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Environmental Impact Statement

Draft

Wastewater Treatment Facilities Tulsa (Northside), Oklahoma

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Chapter 1

CHAPTER 1

SUMMARY

1.1 INTRODUCTION

Under the authority of the Clean Water Act (CWA), the U.S. Environmental Protection Agency (EPA) administers Federal funds directed at meeting and maintaining a "fishable-swimmable" level of water quality in the nation's waterways by 1983. In the pursuit of this goal, EPA provides financial assistance to municipalities through the Construction Grants Program. Public Law 97-117 amended the CWA in December 1981, changing the funding process of the grants program. Prior to that amendment, EPA grants were given in three steps: (1) planning; (2) design; and (3) construction, and usually consisted of up to 75 percent of eligible project cost. As a result of PL 97-117, grants will be provided in one step and only 55 percent funding will be available for eligible portions of project cost after October 1, 1984. Design and construction for this project should be within the October 1984 timeline for 75 percent funding. Funding of 75 percent of planning costs for this Tulsa 201 Facilities Plan/EIS have been provided by EPA under grant No. C-40-1001-01.

BACKGROUND SUMMARY

The City of Tulsa has been actively involved in EPA's program since the original enactment of the Federal Water Pollution Control Act Amendments PL 92-500 of 1972, with the first 201 Facilities Planning being authorized by EPA for the Tulsa area in 1973. Subsequent studies including a 208 Area-wide Water Quality Management Plan have been completed and the results have led to the development of the Tulsa 201 Facilities Plan/EIS work plan.

EPA approved the ~~first~~ 1st phase of this project when the City of Tulsa initiated 201 Facilities Planning to consider the addition of Advanced Wastewater Treatment (AWT) to meet wasteload allocations and to study the possible enlargement of the Northside Facility capacity to accommodate future growth in the Northside Service Area. In addition, the project will develop an Area-wide Sludge Management Plan for all of Tulsa's municipal wastewater plants.

Under the direction of the National Environmental Policy Act (NEPA) of 1969, Federal agencies must prepare an Environmental Impact Statement (EIS) for all Federal actions which will significantly affect the quality of the environment. EPA determined the need to produce an EIS for this project and that in order to expedite the planning process, the EIS would be "piggybacked" or prepared concurrently with the Facilities Plan.

Final application for funding was made to EPA in July 1980, with final approval and the commencement of work beginning on October 14, 1980.

ISSUES ADDRESSED IN THE EIS

The EIS has been prepared in accordance with the National Environmental Policy Act (NEPA). The major issues addressed within this document are as follows:

Project Alternatives

All feasible project alternatives developed through the Facilities Planning and piggyback EIS process have been addressed to ensure environmental soundness. Specific areas of evaluation include:

(1) Wastewater treatment plant (WWTP) location and capacity

(2) Wastewater treatment process

(3) Effluent disposal method

(4) Sludge disposal method

(5) Levels of effluent quality that could be achieved through phased implementation

Primary and Secondary Impacts

All primary and secondary impacts, both beneficial and adverse, that could result from the proposed action were evaluated as follows:

Water Resources. The main concerns were surface water, groundwater, and flood hazards.

Physical Resources. Areas assessed were geology and soils with particular attention to environmentally significant or prime agricultural lands, and to air quality and the impacts of meteorological conditions.

Biological Resources. The focus of study was on terrestrial flora and fauna, and the aquatic flora and fauna, with specific attention to habitat requirements. Where significant areas such as unusual biological communities were found, they were noted.

Socioeconomics. Areas addressed include population and land use, transportation, institutional constraints, and economics.

Cultural Factors. Cultural factors include recreation, aesthetics, noise, odors and insects, public health and safety, and archaeological and historical resources.

Other areas of study and issues of specific concern addressed throughout the preparation of the EIS are identified below:

(1) Impacts on water quality in Bird Creek and the Verdigris River with respect to their beneficial use designations as warm water fisheries and potable water supplies as a result of municipal discharge. Specific attention was given to changes in stream water quality with phased implementation.

(2) Impacts of industrial wastes on treatment facilities, including problems with sludge management because of toxic substances and the passing of toxic pollutants through the treatment facilities and subsequent discharge to the receiving stream were addressed.

(3) Population projections and disaggregation of those populations by drainage basin were evaluated with respect to the appropriate Federal requirements. In addition, the effects of growth on land use, employment, and personal income and area economy were also addressed.

1.2 PROJECT PLANNING AREA

As discussed previously, this 201 Facilities Plan/EIS project is made up of two separate but parallel studies for the City of Tulsa. The first entails an assessment of the Northside WWTP Service Area (located on Figure 1-1) to determine the potential for future growth and the need for expansion, and to address the effects of treating the Northside flows to a level of AWT. The second is to develop an area-wide sludge management plan for Tulsa's three wastewater treatment plants; Northside, Southside and Haikey Creek (Figure 1-1). This includes the assessment of possible disposal and/or reuse options for the combined sludges from all three plants, along with the screening of potential sites within a 30-mi radius of Tulsa.

WASTEWATER MANAGEMENT PLAN

This project is part of an ongoing effort to improve the water quality and the potential beneficial uses of Bird Creek.

EXISTING CONDITIONS 1981

Presently, there are several municipal effluents being discharged to Bird Creek. The most significant contributions result from the City of Tulsa's Flat Rock, Coal Creek, and Northside WWTPs. Previous planning studies have indicated that the two upstream plants, Flat Rock and Coal Creek, are outdated and should be closed, and the flow should be diverted to the Northside Facility. Concurrently with the planning portion of this project, designs are being developed for expansion of the Northside Facility to accommodate the flows from these two plants when they are closed in 1985. This will increase the Northside plant's capacity from 19 MGD to a total of 30 MGD.

NO ACTION 1985

The wastewater management portion of this project would not be implemented until 1985. By that time the flows to the Northside plant are projected to match its available capacity of 30 MGD. The purpose of this portion of the

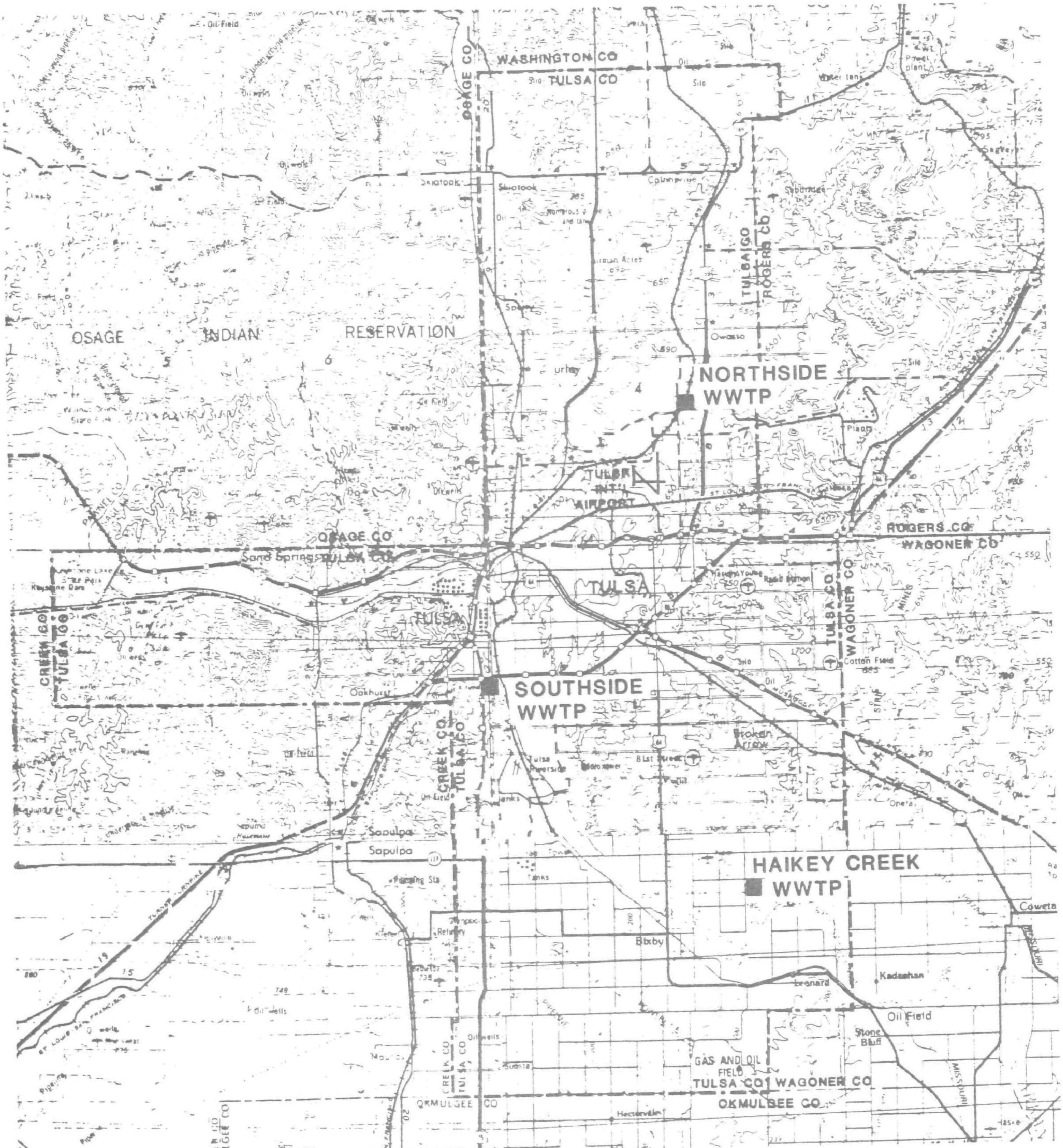

Figure 1-1 Project Planning Area.

201 Facilities Plan/EIS is to evaluate the potential for future growth in the Northside service area during the 20-year planning period from 1985 to 2005 and assess the level of expansion required to accommodate this growth. In addition, the effects of AWT are to be addressed.

Therefore, the No Action alternative would provide for no expansion of the Northside plant beyond the 1985 projected capacity of 30 MGD, and would continue the discharge of a secondarily treated effluent. This would not enable the Northside plant to comply with State Stream Standards or the Administrative Order. For these reasons, No Action is not considered a viable option. It is provided only as a point of reference from which the developed alternatives can be assessed and to establish the net change in Bird Creek that would occur as a result of the closure of the Flat Rock and Coal Creek plants.

DEVELOPMENT AND SCREENING OF ALTERNATIVES

The purpose of the wastewater management plan was to develop alternatives that would provide the necessary level of expansion of the plant and to ensure compliance with State Stream Standards.

Because all of the alternatives would provide for the same level of expansion, the methods of protecting the receiving stream became an important factor in the alternatives' development. Initially the proposed alternatives came under two approaches; the first would completely remove the effluent from the stream returning it to a pre-Northside condition, and the second would treat the flow to a high degree (advanced wastewater treatment) prior to discharge. A total of 17 alternatives were developed and are broken down as follows: two alternatives would transfer the effluent to the Arkansas River, which maintains a greater assimilative capacity than Bird Creek; two alternatives would remove the effluent using it for agricultural land application; three alternatives would remove the effluent for industrial reuse; and the remaining ten alternatives consist of various process trains designed to achieve AWT.

The initial screening process was conducted on the basis of engineering and environmental criteria. The purpose was to narrow and select the four most viable alternatives for more detailed evaluation.

The four alternatives included: (1) Out-of-Basin Transfer, with discharge to the Arkansas River, (2) the modification of the existing plant with continued use of trickling filters to achieve AWT, (3) the construction of an activated sludge train employing breakpoint chlorination to provide seasonal ammonia removal (AWT), and (4) the construction of an activated sludge train, including biological filtration (AWT). A detailed environmental evaluation of each of the alternatives is provided in Chapter 5.

DESCRIPTION OF THE PREFERRED ALTERNATIVE

Based on detailed engineering and environmental analysis followed by review and comment from City Staff and the Public Advisory Committee (PAC), the AWT process train employing biological filtration with activated sludge was selected as the most cost-effective alternative. This alternative was chosen over the alternative with the least present worth (AWT with breakpoint chlorination) because of environmental and health concerns associated with the use of highly reactive chemicals in the latter.

Phased Implementation

Due to funding constraints associated with a project of this size, a method of phasing or staged construction of the preferred alternative was proposed and recommended by the City and adopted by the PAC during the June 1, 1982 PAC meeting. This approach would allow for funds, as they become available, to be applied to the more critical areas of the wastewater and sludge management portions of the project. In addition, the phasing plan would allow the existing plant to be operated in such a way that progressive levels of improvement in water quality can be maintained and continued with subsequent expansions and additions of AWT unit processes.

RESIDUALS SOLIDS MANAGEMENT PLAN

The purpose of the Residuals Solids Management portion of the Facility Plan and EIS is to address the overall area-wide sludge processing, handling, and disposal or reuse. The three regional wastewater treatment plants are the Northside, Southside, and Haikey Creek plants shown on Figure 1-1. The alternative development, selection, and elimination are summarized below.

EXISTING CONDITIONS AND NO ACTION ALTERNATIVE

Currently, sludge from the three treatment plants is stored separately at each plant. A No Action alternative would mean a continuation of the present stockpiling of sewage sludge. This is not considered a viable alternative since both Federal and State laws require permitted disposal of solid waste.

ALTERNATIVE DEVELOPMENT AND ASSESSMENT

There were a number of variables or components involved in the development of Residuals Solids Management alternatives. These included processing, transportation, and disposal/reuse methods and sites for disposal. The different types of processing, transportation and disposal were put together in various combinations and reduced in number through the use of engineering factors such as reliability and cost (see Facilities Plan). Site evaluations were also conducted because most of the alternatives required a disposal or reuse site except for the agricultural reuse and marketing/giveaway alternatives.

Beneficial reuse alternatives were heavily favored by the Public Advisory Committee (PAC). Some form of beneficial reuse such as agricultural utilization, marketing, giveaway/sale or active strip•mine reclamation was considered to be the primary alternative. However, the inherent fluctuations of market conditions was also recognized, so backup options were developed. The sites for backup alternatives were identified through the screening of areas within a 30-mi radius of Tulsa based on engineering and environmental factors. As the components and sites were eliminated, revised, and refined, more detailed information was collected. Finally, the method and disposal/reuse sites that had survived the engineering and environmental evaluations were combined and assessed as residuals solids management alternatives. Again, these plans all included beneficial reuse or marketing in some form, with the main variable being the type and site for a "fail-safe" or backup disposal/reuse option.

The seven resulting alternatives were then screened environmentally based on water resources and physical resources factors. Subsequently, two alternatives were eliminated and one was revised. These changes were due to potential nitrate contamination of potable water supplies at one particular site involved in all three alternatives.

The five remaining alternatives were those that were carried through for more detailed assessment and comparison to determine the preferred alternative. These combined the various disposal/reuse methods of landfilling, dedicated land disposal, abandoned mine land reclamation, and marketing options with a number of sites and transportation methods. These five alternatives were analyzed in three main phases.

The first was a comparison of sludge to commercial fertilizer to determine any differences in potential environmental impacts. This was the primary assessment of the marketing alternative, in that sludge would essentially be replacing commercial fertilizer in any of the marketing options. The second phase was a generic evaluation of the other methods; landfilling, dedicated land disposal and abandoned strip mine reclamation. Finally, the sites were assessed in terms of all the environmental parameters of water resources, physical resources, socioeconomics and cultural factors. The generic and site assessments were then combined to determine the most suitable alternative(s).

DESCRIPTION OF THE PREFERRED ALTERNATIVE

The preferred alternative was selected by the applicant based on input from the Public Advisory Committee (PAC), Federal, State, and local agencies. It is a combination of two primary alternatives. Marketing, with no specified type, is the long-term preferred method of residuals solids reuse. It may be agricultural or active strip mine utilization, or give away/sale. Any of the methods would follow appropriate precautions and regulations, but the method would depend primarily on local market availability.

Because marketing is not considered "fail-safe", a backup alternative was selected for the initial stages of the sludge management program and for use in the event that the market for the sludge is not steady or reliable. The backup alternative selected was reclamation of an area of abandoned strip mines northeast of Tulsa. The combined alternative is considered the most cost-effective alternative because it is the least present worth cost with no major environmental problems.

The site is a large area of orphaned strip mines about 4 mi northeast of the town of Claremore. Out of approximately 10,000 acres, about 130 acres plus a buffer would be required for the reclamation operation. The shaley (clay) spoil material would be worked and layered in the bottoms of the trenches to provide a sealer similar to a commercial liner. Sludge would then be layered alternately with the spoil material, with 2 ft of dried (40 percent) sludge to 1 ft of spoil material until the land is relatively level. Another layer of spoil material could be layered on top of this to provide a cap. Finally, a cover of mixed spoil and sludge at around 50 tons per acre dry sludge would be placed on top, followed by final grading and reseeding. The final layer provides nutrients for revegetation in a one-time application adjusted so that site life cadmium limitations for food chain crops are not exceeded.

The abandoned strip mines at R-3 would be used as a backup to a marketing plan. If for some reason the above site cannot be utilized, other strip mine sites would be examined. Should all reclamation sites be unimplementable, codisposal at a privately-owned municipal solid waste landfill would be considered next, followed by potential landfill sites not on prime farmland in Tulsa County. As a last resort, the landfill site on Class 1 Mason soils in Okmulgee County would be considered.

1.3 ALTERNATIVES AVAILABLE TO EPA

Under Section 201 of the Clean Water Act, EPA maintains three available options in its execution of the Construction Grants Program. These options are detailed in Chapter 5, but in general include: the award of grant funds for the design and construction of the grantee's preferred alternative; the awarding of funds based on a modified alternative or approach to the project's implementation; or denial of all grant funds for the project.

1.4 ALTERNATIVES AVAILABLE TO OTHERS

The State of Oklahoma maintains a funding program for public works projects. Grants are awarded based on a priority system established by the State. The availability of these funds has been taken into account through the phasing approach to implementation.

Presently, the Oklahoma Water Resources Board is in the process of reviewing the State's Water Quality Standards. Regulations under evaluation include stream classification for beneficial uses, numerical limitations on water quality parameters, and assessments of stream classifications as intermittent or perennial. In addition, the State Department of Health has just revised its solid waste regulations and, as of July 1982, will require permitting of any disposal facilities.

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CHAPTER 3

INTRODUCTION, PURPOSE AND NEED

3.1 BACKGROUND RESULTING IN THE PROPOSED ACTION

This section provides a brief history of the water quality and facilities planning for the City of Tulsa which has led to the current project. This planning process, the Northside Facilities Plan and the Piggyback EIS, are made up of two separate but parallel studies. These studies are designed to develop, evaluate, and select a preferred alternative for wastewater treatment and residuals solids management for the Tulsa area (see Regional Location Map, Figure 3-1).

WASTEWATER MANAGEMENT PLAN

This assessment and previous studies are part of an ongoing process, the goals of which are to meet and maintain a level of water quality in receiving streams described as "fishable-swimmable", by 1983, as mandated by the Federal Water Pollution Control Act Amendments of 1972, PL 92-500.

Since the initiation of PL 92-500, the City of Tulsa has been actively involved in U.S. Environmental Protection Agency (EPA) programs to reach this goal. During the initial 201 Facilities Planning studies, efforts were directed toward updating municipal wastewater treatment plants to meet Water Quality Standards and to obtain effluent limitations as described in the State of Oklahoma 303e Plan. As the program grew and states developed more specific standards, Section 208 planning activities were initiated to provide area-wide water quality management plans. The history of Tulsa's involvement in this program and those events that took place leading to the present project are outlined below.

In 1973, EPA authorized the Regional Metropolitan Utility Authority (RMUA) to conduct 201 Facility Planning in the Tulsa area. The final report was published in December 1975, with three primary recommendations regarding the Northslope service area: (1) expand the Northside Facility by 11 MGD and treat to a secondary level; (2) close the two old wastewater treatment

Figure 3-1 Regional Location Map.

plants (Flat Rock and Coal Creek) upstream of the Northside facility; and (3) divert the wastewater flow from Flat Rock and Coal Creek plants to the Northside plant and provide another expansion at Northside to accommodate this flow and treat it to a secondary level.

The first recommendation was implemented and finally completed in 1979, bringing the Northside capacity to 19 MGD. The remaining two RMUA 201 Plan recommendations for the Northslope were carried through for further study under a new grant.

The Indian Nations Council of Governments was designated as the 208 planning agency. The 208 study proceeded for two years with the INGOG 208 Area-wide Water Quality Management Plan being completed in May 1978 and granted conditional approval by EPA in November 1978.

Concurrently, the 1976 Oklahoma Water Quality Standards were in review and were finally promulgated and published in 1979. EPA Region 6 approved the 1979 standards in September 1980 with the understanding that the next version would consider several points. Specifically, they should consider the Intermittent Stream Policy with respect to the results of Advanced Secondary Treatment/Advanced Wastewater Treatment (AST/AWT) studies, and should incorporate additional numerical criteria for toxic pollutants based on 208 studies and other program outputs which could become available.

Results of the 208 study supported the original RMUA 201 recommendation for the abandonment of the two old plants and the expansion of Northside (to 30 MGD) to treat these flows. In addition, the 208 Basin Plan provided wasteload allocations and effluent limitations for the City of Tulsa wastewater treatment plants discharging to Bird Creek. EPA approved this first phase with the stipulation that the City initiate an update of the previous 201 Facilities Planning which would consider the addition of AWT to meet these wasteload allocations and study the possible enlargement of the Northside Facility capacity to accommodate future growth in the Northside service area (Figure 3-2). EPA also required that an Environmental Impact Statement (EIS) be prepared to assess the impacts of expansion and addition of AWT before future projects would be approved.

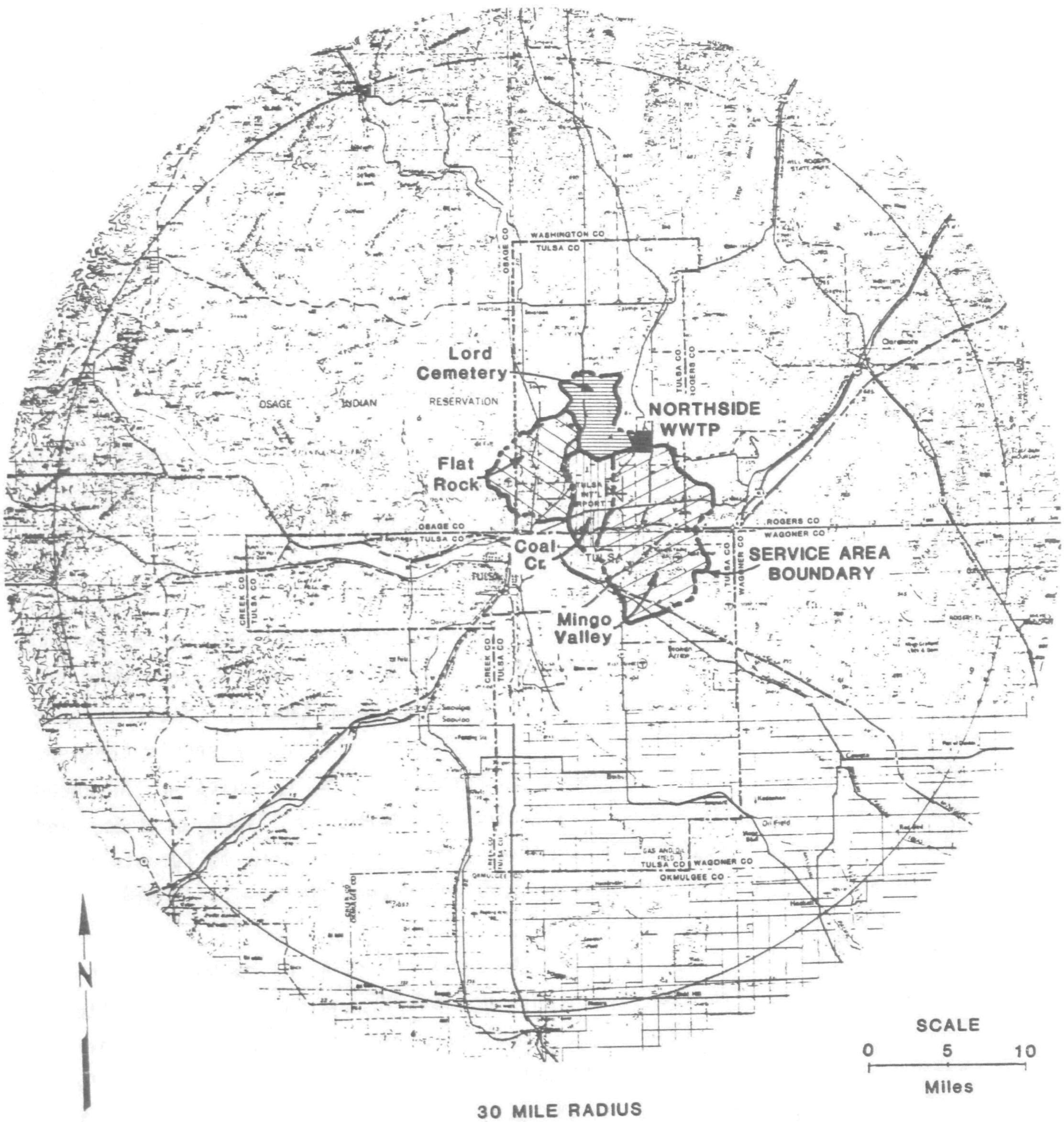


Figure 3-2 Tulsa Northside Service Area.

In August 1979, the 201/EIS Public Advisory Committee was established in accordance with the new public participation regulations to participate in the 201 Facilities Planning process. To expedite the process the EIS would be "piggybacked" or performed concurrently with the Facility Planning.

Final application for funding was made to EPA in July 1980, with final approval on this project's scope of services and the commencement of work beginning on October 14, 1980.

RESIDUALS SOLIDS MANAGEMENT

The Residuals Solids Management Plan is a parallel but separate part of this project and was also under development during the same relative timeframe as the wastewater management plan.

Based on recommendations made by the 208 Plan, the Tulsa City-County Health Department in a letter of September 1978, to the City of Tulsa expressed concern over the practice of give away of municipal sludges when the end use is unknown. This was directed specifically at the Northside Facility due to the high level of cadmium in its sludge. At that time no specific regulations existed which would prohibit this practice, but because of the public health issues involved the City suspended such actions at the Northside Facility, as well as the Southside and Haikey Creek plants. Since these events left the City without an approved sludge disposal plan, the development of a Area-wide Sludge Management Plan was made a part of the present facilities planning and piggyback EIS process.

EPA developed preproposal draft regulations on the distribution and marketing of sewage sludge products which were to be published in late 1981 in the Federal Register. Based on communications with the EPA, Office of Solid Waste, in Washington, D.C., these regulations have been indefinitely postponed. However, they were used as guidelines through the course of this study.

3.2 EPA LEGISLATIVE AUTHORITY AND RESPONSIBILITY

The initiation of this project as well as prior studies that led to the development of this EIS are partially dependent upon the laws, regulations, and grant programs of the Federal government. More specific to this project are the congressional mandates known as the Clean Water Act (CWA) and National Environmental Policy Act (NEPA).

ADMINISTRATIVE ORDER

As a result of the events discussed above, permits were issued for the Northside, Flat Rock, and Coal Creek Plants, with interim effluent limitations and a schedule of compliance for specific activities.

PERMIT STATUS

The interim National Pollutant Discharge Elimination System (NPDES) Permit limitations for Northside, Flat Rock and Coal Creek wastewater treatment plants are as follows:

Interim Permit Limitations

Plant Permit	Effluent Characteristic	30-day Avg.	7-day Avg.
Northside Plant (OK0026221)	Biochemical Oxygen Demand (5-day BOD)	20 mg/l	30 mg/l
	Suspended Solids (SS)	30 mg/l	45 mg/l
	Fecal Coliform (Number/100 ml)	200	400
Coal Creek Plant (OK0026204)	BOD_5	50 mg/l	75 mg/l
	SS	50 mg/l	75 mg/l
	Fecal Coliform	1×10^6	1×10^6
Flat Rock Plant (OK0026212)	BOD_5	60 mg/l	90 mg/l
	SS	80 mg/l	100 mg/l
	Fecal Coliform	10×10^6	10×10^6

The most current wasteload allocations for the Tulsa Northside Wastewater Treatment Plant are those contained in the INCOG 208 Area-wide Water Quality Management Plan as updated, and are the focal point of this project.

Current wasteload allocations/effluent limitations for the Northside Plant discharge to Bird Creek are:

<u>Interim Effluent Limitation</u>

Dissolved Oxygen (D.O.): 5 mg/l
BOD_5: 5 mg/l
TSS: 5 mg/l
Total NH_3: 3 mg/l
Fecal Coliform Bacteria: 200 #/100 ml

COMPLIANCE SCHEDULE

The schedule of compliance provided for in the original Administrative Order specified December 1, 1980 for the completion of the new Facilities Plan. EPA has amended the original Administrative Order. On November 26, 1982, the City requested a revised Administrative Order, the recommended dates, which reflect the present project schedule, are as follows:

1. Submit plans and specifications to the State (Step 2 of Grant number C-400784-20, expansion of the Northside Plant) by <u>September 30, 1981</u>.

2. Submit Pre-draft EIS to EPA for review by June 3, 1982.

3. Submit Draft EIS for publication and the Federal Register (Step 1 of Grant Number C-40-1001-01) by July 2, 1982.

4. Submit complete Facilities Plan to the State and allow public access to EIS (Step 1 of Grant Number C-401001-01) by July 21, 1982.

5. Submit final Infiltration/Inflow (I/I) report to the State (Step 1 of Grant Number C-40-1001-01 and study of the alternative for Advanced Waste Water Treatment, AWT, at the Northside Plant) by July 22, 1982.

6. Facilities Plan and EIS Public Hearing (Step 1 of Grant Number C-40-1001-01) on September 22, 1982.

7. Submit Response to Review Comments to EPA Pre-final EIS by October 12, 1982.

8. Submit Response to Review Comments Final EIS for Printing (Step 1 of Grant Number C-40-1001-01) by November 10, 1982.

9. Submit Final Facilities Plan Response to Review Comments to the State (Step 1 of Grant Number C-40-1001-01) by December 1, 1982.

10. Submit Step 3 application to the State (Grant Number C-401001-10) by February 1, 1983.

11. Submit progress reports to the Water Division and Enforcement Division of the EPA by March 1, 1981; June 1, 1981; September 1, 1981; December 1, 1981; March 1, 1982; and June 1, 1982.

The request for revision of the Administrative Order to reflect the current project schedule is still pending. The effluent limitations and the schedule set forth in the Administrative Order were issued under the authority granted in Section 309 of the Clean Water Act.

CLEAN WATER ACT (CWA)

In 1972 Congress enacted Public Law 92-500, which was revised in 1977 under Public Law 95-217. The purpose of this law was to correct the nation's greatest source of water pollution, i.e., municipal sewage. Public Law 92-500 provided a Federal assistance program under the direction of EPA, which made as much as 75 percent of funding available to state and local governments in order to clean up the nation's waterways. Grants were generally provided in three steps; planning, design and construction. A permitting system was developed as a part of this action which specified the level of water quality for wastewater dischargers and provided a compliance requirement for facilities that underwent this planning process. This regulatory requirement comes under the National Pollutant Discharge Elimination System (NPDES) which is referred to as the facilities' NPDES permit.

Public Law 95-217 encouraged the use of innovative technologies for wastewater reuse, energy conservation and achievements of high levels of treatment, and provided greater Federal assistance for doing so.

More recently (1981), Congress revised the CWA with Public Law 97-117 which provides for a one-step construction grant process and, after October 1, 1984, reduces the current 75 percent level of Federal financial support to 55 percent.

NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)

NEPA is Public Law 91-190, which was enacted in 1969. As set forth in Section 101(b) of NEPA for Federally funded action there are specific environmental objectives which direct the approach to an Environmental Impact Statement (EIS). These are the study of water, physical and biological resources, socioeconomics, and cultural factors.

NEPA also provides that an EIS be prepared by Federal agencies proposing a major action that might significantly affect the quality of the human environment. The EIS must provide information to be used in Federal decision-making. Section 102(2)(c) of NEPA requires that the EIS consider:

- "the environmental impact of the proposed action;
- any adverse environmental effects which cannot be avoided should the proposal be implemented;
- alternatives to the proposed action;
- the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and
- any irreversible and irretrievable commitments of resources which would be involved due to the implementation of the proposed action."

This EIS was prepared under the "piggyback" method as defined in EPA Program Requirements Memorandum, PRM 75-31 (September 1975). Utilizing this approach, EIS preparation has paralleled the development of the Facilities Plans for both the wastewater management alternatives and the residuals solids management alternatives to ensure that the overall plan and its selected alternatives will be both cost-effective and environmentally sound.

3.3 EXISTING FACILITIES

This 201 Facilities Plan and EIS are made up of two separate but parallel studies (Figure 3-3) that entail an abandonment, the combination, and joint operation of several facilities in the Tulsa area as described below.

WASTEWATER TREATMENT AT THE NORTHSIDE PLANT

As discussed previously there have been a series of 208 and Water Quality Management studies conducted in the Tulsa area over the past several years. The conclusions and recommendations made during those evaluations led to the development of the work plan for this project. Those facilities that are involved in this portion of the project are discussed below.

CLOSURE OF THE FLAT ROCK AND COAL CREEK PLANTS

Other than the Northside Plant the two largest municipal dischargers to Bird Creek are the Tulsa Flat Rock Plant, which is a 6 MGD bio-sorption modified activated sludge plant, and the Coal Creek Plant, which is a 5 MGD trickling filter plant. Based on the evaluations of both the 201 RMUA and 208 INCOG studies, these two plants are outdated and cannot be upgraded cost-effectively. Therefore, these two plants are to be abandoned and the flows treated to a secondary level at an 11 MGD expansion at the Northside Facility specifically designed for this purpose. This expansion is about to begin construction and is expected to be on-line by 1985.

