primary & Activated Sludge
GRAND TOTAL	1116.25/36.87	1230.16/40.18	1319.50/42.75	1331.50/45.56	1367.58/46.74	Knoxville-Knox County

Note: 1. Values given in wet tons per day and dry tons per day.

2. For contact stabilization, used 143 lbs. dry solids per day per 1000 people at 1.5% solids.

3. For modified extended aeration, used 80 lbs. dry solids per day per 1000 people at 2.0% solids.

4. Knob Creek and Forks-of-the-River wet tons are for a thickened sludge at 4% solids and 234 lbs. dry solids per day per 1000 people.

5. Trickling filter dry tons based upon 48 lbs. dry solids per day per 1000 people and 2% solids for discharge into sewers to Knob Creek.

6. tons x 0.91 = metric tons.

CHAPTER V

REFERENCES

V-1 Knox County Facilities 201 Plan, in progress by Ryckman, Edgerley, Tomlinson and Associates, Inc., Knoxville, Tennessee (May 7, 1975).

V-2 Information supplied by Mr. Jim Clark of the Wastewater Control Department, City of Knoxville to MPC, (6 May 1975).

V-3 Newsletter, TVA (1 May 1975).

V-4 "Demonstration of a Developed Scheme for the Ultimate Disposal of Residual Wastes", Engineering-Science, Inc., EPA Contract 68-01-3225 (4 June 1975)

V-5 Guidelines for Areawide Waste Treatment Management Planning, Section 208, Federal Water Pollution Control Act Amendments of 1972, Environmental Protection Agency (August 1975).

V-6 Wastewater Treatment Plant Site Evaluation, Knoxville-Knox County Metropolitan Planning Commission (8 July 1975).

V-7 Water Quality Management Plan for the French Broad River Basin, Division of Water Quality Control, Tennessee Department of Public Health (undated).

V-8 Water Quality Management Plan for the Holston River Basin, Division of Water Quality Control, Tennessee Department of Public Health (undated).

V-9 Water Quality Management Plan for the Upper Tennessee River Basin, Division of Water Quality Control, Tennessee Department of Public Health (undated).

V-10 Sludge Processing, Transportation, and Disposal/Resource Recovery: A Planning Perspective, Wyatt, J.M. and White, P.E. Jr., Engineering-Science, Inc., EPA Contract No. 68-01-3104 (April 1975).

V-11 Water and Wastewater Plan; Anderson, Blount, and Knox Counties, Tennessee, Volumes I and II, Allen & Hoshall, Consulting Engineers (July 1972).

CHAPTER VI

SELECTION OF ALTERNATIVE SLUDGE DISPOSAL OPTIONS

INTRODUCTION

The Methodology allows for the selection of alternative sludge disposal options in one of two ways: 1) evaluation of ultimate disposal options per specific types and quantities of sludge or 2) evaluation of the suitability of an area relative to the known disposal options. The primary difference in the selection approaches is the former initially eliminates disposal options by the types of sludges to be disposed, while the latter does not. As a result, more disposal options are considered in the latter approach. As discussed in Chapter III, the study is to utilize the latter selection approach which does not consider existing or proposed solids handling processes and resultant sludges as a selection criterion.

The general sludge disposal options available, as defined in the Methodology, are: 1) sanitary landfill; 2) ocean disposal; 3) waste disposal ponds; 4) sludge recycling (i.e., land application); 5) land reclamation; and 6) resource recovery. Resource recovery includes such alternatives as incineration, pyrolysis, recalcination, composting, and sludge reuse (e.g., as a fuel or a fertilizer base). The first three options are traditional methods which have been utilized within the context of sludge as being a waste to be disposed of as cheaply as possible. The latter options reflect a different attitude, one of sludge as a resource, which is currently being encouraged by Federal and State agencies and environmental groups.

In order to define the more feasible or suitable disposal options to be considered for incorporation into a set of alternative sludge management plans, a selection procedure was developed. The basic steps involved in the procedure were:

(1) characterization of the natural and cultural settings of the Study Area (Chapter IV);

(2) characterization of the sludge disposal problem in the Study Area (Chapter V);

(3) delineation of the Study Area constraints as derived from Chapters IV and V;

(4) evaluation of the sludge disposal options relative to the Study Area constraints; and

(5) selection of the sludge disposal options for incorporation into alternative sludge management plans.

The critical step in this selection procedure is the delineation of the Study Area constraints (Step 3). Based on these environmental, socioeconomic, and institutional conditions and values assumed to exist in the Study Area, infeasible and inapplicable disposal options are defined and eliminated from further consideration. Characterization of the Study Area's natural and cultural systems was perceived to be a necessary inclusion to this case-study to provide background for readers unfamiliar with the Knoxville-Knox County area. This type of knowledge would or should be resident in a 208 agency and would not necessarily be presented in a real-life study in the detail or format used in this report.

STUDY AREA CONSTRAINTS

The environmental, socioeconomic, and institutional constraints listed below evolved from general comparisons of the desired characteristics for the siting and institutional arrangements of the disposal options, as delineated in the Methodology, and the actual or assumed characteristics presented in Chapters IV and V. The environmental constraints defined in this study are primarily site limiting and do not exclude alternative disposal options per se. However, these constraints are used in defining suitable site areas, if any, for the various disposal options considered in the evaluation process. The socioeconomic and institutional constraints are of a nature which could exclude entire disposal options (e.g., owing to the complexity of the implementation required and/or the lack of appropriate existing institutional mechanisms).

Environmental Constraints/Considerations:

- Valley and ridge topography limits the area of developable land to valleys and the lower slopes of ridges.
- A large proportion of the undeveloped land is forested.
- There are large areas where the depths to bedrock are very shallow (less than six feet).

- The groundwater hydrology is primarily carbonate-rock type (i.e., fracture porosity) which is particularly susceptible to pollution from infiltration.

- There are numerous sinkhole areas present which adversely affect local topography and groundwater quality.

- There are many areas susceptible to flooding.

Socioeconomic Constraints/Considerations:

- The area is rapidly urbanizing with major development concentrated in western and north central Knox County.

- Prime agricultural soil areas are limited and decreasing with suburban expansion.

- There has been only a limited demand for sludge product by the Study Area public in the past and current demand is declining.

Institutional Constraints/Considerations:

- The current "201" and "208" planning studies require immediate solutions (i.e., the disposal option must be technically, financially, and institutionally implementable in the near future).

- The sludge disposal option must guarantee disposal (e.g., if public demand is required for disposal, such demand must exist or be a virtual certainty at the time it would be required).

- The area is institutionally fragmented making regional or metropolitan solutions uncertain.

- Although regional agencies exist (e.g., Eastern Tennessee Development District), no regional sludge disposal projects have ever been implemented.

- The Study Area is just beginning to have problems requiring metropolitan or regional solutions. As a result, long-term planning in related areas, such as solid waste management, is only starting with no commitments being made to a particular future policy.

- Physical-chemical sludges are not considered in this study because of institutional decisions previously made excluding the consideration of a physical-chemical STP as a viable treatment alternative.

EVALUATION OF SLUDGE DISPOSAL OPTIONS

The principle function of this section was to apply the Study Area constraints, as defined above, to the specific disposal options available in order to evaluate their applicability to the Study Area. In this study, this was done by comparing possible impacts, disadvantages, and/or problems for each disposal option, as stated in the Methodology, with the Study Area constraints and noting those areas where adverse relationships exist. It was assumed that during the course of this process certain disposal options could be eliminated as infeasible or inapplicable to the needs of the Study Area, thereby reducing the number of disposal options to be considered.

Before certain disposal options could be analyzed, in particular land reclamation and sludge reuse, it was necessary to define the local options available. In the case of sludge reuse, two alternatives were defined. In addition, during the analysis of the sanitary landfill option, it became obvious that an alternative type of landfilling incorporating only sludge (i.e., trenching) would need to be considered. As a result, 12 disposal options were initially defined and evaluated against the Study Area constraints. A summary evaluation of the sludge disposal options is presented in Table VI-1.

Elimination of Infeasible Alternatives

The sludge disposal options which immediately fell out as being infeasible or inapplicable were ocean disposal, waste disposal ponds, pyrolysis, and recalcination. Ocean disposal is inappropriate for geographic and institutional reasons. Waste disposal ponds, although a viable local disposal method, require large land areas and are incompatible with most land uses for health and aesthetic reasons. Generally, waste disposal ponds are utilized by small, rural wastewater treatment plants where land is abundant, cheap, and relatively free of people to complain of odors. It is doubtful if waste disposal ponds could ever be considered a real disposal option for a treatment plant of any large size, because of the large land requirements and the proximity to residential land uses. Pyrolysis is a new process which has had only limited field testing. Primarily developed to utilize solid waste refuse, pyrolysis has only recently been considered as a method to utilize sewage sludge. Although a pyrolysis unit is being incorporated into a large wastewater treatment plant in Minneapolis/St. Paul (as noted in the Methodology), only 15 to 40 percent of the sludge solids are to be treated by the unit. As a result, pyrolysis is neither a proven nor a total solution at this time. Recalcination is not a feasible alternative without lime being used in the wastewater treatment process. As stated in Chapter V, no such wastewater processes currently exist

TABLE VI-1

SUMMARY EVALUATION OF SLUDGE DISPOSAL OPTIONS

SLUDGE DISPOSAL OPTION	STUDY AREA CONSTRAINTS		
	Environmental	Socioeconomic	Institutional
Sanitary Landfill	Potential groundwater pollution.	Requires rural location; restricts future land use options.	Future of solid waste management uncertain.
Trenching	Potential groundwater pollution; substantial land requirements.	Requires rural location.	Experimental; requires strict operation and monitoring.
Ocean Disposal	Unknown impact on ocean ecology.	Uneconomic distance.	Federal regulations prohibit new permits.
Waste Disposal Ponds	Substantial land requirements.	Incompatible with other land uses.	None
Resource Recovery			
Land Application	Substantial land requirements; potential surface and ground-water pollution.	Requires rural location.	Requires strict operation and monitoring.
Land Reclamation	Potential surface and ground-water pollution.	None	Requires complex institutional arrangements, strict operation and monitoring.
Incineration	Some air quality degradation.	None	None
Pyrolysis	None	No market for product.	Largely experimental; never been used to handle all solids produced.
Recalcination	None	None	Physical-chemical plant eliminated from study.
Composting	None	No market for all of product.	None
Sludge Reuse: IRD*	None	None	Requires guarantee from private company.
Sludge Reuse: TVA Boiler Feed	None	None	Currently only being considered by TVA

*IRD-Independent Research and Development Company or are proposed for future wastewater treatment plants.

Local Definition of General Disposal Options

Two general disposal options requiring local definition are land reclamation and sludge reuse. During this study land reclamation feasibility was derived from a general analysis of the mining operations occurring within the eastern Tennessee region. Two sludge reuse proposals were identified after discussions with local planning agencies. One sludge reuse option is a recent business proposal made to the City of Knoxville by the Independent Research and Development Company (IRD) involving the processing of sewage sludge to a high-nitrogen fertilizer. The other sludge reuse option is tied to an on-going study being conducted by TVA. The study is evaluating the feasibility of regional solid waste recovery including firing TVA power plant boilers with the organic fraction of solid waste. It has been suggested that organic sewage sludges could be mixed with the solid waste and used as a fuel.

Within the Study Area, no feasible mining reclamation projects or possibilities were identified. Subsequent investigation involved the use of a regional mineral resource map (Ref. VI-1) and a TVA study of strip-mined areas in eastern Tennessee (Ref. VI-2). Synthesis of these sources led to the identification of numerous potential strip-mine reclamation areas within 20 to 50 miles (40 to 80 kilometers) of Knoxville (Figure VI-1). Access to these areas via rail or highway is adequate and over one-third of the haul roads to abandoned or orphan strip-mine areas are in good condition. Most of the orphan strip-mines are of the contour type and are less than 40 acres (16 hectares) in extent; the total bare strip-mine acreage requiring reclamation being estimated to be 6000 acres (2430 hectares) (Ref. VI-2). However, these areas are scattered and a reclamation project incorporating Study Area sludge would have to be well-coordinated to minimize transportation costs.

The IRD sludge reuse option is part of an overall effort to develop Pickel Island in Knox County into a "Resource Recovery and Research Center." IRD plans to:

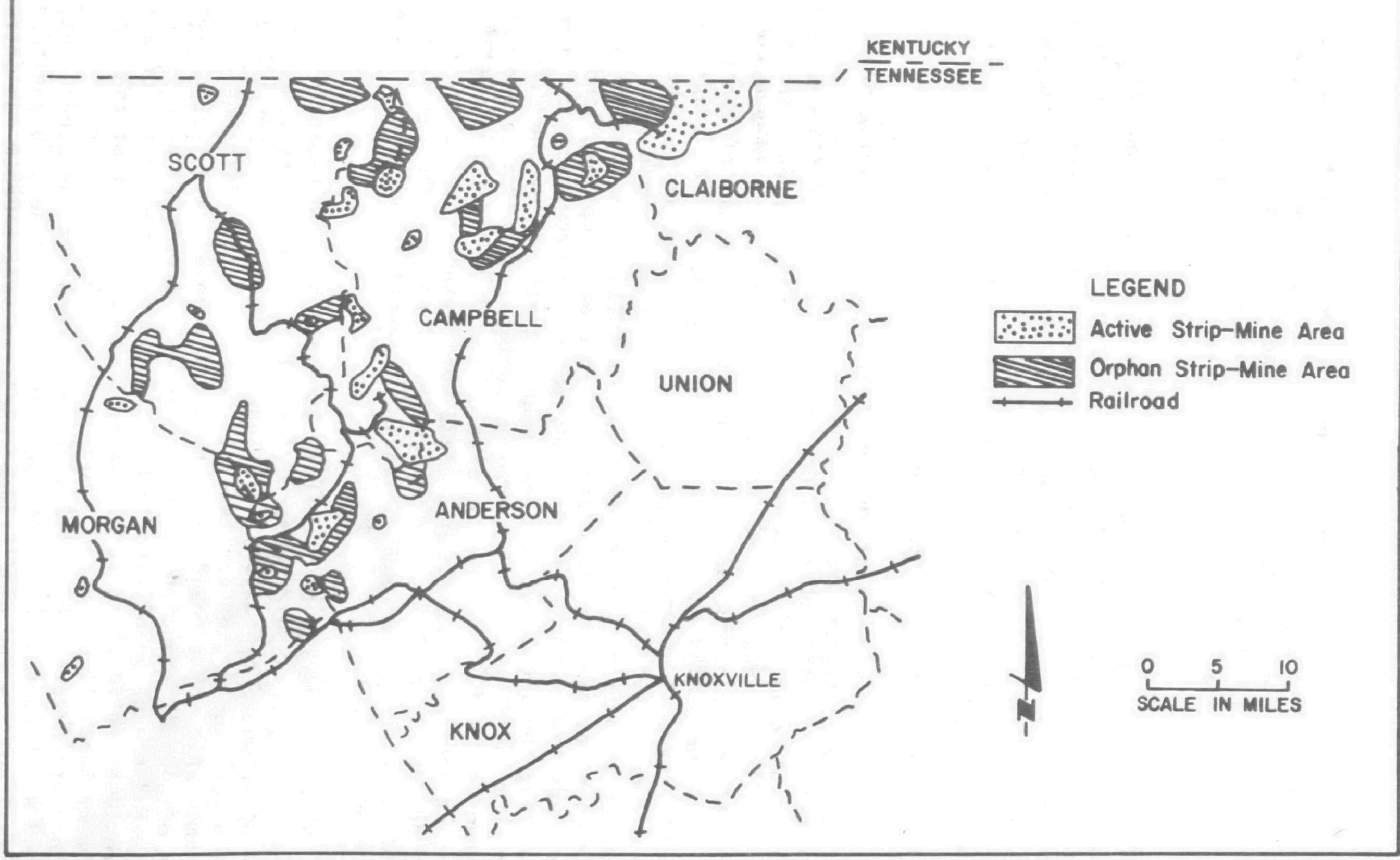
"1. Construct a wood waste processing plant that will produce marketable steam and commercial grade charcoal.

2. Construct a municipal refuse processing plant that will provide a fuel product and recover metals and glass.

3. Construct a rubber tire recycling plant which would produce carbon black and a fuel product.

4. Construct a sewage sludge processing plant that would produce a high-nitrogen fertilizer.

STRIP-MINE AREAS NEAR KNOX COUNTY



SOURCE: References VI-1 and VI-2

FIGURE VI-1

5. Develop a river terminal and related transportation network to bring raw wastes to the island from outlying areas. Since Knoxville has no public use river terminal, the terminal planned for Pickel Island will be used to tranship steel and other vital commodities." (Ref. VI-3)

The IRD sludge processing plant [100 dry tons/day (91 metric tons/day)] would convert all the sludge from the cities of Knoxville and Chattanooga into a granular fertilizer which will have, following supplemental nutrient (urea) addition, a nitrogen content of 15 to 20 percent by weight. The product is claimed to be in demand in the professional turf grass and the home and garden market. The process used was developed by Organics, Inc. and is discussed in the Methodology.

Implications of Solid Waste Management Planning

Solid waste management in the Study Area is a growing problem, particularly in regards to the siting and operation of sanitary landfills. Currently there is only one sanitary landfill operating in the Study Area with an expected useful life of three years (Ref. V-3). Because of the increasing expense of solid waste collection and disposal and the increasing difficulty of locating both environmentally and socially acceptable sites, the long-term objective of solid waste management is anticipated to be toward resource recovery (Ref. VI-4). Resource recovery would provide a means for recovering part of the cost of solid waste management in addition to eliminating the need to locate an acceptable landfill site every few years. The TVA study mentioned previously is currently dominating the local and regional planning efforts by the City of Knoxville and ETDD. A TVA-sponsored regional solid waste recovery program is the first choice of most of the Study Area and regional planning agencies. As a result, all solid waste studies are in abeyance until the TVA study is completed, causing the future of solid waste management and the sanitary landfill in the Study Area to be uncertain.

When considering the sanitary landfill as an ultimate disposal option, it should be recognized that the sanitary landfill is a solid waste repository first and foremost. It is perceived that a need for a sanitary landfill would exist, regardless of the implementation of a solid waste resource recovery scheme, to dispose of a small fraction of inert residual material. However, the projected sludge quantities to be disposed compared to the quantity of residual solid waste to be disposed would be so great that normal sanitary landfill operation would be impossible. As a result of the uncertain future of solid waste management in the Study Area, a method which approximates the operation and purpose of a sanitary landfill and has the same sludge condition requirements was introduced-trenching. Trenching is a recent disposal technique which is utilized exclusively for sludge disposal. At this time, no municipality is using this method although large-scale field studies have proved its feasibility (Ref. VI-5).

Suitability of the Study Area for Land Disposal Options

In order to evaluate the feasibility of long-term land disposal (i.e., sanitary landfill, trenching, and land application), it was perceived necessary to locate possible site areas within the Study Area. The approach used in locating possible site areas was a graphical technique involving factor maps, a factor map being the presentation of a siting criterion such as existing land use or sink-hole locations. Many of the factor maps used were generated during the compilation of Chapter IV and are presented as figures in that chapter.

An important assumption made in this analysis was that it was desirable to locate site areas which required minimum engineering and, as a result, a minimum cost to protect the environment or to prepare a site for operation. Consequently, the suitable site areas identified in the following figures represent those areas which, based on the available data, would require a minimum engineering cost and/or maximum resource utility of the sludge. This analytical technique does not preclude the existence of reasonable site areas out-side those identified as suitable, but merely attempts to locate, in a general fashion, cost-effective site areas.

The suitability analysis began with the listing of siting/ suitability criteria (i.e., factors) discussed in the Methodology. Subsequently, if they did not already exist, relevant factor maps were compiled from available data. The information presented on each map was ranked subjectively on a negative scale where zero = no impact, -1 = some impact, -2 = significant impact, and unsuitable = major impact. Each factor map was then coded per the ranking system. The applicable factor maps were then overlaid and, by visual analysis, a composite map was derived which showed the sum of the factor rank-ings for areas within the Study Area. The composite map was then further refined by assuming that all areas with a summed factor rat-ing greater than -2 were unsuitable. Unsuitable in this case meant that significant engineering (and cost) was required to improve the site characteristics or provide environmental protection. In addition, only those suitable site areas having sufficient areal extent to incorporate the anticipated sludge volume to be generated in the Knoxville-Knox County County between 1975 and 1995 are presented.

The factor maps used and their ranking for each disposal or management option are presented in Table VI-2. Some of the factors utilized (e.g., sinkhole areas, flood-prone areas, etc.) were declared

TABLE VI-2

FACTOR MAPS AND RANKING USED FOR SITE SUITABILITY ANALYSES

FACTOR MAPS	FACTOR RANKING		
	Sanitary Landfill	Trenching	Land Application
Carbonate-rock Area	-1	0	0
Sinkhole Area	Unsuitable	Unsuitable	Unsuitable
Percent Land Slope			
≤ 3%	-1	0	0
3%-9%	0	0	-1
> 9%	0	0	Unsuitable
Depth to Bedrock			
< 6 feet (carbonate rock)	Unsuitable	Unsuitable	-2
< 6 feet (non-carbonate rock)	-2	-2	-2
≥ 6 feet	0	0	0
Flood-prone Areas	Unsuitable	Unsuitable	Unsuitable
Soil Utility			
Prime agricultural soil	Unsuitable	Unsuitable	Unsuitable
Secondary agricultural soil	0	0	0
Other soils	0	-1	-1
Forested Areas	Unsuitable	Unsuitable	Unsuitable
Existing Land Use	Unsuitable	Unsuitable	Unsuitable
Proposed Land Use			
Residential	-1	-2	-2
Industrial	-1	-2	-2
Distance from Knoxville			
6-8 miles	-1	0	0
> 8 miles	-2	0	0

unsuitable initially and deserve some further explanation. Sinkhole areas were undesirable locations because of their direct connection with the underlying groundwater system and disruptive topographic expression (i.e., deep depressions). Flood-prone areas were unsuitable for obvious reasons related to site safety, operability, and environmental protection. Prime agricultural soils were considered a valuable local resource which should be preserved where possible. Forested areas were considered unsuitable for ecological purposes, particularly wildlife habitat alteration, and the cost of clearing. Existing land use areas (i.e., residential, industrial, and recreational) were excluded from consideration because of their already existing utility which would be disrupted and/or degraded by the incorporation of sanitary landfill, trenching or land application systems.

For the purposes of this study, identification of suitable land disposal sites ended with this process. Ideally, if a similar analysis were performed in the future, actual site visits would be desirable in order to field-check and refine the limits of possible site areas. Suitable site areas within the Study Area were identified for sanitary landfills, trenching, and land application and are shown in Figures VI-2, VI-3, and VI-4. As a result, all the land disposal options remained as feasible disposal options to be considered further.

Alternative Disposal Options Selected for Further Review

Of the 12 alternative sludge disposal options originally considered in this study, four have been previously defined as infeasible or inapplicable: 1) ocean disposal; 2) waste disposal ponds; 3) pyrolysis; and 4) recalcination. The remaining eight alternatives appear to be environmentally and socioeconomically feasible. However, some do not meet the institutional constraints defined earlier in this Chapter. The particular constraints violated are: 1) an immediate solution; and 2) guaranteed disposal.

Land (i.e., strip-mine) reclamation, although a desirable sludge use, would require extensive investigation into the institutional responsibilities involved. During the course of this study, no institution was identified as having or taking responsibility for the unreclaimed strip-mine areas and no studies had been conducted considering such a reclamation approach. It was considered to be beyond the scope of this study to initiate or formulate institutional arrangements to increase the feasibility of this alternative. As a result, although it is an attractive future possibility, strip-mine reclamation does not meet the immediate needs of the study.

For essentially the same reason, the sludge reuse option that would burn sewage sludge with solid waste refuse in TVA power plant

KNOXVILLE AND KNOX COUNTY
SANITARY LANDFILL SITE SUITABILITY MAP

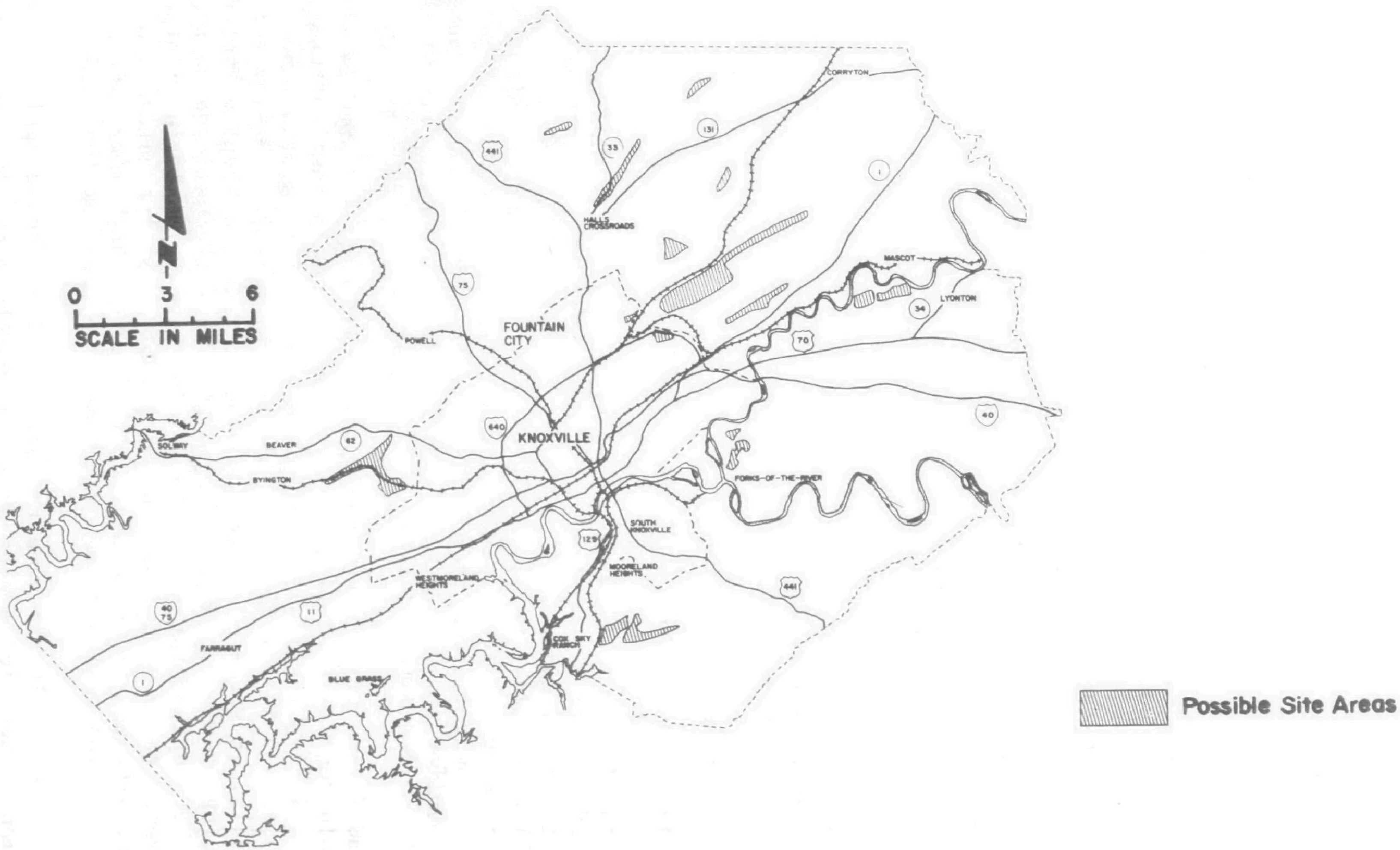


FIGURE VI-2

KNOXVILLE AND KNOX COUNTY TRENCHING SITE SUITABILITY MAP

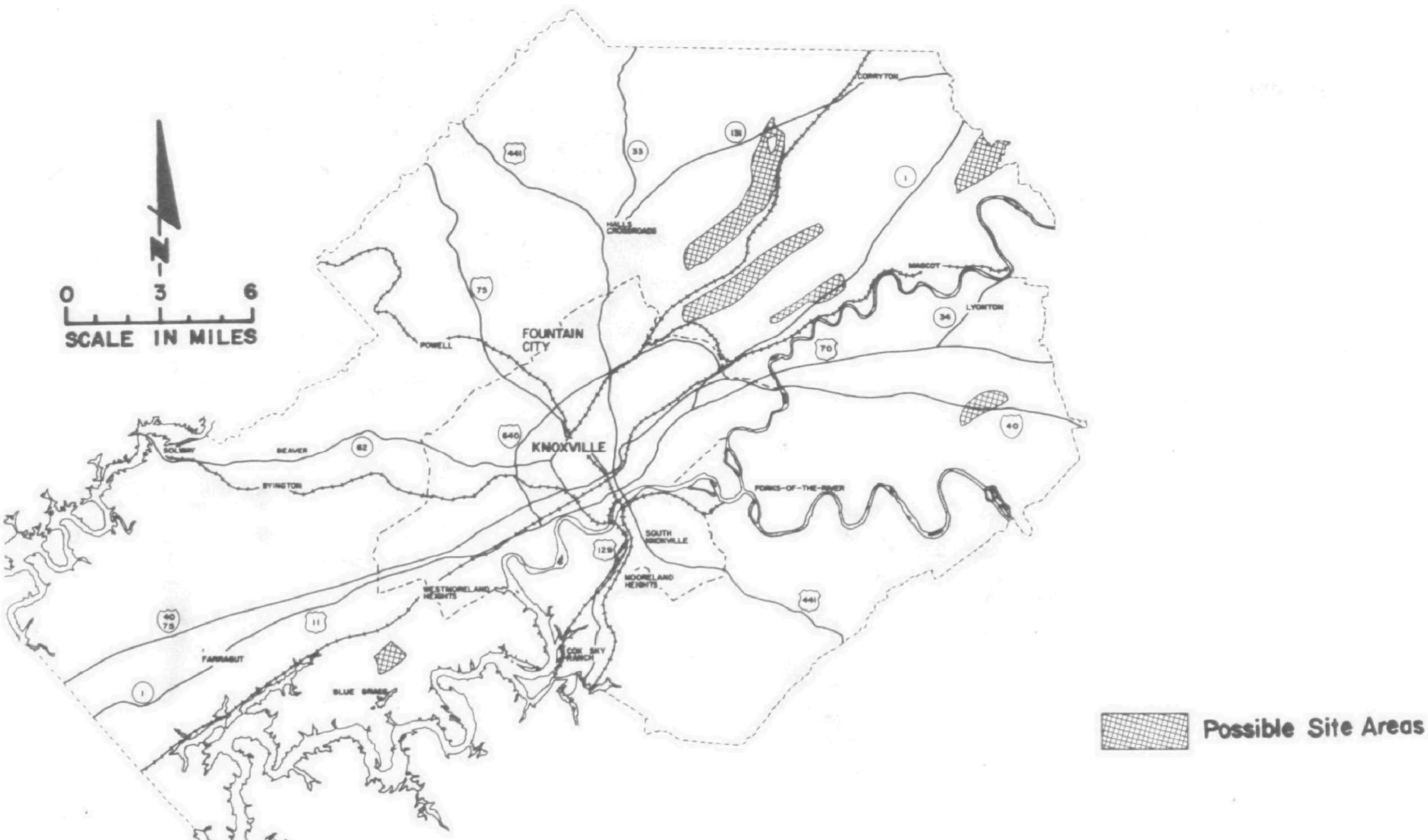


FIGURE VI-3

KNOXVILLE AND KNOX COUNTY
LAND APPLICATION SITE SUITABILITY MAP

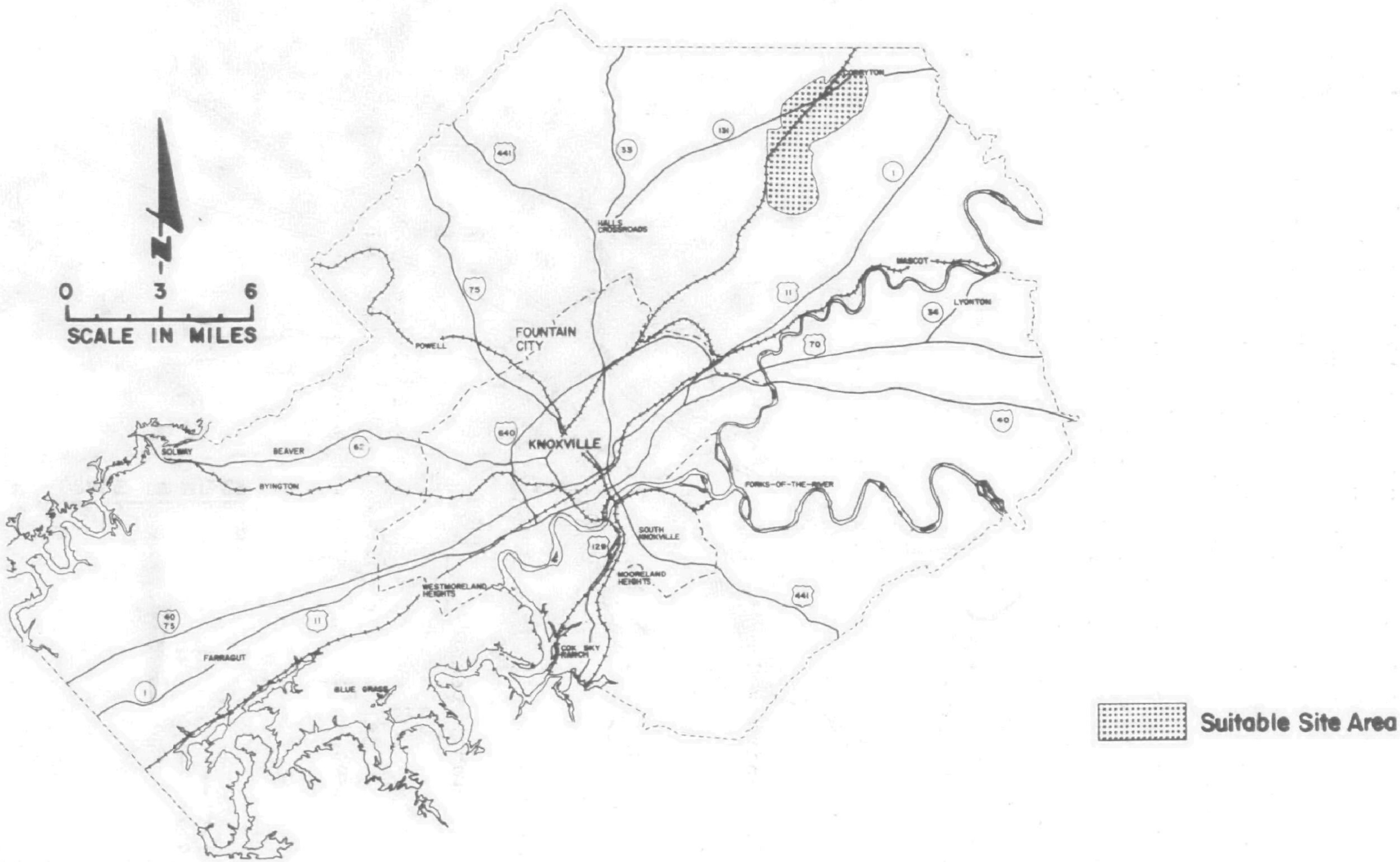


FIGURE VI-4

boilers is also put off as a possible near term alternative. The initial results of the TVA study, which will probably not be available until late in 1975, will be looking at solid waste only. If TVA decides that using solid waste refuse to fire boilers is both feasible and desirable, then the addition of sewage sludge should be investigated. Consequently, the TVA position on burning sewage sludge will not be known for some time.

Composting of sewage has only rarely been economically successful in this country. This has been primarily due to a lack of a market for the product. Although there is a history of the local public hauling substantial quantities of sludge from existing treatment plants in the area, this practice appears to be declining (see Chapter V of this report). Moreover, the sludge was supplied at no cost. One can assume that if there were to be a charge for compost, it would only decrease the demand of the compost product.

The remaining sludge disposal options to be considered, then, which will be incorporated into alternative sludge management plans are:

(1) sanitary landfilling;

(2) trenching;

(3) incineration;

(4) land application-spray irrigation;

(5) land application-composting; and

(6) sludge reuse-IRD.

Descriptions and evaluations of these alternative disposal options occur in the subsequent Chapter. The sludge conditions required for the disposal options are presented in Table VI-3.

TABLE VI-3

SLUDGE CONDITION REQUIRED FOR ALTERNATIVE DISPOSAL OPTIONS

ULTIMATE DISPOSAL OPTION	SLUDGE CONDITION*
1. Sanitary Landfilling	Digested, Dewatered
2. Trenching	Digested, Dewatered (Ref. VI-5)
3. Incineration	Dewatered
4. Land Application: Spray Irrigation	Digested
5. Land Application Composting	Digested, Dewatered
6. IRD (fertilizer base)	Digested (Ref. VI-3)

*Note: Unless noted otherwise, the reference for the sludge condition requirement is the Methodology.

CHAPTER VI

REFERENCES

VI-1 "Mineral Resources of the Tennessee Valley Region (Map)," Tennessee Valley Authority, Div. Water Control Planning, Geologic Branch (1970).

VI-2 Information supplied by Allen Curry of Tennessee Valley Authority, Knoxville, Tenn. (July 1975).

VI-3 "Pickel Island-A Regional Resource Recovery and Research Center," Independent Research and Development Company, Knoxville, Tennessee (April 1975).

VI-4 "Solid Waste Management Plan for Anderson, Blount, and Knox Counties, Tennessee," prepared by Allen & Hoshall Engineers, for East Tennessee Development District, Knoxville, Tenn. (Oct. 1971).

VI-5 "Trench Incorporation of Sewage Sludge," Walter, J. M. in Municipal Sludge Management, proceedings of National Conference on Municipal Sludge Management (June 1974).

CHAPTER VII

DEVELOPMENT AND EVALUATION OF ALTERNATIVE SLUDGE MANAGEMENT PLANS

INTRODUCTION

Having defined the quantity and distribution of raw sludge to be disposed (Chapter V) and the feasible disposal options (Chapter VI), the next step was to synthesize these data into alternative sludge management plans. The development of a sludge management plan includes the definition of a solids handling system for each sewage treatment plant considered, the transportation scheme for solids handling and/or disposal, and the ultimate disposal method. Subsequently, these plan aspects (i.e., solids handling, transportation, and disposal) were evaluated according to the criteria and procedures presented in Chapter VII of the Methodology.

DEVELOPMENT OF ALTERNATIVE SLUDGE MANAGEMENT PLANS

Although only six ultimate disposal options were defined as feasible within the Study Area, the number of possible solids handling and transportation schemes that could be combined with each disposal option is quite large. As a result, the several alternative sludge management plans developed are largely representative. For the purposes of this study, only one management plan was developed for each disposal option with each management plan incorporating a regional solution where possible. The latter condition (regionalization) was imposed at the request of the MPC, the current 208 planning agency, and is in keeping with its planning perspective and objectives.

Alternative 1 - Sanitary Landfill

This alternative represents the base case as most existing and proposed STP's in the Study Area currently use or intend to use sanitary landfilling as their ultimate disposal method. Based on the suitability analysis performed earlier in the study, it was assumed that sanitary landfill sites would be available for the design period (i.e., 1975 to 1995). However, current local and regional solid waste management plans are recommending alternative disposal schemes for solid waste which would eliminate the sanitary landfill as a disposal method (see Chapter VI). As a result, although the existence of sanitary landfills is assured for the next several years, the longer-term is far less certain.

The solids handling processes vary from plant to plant and were based on existing or proposed processes. This is a deviation in concept from the Methodology approach but it is justified somewhat in its truer representation of the base case situation. In the development of all the alternatives, the solids handling systems for existing and proposed STP's were used in part or in total if they met the required sludge condition for the various disposal options. The Methodology was used to define any additional or substitutive solids handling processes required.

The sludge condition required for sanitary landfill disposal is digested and dewatered. Aerobic digestion would be utilized by Powell, Turkey Creek, Karns, and Forks-of-the-River STP's. Anaerobic digestion preceded by gravity thickening would occur in Knob Creek and Lyon Creek STP's. Dewatering would be accomplished by pressure filtration in Knob Creek and Powell STP's, sand beds in Turkey Creek, Lyon Creek, and Forks-of-the-River STP's, and vacuum filtration in Karns STP.

The raw-sludge quantities presented in Chapter V of this report and the following assumptions (from information presented in Chapter IV of the Methodology) were used to project sludge quantities.

(1) A 40 percent reduction in the dry solids input during both anaerobic and aerobic digestion;

(2) for anaerobic digestion a three percent solids output and for aerobic digestion a four percent solids output;

(3) pressure filtration and sand bed dewatering produces a cake dry solids content by weight of 40 percent, while vacuum filtration produces a cake dry solids content by weight of 20 percent and the specific gravities of both types of cake are equal; and

(4) a specific gravity of the digested, dewatered sludge of 0.95 which is used to convert from wet tons per day to cubic yards per day as follows:

$$\frac{yd^3}{day} = \frac{\text{wet tons}}{day}\left(\frac{2000\ lb.}{\text{wet ton}} \times \frac{ft^3}{62.4\ lb.} \times \frac{yd^3}{27\ ft^3} \times \frac{1}{0.95}\right)$$

$$\frac{yd^3}{day} = \frac{\text{wet tons}}{day}\left(\frac{1.25\ yd^3}{\text{wet ton}}\right)$$

Table VII-1 presents the estimated sludge production for various design years.

The dewatered sludges would then be transported via a trucking operation to a landfill site near the currently operating sanitary

TABLE VII-1

SLUDGE PROJECTIONS FOR THE ANTICIPATED FACILITIES
ALTERNATIVE 1 - SANITARY LANDFILL AND ALTERNATIVE 2 - TRENCHING

Facility	1975	1980	1985	1990	1995	
1. Knob Creek	45.85/57.31[1]	49.30/61.63	51.90/64.88	53.40/66.75	54.70/68.38	Digested, de-watered sludge to either sanitary land-fill or trench-ing
2. Loves Creek	0.65/0.81	0.65/0.81	0.65/0.81	0.68/0.85	0.70/0.88	
Sub Total	46.50/58.12	49.95/62.44	52.55/65.69	54.08/67.60	55.40/69.26	
3. Powell	3.98/4.98	4.70/5.88	5.38/6.73	5.95/7.44	6.15/7.69	
4. Turkey Creek	1.48/1.85	1.70/2.13	1.83/2.29	3.18/3.98	3.23/4.04	
5. Karns	1.25/1.56	1.50/1.88	1.70/2.13	3.10/3.88	3.20/4.00	
Sub Total	6.71/8.39	7.90/9.89	8.91/11.15	12.23/15.30	12.58/15.73	
6. Lyon Creek	0.90/1.13	0.93/1.16	0.95/1.19	0.98/1.23	1.00/1.25	
7. Forks of the River	1.85/2.31	2.20/2.75	2.55/3.19	2.60/3.25	2.73/3.41	
GRAND TOTAL	55.96/69.95	60.98/76.24	64.96/81.22	69.89/87.38	71.71/89.65	Knoxville-Knox County

Note: 1. Values given in wet tons per day and wet cubic yards per day.

landfill site near Rutledge Pike in northeastern Knox County. Trucking distances would vary from 12 to 31 miles (19.3 to 49.9 km) depending on the location of the treatment facility. There the sludge would be mixed and buried with the daily collections of municipal refuse. No significant increase in landfill volume required is expected from this practice due to the largely liquid nature of the sludge (i.e., the sludge would merely fill in the spaces within the solid waste).

Each treatment facility would operate independently in this alternative. It is assumed that the County would continue to operate the sanitary landfill, charging a user's fee of $6.00 per wet short ton ($6.60 per wet metric ton).

Alternative 2 - Trenching

As discussed in Chapter VI, trenching (i.e., the burial of sludge in trenches) was introduced into this study as an alternative to sanitary landfills. The solids handling systems (and the estimated sludge production) and transportation plans are the same as those for Alternative 1.

Using the site suitability map developed for Chapter VI, a trenching site was located in the same general area as the sanitary landfill in Alternative 1. The area required to dispose the sludge estimated to be generated in the Study Area from 1975 to 1995 (1,110,000 yd^3 or 839,160 cu m) is 500 acres (202.5 ha). This is based on a trench width of two feet (0.61 m), trench depth of three feet (0.91 m), and trench spacing of two feet (0.61 m). An additional 200 acres to be used for buffer, buildings, and equipment storage would also be required.

It was assumed that the City of Knoxville would own and operate the trenching facility. The City was selected for this function over the County and utility districts because it has the largest financial, administrative, and technical base in addition to being the largest user of the facility. Although the suitable site areas for trenching are outside its corporate limits, the City does have the legal powers (i.e., eminent domain) and precedent (e.g., Knoxville Municipal Airport) to condemn land and operate facilities outside its jurisdiction. The City would charge a user's fee to the County and each participating utility district utilizing the facility.

Alternative 3 - Incineration

Incineration of sewage sludges is a common disposal method in many areas of the country. In this alternative, one regional incinerator located at Knob Creek would incinerate undigested dewatered sludge from the Knob Creek, Powell, Turkey Creek, and Karns STP's.

Lyon Creek and Forks-of-the-River STP's would dispose their digested and dewatered sludge to a sanitary landfill per Alternative 1 because of their proximity to probable landfill sites and small sludge contributions.

Undigested primary and secondary sludges would be conditioned with lime and ferric chloride prior to dewatering by pressure filtration. In addition to conditioning the sludge for dewatering, lime addition would also stabilize the raw sludge and minimize the possible public health risk of transporting raw sludge from the outlying treatment plants to Knob Creek.

The following assumptions based upon information provided in the Methodology were utilized to estimate sludge and ash production.

(1) Pressure filtration and sand bed dewatering produces a cake dry solids content by weight of 40 percent;

(2) a specific gravity of the undigested, dewatered sludge of 0.95 used in the same manner as indicated earlier;

(3) lime and ferric chloride addition prior to pressure filtration increases dry weight by 25 percent;

(4) incineration provides a volume reduction of 80 percent and a weight reduction of 75 percent; and

(5) Lyon Creek and Forks-of-the-River solids handling is the same as for Alternative 1.