INTERIM EXPANSION OF NORTHSIDE

The Northside Plant was originally designed as an 11 MGD two-stage trickling filter plant. As Tulsa grew so did the flow to the Northside Plant. In 1979, the first 11 MGD activated sludge expansion came on-line and the trickling filter plant was aerated to 8 MGD by the Oklahoma State Department of Health (OSDH). This included the addition of disinfection processes.

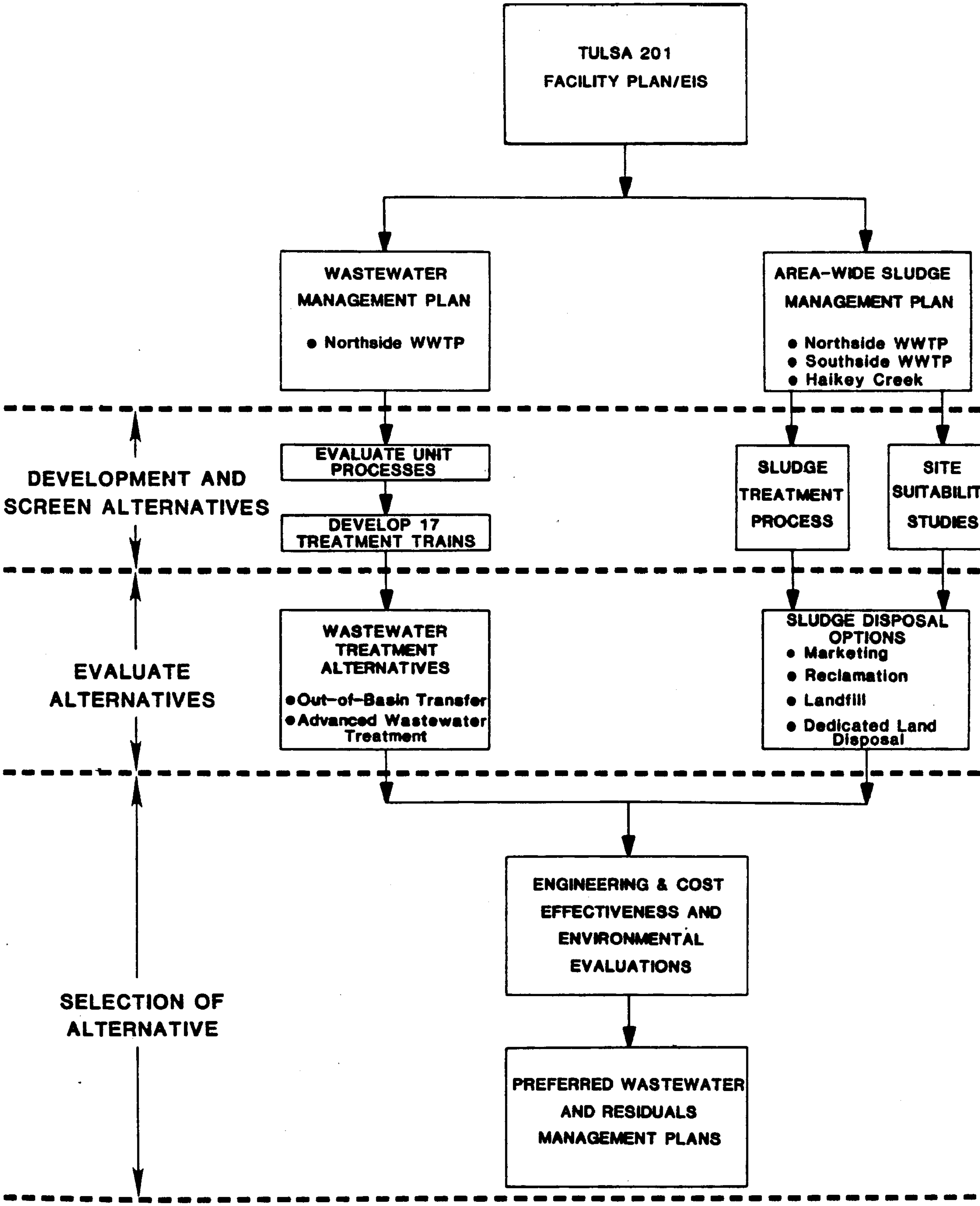


Figure 3-3 Overview: Project Flow Chart.

This brought the Northside Plant up to a secondary municipal wastewater treatment plant designed for 19 MGD. In this study this is considered as the 1981 existing conditions. In 1985, the expanded 30 MGD Northside Facility will be the base conditions from which this project is conducted.

INFILTRATION/INFLOW (I/I) EVALUATION

As a part of an ongoing effort to improve the service area collection system and wastewater treatment process in Tulsa, an Infiltration/Inflow (I/I) evaluation of the Northside Plant's collection system is being conducted to determine the degree and effect of storm water and groundwater intrusion. The next step is the Sewer System Evaluation Survey (SSES) which will verify the cost-effectiveness of I/I reductions, followed by sewer system rehabilitation where necessary. The information from this study will be available in portions of the amended Facilities Plan document.

RESIDUALS SOLIDS MANAGEMENT PLAN

While the wastewater treatment alternatives involve only Tulsa's Northside Wastewater Treatment Plant, the residuals solids portion of the EIS includes area-wide residuals solids disposal for sludge from the Northside, Southside, and Haikey Creek wastewater treatment plants (WWTP's). Sludges from each of the plants have quantities and qualities that are based on the plant's specific treatment processes and service area characteristics. Current disposal methods are also separate and different for each of the three plants. These are described briefly below.

NORTHSIDE WWTP SLUDGE

Currently, primary and trickling filter sludges are pumped to two gravity thickeners prior to anaerobic digestion. Waste activated sludge is aerobically digested; however, it will be thickened in a dissolved-air flotation (DAF) thickener and pumped to two new anaerobic digesters for stabilization when the expansion presently under design is complete.

The digested sludge is then pumped to four onsite storage lagoons, where it is allowed to thicken. The supernatant is decanted back to the treatment works, while the sludge solids are periodically removed from the lagoons and disposed of by surface spreading and plowing into the City-owned land north of the treatment plant (see Facilities Plan).

Presently, about 5-10 dry tons per day (tpd) of digested sludge are produced at the Northside WWTP. This will increase to 11.1 dry tpd after the expansion. The current sludge quality at Northside is heavily influenced by industrial wastes, particularly the heavy metal cadmium (Cd). Sludge characteristics are discussed further in later sections.

SOUTHSIDE WWTP SLUDGE

At the Southside plant, primary sludge is gravity thickened and then anaerobically digested. The waste activated sludge is aerobically digested. The sludges are then pumped to storage lagoons about 2 mi from the plant. These lagoons allow sufficient storage for several years, so no final disposal method presently exists (see Facilities Plan).

Currently, 5-20 dry tpd of sludge are produced at the Southside WWTP. The sludge quality, while better than Northside's, is mainly degraded by industrial discharges and is moderately high in cadmium.

HAIKEY CREEK WWTP SLUDGE

The Haikey Creek plant is a high-purity oxygen activated sludge plant, and does not currently have grit removal or primary clarification. The waste sludge (about 3-5 tpd) is aerobically digested in high purity oxygen digesters and then dewatered on sand drying beds or stored in a lagoon. The dried sludge from the sand drying beds is spread on the surface of the ground at the treatment plant site. The liquid sludge from the lagoons is removed and injected on the plant site (see Facilities Plan). The Haikey Creek WWTP produces a very good quality sludge, with low contaminant levels.

INDUSTRIAL PRETREATMENT PROGRAM

The purpose of this program is to conduct qualitative evaluations of pollutants that enter the municipal system through industrial sources. Ultimately, the intent is to conduct a joint effort between the City and industry through pretreatment to improve the quality of the municipal sludges for enhancement of their reuse potential.

3.4 PURPOSE OF THE PROJECT AND EIS

As a part of the ongoing process started by the Clean Water Act, EPA initiated this 201 (Phase II, Step I) Facilities Planning/EIS project. The course of action is presented below.

DEVELOPMENT OF A WASTEWATER MANAGEMENT PLAN

The 1976 Oklahoma Water Quality Standards have been revised and adopted by the Oklahoma Water Resources Board, February 1979. Because Bird Creek is classified as a perennial stream, it is required to meet the numerical water quality limits as designated by its classification, except when the flow is less than the 7-day, 2-year low flow value. In addition, when a perennial stream receives loadings of oxygen demanding substances, such as a municipal wastewater, allowable limits for these discharges are set based on attaining an in-stream dissolved oxygen (D.O.) of 5 mg/l.

In order to meet this numerical limitation and beneficial use designation for Bird Creek, the 208 Planning Agency recommended stringent wasteload allocations for the Northside Facility based on available information. To achieve these limitations the Northside Facility is to employ a method of advanced wastewater treatment (AWT) capable of producing an effluent quality of 5 mg/l Biochemical Oxygen Demand, 5 mg/l suspended solids and 3 mg/l ammonia-nitrogen.

It was based on the above recommendation that EPA issued the original Administrative Order directed at the assessment of capacity requirements for Northside and the implementation of AWT. This project was developed to evaluate the potential future growth in the Northside service area and population projections through the planning period 1985-2005. In addition, several methods designed to meet State Stream Standards were to be developed, including such methods as agricultural land application and out-of-basin transfer as well as AWT.

DEVELOPMENT OF AN AREA-WIDE SLUDGE MANAGEMENT PLAN

As a result of 208 recommendations, the Tulsa City-County Health Department and the City of Tulsa stopped the practice of sludge give away. No cohesive sludge management plan was developed subsequently. Presently, the sludge is stockpiled, rather than being disposed of or reused, until the results of this study are completed.

By 1985, the total projected quantity of sludge from Tulsa's three treatment plants will be about 35 dry tpd. By the end of the planning period in 2005, with the expansion of Northside, production would reach about 45 dry tpd.

The purpose of the area-wide sludge management plan is to develop options for the disposal and/or reuse of the sludge. It must be compatible with all three plants and take into account their differences as well as the potential changes that will result from the ongoing industrial pretreatment program.

Chapter 4

CHAPTER 4

DESCRIPTION AND EVALUATION OF THE ALTERNATIVES

The text of this section provides a description and evaluation of alternatives for both the Tulsa Northside Wastewater Management Plan and the Area-wide Residuals Solids Management Plan. These plans represent separate but parallel studies designed to produce a series of alternatives for each Management Plan that could be screened down to a smaller group of compatible alternatives. The No Action alternative is discussed as a point of reference from which the alternatives for each plan are evaluated. This section also considers the development of the alternatives, including an evaluation and presentation of those that are eliminated from further study and the reasons for which they are eliminated. The remaining alternatives are carried through more detailed evaluation in the subsequent sections of this document. Also discussed are the options available to EPA, particularly with respect to project funding, and the impacts these could have on the Grantee.

General construction impacts are summarized at the end of Chapter 5. These impacts are rather generic in that they may apply to nearly any of the construction related activities involved in wastewater or residuals management.

4.1 ALTERNATIVES CONSIDERED BY THE APPLICANT

WASTEWATER MANAGEMENT PLAN

This section of the EIS summarizes the development, screening and assessment of alternatives for wastewater management. Section 5.1, "Environmental Consequences of the Wastewater Management Plan Alternatives", provides a detailed environmental assessment of the four final alternatives, which are only summarized here. The alternative development, selection and elimination is described in the following sequence in this section:

- o Existing Conditions 1981
- o No Action 1985

- o Development of Preliminary Alternatives
- o Screening of Alternatives
- o Selection of Alternatives for Further Evaluation
- o Presentation of Selected Alternatives
- o Description of the Preferred Alternative

This Facilities Plan and EIS are a part of an ongoing effort to upgrade and improve the quality of effluent being discharged from the Northside WWTP (see Figure 4-1) to the receiving stream, Bird Creek. This portion of the project will not be implemented until 1985. The stream is in a state of progressive improvement and the data base for the project will change as outlined below.

EXISTING CONDITIONS 1981

Since the original 208 sampling survey of 1976, the Northside Plant has undergone an 11 MGD expansion along with the inclusion of disinfection (1979). In addition to the Northside Plant discharge, several other municipal point source contributions are located along the portion of the stream under evaluation. The most significant discharges are from the Tulsa Flat Rock and Coal Creek plants, which are located above the Northside Plant and contribute approximately 11 MGD of treated municipal wastewater to Bird Creek. Because of the expansion and disinfection at Northside and the operational improvements at all three plants, a new sampling survey was conducted in 1981 by INCOG. The new data indicated a substantial improvement in the stream's water quality since the original study and it is this data that provides the basis from which the water quality impact evaluations were assessed. In terms of the socioeconomics, or the assessment of the effects on the service area, historical trends from 1970 through 1981 are established and used as a guide for future projections.

NO ACTION 1985

The No Action evaluation for this project is not considered a viable alternative. As discussed previously, the City of Tulsa is under an

Figure 4-1 Northside Wastewater Treatment Plant Location.

Administrative Order to achieve a specified effluent limitation that enables Bird Creek to meet the present State Stream Standards of 5 mg/l Dissolved Oxygen (DO) for streams classified as warm water fisheries. No Action, or no project, would result in the discharge of secondarily treated effluent which would prevent the receiving stream from meeting these limitations.

In this study, No Action will represent the conditions expected to occur in 1985, when the project is expected to be implemented. The most significant change in terms of water quality will be the closure of the two upstream plants, Flat Rock and Coal Creek. Their flows (11 MGD) will be conveyed to the Northside Plant where they will be treated to a secondary level in an additional 11 MGD expansion that is to be on-line by 1985. The net result will be the return of the approximately 7 mi of Bird Creek upstream of the Northside Plant to a more natural condition. From a socioeconomic standpoint, however, no new capacity will be provided at the plant to accommodate future growth in the service area. This will bring the total plant flow to 30 MGD.

DEVELOPMENT OF PRELIMINARY ALTERNATIVES

The Wastewater Management Alternatives developed by the Facilities Plan Engineer, CH2M Hill, are divided into two distinctly separate approaches. They are designed to ensure compliance with the beneficial use criteria and State Stream Standards designated for Bird Creek.

The first approach is to remove the flow contributed by the Northside Facility and either transport it out of the Bird Creek watershed to a river with greater flow and assimilative capacity, such as the Arkansas River, or to make the effluent available for industrial reuse or land application.

The second approach calls for a high degree of treatment of the wastewater prior to discharge to Bird and Mingo creeks. The level of effluent quality as required by the Administration Order is 5 mg/l BOD, 5 mg/l SS, and 3 mg/l NH_3-N, which is accomplished through a system of Advanced Wastewater Treatment (AWT).

Under these two approaches, a total of 17 Wastewater Management Alternatives were developed for the initial screening process. Seven of these would remove the flow from Bird and Mingo creeks, and ten would treat the flow to a high degree prior to discharge.

SCREENING OF PRELIMINARY ALTERNATIVES

A detailed environmental evaluation of the proposed wastewater management alternatives is not practical at this level because a total of 17 alternatives are under consideration. In this initial screening process, the evaluation is limited to available data and the inherent impacts of operating the overall process trains. Because of the two approaches, many of the potential impacts as well as mitigation measures would be similar for each of the alternatives under that approach. For this reason, a general discussion of these common impacts is provided in the introduction for each approach followed by a narrative description for each of the alternatives outlining its strengths and weaknesses. The evaluation is followed by a summary matrix, provided to present a relative comparison by environmental indicator. The Wastewater Management Alternatives are prefixed MA and numbered 1-17.

Approach I: Effluent Removal

As discussed previously, the options under this approach would maintain stream standards by removing the effluent that is presently being discharged to Bird Creek. Several points of consideration are common to all the alternatives in this approach and are presented below. Each alternative includes the construction of a pipeline to convey the effluent from its existing discharge at Bird and Mingo creeks to an alternate point for either discharge and/or reuse. The routing of the transmission line would vary as presented below; however, each line would produce some noise and dust impacts from construction as well as crossing county lines. Additionally, the length or the retention time of the effluent in these lines may result in septic conditions and potential odor problems. The common, and probably most significant, change that would result from the transfer of effluent is the sizable decrease in flow to Bird Creek. The overall effect would be a return of the stream to "pre-Northside" conditions with flows becoming more dependent on storm water runoff and groundwater seepage.

Out-of-Basin Transfer. Two alternatives call for the conveyance of secondarily treated effluent to the Arkansas River.

- o MA-1; parallel activated sludge and trickling filter trains
- o MA-2; complete activated sludge trains

The only difference in these two alternatives is whether the existing plant trickling filter trains are maintained or abandoned and replaced with new activated sludge trains. From an environmental standpoint, the differences between the unit processes used in the alternatives to reach a level of secondary treatment are negligible. Therefore, the alternatives are discussed jointly.

These alternatives would discontinue the existing practice of discharging treated wastewater to Bird and Mingo creeks, and a new transmission line would be built for the conveyance of the effluent to the Arkansas River.

According to a wasteload allocation analysis performed during the 208 Study, the Arkansas River should maintain sufficient assimilative capacity to accommodate a secondary effluent. The implementation of either of these alternatives would require further evaluation by the planning agency, however.

The major environmental considerations involve the actual physical construction of an off-site transmission line, the acquisition of rights-of-way and the crossing of political boundaries. The pipeline would begin at the Northside Plant following Bird Creek generally southeast and crossing into Rogers County. At Round Mountain, the route proceeds south, crossing the St. Louis and San Francisco Railroad lines and passing between Indian Hills and the town of Catoosa. Major highway crossings include U.S. 66 and State Highway 33 before crossing into Wagoner County. The line crosses Spunky Creek at approximately the intersection of State Highway 33 and Spunky Creek. At this point, the route continues alongside a narrow band of strip mines south-southwest for about 10 mi to the Wagoner - Tulsa County border. It then turns due south for the remaining 3 mi to the Arkansas River, entering just downstream of Broken Arrow Creek.

Industrial Reuse. Two alternatives call for the transport of secondary effluent to the Black Fox Power Station for reuse as cooling water.

- o MA-3; parallel activated sludge and trickling filter trains
- o MA-4; complete activated sludge trains

Again, the differences among the unit processes utilized by the two alternatives are not significant. The outstanding feature would be the beneficial reuse of a municipal effluent. Currently, the City of Tulsa is under contract to sell 44.6 MGD of either raw water or treated wastewater to Public Service Company for use at Black Fox Power Station.

The reuse of effluent could reduce the projected demand on the City's potable water supply, create revenue, and postpone the need to develop new raw water supplies.

These alternatives would require that a transmission line of approximately 26 mi in length be built, which would be accompanied by construction, rights-of-way, and jurisdictional considerations.

The route to Black Fox generally follows Bird Creek to the Verdigris River. It then follows the Verdigris River southeast across the St. Louis and San Francisco Railroad Lines, Spunky Creek, U.S. 66, and the Will Rogers Turnpike. Continuing south, the route crosses State Highway 33 and the Rogers - Wagoner County line. Heading east, it crosses the Verdigris River at about the Rogers - Wagoner County line and then crosses Commodore Creek about 4 mi before reaching the Black Fox site.

Land Application. These two alternatives are the same except for the unit processes involved. The secondary effluent would be transported to an agricultural land application site for beneficial reuse.

- MA-5; parallel activated sludge and trickling filter trains
- MA-6; complete activated sludge trains

Basically, these alternatives would replace normal irrigation water with treated effluent. The primary advantage is in the beneficial reuse of both the water and the nutrient value in the effluent for crop growth.

The two greatest concerns with land application are associated with site selection and the method of operation. Site screening is based specifically on characteristics for depth to bedrock and seasonal high groundwater, topography, and soil permeability. The method of land application would provide agricultural reuse by slow rate infiltration (Tech. Memo. III-4). In wastewater land application, the concern is for potential contamination of surface and groundwater with nitrates. Heavy metals, which are often the limiting factor in sludge land application, are not as important here due to the lower concentrations associated with wastewater. The nutrient values of wastewater, particularly nitrogen, are higher. Therefore, the loading rates are set so that the appropriate amount of nitrogen is supplied to meet the uptake requirements of the crops grown. Excessive loading rates could result in groundwater contamination by nitrates, so areas over potable water supplies should be avoided. Surface water contamination should also be prevented by utilizing sites which have closed drainage or soils with low runoff potential, and application during wet weather should be avoided.

Another concern in agricultural reuse of wastewater is pathogens and parasites. Much of the risk is eliminated during treatment prior to application, however, some harmful organisms may be carried by aerosols from sprinkler irrigation and on plants and soil. The risk of exposure to humans and the surrounding areas may be reduced or eliminated by disinfection, buffer zones, and/or access controls such as fencing.

The route of the transmission line to the land application or agricultural reuse site crosses Bird Creek from the Northside WWTP and travels northeasterly into Rogers County. It crosses State Highway 20 about 2 mi northwest of Keetonville and then crosses the Verdigris River just below the mouth of Caney River. The transmission line would go to one of the potential land application sites in the area.

Approach II: Advanced Wastewater Treatment (AWT)

Based on the 208 wasteload allocations, the Beneficial Use Designation for Bird Creek and the State Water Quality Standards for an instream dissolved oxygen level of 5 mg/l, the Northside Facility must maintain an effluent quality of 5 mg/l BOD, 5 mg/l SS and 3 mg/l NH_3-N. To accomplish this high degree of treatment, all of the alternatives under this approach are dependent primarily on the biological assimilation of the organic material (BOD) as well as the biological or chemical conversion of ammonia (NH_3).

AWT Alternative Evaluation. From an environmental standpoint the differences among the methods of biological treatment are not significant. However, in some cases additional processing is required. To ensure consistency in the evaluation, all the alternatives will be discussed generally and where environmental or system reliability concerns occur they will be stated.

- MA-7; expanded parallel activated sludge and trickling filter trains.

  Except for the operational difficulties in the joint operation of separate and differing facilities, the alternative should sustain high levels of treatment. As stated in Tech. Memo. III-4, the inherent problem of fixed growth media biological treatment systems is their susceptibility to low temperatures. The temperature constraint is of particular importance in the nitrification phase of treatment during the winter months.

  This alternative, as in all the AWT processes, employs the use of granular media filtration. The advantage of this is a high degree of suspended material removal from the flow prior to disinfection. This removes particles that harbor pathogens, thus reducing the chlorine requirement.

- MA-8; trickling filter trains in series with activated sludge trains.
  MA-16; biological filters followed by activated sludge trains.

  These two alternatives are comparable and have been combined by the Facilities Plan Engineer, CH2M Hill, for evaluation purposes. Both utilize fixed growth unit processes, trickling filters and biological filters, respectively, followed by an activated sludge process. The advantage is that the nitrification phase of treatment occurs in the activated sludge process, making nitrification less susceptible to cold weather. In addition, the fixed growth processes come first, buffering the more sensitive nitrification phase from potential toxic shocks by industrial spills. The benefits from granular media filtration, as discussed previously, are also provided in these alternatives.

- MA-9; parallel activated sludge and trickling filter trains followed by rotating biological contactors.
  MA-10; parallel activated sludge and trickling filter trains followed by biological filters.

  MA-9 and MA-10 are comparable, using the same biological process trains for initial treatment, followed by fixed growth units for nitrification. They have been combined for evaluation purposes. These latter units are rotating biological contactors (RBC's) and biological filters, respectively. As discussed, fixed growth units, particularly when used for nitrification, are more susceptible to cold weather. As with the other alternatives, granular media filters will be provided.

- MA-11; complete activated sludge trains.

  This alternative would utilize an activated sludge process train for all modes of treatment, with the advantages of a single facility's operation and flexibility. In addition, biological nitrification would occur in the suspended growth activated sludge process which is less susceptible to cold weather. Granular media filtration is also provided.

- MA-12; activated carbon sludge trains.

  This alternative is comparable to MA-11 in that a complete activated sludge process train is utilized. In this case, however, the size of the aeration capacity has been reduced due to the addition of powdered activated carbon. The activated carbon would be added during cold weather. This provides a suspended growth media to support a higher population of microorganisms which enhances the nitrification process. Granular media filtration is also a part of this alternative.

- MA-13; activated sludge trains followed by breakpoint chlorination.

  This alternative utilizes a single process train of activated sludge as the primary method of treatment and nitrification, followed by granular media filtration.

  The distinct difference in this alternative is that a series of non-biological chemical reactions are used to remove ammonia. This method of treatment is called breakpoint chlorination. The process would be employed during those times of the year when the operating temperatures are too low (winter) to sustain biological nitrification. The process requires large dosages of chlorine to oxidize (convert) the ammonia-nitrogen (NH_3-N) to nitrogen gas (N_2). In theory, a dosage ratio of approximately 7.6 parts chlorine to 1 part ammonia would be required to bring about this conversion, but in practice the ratio is closer to 9:1. Many factors govern the NH_3 to N_2 conversion, including dosage, pH, contact time, and temperature. The pH would probably decrease (acid) with chlorine addition, requiring some buffering. If the pH drops below 6.5 (7.0 is neutral), the chemical reactions would favor the formation of malodorous nitrogen trichloride, NCl_3. Other chemical reactions could occur between chlorine and organic precursors found in wastewater and potentially lead to the formation of trihalomethane (THM). In addition, depending on the dosage, the combined or residual chlorine would be high, exerting its own toxicity on the aquatic biota. The mitigation for this problem is dechlorination, which has been included as a part of the design.

- MA-14; activated sludge followed by rotating biological contactors.
  MA-15; activated sludge followed by biological filters.

  These two alternatives utilize the activated sludge processes for initial treatment followed by a fixed growth media unit process to provide nitrification. As discussed, the fixed growth system is susceptible to cold weather, particularly when it is used to nitrify. Granular media filters are also provided.

- MA-17; parallel activated sludge and trickling filters followed by granular media filtration.

  This alternative would treat the wastewater beyond the secondary level, making it reusable by industries along its route to a discharge point along the Arkansas River (route would be dependent on demand). The major advantages are the reuse of effluent which would reduce the current demand on the City's potable water supply, develop revenue, and postpone the need to develop the raw water supplies. Dependent on the industrial users' needs, additional chlorine could be required, due to extended pipeline retention time. The purpose would be to ensure a chlorine residual (disinfection) for the protection of public health.

Summary of Preliminary Alternative Screening

All of the alternatives that have been presented were developed with the purpose of achieving the level of water quality in Bird Creek specified by the Oklahoma State Water Quality Standards. To accomplish this task, two approaches were developed; one to remove the effluent from the stream, and the other to treat the flow to a high degree prior to discharge. Table 4-1 summarizes the environmental effects of these alternatives.

Table 4-1 SUMMARY EVALUATION OF THE WASTEWATER MANAGEMENT ALTERNATIVES

	Water Resources			Physical Resources			Biological Resources	
Alternatives	Surface Water	Ground-water	Flood Hazards	Geology	Soils	Air Quality	Terrestrial Flora/Fauna	Aquatic Flora/Fauna
MA-1	+[a,j]	0	0[c]	0	0	0	0	0[a]
MA-2	+[a,j]	0	0[c]	0	0	0	0	0[a]
MA-3	+[a]	0	0[c]	0	0	0	0	0[a]
MA-4	+[a]	0	0[c]	0	0	0	0	0[a]
MA-5	+[a]	0	0[c]	0	0[d]	0	0[e]	0[a]
MA-6	+[a]	0	0[c]	0	0[d]	0	0[e]	0[a]
MA-7	+[b]	0	0	0	0	0	0	0[b]
MA-8	+[b]	0	0	0	0	0	0	0[b]
MA-9	+[b]	0	0	0	0	0	0	0[b]
MA-10	+[b]	0	0	0	0	0	0	0[b]
MA-11	+[b]	0	0	0	0	0	0	0[b]
MA-12	+[b]	0	0	0	0	0	0	0[b]
MA-13	+[b]	0	0	0	0	0	0	0[b]
MA-14	+[b]	0	0	0	0	0	0	0[b]
MA-15	+[b]	0	0	0	0	0	0	0[b]
MA-16	+[b]	0	0	0	0	0	0	0[b]
MA-17	+[a,j]	0	0[c]	0	0	0	0	0[b]

[a] Return Bird Creek to a more natural state of water quality and flow, absent of Northside discharge.
[b] Provides the discharge of a high quality effluent.
[c] Removes consistent instream flow.
[d] Agricultural reuse is highly dependent on available soils.
[e] Beneficial reuse of effluent for agriculture.
[f] All alternatives provide for the expansion of the plant to accommodate growth.
[g] Transmission line is required, potentially adverse.
[h] Long pipeline retention time could produce septic conditions, requires mitigation.
[i] Potential for public access to application sites, buffer zones required to limit aerosols.
[j] Study of Arkansas River assimilative capacity is required.

Key:
- ++ major beneficial
- + minor beneficial
- 0 no impact
- \- minor adverse
- -- major adverse

SELECTION OF ALTERNATIVES FOR FURTHER EVALUATION

All of the aforementioned alternatives were evaluated based on both engineering and environmental criteria. Several operational concerns relating to wintertime nitrification and environmental problems were identified during this initial screening process. However, because of available mitigation measures none were considered to be of great enough significance to remove any of the proposed options from further evaluation.

In the initial screening to select the four alternatives for more detailed evaluation, the comparative present worths were used. In assessing all of the alternatives, a significant gap in cost occurs between the five most costly alternatives and the next group. Those alternatives in excess of this break are ruled out from a cost-effectiveness standpoint. Those eliminated on this basis were MA-5, MA-6, MA-9, MA-11, and MA-14. The average present worth for the remaining alternatives was approximately 65 million dollars, with a range of 59 to 76 million dollars in total cost.

Several of the alternatives were very similar, such as MA-1 and 2, MA-3 and 4, MA-8 and 16, and MA-10 and 15. The only difference between each pair is the abandonment or incorporation of the existing trickling filter train. To prevent two very similar alternatives from being selected for more detailed consideration, one of each of the aforementioned pairs was eliminated. Because of a higher comparative present worth, MA-2, MA-4, MA-8, and MA-15 were eliminated (Tech. Memo. III-5).

The remaining eight alternatives are ranked by cost from the least to the most comparative present worth as follows:

- MA-3; parallel activated sludge and trickling filter trains/industrial reuse at Black Fox Power Station ($46.49 million).
- MA-16; biological filters followed by activated sludge trains/discharge to Bird and Mingo Creeks ($58.70 million).
- MA-10; parallel activated sludge and trickling filter trains followed by biological filters/discharge to Bird and Mingo Creeks ($63.36 million).

Table 4-1 SUMMARY EVALUATION OF THE WASTEWATER MANAGEMENT ALTERNATIVES (continued)

	Socioeconomics				Cultural Factors			
Alternatives	Population[f]	Employment[f]	Personal Income[f]	Land Use	Recreation	Aesthetics Odors & Noise	Public Health	Archaeological Historical
MA-1	0	0	0	-[g]	+[a]	-[h]	0	0[g]
MA-2	0	0	0	-[g]	+[a]	-[h]	0	0[g]
MA-3	0	0	0	-[g]	+[a]	-[h]	0	0[g]
MA-4	0	0	0	-[g]	+[a]	-[h]	0	0[g]
MA-5	0	0	0	-[g]	+[a]	-[h]	-[i]	0[g]
MA-6	0	0	0	-[g]	+[a]	-[h]	-[i]	0[g]
MA-7	0	0	0	0	+[b]	0	0	0
MA-8	0	0	0	0	+[b]	0	0	0
MA-9	0	0	0	0	+[b]	0	0	0
MA-10	0	0	0	0	+[b]	0	0	0
MA-11	0	0	0	0	+[b]	0	0	0
MA-12	0	0	0	0	+[b]	0	0	0
MA-13	0	0	0	0	+[b]	0	0	0
MA-14	0	0	0	0	+[b]	0	0	0
MA-15	0	0	0	0	+[b]	0	0	0
MA-16	0	0	0	0	+[b]	0	0	0
MA-17	0	0	0	-	+[a]	-[h]	0	0[g]

[a] Return Bird Creek to a more natural state of water quality and flow, absent of Northside discharge.
[b] Provides the discharge of a high quality effluent.
[c] Removes consistent instream flow.
[d] Agricultural reuse is highly dependent on available soils.
[e] Beneficial reuse of effluent for agriculture.
[f] All alternatives provide for the expansion of the plant to accommodate growth.
[g] Transmission line is required, potentially adverse.
[h] Long pipeline retention time could produce septic conditions, requires mitigation.
[i] Potential for public access to application sites, buffer zones required to limit aerosols.
[j] Study of Arkansas River assimilative capacity is required.

Key:
- ++ major beneficial
- + minor beneficial
- 0 no impact
- - minor adverse
- -- major adverse

- MA-1; parallel activated sludge and trickling filter trains/out-of-basin transport to the Arkansas River ($67.55 million).
- MA-13; activated sludge trains followed by breakpoint chlorination/ discharge to Bird and Mingo Creeks ($68.75 million).
- MA-7; parallel activated sludge and trickling filter trains/discharge to Bird and Mingo Creeks ($72.02 million).
- MA-12; activated carbon sludge trains/discharge to Bird and Mingo Creeks ($72.08 million).
- MA-17; parallel activated sludge and trickling filter trains/reuse and out-of-basin transport combination ($76.61 million).

Based on concern expressed during Public Advisory Committee (PAC) meetings and the more qualitative factors surrounding the implementability of Alternative MA-3 as well as the uncertainty of construction of the Black Fox Power Station, MA-3 was eliminated from further consideration. The next four least-cost alternatives of the remaining seven were selected for further evaluation. Therefore, the four alternatives which were chosen for more detailed evaluation are MA-1, MA-10, MA-13 and MA-16.

PRESENTATION OF THE SELECTED ALTERNATIVES

The four selected alternatives, MA-1, MA-10, MA-13, and MA-16, were subjected to detailed evaluation. The information and the environmental concerns for each alternative developed during this evaluation are presented in Section 6 and will not be repeated here. At the end of Section 5.1 there is a summary evaluation and a detailed matrix of significant impacts for each of the alternatives providing an overall comparison of the alternatives. This is summarized on Table 4-2, followed by Table 4-3 which provides the alternatives' major advantages and disadvantages. In addition to these environmental issues, the capital, operation and maintenance, energy consumption, and total alternative costs are provided on Table 4-4.

DESCRIPTION OF THE PREFERRED ALTERNATIVE

Upon completion of the detailed evaluations of the alternatives, two remained as the least costly and most implementable plans. These were;

Table 4-2 SUMMARY MATRIX OF WASTEWATER MANAGEMENT ALTERNATIVES

Environmental Parameters	No Action	WASTEWATER MANAGEMENT ALTERNATIVES: Out-of-Basin MA-1	Advanced Wastewater Treatment MA-10	MA-13	MA-16
WATER RESOURCES					
Surface Water	--	+	++	++	++
Groundwater	0	0	0	0	0
Flood Hazards	-	0	0	0	0
PHYSICAL RESOURCES					
Geology	0	0	0	0	0
Soils	-	0	0	0	0
Air Quality	0	-	-	-	-
BIOLOGICAL RESOURCES					
Terrestrial Flora/Fauna	0	0	0	0	0
Aquatic Flora/Fauna	-	+	+	+	+
SOCIOECONOMICS					
Population	-	+	+	+	+
Employment	-	+	+	+	+
Personal Income	-	+	+	+	+
Land Use	-	+	+	+	+
CULTURAL FACTORS					
Recreation	-	+	+	+	+
Aesthetics, Odors and Noise	0	-[a]	0	-[a]	0
Public Health	-	0	0	0	0
Archaeological/Historical	0	-[b]	0	0	0

[a] Dependent on operation
[b] Dependent on pipeline route

EVALUATION KEY:
- ++ major beneficial
- \+ minor beneficial
- 0 no impact
- \- minor adverse
- -- major adverse

Table 4-3 SUMMARY OF MAJOR ADVANTAGES AND DISADVANTAGES OF WASTEWATER ALTERNATIVES

Alternative	Advantages	Disadvantages
No Action		Would not meet Admin. Order or NPDES permit Effluent limits exceed stream's assimilative capacity High levels of ammonia are toxic to aquatic life Limits recreational reuse
Out-of-Basin Transfer	Potential for future reuse of effluent depending on routing Complete removal of effluent NH_3 and Cl_2 toxicities to aquatic life from Bird Creek Returns stream to a more natural state	Potential for impacts from pipeline construction Archaeological and historical clearances are recuired for pipeline route Potential for loss of aquatic habitat during low-flow and seasonal warm weather D.O. sags In-line chlorine addition or reaeration may be required to prevent septic conditions and odor problems
MA-10	Provides the advantages of advanced treatment o good quality effluent o low NH_3 concentration o constant downstream flow All biological treatment	Nitrification process is susceptible to cold weather-the addition of covers may offset this problem
MA-13	Same benefits of AWT Seasonal use with the potential for off-season backup in the event of a toxic shock to the biological nitrification process Not susceptible to weather	The use of highly reactive chemicals for treatment Probable THM formation, but at low levels High level of system monitoring to prevent chlorine toxicity or D.O. sags from excess dechlorination Effluent pH buffering is required Potential for nitrogen trichloride (NCl_3), a noxious gas, production at a pH less than 6.5
MA-16	AWT All biological treatment Nitrification occurs in the activated sludge process, not as susceptible to cold weather Biofilters buffer the primary mode of treatment and nitrification (activated sludge process) from potential shock loadings year round	Requires energy for flow pumpage through biological filters. This alternative, as with the other plans, could exert a financial burden on the City.

Table 4-4 SUMMARY OF COST INFORMATION FOR THE SELECTED WASTEWATER MANAGEMENT ALTERNATIVES

Alternative		Capital ($ Million)[a]	Energy (Annual kwh (10^6))[b]	O & M (Annual $ Million)[c]	Present Worth ($ Million)[a]
MA-1;	Out-of-Basin Transfer	$64.41	25.3	$2.10	$86.10
MA-10;	Activated Sludge with Trickling & Biological Filters	$68.17	17.9	$2.56	$95.77
MA-13;	Activated Sludge and Breakpoint Chlorination	$34.75	16.5	$2.48	$68.68
MA-16;	Biological Filters and Activated Sludge	$37.62	19.8	$2.43	$65.39

[a] January, 1982 dollars at full capacity in 2005.
[b] Values are kilowatt-hour (10^6). Energy costs are equal to 3.23 cents/kwh in 1982, escalated at 2.893 percent/year from 1982 to 1990, and at 0.679 percent/year from 1990 to 2005.
[c] EPA wastewater treatment plant O & M cost index of 3.32.

SOURCE: Tech. Memo. III-7

MA-13 using activated sludge and breakpoint chlorination with a present worth of $65.385 million; and MA-16 using activated sludge with biological filters at a total cost of $68.684 million. The basic difference between the alternatives was the method in which wintertime nitrification would be provided; MA-13 requires chemical addition, and MA-16 utilizes biological processes.

Based on the concerns expressed by both the Public Advisory Committee and City staff regarding the use of the highly reactive chemicals required in breakpoint chlorination, Alternative MA-16 was recommended over MA-13 because the potential environmental hazards and the concern for operator safety outweigh the slightly higher costs. MA-16 was therefore determined to be the most cost-effective alternative because it is the least costly with no major environmental effects.

Phased Implementation

Due to the financial burden that may be placed on the City as a result of the funding requirements for a project of this size, phasing or a method of staged construction of the two preferred alternatives (one for wastewater and one for residuals) was recommended by the City. This is particularly true in light of the many urgent needs of the separate wastewater and residuals portions of the project, each with its specific priorities. A detailed evaluation of various options for phased implementation, the financial impacts, and the environmental analysis of the changes in water quality were presented in Tech. Memo. III-8, IV-9, V-4, and Report XII. Because phasing more directly affects wastewater management and the time frame in which AWT is implemented at the Northside Plant, a general summary of the environmental effects presented in Report XII along with input provided during the June 1, 1982 PAC are given below.

Effluent Quality vs. Plant Capacity. A new facility's NPDES permit is usually based on the plant's rated capacity and its ability to consistently achieve specific effluent limitations for that flow. As a result, many factors must be taken into account when the plant is designed; for instance, infiltration and inflow (I/I), and seasonal flow and load fluctuations.

Generally, when a plant designed to produce a secondary effluent of 20 mg/l BOD and 30 mg/l SS at its rated capacity is underloaded or below flow capacity, better than the original design effluent qualities are achievable.

The following data shows the recent quality of the Northside Plant effluent, from the activated sludge process train for a range of flows from about 74 to 101 percent of the 11 MGD rated capacity.

Northside Plant Effluent Quality
(11 MGD Activated Sludge)

Month	Flow MGD	Percent of Capacity	BOD mg/l Avg	BOD mg/l Max	TSS mg/l Avg	TSS mg/l Max
April 1981	8.1	74	7	8	10	11
May 1981	9.2	84	6	8	11	17
June 1981	9.4	86	10	12	11	16
July 1981	8.8	80	5	8	12	26
August 1981	9.5	86	5	7	7	12
September 1981	9.3	85	5	6	11	15
October 1981	10.3	94	6	8	10	12
*November 1981	11.1	101	4	7	8	11
*December 1981	9.7	88	5	8	10	11
*January 1982	9.8	89	5	6	11	15
*February 1982	11.7	106	5	5	7	7
*March 1982	9.8	89	3	6	6	7

* During these months the plant was operated to provide for complete nitrification, (oxidation of ammonia NH_3 to nitrate NO_3).

As indicated, the Northside activated sludge plant has demonstrated ability to provide for complete nitrification during colder weather at or near design flow. Based on this demonstrated capability, it was decided to make a careful assessment of phasing.

To project the plant's ability to continue to produce this level of effluent quality in the future, the relationship between flow to the plant and the addition of capacity by phasing was evaluated throughout the 20-yr planning period using these projected flows.

Projected Future Wastewater Flows MGD*

Year				
1985	1990	1995	2000	2005
30.8	33.4	37.1	40.4	42.6

*Tech. Memo. III-2, including Lord Cemetery flows of 0.8 MGD in 1985, increasing to 4.5 MGD by 2005

Starting in 1985 it can be seen that the Northside Facility could be receiving approximately 30.8 MGD of flow to the plant when it would have a rated capacity of 30 MGD.

If the plant (30 MGD) is operated at only a secondary level (20 mg/l BOD, 30 mg/l SS) with no nitrification, the resultant instream dissolved oxygen (D.O.) sag would resemble the lower profile which is illustrated on Figure 4-2. However, if the same plant is operated more efficiently by providing higher levels of O_2 in the activated sludge system it will run in a nitrification mode as has been exhibited in the recent past. In this situation, an effluent quality of 15 mg/l BOD and 3 mg/l NH_3 could be achieved, and the D.O. profile instream could improve to the level shown by the dashed line on Figure 4-2. In addition, if nitrification is carried beyond the NPDES requirement of 3 mg/l NH_3, the dashed-line D.O. profile would be at an even higher level. In either case, with this improved level of operation, the water quality downstream of the Northside discharge should improve beyond that which presently exists. (Note: the profiles are based on Biochemical Oxygen Demand (BOD) and Ammonia (NH_3) loadings. Suspended solids (SS) will be comparable to the levels shown for BOD as exhibited by previous plant data).

Phased Construction. Shown on Figure 4-3 is the flow chart for phasing. This assessment is based on the phasing approach selected by the City,

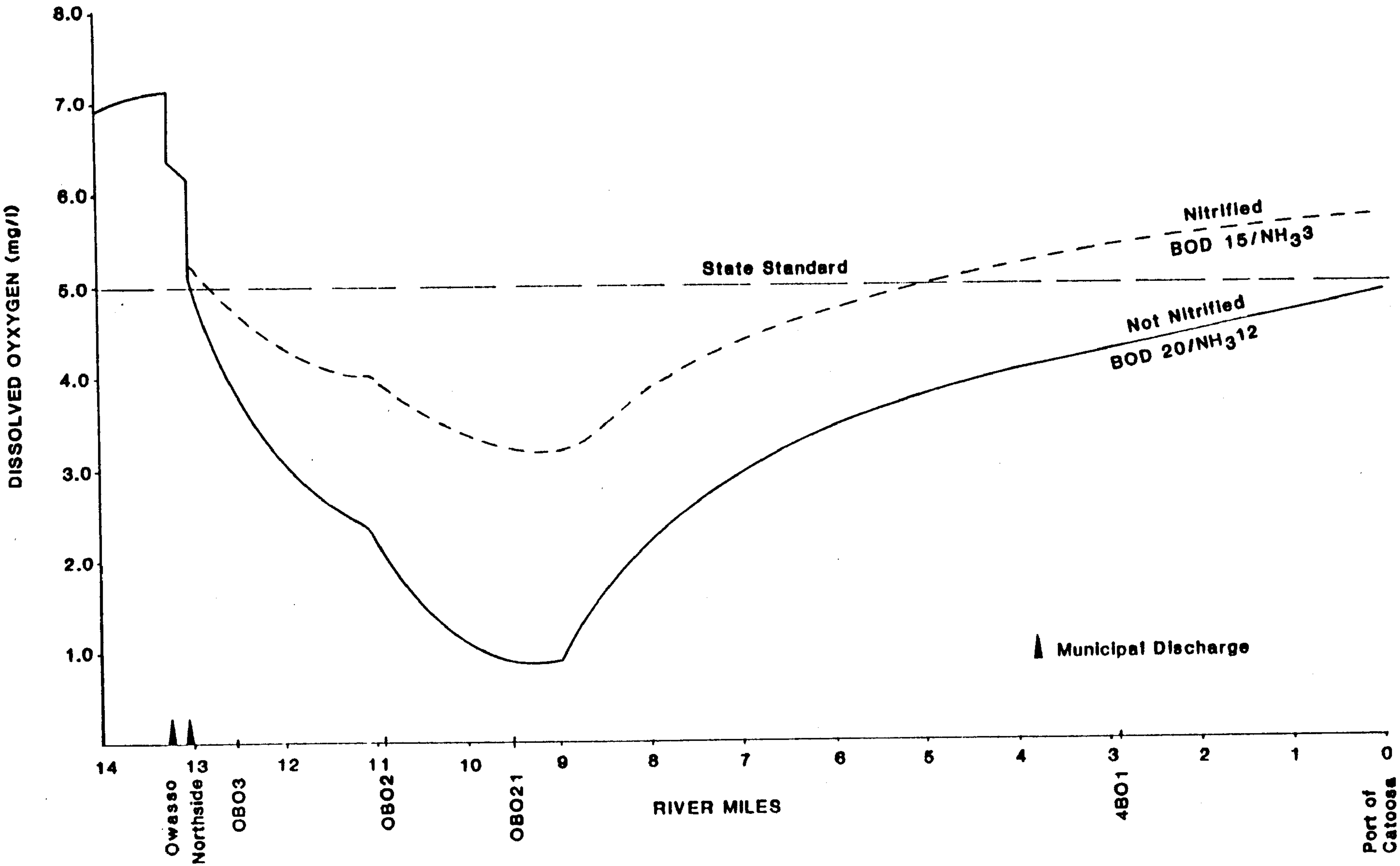


Figure 4-2 Effects of Plant Operational Improvements on Water Quality.

PHASING FLOW CHART

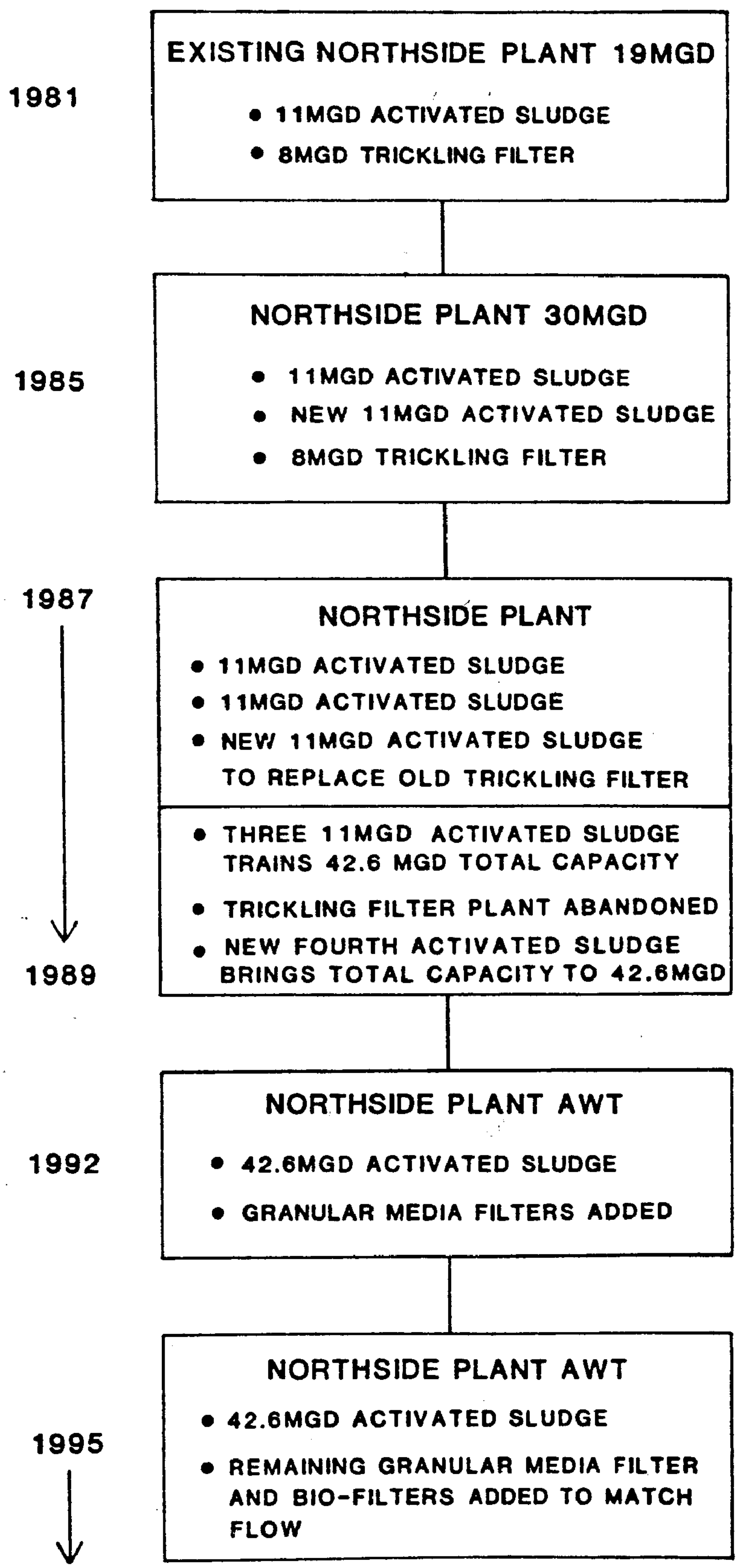


Figure 4-3

referred to as Alternative 1 in the Facilities Plan. the dates used here are the proposed implementation dates for this approach.

As the project is phased in, the first improvement to wastewater treatment would be the addition of an 11 MGD activated sludge train. This could be around 1987-1988 as funds become available. This was presented by the City during the June 1, 1982 meeting as one of the possible approaches to phasing which was approved by the PAC. The purpose of this first expansion is to provide for additional capacity so that the older trickling filter plant could be abandoned. The result would be a plant with a total of 41 MGD of capacity prior to the trickling filter plant being removed from operation. This would ensure excess capacity beyond the higher flow projections for 1990 of 33.4 MGD. Therefore, the larger plant would only be operating at 81 percent of capacity and would be expected to produce an effluent quality similar to that presently achieved at Northside (the plant is presently operating at about 89 percent of capacity). Because of the improvements in effluent quality that can be attributed to the underloading of a plant, the trickling filter plant should remain on-line until the last activated sludge process train is brought into operation. This latter expansion is projected to follow a few years later in 1989 and would provide a total capacity of 42.6 MGD when all four activated sludge process trains are in operation and the trickling filter plant (8 MGD) has been abandoned.

Moreover, as the flows to the plant continue to increase, the hydraulic flow rates through the secondary clarifiers would reach a point where some suspended material could be carried over the weirs into the effluent. These suspended solids (SS) are associated with a level of BOD that would exert an oxygen demand on the receiving stream, however, polymer feed to the secondary clarifiers would cause the lighter suspended material to combine into larger particles. Settling would occur more readily because of the increased particle size, resulting in a greater degree of removal and reducing the SS to the 12-15 mg/l range providing for even lower levels of BOD. In addition to the improvements in the effluent quality that result from complete nitrification and polymer feed, the inclusion of post-aeration would further limit the initial impact of the effluent at the point of discharge. Post-aeration would mean that the effluent discharged to the stream would have a high D.O. content and thus would have less adverse effect on aquatic life.

The improvements in the downstream D.O. profile as a result of complete nitrification, polymer feed and post-aeration (12 mg/l BOD, 1 mg/l NH_3, 6 mg/l D.O.) are illustrated on Figure 4-4, with the D.O. profile from an AWT effluent (5 mg/l BOD 3 mg/l NH_3) provided as a point of reference.

Ultimately, this level of advanced wastewater treatment would be achieved when the granular media filters are brought on-line in approximately 1992 to reduce the BOD and SS loadings to 5 mg/l.

As flows increase, the ability of the plant to nitrify in cold weather will decrease. At this point, biological filters would be brought on-line (approximately 1995) to reduce the carbonaceous BOD loadings to the activated sludge train, ensuring that the nitrifiers remain active during the winter months. This would maintain a level of 3 mg/l ammonia in the plant effluent year round. However, based on available data (see Report XII), a wintertime effluent ammonia level of 3 mg/l may not be required to maintain the designated instream levels of D.O. or to prevent ammonia toxicity to aquatic life. This results from the effects of colder temperatures on sustaining high levels of dissolved oxygen and maintaining ammonia in the less toxic ionized (NH_4^+) form. For information purposes, the D.O. profiles for both the summer conditions with nitrification and winter conditions without nitrification are provided in Figure 4-5. Summer conditions include a 12 mg/l BOD effluent with nitrification to a level of 1 mg/l NH_3 discharging to Bird Creek at a temperature of 28°C, and winter conditions include the same 12 mg/l BOD effluent with no nitrification and an NH_3 level of 20 mg/l discharging to a stream at 11°C (see Report XII). The indication is a sizable drop in the instream metabolic activity with cold weather and that colder water holds more oxygen. Further evaluation and the applicability of a seasonal permit or a split-year summer and winter ammonia limit should be considered.

Summary and Conclusions. During the June 1, 1982 PAC, concern was expressed over the potential for phased implementation to result in a gradual loss of

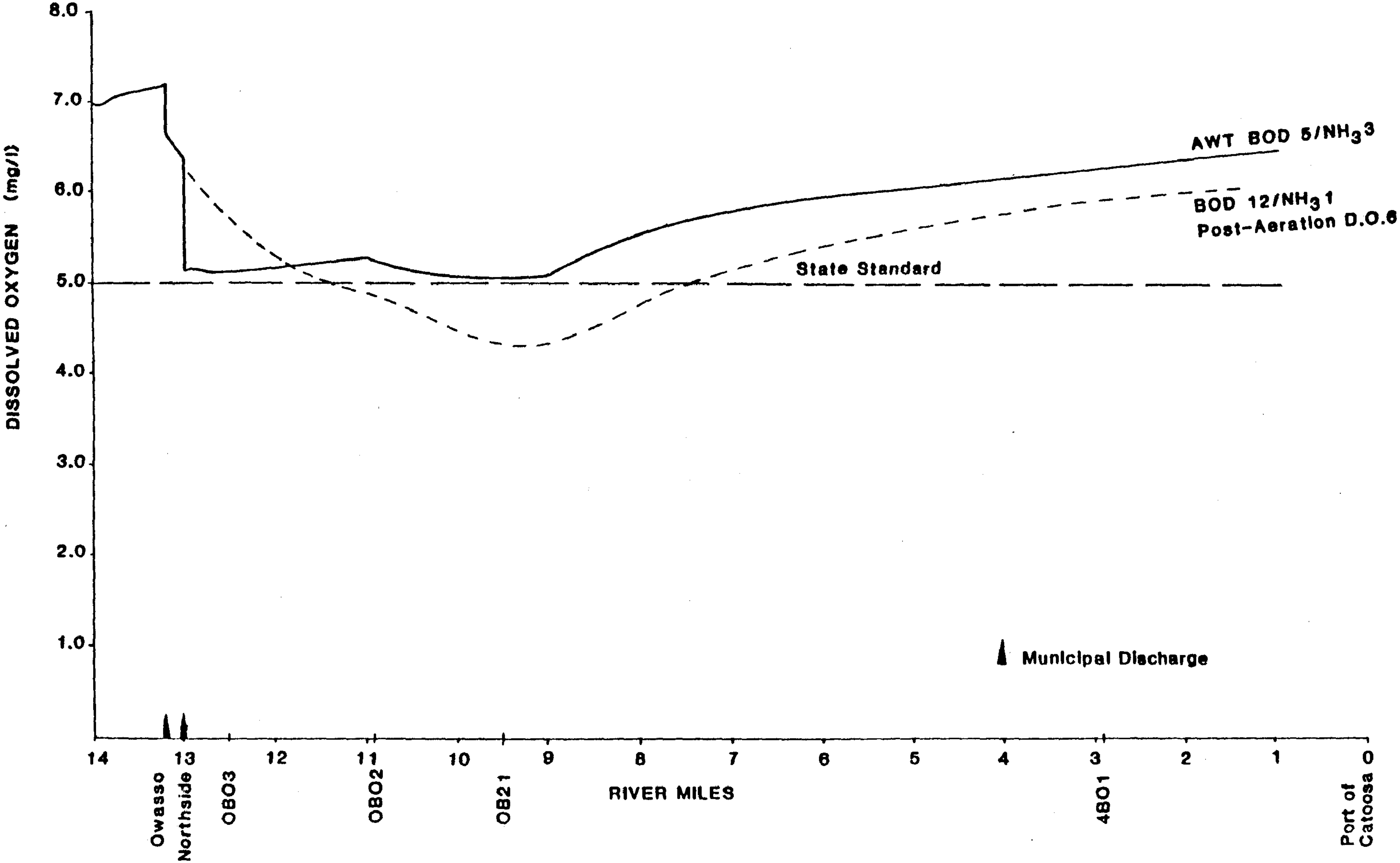


Figure 4-4 Potential Improvements from Polymer Feed and Post-Aeration.

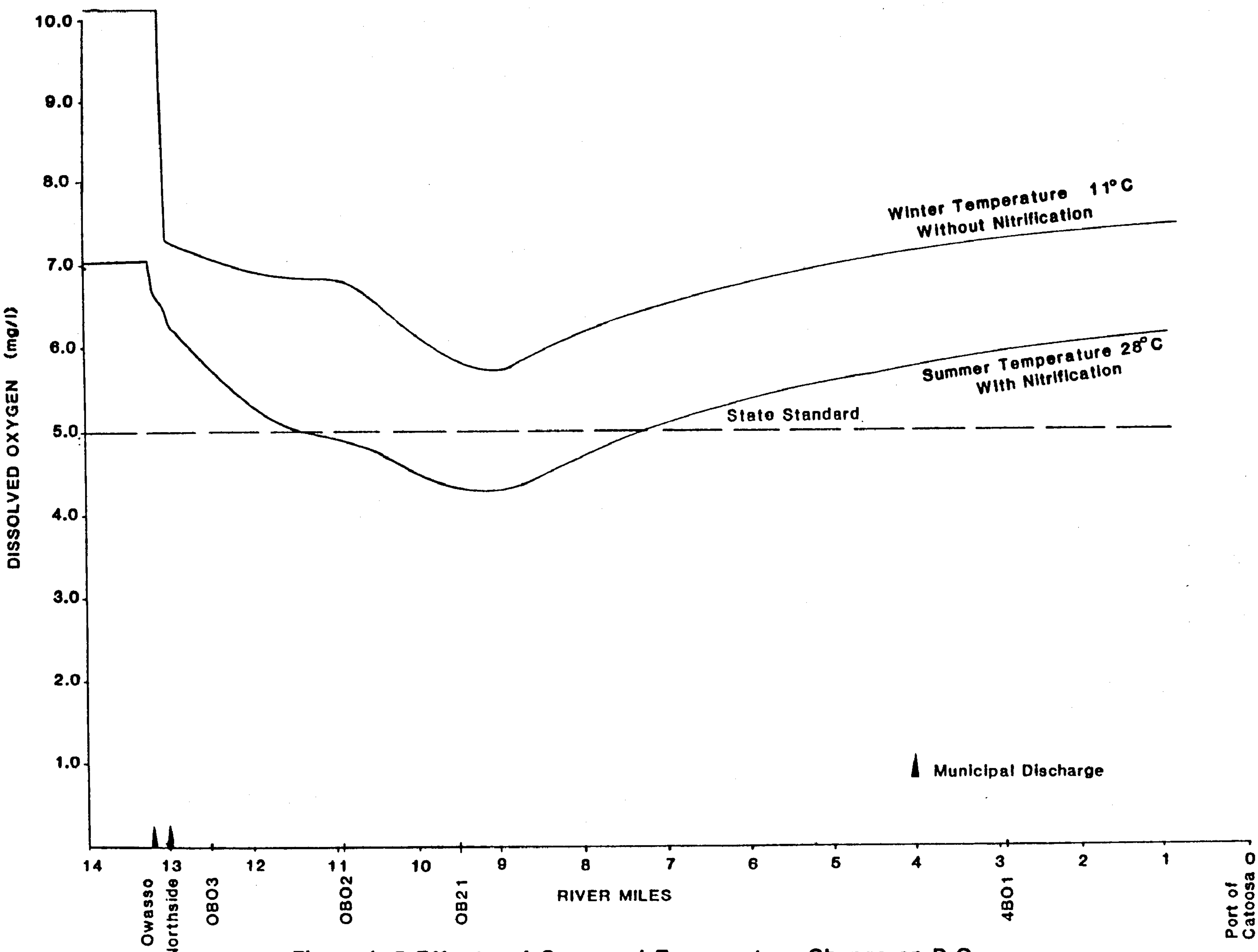


Figure 4-5 Effects of Seasonal Temperature Change on D.O.

those improvements that have already occurred in Bird Creek's water quality. However, as can be seen on Figure 4-6, this is not the case. Provided that the plant is operated efficiently, consistant improvements in plant effluent and stream quality can be achieved with phasing. Figure 4-6 depicts the different D.O. profiles that could be expected as a result of phased construction, assuming that the operational techniques presented earlier are employed.

- Level I: Existing Conditions (1981) - This profile is based on the data collected during the INCOG stream sampling survey of September 9, 1981. The profile illustrates the present water quality of Bird Creek receiving flows from the Flat Rock, Coal Creek, and Northside plants.
- Level II: Nitrification (1985) - This profile illustrates the D.O. levels of Bird Creek in 1985 when Flat Rock and Coal Creek will be closed and the combined flows are being treated at the expanded 30 MGD Northside Facility, with a continuation of the present practices of operational efficiency and nitrification. This profile is based on 15 mg/l BOD and 3 mg/l NH_3.
- Level III: Polymer Feed and Post-aeration (1987-1989) - With the implementation of the first expansion, of this project in 1987 the water quality would begin to improve still further and may reach Level III provided that the trickling filter plant remains on-line. Level III would be reached with the implementation of the last expansion in 1989 if complete nitrification, polymer feed and post-aeration are employed. This profile is based on a 12 mg/l BOD, 1 mg/l NH_3 and 6 mg/l D.O. effluent.
- Level IV: AWT (1992) - This level would be obtained when the granular media filters are brought on-line to produce an effluent BOD and SS of 5 mg/l with 3 mg/l NH_3. Additional granular media filter and biological filters will be added to maintain quality as flow to the plant increases, projected for 1995.

These D.O. profiles or levels are based on the computer model "RIVER" and its interpretation of Bird Creek's response to specific effluent qualities. These effluent qualities are not specific to the Northside plant, but are projections of what could be achieved at a properly designed and operated plant employing these techniques.

Based on available plant records, if the proposed phasing schedule and the aforementioned operational mitigation measures are employed, a continued and progressive improvement in the level of water quality in Bird Creek may be

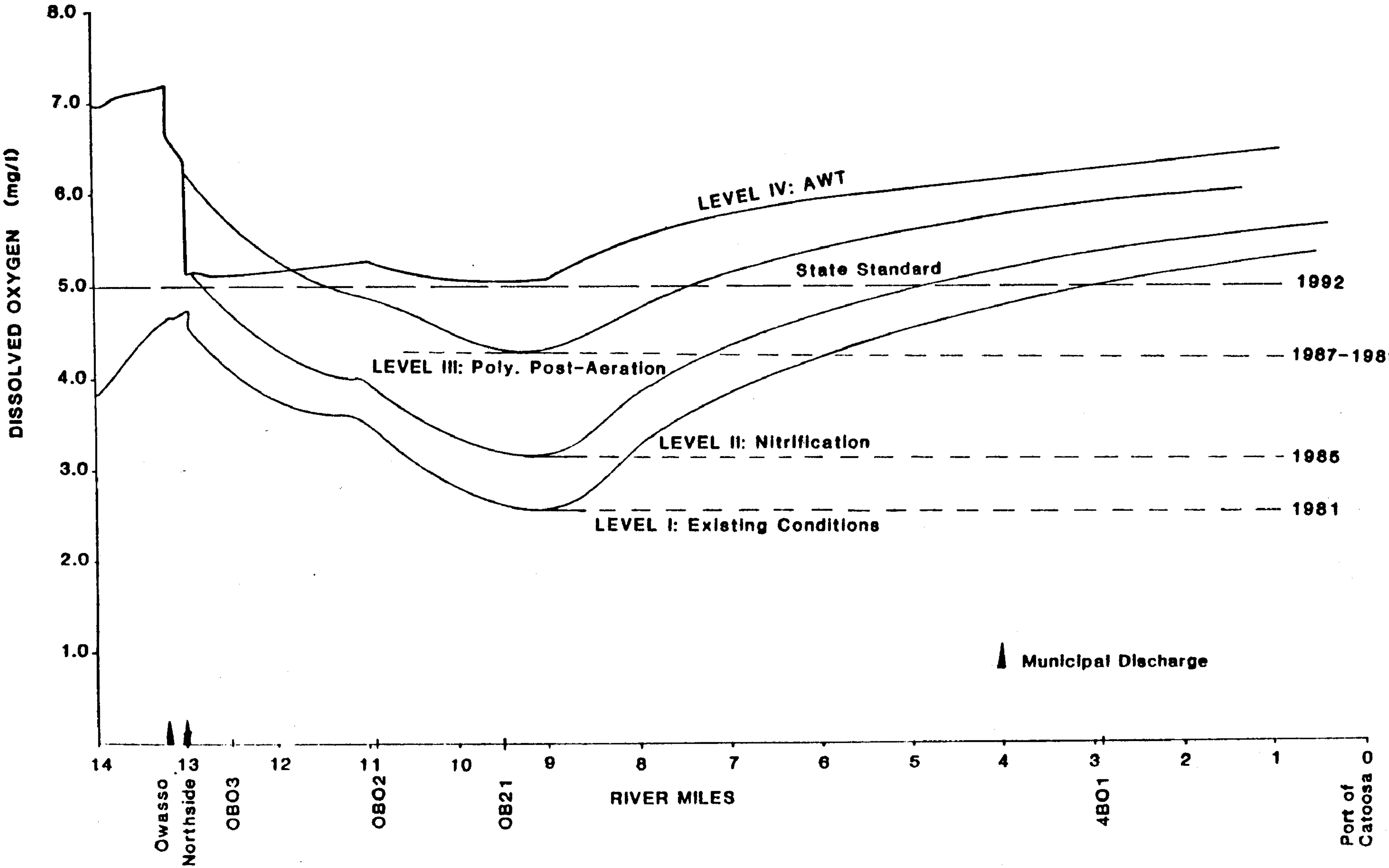


Figure 4-6 Potential Improvements Resulting from Phasing.

achieved. Phasing would provide a balance between the socioeconomic impacts of project funding and the goal of obtaining improvements in water quality as well as maintain project flexibility through the implementation of AWT.