Table VII-2 indicates the amount of incinerator ash to be disposed into a sanitary landfill for Knob Creek, Loves Creek, Powell, Turkey Creek, and Karns, and the digested, dewatered sludge to the landfill for Lyon Creek and Forks-of-the-River.

A multiple-hearth incinerator was assumed for treatment because it is simple, durable, and has lower capital and operating costs than other types of incinerators. At 30 to 40 percent solids content, the undigested, dewatered sludge should have sufficient energy for self-sustaining combustion in the incinerator, thereby eliminating supplemental fuel costs. Air pollution control equipment, such as scrubbers and cyclone separators, has been included in the capital and operating costs. The incinerator ash would be trucked to a local landfill for disposal.

It was assumed that each participating utility would be charged a user's fee by the City for use of the incinerator and transportation and disposal costs of the ash to a landfill.

TABLE VII-2

SLUDGE PROJECTIONS FOR THE ANTICIPATED FACILITIES
ALTERNATIVE 3 - INCINERATION

Facility	1975	1980	1985	1990	1995	
1. Knob Creek[1]	7.64/38.16	8.22/41.07	8.65/43.24	8.90/44.48	9.12/45.58	Incinerator ash to landfill
2. Loves Creek[1]	0.11/0.54	0.11/0.55	0.11/0.55	0.11/0.56	0.12/0.59	
Sub Total	7.75/38.70	8.33/41.62	8.76/43.79	9.01/45.04	9.24/46.17	
3. Powell[1]	0.66/1.66	0.79/1.96	0.90/2.24	0.99/2.47	1.03/2.56	
4. Turkey Creek[1]	0.25/0.61	0.29/0.71	0.31/0.76	0.53/1.32	0.54/1.34	
5. Karns[2]	0.11/0.52	0.13/0.62	0.14/0.71	0.26/1.30	0.27/1.34	
Sub Total	1.02/2.79	1.21/3.29	1.35/3.71	1.78/5.09	1.84/5.24	
6. Lyon Creek[2]	0.36/1.13	0.37/1.16	0.38/1.19	0.39/1.23	0.40/1.25	Digested, De-watered, truck to landfill
7. Forks-of-the-River[2]	0.74/2.31	0.88/2.75	1.02/3.19	1.04/3.25	1.09/3.41	
GRAND TOTAL	9.87/44.93	10.79/48.82	11.51/51.88	12.22/54.61	12.57/56.07	Knoxville-Knox County

Note: 1. Values given in dry tons per day and dry cubic yards per day for Knob Creek, Loves Creek, Powell, Turkey Creek, and Karns for incinerator ash.

2. Values given in dry tons per day and dry cubic yards per day for Lyon Creek, and Forks-of-the-River for digested and dewatered.

Alternative 4 - Land Application: Spray Irrigation

Spray irrigation of liquid sludge on agricultural land has received considerable attention in recent years because of its beneficial effect on crop productivity. This alternative sludge management plan would utilize digested sludge from all the wastewater treatment plans except Forks-of-the-River STP, which would continue to dispose its sludge to a sanitary landfill. It was assumed that, because of the substantial industrial contribution to Forks-of-the-River STP, as noted in Chapter V of this report, the heavy metal content of the sludge would be too high for safe long-term application to agricultural land.

The remaining wastewater treatment plants would end their solids handling processes with either aerobic or anaerobic digestion. The liquid sludge would then be transported by tank truck to the land application site and pumped into a storage lagoon for later application. The transportation distances to the site vary from 14 to 40 miles (22.5 to 64.4 km).

The following assumptions based upon information provided in the Methodology were utilized to project sludge production.

(1) A 40 percent reduction in the dry solids input during both anaerobic and aerobic digestion;

(2) for anaerobic digestion a three percent solids output and for aerobic digestion a four percent solids output;

(3) a specific gravity of the digested sludge of 1.03 which is used to convert from wet tons per day to cubic yards per day as follows:

$$\frac{yd^3}{day} = \frac{\text{wet tons}}{day}\left(\frac{2000\ lb.}{\text{wet ton}} \times \frac{ft^3}{62.4\ lb.} \times \frac{yd^3}{27\ ft^3} \times \frac{1}{1.03}\right)$$

$$\frac{yd^3}{day} = \frac{\text{wet tons}}{day}\left(1.1525\ \frac{yd^3}{\text{wet ton}}\right)$$

(4) Forks-of-the-River solids handling the same as for Alternative 1.

Table VII-3 indicates the amount of digested, undewatered sludge from Knob Creek and Loves Creek, Powell, Turkey Creek, Karns, and Lyon Creek to be applied to the land and the digested, dewatered sludge from Forks-of-the-River to the landfill.

TABLE VII-5

SLUDGE PROJECTIONS FOR THE ANTICIPATED FACILITIES
ALTERNATIVE 4 - LAND APPLICATION: SPRAY IRRIGATION

Facility	1975	1980	1985	1990	1995	
1. Knob Creek[1]	18.34/704.56	19.72/757.58	20.76/797.54	21.36/820.59	21.88/840.56	To Land Application Site
2. Loves Creek[1]	0.26/ 9.99	0.26/ 9.99	0.26/ 9.99	0.27/ 10.37	0.28/ 10.75	
Sub Total	18.60/714.55	19.98/767.57	21.02/807.53	21.63/830.96	22.16/851.31	
3. Powell[1]	1.59/ 45.81	1.88/ 54.17	2.15/ 61.95	2.38/ 68.57	2.46/ 70.88	
4. Turkey Creek[1]	0.59/ 17.00	0.68/ 19.59	0.73/ 21.03	1.27/ 36.59	1.29/ 37.17	
5. Karns[1]	0.25/ 7.20	0.30/ 8.64	0.34/ 9.80	0.62/ 17.86	0.64/ 18.44	
Sub Total	2.43/ 70.01	2.86/ 82.40	3.22/ 92.78	4.27/123.02	4.39/126.49	
6. Lyon Creek	0.36/ 13.83	0.37/ 14.21	0.38/ 14.60	0.39/ 14.98	0.40/ 15.36	
Sub Total	21.39/798.39	23.21/864.18	24.62/914.91	26.29/968.96	26.95/993.16	
7. Forks-of-the-River[2]	1.85/ 2.31	2.20/ 2.75	2.55/ 3.19	2.60/ 3.25	2.73/ 3.41	To Sanitary Landfill
GRAND TOTAL in cubic yards per day	800.70	866.93	918.10	972.21	996.57	Knoxville-Knox County

Note: 1. Values given in dry tons per day and dry cubic yards per day for Knob Creek, Loves Creek, Powell, Turkey Creek, Karns, and Lyon Creek and the resultant subtotal to land application site.

2. Values given in wet tons per day and cubic yards per day for Forks-of-the-River to sanitary landfill or on-site disposal.

The land application site assumed for this study was located using the land application suitability map developed in Chapter VI and would occupy that area adjacent to and west of House Mountain in northeastern Knox County. The land requirements for the land application area are estimated to be 670 acres (271 ha). This is based on an application rate of 15 dry short tons of sludge/acre/year (34 dry metric tons/ha/year) and the estimated 1995 sludge production for the Study Area (see Table VII-3). The application rate is an average rate for humid climatic regions and was obtained from the Methodology. Because of the high water content of the sludge, a subsurface collection system would need to be installed to collect leachate for water quality analysis and possible treatment before discharge to surface water courses. An additional 330 acres (134 ha) would be acquired for buffer land and a storage lagoon. The storage lagoon would be capable of holding liquid sludge for the several month period between growing seasons and would be 15 to 20 acres (6 to 8 ha) in area (six-month storage capacity).

Because of the large and long-term land requirements of the spray irrigation system, a joint City/County ownership of the system was assumed to be the most viable institutional arrangement. For the purposes of this study, the County would own the land while the City would own and operate the storage, application, and collection facilities. Acreage would be leased to local farmers for crop production with the crops grown monitored by the state public health department which is operated at the County level. User charges would be levied on the participating utility districts. No leasing revenues were included in the economic analysis.

Alternative 5 - Land Application: Composting

This is a unique alternative developed for this study. In concept, it is similar to Alternative 4 in that the sludge would be applied to agricultural land to benefit crop production. Instead of liquid sludge, however, digested, dewatered sludge and compost would be applied to the land during the period between growing seasons. During the growing season, the digested, dewatered sludge would be composted and stored. Depending on the demand, a quantity of compost could be packaged for public sale. If public demand were substantial, a significant reduction in land requirements at the land application site could be realized in addition to increased revenue.

As in Alternative 4, all the wastewater treatment plants would participate except for Forks-of-the-River STP which would dispose to a landfill. The solids handling processes and the pertinent assumptions for the wastewater treatment plants would be the same as those for Alternative 1, the required sludge conditions being the same. Table VII-4 presents the anticipated sludge production from these processes for various years. The dewatered sludges would be transported via container truck to the land application site.

The composting and land application site location and area requirements are identical to those of Alternative 4. However, owing to the low water content of the dewatered sludge and compost, site development would not require subsurface collection or spray application systems. The composting area would require a five acre (2 ha) concrete pad for sludge processing (i.e., bulking and windrowing) and storage.

The institutional arrangements and rationale for Alternative 4 were assumed to apply to this alternative, also. No leasing or composting revenues were considered in the economic analysis.

Alternative 6 - Resource Recovery: IRD

As discussed in Chapter VI, Independent Research and Development Company (IRD) has proposed to develop a resource recovery center on Pickel Island, located near the mouth of the French Broad in eastern Knox County. Among its planned operations is a sludge processing plant that would convert wastewater sludges from the Chattanooga and Knoxville metropolitan areas into a high nitrogen fertilizer. For this alternative, all the wastewater treatment plants (including Forks-of-the-River STP) would deliver a digested liquid sludge to IRD.

The solids handling processes would end with digestion, either aerobic or anaerobic depending upon the facility producing the sludge quantities presented in Table VII-5. The liquid sludge would be transported via tank truck to Pickel Island except for that of Knob Creek STP which would be barged. It was assumed that each treatment facility would make its own transportation arrangements and that IRD would provide a vacuum filter dewatering process and charge a dewatering fee for liquid sludge received.

EVALUATION OF ALTERNATIVE SLUDGE MANAGEMENT PLANS

The six sludge management alternatives were evaluated with respect to economics, environmental factors, feasibility, and performance according to the guidelines presented in Chapter VII of the Methodology. Table VII-6 shows the completed sludge management evaluation matrix. The bases of the quantifiable (i.e., economics) and qualitative (i.e., environmental, feasibility, and performance) factors are presented in the following sections.

TABLE VII-4

SLUDGE PROJECTIONS FOR THE ANTICIPATED FACILITIES
ALTERNATIVE 5 - LAND APPLICATION: COMPOSTING

Facility	1975	1980	1985	1990	1995	
1. Knob Creek	45.85/ 57.31[1]	49.30/ 61.63	51.90/ 64.88	53.40/ 66.75	54.70/ 68.38	To Compost Site
2. Loves Creek	0.65/ 0.81	0.65/ 0.81	0.65/ 0.81	0.68/ 0.85	0.70/ 0.88	
Sub Total	46.50/ 58.12	49.95/ 62.44	52.55/ 65.69	54.08/ 67.60	55.40/ 69.26	
3. Powell	3.98/ 4.98	4.70/ 5.88	5.38/ 6.73	5.95/ 7.44	6.15/ 7.69	
4. Turkey Creek	1.48/ 1.85	1.70/ 2.13	1.83/ 2.29	3.18/ 3.98	3.23/ 4.04	
5. Karns	1.25/ 1.56	1.50/ 1.88	1.70/ 2.13	3.10/ 3.88	3.20/ 4.00	
Sub Total	6.71/ 8.39	7.90/ 9.89	8.91/ 11.15	12.23/ 15.30	12.58/ 15.73	
6. Lyon Creek	0.90/ 1.13	0.93/ 1.16	0.95/ 1.19	0.98/ 1.23	1.00/ 1.25	
Sub Total	54.11/ 67.64	58.78/ 73.49	62.41/ 78.03	67.29/ 84.13	68.98/ 86.24	
7. Forks-of-the-River	1.85/ 2.31	2.20/ 2.75	2.55/ 3.19	2.60/ 3.25	2.73/ 3.41	To Sanitary Landfill
GRAND TOTAL	55.96/ 69.95	60.98/ 76.24	64.96/ 81.22	69.89/ 87.38	71.71/ 89.65	Knoxville-Knox County

Note: 1. Values given in wet tons per day and wet cubic yards per day.

TABLE VII-5

SLUDGE PROJECTIONS FOR THE ANTICIPATED FACILITIES
ALTERNATIVE 6 - RESOURCE RECOVERY: IRD

Facility	1975	1980	1985	1990	1995	
1. Knob Creek	611.33/704.56 [1]	657.33/757.58	692.00/797.54	712.00/820.59	729.33/840.56	Digested sludge to Pickel Island
2. Loves Creek	8.67/9.99	8.67/9.99	8.67/9.99	9.00/10.37	9.33/10/75	
Sub Total	620.00/714.55	666.00/767.57	700.67/807.53	721.00/830.96	738.66/851.31	
3. Powell	39.75/45.31	47.00/54.17	53.75/61.95	59.50/68.57	61.50/70.88	
4. Turkey Creek	14.75/17.00	17.00/19.59	18.25/21.03	31.75/36.59	32.25/37.17	
5. Karns	6.25/7.20	7.50/8.64	8.50/9.80	15.50/17.86	16.00/18.44	
Sub Total	60.75/70.01	71.50/82.40	80.50/92.78	106.75/123.02	109.75/126.49	
6. Lyon Creek	12.00/13.83	12.33/14.21	12.67/14.60	13.00/14.98	13.33/15.36	
7. Forks of the River	18.50/21.32	22.00/25.36	25.50/29.39	26.00/29.97	27.25/31.41	
GRAND TOTAL	711.25/819.71	771.83/889.54	819.34/944.30	866.75/998.93	888.99/1024.57	Knoxville-Knox County

Note: 1. Values in wet tons per day and wet cubic yards per day.

TABLE VII-6A

ALTERNATIVES EVALUATION MATRIX
Economics and Environmental Factors

PARAMETERS		ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
ECONOMICS[1]	CAPITAL COST	$ 4,836,000	$ 6,876,000	$ 5,099,000
	ANNUAL CAPITAL AMORTIZATION	$ 456,000	$ 649,000	$ 481,000
	O. AND M. COST	$ 484,000	$ 496,000	$ 357,000
	RECLAMATION* REVENUE	$ 13,000	$ 13,000	$ 0
	PRESENT WORTH	$ 9,828,000	$11,994,000	$ 8,879,000
		RATING	RATING	RATING
ENVIRONMENTAL FACTORS	WATER QUALITY	No change in any water quality**	No change in any water quality**	No change in any water quality**
	AIR QUALITY	Produces slight increases in odors and truck emissions	Produces slight increases in odors, dust, and truck emissions	Produces slight increases in odors, dust, and truck emissions
	LAND QUALITY	Ultimately limits soil productivity and use options	Increase soil productivity; limits use options	No change in land quality
	FLORA AND FAUNA	Severely disrupts local ecology	Severely disrupts local ecology	Has only Minor impact on ecology
	AESTHETICS	Degradation of aesthetic qualities in some local areas	Some loss of areas with desirable aesthetic qualities	No changes in present aesthetic quality
	PUBLIC HEALTH	No change in public health involvement	Some increase in public health involvement	No change in public health involvement
	COMMUNITY IMPACT	No change in social or physical elements of the community	Involves displacement of residents from community	Increases noise or odor levels in community
	RESOURCE CONSERVATION	Maintains present level of energy and materials resource usage	Increase primary resource consumption and decreases secondary resource production	Increases primary resource consumption and decreases secondary resource production

* Methane recovery from anaerobic digestion
** If site is properly managed

Note: 1. See also Table VII-7

TABLE VII-6A (Continued)

ALTERNATIVES EVALUATION MATRIX
Economics and Environmental Factors

PARAMETERS		ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
ECONOMICS[1]	CAPITAL COST	$ 9,060,000	$ 6,536,000	$ 4,304,000
	ANNUAL CAPITAL AMORTIZATION	$ 855,000	$ 617,000	$ 406,000
	O. AND M. COST	$ 938,000	$ 561,000	$ 565,000
	RECLAMATION* REVENUE	$ 13,000	$ 13,000	$ 13,000
	PRESENT WORTH	$ 18,965,000	12,342,000	$10,147,000
		RATING	RATING	RATING
ENVIRONMENTAL FACTORS	WATER QUALITY	No changes in any water quality**	No changes in any water quality**	No changes in any water quality**
	AIR QUALITY	Produces slight increases in odors and truck emissions	Produces slight increases in odors, dust, and truck emissions	Produces slight increases in odor and tug and truck emissions.
	LAND QUALITY	Increases soil productivity	Increases soil productivity	No change in land quality
	FLORA AND FAUNA	Severely disrupts some local ecology	Severely disrupts some local ecology	No impacts on ecology
	AESTHETICS	Degradation of aesthetic qualities in some local areas	Degradation of aesthetic qualities in some local areas	No change in present aesthetic quality
	PUBLIC HEALTH	Increases potential of harm to public health	Increases potential of harm to public health	No change in public health involvement
	COMMUNITY IMPACT	Involves displacement of residents from community	Involves displacement of residents from community	No change in social or physical elements of the community
	RESOURCE CONSERVATION	Promotes beneficial use of sludge and reduces usage of natural resources	Promotes beneficial use of sludge and reduces usage of natural resources	Promotes beneficial use of sludge and reduces usage of natural resources

* Methane recovery from anaerobic digestion
** If site is properly managed

Note: 1. See also Table VII-7

TABLE VII-6B

ALTERNATIVES EVALUATION MATRIX
Feasibility and Performance

PARAMETERS		ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6
FEASIBILITY	FINANCIAL FEASIBILITY	Readily falls within funding capabilities of responsible agency	Readily falls within funding capabilities of responsible agency	Readily falls within funding capabilities of responsible agency
	PUBLIC ACCEPTABILITY	Opposed by some local groups	Opposed by some local groups	Supported by some local groups
	LAND USE COMPATIBILITY	Compatible with existing land use plans	Compatible with existing land use plans	Compatible with existing land use plans
	EASE OF IMPLEMENTATION	Will require minor reorganization of agencies	Will require minor reorganization of agencies	Readily implementable by existing agencies within current legislative limits
PERFORMANCE	SYSTEM EFFECTIVENESS	Will meet performance criteria	Will meet performance criteria	Will meet performance criteria
	RELIABILITY	Complex system with little mechanical downtime	Simple system with little mechanical downtime	Complex system unproven in full-scale operation
	ADAPTABILITY	Will not adapt to new processes or performance criteria	Will adapt to some new processes	Will adapt to some new processes
	CALAMITY RESISTANCE	Will cease function for more than several days	Will cease functions for a very short period of time	In event of calamity, will cease function and require major repairs
	PERMANENCE	System adequate for immediate planning horizon	System adequate for immediate planning horizon	System adequate for immediate planning horizon

TABLE VII-6B (Continued)

ALTERNATIVES EVALUATION MATRIX
Feasibility and Performance

PARAMETERS		ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
FEASIBILITY	FINANCIAL FEASIBILITY	Readily falls within funding capabilities of responsible agency	Readily falls within funding capabilities of responsible agency	Readily falls within funding capabilities of responsible agency
	PUBLIC ACCEPTABILITY	Public ambivalent toward this system	Opposed by some local groups	Strongly opposed by local groups
	LAND USE COMPATIBILITY	Compatible with existing land use plans	Compatible with existing land use plans	Compatible with existing land use plans
	EASE OF IMPLEMENTATION	Readily implementable by existing agencies within current legislative limits	Readily implementable by existing agencies within current legislative limits	Readily implementable by existing agencies within current legislative limits
PERFORMANCE	SYSTEM EFFECTIVENESS	Will meet performance criteria	Will meet performance criteria	Will meet performance criteria
	RELIABILITY	Simple system with little mechanical downtime	Simple system unproven in full-scale operation	Simple system with little mechanical downtime
	ADAPTABILITY	Will adapt to some new processes	Will adapt to some new processes	Will adapt to some new performance criteria
	CALAMITY RESISTANCE	Will remain fully functional and require only minor repairs	Will remain fully functional and require only minor repairs	Will cease function for more than several days
	PERMANENCE	Interim measure, usable for several years only	System adequate for immediate planning horizon	System adequate for immediate planning horizon

It should be noted at this time that the level of analysis is at a general feasibility level. Only representative transportation distances and routes were used in this study. In addition, disposal site areas were only generally located. However, the evaluation procedures which follow can be taken to any level of detail desired. It is recommended that, in the actual use of the Methodology, such a feasibility level of analysis, as represented by this case study, be done initially prior to detailed transportation routing and site evaluation. Undesirable alternatives, as defined by the involved institutions and public, could then be eliminated without undue time and money commitments.

Economic Analysis

Included in Tables VII-7a through 7f and summary Table VII-7g are the cost worksheets and figures used for the six alternatives. Figures VII-1, VII-2, and VII-3 show the capital, operation and maintenance, and truck transportation costs, respectively, used and extrapolated from the Methodology cost curves. The following assumptions were made in the preparation of these costs:

(1) sludge processing equipment (thickeners, digesters, pressure or vacuum filters, incinerators, etc.) were assumed to have a service life of 20 years;

(2) the interest rate used was seven percent;

(3) transportation modes (trucks or barge) would not entail a capital cost because either existing trucks would be utilized or future truck and barge capacity would be leased;

(4) landfills would not entail a capital expenditure because a landfill will be required and operated for either solid wastes or the residuals remaining from solid waste processing and the landfill user charge would include the user's share of the amortized capital (the local land fee by 1995 was assumed at $6/wet ton);

(5) land costs were included as a necessary capital expenditure and ammortized over the 20-year planning period at seven percent;

(6) assuming that one-half of the total anaerobic digestion methane gas production per day to be excess suitable for reclamation revenue, it was estimated (using 0.4 cubic feet (0.01 cu m) per capita, 600 BTU/ft^3 (5350 kg-cal./cu m), and $0.085/therm) that the contribution would be

TABLE VII-7a

COST ESTIMATE FOR ALTERNATIVE 1
SANITARY LANDFILL
(Base Case)

PROCESSING

No.	Plant	Unit Processes	1995 Dry Tons/Day Processed	Capital $1000	Annual Capital $1000	Annual* O&M $1000	Total Annual $1000
1 & 2	Knob Creek & Loves Creek	Thickening (Gravity)	36.94	440	41.53	22	63.53
		Digestion (Anaerobic)	36.94	2800	264.29	39	303.29
		Dewater (Pressure Filters)	22.16	720	67.96	62	129.96
3	Powell	Digestion (Aerobic)	4.10	155	14.63	29	43.63
		Thickening (Gravity)	2.46	42	3.96	7	10.96
		Dewater (Pressure Filters)	2.46	120	11.33	16	27.33
4	Turkey Creek	Digestion (Aerobic)	2.15	90	8.50	20	28.50
		Dewater (Sand Beds)	1.29	96	9.06	13	22.06
5	Karns	Digestion (Aerobic)	1.07	50	4.72	14	18.72
		Dewater (Vacuum Filters)	0.64	26	2.45	4	6.45
6	Lyon Creek	Thickening (Gravity)	0.66	13	1.23	4	5.23
		Digestion (Anaerobic)	0.66	100	9.44	1	10.44
		Dewater (Sand Beds)	0.40	28	2.64	4	6.64
7	Forks-of-the-River	Digestion (Aerobic)	1.82	76	7.17	18	25.17
		Dewater (Sand Beds)	1.09	80	7.55	11	18.55

TRANSPORTATION

No.	Plant	Transportation Mode	Miles	1995 Dry Tons/Day	% Solids	$/Dry Ton	$/Day	Total Annual $1000
1 & 2	Knob Creek & Loves Creek	Truck	18.4	22.16	40	6.00	132.96	48.53
3	Powell	Truck	16.6	2.46	40	5.70	14.02	5.12
4	Turkey Creek	Truck	30.8	1.29	40	8.80	11.35	4.14
5	Karns	Truck	24.4	0.64	20	9.60	6.14	2.24
6	Lyon Creek	Truck	14.1	0.40	40	5.10	2.04	0.74
7	Forks of the River	Truck	11.7	1.09	40	4.50	4.91	1.79

ULTIMATE DISPOSAL

	Wet Tons/Day	$/Wet Ton	Total Annual $1000
All Plants to Sanitary Landfill	72	6	157.68

	Capital	Annual O&M	Total Annual
TOTAL COSTS (Capital, Annual O&M, Total Annual)	$4,836,000	$484,240	$940,700

*Based upon average sludge production for 1975-1995.

TABLE VII-7b

COST ESTIMATE FOR ALTERNATIVE 2
TRENCHING

PROCESSING

No.	Plant	Unit Processes	1995 Dry Tons/Day Processed	Capital $1000	Annual Capital $1000	Annual* O&M $1000	Total Annual $1000
1 & 2	Knob Creek & Loves Creek	Thickening (Gravity)	36.94	440	41.53	22	63.53
		Digestion (Anaerobic)	36.94	2800	264.29	39	303.29
		Dewater (Pressure Filters)	22.16	720	67.96	62	129.96
3	Powell	Digestion (Aerobic)	4.10	155	14.63	29	43.63
		Thickening (Gravity)	2.46	42	3.96	7	10.96
		Dewater (Pressure Filters)	2.46	120	11.33	16	27.33
4	Turkey Creek	Digestion (Aerobic)	2.15	90	8.50	20	28.50
		Dewater (Sand Beds)	1.29	96	9.06	13	22.06
5	Karns	Digestion (Aerobic)	1.07	50	4.72	14	18.72
		Dewater (Vacuum Filters)	0.64	26	2.45	4	6.45
6	Lyon Creek	Thickening (Gravity)	0.66	13	1.23	4	5.23
		Digestion (Anaerobic)	0.66	100	9.44	1	10.44
		Dewater (Sand Beds)	0.40	28	2.64	4	6.64
7	Forks-of-the-River	Digestion (Aerobic)	1.82	76	7.17	18	25.17
		Dewater (Sand Beds)	1.09	80	7.55	11	18.55

TRANSPORTATION

No.	Plant	Transportation Mode	Miles	1995 Dry Tons/Day	% Solids	$/Dry Ton	$/Day	Total Annual $1000
1 & 2	Knob Creek & Lyon Creek	Truck	18.4	22.16	40	6.00	132.96	48.53
3	Powell	Truck	16.6	2.46	40	5.70	14.02	5.12
4	Turkey Creek	Truck	30.8	1.29	40	8.80	11.35	4.14
5	Karns	Truck	24.4	0.64	20	9.60	6.14	2.24
6	Lyon Creek	Truck	14.1	0.40	40	5.10	2.04	0.74
7	Forks-of-the-River	Truck	11.7	1.09	40	4.50	4.91	1.79

ULTIMATE DISPOSAL

	Wet Tons/Day	$/Wet Ton	Capital $1000	Annual Capital $1000	Annual* O&M $1000	Total Annual $1000
All Plants to Trenching Site	72	6.45				169.51
Land Cost (700 acres @ $700/acre)			490	46.25		46.25
Site Development			1440	135.92		135.92
Equipment			250	23.60		23.60
TOTAL COSTS (Capital, Annual O&M, Total Annual)			$6,876,000		$496,070	$1,158,300

*Based upon average sludge production for 1975-1995.

TABLE VII-7c

COST ESTIMATE FOR ALTERNATIVE 3
INCINERATION

PROCESSING

No.	Plant	Unit Processes	1995 Dry Tons/Day Processed	Capital $1000	Annual Capital $1000	Annual* O&M $1000	Total Annual $1000
1 & 2	Knob Creek & Loves Creek	Thickening (Gravity)	36.94	440	41.53	22	63.53
		Dewater (Pressure Filters)	36.94	1100	103.83	86	189.83
		Incineration	44.26	2900	273.73	90	363.73
3	Powell	Dewater (Pressure Filters)	4.10	190	17.93	21	38.93
4	Turkey Creek	Dewater (Pressure Filters)	2.15	110	10.38	15	25.38
5	Karns	Dewater (Pressure Filters)	1.07	62	5.85	9	14.85
6	Lyon Creek	Thickening (Gravity)	0.66	13	1.23	4	5.23
		Digestion (Anaerobic)	0.66	100	9.44	1	10.44
		Dewater (Sand Beds)	0.40	28	2.64	4	6.64
7	Forks-of-the-River	Digestion (Aerobic)	1.82	76	7.17	18	25.17
		Dewater (Sand Beds)	1.09	80	7.55	11	18.55

TRANSPORTATION

		Transportation Mode	Miles	1995 Dry Tons/Day	% Solids	$/Dry Ton	$/Day	Total Annual $1000
1 & 2	Knob Creek & Loves Creek (Ash to Landfill)	Truck	18.4	11.08	Ash	3.45	38.23	13.94
	To Incinerator at Knob Creek							
3	Powell	Truck	19	4.10	40	6.30	25.83	9.43
4	Turkey Creek	Truck	26.6	2.15	40	8.00	17.20	6.28
5	Karns	Truck	26.6	1.07	40	8.00	8.56	3.12
	Dewatered/Digested Sludge to Landfill							
6	Lyon Creek	Truck	14.1	0.40	40	5.10	2.04	0.74
7	Forks-of-the-River	Truck	11.7	1.09	40	4.50	4.91	1.79

ULTIMATE DISPOSAL

		Wet Tons/Day	$/Wet Ton	Total Annual $1000
1 - 5	Incinerator Ash	14.77	6	32.35
6 & 7	Sludge	3.73	6	8.17

	Capital	Annual O&M	Total Annual
TOTAL COSTS (Capital, Annual O&M, Total Annual)	$5,099,000	$356,830	$838,110

*Based upon average sludge production for 1975-1995.

TABLE VII-7d

COST ESTIMATE FOR ALTERNATIVE 4
LAND APPLICATION/SPRAY IRRIGATION

PROCESSING

No.	Plant	Unit Processes	1995 Dry Tons/Day Processed	Capital $1000	Annual Capital $1000	Annual* O&M $1000	Total Annual $1000
1 & 2	Knob Creek & Loves Creek	Thickening (Gravity)	36.94	440	41.53	22	63.53
		Digestion (Anaerobic)	36.94	2800	264.29	39	303.29
3	Powell	Digestion (Aerobic)	4.10	155	14.63	29	43.63
4	Turkey Creek	Digestion (Aerobic)	2.15	90	8.50	20	28.50
5	Karns	Digestion (Aerobic)	1.07	50	4.72	14	18.72
6	Lyon Creek	Thickening (Gravity)	0.66	13	1.23	4	5.23
		Digestion (Anaerobic)	0.66	100	9.44	1	10.44
7	Forks-of-the-River	Digestion (Aerobic)	1.82	76	7.17	18	25.17
		Dewater (Sand Beds)	1.09	80	7.55	11	18.55

TRANSPORTATION

No.	Plant	Transportation Mode	Miles	1995 Dry Tons/Day	% Solids	$/Dry Ton	$/Day	Total Annual $1000
To Land Application Site								
1 & 2	Knob Creek & Loves Creek	Truck	28.0	22.16	3	80.00	1772.80	647
3	Powell	Truck	20.9	2.46	4	44.00	108.24	40
4	Turkey Creek	Truck	40.4	1.29	4	75.00	96.75	35
5	Karns	Truck	29.0	0.64	4	56.50	36.16	13
6	Lyon Creek	Truck	13.8	0.40	3	46.00	18.40	7
To Landfill								
7	Forks-of-the-River	Truck	11.7	1.09	40	4.50	4.91	2

ULTIMATE DISPOSAL

	Acreage	Cost	Capital $1000	Annual Capital $1000	Annual O&M $1000	Total Annual $1000
Land	1000	$ 700/acre	700	66		66
Site Development - includes screening and pumping from lagoons, distribution lines, underdrain PVC pipe, fencing		$6800/acre	4556	430		430
O&M - includes pumping manpower, materials					40	40
	Wet Tons/Day	$/Wet Ton		$/Day		
Landfill	2.73	6		16.38	6	6
TOTAL COSTS (Capital, Annual O&M, Total Annual)			$9,060,000		$948,000	$1,803,060

*Based upon average sludge production for 1975-1995.

TABLE VII-7e

COST ESTIMATE FOR ALTERNATIVE 3
LAND APPLICATION/COMPOSTING

PROCESSING

No.	Plant	Unit Processes	1995 Dry Tons/Day Processed	Capital $1000	Annual Capital $1000	Annual* O&M $1000	Total Annual $1000
1 & 2	Knob Creek & Loves Creek	Thickening (Gravity)	36.94	440	41.53	22	63.53
		Digestion (Anaerobic)	36.94	2800	264.29	39	303.29
		Dewater (Pressure Filters)	22.16	720	67.96	62	129.96
3	Powell	Digestion (Aerobic)	4.10	155	14.63	29	43.63
		Thickening (Gravity)	2.46	42	3.96	7	10.96
		Dewater (Pressure Filters)	2.46	120	11.33	16	27.33
4	Turkey Creek	Digestion (Aerobic)	2.15	90	8.50	20	28.50
		Dewater (Sand Beds)	1.29	96	9.06	13	22.06
5	Karns	Digestion (Aerobic)	1.07	50	4.72	14	18.72
		Dewater (Vacuum Filters)	0.64	26	2.45	4	6.45
6	Lyon Creek	Thickening (Gravity)	0.66	13	1.23	4	5.23
		Digestion (Anaerobic)	0.66	100	9.44	1	10.44
		Dewater (Sand Beds)	0.40	28	2.64	4	6.64
7	Forks-of-the-River	Digestion (Aerobic)	1.82	76	7.17	18	25.17
		Dewater (Sand Beds)	1.09	80	7.35	11	18.55

TRANSPORTATION

		Transportation Mode	Miles	1995 Dry Tons/Day	% Solids	$/Dry Ton	$/Day	Total Annual $1000
1 & 2	Knob Creek & Loves Creek	Truck	28.0	22.16	40	8.30	183.93	67
3	Powell	Truck	20.9	2.46	40	6.70	16.48	6
4	Turkey Creek	Truck	40.4	1.29	40	10.75	13.87	5
5	Karns	Truck	29.0	0.64	20	11.25	7.20	3
6	Lyon Creek	Truck	13.8	0.40	40	5.00	2.00	1
7	Forks-of-the-River	Truck	11.7	1.09	40	4.50	4.91	2

ULTIMATE DISPOSAL

		Acreage	Cost	Wet Tons/Day	$/Wet Tons	Capital $1000	Annual Capital $1000	Annual O&M $1000	Total Annual $1000
1 - 6	Composting								
	Land	1000	$700/acre			700	66		66
	Pad, Storage Runoff Ponds					600	62.30		62.30
	Composters, Trucks, Loaders, Scales, Control House					400	37.76		37.76
	O&M							207	207
	Landfill								
7	Forks of the River			2.73	6			6	6
TOTAL COSTS (Capital, Annual O&M, Total Annual)						$6,536,000		561,000	$1,183,520

*Based upon average sludge production for 1975-1993.

TABLE VII-7f

COST ESTIMATE FOR ALTERNATIVE 6
RESOURCE RECOVERY
(IRD)

PROCESSING

No.	Plant	Unit Processes	1995 Dry Tons/Day Processed	Capital $1000	Annual Capital $1000	Annual* O&M $1000	Total Annual $1000
1 & 2	Knob Creek & Loves Creek	Thickening (Gravity) Digestion (Anaerobic)	36.94 36.94	440 2800	41.53 264.29	22 39	63.73 303.29
3	Powell	Digestion (Aerobic)	4.10	155	14.63	29	43.63
4	Turkey	Digestion (Aerobic)	2.15	90	8.50	20	28.50
5	Karns	Digestion (Aerobic)	1.07	50	4.72	14	18.72
6	Lyon Creek	Thickening (Gravity) Digestion (Anaerobic)	0.66 0.66	13 100	1.23 9.44	4 1	5.23 10.44
7	Forks-of-the-River	Digestion (Aerobic)	1.82	76	7.17	18	25.17

TRANSPORTATION

No.	To Pickel Island	Transportation Mode	Miles	1995 Dry Tons/Day	% Solids	$/Dry Ton	$/Day	Total Annual $1000
1 & 2	Knob Creek & Loves Creek	Barge	16		3			319.50**
3	Powell	Truck	15.8	2.46	4	30.00	73.80	27
4	Turkey Creek	Truck	23.1	1.29	4	47.00	60.63	22
5	Karns	Truck	21.1	0.64	4	44.00	28.16	10
6	Lyon Creek	Truck	14.7	0.40	3	48.25	19.30	7
7	Forks-of-the-River	Truck	1.0	1.09	3.5	4.60	5.01	2

RESOURCE RECOVERY

Plant	Unit Processes	1995 Dry Tons/Day	Capital $1000	Annual Capital $1000	Annual O&M $1000	Total Annual $1000
IRD	Dewater (Vacuum Filters)	28.04	580	54.75	30	84.75
TOTAL COSTS (Capital, Annual O&M, Total Annual)			$4,304,000		$564,500	$970,760

* Based upon average sludge production for 1975-1995

**Annual Capital = $80,500 (payable to barge owners)
Annual O&M = $239,000†

† $19.66 towing cost/trip mile x 32 miles x 32 miles = $629.12/trip x 365 trips/year = $229,628.80/year + $9660 (maintenance) = $239,000

TABLE VII-7g

CAPITAL, O & M, AND PRESENT WORTH
FOR THE ALTERNATIVES

Alternative	Total Capital	Total Annual O & M	Present Worth*
1. Sanitary Landfill	$ 4,836,000	$ 471,000**	$ 9,828,000
2. Trenching	$ 6,876,000	$ 483,000**	$ 11,994,000
3. Incineration	$ 5,099,000	$ 357,000	$ 8,879,000
4. Land Application: Spray Irrigation	$ 9,060,000	$ 935,000**	$ 18,965,000
5. Land Application: Composting	$ 6,536,000	$ 548,000**	$ 12,342,000
6. Resource Recovery: IRD	$ 4,304,000	$ 552,000**	$ 10,147,000

* Amortized Capital at 7 percent for 20 years (factor = 0.09439).

** Includes $13,000/year debited against annual O & M for reclaimed resource of methane off-gas.

CAPITAL COSTS FOR SOLIDS PROCESSING FACILITIES

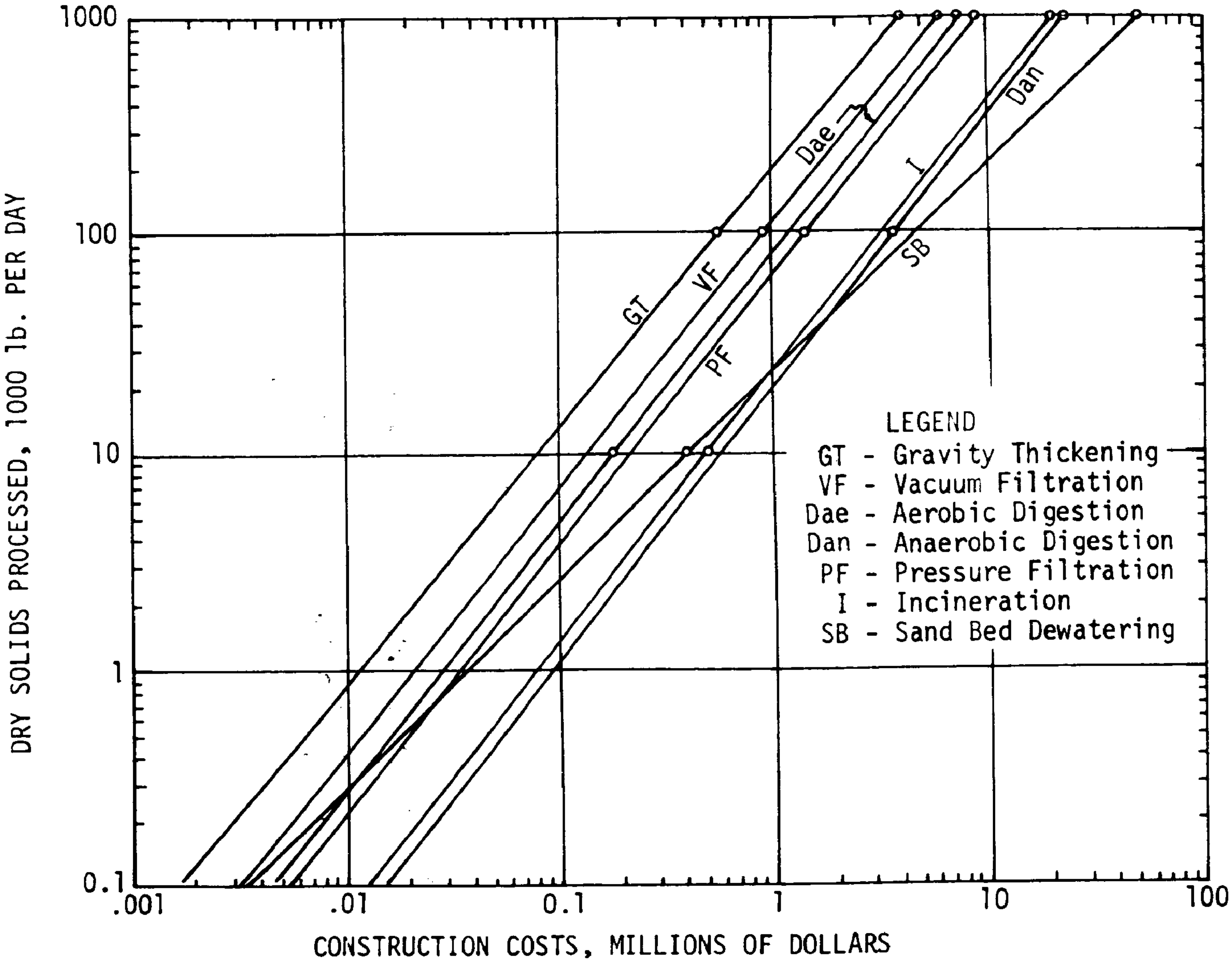


FIGURE VII-1

OPERATING COSTS FOR SOLIDS PROCESSING FACILITIES

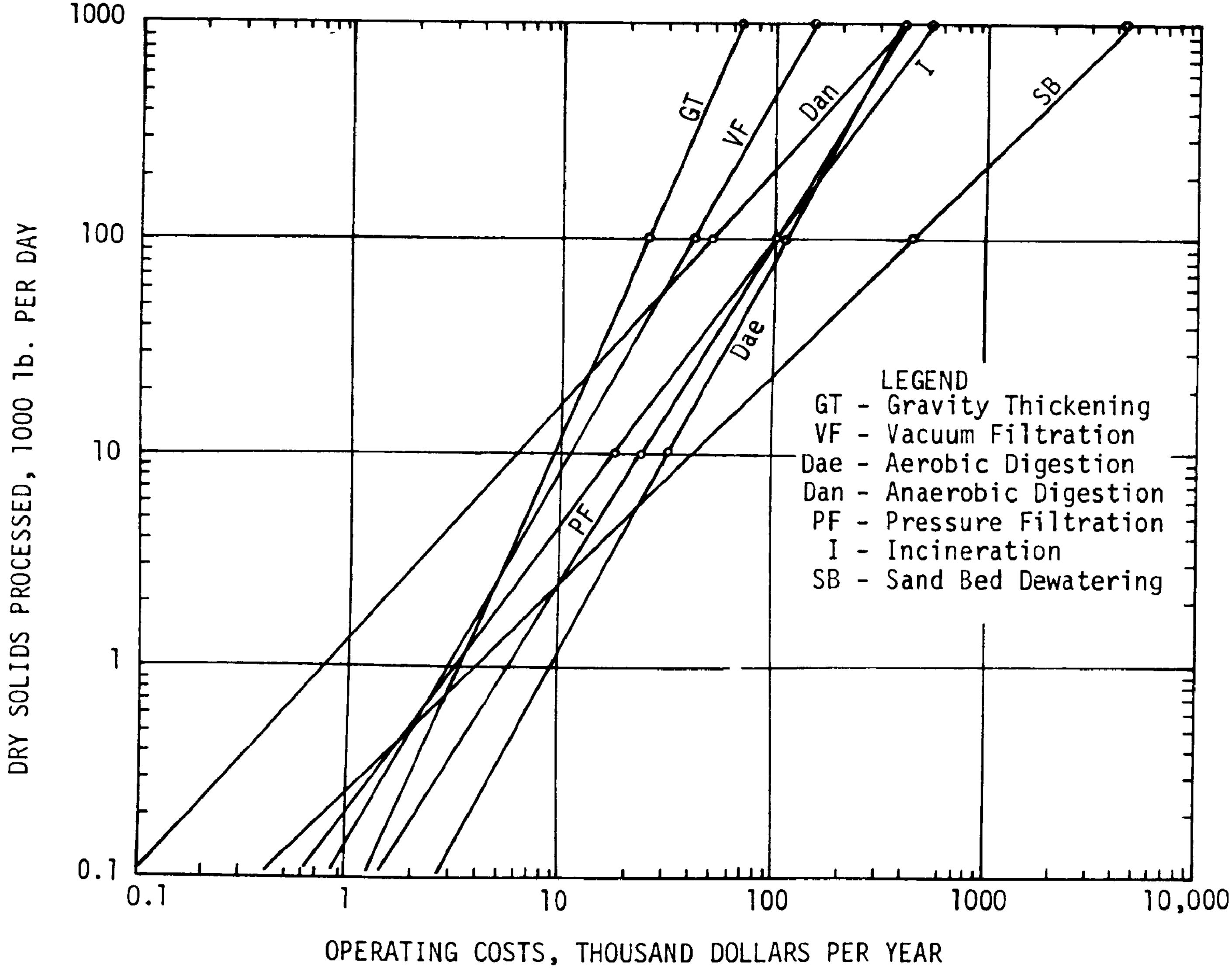
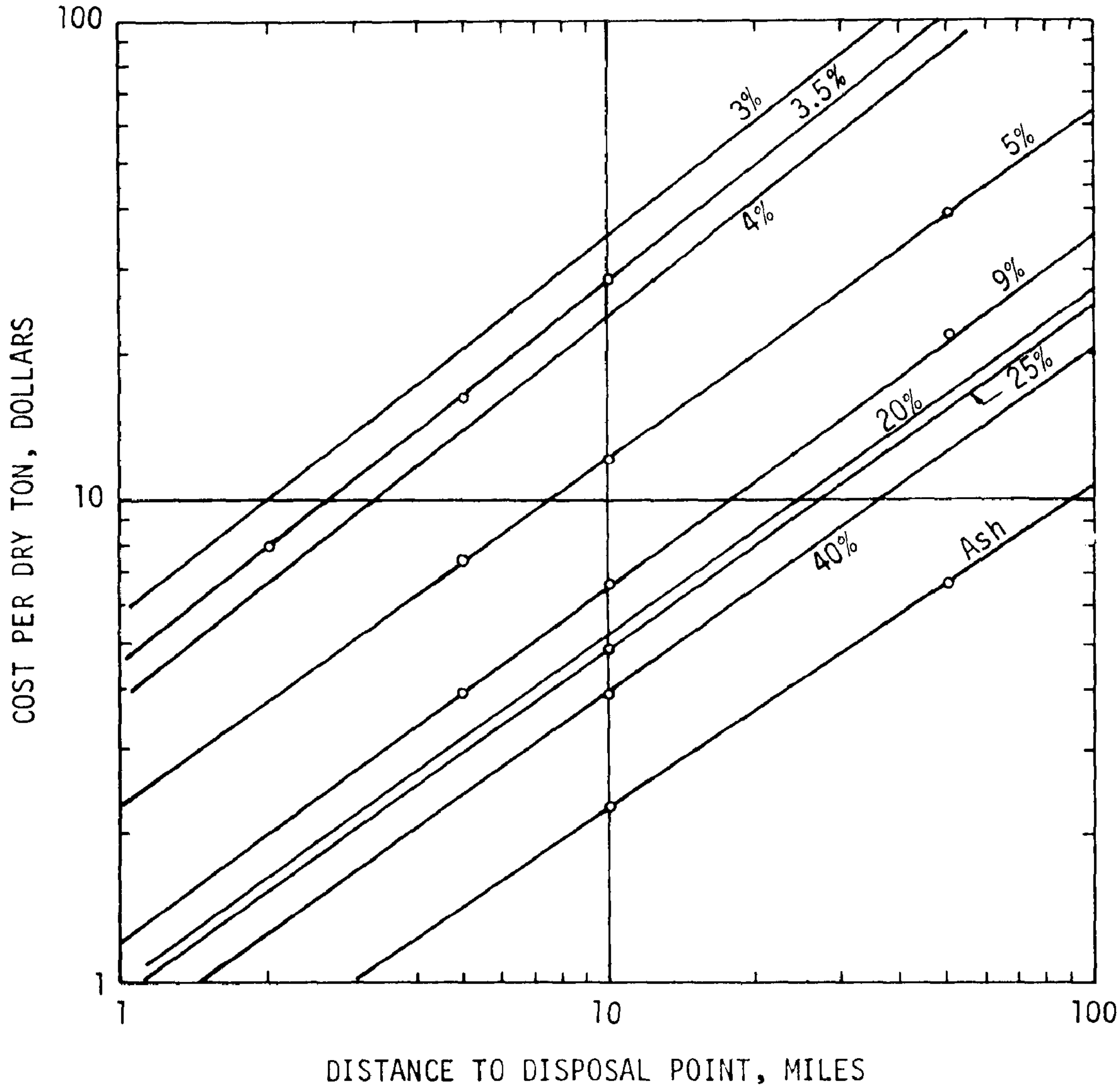