To ensure that these improvements continue, a monitoring program should be conducted in conjunction with phasing by the appropriate agency. This would provide a data base from which improvements to the plant and the resulting changes in the stream could be evaluated. In addition, monitoring would ensure a more accurate assessment of these levels of phasing and indicate points or specific times at which subsequent AWT unit processes should be brought on line.

Because of the probable changes in water quality between now and the time the project is implemented, updated information is needed. The computer model "RIVER" was originally used to develop the 5/5/3 effluent limitation. It was also used to provide the D.O. profiles presented in this assessment of phasing. The model was calibrated based on 1976 data; however, changes occurred which required collection of new data. This new data was collected in 1981 by INCOG and showed a dramatic improvement in the stream as a result of the changes. Additional improvements are expected in the future, specifically as a result of the closure of the upstream discharges, Flat Rock and Coal Creek. After the closure of the upstream discharges, the model should be updated to reflect these specific changes and rerun. Points that should be assessed are as follows:

- the effect that removing the upstream loadings would have on the downstream benthic demand coefficients;
- the effect, if any, these changes would have on the selected BOD and nitrogenous decay rates originally used in the model;
- the possible effect of the presence of instream structures in the stream and their possible impacts on this specific segment's assimilative rate;
- the stream's response to a single treatment plant discharge as opposed to the three presently existing.

Evaluations of the summertime low-flow or worst-case conditions indicate that nitrification to a level of 3 mg/l NH_3 is required to limit the nitrogenous oxygen demand on the stream and to meet standards. However, wintertime nitrification to this level may not be required from an environmental standpoint to limit toxicity to aquatic life, or to meet standards. A more detailed evaluation and an assessment of a seasonal NPDES permit should be made.

RESIDUALS SOLIDS MANAGEMENT PLAN

The purpose of the Residuals Solids Management portion of the Facilities Plan and EIS is to address the overall area-wide sludge processing, handling, and disposal/reuse. This section of the EIS summarizes the development, screening, and assessment of alternatives for area-wide sludge management. Section 5.2, "Environmental Consequences of the Residuals Solids Management Alternatives", provides a detailed environmental assessment of the five final alternatives, which are only summarized here. The alternative development, selection, and elimination is described in the following sequence in this section:

- Existing Conditions and No Action Alternative
- Development of Preliminary Alternatives
- Screening of Alternatives
- Selection of Alternatives for Further Evaluation
- Presentation of Selected Alternatives
- Description of the Preferred Alternative

EXISTING CONDITIONS AND NO ACTION ALTERNATIVE

The three wastewater treatment plants in the area are the Northside, Southside, and Haikey Creek plants shown on Figure 4-7. Currently, sludge from the three treatment plants is handled separately. Sludge from the Northside Wastewater Treatment Plant is digested, thickened, and disposed. The sewage sludge from the Southside Wastewater Treatment Plant (WWTP) is stored in lagoons, and Haikey Creek WWTP sludge is spread or injected on the

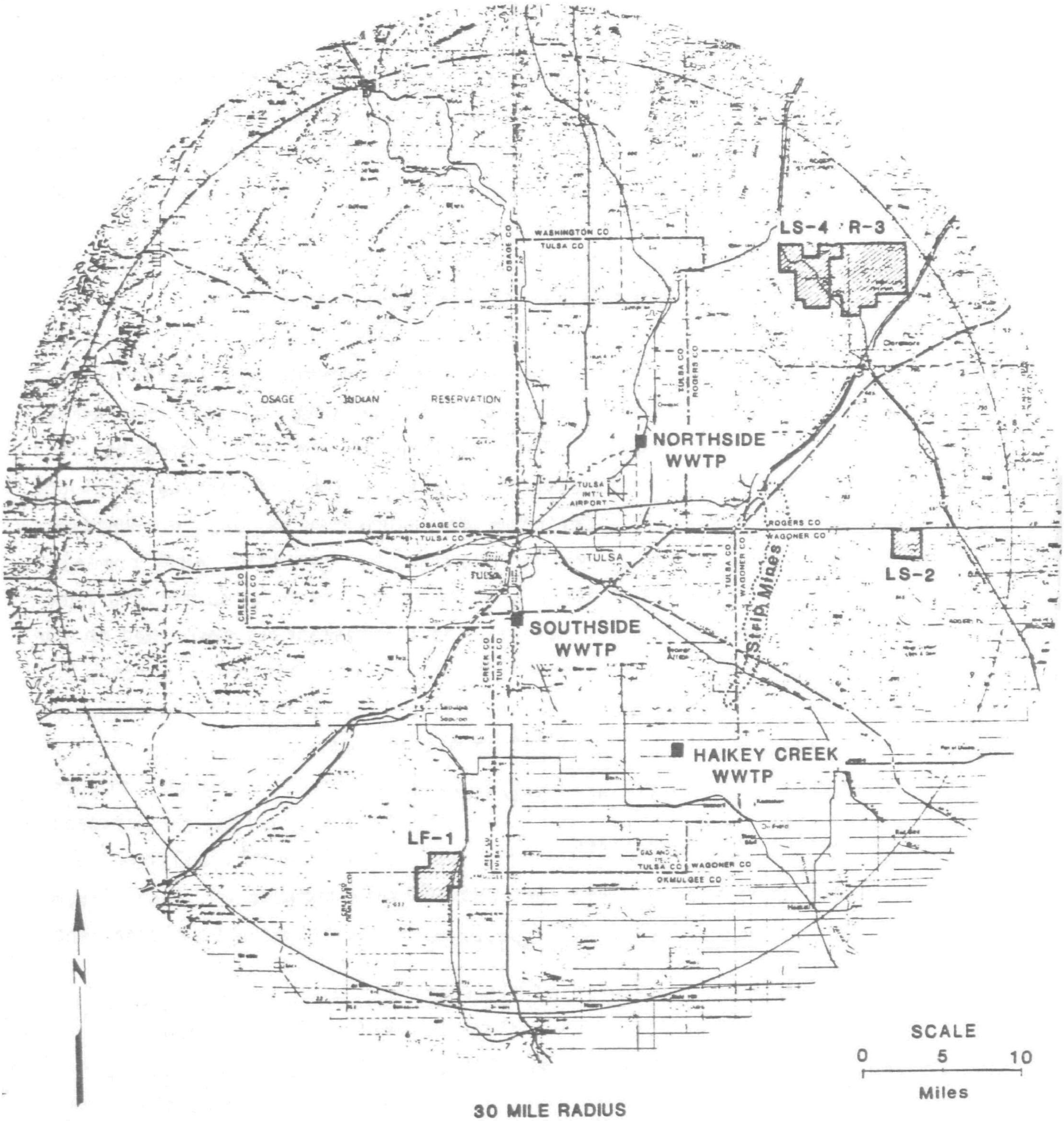


Figure 4-7 Regional Wastewater Treatment Plant Locations and Disposal/Reuse Site Locations.

ground at the plant site. None of these current methods provide for long-term disposal of the sewage sludge.

The No Action alternative in terms of residuals management is not considered a viable alternative due to the fact that sludge will continue to be produced in any event, and both Federal and State law require permitted disposal of solid wastes, which include sewage sludge. Basically, the No Action alternative would mean a continuation of the current unpermitted stockpiling and disposal of sewage sludge.

DEVELOPMENT OF PRELIMINARY ALTERNATIVES

A number of variables are involved in the development of a Residuals Management Plan. These include the sludge processing alternatives, modes of transportation, disposal methods and site selection. The development of the Residuals Solids Management Alternatives from processing, transportation, and disposal alternatives is documented in Tech. Memo. IV-2. The resulting alternatives for evaluation are shown on Table 4-5.

The site selection resulted from a series of engineering and environmental evaluations* briefly listed below:

1. Definition of environmental criteria to be utilized in the site selection for a landfill or land application operation (Report III).

2. Screening of areas within a 30-mi radius of Tulsa for general suitability for landfilling and for agricultural land application (Tech. Memo. IV-3).

3. Examination of the above areas for environmental suitability. Agricultural land application as an alternative is revised to a non-site-specific "marketing" alternative due to extremely large site requirements (Report V).

4. Secondary identification of sites or areas for landfilling, dedicated land disposal, and reclamation (Tech. Memo. IV-6).

*The engineering evaluations were presented in Tech. Memo.s referenced in the Facilities Plan. Environmental evaluations were similarly presented in Reports 1-12, and the Residuals Solids Management evaluations may be found in Volume 3 of this EIS. Report and Tech. Memo. numbers may not be consecutive due to working papers on wastewater issues only and vice versa.

Table 4-5 SCREENING FOR RESIDUALS SOLIDS MANAGEMENT ALTERNATIVES

	Sludge Processing Alternatives					Sludge Transportation and Disposal Alternatives	
Thickening	Stabilization	Disinfection	Dewatering	Drying	Reduction	Transportation	Disposal
Gravity thickening	Anaerobic digestion	Gamma ray irradiation	Vacuum filtration	Drying beds	Incineration	Pipeline	Landfill
Flotation thickening	Aerobic digestion	Electron beam irradiation	Pressure filtration	Heat drying	Pyrolysis	Truck	Agricultural use
Centrifugal thickening	Chemical stabilization	Heat processes	Belt filter press	Oil immersion dehydration	Wet-air oxidation	Rail	Dedicated land disposal
		Composting	Centrifugal dewatering			Barge	Strip mine reclamation
							Product marketing or give away

SOURCE: Tech. Memo. IV-2

5. Ranking of sites identified above based on environmental factors (Report VIII).

The marketing alternative was developed and refined throughout the studies, but was specifically assessed in Report VI. Essentially it includes three main components. One is agricultural reuse with the City applying it; another is marketing or give away/sale from the plant site(s) with an unknown end use, and the third is use in reclamation of active strip mines. The Public Advisory Committee heavily favored some form of marketing or beneficial reuse and requested that it be the primary alternative and be combined with all of the backup alternatives.

SCREENING OF PRELIMINARY ALTERNATIVES

At each point in the process where alternatives were eliminated or revised, more detailed information was collected on the remaining alternatives. Following detailed evaluations of each of the components, including the processing, transportation, disposal/reuse and site options, those that had survived the engineering and environmental evaluations were combined as residuals management plan alternatives (Tech. Memo. IV-7). These were then assessed for engineering and environmental factors.

This included a cost analysis of the most practical and apparently feasible alternatives combined with the best sites, resulting in a final list of seven alternatives that were evaluated environmentally (Report X). Components of each of the seven plan alternatives are shown on Table 4-6.

As mentioned, beneficial reuse is a part of all of the backup alternatives (RA-1 through 6). RA-7 was developed for comparison purposes in that it combines a form of marketing through the resale of sludge and one of the backup alternatives. Sites utilized for the seven alternative plans are shown on Figure 4-7. Each of the seven alternatives was then screened again.

This environmental screening reduced the seven alternatives to five and revised one of the alternatives. The screening was based on water resources

Table 4-6 SLUDGE MANAGEMENT ALTERNATIVES SUMMARY

Alternative Number	Plants	Truck	Pipeline	Lagoon	Drying Bed	Landfill	Dedicated Land Disposal		Marketing
							Injection	Surface Spread and Incorporate	
RA-1	N		X	X			X LS-4		
	S	X			X	X LF-1			
	H	X			X	X LF-1			
RA-2	N		X	X			X LS-2		
	S		X	X			X LS-2		
	H	X			X			X LS-2	
RA-3	N	X			X	X LF-1			
	S	X			X	X LF-1			
	H	X			X	X LF-1			
RA-4	N	X			X			X LS-2	
	S	X			X			X LS-2	
	H	X			X			X LS-2	
RA-5	N	X			X			X LS-4	
	S	X			X	X LF-1			
	H	X			X	X LF-1			
RA-6	N	X			X	(Reclamation R-3)			
	S	X			X				
	H	X			X				
RA-7	N	X			X			(Failsafe system included)	X
	S	X			X			X LS-2	X
	H	X			X				X

N = Northside WWTP
S = Southside WWTP
H = Haikey Creek WWTP

SOURCE: Report X

factors and physical factors. Water resources include surface water, groundwater and flood hazards. Physical factors include geology, soils and air quality/meteorology. The results of this impact analysis and screening are summarized on Table 4-7 and discussed below.

Alternative RA-1

This alternative involves pipeline transport of Northside sludge to dedicated land disposal at Site LS-4 and drying bed dewatering and trucking of Southside and Haikey Creek sludges to landfill at Site LF-1 (see Figure 4-7). The impacts of this alternative with respect to water resources and physical factors relate mainly to Site LS-4.

There would be only minor impacts on surface waters at LS-4, if the Verdigris soils on the western portion of the site are avoided. On the Verdigris soils, nitrates might enter alluvial aquifers which may interconnect with surface waters. No impact would be expected at LF-1 as long as runoff is controlled.

There may be a major adverse impact on groundwater even if Verdigris soils are avoided at LS-4. This is because the high rate application is likely to cause severe localized nitrate contamination. Careful site monitoring would be required to ensure that contaminants do not travel beyond the solid waste boundary. There should be no impact at LF-1 since a liner is included in the landfill design. While there should be no impact on flood hazards as long as flood prone Verdigris soils are avoided, there may be adverse impacts on geology and soils. According to Oklahoma Geological Survey maps, parts of Site LS-4 may be in Zone 3 areas, which are not likely to contain suitable geologic formations. If the disposal area were sited where the geology is unsuitable, indirect contamination of other resources could occur.

With respect to soils, two problems are evident. At LS-4, the Newtonia soils are likely to clog at the high rates of application proposed. Indirectly, there would be a temporary loss of production in the prime farmlands of LF-1, which involves approximately 100 acres plus a buffer of

Table 4-7 SUMMARY MATRIX OF FINAL RESIDUALS MANAGEMENT ALTERNATIVE SCREENING

Residuals Management Alternative	Environmental Parameter: Surface Water	Ground-water	Flood Hazards	Geology	Soils	Air Quality/ Meteorology
RA-1	-	--	0	-	--	-
RA-2	--	--	0	-	--	--
RA-3	0	0	0	0	-	0
RA-4	--	--	0	-	--	--
RA-5	0	-	0	0	-	--
RA-6	0	-	0	0	++	0
RA-7 W/LS-2	--	--	0	-	--	--
RA-7 W/O LS-2	0	0	0	0	++	0

EVALUATION KEY:

++ major beneficial
\+ minor beneficial
0 no impact
\- minor adverse
-- major adverse

Class 1 Mason soils. These would be expected to return to production, however, after closure of the landfill. The use of Newtonia and Verdigris soils at LS-4 for dedicated land application, however, may result in their permanent removal from food-chain crop production, and these are prime farmlands also. Since dedicated land disposal does not involve excavation, soil would not be readily available to cap or cover the site. Since prime farmlands are based on specific soil characteristics and structure, this use at LS-4 would probably constitute an irreversible and irretrievable loss of 130 acres of prime farmlands.

Injection of liquid sludge would not normally be expected to cause any air quality impacts. However, the very high application rates at LS-4 may damage or kill vegetation, resulting in indirect air quality impacts from blowing dust.

Alternative RA-2

This alternative involves pipeline transport of Northside and Southside sludges to dedicated land disposal at Site LS-2 (see Figure 4-7), and drying bed dewatering and trucking of Haikey Creek sludges to dedicated land disposal at Site LS-2.

As shown on Table 4-7, there are several adverse impacts with respect to RA-2. These are principally due to the soils of the site. The soil is Riverton Gravelly Loam, and is likely to have pockets of gravel (Personal communication, SCS 1982). The site is adjacent to the Verdigris River and is, in fact, very close to a drinking water intake. Because of the pockets of gravel, nitrates may leach into the alluvial groundwater aquifers adjacent to the site and these are likely to interconnect with the surface water. The impacts on groundwater and surface water are therefore considered major adverse.

There would be no impact on flood hazards since the site is not in a flood prone area. As in RA-1, some of the geologic formations may not be capable of containing the wastes, and careful siting would be required based on bedrock characteristics.

The impact on soils would probably be major, since these soils are classified as prime farmlands and the high loading rates would likely remove about 360 acres from production permanently. Air quality may also suffer major negative impacts from vegetation die-off leading to blowing dust, and, because part of the sludge would be dry, incorporation (discing or plowing in) may result in more disturbance and blowing material.

Alternative RA-3

This alternative includes the drying bed dewatering of all sludges with truck transportation to landfill at Site LF-1. This alternative, because of the built-in safeguards of landfilling, has little potential for negative impacts on water resources or physical factors. As shown on Table 4-7, there should be few significant impacts if the landfill is designed, constructed and operated correctly. The only exception is a minor adverse effect on soils, due to their classification as prime farmland. As mentioned in RA-1, about 150 acres plus a buffer would be taken temporarily out of production. However, their possible return to agricultural production could occur with a final cap, cover, and reseeding efforts. Possible subsidence problems would prevent most urban land uses.

Alternative RA-4

This alternative utilizes drying bed dewatering of all sludges and truck transport to dedicated land disposal at Site LS-2. This alternative is almost identical to RA-2, except that sludge from Northside is dried and trucked rather than pipelined as a liquid. Differences in the magnitude of impacts may not be significant, however, they may be slightly less in this alternative since all of the sludge is dried.

Alternative RA-5

This alternative entails drying bed dewatering and trucking of Northside sludge to dedicated land disposal at Site LS-4, and the drying bed dewatering and trucking of Southside and Haikey Creek sludges to landfill at

Site LF-1. This alternative is essentially the same as RA-1 except that dried sludge would be used instead of liquid at LS-4.

The use of dried sludge may reduce minor impacts on surface water and geological effects to an insignificant level, and reduce those on groundwater and soils to minor. The primary difference would be less potential to clog the Newtonia soils than in RA-1. Air quality impacts may be worse due to constant disturbance and resulting blowing dust.

Alternative RA-6

Alternative RA-6 involves drying bed dewatering and trucking of all sludges for strip mine reclamation at Site R-3. This alternative could have minor adverse impacts on groundwater; however, worked spoil (shaley) material may provide a good liner.

This alternative may have highly beneficial impacts on soils for two reasons:

1. Spoil materials are unlikely to contain enough organic materials to support plant growth in the early stages of mine abandonment. The sludge (dried to 40% and mixed with spoil in the final cover) would provide organic material and nutrients, decrease the bulk density of the spoil and generally improve tilth.

2. These orphan or abandoned strip mines are classified as wasteland by the Soil Conservation Service (SCS). Their use would not remove any prime farmlands from production as do Alternatives RA-1 through 5.

Alternative RA-7

This last alternative involves drying bed dewatering and trucking of all sludge to Site R-1, and sale of sludge to strip mine operators for use in mine reclamation at Site R-1, with a backup system similar to RA-4.

This alternative basically represents one of the backup alternatives, specifically RA-4, in combination with marketing of the sludge, specifically sale to active strip mine operations for use in reclamation. The backup would have impacts the same as RA-4 as shown on Table 4-7 (RA-7 with LS-2).

Site LS-2 is used and most of the negative impacts are associated with this site. As shown in Table 4-7, RA-7 without using a backup of Site LS-2 (Alternative RA-4) would have no significant negative impacts and would have major beneficial impacts on soils, as did RA-6. This is due to the soil improvements provided by dried sludge and the fact that no prime agricultural lands are lost or taken out of production.

SELECTION OF ALTERNATIVES FOR FURTHER EVALUATION

Based on the assessment presented above, it appears that there are wide differences in the potential for environmental damage from the seven alternatives. Although not all of the environmental parameters had been assessed at this point, it was apparent that some alternatives could be eliminated or revised before the final assessment.

The alternatives that utilize Site LS-2 for the disposal of the sludge by the land application of either a liquid or dried sludge are RA-2 and RA-4, respectively, and the backup for RA-7. Site LS-2 is located on Riverton gravelly loam soil, which has pockets of gravel through which contaminants might leach (SCS 1982). Site LS-2 is also very near the Verdigris River, which is likely to have associated alluvial groundwater aquifers. Although the quality and quantity of groundwater in alluvial aquifers near LS-2 is unknown, they are likely to interconnect with the Verdigris River, which is a source of drinking water.

The potential for the contamination of groundwater is highly dependent on the rates at which the sludge is applied and type of the soils onsite. In dedicated land disposal the loading rate, particularly with respect to nitrogen, would be in excess of what the area crop requirements would be. Taking the total annual application rates for RA-2 and RA-4 and subtracting the expected crop requirements based on available site acreage, the total excess available nitrogen from RA-2 applied to the land would be about 2,430 lbs/acre or 873,700 lbs for the entire site; and 4,080 lbs/acre or 489,400 lbs for the entire site for Alternative RA-4.

The site is bisected by Commodore Creek, a tributary of the Verdigris River which is used as a potable water source. Since ammonia-nitrogen can readily convert to soluble nitrates and because the soils for LS-2 are Riverton gravelly loam which has pockets of gravel, there may be no water retention capacity for the site. Therefore, uncontrolled leachate of nitrates may occur. Even though the potential for public health problems would be limited due to the large dilution capability of the Verdigris, the factors controlling this problem are variable with no available mitigation measures for the worst- case condition. For this reason any alternative with Site LS-2 for dedicated land disposal should not be utilized, and these alternatives were not further evaluated. Because RA-7 only uses LS-2 as a backup, this alternative was not eliminated but was revised to assume utilization of the preferred backup alternative when selected. In addition, the marketing may be in the form of give away/sale, agricultural land application, or active strip mine reclamation (Report VI).

The alternatives that remain, RA-1, RA-3, RA-5, RA-6, and RA-7, were those that were environmentally assessed and compared to determine the preferred alternative. Again, RA-7 is basically used for comparison since the concept of marketing is included in all of the alternatives. Each of the alternatives is basically a backup for beneficial reuse in some form.

PRESENTATION OF THE SELECTED ALTERNATIVES

The five remaining alternatives, RA-1, 3, 5, 6, and 7 underwent one final environmental assessment. This assessment included three main phases. The first was a comparison of sludge and commercial fertilizer to determine any differences in potential environmental impacts (Report VI). This was the primary assessment of the marketing alternative, in that sludge would essentially be replacing commercial fertilizer in any of the marketing options. The results of this assessment are non-site-specific and are represented by the evaluation under Alternative RA-7 on the Summary Matrix on Table 4-7.

The second was a generic evaluation of the other methods involved; namely landfilling, dedicated land disposal, and abandoned mine land reclamation.

Finally, the sites were assessed in terms of all of the environmental parameters, and the generic and site assessments were combined to determine the most suitable alternative(s). The overall comparison of all five alternatives is shown on Table 4-8. This is followed by Table 4-9 which provides the alternatives major advantages and disadvantages. In addition, Table 4-10 provides a comparison of the alternatives capital, operation and maintenance, energy consumption, and total present worth. The detailed evaluations on which the results are based may be found in Chapter 5.

DESCRIPTION OF THE PREFERRED ALTERNATIVE

The preferred alternative was selected by the applicant based on input from the Public Advisory Committee (PAC), Federal, State and local agencies. It is a combination of two primary alternatives. Beneficial reuse or marketing, with no specified type, is the long-term preferred method of residuals solids reuse. It may be agricultural or active strip mine utilization, or give away/sale. Any of the methods would follow appropriate precautions and regulations, but the method would depend primarily on local market availability.

The beneficial reuse concept essentially uses sewage sludge to supplement commercial fertilizer, and by adding organic matter, adds the benefits of a soil conditioner. With respect to environmental impacts, the use of sewage sludge would be very similar to commercial fertilizers, thus producing few effects that would not occur under normal agricultural practices.

Because marketing is not considered "fail-safe", a backup alternative was selected for the initial stages of the sludge management program and for use in the event that the market for the sludge is not steady or reliable. The fail-safe alternative selected was RA-6, reclamation of abandoned strip mines at Site R-3. A photograph of a portion of Site R-3 is shown on Figure 4-8. As shown on Table 4-8, Alternative RA-6 has not only the least negative impacts, but because it is a beneficial reuse, it has the most positive or beneficial impacts.

Table 4-8 SUMMARY MATRIX OF RESIDUALS SOLIDS MANAGEMENT ALTERNATIVES

Environmental Parameter	RESIDUALS MANAGEMENT ALTERNATIVE RA-1	RA-3	RA-5	RA-6	RA-7
WATER RESOURCES					
Surface Water	-	0	0	0	0
Groundwater	--	0	-	-	0
Flood Hazards	0	0	0	0	0
PHYSICAL RESOURCES					
Geology	-	0	0	0	0
Soils	--	-	-	++	++
Air Quality	-	0	--	0	0
BIOLOGICAL RESOURCES					
Terrestrial Flora/Fauna	-	-	-	+	0
Aquatic Flora/Fauna	0	0	0	0	0
SOCIOECONOMICS					
Population and Land Use	-	0	-	+	0
Transportation	-	-	-	-	-
Institutional Factors	--	-	-	+	0
Economics	-	0	-	++	0
CULTURAL FACTORS					
Recreation	-	0	--	+	0
Odors and Insects	-	0	-	0	0
Aesthetics and Noise	-	-	-	+	0
Public Health and Safety	-	0	-	0	0
Archaeological/Historical	-	-	-	+	+

EVALUATION KEY:

++ major beneficial
+ minor beneficial
0 no impact
- minor adverse
-- major adverse

Table 4-9 SUMMARY OF MAJOR ADVANTAGES AND DISADVANTAGES

Alternative	Advantages	Disadvantages
No Action		Not a permitted disposal operation. Lack of storage and disposal capacity would prevent this method.
Alternative RA-1		Localized contamination of groundwater at LS-4. Operational problems with Newtonia soils and loss of prime farmlands at LS-4. Difficult implementation due to site locations in 3 counties other than Tulsa and crossing political boundaries with a pipeline. Construction impacts at 2 sites and from pipeline.
Alternative RA-3	Safe, controlled disposal of sludge.	Provides no beneficial reuse. LF-1 is not in Tulsa County.
Alternative RA-5		Air quality impacts due to continuous disturbance of soil. Loss of prime farmlands at LS-4. Difficult implementation due to 3 counties other than Tulsa.
Alternative RA-6	Beneficial reuse provided. No prime farmlands removed. Increase in value of land. No new land is disturbed. Land is returned to productivity, spoil material improved with sludge organic matter and nutrients.	R-3 is not in Tulsa County.
Alternative RA-7	No construction impacts. Improvement in soils, without removal of prime farmlands from production. No sites opened or disturbed.	Market conditions variable.

Table 4-10 SUMMARY OF COST INFORMATION FOR THE SELECTED RESIDUALS SOLIDS MANAGEMENT ALTERNATIVES

	Alternative	Capital ($ Million)[a]	Energy (Annual kwh (10^6))[b]	Consumption[b] Fuel gal/yr	O & M (Annual $ Million)[c]	Present Worth ($ Million)[a]
RA-1;	Landspreading (liq LS-4) and Landfill (LF-1)	$37.57	15.34	120,700	$2.49	$64.03
RA-3;	Landfill (LF-1)	$41.01	15.21	76,700	$2.77	$69.33
RA-5;	Landspreading (dry LS-4) Landfilling (LF-1)	$42.95	15.21	92,500	$2.71	$71.06
RA-6;	Reclamation (R-3)	$42.54	15.21	109,400	$2.58	$69.87
RA-7;	Example of Marketing Revenues	$40.43	15.21	48,900	$2.18	$61.59

[a] January 1982 Dollars.
[b] Based on average energy requirements over the 20-yr planning period 1995 4.2 cents/kwh and $1.42/gal of diesel fuel.
[c] EPA wastewater treatment plant O & M cost index of 3.32.

SOURCE: Tech. Memo. III-7

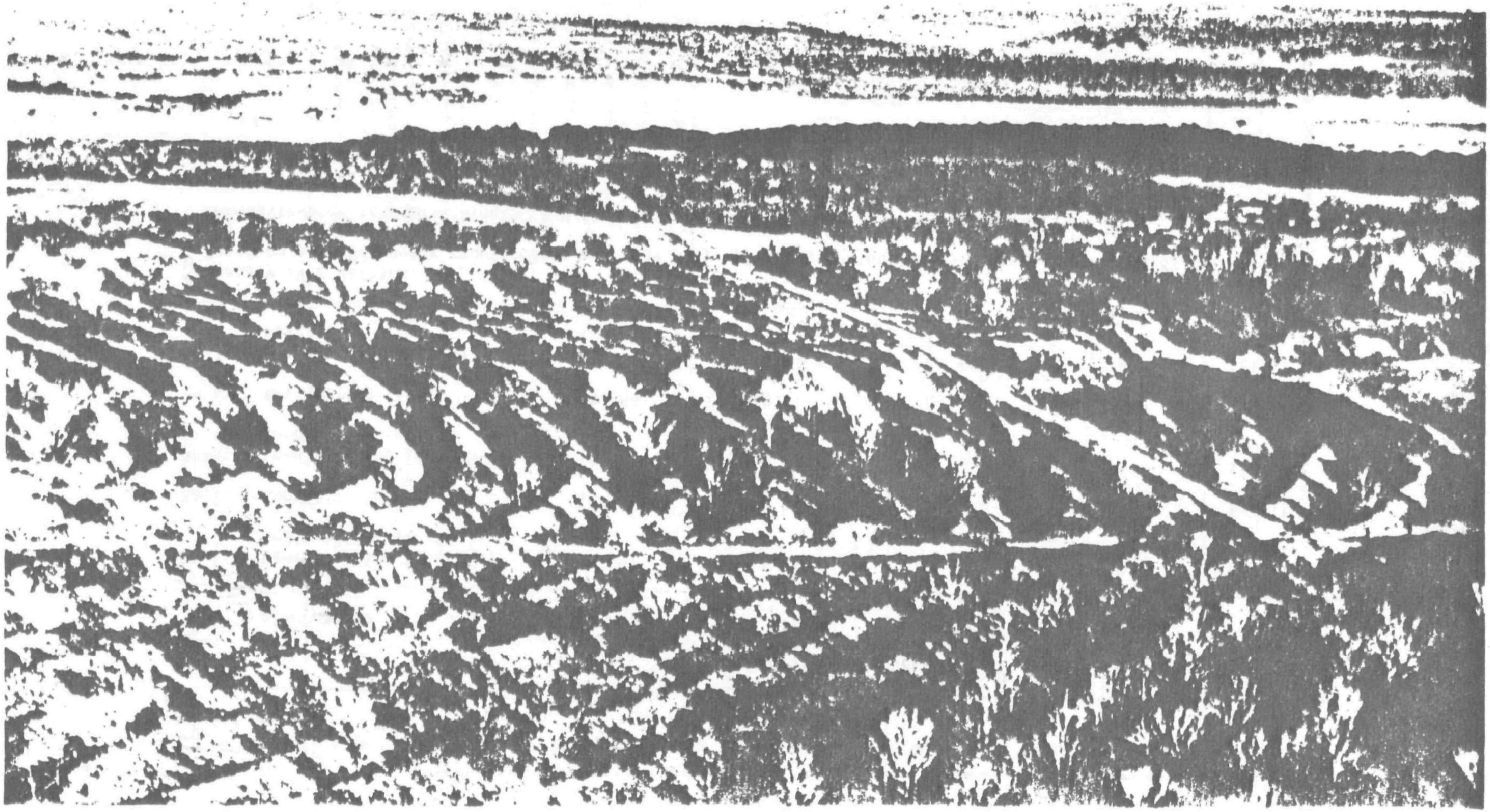


Figure 4-8 Backup Site for Preferred Alternative (Reclamation Site No.3, R-3).

Site R-3 is a large area of orphaned strip mines about 4 mi northeast of the town of Claremore. Out of approximately 10,000 acres, about 130 acres plus a buffer would be required for the reclamation operation. The shaley (clay) spoil material would be worked and layered in the bottoms of the trenches to provide a sealer similar to a commercial liner. Sludge would then be layered alternately with the spoil material, with 2 ft of dried (40 percent) sludge to 1 ft of spoil material until the land is relatively level. Another layer of shaley material could be added on top of this to provide a cap. Finally, a cover of mixed spoil and sludge at around 50 tons per acre would be placed on top, followed by final grading and reseeding. The final layer provides nutrients for revegetation in a one-time application adjusted so that site-life cadmium limitations for food chain crops are not exceeded.

The abandoned strip mines would be used as a backup to a marketing plan. If for some reason Site R-3 cannot be utilized, other strip mine sites would be examined. Should all reclamation sites be unimplementable, codisposal at a privately-owned municipal solid waste landfill would be considered next, followed by potential landfill sites in Tulsa County. As a last resort, Site LF-1 would be considered.

4.2 ALTERNATIVES AVAILABLE TO EPA

EPA has several options available to it based on final review and approval of this Step 1, 201 Facilities Plan and EIS portion of the Construction Grants Program. These include (1) appropriating funds for the remaining Step 3 portions of the Grants Program for the preferred alternative as presented, (2) awarding funds based on a modified alternative or approach to the project's implementation, or (3) denying further grant funds.

GRANT FUNDING

PROVIDE STEP 3 GRANT FUNDING

At present, if EPA awards funds for the remainder of the project, as stipulated under Public Law 92-500, grants for 75 percent of eligible project costs can be given. However, based on Public Law 97-117, if no funds have been awarded by October 1, 1984, then only 55 percent of eligible project cost would be available.