FIGURE VII-2

TRUCK TRANSPORTATION COSTS (1975)



for both Knob Creek/Loves Creek and Lyon Creek approximately $13,000 per year, of which 95 percent ($12,350 per year) is attributed to Knob Creek/Loves Creek and five percent ($650 per year) is attributed to Lyon Creek;

(7) no other reclamation resource revenues were developed due to lack of specific cost data in the Study Area (i.e., the revenue numbers presented in the Methodology were felt to be unrepresentative of the Study Area);

(8) other transportation modes such as rail or pipeline were not investigated due to the substantial amount of railcar switching necessary in the Study Area and the relatively short distances involved from the plants to the ultimate disposal areas;

(9) the annual O & M costs were based on the average sludge quantities handled over the 20-year planning period; and

(10) the cost curves in the Methodology were utilized due to lack of local data and extrapolated when necessary, recognizing however the possible degree of error introduced by such a technique.

Table VII-7g shows, for each of the six alternatives, the total capital cost, the total annual operation and maintenance costs (O & M), and the calculated present worth.

Where local costs were unavailable (e.g., site development or composting and trenching costs), the following references cited in the Methodology were utilized:

(1) for trenching site development and equipment costs, Ref. VII-1;

(2) for land application/spray irrigation site development and operating costs, Ref. VII-2; and

(3) for land application/composting site development, equipment, and operating costs, Ref. VII-3.

Table VII-8 shows for each alternative the costs by alternative and by each plant without Federal funding and with 75 percent Federal funding. Thus, the lower case numbers would reflect the cost per ton borne by State and local funding.

TABLE VII-8

COSTS (DOLLARS) PER TON OF DRY SLUDGE SOLIDS PROCESSED, TRANSPORTED, AND DISPOSED OR RECLAIMED WITHOUT FEDERAL FUNDING AND WITH FEDERAL FUNDING - 1995 SLUDGE PROJECTION

Sewage Treatment Plant	Alternative					
	1	2	3	4	5	6
Knob Creek	49[1] / 28[2]	61 / 31	43 / 22	107 / 67	64 / 35	55 / 38
Powell	67 / 52	79 / 55	58 / 36	88 / 58	81 / 59	52 / 30
Turkey Creek	79 / 62	91 / 65	66 / 43	113 / 83	93 / 69	69 / 60
Karns	88 / 74	92 / 81	72 / 47	115 / 82	94 / 74	78 / 68
Lyon Creek	102 / 60	114 / 64	102 / 60	124 / 68	116 / 68	97 / 64
Forks-of-the-River	77 / 61	90 / 64	77 / 61	77 / 61	77 / 61	46 / 25
Alternative Cost	54 / 34	66 / 38	49 / 28	105 / 67	68 / 41	56 / 38

[1] Cost ($/ton of dry solids) without Federal Funding.
[2] Cost ($/ton of dry solids) 75 percent Federal funding of capital costs.

Environmental Factors

The summary listing of potential environmental impacts presented in Table VII-9 shows the categories of concern investigated for each alternative. The following discussions present the rationale for the evaluations found in Table VII-6.

Alternative 1 - Sanitary Landfill

No unacceptable changes in any water quality are expected from this alternative because of strict state guidelines and regulations for the location, design, and operation of the sanitary landfill, precluding degradation of surface and ground waters. Whether nondegradation of water quality occurs in fact is the responsibility of the operating agency and the concerned state regulatory agencies.

A very minor increase in pollutant emissions could be expected from the operation of the trucks transporting the sludge (on the average, 3-4 truck trips/day would be required). Disposal of the sludge would be expected to contribute additional odors at the landfill site prior to the daily covering operations.

Although abandoned sanitary landfill sites often are used to provide new recreational facilities (e.g., parks, baseball diamonds, etc.), this is done not so much out of choice as by limitation. Methane gas generation, subsidence, corrosive leachate, and undeveloped soil profiles severely limit the possible uses of such a site for many years after landfilling ceases.

Sanitary landfills by their very nature damage the existing aesthetic value of an area and disrupt the existing ecologic systems. However, the sanitary landfill (and the open dump which preceded it) has been in existence in the Study Area for many years and most likely will continue to exist in the future. As a result, no changes are expected in community impact, public health involvement or resources consumed because of the implementation of this alternative.

Alternative 2 - Trenching

No unacceptable changes in any water quality are expected from this alternative for much the same reason as given in Alternative 1. A trenching operation would undoubtedly come under strict supervision and regulation by the state environmental and public health agencies and would necessarily be located in the best natural location with water quality protection devices provided if necessary.

TABLE VII-9

POTENTIAL SIGNIFICANT ENVIRONMENTAL IMPACTS OF ALTERNATIVE SLUDGE MANAGEMENT PLANS

Alternative	Process	Potential Significant Environmental Impact
1. Sanitary Landfill	• Truck transport of digested, dewatered sludge to landfill	• Air pollutant emissions • Noise • Traffic
	• Disposal of sludge at sanitary landfill site	• Destruction of wildlife habitat • Groundwater degradation • Damage to aesthetics • Development of new recreation lands • Odors • Public health hazard • Incompatibility with other land uses
2. Trenching	• Truck transport of digested, dewatered sludge to trenching site	• Same as Alternative 1
	• Disposal of sludge at trenching site	• Same as Alternative 1
3. Incineration	• Truck transport of dewatered sludge to Knob Creek STP	• Air pollutant emissions • Noise • Traffic • Vector propagation
	• Truck transport of digested, dewatered sludge (Lyon Creek & Forks-of-the-River STP's) to sanitary landfill site	• Same as Alternative 1
	• Incineration	• Air pollutant emissions • Public health hazard • Damage to aesthetics • Construction dust • Construction noise

TABLE VII-9 (Continued)

POTENTIAL SIGNIFICANT ENVIRONMENTAL IMPACTS OF ALTERNATIVE SLUDGE MANAGEMENT PLANS

Alternative	Process	Potential Significant Environmental Impact
3. Incineration	• Truck transport of incinerator ash to sanitary landfill site	• Air Pollutant emissions • Noise • Traffic • Dust
	• Disposal of sludge at sanitary landfill site	• Same as Alternative 1
	• Disposal of incinerator ash at sanitary landfill site	• Destruction of wildlife habitat • Groundwater degradation • Damage to aesthetics • Dust • Development of new recreation land • Incompatibility with other land uses
4. Land Application: Spray Irrigation	• Truck transport of digested sludge to land application site	• Air pollutant emissions • Noise • Traffic
	• Truck transport of digested, dewatered sludge (Forks-of-the-River STP) to sanitary landfill site	• Same as Alternative 1
	• Spray irrigation of digested sludge at land application site	• Odors • Construction dust • Construction noise • Destruction of natural vegetation • Destruction of wildlife habitat • Damage to aesthetics • Vector propagation • Displacement of local residents

TABLE VII-9 (Continued)

POTENTIAL SIGNIFICANT ENVIRONMENTAL IMPACTS OF ALTERNATIVE SLUDGE MANAGEMENT PLANS

Alternative	Process	Potential Significant Environmental Impact
4. Land Application: Spray Irrigation		• Groundwater degradation • Surface water pollution • Incompatibility with other land uses • Enhance soil productivity • Toxic elements to food chain
	• Disposal of sludge at sanitary landfill site	• Same as Alternative 1
5. Land Application: Composting	• Truck transport of digested, dewatered sludge to land application site or sanitary landfill (Forks-of-the-River STP)	• Same as Alternative 1
	• Disposal of sludge at sanitary landfill site	• Same as Alternative 1
	• Composting at land application site	• Odors • Dust • Noise • Vector propagation • Groundwater degradation • Incompatibility with other land uses • Surface water pollution • Damage to aesthetics • Construction noise • Construction dust
	• Land application of compost and/or digested, dewatered sludge	• Odors • Dust • Noise • Vector propagation • Groundwater degradation • Incompatibility with other land uses

TABLE VII-9 (Continued)

POTENTIAL SIGNIFICANT ENVIRONMENTAL IMPACTS OF ALTERNATIVE SLUDGE MANAGEMENT PLANS

Alternative	Process	Potential Significant Environmental Impact
5. Land Application: Composting		• Displacement of local residents • Surface water pollution • Destruction of natural vegetation • Destruction of wildlife habitat • Damage to aesthetics • Enhance soil productivity • Toxic element to food chain
6. Resource Recovery: IRD	• Truck transport of digested sludge to IRD facility	• Same as Alternative 4
	• Barge transport of digested sludge to IRD facility	• Surface water pollution • Vector propagation • Air pollutant emissions • Traffic • Damage to aesthetics
	• Use of product	• Enhance soil productivity • Groundwater degradation • Toxic elements to food chain

Air quality considerations are the same as those for Alternative 1. In addition, noise and dust would be generated during the operation of the trenching system.

Assuming the location of the trenching site would be on land of only marginal productivity, a slight increase in soil productivity would be realized after the incorporation of sludge.

This benefit, however, would only be realized if cropping of the trenching site were the subsequent land use. As a result, this is a conditional benefit. In addition, trenching could be viewed as development limiting in that residential and industrial development would probably not be allowed on the site until the buried sludge degraded anaerobically to an inert humus, a slow process requiring many years to occur.

Considerable disruption of existing ecosystems and damage to aesthetics would occur during the operation of the trenching facility. In addition, it is likely that some local residents would be displaced by the acquisition of site and buffer lands, owing to the large acreage and type of land (i.e., cleared) required.

Depending on one's point of view, resource conservation might or might not be occurring in this alternative. If one assumes that the land utilized would have been upgraded in productivity with or without trenching (viz. fertilizer or compost), then resources would be conserved. However, the decline in the agricultural economy of Knox County (at least in terms of acreage and number of farms) and increase in population and residential land use requirements seem to indicate that the development-potential loss would be greater than the potential agricultural benefits that would occur.

Alternative 3 - Incineration

No unacceptable changes in water quality, land quality, public health, ecology or aesthetics are expected to occur with the incineration of the dewatered sludges or disposal of the incinerator ash to a sanitary landfill. Air quality would be somewhat impacted by truck emissions, incinerator stack emissions, and incinerator dust leakage during transit and disposal.

The possible air quality impacts from the operation of the regional incinerator at Knob Creek were investigated by utilizing in-house air quality models. Air quality data, specifically wind rose data from sources noted in Chapter IV of this report and the following typical incinerator stack parameters were used: stack height of 75 feet (22.86 meters), stack diameter of 4 feet (1.22 meters), exit gas temperature of 350 F (177C), and exit gas velocity of 30 feet per second (9.14 meters per second).

The average annual particulate concentrations within approximately a two-mile (1.61 kilometer) radius of the incinerator were never above 0.03 $\mu g/m^3$ and the distribution was in a northeasterly and southwesterly direction.

The maximum 24-hour concentration would occur under an A stability classification with the wind from the north and would result in a concentration of 0.33 $\mu g/m^3$; an insignificant addition to the existing levels (see Appendix A).

Thus, the operation of a regional sludge incinerator located at Knob Creek utilizing proper emission control devices to meet Federal, State, and local regulations is anticipated to create no significant impact to the existing levels of particulates within the Study Area.

Alternative 4 - Land Application: Spray Irrigation

With the incorporation of the surface and underground collection and storage systems required for a liquid sludge spray irrigation system and the expected nutrient uptake by crops, no unacceptable changes in any water quality are anticipated by the implementation of this alternative. As in Alternative 2, considerable State participation in the design, operation, and monitoring of the system by environmental protection and public health agencies would be expected to guarantee proper system performance.

Minor increases in air pollutant emissions and traffic from truck transportation of the sludge (averaging 40 truck trips/day) and some increase in odors would be expected at the land application site. The possibility of vector propagation via wind-blown aerosols from the spray irrigation would be minimized by proper operational considerations and surrounding buffer land.

The land application site would be located on already existing or potential farmland and would not be incompatible with existing land uses, aesthetics or ecosystems. However, the lagoon required for system operation and seasonal storage would locally disrupt existing ecosystems and degrade the local aesthetic quality. Local residents would be displaced by the substantial land acquisition required, which would include land for spray irrigation, buffer area, and surface runoff control.

Use of the digested sludge would increase the soil productivity and would reduce the need for other fertilizers to be used for crop production. There is some question, however, as to the net benefit to agricultural production because of the restrictions on the types of crops to be grown likely to be imposed by public health authorities. Because of the continued long-term use of sludge at the land application site, there would be a heavy metal build-up in the soil with increasing potential to introduce toxic elements to the food chain. The sludge application rate (a conservative figure) and the exclusion of Forks-of-the-River sludge assumed for this alternative are based largely or solely on this consideration. However, sludge, soil, and crop monitoring for toxic element concentrations would be required to verify this application rate locally.

Alternative 5 - Land Application: Composting

No unacceptable water quality changes are expected with the implementation of this alternative. As with Alternatives 2 and 4, State regulation and monitoring could be expected to be rigorous. Some runoff, collection, and storage facilities might be necessary, particularly around the composting pad, although subsurface drainage collection (at the land application site) should not be required, owing to the low water content of the dewatered sludge and/or compost.

Minor increases in air pollutant emissions from trucks transporting the sludge to the composting facility would be expected to occur. The composting operation and the land application of the sludge/compost (viz. disking) would be expected to generate some dust, although the former would be mitigated by utilizing a concrete compost pad. The rural location and the use of buffer areas would tend to minimize the impact of dust generated during disking.

The construction and operation of the composting facility could be expected to disrupt existing ecosystems and degrade the aesthetics (viz. noise, odors, etc.) of the area local to it. These aesthetic impacts could be alleviated by the use of buffer lands. The land application site and operation would be compatible with existing land uses and practices. However, the displacement of some local residents would be required to obtain the necessary land.

The use of the sludge and/or compost on the land would increase the soil productivity and represents a beneficial use of the sludge. It is anticipated that fewer restrictions would be placed on the types of crops grown making this alternative a greater potential contribution to the local agricultural economy. Considerations of long-term sludge/compost application to the soil, particularly in regards to heavy metal build-up and soil toxicity, are the same as those discussed in Alternative 4.

Alternative 6 - Resource Recovery: IRD

No unacceptable changes in water quality, land quality, ecology, aesthetics, public health involvement, or community impact are expected to occur with the implementation of this alternative. Some minor increases in pollutant emissions could be expected from barge and truck transportation operations. Because it would be used to product a high-nitrogen fertilizer, the sludge would become a resource.

Feasibility of Alternatives

The feasibility of implementing the alternative sludge management plans was evaluated in this section by preliminary analyses of four parameters: (1) financial feasibility; (2) public acceptability; (3) land use compatibility; and (4) ease of implementation. The procedures and rationale used in these analyses are particular both to the general feasibility level of the Study and the nature of the Knoxville-Knox County Study Area and should be viewed as an example only. It would be the responsibility of the individual planning agency using the Methodology to identify the evaluating criteria (e.g., bonding capability, public opinion surveys, etc.) and detail most relevant to discerning the feasibility of alternatives.

For the financial feasibility analysis, it was assumed that the City of Knoxville (viz. Knob Creek STP) could readily finance on an individual basis or as a regional administrator, any of the alternatives considered. As noted earlier, the PSD (City of Knoxville) has the capability to issue A-rated bonds of any type and adjust user charges, is currently on a pay-as-you-go basis, and is high on the state priority list for Federal funding. The utility districts are not nearly as capable financially and are already charging high user's fees. As a result, alternative sludge management costs considerably higher than those currently incurred would be undesirable although not necessarily infeasible. A percent increase in sewer charges was estimated for the utility districts for comparative purposes based on the assumptions that: (1) 30 percent of the total annual cost (i.e., O&M and amortized capital costs) of the sewer system is attributable to solids handling and disposal; and (2) Alternative 1 (sanitary landfilling) represents the base case to which all alternative costs are referenced. The costs per dry ton of solids (without Federal funding) presented in Table VII-8 were used as a basis for this analysis..

Public acceptability was gauged by project and MPC staff familiar with the feelings of local interest groups in the Study Area. This method is acceptable only at the preliminary feasibility stage. Subsequent evaluations and investigations should include public participation via public meetings, mass-media presentations, and/or public opinion surveys.

Land use compatibility with future land use plans was a siting criterion for all the alternatives considered. As a result, all the alternatives are compatible with existing land use plans.

Alternative 1 - Sanitary Landfill

This alternative, as noted above, is the base case and will occur barring the implementation of another sludge management plan developed in this or subsequent studies. As a result, it is assumed to be both financially feasible and easily implementable in that no changes in the institutional relationships or responsibilities from those currently existing are recommended.

Landfilling of sewage sludge shares common public acceptability problems with landfilling of municipal refuse. The majority of the public is ambivalent toward landfilling, but residents in the immediate vicinity of a disposal site usually voice strong objections to the facility.

Alternative 2 - Trenching

Trenching is estimated to be somewhat more expensive than sanitary landfilling. Increases in utility district costs would range from one to five percent above those estimated for Alternative 1.

Some local opposition to this alternative would be expected from those residents who either would be displaced or adjacent to the facility. In addition, some local real estate developers might view this as an undesirable use of potentially developable land. Local environmental groups could be expected to be ambivalent depending on the balance between aesthetic and resource conservation values extant.

This alternative would be readily implementable because no changes in institutional relationships or powers are recommended for this alternative. There would be an increase in the functions and responsibilities of Knoxville, but this would not be expected to hinder implementation to any great extent.

Alternative 3 - Incineration

Incineration, based on the cost assumptions and procedures used in this study, would be overall, the lowest cost alternative. Cost reductions of four to five percent from Alternative 1 were estimated for those utility districts participating in regional incineration. Lyon Creek and Forks-of-the-River STP's would incur no cost change as they would continue to use sanitary landfilling.

Some strong local opposition to the incinerator would be expected from residents in the vicinity of the Knob Creek plant.

The general public and local environmental groups would be expected to be ambivalent, at best, towards incineration.

No implementation problems are foreseen with this alternative. There would be no institutional changes required and no significant additional responsibilities or functions assumed by the City of Knoxville in operating a regional incinerator.

Alternative 4 - Land Application: Spray Irrigation

Spray irrigation of sludge is the most expensive of the alternatives considered. Utility district costs increase six to 13 percent over those for Alternative 1.

The acquisition of the land and the construction and operation of the facility are expected to generate opposition from the residents to be displaced and those that would be living adjacent to the facility. The general public would probably have an ambivalent attitude to the facility owing to its rural location. Local environmental groups would probably support this alternative more readily than any of the preceding alternatives.

Some minor reorganizational changes, particularly within the Knox County government, would be expected with the implementation of this alternative. Because Knox County would be involved in the ownership and, consequently, in the operation (primarily advisory), an agency would need to be established to administer its responsibilities and advise the operation of the facility. The City of Knoxville would acquire significant new functions and responsibilities requiring administrative and technical staff recruitment.

Alternative 5 - Land Application: Composting

This alternative is comparable in cost to Alternative 2 (Trenching). Increases in utility district costs would be an estimated two to six percent over those of Alternative 1.

Some local opposition to this alternative would be expected from residents in the vicinity of the land application site. The general public attitude would probably range from ambivalent to moderately supportive owing to its rural location and the availability of a cheap compost product. Local environmental groups would probably support this alternative more readily than spray irrigation.

The ease of implementation would be equivalent to that of Alternative 4.

Alternative 6 - Resource Recovery: IRD

The transport of digested sludge to the IRD sludge processing facility, based on the assumptions made in this study, is one of the less expensive alternatives. Cost reductions would be expected for all the utility districts ranging from an estimated one to seven percent. Forks-of-the-River STP would have an estimated cost savings of 12 percent owing primarily to its proximate location to the proposed IRD facility.

The general public and most special interest groups would probably support this alternative owing to its minor community and environmental impacts.

Because no changes in institutional relationships or responsibilities would be necessary, no implementation problems are anticipated for this alternative.

Performance

Performance capabilities of the alternatives have been evaluated utilizing five basic parameters, namely: 1) system effectiveness; 2) reliability; 3) adaptability; 4) calamity resistance; and 5) permanence.

As noted earlier in this report, many of the sludge processing systems used in the alternatives were based upon either existing or proposed systems if they would meet the required final sludge characteristics needed prior to transport and ultimate disposal. This was done to provide a degree of commonality with the 201 facilities planning effort. Other sludge processing systems provided in the Methodology and not proposed for use in the 201 facilities plans were evaluated for their possible substitution if they would clearly provide a greater degree of performance capabilities. At the level of detail provided on a local basis, no substitutions of systems were identified at this time. Potential operational difficulties of the sludge processing systems used in the development of the six sludge management plans which may adversely affect their performance capabilities are discussed in the evaluation below.

Where, in addition to the sludge processing systems, the transport and ultimate disposal systems could also be adversely affected in maintaining their performance capabilities, these are also noted and discussed below. Means of system monitoring and control are pointed out such that the potential for system upset or malfunction could be mitigated.

Alternative 1 - Sanitary Landfills

As noted earlier, regulatory and public health agencies would establish requisite performance criteria such that proper control and monitoring of a sanitary landfill operation would occur. It is expected that the overall system effectiveness of this alternative would be such that performance criteria would be met.

The systems employed in this alternative are relatively simple and their reliability good (see Table VII-6 of the Methodology). Little mechanical downtime is anticipated and transportation subsystems are expected to present no operational problems based upon the existing local history of landfill operation.

Without proper industrial pretreatment controls, the anaerobic digestion process can be adversely affected; thus, as pointed out earlier, the City must exercise care in what it will allow discharged to its sewers. Sand bed dewatering, because of large land requirements (see Table VII-6 of the Methodology), may necessitate incorporation of covers to allow proper operation during rainy seasons of the year, although local rainfall records (see Chapter IV of this report) do not indicate substantial problems in this regard.

The overall ability of the system to maintain operational integrity and, hence, to be relatively calamity resistant, ranges from good to very good (see Table VII-6 of the Methodology).

As noted in Chapter V of this report, the permanence of this alternative in the Study Area is questionable and thus may be some degree be expected to serve only as an interim measure usable only as long as solid waste in the area is also disposed in sanitary landfills.

Alternative 2 - Trenching

System effectiveness, adaptability, and calamity resistance of this alternative would be similar in nature to sanitary landfills as discussed above.

The trenching system, although simple in concept, is unproven in full-scale operation and would, during the initial stages of operation, be somewhat of an experimental procedure. Its reliability would therefore be constrained until local acceptance and any operational problems were addressed and solved. Once these difficulties were overcome, the overall system should be adequate for the planning horizon of twenty years.

Alternative 3 - Incineration

As noted earlier under Environmental Factors, adherence to emission standards for the incinerator is not expected to create difficulties in meeting applicable air quality standards. Other sub-systems within this alternative are also expected to meet performance criteria.

Reliability of the system is expected to range from good to very good (see Table VII-6 of the Methodology). The incinerator sub-system could also meet new performance criteria by incorporating a higher degree of emission control, albeit at higher costs to the users.

Due to potential explosion hazards and a fair rating for ease of operation and maintenance (see Table VII-6 of the Methodology), the ability of the incinerator to withstand a calamity (i.e. an internal explosion) was such that this sub-system would, under such circumstances, cease functioning for more than several days. Thus, on-site storage of the raw dewatered sludge feed would be required.

The overall system is expected to be adequate for the twenty year planning horizon.

Alternative 4 - Land Application: Spray Irrigation

The overall system effectiveness of this alternative is expected to be such that all performance criteria can be met. The low application rates utilized during the growing season and the exclusion of Forks-of-the-River sludge is anticipated to provide a degree of control over long-term heavy metal build-up in the soils and crops at the land application site. City control and monitoring of heavy metals discharges to its sewers is also expected to provide a measure of protection in this regard. The low application rates and leachate collection, monitoring, and possible treatment is expected to provide protection against groundwater contamination from nitrates.

The alternative, although complex as a total system, has a low reliance upon those mechanical systems which could create downtime problems.

If new performance criteria are established during the twenty-year operation period, the overall system has no reliable and relatively inexpensive means of adapting. No further sludge processing procedures beyond digestion have been incorporated and their inclusion either at the plants or at the application site may be either economically disruptive or infeasible due to process or land constraints.

Calamity resistance, particularly at the land application site, is such that if during unanticipated severe weather the site were to become flooded, the system would cease functioning for more than several days. Although the site storage lagoon is provided for just such a potential difficulty, the impact of adverse weather during the application periods could be severe. Barring the unlikely event of such weather, the alternative is deemed to adequate for the twenty-year planning horizon.

Alternative 5 - Land Application: Composting

This alternative was included for evaluation primarily to overcome the difficulties noted for the land application (spray irrigation) system above, namely, a complex system unable to adapt to new processes and potentially constrained during calamity events.

As noted for the spray irrigation system, the composting/ land application system effectiveness is expected to meet performance criteria. There would also be less likelihood of groundwater contamination due to the application of a dewatered, rather than liquid, sludge.

Although the composting operation sub-system has some reliance upon mechanical components, their complexity is not great and provision has been made for backup equipment. Therefore, the reliability of this system is expected to be good and certainly better than spray irrigation.

Because provisions in this alternative have been made for dewatering at the various plants, some adaptability, such as enclosing sand beds or modifications in pressure filter chemical feed systems, could be accomplished if future operational conditions so dictated. In addition, if the local market for a composted product were sufficient, a degree of operational adaptability in terms of the amount to dispose to the land application site could be accomplished. The composting operation would also allow a greater degree of freedom for storage and processing during inclement weather conditions, thus making the overall system more resistant to calamity.

This alternative is expected to be adequate for the twenty-year planning horizon.

Alternative 6 - Resource Recovery: IRD

Because the operation and marketing of a fertilizer product is expected to come under close scrutiny by regulatory and public health agencies and allowed only if proper percautions are taken, the overall system is expected to meet performance criteria.

The reliability of the system, particularly during the fertilizer production phase, is anitcipated to be a complex system which, as noted in the Methodology, is unproven on a scale comparable to that proposed in this alternative. Also, as noted earlier in this chapter. the operation of this phase of the overall system is in private, not public, control which could impact upon the reliability of the overall system, particularly if the private operation were to abandon the project.

The sub-system of fertilizer production may, as time progresses, provide a measure of adaptability in that better processes could be employed to handle variations in the quality of sludge input and to produce a product with wider market and sale potential. Here again, the adaptability feature is centered in private and not public control, which may present problems of passing along these new process costs to the public sector or passing along the savings incurred in the operation due to a better sales picture.

This alternative has a higher potential for operational problems due to calamity. Daily barge traffic from Knob Creek to Pickel Island could be seriously disrupted during flooding, barge spills during loading, transport or unloading, or barge wrecks while passing under rail and road bridges. Digested sludge delivery via road to Pickel Island could be impaired and the overall operation of this alternative crippled if the road and rail bridge to Pickel Island were rendered impassable due to flooding and failure of the bridge supports, thus necessitating major repairs. The likelihood of such a calamity as bridge failure due to flooding would however be quite small because of the upstream TVA dams on the French Broad River. However, the potential barging difficulties noted for Knob Creek, although remote, would create the necessity of providing an alternate backup transport mode such as tank trucking.

The overall system is expected, with proper safeguards as noted in this chapter, to be adequate for the twenty-year planning horizon.

CHAPTER VII

REFERENCES

VII-1 "Trench Incorporation of Sewage Sludge," Walker, J.M. in Municipal Sludge Management, Proceedings of the National Conference on Municipal Sludge Management, Information Transfer, Inc., Washington, D.C. (June 1974).

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APPENDIX A

NATIONAL AND STATE/COUNTY AIR QUALITY STANDARDS AND AIR QUALITY DATA FOR KNOXVILLE, TENNESSEE

APPENDIX A

NATIONAL AND STATE/COUNTY AIR QUALITY STANDARDS AND AIR QUALITY DATA FOR KNOXVILLE, TENNESSEE

NATIONAL

NATIONAL AMBIENT AIR QUALITY STANDARDS**

	Primary Standard		Secondary Standard	
	ug/m^3	ppm	ug/m^3	ppm
Sulfur oxides -				
annual arithmetic mean	80	0.03		
24-hour concentration	365*	0.14*		
3-hour concentration			1300*	0.5*
Suspended Particulate matter -				
annual geometric mean	75		60	
24-hour concentration	260*		150*	
Carbon monoxide -				
8-hour concentration		9.0	Same as primary	
1-hour concentration		35.0		
Photochemical oxidants -	160*	0.08*	Same as primary	
1-hour concentration	1			
Hydrocarbons (corrected for methane)				
3-hour concentration (6-9am)	160*	0.24*	Same as primary	
Nitrogen oxides -				
annual arithmetic mean	100	0.05	Same as primary	

* Not to be exceeded more than once a year.
** 40 CFR 50; 36 FR 22384, November 25, 1971, EPA Regulations.

40 CFR, PART 60 - STANDARDS OF PERFORMANCE FOR NEW STATIONARY SOURCES

60.2 Definitions

(a) "Act" means the Clean Air Act (42 U.S.C. 1857 et seq., as amended by Public Law 91-604, 84 Stat. 1676).

...

(c) "Standard" means a standard of performance proposed or promulgated under this part.

(d) "Stationary source" means any building, structure, facility, or installation which emits or may emit any air pollutant.

...

(f) "Owner or operator" means any person who owns, leases, operates, controls, or supervises an affected facility or a stationary source of which an affected facility is a part.

(g) "Construction" means fabrication, erection, or installation of an affected facility.

...

(j) "Opacity" means the degree to which emissions reduce the transmission of light and obscure the view of an object in the background.

...

(v) "Particulate matter" means any finely divided solid or liquid material, other than combined water, as measured by Method 5 of Appendix A to this part or an equivalent or alternative method.

Subpart O - Standards of Performance for Sewage Treatment Plants

60.150 Applicability and designation of affected facility.

The affected facility to which the provisions of this subpart apply is each incinerator which burns the sludge produced by municipal sewage treatment facilities.

...

60.152 Standard for particulate matter.

(a) On and after the date on which the performance test required to be conducted by 60.8 is completed, no owner or operator of any sewage sludge incinerator subject to the provisions of this subpart shall discharge or cause the discharge into the atmosphere of:

(1) Particulate matter at a rate in excess of 0.65 g/kg dry sludge input (1.30 lb/ton dry sludge input).

(2) Any gases which exhibit 20-percent opacity or greater. Where the pressence of uncombined water is the only reason for failure to meet the requirements of this paragraph, such failure shall not be a violation of this section.

60.154 Test Methods and Procedures

...

(b) For Method 5, the sampling time for each run shall be at least 60 minutes and the sampling rate shall be at least 0.015 dscm/min (0.53 dsef/min), except that shorter sampling times, when necessitated by process variables or other factors, may be approved by the Administrator.

(c) ...

(3) Determine the quantity of dry sludge per unit sludge charged in terms of either R_{DV} or R_{DM}.

(i) If the volume of sludge charged is used:

$$S_D = (60 \times 10^{-3}) \frac{R_{DV} S_V}{T} \text{ (Metric Units)}$$

or

$$S_D = (8.021) \frac{R_{DV} S_V}{T} \text{ (English Units)}$$

where:

S_D = average dry sludge charging rate during the run, kg/hr (English units: lb/hr).

R_{DV} = average quantity of dry sludge per unit volume of sludge charged to the incinerator, mg/l (English Units: lb/ft^3).

S_V = sludge charged to the incinerator during the run, m^3 (English units: gal).

T = duration of run, min (English units: min).

60×10^{-3} = metric units conversion factor, l-kg-min/m^3-mg-hr.

8.021 = English units conversion factor, ft^3-min/gal-hr.

(ii) If the mass of sludge charged is used:

$$S_D = (60) \frac{R_{DM} S_M}{T} \text{ (Metric or English Units)}$$

where:

S_D = average dry sludge charging rate during the run, kg/hr (English units: lb/hr).

R_{DM} = average ratio of quantity of dry sludg to quantity of sludge charged to the incinerator, mg/mg (English units: lb/lb).

S_M = sludge charged during the run, kg (English units: lb).

T = duration of run, min (Metric or English units).

60 = conversion factor, min/hr (Metric or English units).

(d) Particulate emission rate shall be determined by:

$C_{aw} = C_s Q_s$ (Metric or English Units)

where:

C_{aw} = particulate matter mass emissions, mg/hr (English units: lb/hr).

C_s = particulate matter concentration, mg/m^3 (English units: lb/dscf).

Q_s = volumetric stack gas flow rate, dscm/hr (English units: dscf/hr). Q_s and C_s shall be determined using Methods 2 and 5, respectively.

(e) Compliance with 60.152(a) shall be determined as follows:

$$C_{ds} = (10^{-3}) \frac{C_{aw}}{S_D} \text{ (Metric Units)}$$

or

$$C_{ds} = (2000) \frac{C_{aw}}{S_D} \text{ (English Units)}$$

where:

C_{ds} = particulate emission discharge, g/kg dry sludge (English units: lb/ton dry-sludge).
10^{-3} = Metric conversion factor, g/mg.
2000 = English conversion factor, lb/ton.

(39 FR 9319, Mar. 8, 1974; 39 FR 13776, Apr. 17, 1974; 39 FR 15396, May 3, 1974)

STATE AND KNOX COUNTY

Tennessee Air Quality Act (Tennessee Code Annotated Section 53-3408 et seq.)

Tennessee Air Pollution Control Regulations

Chapter II - Definitions

The following terms shall, unless the context clearly indicates otherwise, have the following meaning:

1. Air Contaminant is particulate matter, dust, fumes, gas, mist, smoke, or vapor, or any combinations thereof.

2. Air Contaminant Source is any and all sources of emission of air contaminants, whether privately or publicly owned or operated. Without limiting the generality of the foregoing, this term includes all types of business, commercial and industrial plants, works, shops, and stores, and heating and power plants and stations, building and other structures of all types, including multiple family residences, apartment houses, office buildings, hotels, restaurants, schools, hospitals, churches and other institutional buildings, automobiles, trucks, tractors, buses and other motor vehicles, garages and vending and service locations and stations,

railroad locomotives, ships, boats and other water borne craft, portable fuel-burning equipment, incinerators of all types, indoor and outdoor, refuse dumps and piles, and all stack and other chimney outlets from any of the foregoing; provided, however, that neither automobiles, trucks, tractors, buses or other motor vehicles powered by any fuel other than diesel oil and which were manufactured prior to September 1, 1967, automobiles, trucks, tractors, buses or other motor vehicles powered by diesel oil and manufactured prior to January 1, 1970, nor automobiles, trucks, tractors, buses or other motor vehicles which are equipped to comply and do comply with the Federal "Motor Vehicle Air Pollution Control Act" shall be considered or determined to be an "air contaminant source."

...

4. Air Pollution is presence in the outdoor atmosphere of one or more air contaminants in sufficient quantities and of such characteristics and duration as to be injurious to human, plant or animal life or to property, or which unreasonably interfere with the enjoyment of life and property.

5. Ambient Air is that portion of the atmosphere, external to buildings.

6. Board is the Air Pollution Control Board of the State of Tennessee.

...

9. Department is the Department of Public Health of the State of Tennessee.

10. Effective date of these regulations is April 3, 1972.

11. Emission is the release of material to the ambient air.

...

15. Fugitive Dust is any visible emission, other than water droplets, issuing from any source other than through a stack.

16. Garbage is putrescible animal or vegetable waste.

17. Hazardous Air Contaminant is any air contaminant which may cause, or contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness and has been so designated by the Technical Secretary.

18. Incinerator is any equipment, device or contrivance used for disposal of waste of refuse by burning, excluding wigwam burners and air curtain destructors.

...

20. Modification is any physical change in, or change in the method of operation of an air contaminant source which increases the amount of any air contaminant emitted by such source or which results in the emission of any air contaminant not previously emitted except that:

    a. routine maintenance, repair, and replacement shall not be considered physical changes, and

    b. the following shall not be considered a change in the method of operation:

        1. an increase in the production rate, if such increase does not exceed the operating design capacity of the affected source;

        2. an increase in the hours of operation; and

        3. the use of an alternate fuel if the source is designed to accommodate such alternate fuel:

    provided, however, that the Technical Secretary is notified within thirty (30) days of such changes.

...

22. New Source is any air contaminant source constructed after April 3, 1972, and any air contaminant source constructed prior to that date to which any modification is made after that date.

23. New Source Performance Standard is a standard for the emission of an air contaminant promulgated by the Administrator of the Environmental Protection Agency and published in the Federal Register.

...

25. Opacity is that property of a substance tending to obscure vision and is measured in terms of percent obscuration. As used in these regulations it does not include obscuration of vision due to uncombined water droplets. The percentage opacity of a plume is numerically equal to twenty (20) times the Ringelmann number for a plume of black smoke having equivalent capacity of obscuration.

26. Open Burning is the burning of any matter under such conditions that the products of combustion are emitted directly into the open atmosphere without passing directly through a stack except when equipment is provided and used to control fuel-air ratio.

27. Particulate Matter is any material, except uncombined water that exists in a finely divided form as a liquid or a solid.

28. Parts Ber Billion (ppb) is a term describing parts of an air contaminant per billion parts of gas by volume (1 ppb equals 0.0000001 percent by volume).

29. Parts Per Million (ppm) is a term describing parts of an air contaminant per million parts of gas by volume (1 ppm equals 0.0001 percent by volume).

30. Person is any individual, partnership, copartnership, firm, company, corporation, association, joint stock company, trust, estate, political subdivision, or any other legal entity, or their legal representative, agent or assigns.

31. Political Subdivision is any municipality, city, incorporated town, county, district or authority, or any portion of combination of two or more thereof.

...

33. Process Emission is any emission of an air contaminant to the ambient air other than that from fuel burning equipment, incinerator, wigwam burners, or open burning.

...

38. Ringelmann Chart is the chart published and described in the U. S. Bureau of Mines Information Circular 8333.

39. Salvage Operation is any business, trade or industry engaged in whole or in part, in reclaiming one or more items of value.

40. Smoke is small gas-borne particles resulting from incomplete combustion, consisting predominantly, but not exclusively, of carbon and other combustible material. It does not include water vapor or water droplets.

41. Soiling Index is a measure of the soiling properties of suspended particulates determined by drawing a measured volume of air through a known area of Whatman No. 4 filter paper for a measured period of time, expressed as coefficient of haze (COH) per 1,000 linear feet.

42. Stack is any chimney, flue, duct, conduit, exhaust, vent, or opening of any kind whatsoever capable of, or used for, the emission of air contaminants.

43. Suspended Particulates is particulate matter which will remain suspended in air for an appreciable period of time.

44. Technical Secretary is the Technical Secretary of the Air Pollution Control Board of the State of Tennessee.

45. Wigwam Burner is a type of burner commonly known as tepee, truncated cone, conical burner, or silo burner.

Chapter III - Ambient Air Quality Standards

Section I -- Applicability

Ambient air quality standards as given in Tables I, II, and III are applicable throughout Tennessee.

These ambient air quality standards shall not be construed, applied or interpreted to allow any significant deterioration of the existing air quality in any portion of the state.

Section 2 -- Definitions

Primary ambient air quality standards define levels of air quality believed adequate, with an appropriate margin of safety, to protect public health.

Secondary ambient air quality standards define levels of air quality believed adequate, with an appropriate margin of safety, to protect the public welfare from any known anticipated adverse effects of the pollutant.

TABLE A-1

TENNESSEE AND KNOX COUNTY AMBIENT AIR QUALITY STANDARDS FOR SUSPENDED PARTICULATES SULFUR DIOXIDE, CARBON MONOXIDE, PHOTOCHEMICAL OXIDANTS, NON-METHANE HYDROCARBONS, AND NITROGEN DIOXIDE

Contaminants	Primary Standard			Secondary Standard		
	Concentration		Average Interval	Concentration		Average Interval
	ug/m^3	ppm by vol.		ug/m^3	ppm by vol.	
Suspended Particulates	75 260	--- ---	AGM 24 hr	60 150	--- ---	AGM 24 hr
Sulfur Dioxide	80 365	0.03 0.14	AAM 24 hr	60 364 1,300	0.02 0.139 0.5	AAM 24 hr 3 hr
Carbon Monoxide	10,000 40,000	9.0 35.0	8 hr 1 hr	10,000 40,000	9.0 35.0	8 hr 1 hr
Photo-Chemical Oxidant	160	0.08	1 hr	160	0.08	1 hr
Hydrocarbons (non-methane)	160	0.24	3 hr a.m.	160	0.24	3 hr a.m.
Nitrogen Dioxide	100	0.05	AAM	100	0.05	AAM

Note: 1. All values other than annual values are maximum concentrations not to be exceeded more than once per year.
2. PPM values are approximate only.
3. All concentrations relate to air at standard conditions of 25°C temperature and 760 millimeters of mercury pressure.

4. ug/m^3 - micrograms per cubic meter.
5. AGM - Annual geometric mean.
6. AAM - Annual arithmetic mean.

TABLE A-2

TENNESSEE AMBIENT AIR QUALITY STANDARDS FOR SOILING INDEX IN COH UNITS PER 1000 LINEAR FEET OF AIR

Primary Standards		Secondary Standards	
Soiling Index	Averaging Interval	Soiling Index	Averaging Interval
1.0	24 hr average	0.6	24 hr average
3.5	2 hr average	2.0	2 hr average

Note: All values are maximums not to be exceeded more than once per year.

TABLE A-3

TENNESSEE AMBIENT AIR QUALITY STANDARDS FOR GASEOUS FLUORIDES EXPRESSED AS HF

Primary Standards			Secondary Standards		
Concentration		Averaging Interval	Concentration		Averaging Interval
ug/m^3	ppb by vol.		ug/m^3	ppb by vol.	
1.2	1.5	30 days	1.2	1.5	30 days
1.6	2.0	7 days	1.6	2.0	7 days
2.9	3.5	24 hr	2.9	3.5	24 hr
3.7	4.5	12 hr	3.7	4.5	12 hr

Notes:
1. All values are maximums not to be exceeded more than once per year.
2. Concentrations in micrograms per cubic meter (ug/m^3) are approximate only.
3. All concentrations relate to air at standard conditions of 25°C temperature and 760 millimeters of mercury pressure.

Section 4 --

The standards set forth in this Chapter shall be achieved by July 1, 1975.

Chapter V - Visible Emission Regulations

Section 1 -- Definition

As used in this Chapter, existing air contaminant source refers to such sources as were in operation or under construction prior to August 9, 1969, and new air contaminant sources refers to such sources as began construction on or after August 9, 1969.

Section 2 -- General

A. No person shall cause, suffer, allow or permit discharge of a visible emission from any new air contaminant source within a density greater than number one (1) on the Ringelmann Chart or an opacity in excess of twenty (20) percent for an aggregate of more than five (5) minutes in any one (1) hour or more than twenty (20) minutes in any twenty-four (24) hour period.

B. On and after August 9, 1973, no person shall cause, suffer, allow or permit discharge of a visible emission from any existing air contaminant source with a density equal to or greater than number two (2) of the Ringelmann Chart or an opacity equal to or in excess of forty (40) percent for more than five (5) minutes in any one (1) hour or an aggregate of more than twenty (20) minutes in any twenty-four (24) hour period.