For the typical residential customer, effects of funding are as follows. A monthly sewer service bill of $8.71, projected for 1987, is used as a point of reference. The implementation of alternatives with a combined present worth similar to that of the preferred plan would raise the monthly sewer service bill by approximately 40 percent. This assumes that the ad valorem tax support for sewer utility debt payments continues and the 75 percent EPA/OSDH funding is made available (Tech. Memo. III-8, IV-9, V-4).

PROVIDE FUNDS FOR MODIFIED PLAN

EPA may choose to fund the preferred plan or to modify the plan's selected wastewater and residuals alternatives.

DENY GRANT FUNDS

Ultimately, EPA could deny funcing for the project in total, either due to a shift in priorities or based on a lack of funds. If the project were still implemented without EPA/OSDH funding and no ad valorem tax supports were provided, the monthly rates could increase by approximately 114 percent (Tech. Memo. III-8, IV-9, V-4). The City of Tulsa would still be required to comply with current regulations but the financial strain could result in the postponement of the project.

Chapter 5

CHAPTER 5
ENVIRONMENTAL CONSEQUENCES OF THE ALTERNATIVES

The environmental consequences of the alternatives for both the wastewater and residuals management plans that were selected through the screening process presented in Chapter 4 are described below. Because this project is made up of two separate but parallel studies, the information in this chapter will be provided in several sections; Section 5.1 covers the wastewater management alternatives; Section 5.2 presents the alternatives for residuals solids management; Section 5.3 summarizes construction impacts; Section 5.4 includes rare, threatened, and endangered species; Section 5.5 discusses alternatives available to EPA; and Section 5.6 presents the options available to other agencies.

5.1 WASTEWATER MANAGEMENT ALTERNATIVES CONSIDERED BY THE APPLICANT

Because changes are expected to occur from the present to the time of implementation, the current 1981 or Existing Conditions are provided as a data base. The first change would occur in 1985 when the two upstream plants, Flat Rock and Coal Creek, are projected to be closed and the flows treated at the Northside Plant.

The 1985 conditions or No Action are the conditions that are projected to be in effect at the time the Facilities Plan is implemented (1985), through the planning period to 2005. These conditions are represented by a 30 MGD Northside Plant operating at capacity to produce a secondary effluent quality of only 20 mg/l BOD and 30 mg/l SS with no nitrification.

The evaluation will be based on five primary areas: water, physical and biological resources, socioeconomics, and cultural factors. Under each of these evaluation parameters the Existing Conditions and No Action Alternative will be followed by an evaluation of each of the alternatives in operation and the effects that are expected at the time of implementation, through the 20 year planning period of 1985 to 2005.

WATER RESOURCES

This environmental parameter is made up of several more detailed indicators that were examined through the course of this evaluation. These include surface water, groundwater, and flood hazards.

EXISTING CONDITIONS

In this evaluation, the area of study or the affected environment entails Bird Creek and its watershed. The watershed is essentially split into two relatively separate basins. The Upper Bird Creek Basin encompasses approximately 905 sq mi of the Bird Creek watershed. The upper basin of the watershed ends at the confluence of the two predominant streams, Bird Creek and Hominy Creek, which joins Bird Creek from the west (River Mile 27.4, see Figure 5-1). The channel width in this area ranges from 100-200 ft, with an average gradient of 6.4 ft per mile. This portion of the watershed is sparsely populated, with much of the basin devoted to grazing, woodlands, cultivation, and scattered points of oil production. The Lower Bird Creek Basin from R.M. 27.4 to the confluence with the Verdigris River (the primary area of study) adds roughly an additional 240 sq mi to the watershed. The southern portion of the basin is largely urbanized, with significant residential and industrial development occurring in the adjacent lands. Many smaller tributaries feed into this reach of Bird Creek; Delaware Creek (R.M. 23.3), Flat Rock Creek (R.M. 20.1), Coal Creek (R.M. 15.4), Ranch Creek (R.M. 13.8), Mingo Creek (R.M. 12.7), and Elm Creek (R.M. 11.8).

Surface Water

The majority of the flow in Bird Creek is contributed by rainfall and the resultant runoff from the watershed. U.S. Geological Survey has been operating a flow gauge (#1775) since 1938, just downstream of the Hominy Creek confluence. This gauge provides information on the flow contribution from the Upper Basin to the Lower Basin and project area. The average annual rainfall from the area is about 37 in/yr, with the peak occurring from March through June and a secondary peak occurring in late fall.

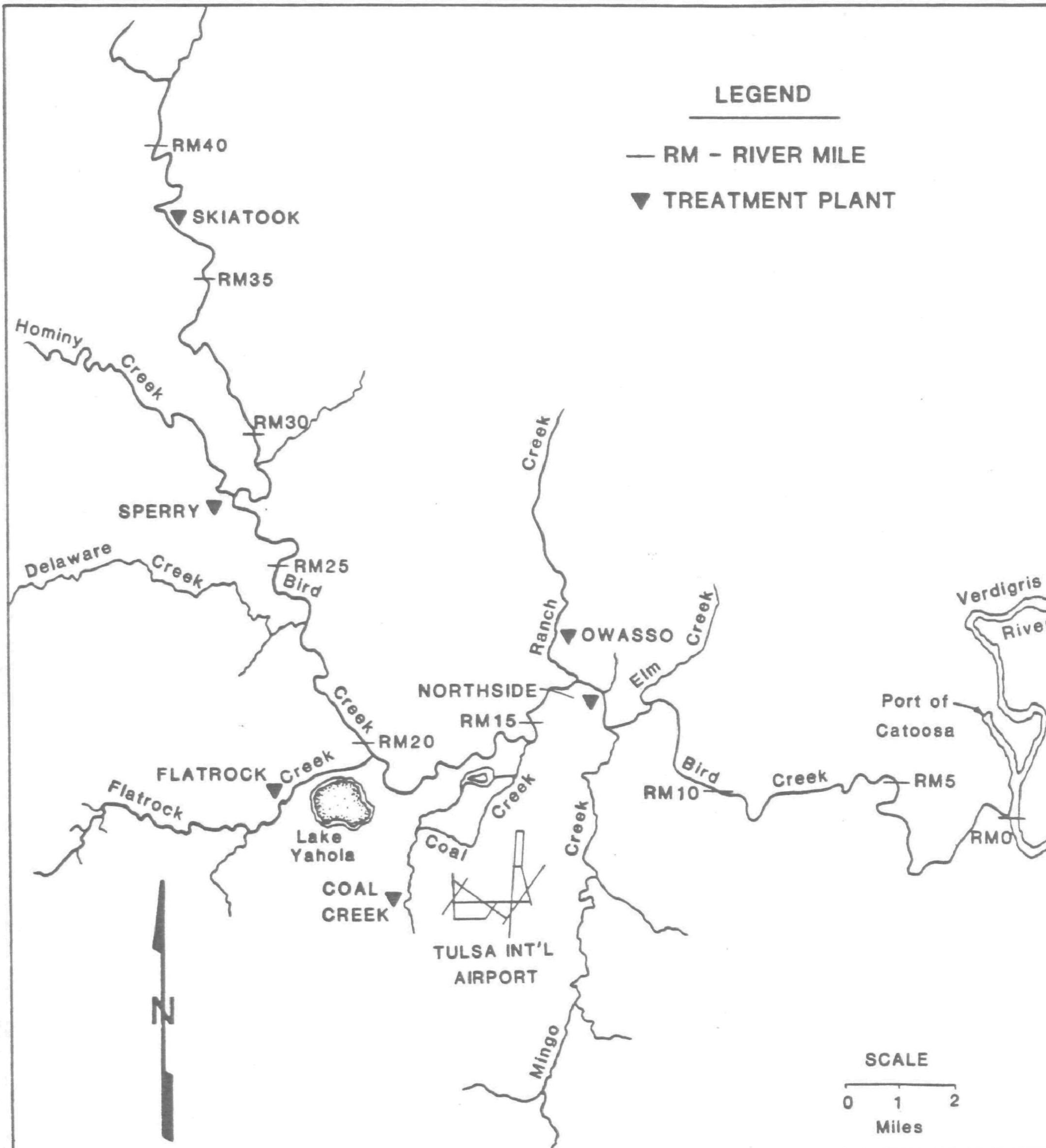


Figure 5-1 Treatment Plant Locations and River Miles.

Table 5-1 provides the average daily flows in the stream by month, based on USGS #1775 ten year period of record 1972-1981.

Bird Creek also receives flow from many other sources, most of which are man-made. Some of the contributions include oil production waste (i.e. brine) that enters the stream throughout the basin, and industrial discharges which primarily occur in the lower segments. More significant and relatively continuous flows originate from the six municipal wastewater treatment facilities located along Bird Creek, Figure 5-1.

Municipal Discharges. The type and capacity for each of these facilities is presented as follows:

- Skiatook - the town of Skiatook utilizes lagoons as the primary method of treatment, discharging at a rate of approximately 508,000 gal/day (0.786 cfs) and is the furthest upstream point source considered in this study, (located at River Mile 37.1).
- Sperry - the next discharge comes from the town of Sperry (River Mile 27.4) which uses an Imholf Tank to treat 100,000 gal/day (0.16 cfs).
- Flat Rock - the Flat Rock plant is one of Tulsa's older treatment facilities and is scheduled to be closed (see No Action). Bio-absorption is used to treat approximately 4.87 MGD (7.54 cfs) of flow that discharges to Flat Rock Creek which is a tributary of Bird Creek (River Mile 19.9).
- Coal Creek - the Coal Creek facility is a 3.58 MGD (5.54 cfs) trickling filter plant which discharges by pipeline (River Mile 18.9) directly to Bird Creek, and is also scheduled to be closed (see No Action).
- Owasso - the town of Owasso treats 880,000 gal/day (1.36 cfs) of municipal wastewater by an aerated lagoon prior to discharge to Bird Creek (River Mile 13.2).
- Northside - the Northside plant, upon which this assessment is based, initially came on-line as a trickling filter plant. An eleven MGD (17 cfs) activated sludge expansion, plus the inclusion of disinfection was added to the plant in 1979. This increased the design capacity to a total of 19 MGD (29 cfs), however, the plant is presently operating below capacity at approximately 16 MGD (25 cfs).

In comparing the stream flows presented in Table 5-1 to the combined discharges of the larger municipal wastewater plants, the point source

Table 5-1 AVERAGE DAILY FLOW IN BIRD CREEK
USGS #1775; WATER YEARS 1972 - 1981
(cubic feet per second)

Year	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug.	Sept.
1972	1304	130	1782	186	68	45	221	168	17	514	19	137
1973	738	1866	437	1702	581	4491	3503	681	942	95	44	427
1974	517	1940	1178	225	601	3565	255	1699	1341	22	821	2169
1975	1850	5419	998	990	2089	1918	522	2509	1300	74	126	82
1976	53	41	89	45	47	369	990	513	118	695	8	8
1977	21	9	9	11	42	136	27	1449	141	101	366	552
1978	46	328	30	20	879	933	816	2395	1097	46	17	5
1979	5	28	12	383	120	811	655	553	742	99	52	29
1980	6	484	32	94	226	632	1439	812	900	25	29	24
1981	9	6	10	7	12	15	15	260	302	122	124	25
Mean	455	1025	458	366	467	1292	844	1104	690	179	161	402
	Average Minimum Flows (cfs) for Comparison											
Mininum	19.2	55.2	74.6	67.3	83.3	108.5	118.1	83.4	42.1	16.7	8.9	13.3

contributions to the stream may meet or exceed base flow. The response of the stream to these loadings and the effect on water quality under the existing conditions is presented below.

Many constituents can be perceived as pollutants, however, in light of Bird Creek's beneficial use designations for the protection of aquatic life and availability as an emergency raw water source, two constituents become more important. These are heavy metals, specifically cadmium and chromium, and those that deplete the level of instream dissolved oxygen (D.O.) such as organic material referred to as Biochemical Oxygen Demand (BOD) and ammonia (NH_3). In general, ammonia is considered to be toxic to most aquatic species.

Heavy Metals. Heavy metals can enter the stream through both point (municipal discharges) and non-point (storm water runoff) source contributions. To indicate the stream's relative background quality and areas of contribution, a 40 mi reach of Bird Creek from Skiatook to its confluence with the Verdigris River was evaluated. Figure 5-2 illustrates the study area and Table 5-2 details sampling station locations. Table 5-3 is an average of accumulated data taken along Bird Creek, for points that represent a tributary's contribution as well as discharges of the existing municipal plants (INCOG 208 stream sampling data and CH2M Hill industrial pretreatment studies).

Table 5-3 provides the instream concentrations of cadmium, the point and quality of flow contributions of both tributaries and municipal discharges, and the concentrations at consecutive stream sampling stations. Based on the available cadmium data, it appears that the tributaries that drain the Tulsa metropolitan area may make a significant heavy metal contribution to Bird Creek. This data represents the existing conditions or the quality of Bird Creek in terms of heavy metals. An assessment of the specific sources and their significance is not a part of this 201, but further study is required.

Oxygen Demand. The level of dissolved oxygen (D.O.) in a stream is highly dependent on its organic content or pollutant loads, particularly with

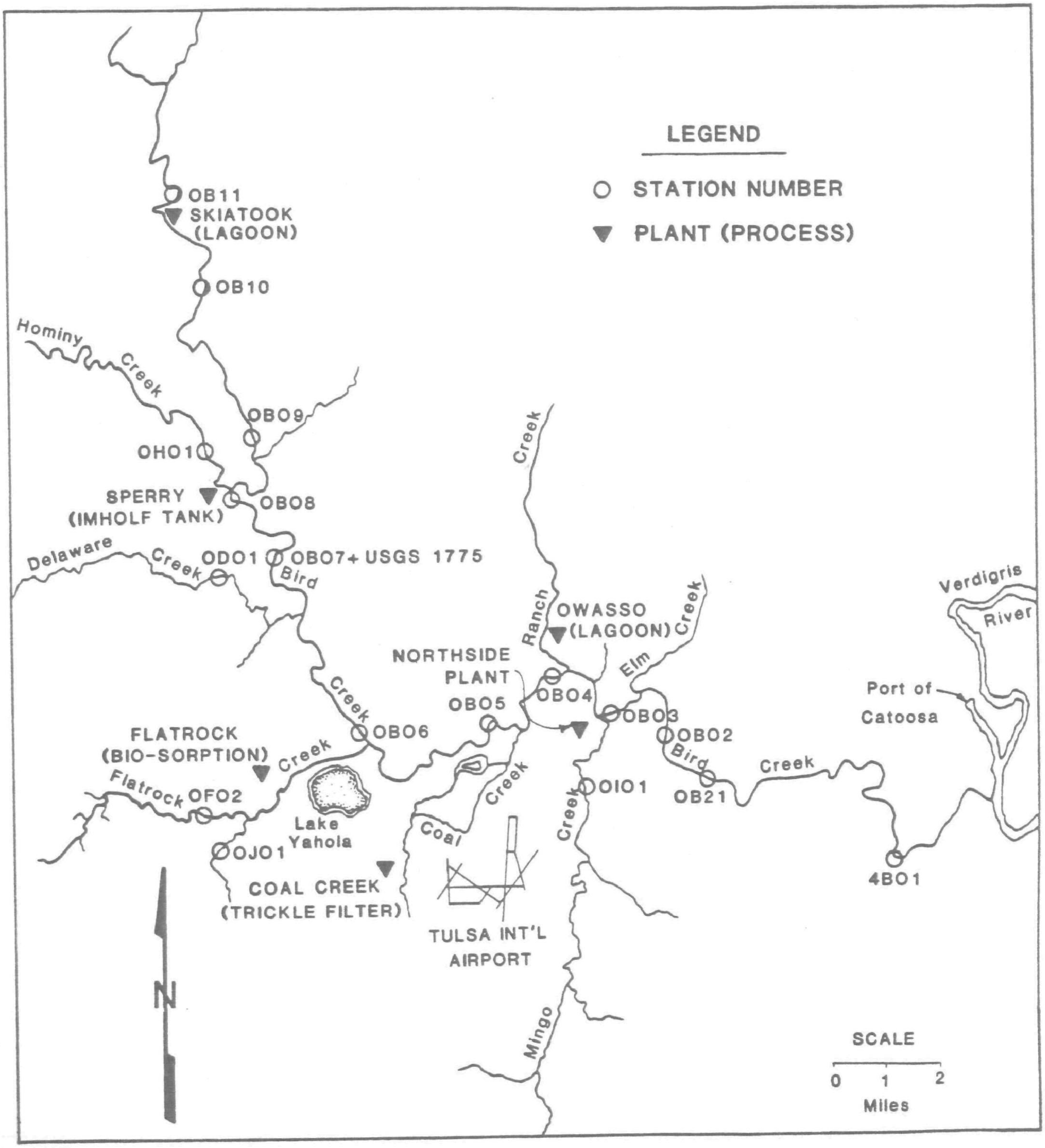


Figure 5-2 Bird Creek Treatment Plants and Station Locations.

Table 5-2 STREAM MAP REFERENCE POINTS

River Miles	Sampling Station Numbers	Station Description
40----		
37.3	OB11	State Hwy. 20, 0.5 miles East of Skiatook
37.1	Skiatook	Skiatook Wastewater Lagoon
35----		
34.3	OB10	136th St. North, 2 miles East of Peoria
30----		
29.8	OB09	106th Street North
27.4	Sperry	Sperry Imholf Tank discharges to Hominy Cr.
	Hominy	Hominy Creek confluence
27.3	OB08	96th Street North
25----	USGS # 1775	U.S.G.S. gauging station
	OB07	86th Street North
23.4	Delaware Cr.	Delaware Creek confluence
20.3	OB06	56th St. North, West of Yale
20----		
19.9	Flat Rock	Flat Rock Wastewater Plant
18.9	Coal Creek	Coal Creek Wastewater Plant
16.0	OB05	56th St. North at Memorial
15.5	Coal Creek	Coal Creek (Stream confluence)
15----		
14.1	USGS # 1780.5	U.S.G.S. Sampling Station
	OB04	North Mingo Road
13.2	Owasso	Owasso Wastewater Lagoon
13.0	Northside	Northside Wastewater Plant
12.5	OB03	U.S. Highway 169
10.9	OB02	56th St. North, East of U.S. Hwy 169
10----		
9.5	OB021	U.S. Highway 266
5-----		
2.9	4B01	State Hwy. 167
0-----	Verdigris R.	Verdigris River confluence

Table 5-3 AVAILABLE HEAVY METALS SAMPLING DATA (mg/l)

	Instream Sampling Station Data					Point Source Sampling Data				
River Miles	Station[1]	Cd	Cr	Zn	Pb	WWTP[2] and Tributaries	Cd	Cr	Zn	Pb
40										
37.3	OB11	0.211	0.055	0.13	0.069					
37.1						Skiatook WWTP	N/A	N/A	N/A	N/A
35.0										
34.3	OB10	0.115	0.053	0.023	0.068					
30.0										
29.8	OB09	0.068	0.063	0.018	0.088					
	OH01					Hominy Creek	0.055	0.043	0.023	0.051
27.4						Sperry WWTP	N/A	N/A	N/A	N/A
27.3	OB08	0.039	0.04	--	0.058					
25.0	USGS #1775									
	OB07	0.14	0.064	0.045	0.149					
23.4	OD01					Delaware Cr.	0.050	0.119	0.009	0.021
21.3	OB06	0.024	0.058	0.025	0.09					
20.0										
	OF02					Flat Rock Cr.	0.108	0.034	0.023	0.048
	OJ01					Dirty Butter	0.152	0.026	0.054	0.03
19.9						Flat Rock WWTP	0.004	0.016	0.026	0.018
18.9						Coal Creek WWTP	0.015	0.035	0.038	0.023
16.0	OB05	0.053	0.066	0.035	0.089					
15.5	OY01					Coal Creek	0.136	0.021	0.029	0.038
15.0										
14.1	OB04	0.064	0.055	0.09	0.073					
13.2						Owasso WWTP	N/A	N/A	N/A	N/A
13.0						Northside WWTP	0.009	0.02	0.036	0.021
	OI01					Mingo Creek	0.027	0.026	0.023	0.032
12.5	OB03	0.123	0.058	0.07	0.083					
10.9	OB02	0.077	0.063	0.117	0.102					
10.0										
9.5	OB21	0.07	0.061	0.103	0.088					
5.0										
2.9	4B01	0.057	0.055	0.215	0.089					
0										

[1] INCOG Sampling Data 5/12/76 - 5/31/77

[2] CH2M Hill "Technical Information" Jan 1980 - April 1981

respect to municipal discharges. As stated previously, most of the point source contributions occur in the lower half of the study segment, from Flat Rock Creek (R.M. 19.1) to the confluence of Bird Creek with the Verdigris River (R.M. 0.0), (see Table 5-2). An extensive amount of water quality data has been collected in this segment, with the original stream survey occurring on August 19, 1976.

It was this data that provided calibration for the Hydroscience computer model "RIVER" that was used to develop the present wasteload allocations.

The model has been shown to be an effective tool in illustrating the impacts on Bird Creek as a result of these point source contributions. Figure 5-3 presents the modelling results for the stream's dissolved oxygen (D.O.) level at various points along its reach. Changes in this D.O. profile illustrate the stream's response to organic loading and its rate of assimilation. The dotted line on Figure 5-3 represents the D.O. profile and the general condition of the stream in 1976 (ultimate BOD was 32,100 lbs of O_2 per day) when the model was originally developed. The data used for that profile is presented below.

Effluent Characteristics 8/19/76

Plant	River Mile	Flow MGD/cfs	BOD (mg/l)	NH_3(mg/l)	UBOD lbs/day
Flat Rock	19.9	4.87/7.54	34.7	28.00	7,356
Coal Creek	19.1	3.58/5.54	38.0	28.00	5,522
Northside	13.0	11.63/18.00	46.9	28.00	19,235

As discussed earlier, since the time of this original sampling and model calibration, several changes have occurred which could affect the stream's water quality. These include the expansion and additíon of disinfection at Northside along with improvements in operations at both the Flat Rock and Coal Creek plants.

Because of these changes a new water quality sampling program was conducted on September 9, 1981 by INCOG to update the overall modeling data base.

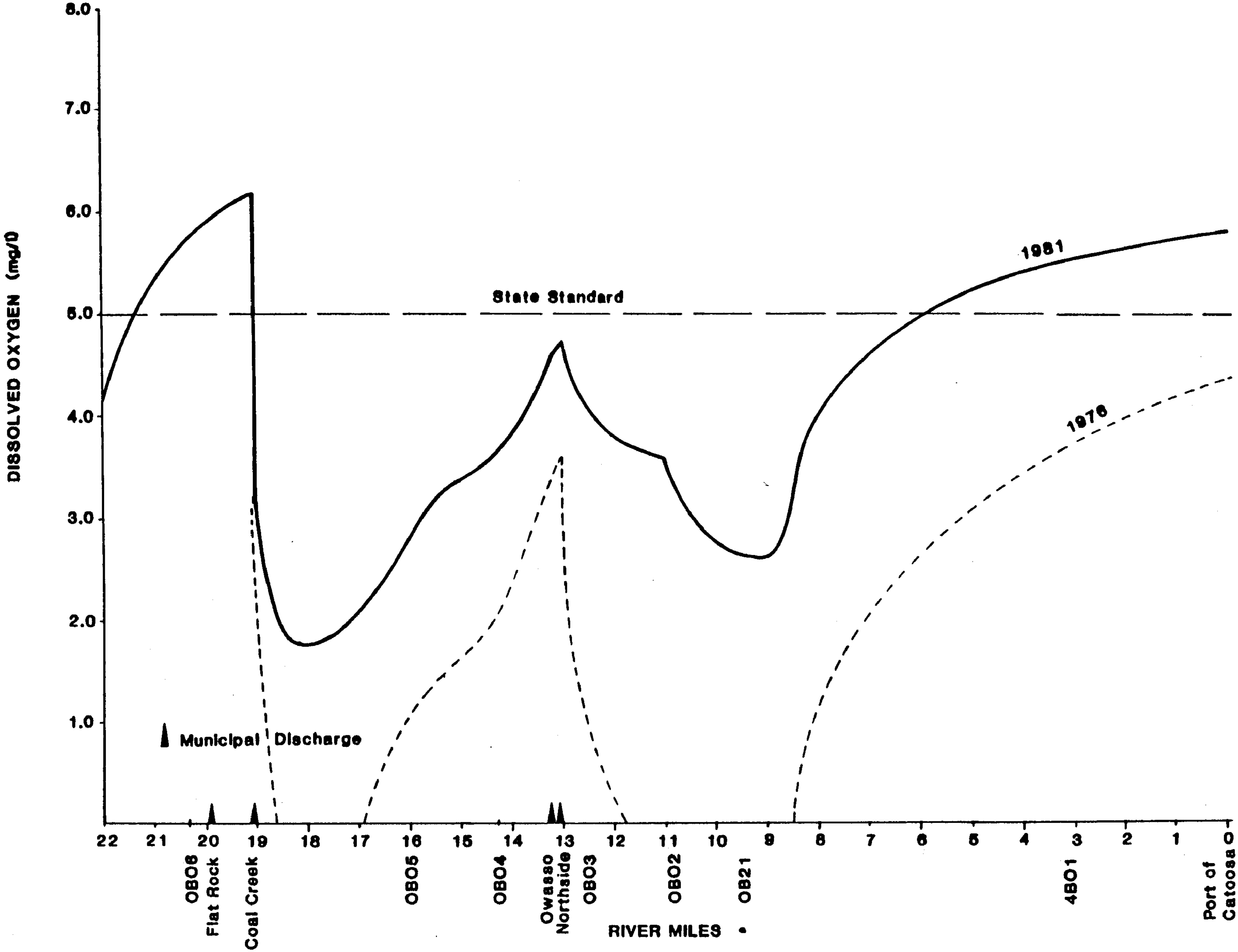


Figure 5-3 Model Dissolved Oxygen Profiles Based on 1981 and 1976 Data.

These improvements reduced the total BOD contribution from these point sources to 16,500 pounds of oxygen required for assimilation, as indicated below.

Effluent Characteristics 9/8/81

Plant	River Mile	Flow MGD/cfs	BOD (mg/l)	NH_3(mg/l)	UBOD lbs/day
Flat Rock	19.9	4.9/7.58	32.7	13.8	4,582
Coal Creek	19.1	4.39/6.8	26.6	6.0	2,464
Northside	13.0	15.7/24.3	12.0	12.1	9,530

This new data (1981) was plugged into the same model (Hydroscience, 1978; "RIVER") that was used in the original modelling runs. The solid line provided in Figure 5-3 illustrates the stream's responses, with the overall rise in the level of the dissolved oxygen profile indicating a relative improvement as a result of the expansion of the Northside plant and improvements in effluent quality at Flat Rock and Coal Creek.

The most important characteristic of the dissolved oxygen (D.O.) profile is the extent and degree of the D.O. sag. This is the area of the stream in which the organic matter from a discharge depletes the D.O. level of the stream. The assimilative capacity of the stream regulates the rate (slope of the profile) at which the instream D.O. level recovers.

The new D.O. profile (solid line, Figure 5-3) based on the 1981 data exhibits two D.O. sags. The first sag is downstream of Flat Rock and Coal Creek's discharges (R.M. 19.0) and the second is below the Northside plant (R.M. 13.0). The profile below Northside exhibits an uncharacteristic double sag with the second and more severe D.O. depletion occurring between River Mile 11 and 9. In this segment (R.M. 11-9) the stream channel is both deeper and wider than the upstream segment. This means that the velocity, and the reaeration rate have been reduced, and it follows that the rate of assimilation would be reduced. The net effect is a long, deep pool, especially during low flow conditions.

Evaluation of the channel indicates two possible obstructions; one results from dikes or obstructions placed in the stream by a gravel company to provide a platform for wash water pumps, the other and most likely cause is a rock outcropping and diversion structure used in the mid-30's as an irrigation pool. This is located at about RM 10.6. The actual physical extent of the obstruction and its effect on water quality is not known at this time, but the model's D.O. profile response to the segment's cross-sectional area, which may be at least in part caused by this structure is clearly illustrated on Figure 5-3.

In summary, the point of the D.O. sag relates to a specific stream segment with a particularly low rate of reaeration. It appears that the channel configuration, enhanced by the presence of an instream obstruction which affects flow velocity is an important factor affecting the D.O. levels in this section of the stream.

Groundwater

Groundwater resources in Tulsa County are generally of limited extent, however, some rural residents presently have irrigation and private drinking water wells in the downstream area that should be addressed.

The Oklahoma Geological Survey has developed maps for the state, showing generalized aquifers and their relative quality (OGS, 1955 and 1971). According to these maps, Tulsa County has primarily localized groundwater reservoirs of limited extent, fair to poor quality and yields of usually less than 50 gallons per minute. Two local areas, however, have more substantial resources. These are the terrace deposits and alluvium along the Arkansas and the Verdigris, and on parts of Bird Creek. The chemical quality is listed as fair to good, but with generally low yields. The water from alluvium along the Verdigris and Bird Creek is listed as usually hard with high dissolved solids.

There are scattered records of drinking water wells with the Tulsa City/County Health Department. These usually provide only the results of coliform counts on water samples, however, and are only done at the owner's request. An examination of the records for the last two years did not show any new wells in the Bird Creek area, but since well locations were not always listed, some may have been overlooked.

The U.S. Geological Survey keeps records of wells in most areas, but their information in the study area is limited, USGS lists several areas on Bird Creek as favorable for development of groundwater supplies based on geological structure (Figure 5-4).

In addition, some USGS well records exist. These are numbered on Figure 5-4 and described on Table 5-4. Because of the lack of recorded information, local residents were contacted in an attempt to delineate any other wells. The lettered wells on Figure 5-4 resulted. Information on those wells is also given in Table 5-4. Most residents abandoned their wells when City water became available, although several residents reported that their wells had become too salty for drinking.

Flood Hazards

The effects of a project on flood hazards generally relate directly to the facility's location in a floodplain and indirectly to the facility's effect on development in a floodplain, increasing a stream's flood stage or area of inundation. However, institutional constraints outlined as follows limit such development (see Report IV for more detail).

The Floodway Zoning Ordinance created a new zoning district classification, FD, to control development in the floodway portion of the floodplain, i.e., the area required to convey the 100-year frequency flood. The ordinance prohibits development in the floodway which may increase flood hazards to other property owners; thus, so-called "open air" uses are virtually the only allowable type of development in floodway districts.

Development in the floodplain is also regulated under the Earth Change and Stormwater Drainage Control Ordinance and Floodplain Development Ordinance. The former regulation requires that the developer prepare and submit to the City Engineer a drainage plan (in conjunction with the subdivision

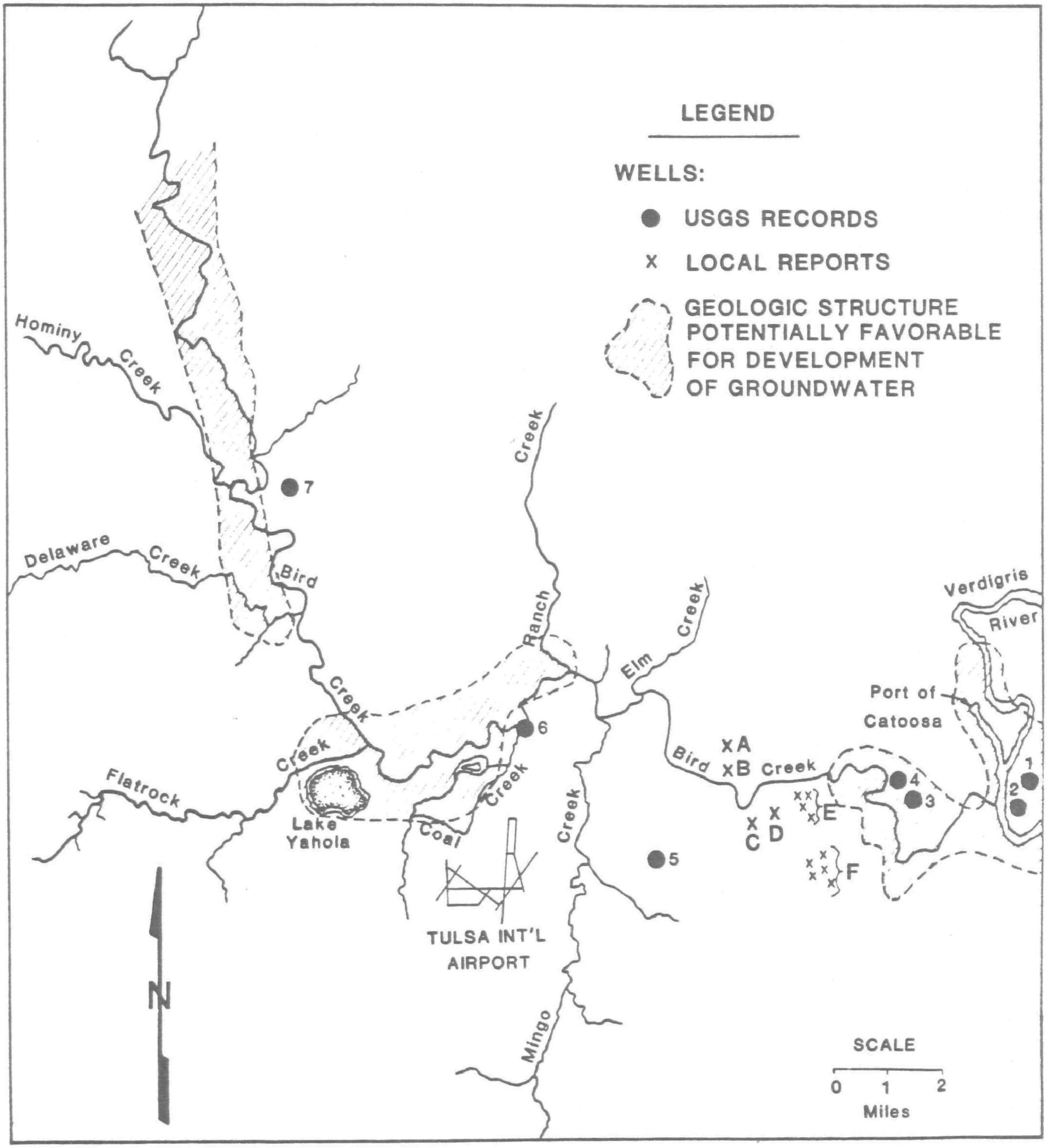


Figure 5-4 Groundwater Resources and Well Locations on Bird Creek.