C. On and after August 9, 1975, the provisions of subsection B of this Chapter shall no longer be applicable and all air contaminant sources shall be construed as new sources for the purpose of this Chapter.

...

E. It is expressly intended that in testing compliance with subsections A and B that visible emissions tending to produce a black plume will be evaluated in terms of the Ringelmann scale and that visible emissions tending to produce a non-black plume will be evaluated in terms of equivalent opacity and expressed as percent opacity.

Chapter VI - Non-Process Emission Standards

Section 1 -- General Non-Process Particulate Emissions

A. No person shall cause, suffer, allow or permit particulate emissions in excess of the standards in this Chapter.

B. In any county where one or more sources are emitting particulates at rates in conformity with applicable maximum allowable emission rates and the ambient air quality standard for particulate matter is being exceeded, the Board shall be responsible for setting an appropriate emission standard for each source contributing to the particulate matter in the ambient air of the county, at such value as the Board may consider necessary to achieve the desired air quality.

C. The owner or operator of an existing fuel burning installation proposing to make a modification of this source or to rebuild or replace it shall only take such action if it will result in the source meeting the maximum allowable particulate emission standards for a new fuel burning installation.

D. As used in this chapter, existing installations or equipment shall mean such as were under construction or in operation prior to the effective date of these regulations.

Section 2 -- Non-Process Particulate Emission Standards

...

C. Incinerators

From and after the effective date of these Regulations, the maximum allowable particulate emission from incinerators shall be as indicated in Table 1 of this Chapter. It is further provided that from and after July 1, 1975, the particulate emission standards as given for existing incinerators shall no longer be applicable and the particulate emission standards as given for new incinerators shall be applicable to all incinerators.

TABLE A-4

MAXIMUM ALLOWABLE PARTICULATE EMISSION STANDARDS FOR INCINERATORS

Rated of Operated Charging Rate in Pounds per Hour	Emission Standard in Percent of Charging Rate	
	New Incinerator	Existing Incinerator
Less than 200	0.2	0.6
200 to 2000	0.2	0.4
Greater than 2000	0.1	0.4
Greater than 2000*	0.075	

* For Knox County

Incinerators having 2.5 cu ft furnace volume or less used solely for the disposal of infective dressings and other similar material shall not be required to meet these emission standards.

Section 3 -- General Non-Process Gaseous Emissions

A. No person shall cause, suffer, allow or permit gaseous emissions in excess of the standards in this Chapter.

B. Any person constructing or otherwise establishing an air contaminant source emitting gaseous air contaminants after the effective date of these regulations shall install and utilize the best equipment and technology currently available for controlling such gaseous emission.

Section 4 -- Sulfur Oxides

A. General Provisions

1. In any county where one or more sources are emitting sulfur oxides and all sources within the county are meeting the applicable emission standards of 2000 parts per million corrected to 50 percent excess air or 620 parts per million corrected to 15 percent excess air by volume calculated as sulfur dioxide (SO_2) and the ambient air quality for sulfur dioxide is being exceeded, the Board shall be responsible for setting emission standards for sources contributing to the sulfur oxides in the ambient air of the county, at such value as the Board may consider necessary to achieve the desired air quality.

...

B. Emission Standards

...

2. New Air Contaminant Source

After January 1, 1973, the owner or operator of an air contaminant source constructed after the effective date of these regulations shall not cause, suffer, allow or permit the emission from that source of sulfur oxides (calculated as sulfur dioxide) in excess of the following:

a. 440 ppm corrected to 15 percent excess air when liquid fossil fuel is burned (equivalent to 0.80 lbs per million Btu heat input, maximum 2 hour average).

b. 620 ppm corrected to 15 percent excess air when solid fossil fuel is burned (equivalent to 1.2 lbs per million Btu heat input, maximum 2 hour average).

c. Where different fossil fuels are burned simultaneously in any combination, the applicable standard shall be determined by proration. Compliance shall be determined by using the following formula:

$$\frac{Y\ (0.80) + Z\ (1.2)}{X + Y + Z}$$

where:

X is the percent of total heat input derived from gaseous fossil fuel and,

Y is the percent of total heat input derived from liquid fossil fuel and,

Z is the percent of total heat input derived from solid fossil fuel.

3. It shall be the responsibility of the owner or operator of such air contaminant source to monitor or otherwise demonstrate that sulfur oxides in gases discharged from the source do not exceed the applicable concentration.

...

Section 5 -- Nitrogen Oxides

A. Emission Standards

1. New Air Contaminant Sources

Air contaminant sources with a total heat input of 250 million Btu's per hour or greater constructed after April 3, 1972, shall not cause, suffer, allow or permit the emission of nitrogen oxides (measured as NO_2) in excess of the following:

a. 165 ppm corrected to 15 percent excess air when gaseous fossil fuel is fired [equivalent to 0.20 lbs of nitrogen oxides (measured as NO_2) per million Btu heat input, maximum 2 hour average].

b. 227 ppm corrected to 15 percent excess air when liquid fossil fuel is firec [equivalent to 0.30 lbs of nitrogen oxides (measured as NO_2) per million Btu heat input, maximum 2 hour average].

c. 525 ppm corrected to 15 percent excess air when solid fossil fuel is fired [equivalent to 0.70 lbs of nitrogen oxides (measured as NO_2) per million Btu heat input, maximum 2 hour average].

d. When different fossil fuels are burned simultaneously in any combination the applicable standard shall be determined by proration. Compliance shall be determined by using the following formula:

$$\frac{X\ (0.20)\ Y\ (0.30)\ Z\ (0.70)}{X + Y + Z}$$

where:

X is the percent of total heat input derived from gaseous fossil fuel and,

Y is the percent of total heat input derived from liquid fossil fuel and,

Z is the percent of total heat input derived from solid fossil fuel.

Chapter IX - Construction and Operating Permits

Section 1 -- Construction Permits

A. On and after April 3, 1972, no person shall begin the construction of a new air contaminant source or the modification of an air contaminant source existing prior to April 3, 1972, which may result in the discharge of air contaminants without first having applied for and received from the Technical Secretary a construction permit for the construction or modification of such air contaminant source.

B. The application for a construction permit shall be made on forms available from the Technical Secretary not less than ninety (90) days prior to the estimated starting date of construction.

C. In the event the requirement for a construction permit prior to the construction of a new air contaminant source or the modification of any existing air contaminant source will create an undue hardship on the applicant, the applicant may request of the Technical Secretary a waiver to proceed with construction or modification prior to the issuance of a Construction Permit. The applicant for a waiver shall explain the circumstances which will cause such undue hardship. If a waiver is granted, the applicant shall, as soon as reasonably practical, submit a report containing such information as would have otherwise been required in filing for a construction permit.

   The applicant, after a waiver is granted, proceeds at his own risk; and, if after construction or modification has begun or been completed, the proposed or completed installation does not meet with the Technical Secretary's approval, alterations required to effect such approval shall be made within a reasonable time as specified by the Technical Secretary. In no case shall this reasonable time exceed 180 days after notification that the construction or modification does not meet the Technical Secretary's approval.

D. Construction permits issued under this section are based on the control of air contaminants only and do not in any way affect the applicant's obligation to obtain necessary permits from other governmental agencies.

E. The Technical Secretary shall not grant a permit for the construction or modification of any air contaminant source if such construction or modification will interfere with the attainment or maintenance of the secondary air quality standards or will violate any provision of these regulations.

Section 2 -- Operating Permit

A. Any person planning to operate an air contaminant source constructed or modified in accordance with a construction permit issued by the Technical Secretary, in Section 1, shall apply for and receive an operating permit from the Technical Secretary within sixty (60) days after commencement of the operation of said air contaminant source.

...

D. Application for an operating permit shall be made on forms available from the Technical Secretary and signed by the applicant. Such application for an operating permit shall be filed with the Technical Secretary not less than thirty (30) days prior to the expiration of an existing operating permit.

E. The operating permit shall only be issued on evidence satisfactory to the Technical Secretary that the operation of said air contaminant source is in compliance with any standards or rules and regulations promulgated by the Board and that the operation of said air contaminant source will not interfere with the attainment or maintenance of the secondary air quality standard. Such evidence may include a requirement that the applicant conduct such tests as are necessary in the opinion of the Technical Secretary to determine the kind and/or amount of air contaminants emitted from the source. Standard operating permits shall be valid for a period of one (1) year or for such longer period of time as the Technical Secretary may designate. A permit issued for a period of less than one (1) year shall be designated as a temporary permit.

F. Any person in possession of an operating permit shall maintain said operating permit readily available for inspection by the Technical Secretary or his designated representative on the operating premises.

G. Operation of each air contaminant source shall be in accordance with the provisions and stipulations set forth in the operating permit.

...

Section 3

...

No person shall discharge from any source whatsoever such quantities of air contaminants, uncombined water, or other materials which cause or have a tendency to cause a traffic hazard or an interference with normal means of public transportation.

...

Section 4 -- Exemptions

A. No person shall be required to obtain or file a request for a State permit due to ownership or operation of the following air contaminant sources unless specifically required to do so by the Board:

1. Mobile sources such as: automobiles, trucks, buses, locomotives, planes, boats and ships;

2. Fuel-burning equipment of less than 500,000 Btu per hour capacity;

3. Particulate emissions from a single stack, of an air contaminant source, discharging less than 0.5 lb per hour of non-hazardous particulates or the total particulate emissions from an air contaminant source amounting to less than two (2) pounds per hour of non-hazardous particulates, whichever is the more restrictive. This exemption does not apply to inci incinerators;

4. Equipment used on farms for soil preparation, tending or harvesting of crops or for preparation of feed to be used on the farm where prepared;

5. Operations exempted under Chapter IV (Open Burning) of these regulations;

6. Sources within the counties of Shelby, Davidson, Hamilton and Knox until such time as the Board shall determine that air pollution is not being controlled in such county to a degree consistent with the substantive provisions of the Tennessee Air Pollution Control Act and regulations adopted pursuant thereto.

B. Notwithstanding the exemptions granted in Section 4A above, no person shall discharge, from any source whatsoever, such quantities of air contaminants or other materials which cause or have a tendency to cause injury, detriment, annoyance, or adverse effect to the public.

Amendments to the Regulations, 19 June 1973

1. Chapter II (Definitions) is amended by adding a new definition as follows:

   Point Source shall have the same meaning as defined in Part 51 of Title 40 of the Code of Federal Regulations.

2. Chapter VI is amended by deleting entirely Section 4 and renumbering the remaining sections accordingly.

. . .

6. Add the following Chapter XIV - Control of Sulfur Compounds Emissions

Section I -- General Provisions

A. For the purpose of this chapter each county in Tennessee will be classified by the Board into one of three categories, defined as Class I, Class II, and Class III. Ambient concentration limits expressed as micrograms per cubic meter which define the classification system for sulfur oxides are:

	Class I Greater Than	Class II From - To	Class III Less Than
Annual Arithmetic Mean	100	60-100	60
24-hour Maximum	455	260-455	260
3-hour Maximum		1,300a	1,300

[a] Any concentration above 1,300 ug/m^3

B. The above classification will be based upon measured ambient air quality, where known, or where not known, estimated air quality in the area of maximum sulfur oxide concentration.

C. The more restrictive classification will be chosen where there is a difference between the maximum value(s) and the annual arithmetic mean, e.q., if a county is a Class I with respect to the annual arithmetic mean and Class II with respect to a 24-hour maximum value, the Classification will be Class I.

D. Where a county is classified a Class I county on the basis of measured or estimated air quality levels reflecting emissions predominantly from a single point source, it shall be further classified as a Class IA county.

E. In any county where one or more sources are emitting sulfur oxides and all sources within the county are meeting the applicable emission standards of 1.6, 3.0, or 4.0 lb/10 Btu for fuel burning sources and 2000, 1000, or 500 parts per million for process sources and the ambient air quality for sulfur dioxide is being exceeded, the Board shall be responsible for setting emission standards for sources contributing to the sulfur oxides in the ambient air of the county, at such value as the Board may consider necessary to achieve the desired air quality.

Section II -- <u>Non-Process Emission Standards</u>

A. On and after July 1, 1975, the owner or operator of an air contaminant source located in a Class I County shall not cause, suffer, allow, or permit the emission from that source of sulfur oxides (calculated as sulfur dioxide) in excess of 1.6 lbs per million Btu heat input, maximum 2 hour average.

B. On and after July 1, 1975, the owner or operator of an air contaminant source located in a Class II County shall not cause, suffer, allow or permit the emission from that source of sulfur oxides (calculated as sulfur dioxide) in excess of 3.0 lbs per million Btu heat input, maximum 2 hour average.

C. On and after July 1, 1975, the owner or operator of an air contaminant source located in a Class III County shall not cause, suffer, allow or permit the emission from that source of sulfur oxides (calculated as sulfur dioxide) in excess of 4.0 lbs per million Btu heat input, maximum 2 hour average.

...

H. After January 1, 1973, the owner or operator of an air contaminant source with more than 250 million Btu per hour heat input, constructed after April 3, 1972, shall not cause, suffer, allow or permit the emission from that source of sulfur oxides (calculated as sulfur dioxide) in excess of the following:

   a. 0.80 lbs per million Btu heat input, maximum 2 hour average, when liquid fossil is burned.

   b. 1.2 lbs per million Btu heat input, maximum 2 hour average, when solid fossil fuel is burned.

   c. Where different fossil fuels are burned simultaneously in any combination, the applicable standard shall be determined by proration. Compliance shall be determined by using the following formula:

$$\frac{Y\ (0.80) + Z\ (1.2)}{X + Y + Z}$$

where:

X is the percent of total heat input derived from gaseous fossil fuel and,

Y is the percent of total heat input derived from liquid fossil fuel and,

Z is the percent of total heat input derived from solid fossil fuel.

Amendments to the Regulations, 9 October 1973

Chapter XIV, Section I, is amended by adding the following subparagraph (F) to read:

"F. The following is the Board designation of counties adopted pursuant to paragraph (A) above:

Class 1A - Polk

Class 1 - Sullivan, Roane, Maury

Class 2 - Humphreys

Class 3 - All other counties in the State."

Amendments to the Regulations, 10 May 1974

...

3. That Chapter III (Ambient Air Quality Standards) be and the same is hereby amended by deleting in Table 1, the secondary standard for Sulfur Dioxides for the A.M. and 24 hour average interval and having such standard read the same as the primary standard.

AIR QUALITY

KNOXVILLE-KNOX COUNTY

SUSPENDED PARTICULATES

Annual Geometric Mean (AGM)

($\mu g/m^3$)

Station	1973	1974	Location
012	47.7	41.7	Rutledge Pike (Skaggston Sch.)
013	32.5	29.6	Beaver Cr. Dr. (Hallasdale-Powell Lab)
014	48.0	48.1	Hendon Chapel Rd. (Gap Creek Sch.)
003	81.6	73.6	Locust St. & Cumberland Ave.
005	96.5	88.7	Papermill Rd. & Westover Dr.
006	59.5	56.1	Young High Pike & Chapman Highway
007	71.1	71.8	Asheville Highway & Tulane Ave.
008	84.4	74.6	I-95 & Heiskell Ave.
011	95.4	103.0	17th Street & Dale Ave.

APPENDIX B

GENERAL WATER QUALITY CRITERIA FOR THE DEFINITION AND CONTROL OF POLLUTION IN THE WATERS OF TENNESSEE

APPENDIX B

GENERAL WATER QUALITY CRITERIA FOR THE DEFINITION AND CONTROL OF
POLLUTION IN THE WATERS OF TENNESSEE
Adopted on October 26, 1971
Amended on December 14, 1971 and October 30, 1973
Tennessee Water Quality Control Board

The Water Quality Control Act of 1971, Chapter 164 Public Acts of 1971 as Amended by Chapter 386, makes it the duty of the Water Quality Control Board to study and investigate all problems concerned with the pollution of the waters of the State and with its prevention, abatement, and control and to establish such standards of quality for any waters of the State in relation to their reasonable and necessary use as the Board shall deem to be in the public interest and establish general policies relating to existing or proposed future pollution as the Board shall deem necessary to accomplish the purpose of the Control Act. The following general considerations and criteria are officially adopted by the Board as a guide in determining the permissible conditions of waters with respect to pollution and the preventive and corrective measures required to control pollution in various waters or in different sections of the same waters.

GENERAL CONSIDERATIONS

1. Waters have many uses which in the public interest are reasonable and necessary. Such uses include: sources of water supply for domestic and industrial purposes; propagation and maintenance of fish and other desirable aqautic life; recreational boating and fishing; the final disposal of municipal sewage and industrial waste following adequate treatment; stock watering and irrigation; navigation; generation of power; and the enjoyment of scenic and esthetic qualities of the waters.

2. The rigid application of uniform water quality is not desirable or reasonable because of the varying uses of such waters. The assimilative capacity of a stream for sewage and waste varies depending upon various factors including the following: volume of flow, depth of channel, the presence of falls or rapids, rate of flow, temperature, natural characteristics, and the nature of the stream. Also the relative importance assigned to each use will differ for different waters and sections of waters throughout the stream.

3. To permit reasonable and necessary uses of the waters of the State, existing pollution should be corrected as rapidly as practical and future pollution controlled by treatment plants or other measures. There is an economical balance between the cost of sewage and waste treatment and the benefits received. Within permissible limits, the dilution factor and the assimilative capacity of surface water should be utilized. Waste recovery, control of rates and dispersion of waste into the streams, and control of rates and characteristics of flow of waters in the stream where adequate, will be considered to be a means of correction.

4. Sewage, industrial wastes, or other wastes, as defined in the Water Quality Control Act of 1971, Chapter 164 Public Acts of 1971, as amended by Chapter 386, shall not be discharged into or adjacent to streams or other surface waters in such quantity and of such character or under such conditions of discharge in relation to the receiving waters as will result in visual or olfactory nuisances, undue interference to other reasonable and necessary uses of the water, or appreciable damage to the natural processes of self-purification. In relation to the various qualities and the specific uses of the receiving waters, no sewage, industrial wastes, or other wastes discharged shall be responsible for conditions that fail to meet the criteria of water quality outlined below. Bypassing or accidental spills will not be tolerated.

   The criteria of water quality outlined below are considered as guides in applying the water quality objectives in order to insure reasonable and necessary uses of the waters of the State. In order to protect the public health and maintain the water suitable for other reasonable and necessary uses; to provide for future development; to allow proper sharing of available water resources; and to meet the needs of particular situations, additional criteria will be set.

CRITERIA OF WATER CONDITIONS

1. Domestic Raw Water Supply

(a) Dissolved Oxygen - There shall always be sufficient dissolved oxygen present to prevent odors of decomposition and other offensive conditions.

(b) pH - The pH value shall lie within the range of 6.0 to 9.0 and shall not fluctuate more than 1.0 unit in this range over a period of 24 hours.

(c) Hardness or Mineral Compounds - There shall be no substances added to the waters that will increase the hardness or mineral content of the waters to such an extent to appreciably impair the usefulness of the water as a source of domestic water supply.

(d) Total Dissolved Solids - The total dissolved solids shall at no time exceed 500 mg/1.

(e) Solids, Floating Materials and Deposits - There shall be no distinctly visible solids, scum, foam, oily sleek, or the formation of slimes, bottom deposits or sludge banks of such size or character as may impair the usefulness of the water as a source of domestic water supply.

(f) Turbidity or Color - There shall be no turbidity or color added in amounts or characteristics that cannot be reduced to acceptable concentrations by conventional water treatment processes.

(g) Temperature - The maximum water temperature change shall not exceed 3C° relative to an upstream control point. The temperature of the water shall not exceed 30.5°C and the maximum rate of change shall not exceed 2C° per hour. The temperature of impoundments where stratification occurs will be measured at a depth of 5 feet, or mid-depth whichever is less, and the temperature in flowing streams shall be measured at mid-depth.

(h) ~~Microbiological~~ Coliform - The concentration of the fecal coliform group shall not exceed 1,000 per 100 ml. as the logarithmic mean based on a minimum of 10 samples collected from a given sampling site over a period of not more than 30 consecutive days with individual samples being collected at intervals of not less than 12 hours. In addition, the concentration of the fecal coliform group in any individual sample shall not exceed 5,000 per 100 ml.

(i) Taste or Odor - There shall be no substances added which will result in taste or odor that prevent the production of potable water by conventional water treatment processes.

(j) Toxic Substances - There shall be no toxic substances added to the waters that will produce toxic conditions that materially affect man or animals or impair the safety of a conventionally treated water supply.

(k) Other Pollutants - Other pollutants shall not be added to the water in quantities that may be detrimental to public health or impair the usefulness of the water as a source of domestic water supply.

2. Industrial Water Supply

(a) Dissolved Oxygen - There shall always be sufficient dissolved oxygen present to prevent odors of decomposition and other offensive conditions.

(b) pH - The pH value shall lie within the range of 6.0 to 9.0 and shall not fluctuate more than 1.0 unit in this range over a period of 24 hours

(c) Hardness or Mineral Compounds - There shall be no substances added to the waters that will increase the hardness or mineral content of the waters to such an extent as to appreciably impair the usefulness of the water as a source of industrial water supply.

(d) Total Dissolved Solids - The total dissolved solids shall at no time exceed 500 mg/1.

(e) Solids, Floating Materials and Deposits - There shall be no distinctly visible solids, scum, foam, oily sleek, or the formation of slimes, bottom deposits or sludge banks of such size or character as may impair the usefulness of the water as a source of industrial water supply.

(f) Turbidity or Color - There shall be no turbidity or color added in amounts or characteristics that cannot be reduced to acceptable concentrations by conventional water treatment processes.

(g) Temperature - The maximum water temperature change shall not exceed 3C° relative to an upstream control point. The temperature of the water shall not exceed 30.5°C and the maximum rate of change shall not exceed 2C° per hour. The temperature of impoundments where stratification occurs will be measured at a depth of 5 feet, or mid-depth whichever is less, and the temperature in flowing streams shall be measured at mid-depth.

(h) Taste or Odor - There shall be no substances added that will result in taste or odor that would prevent the use of the water for industrial processing.

(i) Toxic Substances .here shall be no substances added to the waters that may produce toxic conditions that will adversely affect the water for industrial processing.

(j) Other Pollutants - Other pollutants shall not be added to the waters in quantities that may adversely affect the water for industrial processing.

5. Fish and Aquatic Life

(a) Dissolved Oxygen - The dissolved oxygen shall be a minimum of 5.0 mg/l except in limited sections of streams where, (i) present technology cannot restore the water quality to the desired minimum of 5.0 mg/l dissolved oxygen, (ii) the cost of meeting the standards is economically prohibitive when compared with the expected benefits to be obtained, or (iii) the natural qualities of the water are less than the desired minimum of 5.0 mg/l dissolved oxygen. Such exceptions shall be determined on an individual basis but in no instance shall the dissolved oxygen concentration be less than 3.0 mg/l. The dissolved oxygen concentration shall be measured at mid-depth in waters having a total depth of ten (10) feet or less and at a depth of five (5) feet in waters having a total depth of greater than ten (10) feet. The dissolved oxygen concentration of recognized trout streams shall not be less than 6.0 mg/l.