Table 5-4 DATA FOR WELLS SHOWN ON BIRD CREEK

Well No.	Well Depth (in ft)	Depth to Groundwater (in ft)	Current Usage	Comments
(USGS Records)				
1	69	21		
2	28	21		
3	39	25		
4	37	18		
5	16	5	Home*	1948 Record
6	28	20	Home*	1948 Record
7	83	27	Stock*	1948 Record
(Local Reports)				
A		30	Unused	High coliform
B		20	(destroyed)	Salty-now lies under Port Road
C		60-70	Unused	"Sulfur water"
D		30	Unused	
E		30	Unused	
E		80	Unused	
E		40	Unused	
E		102	Unused	Salty
F		60	Unused	Reported good quality
		50	Unused	Dry
F		50	Unused	Salty
F		50	Unused	Salty
F		--	Unused	Salty

* This was the reported usage in 1948, present use unknown.

application) and obtain an Earth Change Permit prior to any grading, excavation, or landfilling. The latter regulation established mapped floodplain locations and required review by the City Engineer of all planned alterations to the natural environment within the floodplain.

NO ACTION

As presented earlier, the conditions that will be in effect at the time the selected alternative would be implemented (1985) will have changed dramatically in relation to the existing conditions (1981). The primary change will occur as a result of the closure of Tulsa's Coal Creek and Flat Rock wastewater treatment plants located six and seven miles upstream of the Northside Plant, respectively.

These plants are outdated and scheduled to be closed by 1985 with the flow conveyed to the Northside Plant for treatment at the planned 11 MGD secondary expansion. This condition will be represented by the Northside Plant operating at capacity (30 MGD) and producing a 20 mg/l BOD and 30 mg/l SS, with no nitrification for the planning period from 1985 through 2005.

Surface Water

The treatment of these combined flows at the Northside Plant would increase its total capacity to 30 mgd. The flow would be treated to a secondary level with the following effluent quality.

Effluent Characteristics 1985

Plant	River Mile	Flow MGD/cfs	BOD (mg/l)	NH_3(mg/l)	UBOD lbs/day
Northside	13.0	30/46.4	20	12	21,300

As indicated, this will increase the ultimate organic loading to the stream from the 1981 level of 16,500 pounds of oxygen for assimilation. The No Action (1985) effluent characteristics would be 20 mg/l BOD, 30 mg/l SS and the NH_3 would be approximately 12 mg/l, producing a UBOD of 21,300 lbs of oxygen. The Northside plant would reach capacity at 30 MGD (46 cfs). It is assumed that any additional population growth (i.e., increased municipal flow) would require onsite treatment. The downstream project area is shown on Figure 5-5. The No Action D.O. profile that will be used in the alternative evaluation is shown on Figure 5-6.

In assessing this profile, it can be seen that the 20 mg/l carbonaceous BOD loading from a secondary plant would have a detrimental impact on Bird Creek during low flow conditions. The slope of the profile from River Mile 13 (Northside) to R.M. 9 illustrates a high D.O. reouirement from this organic loading. From R.M. 9 to the mouth (R.M. 0), the stream exhibits a gradual recovery. The slope of the recovery profile is dependent on the stream channel characteristics and the rate of ammonia conversion (NH_3-NO_3). In addition, because of the minimal degree of in-plant nitrification, the level of ammonia at the mouth of Bird Creek would be in excess of 7 mg/l (NH_3) which can be toxic to most fish species.

It is anticipated that the section upstream of Northside which had received loadings from Flat Rock and Coal Creek will improve with time. Once the point sources are removed, it is the nature of the watershed and the physical characteristics of the channel that become the controlling factors in a stream's water quality as well as the types and species of aouatic organisms that will inhabit it (see Biological Resources).

Groundwater

The effects on the area groundwater would not be significantly different than what was presented under existing conditions. The higher rate of solids loading may further seal the stream channel's bottom limiting recharge to alluvial aquifers.

Flood Hazards

Because No Action would not involve the construction of any new facilities, the potential for site development in the floodplain would not be presented.

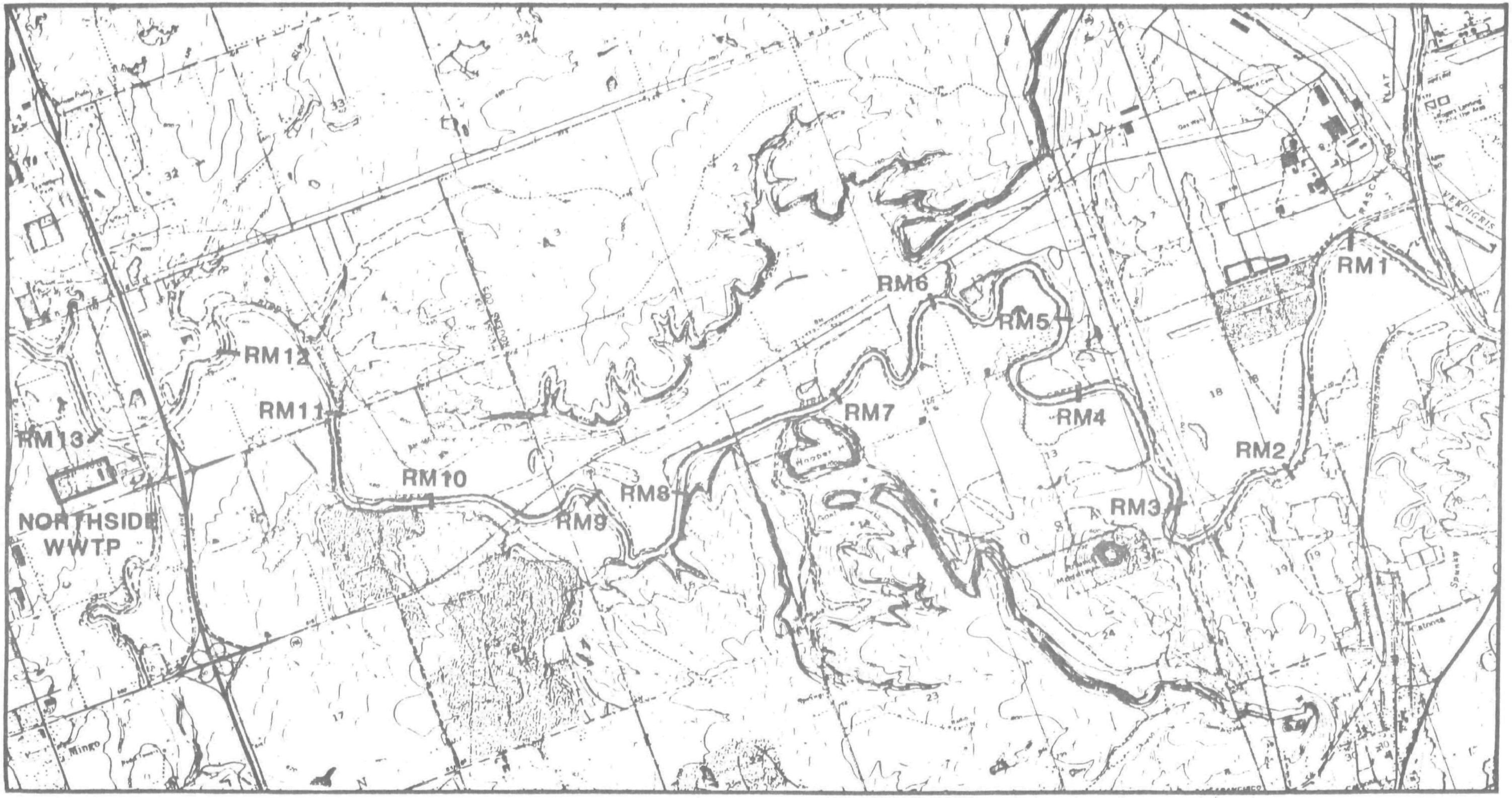


Figure 5-5 Downstream Project Area and River Mile Location Map.

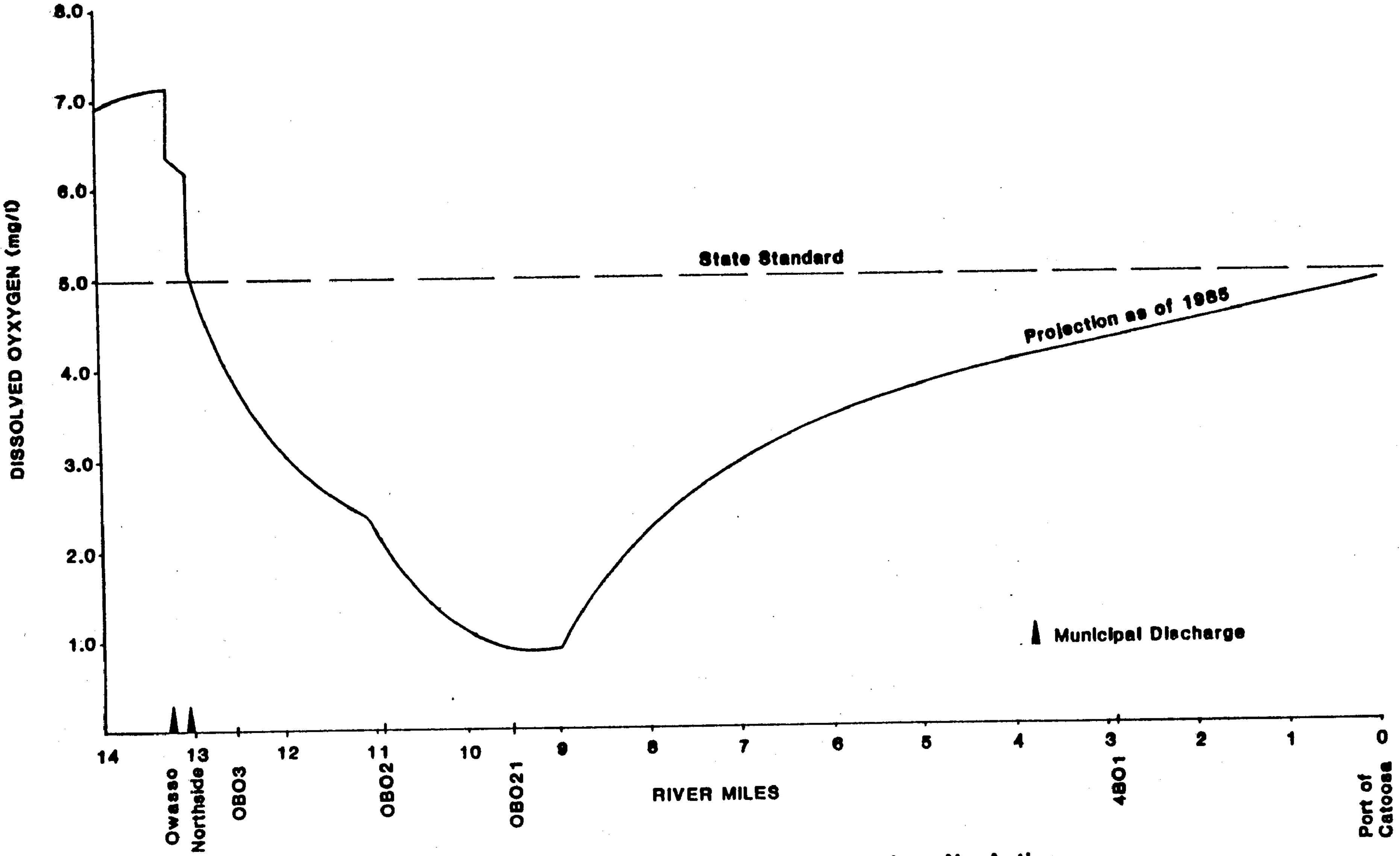


Figure 5-6 Model Dissolved Oxygen Profile Based on No Action.

However, No Action would result in the lack of available sewer service for new housing development, requiring the employment of onsite disposal systems. Since these systems require suitable soils and larger lot sizes, pressures for development into floodprone areas could result (see Socioeconomic evaluation).

OUT-OF-BASIN TRANSFER MA-1

In contrast to the other wastewater management alternatives presented in this section where the flow is treated to a high degree and discharged to Bird Creek, this alternative would transport secondarily treated effluent by pipeline to the Arkansas River for discharge.

Surface Water

According to the 208 study, the Arkansas River should possess sufficient assimilative capacity to accommodate the additional organic loading. In terms of Bird Creek, the net result would be the return of the stream to a pre-Northside condition. The removal of the Northside discharge would make the entire downstream reach more susceptible to fluctuations in flow. Based on a 10 year period of record (USGS #1775, 1972-1981), the mean flow was 643 cfs with average peaks as high as 19,290 cfs, average low flows of 4.5 cfs and with minimum flows dropping as low as 0.20 cfs. Because the majority of the stream's flow would result from storm water runoff, its water quality would be controlled by the pollutant loading from non-point sources (see Report XII for more detail).

As the Bird Creek channel is influenced by the floodplain of the Verdigris River, the channel becomes wider and shallower. This is further shown by the backwater effects of the Port of Catoosa turning basin into the last three miles of Bird Creek. The result is a reduction in flow velocities and instream reaeration. This indicates that the downstream area would probably be affected by warm weather low-flow conditions that could result in depressed levels of dissolved oxygen.

Seasonal fluctuations in stream D.O. levels may also occur. "Instream decay of accumulated organic materials resulting from the die off of summer vegetation which is washed into receiving streams by rainfall as well as the decay of large quantities of leaves resulting from autumn leaf falls in forested areas has resulted in significant oxygen depressions and occasionally, in fish kills in small streams in the Tulsa area," (INCOG, February 1978).

This naturally occurring instream oxygen demand could be more pronounced during times of warmer temperatures and low flows. The reason is that water holds less oxygen at warmer temperatures. For example, at 20°C the saturation level of water is 9.17 mg/l of oxygen, whereas at 30°C that level is only 7.63 mg/l. Adding to the problem, the flow in most streams is diminished during warmer weather. A loss in flow and velocity may be accompanied by stagnant pools and a reduction in reaeration.

To illustrate this effect on Bird Creek's water quality, the available sampling data taken during warm weather low flow periods around the USGS sampling station #1775, located on Figure 5-2 was evaluated. A regression analysis was used to produce a linear best fit for the data points (a more detailed discussion of this data is presented in Report IX; Volume 3). The available data indicates that during summer low flow conditions of less than 11 cfs, the dissolved oxygen content of the stream could fall below the designated level of 5.0 mg/l used in the State Stream Standards.

It would be expected that despite the extreme fluctuations in flow and the possible seasonal drops in D.O. due to the low flow conditions, the water quality of this downstream area would improve greatly over that resulting from No Action. This would primarily be due to the elimination of the large D.O. sag and the removal of the ammonia toxicity associated with municipal effluents.

Groundwater

The removal of this flow would limit groundwater recharge of the adjacent alluvial aquifers to storm water runoff and periods of seasonally higher flows.

Flood Hazards

This wastewater management alternative as well as the following options under evaluation will provide for additional capacity to accomodate future growth. This would control growth patterns further limiting the potential of floodplain encroachment by development (see Socioeconomic Evaluation).

AWT ALTERNATIVE MA-10

This alternative along with the remaining two alternatives (MA-13 and MA-16) under evaluation are directed at the expansion of the Northside Plant to accommodate an average daily flow of 42.6 mgd, employing a method of Advanced Wastewater Treatment (AWT). Since all these alternatives are designed to achieve the same level of effluent quality the impacts on the stream will be summarized jointly below. Because each alternative utilizes a different approach to treat the wastewater, an assessment of the alternative's process trains and operation will be presented separately.

Surface Water

This level of treatment would produce an effluent with a quality of 5 mg/l BOD, 5 mg/l SS and 3 mg/l NH_3, which would exert a UBOD of 7,500 lbs of oxygen.

The major advantages of these alternatives is the combined reduction of both the carbonaceous and nitrogenous oxygen demand exerted on the stream, and the continued contribution of a constant flow (57 cfs). Figure 5-7 presents the stream's D.O. profile in response to these loadings.

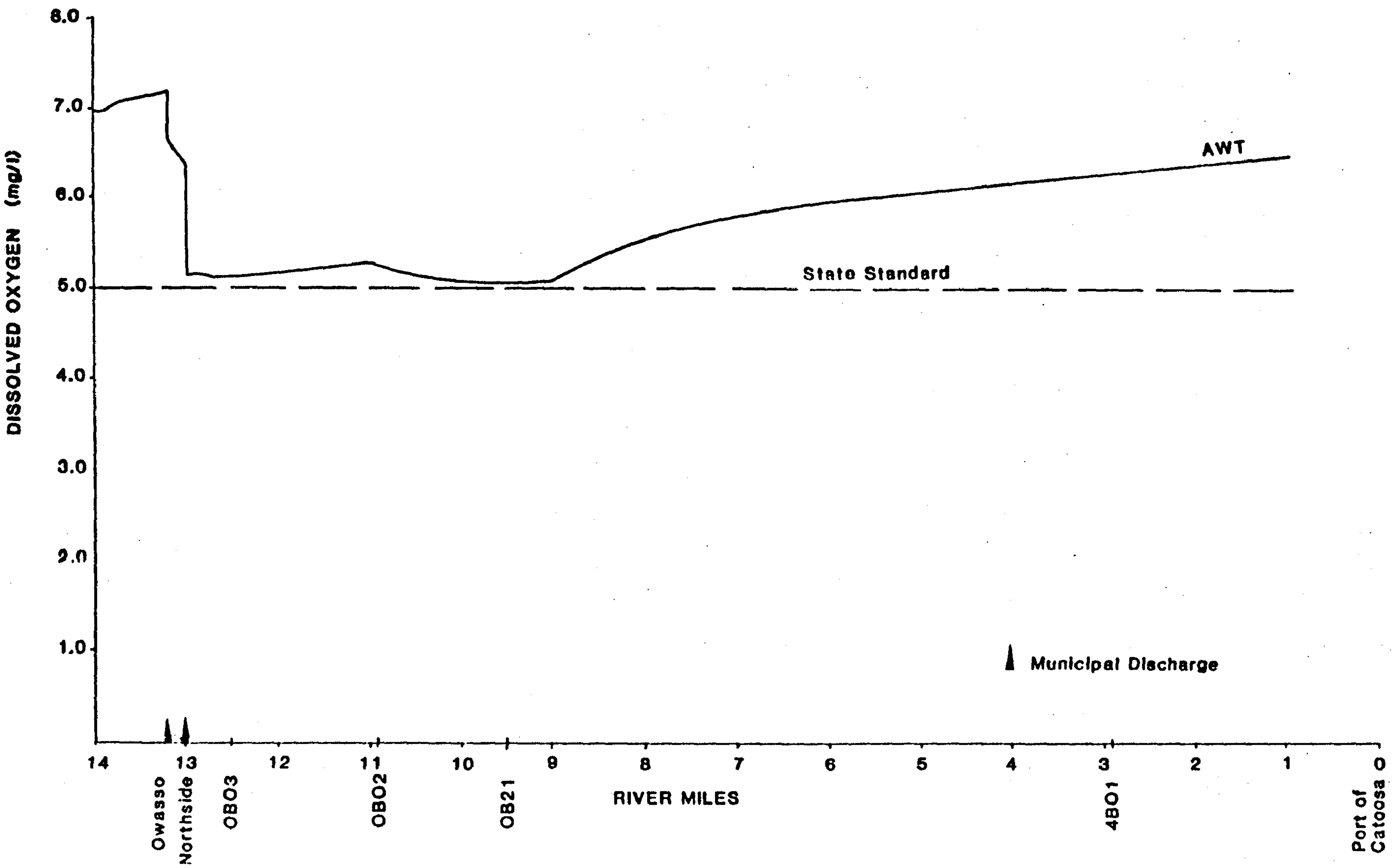


Figure 5-7 Model Dissolved Oxygen Profile Based on Advanced Wastewater Treatment.

Aside from the reduction in the organic loading and the elevated levels of dissolved oxygen, probably the most significant change, in comparison to the No Action alternative, is the reduction in ammonia toxicity. It would be expected that the ammonia concentration would be less than 2 mg/l at the mouth of Bird Creek, providing a major beneficial impact to water quality.

This AWT alternative, MA-10, would utilize the existing trickling filter process in combination with an expanded activated sludge system to provide a secondary level of treatment, as discussed in the Facilities Plan. Biological filtration would follow utilizing a fixed growth media to support bacterial cultures of Nitrosomonas and Nitrobacter to acheive nitrification.

Any biological nitrification process is susceptible to cold weather, because the organisms are mesophilic and their peak growth curve occurs between 20-30°C. This is followed by a gradual reduction in metabolic activity as the temperature varies to either side of that range. The concern with this alternative (MA-10) is that the fixed growth process is much more susceptible to cold weather and this could affect its reliability. Covers for the biological filters may reduce this susceptibility.

Groundwater

The AWT alternatives would continue the discharge of a good quality effluent that could produce some recharge.

Flood Hazards

As discussed previously, the plant would be expanded to accommodate growth, limiting the potential for floodplain encroachment by development.

AWT ALTERNATIVE MA-13

This alternative provides the same improvements in water quality as the other AWT options. The primary difference, however, is that ammonia removal would be accomplished through chemical means, at least during the coldest times of the year. The activated sludge process would be designed with sufficient retention time to provide biological nitrification during most of the year.

Surface Water

The removal of ammonia is an important factor in water quality. Because of the influence of colder temperatures on ammonia removal by nitrification as discussed earlier, a process referred to as breakpoint chlorination was added as a part of this alternative to offset this potential during the six coldest weeks of the year.

The breakpoint process removes ammonia from wastewater by converting ammonia (NH_3) to nitrogen gas (N_2) through a series of chemical reactions employing the oxidizing agent chlorine. To carry out this reaction a greater amount of chlorine in relation to ammonia must be added. At the normal chlorine dosage of 25 mg/l for disinfection, a combined residual chlorine level of 0.5 mg/l would be expected. However, in breakpoint chlorination with design levels of 200 mg/l, the residual chlorine levels would be higher.

Because even low levels of chlorine are toxic to fish a process of dechlorination would be required. The accepted method is the addition of sulfur dioxide at a ratio of 1:1. Since sulfur dioxide is a strong reducing agent it will exert an oxygen demand of its own if added at levels higher than what is required for dechlorination. Therefore, precise metering of the chlorine residual and sulfur dioxide is required. In addition, post-aereation should be considered as a safeguard, similar to the cascade structures provided at the present Northside Plant.

Independent of the concern over the use of highly reactive chemicals, an advantage of this process is its year-round availability. In case of an industrial shock loading or some other unexpected die-off or decline in the summertime population of nitrifiers, the breakpoint process could be put into operation. This would provide a backup until the biological process recovered. This alternative would provide a major beneficial impact to water quality.

Groundwater

The potential benefits are the same for all AWT options.

Flood Hazards

A more detailed discussion is provided under the socioeconomic evaluation.

AWT ALTERNATIVE MA-16

This (AWT) alternative would utilize biological filters and activated sludge for treatment.

Surface Water

In this AWT alternative, the primary mode of treatment would be the activated sludge process, plus biological filters. The bio-filters would be placed in front of the activated sludge train providing two advantages. First, the biological filters are less sensitive to potential toxic shocks from industrial spills and would act as a buffer for the primary system of treatment. Second, the purpose would be to reduce the carbonaceous BOD loading to the activated sludge process. This would allow for nitrification to take place in the activated sludge process which is a suspended growth system that is less susceptible to cold weather. This alternative would provide a major beneficial impact to water quality.

Groundwater

All AWT options are comparable.

Flood Hazards

All AWT options are comparable.

PHYSICAL RESOURCES

For the purposes of this evaluation, discussion of the physical environment and the effects of the alternatives will be restricted to geology, soils and air quality/meteorology.

EXISTING CONDITIONS AND NO ACTION

Because there are no anticipated changes between the existing physical environment (1981) and that which will occur in 1985, Existing Conditions and No Action will be presented jointly.

Geology

An assessment of geology provides the necessary data base from which the planning of future structures or modifications can be made.

Tulsa County is underlain entirely by Pennsylvanian rocks, but with local surface deposits of Pleistocene river sediments and wind blown sands. Pennsylvanian age rocks are divided into several species of rocks. Of these, the Missourian and Desmoinesian Series are the "Foundation of Tulsa County". These series are further divided into groups and then formations. They are outlined below:

DESMOINESIAN SERIES	MISSOURIAN SERIES
Marmaton Group	Ochelata Group
Holdenville Shale	Barnsdall Formation
Nowata Formation	Wann Formation
Oologah Limestone	Iola Limestone
Labette Formation	Chanute Formation
Fort Scott Limestone	Dewey Limestone
Cabaniss Group	Skiatook Group
Senora Formation	Nellie Bly Formation
Krebs Group	Hogshooter Limestone
	Coffeyville Formation
	Checkerboard Limestone
	Seminole Formation

SOURCE: From A.P. Bennison, "Tulsa's Physical Environment", 1972.

The area that lies within a one mile radius of the Northside is predominated by Modern Floodplain Alluvium of the Bird and Mingo Creek floodplains. Oologah Limestone Formation lies to the southeast of the Bird/Mingo confluence. The Nowata Shale Formation and undifferentiated terrace deposits lie to the west. The general location of these formations are shown on Figure 5-8, taken from Tulsa's Physical Environment, 1972. The formation of particular interest is the Nowata Shale Formation located adjacent to the Northside plant site. This shale is potentially in the area of construction and consists of soft, plastic clay shale. Formations of this type tend to be mechanically weak for large structures.

Soils

The 1977 Soil Survey described three groups of soils and nine soil associations within them. These are listed on Table 5-2, with the percentage make-up of each group and association for Tulsa County. These associations are mapped in the Soil Survey for reference in "broad land use planning". The general soil map shows the Northside Wastewater Treatment Plant and a one mile radius contain the Dennis-Bates Association, the Okemah-Parsons Association and the Osage-Wyona Association. Each of these associations is made up of soils having similar properties.

For smaller-scale planning, detailed soils maps have been compiled. These are based on soil "mapping units", which may be soil series, phases, complexes or other miscellaneous units.

These mapping units have been reproduced for the area of the Northside Wastewater Treatment Plant on Figure 5-9. Table 5-5 corresponds to that figure and describes each of the mapping units in terms of a few of their characteristic problems. The problems listed for each soil relate to properties of the soil which affect land use. The meaning of the terms and their importance are described below;

Permeability. The Apperson, Dennis, Okemah & Osage soils have low permeability (0.6 - 0.20 inches per hour). This is important in that the

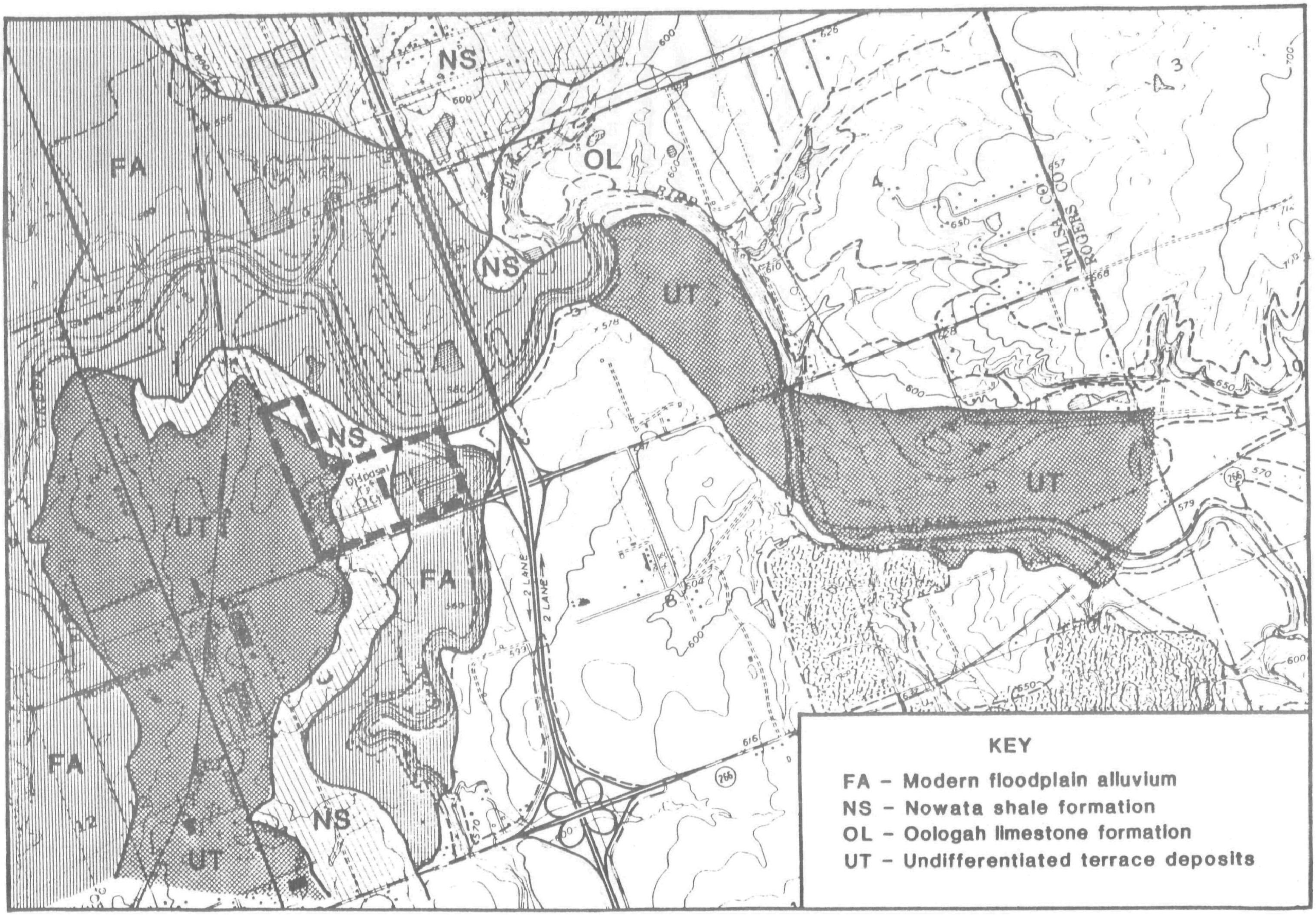


Figure 5-8 Geologic Formations - Northside Treatment Plant Area.

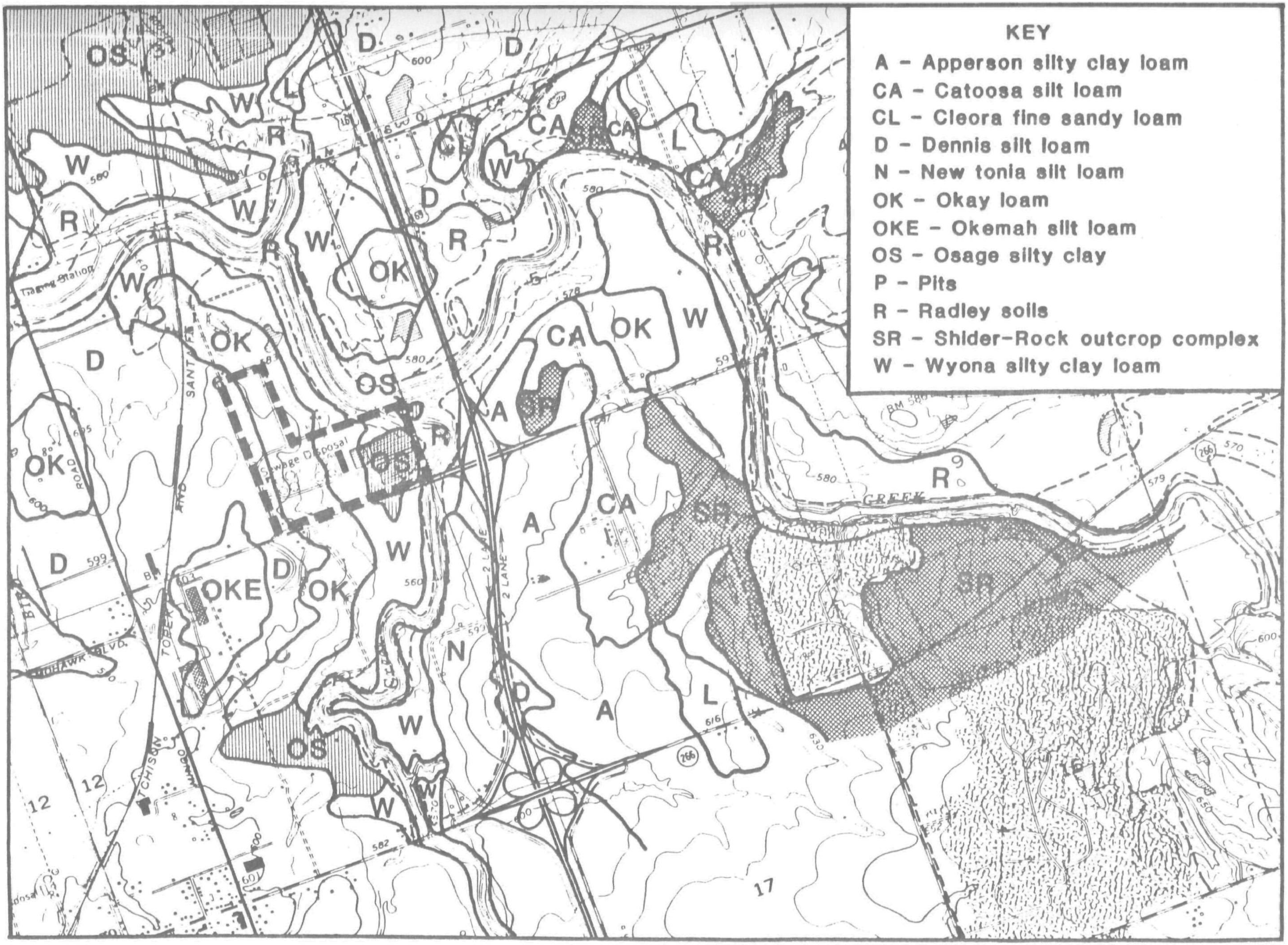


Figure 5-9 Soils Map - Northside Treatment Plant Area.