(b) pH - The pH value shall lie within the range of 6.5 to 8.5 and shall not fluctuate more than 1.0 unit in this range over a period of 24 hours.

(c) Solids, Floating Materials and Deposits - There shall be no distinctly visible solids, scum, foam, oily sleek, or the formation of slimes, bottom deposits or sludge banks of such size or character that may be detrimental to fish and aquatic life.

(d) Turbidity or Color - There shall be no turbidity or color added in such amounts or of such character that will materially affect fish and aquatic life.

(e) Temperature - The maximum water temperature change shall not exceed 3C° relative to an upstream control point. The temperature of the water shall not exceed 30.5°C and the maximum rate of change shall not exceed 2C° per hour. The temperature of recognized trout waters shall not exceed 20°C. There shall be no abnormal temperature changes that may affect aquatic life unless caused by natural conditions. The temperature of impoundments where stratification occurs will be measured at a depth of 5 feet, or mid-depth whichever is less, and the temperature in flowing streams shall be measured at mid-depth.

(f) Taste and Odor - There shall be no substances added that will impart unpalatable flavor to fish or result in noticeable offensive odors in the vicinity of the water or otherwise interfere with fish or aquatic life.

(g) Toxic Substances - There shall be no substances added to the waters that will produce toxic conditions that affect fish or aquatic life.

(h) Other Pollutants - Other pollutants shall not be added to the waters that will be detrimental to fish or aquatic life.

(i) ~~Microbiological~~ Coliform - The concentration of the fecal coliform group shall not exceed 1,000 per 100 ml. as the logarithmic mean based on a minimum of 10 samples collected from a given sampling site over a period of not more than 30 consecutive days with individual samples being collected at intervals of not less than 12 hours. In addition, the concentration of the fecal coliform group in any individual sample shall not exceed 5,000 per 100 ml.

4. Recreation

(a) Dissolved Oxygen - There shall always be sufficient dissolved oxygen present to prevent odors of decomposition and other offensive conditions.

(b) pH - The pH value shall lie within the range of 6.0 to 9.0 and shall not fluctuate more than 1.0 unit in this range over a period of 24 hours.

(c) Solids, Floating Materials and Deposits - There shall be no distinctly visible solids, scum, foam, oily sleek, or the formation of slimes, bottom deposits or sludge banks of such size or character that may be detrimental to recreation.

(d) Turbidity or Color - There shall be no turbidity or color added in such amounts or character that will result in an objectionable appearance to the water.

(e) Temperature - The maximum water temperature change shall not exceed 3C° relative to an upstream control point. The temperature of the water shall not exceed 30.5°C and the maximum rate of change shall not exceed 2C° per hour. The temperature of impoundments where stratification occurs will be measured at a depth of 5 feet, or mid-depth whichever is less, and the temperature in flowing streams shall be measured at mid-depth.

(f) ~~Microbiological~~ Coliform - The concentration of the fecal coliform group shall not exceed 200 per 100 ml. as the logarithmic mean based on a minimum of 10 samples collected from a given sampling site over a period of not more than 30 consecutive days with individual samples being collected at intervals of not less than 12 hours. In addition, the concentration of the fecal coliform group in any individual sample shall not exceed 1,000 per 100 ml. Water areas in the vicinity of domestic wastewater treatment plant outfalls are not considered suitable for body contact recreational purposes.

(g) Taste or Odor - There shall be no substances added that will result in objectionable taste or odor.

(h) Toxic Substances - There shall be no substances added to the water that will produce toxic conditions that affect man or animal.

(i) Other Pollutants - Other pollutants shall not be added to the water in quantities which may have a detrimental effect on recreation.

5. Irrigation

(a) Dissolved Oxygen - There shall always be sufficient dissolved oxygen present to prevent odors of decomposition and other offensive conditions.

(b) pH - The pH value shall lie within the range of 6.0 to 9.0 and shall not fluctuate more than 1.0 unit in this range over a period of 24 hours.

(c) Hardness or Mineral Compounds - There shall be no substances added to the water that will increase the mineral content to such an extent as to impair its use for irrigation.

(d) Solids, Floating Materials and Deposits - There shall be no distinctly visible solids, scum, foam, oily sleek, or the formation of slimes, bottom deposits or sludge banks of such size or character as may impair the usefulness of the water for irrigation purposes.

(e) Temperature - The temperature of the water shall not be raised or lowered to such an extent as to interfere with its use for irrigation purposes.

(f) Toxic Substances - There shall be no substances added to water that will produce toxic conditions that will affect the water for irrigation.

(g) Other Pollutants - Other pollutants shall not be added to the water in quantities which may be detrimental to the waters used for irrigation.

6. Livestock Watering and Wildlife

(a) Dissolved Oxygen - There shall always be sufficient dissolved oxygen present to prevent odors of decomposition and other offensive conditions.

(b) pH - The pH value shall lie within the range of 6.0 to 9.0 and shall not fluctuate more than 1.0 unit in this range over a period of 24 hours.

(c) Hardness or Mineral Compounds - There shall be no substances added to water that will increase the mineral content to such an extent as to impair its use for livestock watering and wildlife.

(d) Solids, Floating Materials and Deposits - There shall be no distinctly visible solids, scum, foam, oily sleck, or the formation of slimes, bottom deposits or sludge banks or such size or character as to interfere with livestock watering and wildlife.

(e) Temperature - The temperature of the water shall not be raised or lowered to such an extent as to interfere with its use for livestock watering and wildlife.

(f) Toxic Substances - There shall be no substances added to water that will produce toxic conditions that will affect the water for livestock watering and wildlife.

(g) Other Pollutants - Other pollutants shall not be added to the water in quantities which may be detrimental to the water for livestock watering and wildlife.

7. Navigation

(a) Dissolved Oxygen - There shall always be sufficient dissolved oxygen present to prevent odors of decomposition and other offensive conditions.

(b) Hardness or Mineral Compounds - There shall be no substances added to the water that will increase the mineral content to such as extent as to impair its use for navigation.

(c) Solids, Floating Materials and Deposits - There shall be no distinctly visible solids, scum, foam, oily sleck, or the formation of slimes, bottom deposits or sludge banks of such size or character as to interfere with navigation.

(d) Temperature - The temperature of the water shall not be raised or lowered to such an extent as to interfere with its use for navigation purposes.

(e) Toxic Substances - There shall be no substances added to water that will produce toxic conditions that will affect the water for navigation.

(f) Other Pollutants - Other pollutants shall not be added to the water in quantities which may be detrimental to the waters used for navigation.

These criteria should not be construed as permitting the degradation of higher quality water when such can be prevented by reasonable pollution control measures. The above conditions are recognized as applying to waters affected by the discharge of sewage and/or industrial waste or other waste and not resulting from natural causes.

DEFINITIONS

1. Conventional Water Treatment - Conventional water treatment as referred to in the criteria denotes coagulation, sedimentation, filtration and chlorination.

2. Mixing Zone - Mixing zone refers to that section of flowing stream or impounded waters necessary for effluents to become dispersed. The mixing zone necessary in each particular case shall be defined by the Tennessee Water Quality Control Board.

INTERPRETATION OF CRITERIA

1. Interpretations of the above criteria shall conform to any rules and regulations or policies adopted by the Water Quality Control Board.

2. Insofar as practicable, the effect of treated sewage or waste discharges on the receiving waters shall be considered after they are mixed with the waters and beyond a reasonable zone of immediate effect upon the qualities of the waters. The extent to which this is practicable depends upon local conditions and the proximity and nature of other uses of the waters.

3. The technical and economical feasibility of waste treatment, recovery, or adjustment of the method of discharge to provide correction shall be considered in determining the time to be allowed for the development of practicable methods and for the specified correction.

4. The criteria set forth shall be applied on the basis of the following stream flows: unregulated streams - stream flows equal to or exceeding the 3-day minimum, 20-year recurrence interval; regulated streams - instantaneous minimum flow.

5. In general, deviations from normal water conditions may be undesirable, but the rate and extent of the deviations should be considered in interpreting the above criteria.

6. The criteria and standards provide that all discharges of sewage, industrial waste, and other wastes will receive the best practicable treatment (secondary or the equivalent) or control according to the policy and procedure of the Tennessee Water Quality Control Board. A degree of treatment greater than secondary when necessary to protect the water uses will be required for selected sewage and waste discharges.

TENNESSEE ANTIDEGRADATION STATEMENT

1. The Standards and Plan adopted are designed to provide for the protection of existing water quality and/or the upgrading or "enhancement" of water quality in all waters within Tennessee. It is recognized that some waters may have existing quality better than established standards.

2. The Criteria and Standards shall not be construed as permitting the degradation of these higher quality waters when such can be prevented by reasonable pollution control measures. In this regard, existing high quality water will be maintained unless and until it is affirmatively demonstrated to the Tennessee Water Quality Control Board that a change is justifiable as a result of necessary social and economic development.

3. All discharges of sewage, industrial waste, or other waste shall receive the best practicable treatment (secondary of the equivalent) or control according to the policy and procedure of the Tennessee Water Quality Control Board. A degree of treatment greater than secondary when necessary to protect the water uses will be required for selected sewage and waste discharges.

4. In implementing the provisions of the above as they relate to interstate streams, the Tennessee Water Quality Control Board will cooperate with the appropriate Federal Agency in order to assist in carrying out responsibilities under the Federal Water Pollution Control Act, as amended.

APPENDIX C

FEDERAL WATER POLLUTION CONTROL

DISCHARGE STANDARDS

APPENDIX C

The goals of the Federal Water Quality Control Act Amendments of 1972 (the Act) require that publicly-owned treatment works utilizing treatment and discharge meet secondary treatment as defined by the Environmental Protection Agency by July 1, 1977, or June 1, 1978 (for new construction). The secondary treatment standards were given in 38 CFR 159 (August 17, 1973) and are shown in Table C-1 below.

TABLE C-1

SECONDARY TREATMENT STANDARDS

Parameter	30 Consecutive Days	7 Consecutive Days
BOD_5 (mg/1)*	30	45
SS (mg/1)*	30	45
Fecal Coliform** (No./100 ml)	200	400
pH	6-9	6-9

* Arithmetic Mean
** Geometric Mean

APPENDIX D

SOLID WASTE REGULATIONS

STATE OF TENNESSEE

APPENDIX D

SOLID WASTE REGULATIONS

REGULATION 1. DEFINITIONS

A. Bulky Waste - Large items of refuse such as but not limited to appliances, furniture, auto or large auto parts, trees and branches, and stumps.

B. Composting - The controlled biological decomposition of solid organic waste material under aerobic conditions, which shall produce an end product free of pathogenic organisms.

C. Commissioner - The Commissioner of the Tennessee Department of Public Health or his authorized representative.

D. Department - The Tennessee Department of Public Health.

E. Garbage - All kitchen and table waste, and every accumulation of animal or vegetable waste that attends or results from the preparation, dealing on or handling of food stuffs.

F. Hazardous Waste - Includes, but is not necessarily limited to, explosives, pathological wastes, radioactive materials, and certain chemicals which shall be determined by the Department.

G. Health Officer - The director of a city, county, or district health department having jurisdiction over the community health in a specific area, or his authorized representative.

H. Incinerator - A solid waste burning device which provides acceptable controlled combustion resulting in a nuisance free residue composed of little or no combustible or organic material.

I. Industrial Waste - All solid wastes which result from industrial processes and manufacturing operations.

J. Open Burning - The burning of any matter under such conditions that the products of combustion are emitted directly into the open atmosphere.

K. Open Dumping - The depositing of solid wastes into a body or stream of water or onto the surface of the ground without compacting the wastes and covering with suitable material to a depth and at such time intervals as prescribed in these regulations.

L. Person - Any and all persons, natural or artificial, including any individual, firm or association, and municipal or private corporation organized or existing under the laws of this State or any other state, and any governmental agency or county of this State.

M. Refuse - Putrescible and nonputrescible solid wastes except body wastes, including, but not limited to, garbage, animal carcasses, rubbish, incinerator residue, street cleanings, and industrial waste.

N. Rubbish - Nonputrescible solid wastes, consisting of both combustible and noncombustible wastes, such as, but not necessarily limited to, paper, cardboard, tin cans, yard clippings, wood, glass, bedding, crockery, plastics, rubber by-products, or litter of any kind.

O. Solid Waste - Garbage, refuse, and other discarded solid materials, including solid-waste materials resulting from industrial, commercial, and agricultural operations, and from community activities, but does not include solids or dissolved material in domestic sewage or other significant pollutants in water resources, such as silt, dissolved or suspended solids in industrial waste water affluents, dissolved materials in irrigation return flows or other common water pollutants.

P. Solid Waste Disposal System - The relationship of the coordinated activities of and resources for processing and disposal of solid wastes within a common geographical area and under the supervision of any person or persons engaging in such activities.

Q. Solid Waste Processing - An operation for the purpose of modifying the characteristics or properties of solid wastes to facilitate transportation or disposal of solid wastes including, but not necessarily limited to, incineration, composting, separation, grinding, shredding, and volume reduction.

R. Solid Waste Disposal - The process of placing, confining, compacting, or covering solid waste except when such solid waste is for reuse, removal, reclamation, or salvage.

S. Transfer Station - An approved place for consolidation or temporary storage of solid waste prior to transportation to a processing operation or the final disposal site.

T. Household - Those who dwell under the same roof and compose a family.

REGULATION 2. REGISTRATION OF DISPOSAL OR PROCESSING OPERATION

A. Registration Required - No person, except as herein specified, shall operate or maintain a solid waste processing facility or disposal facility or site within the State of Tennessee without making application for and receiving acknowledgement from the Commissioner. It is the intent of this section to exempt from registration the individual householder disposing of solid waste from his own household upon his own land providing this does not create a public nuisance.

B. ...

C. Change of Ownership - In the event of an intended change of ownership of a solid waste processing facility or a solid waste disposal facility or site, a written application for registration shall be made to the Commissioner by the proposed new owner at least sixty (60) days prior to the proposed change of ownership.

REGULATION 3. APPLICATION FOR FEDERAL, STATE, OR OTHER GRANTS AND LOANS

All applications made by Tennessee counties, cities, towns, municipalities, or any combination thereof for federal, state, or other grants and loans for assistance in designing, acquiring, constructing, altering, or operating solid waste processing facilities and disposal facilities or sites shall be submitted to the Department for review prior to their submission to the granting agency.

Only those applications shall be accepted and considered which are submitted from counties, towns, and municipalities who have officially adopted a plan for a solid waste disposal system or who are included in an officially adopted plan for a solid waste disposal system which covers two or more such jurisdictions. The Department shall approve or disapprove such plans in accordance with these regulations.

. . .

REGULATION 5. SOLID WASTE DISPOSAL SYSTEM DESIGN AND CONSTRUCTION

A. . . .

B. Processing Facilities - Incinerator (1,000 lbs/hr capacity or greater), composting plants, transfer stations, hazardous waste processing and other processing methods.

1. Incinerators - Processing facility design and construction shall be such as to produce a facility which will preserve the prescribed quality of the environment and provide the maintenance of good health and safety of the operators. This regulation shall also require compliance with other applicable Tennessee environmental control regulations. Plans and specifications shall be prepared by an engineer licensed to practice in Tennessee and shall contain the following:

a. A master plan for the area lying within a one mile radius of the site. This plan shall be drawn at a scale of not less than 1 in. = 400 ft. It shall indicate existing roads, bridges, streams, rail facilities, water impoundments, land use, zoning, topography - 20 ft contour interval, water and waste water treatment facilities, water supply sources, and other utilities adjacent to or located on the site. It shall show the proposed site, location of proposed access roads,.and major drainage routing.

b. A site plan for the area lying within the designated site boundaries. This plan shall be drawn on a scale of not less than 1 in. = 100 ft. On this plan shall be noted site boundaries, topography - 5 ft contour intervals, on-site structure, access roads, drainage appurtenances, sanitary facilities, utilities, water supply, waste water collection and treatment facilities, and any other facilities utilized in waste processing.

c. A set of drawings and specifications for equipment and buildings shall be included.

d. Such other drawings and details as may be required by the Department.

e. Traffic control information in the area of the processing facility must be evaluated. Such evaluation shall be reflected in a letter from the controlling traffic authority indicating that the operation of a processing facility at the proposed site will be acceptable. A map of the proposed route to and from the designated disposal site shall be submitted to the Department.

f. A manual containing operational procedures must be submitted to the Department. This manual must include but not necessarily limit to: operating hours, personnel duties, odor and vector control, waste processing sequence, fire and accident prevention, site and equipment maintenance, and any other operations necessary for the maintenance of an approved system.

g. Operation and/or construction plans shall indicate an acceptable method of handling solid waste in the event of a failure in the primary processing facility.

h. A proposal shall be submitted for the disposal or use of processed waste.

2. Composting Plants - Plans and specifications shall be prepared by an engineer licensed to practice in Tennessee and shall contain the following:

   a. A master plan for the area lying within a one mile radius of the site. This plan shall be drawn at a scale of not less than 1 in. = 400 ft. It shall indicate existing roads, bridges, streams, rail facilities, water impoundments, land use, zoning, topography - 20 ft contour interval, water and waste water treatment facilities, water supply sources, and other utilities adjacent to or located on the site. It shall show the proposed site, location of proposed access roads, and major drainage routing.

   b. Construction plans and specifications in sufficient detail to indicate the actual construction required.

   c. Plans for use of the composted material.

d. Such other drawings and details as may be required by the Department.

Compost plant design and construction shall be such as to produce a facility which will preserve the prescribed quality of the environment and provide for the maintenance of good health and safety of the operators.

3. ...

4. Hazardous Waste Processing Other Processing Methods - Plans and specifications shall be prepared by an engineer licensed to practice in Tennessee and shall contain the following:

a. A master plan for the area lying within a one mile radius of the site. This plan shall be drawn at a scale of not less than 1 in. = 400 ft. It shall indicate existing roads, bridges, streams, rail facilities, water impoundments, land use, zoning, topography - 20 ft contour interval, water and waste water treatment facilities, water supply sources, and other utilities adjacent to or located on the site. It shall show the proposed site, location of proposed access roads, and major drainage routing.

b. Construction plans and specifications in sufficient detail to indicate the actual construction required.

c. Such other drawings and details as may be required by the Department.

Hazardous waste processing and other processing methods shall be such as to preserve the prescribed quality of the environment and provide for the maintenance of good health and safety of the operators.

C. Disposal Facility or Site

1. ...

2. Sanitary Landfill - Basic design considerations:

a. Site selection - No site shall be subject to flooding. Geologic conditions shall be such as not to permit pollution of the ground water.

Sufficient soil cover or other material approved by the Department shall be available, preferably at the site, for covering the waste at the required intervals and to the required depth. The site must comply with local zoning requirements and land use planning.

b. Access Roads - All-weather roads shall be provided to the disposal site and shall be of such design and construction as to safely accommodate the traffic using the site. On-site roads shall be all-weather or, in lieu thereof, wet-weather disposal areas shall be provided.

c. Site Drainage - All surface water shall be diverted around the operations area. Water shall not be allowed to accumulate at any location on the site unless such location has been approved by the Department.

d. Site Fencing - Access to the site shall be controlled by means of gates which may be locked and by fencing if such become necessary. All fencing and gates shall be of sufficient height and strength to serve the purpose intended.

REGULATION 6. SOLID WASTE DISPOSAL SYSTEM OPERATION

A. General - The operation and maintenance of all solid waste disposal systems shall be such as not to endanger the public health or safety, not to adversely affect the quality of the environment and to provide for the proper processing and disposal of solid waste.

B. Processing Facility

1. Incinerators - Incinerator operation shall be such that the requirements of the Tennessee Air Pollution and local control regulations are met.

   a. Access to Site - Access to the incinerator shall be limited to the hours in which authorized operating personnel are on duty at the site.

   b. Site Storage - All solid waste disposed of at the site shall be confined to the designated dumping area. Storage of the waste at the site shall be kept to a minimum.

c. Supervision of Operation - An incinerator shall be operated under the supervision of a responsible individual who is thoroughly familiar with the operating procedures established by the designer.

d. Incinerator Residue - An incinerator shall be so operated that the residue produced will contain little or no combustible or organic material. All incinerator residue shall be disposed of in a sanitary manner.

2. Composting Plants

a. Access to Site - Access to the composting plant shall be limited to the hours in which authorized operating personnel are on duty at the site.

b. Site Storage - All solid waste disposed of at the site shall be confined to the designated dumping area. Storage of the waste at the site shall be kept to a minimum.

c. Supervision of Operation - A composting plant shall be operated under the supervision of a responsible individual who is thoroughly familiar with the operating procedures established by the designer.

d. Nongradable Solid Waste - Solid waste which is not degradable by compost methods and is a resulting by-product of a composting plant shall be disposed of in a sanitary manner.

e. Use of Composted Solid Waste - Composted solid waste offered for use by the general public shall contain no pathogenic organisms, shall be innocuous, shall be nuisance free, and shall not endanger the public health or safety.

3. Transfer Stations, Hazardous Waste Processing Plants, and Other Processing Methods - Operation of transfer stations, hazardous waste processing plants, or other processing methods shall be such that the intended function of the facility will be best served, that the public health and safety will not be endangered, and that nuisances will not be created. Specific operating procedures for each installation shall be approved by the Department prior to initiation of operation.

C. Disposal Facilities and Sites

1. Sanitary Landfill

...

j. Handling of Special Wastes - Dead animals, sewage solids or liquids, and other materials which are either hazardous or hard to manage shall be disposed of in a sanitary landfill only if special provisions are made for such disposal and are approved by the Department.

...

r. Drainage and Grading - The entire site shall be graded and/or provided with drainage facilities to minimize run-off onto the sanitary landfill, to prevent the erosion of earth cover, and to drain rain water falling on the surface of the sanitary landfill. The final surface of the sanitary landfill shall be graded to drain, but no surface slope shall be so steep as to cause erosion of the cover. The surface drainage shall be consistent with the surrounding area and shall in no way adversely affect proper drainage from these adjacent lands.

REQUIREMENTS FOR APPROVAL OF A "SPECIAL" SOLID WASTE

Regulation 6, Section C-1-j, of the Regulations Governing Solid Waste Processing and Disposal in Tennessee concerns "handling of special wastes." This section states that "Dead animals, sewage solids or liquids, and other materials which are either hazardous or hard to manage shall be disposed of in a sanitary landfill only if special provisions are made for such disposal and are approved by the Department."

A thorough understanding of the nature of a special waste must be gained to insure that the waste can be handled at a particular site without posing a threat to public health, or to the well being of the operator and the environment. In order to determine what special provisions should be made to properly handle and dispose of a special waste in a registered facility in Tennessee, this office requires the following information be submitted:

1. Physical Characteristics

    a. color

    b. texture

    c. density

    d. viscosity

2. Chemical Characteristics

    a. A complete chemical analysis

3. Generation Source

    a. Schematic flow diagram of the manufacturing process which creates the waste stream

    or

    b. Schematic flow diagram of waste treatment facilities if special waste is resultant from waste treatment.

4. Quantity

    a. Amount taken to processing or disposal facility per trip (lbs or yds).

    b. Number of trips in a stated amount of time.

5. Location, owner, and registration number of the site at which processing or disposal will occur.

This information should be sent to Mr. Jerry Loftin, Suite 320, Capitol Hill Building, Nashville, Tennessee 37219.

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