Table 5-5 CHARACTERISTICS OF SOILS MAPPING UNITS

Map Symbol	Soil Mapping Unit	Characteristic Problems
A -	Apperson silty clay loam	Slow permeability Shallow depth to bedrock Clayey texture High Shrink-swell potential Low strength
CA -	Catoosa silt loam	Shallow depth to bedrock Clayey texture & acidity Moderate shrink-swell potential Low strength
CL -	Cleora fine sandy loam	Flooding
D -	Dennis silt loam	Slow permeability Clayey texture & acidity High shrink-swell potential
L -	Lula silt loam	Shallow depth to bedrock Moderate shrink-swell potential Clayey texture & acidity Low strength
N -	Newtonia silt loam	High shrink-swell potential Clayey texture; acidity
OK -	Okay loam	Soil acidity
OKE -	Okemah silt loam	Slow permeability High shrink-swell potential Clayey texture and acidity
OS -	Osage silty clay	Flooding Slow permeability High shrink-swell potential Clayey texture
R -	Radley soils	Flooding
SR -	Shidler - Rock outcrop complex	Shallow depth to bedrock Moderate shrink-swell potential Clayey texture Low strength Slope Rock outcrops
W -	Wynona silty clay loam	Flooding Wetness Low strength

Source: SCS Soil Survey of Tulsa County, OK.

soil may not drain well and will remain wet. The wetness of the soil can make it difficult to handle in any earth moving operation.

Depth to Bedrock. The Apperson, Catoosa, Lula and Shidler-Rock Complex soils all have bedrock at a shallow depth, which hampers any kind of excavation. The depth to bedrock in these soils ranges from 4-20 in. for the Shidler-Rock Complex to 20-40 in. for the Catoosa silt loam to 40-60 in. for the Apperson silty clay loam and Lula silt loam. The rest of the soils listed have bedrock at greater than 60 in.

Texture and pH. Several of the soils have clayey textures and some are acidic as well. Acidic (pH <7) and clayey soils tend to corrode uncoated steel and concrete. Nearly all the local soils have this problem.

Shrink-swell Potential. The Apperson, Dennis, Newtonia, Okemah and Osage soils have high shrink-swell potential. This refers to the potential of the soil to shrink when dry and swell when wet, which can damage any type of structure as well as plant roots. The Catoosa, Lula and Shidler-Rock soils have moderate shrink-swell potentials.

Flooding. Soils which are subject to flooding have the least potential for development. The Cleora, Osage, Radley and Wyona soils are flooded occasionally for brief periods, and offer some restraint to management.

Air Quality/Meteorology

Meteorological changes are an important consideration in the assessment of potential impacts on air quality. The National Weather Service has operated a recording station in Tulsa for the past 73 seasons. The data indicates an average annual temperature of 60.2°F (1.57°C), with the first and last killing frosts generally occurring on November 2 and March 25 respectively. The result is an average growing season of 220 days, (U.S. Army Corps, 1977; Report IV).

Over 60 percent of the average annual precipitation (36.9 in.) for the area falls during the growing season. In general, the summer rains are in the form of thunderstorms which are of short duration and high intensity, covering a limited area. In contrast, the winter rains tend to be widespread, low-intensity, and of longer duration. The prevailing surface winds are southerly during most of the year, averaging about 5-7 mph (Table 5-6).

A national program to protect air quality was designated under the Clean Air Act Amendment of 1970. Under this law, the U.S. Environmental Protection Agency (EPA) established the National Ambient Air Quality Standards (NAAQS) for those pollutants of major health significance. The standards are divided into two areas; the primary standards are designed to protect public health, while the more stringent secondary standards are designed to protect a broader array of environmental concerns. The NAAQS have been adopted by the State of Oklahoma.

An air quality impact is determined by the rate of pollutant emissions, the subsequent dispersion and chemical reaction of the pollutants in the atmosphere. A pollution episode results not so much from an increase in the production of specific pollutants, but rather from limitations in the dispersion process, such as area stability and meteorological changes. The most common cause of excessive atmospheric stability and the subsequent pollution episodes are temperature inversions. An inversion restricts the upward movement of air, limiting the total air volume available for mixing. Pollutants released at the ground are thus concentrated. The frequency of inversions by season is not available for Tulsa specifically, however, the inversion characteristics can be expected to be similar to those of Oklahoma City as indicated below.

Frequency of Ground Level Inversions

Season	Percent of Total Hours
Winter	37
Spring	32
Summer	37
Fall	46

SOURCE: Oklahoma City - County Health Department

Table 5-6 MONTHLY AVERAGES OF TEMPERATURE, PRECIPITATION, AND WIND FOR TULSA, OKLAHOMA*

Month	Rainfall Inches (cm) (1940-1971)	Temperature Degrees F (°C) (1940-1971)	Wind Mean Speed mph (cm/sec)	Wind Prevailing Direction
Jan	1.43 (3.63)	36.6 (2.6)	10.8 (482.8)	N
Feb	1.72 (4.37)	41.2 (5.1)	11.3 (505.2)	N
Mar	2.52 (6.40)	48.3 (9.1)	12.5 (558.8)	SSE
Apr	4.17 (10.59)	60.8 (16.0)	12.4 (554.3)	S
May	5.11 (12.98)	68.6 (20.4)	10.9 (487.3)	S
June	4.69 (11.91)	77.3 (25.2)	10.3 (460.4)	S
July	3.51 (8.92)	82.1 (27.8)	9.4 (420.2)	S
Aug	2.95 (7.49)	81.4 (27.4)	9.0 (402.3)	SSE
Sept	4.07 (10.34)	73.3 (22.9)	9.4 (420.2)	SSE
Oct	3.22 (8.18)	62.9 (17.2)	10.0 (447.0)	SSE
Nov	1.87 (4.75)	49.4 (9.7)	10.6 (473.9)	S
Dec	1.64 (4.16)	39.8 (4.3)	10.5 (469.4)	S
Annual	36.90 (93.73)	60.2 (15.7)	10.6 (473.9)	S

* Data from National Weather Service records.

Aside from air pollution episodes than can occur from certain meteorologic conditions (i.e. inversions), specific regions are designated as non-attainment areas. These are areas in which the ambient air contains certain pollutants that exceed clean air standards. For Tulsa, the constituents of concern are carbon monoxide (CO), total suspended particulates (TSP) and ozone (O_3) (ozone and raw atmospheric hydrocarbon (HC) are believed to be related). These specific non-attainment areas are shown in Figure 5-10; which are based on the state standards presented in Table 5-7.

OUT-OF-BASIN TRANSFER MA-1

The primary concern of this alternative relates to the requirements for a 26 mi pipeline.

Geology

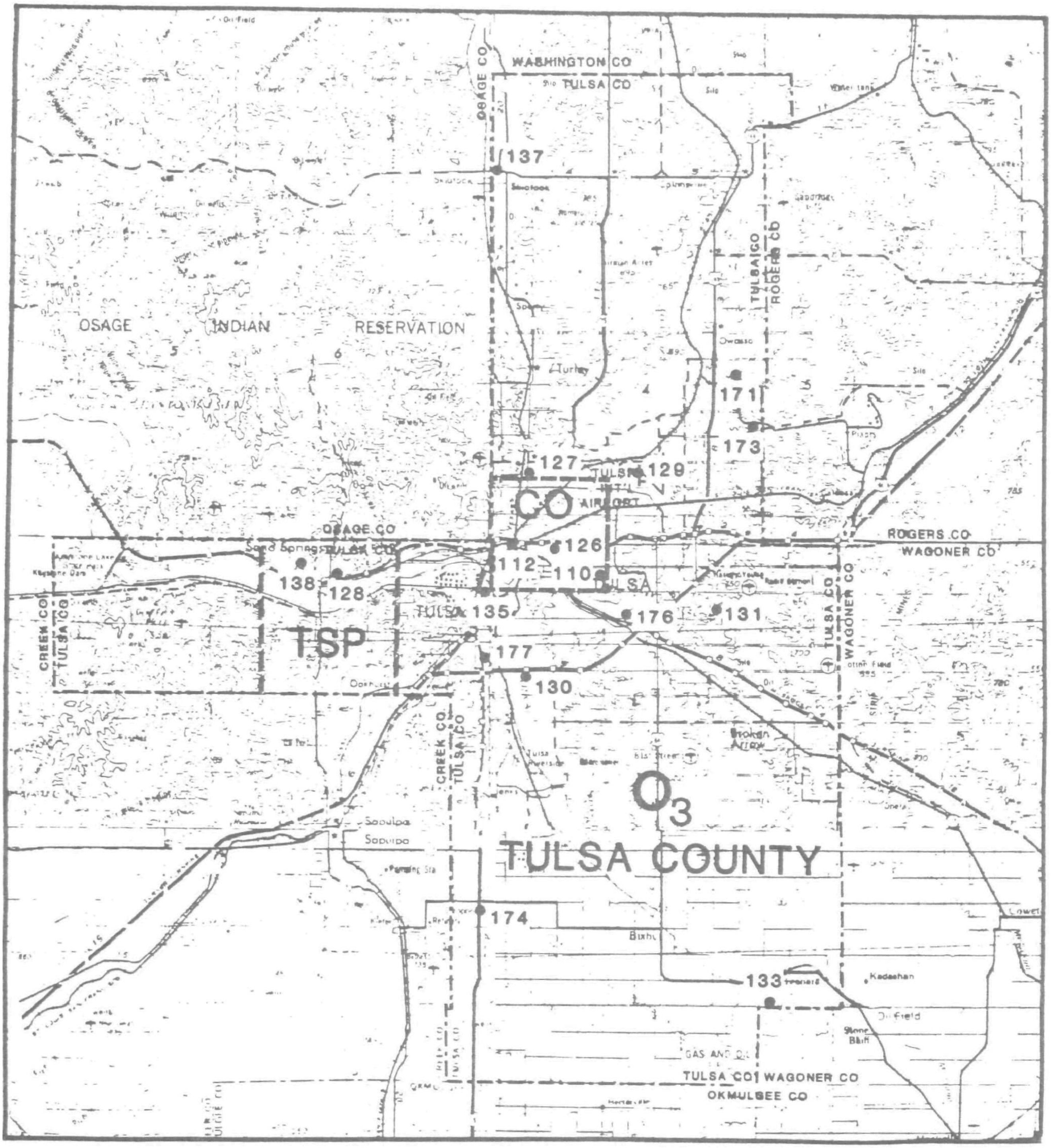
A detailed layout of the pipeline route is not practical until the potential for enroute reuse is determined. However, the use of existing rights-of-way and easements are expected wherever possible. Seismic activity in the Tulsa area does not appear to be a major problem, but the location and avoidance of fault lines should be considered.

Soils

Again, the location of the pipeline with respect to soil types should also be taken into account. The Tulsa area contains several soil types that are classified as prime agricultural lands. The crossing of these areas is not prohibited but care should be given to minimize disturbance and to restore the original soil horizons of the land along the route. Proper regrading and reseeding should be provided to limit erosion.

Air Quality/Meteorology

As with all of the expansion alternatives the local area population density will increase as a result of available sewer service and along with this



• AIR QUALITY SAMPLING STATIONS

SOURCE: OKLAHOMA STATE HEALTH DEPARTMENT

Figure 5-10 Non-Attainment Areas.

Table 5-7 OKLAHOMA AMBIENT AIR QUALITY STANDARDS

	Annual	1 Hour Max.	3 Hour Max.	8 Hour Max.	24 Hour Max.
	Primary Standards				
Sulfur Oxides (Sulfur Dioxide)	(1) 80 ug/m^3				(2) 365 ug/m^3
Particulate Matter	(3) 75 ug/m^3				(2) 260 ug/m^3
Carbon Monoxide		(2) 40 ug/m^3 (35 ppm)		(2) 10 mg/m^3 (9 ppm)	
Photochemical Oxidants		(2) 160 ug/m^3 (0.08 ppm)			
Non-Methane Hydrocarbons			(2)(4) 160 ug/m^3 (0.24 ppm)		
Nitrogen Oxides (Nitrogen Dioxide)	(1) 100 ug/m^3 (0.05 ppm)				
	Secondary Standards				
Sulfur Oxides (Sulphur Dioxide)			1300 ug/m^3 (0.5 ppm)		
Particulate Matter	(3) 60 ug/m^3				(2) 150 ug/m^3
Carbon Monoxide		(2) 40 ug/m^3 (35 ppm)		(2) 10 mg/m^3 (9 ppm)	
Photochemical Oxidants		(2) 235 ug/m^3 (0.12 ppm)			
Non-Methane Hydrocarbons			(2)(4) 160 ug/m^3 (0.24 ppm)		
Nitrogen Oxides (Nitrogen Dioxide)	(1) 100 ug/m^3 (0.05 ppm)				

(1) Annual Arithmetic Mean
(2) Not to be Exceeded More than Once per Year
(3) Annual Geometric Mean
(4) 6 to 9 A.M.

higher density there will be an increase in localized vehicular traffic. Based on INCOG's 1979 Tulsa Metropolitan Area statistics of 1.8 autos per household and 8.5 trips per household per day, a total of 54,000 more cars would be located in the service area as a result of the expansion (see Socioeconomic evaluation), providing 255,000 more trips per day. The Tulsa metropolitan area is classified as a non-attainment area for carbon monoxide (CO). This is not expected to be improved under the expansion alternative, providing a minor adverse impact to local air quality.

AWT ALTERNATIVES MA-10, MA-13, MA-16

Because of the similar area and types of construction, and because the level of expansion would remain unchanged, the AWT alternatives will be discussed jointly with respect to the physical environment.

Geology

Consideration should be given to the precise location of the Nowata Shale Formation because of its soft plastic clay shale consistency, which lies just west of the existing plant site.

Soils

Erosion protection on the plant site and adjacent areas should be provided.

Air Quality/Meteorology

As discussed earlier, all of the expansion alternatives would provide for increased localized growth accompanied by higher volumes of vehicular traffic. The Tulsa metropolitan area is classified as a non-attainment area for CO and this is not expected to improve, providing a minor adverse impact to air quality.

BIOLOGICAL RESOURCES

The biological studies entailed an assessment of the area ecological structure in relation to the terrestrial and aquatic flora and fauna, with greater emphasis directed at the changes in the aquatic ecosystem. More baseline information is presented in Report IV with a discussion of rare, threatened and endangered species provided in Section 5.4.

EXISTING CONDITIONS

Both the terrestrial and aquatic habitats of the area will be presented to provide a basis of evaluation.

Terrestrial Flora/Fauna

The vegetation patterns around the Northside Treatment Plant may be categorized into five general associations; 1) riparian woodland; 2) bottomland forest; 3) upland forest; 4) upland mix grass savannah; and 5) agricultural land. These associations are common to the Tulsa area. For the purposes of this study, the associations are shown in a vegetative cross-section of Figure 5-11.

The vegetative cross-section depicts the soil and vegetative gradients that characterize lower Bird Creek. It is a hypothetical transect, extending from the bottomlands to the uplands. It is not drawn to scale but is presented to enhance perception.

One notable feature of the transect is the thin soils of the uplands, supporting mix grass savannah and hillside forests, with a transition to deep alluvial soils of the floodplain that support bottomland forest, riparian woodland and agriculture. The profile is enhanced by periodic flooding which deposits nutrients and silt throughout the floodplain, and by the activities of agriculture.

The vegetation map Figure 5-12 displays the broad patterns that may be found along lower Mingo and Bird Creeks. These patterns occur within a band

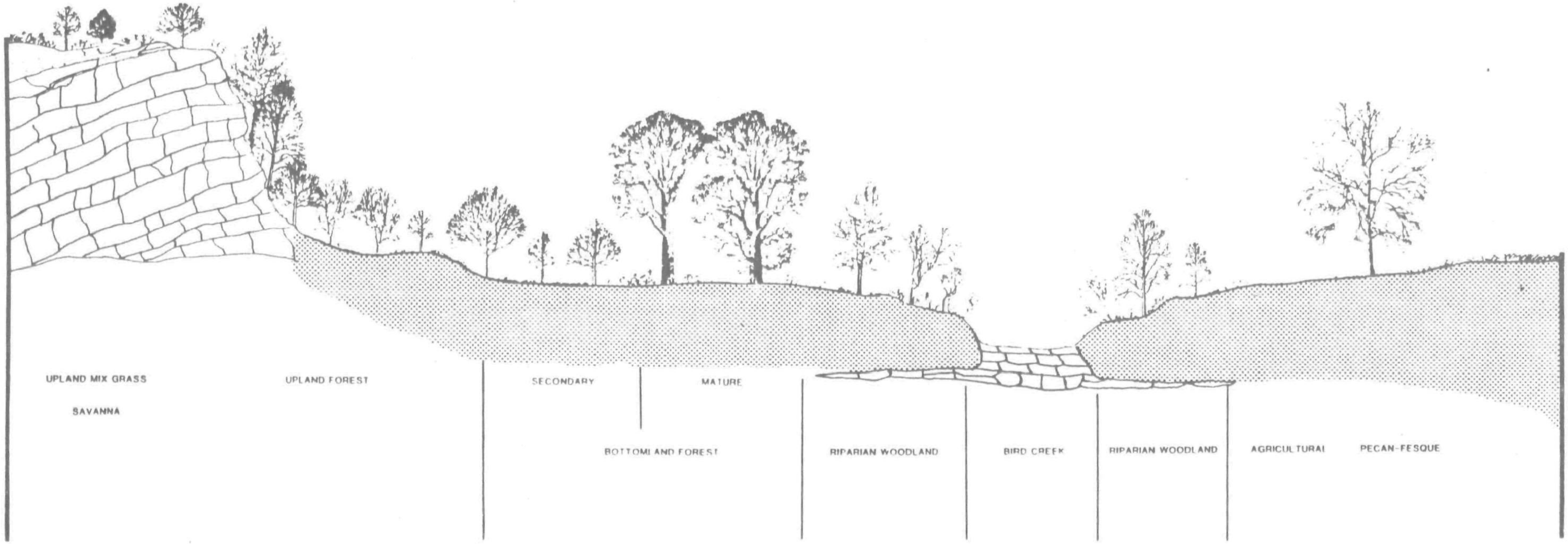


Figure 5-11 A Typical Vegetation Cross Section - Lower Bird Creek.

Figure 5-12 Vegetation Map - Downstream Study Area.

approximately 2 mi wide, extending 1 mi upstream from the confluence of Bird and Mingo Creeks and continuing along Bird Creek to its confluence with the Verdigris River. Mapping zones are keyed to the five vegetative associations and reflect native soil types and modifications made by local land use practices.

As in most river systems, Bird Creek has a system of benches that correspond to periodic flood events. Generally, the lower benches contain the previously mentioned species while upper benches contain those species commonly found in bottomland forests. The species in the upper benches are undergoing succession towards the bottomland forest community. Prominent members in this category include American elm, southern hackberry, green ash, black walnut, honey locust, coffeetree, pecan, and bitternut hickory.

This riparian woodland is primarily of value to wildlife, since the majority of the habitat is not grazed by livestock and the flooding is too frequent for cultivated crops. The wildlife habitat is of high quality, owing to the streamside's elongate slopes and the association's irregular borders. This habitat is a transition zone, where the aquatic and terrestrial ecosystems meet. It is a classic example of the "edge effect", containing more wildlife species than found in either of the two adjoining ecosystems. It is also characterized by large energy, nutrient and biotic exchanges, and provides a convenient linear pathway for animal movements (Odum, 1971).

The terrestrial animals of the Bird Creek area may be divided into several areas, namely mammals, reptiles, birds and amphibians. A presentation of area "indicator species" is detailed in Report IV to provide more specific descriptions and assessment of characteristic plant and animal species of the area.

Aquatic Flora/Fauna

The aquatic plants of lower Bird Creek consist primarily of periphyton, or microscropic plants that live on the surfaces of submerged rocks, mud, logs, and debris. This mass of biological organisms accounts for most of the organic material that is produced within the creek proper. It also provides for a net input of dissolved oxygen and a food source for higher forms of life.

In addition to the periphyton, lesser concentrations of phytoplankton are also present. They too, are considered producers. Like the periphyton they are single-celled organisms, or colonies of single-celled organisms, and they contain chlorophyll. Unlike the periphyton, though, they are usually suspended, instead of being attached or clumped.

Taken together, the periphyton and phytoplankton constitute essentially all the aquatic plant life found in Bird Creek between Mingo Creek and the Verdigris River. Rooted aquatic plants, or macrophytes, may also be found but to a lesser degree.

As presented earlier a broad reach of Bird Creek was studied due to the numerous influences on its quality, both natural and man-made. Figure 5-1 illustrates the original area of study, with respect to the discussion of existing conditions, only that area just above the three major municipal discharges (Flat Rock, Coal Creek and Northside) to the confluence with the Verdigris needs to be detailed. The USGS Station #1775 located upstream (River Mile 25) of the Flat Rock municipal discharge was selected as representative of Bird Creek's natural condition. This station does receive some small municipal discharges upstream, as indicated, but appears to be the most representative of the stations studied.

Despite the above influences on the water quality at this station in comparison to the other stations, the species diversity of aquatic organisms was found to be relatively high by Cox, 1977 (Report IX). Based on a species diversity index for benthic macroinvertebrates, Cox found the Sperry station to support good populations, having a standardized distance (SD) value of 19.978. The SD is a combined measure of D (diversity per individual) and R (redundancy). Essentially, a high SD value indicates a large variety of species with a small number of each.

The SD value of 19.978 at the Sperry station may be compared to the best station on Bird Creek which had an SD value of 28.083 (1B13; 10 mi upstream of Skiatook). The worst station was 4B01 at the confluence of Bird Creek and the Verdigris with an SD value of 2.111. The Sperry station was accordingly classified as Group C, "Clean" to "Slightly Enriched".

The quality of water in the creek at this station supports several intolerant (withstand little or no pollution) and faculative (withstand moderate amounts of pollution) species of macroinvertebrates. Some tolerant species are also present. The presence of intolerant species indicates relatively good water quality, and there appears to be a healthy balance of organisms.

The fish found at the Sperry station exhibited good diversity (Report IX; Cox, 1977). They included:

GARS
- Spotted gar
- Longnose gar
- Shortnose gar

HERRINGS
- Gizzard shad

MINNOWS
- Golden shiner
- Ghost shiner
- Red shiner
- Sand shiner
- Redfin shiner
- Suckermouth minnow
- Fathead minnow
- Slim minnow
- Bullhead minnow

SUCKERS
- River carpsucker

CATFISHES
- Channel catfish
- Freckled madtom

TOPMINNOWS
- Blackstripe topminnow

LIVEBEARERS
- Mosquitofish

SILVERSIDES
- Brook silverside

SUNFISHES
- Green sunfish
- Bluegill
- Longear sunfish
- Spotted bass
- Largemouth bass
- White crappie

PERCHES
- Orangethroat
- Redfin darter
- Logperch
- Channel darter
- Slenderhead darter
- Logperch

The total number of fish species present was 31. This is the largest number of species found at any of the Bird Creek stations. It is particularly notable since it ranked third in terms of water quality. There were a total of nine stations sampled.

Many of the species found here are indicative of good water quality, and the balance of fish species is also good. The presence of all five species of darters and the largemouth and spotted bass at the Sperry station is a good indication that organic pollution is not the major limiting factor since these are relatively sensitive or intolerant species (Report IX; Cox, 1977). Other sensitive fish species found at the Sperry station include the minnows, sunfish and the freckled madtom (catfish). Most of these species are not found in downstream portions of Bird Creek.

In comparison to the 31 species collected at the Sperry station, below Northside to the mouth of Bird Creek, only 10 to 11 species of fish respectively were collected from stations OB21 and 4B01 below Northside and at the mouth of Bird Creek. Here the carp, red shiner, suckermouth minnow, channel catfish, mosquitofish and gizzard shad were the most abundant species. Most of these fish tend to be more tolerant of organic pollution.

NO ACTION

The effects of removing the Flat Rock and Coal Creek discharges on the terrestrial and aquatic ecosystem in this area of Bird Creek are discussed below.

Terrestrial Flora/Fauna

There are no significant effects expected from the closüre of Flat Rock and Coal Creek on the area's terrestrial flora and fauna.

Aquatic Flora and Fauna

As discussed under water quality, the Northside plant would be at capacity (30 mgd) discharging an unnitrified secondary effluent. Therefore, because of the high carbonaceous BOD loadings and higher levels of ammonia the downstream D.O. sag could be extensive (Figure 5-6). As a result only relatively tolerant species of fish that are less sensitive to ammonia toxicity, like gizzard shad, carp and channel catfish would be likely to inhabitat these lower reaches of Bird Creek under No Action.

It is anticipated that the section upstream of Northside which had received loadings from Flat Rock and Coal Creek will improve with time. Once the point sources are removed, it is the nature of the watershed and the physical characteristics of the channel that become the controlling factors in a stream's water quality as well as the types and species of aquatic organisms that will inhabit it. Since this segment of stream has similar cross-sectional areas and flow velocities to the section outlined for Sperry, it may be expected that the same types and diversity of organisms found at the Sperry station may also be able to survive in the area above the Northside outfall.

OUT-OF-BASIN TRANSFER MA-1

The net result would be the return of this downstream segment of Bird Creek to pre-Northside conditions.

Terrestrial Flora/Fauna

The removal of the Northside discharge would make the entire downstream reach more susceptible to fluctuations in flow. Because there are no primary tributaries contributing flow in this area the baseflow in this reach of the stream would be reduced.

Dependent on the extent of these low flow conditions, encroachment into the stream channel by vegetation may occur restricting flow capacities.

Aquatic Flora/Fauna

It would be expected that despite the extreme fluctuations in flow and the possible seasonal drops in D.O. due to the low flow conditions, the quality of this downstream area would improve greatly over that resulting from No Action. This would primarily be due to the elimination of the large D.O. sag and the removal of the ammonia toxicity associated with municipal effluents.

The quality of the water in the lower reaches should closely resemble that which was presented for the Sperry station. The main differences between the Sperry station and the downstream area would result from differences in the stream channel characteristics.

All of the fish species found at the Sperry station may not migrate into this area because of the lower velocities and the potential for stagnant pools. It would be expected, however, that the quality of the aquatic habitat and the diversity of the organisms in this area would be greatly increased from the 10 to 11 species of fish presently found there.

AWT ALTERNATIVES MA-10, MA-13, MA-16

Because all of the AWT Alternatives are designed to achieve the same level of effluent quality, they will be discussed jointly.

Terrestrial Flora/Fauna

Because of the continued discharge of relatively high constant flows, no significant change is expected.

Aquatic Flora/Fauna

With the aforementioned changes in both flow and water quality, it is anticipated that the aquatic habitat as well as the numbers and diversification of organisms would increase providing a beneficial impact to aquatic life. Because of the differences in stream channel characteristics, all of the aquatic species found at the Sperry station may not migrate into the area. However, a substantial improvement in the diversity and stability of organisms inhabiting the area may be expected. This assumes that the effluent chlorine residual is held to 0.5 mg/l.

SOCIOECONOMICS

Except for differences in construction costs and operation and maintenance costs among the several expansion alternatives, the expected socioeconomic impacts of various alternatives to expand the capacity of the Northside Treatment Plant are judged to be virtually identical. Because of this, expansion is treated as a single alternative, and its socioeconomic impacts are analyzed on that basis.

EXISTING CONDITIONS

A discussion of the socioeconomic environment as it presently exists is provided below.

Population

The population of the City of Tulsa and Tulsa County has demonstrated continued growth since 1930 (Table 5-8). The population of the City increased from 141,258 in 1930 to 360,919 in 1980, while during the same period the county's population grew from 187,574 to 470,593. Population in both areas grew at an average rate of approximately 1.9 percent per year.

Moreover, the rate of population growth in Tulsa and the county exceeded that of the state by a considerable margin until 1970. During the two decades after 1930, the state as a whole experienced population loss because of economic depression and dust bowl conditions in the 1930's and in the general shift of population from rural areas in the south and midwest to urban areas of the north and west. The latter condition continued during the 1950's but at a lower rate than before.

During the 1970's population growth in the state exceeded that of the Tulsa area because of the reverse flow of population from the northern states to the Sun Belt states. Because the focus of development had shifted from the City of Tulsa to the area south and east of the city, the city's rate of population growth fell relative to the county's and equalled approximately 50 percent of the county's rate during the 1970's.

Table 5-8 SELECTED POPULATION TRENDS, 1930 - 1980

Year	Oklahoma	Percent Change	Tulsa County	Percent Change	City of Tulsa	Percent Change
1930	2,396,040	--	187,574	--	141,258	--
1940	2,336,434	(2.4)	193,363	3.1	142,157	0.6
1950	2,233,351	(4.4)	251,686	30.2	182,740	28.5
1960	2,328,284	4.3	346,038	37.5	261,685	43.2
1970	2,559,253	9.9	399,982	15.6	330,350	26.2
1980	3,025,266	18.2	470,593	17.7	360,919	9.3

SOURCE: U.S. Bureau of the Census.

Employment

Total nonagricultural employment in Tulsa increased by 61.6 percent between 1970 and 1980, exceeding the state-wide increase in employment of 48.9 percent (Table 5-9). Trade, manufacturing, and services were the major sources of employment in Tulsa in 1980. Services and construction experienced the greatest increase in employment between 1970 and 1980 in Tulsa, while employment in trade and mining also exceeded the rate of growth in total employment. Mining employment exhibited the greatest increase in the state during the 1970's with services, trade, and finance-insurance-real estate also growing faster than total employment.

Manufacturing, transportation and public utilities, and government employment increased the least in Tulsa, while in the state as a whole, government, transportation and public utilities, and manufacturing were the sectors with the smallest increments in employment growth.

Personal Income

Personal income in the Tulsa SMSA totalled $6 billion in 1979 (Table 5-10), an increase of 90 percent since 1974. The rate of growth of personal income in Tulsa exceeded that of the United States by almost one third but was slightly less than the increase for the Southwest Region. The ratio of labor and proprietors' income to total personal income (including dividends, interest, rent, and transfer payments) in Tulsa is higher than in either the region or the U.S. indicating that Tulsa's economy is supported more by wage and salary employment than by financial income.

Manufacturing was the largest single source of income comprising nearly 23 percent of labor and proprietors' income (Table 5-11). The manufacture of durable goods was by far the major source of income from manufacturing. Wholesale and retail trade was the second major source of income (18.3 percent) followed closely by government (16.8 percent). Mining was the only other industry to contribute more than 10 percent of personal income which reflects Tulsa's role as a center for the oil and gas industry.

Table 5-9 NONAGRICULTURAL EMPLOYMENT BY INDUSTRY, 1970 AND 1980 (thousands)

Industry	Oklahoma					Tulsa SMSA				
	1970	Percent	1980	Percent	Percent Change 1970-1980	1970	Percent	1980	Percent	Percent Change 1970-1980
Total Employment	762.6	100.1	1,135.5	100.1	48.9	188.8	100.2	305.1	99.5	61.6
Mining	38.9	5.1	71.5	6.3	83.8	13.2	7.0	21.4	7.0	62.1
Construction	38.9	5.1	57.6	5.1	48.1	9.5	5.0	17.6	5.6	85.3
Manufacturing	134.1	17.6	190.1	16.7	41.8	44.0	23.4	62.5	20.5	42.0
Transportation & Public Utilities	52.4	6.9	68.0	6.0	29.8	16.2	8.6	24.1	7.9	48.8
Trade	168.7	22.1	268.6	23.7	59.2	42.5	22.5	70.9	23.2	66.8
Finance, Insurance & Real Estate	37.0	4.9	56.4	5.0	52.4	9.8	5.2	15.5	4.9	58.2
Services	115.9	15.2	198.7	17.5	71.4	32.3	17.2	60.3	19.8	86.7
Government	176.7	23.2	224.6	19.8	27.1	21.3	11.3	32.8	10.6	54.0

Source: Oklahoma Employment Security Commission, Handbook of Oklahoma Employment Statistics, Volume II, April, 1981.

Table 5-10 PERSONAL INCOME BY TYPE, 1974 AND 1979 (Millions of Current Dollars)

	Total Personal[1] Income		Wage and Salary Payments		Other Labor Income		Proprietors Income		
	Amount	Percent[3] of Total	Amount	Percent of Total	Amount	Percent of Total	Amount	Percent of Total	Per Capita Income
United States									
1974	1,147,257	78.3	758,415	66.1	55,572	4.8	84,715	7.4	5,428
1979	1,927,005	68.6	1,234,660	64.1	122,682	6.4	127,499	6.6	8,757
Percent Change	68.0	--	62.8	--	120.8	--	50.5	--	61.3
Southwest Region[2]									
1974	89,319	77.1	57,204	64.0	4,363	4.9	7,328	8.2	4,968
1979	171,689	77.2	109,158	63.6	10,849	6.3	12,471	7.3	8,600
Percent Change	92.2	--	90.8	--	148.7	--	70.2	--	73.1
Tulsa SMSA									
1974	3,145	80.9	2,132	67.8	182	5.8	230	7.3	5,473
1979	6,000	80.7	4,026	67.1	435	7.3	383	6.4	9,436
Percent Change	90.8	--	88.8	--	139.0	--	66.5	--	72.4

[1] Total personal income is by place of residence and includes dividends, interest, rent and transfer payments. Labor and proprietors income is by place of work.
[2] The Southwest Region consists of Arizona, New Mexico, Oklahoma and Texas.
[3] Total labor and proprietors income as a percent of total personal income.

Source: Local Area Personal Income, 1974-1979.

Table 5-11 PERSONAL INCOME BY INDUSTRY, TULSA SMSA, 1979
(Millions of Dollars)

Industry	Labor and Proprietors' Income	Percent
Total	4,844	100.0
Farm	38	0.8
Agriculture Services-Forestry-Fisheries	6	0.1
Mining	499	10.3
Construction	327	6.8
Manufacturing	1,104	22.8
Nondurable Goods	213	4.4
Durable Goods	890	18.4
Transportation and Public Utilities	526	10.9
Wholesale Trade	407	8.4
Retail Trade	481	9.9
Finance-Insurance-Real Estate	253	5.2
Services	814	16.8
Government	391	8.1

SOURCE: Local Area Personal Income, 1974-1979.

Per capita income in 1979 was $9,436 in Tulsa compared to $8,757 for the U.S. and $8,600 for the southwestern region. This value increased somewhat more rapidly between 1974 and 1979 in Tulsa than it did in the county as a whole, and it increased nearly as much as that of the region.

Land Use

There are more than 78,500 acres of land in the Northside service area, of which about 40,300 acres were devoted to a specific uses by 1980. The remaining 38,300 acres, were left vacant (Table 5-12). Of the latter, nearly 26,900 acres are available for development from 1981 through the end of the planning period in 2005, while 11,400 acres were deemed unsuitable for development. In this context, land unsuitable for development includes significant water features, vacant land in 100-year floodplains and derelict land (e.g., abandoned strip mines and landfill sites).

Of the land in use, 15,200 acres or 19.4 percent of the total land area was devoted to employment purposes — commercial and industrial uses. Roughly 6,400 acres or 8.2 percent of this land was used for "basic" employment or by those industries which are engaged primarily in exporting goods and services from the Tulsa area, while 11.2 percent or 8,700 acres are utilized by firms who primarily provide goods and services for consumption within the community (non-basic employment). An additional 20 percent of the land in the service area was used for residential purposes, and 9,600 acres or 12.2 percent of the total surface area was devoted to rights-of-way of various types.

NO ACTION

A presentation of the socioeconomic conditions as they would occur in 1985 and beyond without the project is presented below.

Population

The population of Tulsa County is expected to continue to grow throughout the study period. Population in the county is projected to increase to

Table 5-12 SUMMARY OF LAND IN USE AND VACANT LAND NORTHSIDE SERVICE AREA, 1980 AND 2000 (Acres)

Category	1980	Percent	2000	Percent	Percent Change
Total Area	78,579	--	78,579	--	--
Land in Use	40,302	51.3	51,874	66.0	28.7
Employment Land	15,208	19.4	20,651	26.3	35.8
Basic	6,439	8.2	9,481	12.1	47.2
Nonbasic	8,769	11.2	11,170	14.2	27.4
Residential Land	15,543	19.8	18,921	24.1	21.7
Rights of Way	9,551	12.2	12,302	15.7	28.8
Vacant Land	38,277	48.7	26,705	34.0	(30.2)
Available	26,883	34.2	15,311	19.5	(43.0)
Unavailable	11,394	14.5	11,394	14.5	---

SOURCE: Erling Helland Associates.

approximately 598,500 by 2005 (Table 5-13). This represents an increase of about 108,000 persons, or about 22 percent. An average rate of growth of 1 percent per year is anticipated during the planning period.

Similarly, the population of the Northside service area is expected to increase by about 12.8 percent or 26,100 people during the planning period. Population in the service area would increase at an average rate of 0.6 percent under the No Action alternative.

Employment

Total employment in the Tulsa SMSA is projected to more than double in size by 2005 in the absence of Northside capacity expansion, while manufacturing is expected to increase by 74 percent during the same period (Table 5-14).

Historical trends of development and the existing mix of industries are expected to be maintained throughout the projection period, so services and construction are expected to increase their relative shares of employment at the expense of slower growing industries. Within manufacturing, machinery, metals manufacture and transportation equipment should continue as the largest employment sectors.

The sharp reduction in growth rates for manufacturing employment and to a lesser degree total employment after 1995 reflect a constraint on further industrial growth caused by a lack of vacant industrial land in Tulsa that is suitable for development. More than two-thirds of all such land in Tulsa lies within the Northside Treatment Plant service area. Lack of adequate treatment capacity would deter development of this land since many companies seek development sites that are served by all public services including public sewers. Development of other industrial land outside of the Northside service area would allow industrial development to continue at its normal, unconstrained level until around 1995.

Subsequent growth could be significantly reduced, however, after that time. The slowing of growth in total employment includes the direct constraint on

Table 5-13 POPULATION PROJECTIONS, THE NO ACTION ALTERNATIVE, 1985-2005

Year	Tulsa County		Northside Treatment Plant Service Area	
	Population	Percent Change	Population	Percent Change
1985	490,400	6.0[1]	203,300	3.3[1]
1990	518,100	5.6	--	--
1995	568,000	9.6	--	--
2000	593,500	4.5	--	--
2005	599,300	1.0	229,400	12.8

Table 5-14 PROJECTED EMPLOYMENT WITHOUT EXPANSION, TULSA SMSA, 1985 - 2005 (thousands)

Year	Total Employment	Percent Change	Manufacturing Employment	Percent Change
1985	409.2	34.1[1]	76.2	21.9[1]
1990	505.4	23.5	89.2	17.1
1995	601.6	19.0	102.3	14.7
2000	674.1	12.1	105.6	3.2
2005	763.0	13.2	108.8	3.0

[1] Percent change from 1980.

SOURCE: Report XI.

manufacturing employment and a smaller increase in employment in other sectors, the indirect and induced change in employment.

Personal Income

Personal income in the Tulsa area under the no action alternative is expected to continue to increase at a rate equal to the historical trend until about 1995 (Table 5-15). With no expansion of capacity of the Northside plant, personal income based on historical trends should increase to about $40,180 million dollars in 1995 and $126,936 million in 2005. The rate of growth after 1995 is lower than that experienced previously reflecting the constraint on the rate of growth of industrial development, manufacturing employment, and income derived from this source.

Land Use

With no expansion of capacity of the Northside Treatment Plant, land use patterns would continue to develop in a manner similar to historical patterns. There would be alterations in this development, however. While the amount of land in the service area expected to be devoted to residential uses could remain constant, development of such lands would be characterized as low density use rather than the high density development that would be anticipated from historical trends.

With no additional treatment capacity at the Northside Plant, residential development could occur only in available areas with suitable soils for on-site wastewater disposal systems (i.e., septic tanks or sewage lagoons). Residential development, therefore, would be limited to single family homes, and multi-family units would be precluded. Because of the existence of extensive areas of soils unsuitable for development with on-site disposal systems and zoning ordinances governing the use of such systems, development densities would be limited to a range from 0.2 to 0.7 lots per acre. Approximately 10,300 additional residential lots could be developed within the service area under these conditions compared to 45,600 lots if low density zoning is assumed or 87,000 lots with high density zoning.

Table 5-15 PERSONAL INCOME TULSA SMSA, 1985-2005, NO ACTION AND EXPANSION ALTERNATIVES (Millions of Current Dollars)

Year	Personal Income Without Expansion	Personal Income With Expansion
1985	$ 12,209	$ 12,209
1990	22,149	22,149
1995	40,180	40,180
2000	71,018	72,892
2005	126,936	132,236

SOURCE: Report XI.

Table 5-16 POPULATION PROJECTIONS, THE EXPANSION ALTERNATIVE, 1985-2005

	Tulsa County		Northside Treatment Plant Service Area	
Year	Population	Percent Change	Population	Percent Change
1985	490,400	6.0[1]	210,428	3.3[1]
1990	518,100	5.6	222,227	5.6
1995	568,000	9.6	243,550	9.6
2000	606,200	6.7	259,904	6.7
2005	620,900	2.4	266,217	2.4

[1] Change from 1980 population.

SOURCE: Erling Helland Associates, revised.

Similarly, industrial development would be limited under this alternative. Of the 17,300 acres of vacant industrial land in the City that is suitable for development, nearly 10,900 acres or 63 percent lie within the service area. Lack of public sewers and adequate treatment capacity would deter development of this land and shift industrial development to similar lands outside the service area that possess such facilities.

It is difficult to project the amount and type of development likely to be undertaken under these conditions. Some land may be developed for industrial purposes by firms willing to treat and dispose of their own wastewater onsite or by firms who generate low volumes of wastewater. Some land (e.g., in the Cherokee Industrial District) may be converted to residential use because of the large demand for residential property under this alternative and some land quite likely would remain vacant.

ALTERNATIVES MA-1, MA-10, MA-13, MA-16

Generally, in terms of socioeconomics the major effects or changes will result from the substantial increase in plant capacity and sewer line connections. Therefore, these alternatives will be discussed together for both no action and expansion alternatives.

Population

Population under the expansion alternative is projected to increase to approximately 620,900 by 2005 (Table 5-16). This is an increase of about 3.6 percent over the expected population under the no action alternative. Population is expected to grow at the same rate under either alternative until 1995. In subsequent years it is projected to grow at a slightly faster rate under the expansion alternative during the remainder of the planning period. The difference in population growth rates after 1995 results from slightly larger projected total employment after that year.

Population under the expansion alternative is expected to continue to grow at a faster rate than under the no expansion alternative in the years after 2005. Under the expansion alternative population in the service area is projected to increase to 266,217 by 2005. This exceeds the expected population under the other alternative by 27,800 or 12.1 percent. Greater population in the service area is anticipated under this alternative because of the higher density of development allowed by public sewering and treatment of domestic wastewater.

Under the no expansion alternative, development of vacant residential land in the service area would be accomplished through the use of onsite disposal systems such as septic tanks or sewage lagoons. The existence of a high proportion of soils in the service area that are unsuitable for this purpose and zoning restrictions on the density of use of these systems would greatly restrict potential residential development in the service area under the no expansion alternative.

Because of the predicted strong continued demand for housing, however, residential development that would have occurred in the service area would be displaced to other locations in the Tulsa area. Projected total population in Tulsa County, therefore, would not be significantly affected under the No Action alternative as noted earlier.

Employment

Total employment in the Tulsa SMSA under the expansion alternative is expected to increase to more than 791,000 by 2005 (Table 5-17). This is greater by 28,400 or 3.7 percent than total employment if the No Action alternative were selected.

Employment in manufacturing would be greater by 19,500 workers or 17.9 percent under the expansion alternative. The remaining increase in employment, 8,900 jobs, would be distributed among other sectors of the local economy with relatively greater concentrations in the trade and service sectors.

Projected growth in both categories of employment is the same under either alternative through 1995. Under the expansion alternative, however, manufacturing employment and total employment both increase at a faster rate

Table 5-17 PROJECTED EMPLOYMENT WITHOUT EXPANSION, TULSA SMSA, 1985 - 2005 (thousands)

Year	Total Employment	Percent Change	Manufacturing Employment	Percent Change
1985	409.2	34.1[1]	76.2	21.9[1]
1990	505.4	23.5	89.2	17.1
1995	601.6	19.0	102.3	14.7
2000	688.3	14.4	115.3	12.7
2005	791.4	15.0	128.3	11.3

[1] Percent change from 1980.

SOURCE: Report XI.

after 1995 than they would if the No Action alternative is chosen. Growth in employment is expected to be greater under this alternative after 1995 because with increased treatment capacity at the Northside Plant manufacturing firms would be more willing to locate on vacant industrial land within the service area.

Personal Income

If expansion of the capacity of the Northside Treatment Plant is undertaken, personal income in the Tulsa area is expected to increase at the same rate as under the No Action alternative until 1995. In subsequent years, the rate of growth of personal income is expected to be greater under the expansion alternative resulting in a projected value of personal income of $132,236 million in 2005. Under the expansion alternative, therefore, personal income is approximately 4 percent greater at the end of the planning period and reflects the higher level of employment and wage and salary payments implicit in the expansion alternative.

Land Use

The pattern of land use in the service area, if expansion is implemented, is also projected in Table 5-12. Land in use is expected to increase by 29 percent to nearly 52,000 acres. Land devoted to basic employment purposes is projected to experience the greatest percentage increase, more than 47 percent or roughly 3,000 additional acres. Land to be used for rights-of-way and for non-basic employment are expected to increase at about the same rate, 29 percent or 2,750 acres for the former and 27 percent or 2,400 acres for the latter.

Residential land use is expected to increase to 24 percent of total land in the service area absorbing nearly 19,000 acres of land. Vacant land available for development is projected to decline by about 30 percent.

The Out-of-Basin Transfer Alternative does have potential impacts from the placement for the 24 mile long pipeline required to reach the Arkansas River. Presently, existing rights-of-way and easements will be used to the extent possible for the transmission line; however, several jurisdictional boundaries will have to be crossed. At the time a more specific route is proposed, a more detailed evaluation will be required.

CULTURAL FACTORS

Cultural factors relate to those elements of the surrounding environment that would directly affect people or their quality of life. These include factors of recreation, aesthetics, noise and odors, public health and safety, and archeological/historical resources.

EXISTING CONDITIONS

The cultural factors under consideration are discussed below.

Recreation

The amount and locations of public, semi-public, and private open space have been inventoried by the TMAPC in two recent documents; The Tulsa Park and Recreation Plan, Technical Supplement (1979), and The Tulsa Open Space Plan, Phase I (1980). According to these reports, public open space consists mainly of public parks and public school land. Detailed location maps and tabulations of land devoted to open space or recreational uses are presented in the TMAPC reports.

Aesthetics, Noise, and Odors

With regard to adjacent properties and the aesthetic impact of the three plants under study, Flat Rock, Coal Creek, and Northside, their present remote location reduces most potential problems. The closure of Flat Rock and Coal Creek will prevent such problems from future development in the area, however, the conversion of farmlands around Northside to residential uses could create problems if zoning restrictions change.

This lack of nearby residential land uses and the rural nature of the surrounding area also contributes to the lack of serious noise problems. A data base has been collected (Report IV) in the event further evaluation is required.

Despite the general isolation of the facilities, some odor production at a wastewater treatment plant could be expected. The magnitude of the problem does not appear to be very large. Less than five complaints per year have been recorded by the Tulsa City-County Health Department (TCCHD) staff from residents in the vicinity of other plants (Haikey Creek and Southside) but no complaints were received relative to the Northside facility. Moreover, the staff suggested that at least some of these complaints may have been caused by gases vented into the atmosphere by nearby lift stations rather than the treatment plants directly.

Public Health and Safety

One of the major concerns of wastewater management is the protection of public health. This is because of the large variety and number of disease-producing organisms (pathogens) in domestic and commercial wastewater. In addition, industrial wastewaters contain numerous toxic substances.

A bacterial examination of water is most commonly done by a quantitative estimation of total organisms of the coliform group, which are indicative of fecal contamination.

In 1980, the only treatment facility that specifically disinfected was the Northside Plant, which adds the oxidizing agent chlorine to destroy the organisms. The average daily concentration of fecal coliform in the effluent from the six study area municipal treatment plants (see Figure 5-1 for location) is as follows:

River Mile	August 1980 Monthly Average Treatment Plant Discharge	No. per 100 ml
13.0	Northside Plant*	8
13.2	Owasso Lagoon	4595
18.9	Coal Creek	0.4×10^6
19.9	Flat Rock	1.08×10^6
27.4	Sperry	5.2×10^6
37.1	Skiatook	776

* Disinfection

Source: INCOG Sampling Data

As a matter of reference, the Northside Facility did not have disinfection capabilities until the first expansion in the Fall of 1979. The 1977 August average was 0.6×10^6 organisms per 100 ml, as compared to the August 1980 figure of 8/100 ml.

Other water related public health problems have also been studied. Two points of special concern are the high levels of lead and pesticides in some fish tissue samples, and the chemical contaminants which exceed EPA criteria and drinking water standards. While these are not based on extensive sampling data, they do indicate areas of concern. This is particularly true in light of the fact that fishing for consumption occurs on the creek. None of these concerns for heavy metals or pesticides are specific to Bird Creek, however. Similar levels have been found in Mingo Creek, the Verdigris and the Arkansas River.

Archaeological/Historical

Archaeological and historical resources refer to sites or areas of significance which contain artifacts or other tangible evidence of human occupation or events within a historic time period. A proposed site for use in a federally funded project would require evaluation by the Oklahoma Archaeological Society and the State Historic Preservation Officer.

NO ACTION

The change in the cultural factors and their status in 1985 is presented below.

Recreation

The No Action alternative may result in less new development in areas with poor soil conditions, due to the unsuitability of these areas for onsite sewage disposal facilities, as compared to the expansion alternative. These areas may be available for recreational uses either through public acquisition or public easements, or through private recreational development. Additional open space and recreational lands are needed in various parts of the service area (TMAPC, 1980).

A part of the Facilities Plan and EIS process is the assessment of other or beneficial uses for municipal facilities such as for recreation. Under No Action the Northside plant would remain in operation limiting other uses to those related to education. The Coal Creek trickling filter plant, however, would be closed. The plant is located upgrade of the Tulsa Zoological Gardens along Coal Creek which meanders through the park. The mechanical equipment should be salvaged and the plant buildings could be used as a staging area for park vehicles with the tanks becoming water storage facilities. The Flat Rock bio-adsorption plant would also be closed. The plant is well concealed from view by adjacent land uses. These land uses include trailer parks and some housing. The plant could be turned over to the residents or renovated with City involvement for public use such as pools or other uses. These are some of the options that are available to the City. The Parks Department would be the responsible agency in undertaking such projects.

Aesthetics, Noise, and Odors

Because of the lack of available sewer service, the type of development would be affected. Low density residential development would characterize most of the new construction, with some commercial and industrial uses on large parcels. Vacant land areas would be much in evidence, due to the generally poor soils, especially in industrial zones, and an increased incidence of sewage lagoons in new residential and commercial areas which may be visible from adjoining properties.

Except for the closure of the outdated plants coupled with improved treatment and a single discharge, no change in either noise or odors from that which was presented for Existing Conditions is expected.

Public Health and Safety

The primary advantage under No Action is that the two upstream municipal discharges, Flat Rock and Coal Creek will be removed from Bird Creek. These flows will be conveyed to the Northside plant where a greater level of treatment will be provided along with disinfection by chlorine. The smaller remaining three plants (1.5 MGD) may not have disinfection by 1985. In relation to the flow from the Northside plant (30 MGD), even during low flow conditions the potential for water borne diseases will be greatly reduced.

Archaeological/Historical

Because No Action represents no physical change to the Northside plant as a result of this project, no impact is expected.

ALTERNATIVES MA-1, MA-10, MA-13, MA-16

The potential effects on the cultural factors as a result of implementing an alternative are discussed jointly and provided below. Where differences occur or impacts are considered alternative specific, they will be noted.

Recreation

All of the presented alternatives provide for the expansion of the plant resulting in additional capacity. This will enable areas with unsuitable soils for onsite disposal systems to be developed as a result of expanded sewer service. In addition, pressure to develop areas with good soils, many of which are in flood prone areas, would be reduced making them available for use as greebelts or parklands by the City in the future. The AWT Alternatives (MA-10, MA-13, MA-16) would greatly improve the recreational uses, such as fishing, boating, and swimming in this downstream segment of Bird Creek.

Aesthetics, Noise, and Odors

Aesthetic impacts of the expansion alternatives include the development of larger buildings for offices, apartments, and industrial uses in currently vacant areas, as well as higher density housing developments. The rolling hills topographic characteristics in the southeast and ridgelines and other high elevation features in northeast and northwest corners of the service area create a high degree of visibility for new buildings. The aesthetic impacts of development in such areas, whether positive or negative, are more relevant to the expansion approach because larger buildings would be anticipated.

In terms of noise, the expansion would increase the density of development in the Tulsa area, resulting in a higher population, greater traffic and eventually more noise.

The Out-of-Basin Transfer Alternative does have problems associated with the use of a 24-mile long pipeline. The potential for odor and septic problems due to the long detention time of the effluent were discussed in the first environmental evaluation of the alternatives. The actual degree of the problems could not be determined until after the pipeline was constructed and in operation. If at that time any one of the aforementioned problems did result, the employment of in-line chlorination (oxidizing agent) or reaeration at lift stations could be used to mitigate the problem at its point of occurrence.

In general, the AWT alternatives would reduce odors because of the higher levels of treatment. However, AWT Alternative MA-13 employs a method of breakpoint chlorination. Chlorine is a strong oxidizing agent requiring precise dosage control. Chlorination beyond the breakpoint promotes the formation of nitrate ion (HNO_3) rather than nitrogen gas, plus additional chloride ion (HCl) which can suppress the pH. Another potential side reaction occurs when the pH drops below 6.5, which encourages the production of nitrogen trichloride (NCl_3), a noxious gas. Because of the high degree of control required for this process the potential for adverse effects as a result of operational or mechanical labor does exist. However, the operational time period for this unit process is limited to 6-8 weeks per year during the winter.

Public Health and Safety

The Out-of-Basin Transfer Alternative does provide the potential for the reuse of the effluent by industries as it is conveyed to the Arkansas River. If this option were employed, disinfection at the outlet point should be provided. The AWT alternative would carry the benefits presented under No Action even further by providing for a high level of treatment of a greater flow, as well as disinfection. Those benefits include the removal of undisinfected effluents of Flat Rock and Coal Creek from Bird Creek.

AWT Alternative MA-13 employs a method of breakpoint chlorination. As a result of the high chlorine dosages required, the potential for the formation of Trihalomethane (THM) was evaluated. Because the reaction rates between chlorine and ammonia occur so quickly limiting the production of THM and because the period of operation was only 6-8 weeks per year, this problem was not considered significant but has been noted for operational considerations (more detail provided in Report IX).

Archaeological/Historical

Since construction relative to the Northside treatment facility project is on City-owned sites currently used for wastewater treatment operations, each of the existing plant sites were submitted to the Oklahoma Archaeological Society for their evaluation in March, 1981. The results of this survey indicate that one previously recorded site, 34 Tu-21, is located near the Northside plant. However, past construction activities have destroyed the site. The results of the survey are in Appendix A, clearing further use of the plant site. A similar survey would be required once a detailed pipeline route for Out-of-Basin Transfer is selected.

SUMMARY EVALUATION

The previous text provides a detailed environmental evaluation of those Wastewater Management Alternatives that were considered by the applicant. The "No Action" provided the conditions as they would exist in 1985 when the plan would be implemented. In addition, it serves as a point of reference from which the four alternatives MA-1, MA-10, MA-13 and MA-16 could be evaluated. Because of the length and complexities of the alternative evaluations, a summary matrix for each, including No Action, is provided in Tables 5-18 through 5-22. Following Table 5-22 is a key or evaluation guide for use with these tables.

These materials provide for easy comparison of each alternative; major impacts (either beneficial or adverse), the projected length of the impact, its type, whether or not it is compounding, and if it is permanent. General summaries discussing the impact and mitigation measures are supplied where possible.

Table 5-18 SUMMARY EVALUATION OF "NO ACTION".

ENVIRONMENTAL PARAMETERS	EFFECTS	BENEFICIAL	ADVERSE	LONG-TERM	SHORT-TERM	DIRECT	INDIRECT	CUMULATIVE	CONST.	IRREVERS. IRRETRIEV.	SUMMARY EVALUATION	MITIGATION MEASURES
WATER RESOURCES	SURFACE WATER		maj.	X		X					Effluent loadings would exceed the stream's assimilative capacity, would not meet the Admin. Order, NPDES permit or State Standards.	
	GROUNDWATER											
	FLOOD HAZARDS		min.	X			X				Increases pressure for development of flood prone areas, see socioeconomics	
PHYSICAL RESOURCES	GEOLOGY											
	SOILS		min.	X			X			X	On site sewage disposal would be needed in future housing projects, requiring the use of deeper better quality soils removing them from agricultural uses, see socioeconomics	
	AIR QUALITY/ METEOROLOGY											
SOCIOECONOMICS	POPULATION		min.	X			X				Without additional treatment capacity on site disposal systems for new development would be required.	
	EMPLOYMENT		min.	X			X				Suitable soils for this use is limited in Tulsa Co. causing uncontrolled outward growth.	
	PERSONAL INCOME		min.	X			X				The types of industries that require wastewater treatment could not move into the area, limiting employment, income and tax revenues.	
	LAND USE		min.	X			X				Controlled development would be limited.	
BIO. RES.	TERRESTRIAL FLORA & FAUNA										Organic loadings would cause a low D.O. sag over a broad reach of the stream.	
	AQUATIC FLORA & FAUNA		min.	X		X					High levels of ammonia would be discharged and are toxic to aquatic life.	
CULTURAL FACTORS	RECREATION		min.	X		X					Secondarily treated effluent discharged to the stream restricts its recreational uses.	
	AESTHETICS, NOISE, & ODOR											
	PUBLIC HEALTH		min.	X			X				Effluent quality would not meet current NPDES permit limitations of 200 coliform per 100 ml.	
	ARCHAEOLOGY & HISTORICAL											

Table 5-19 SUMMARY EVALUATION OF ALTERNATIVE MA-1.

ENVIRONMENTAL PARAMETERS		BENEFICIAL	ADVERSE	LONG-TERM	SHORT-TERM	DIRECT	INDIRECT	CUMULATIVE	CONST.	IRREVERS. IRRETRIEV.	SUMMARY EVALUATION	MITIGATION MEASURES
WATER RESOURCES	SURFACE WATER	min.		0		X			X		Removal of the effluent from Bird Creek would return the stream to a more natural condition, however flows become more susceptable to storm water runoff.	
	GROUNDWATER										Assimilative capacity of the Arkansas River may require more evaluation.	
	FLOOD HAZARDS										Adjacent waterways to pipeline construction should be protected from runoff siltation.	
PHYSICAL RESOURCES	GEOLOGY		noted								Requires pipeline, fault areas should be avoided	
	SOILS		noted								If pipeline bisects areas of good soils, these soils would be stock piled and replace in the original horizons.	
	AIR QUALITY/ METEOROLOGY		min.	X			X				Increases local growth and traffic densities Tulsa is a CO non-attainment area.	
SOCIOECONOMICS	POPULATION	min.		X			X				Provides treatment capacity for new industrial and housing developments, improves local economy	
	EMPLOYMENT	min.		X			X				Provides for more controlled inward growth and best use of available land.	
	PERSONAL INCOME	min.		X			X				Project is high in cost could be a financial burden on the city.	
	LAND USE	min.	noted	X			X				Existing right-of-ways and easements should be used for pipeline route.	
BIO. RES.	TERRESTRIAL FLORA & FAUNA										Complete removal of effluent NH_3 and Cl_2 toxicities to aquatic life, however there is a potential for loss of aquatic habitat during low-flow and seasonal warm weather D.O. sags.	
	AQUATIC FLORA & FAUNA	min.		0		X						
CULTURAL FACTORS	RECREATION	min.		0			X				Improvements in stream quality	
	AESTHETICS, NOISE, & ODOR		min.	0		X					Long retention times in pipeline may cause septic conditions and odor problems at lift station.	In-line chlorine addition or reaeration may be required to prevent septic conditions.
	PUBLIC HEALTH											
	ARCHAEOLOGY & HISTORICAL		noted								Archaeological and historical clearances are required for pipeline route.	

Table 5-20 SUMMARY EVALUATION OF ALTERNATIVE MA-10.

ENVIRONMENTAL PARAMETERS		BENEFICIAL	ADVERSE	LONG-TERM	SHORT-TERM	DIRECT	INDIRECT	CUMULATIVE	CONST.	IRREVERS. IRRETRIEV.	SUMMARY EVALUATION	MITIGATION MEASURES
WATER RESOURCES	SURFACE WATER	maj.		0		X					Provides the advantages of advanced treatment o good quality effluent o low NH_3 concentrations o constant downstream flow	Biological nitrification process is susceptible to cold weather-the addition of covers may offset this problem.
	GROUNDWATER											
	FLOOD HAZARDS										All biological treatment	
PHYSICAL RESOURCES	GEOLOGY											
	SOILS											
	AIR QUALITY/ METEOROLOGY		min	X			X				Increases local growth and traffic densities Tulsa is a CO non-attainment area.	
SOCIOECONOMICS	POPULATION	min.		X			X				Provides treatment capacity for new industrial and housing developments, improves local economy	
	EMPLOYMENT	min.		X			X				Develops more controlled inward growth and best uses of available land	
	PERSONAL INCOME	min.		X			X				Project is high in cost could be a financial burden on the city.	
	LAND USE	min.		X			X					
BIO. RES.	TERRESTRIAL FLORA & FAUNA											
	AQUATIC FLORA & FAUNA	min.		0		X					Improves effluent quality	
CULTURAL FACTORS	RECREATION	min.		0			X				Consistant flow of good quality effluent.	
	AESTHETICS, NOISE, & ODOR											
	PUBLIC HEALTH											
	ARCHAEOLOGY & HISTORICAL											

Table 5-21 SUMMARY EVALUATION OF ALTERNATIVE MA-13.

ENVIRONMENTAL PARAMETERS		BENEFICIAL	ADVERSE	LONG-TERM	SHORT-TERM	DIRECT	INDIRECT	CUMULATIVE	CONST.	IRREVERS. IRRETRIEV.	SUMMARY EVALUATION	MITIGATION MEASURES
WATER RESOURCES	SURFACE WATER	maj.		0		X					Advanced treatment o good quality effluent o low NH_3 concentrations o consistent flow	
	GROUNDWATER											
	FLOOD HAZARDS											
PHYSICAL RESOURCES	GEOLOGY											
	SOILS											
	AIR QUALITY/ METEOROLOGY		min.	X			X				Increases local growth and traffic densities Tulsa is a CO non-attainment area.	
SOCIOECONOMICS	POPULATION	min.		X			X				Provides treatment capacity for new industrial and housing development, improved local economy	
	EMPLOYMENT	min.		X			X				Project has a high cost could be a financial burden on the city.	
	PERSONAL INCOME	min.		X			X				Develops more controlled inward growth and best use of available land.	
	LAND USE	min.		X			X					
BIO. RES.	TERRESTRIAL FLORA & FAUNA										Good quality effluent	High chlorine residual requires dechlorination.
	AQUATIC FLORA & FAUNA	min.	noted	0		X					High level of system monitoring to prevent chlorine toxicity or D.O. sags from excess dechlorination.	Post-aeration.
CULTURAL FACTORS	RECREATION	min.		0			X				Improves stream quality	Effluent pH buffering is required.
	AESTHETICS, NOISE, & ODOR		noted		0						Potential for nitrogen trichloride (NCl_3), a noxious gas, production at a pH less than 6.5.	
	PUBLIC HEALTH		noted		0						The use of highly reactive chemicals for treatment	
	ARCHAEOLOGY & HISTORICAL										Probable THM formation, but at low levels.	

Table 5-22 SUMMARY EVALUATION OF ALTERNATIVE MA-16.

ENVIRONMENTAL PARAMETERS		BENEFICIAL	ADVERSE	LONG-TERM	SHORT-TERM	DIRECT	INDIRECT	CUMULATIVE	CONST.	IRREVERS. IRRETRIEV.	SUMMARY EVALUATION	MITIGATION MEASURES
WATER RESOURCES	SURFACE WATER	maj.		0		x					All biological treatment, AWT Nitrification occurs in the activated sludge process, not as susceptible to cold weather. Biofilters buffer the primary mode of treatment and nitrification (activated sludge process) from potential shock loadings year round.	
	GROUNDWATER											
	FLOOD HAZARDS											
PHYSICAL RESOURCES	GEOLOGY											
	SOILS											
	AIR QUALITY/ METEOROLOGY		min.	X			X				Increases local growth and traffic density Tulsa is a CO non-attainment area.	
SOCIOECONOMICS	POPULATION	min.		X			X				Provides treatment capacity for new industrial and housing development, improves local economy	
	EMPLOYMENT	min.		X			X				Project has a high cost could be a financial burden on the city.	
	PERSONAL INCOME	min.		X			X				Develops more controlled inward growth and best use of available land.	
	LAND USE	min.		X			X					
BIO. RES.	TERRESTRIAL FLORA & FAUNA											
	AQUATIC FLORA & FAUNA	min.		0		0					Improves effluent quality	
CULTURAL FACTORS	RECREATION	min.		0			X				Improves stream quality.	
	AESTHETICS, NOISE, & ODOR											
	PUBLIC HEALTH											
	ARCHAEOLOGY & HISTORICAL											

SUMMARY EVALUATION KEY FOR TABLES 5-18 THROUGH 5-22

Environmental Effects	Definition
BENEFICIAL	Impact is positive.
( ) no impact	Impact, if any, is not large enough to be significant and/or discernable.
(min.) minor	Impact is small but discernable, or for comparison purposes may indicate the lack of a negative impact.
(maj.) major	Impact is highly significant and adds positive factors to the alternative.
ADVERSE	Impact is negative.
( ) no impact	Impact, if any, is not large enough to be significant an/or discernable.
(noted) noted	The potential for an impact exist but is highly unlikely and could be prevented.
(min.) minor	Impact is small but discernable, in most cases mitigation measures could be provided, limiting the negative aspects of the alternatives.
(maj.) major	Impact is significant and could affect the alternative. The adverse impact may not be mitigatible or may require extremely costly measures.
LONG-TERM	Duration of the impact is permanent or indefinite.
( ) none	No long-term impact or no impact.
(o) operational	Length of the impact stays in effect as long as that portion of the alternative is in operation.
(x) present	Impact is long-term in duration.
SHORT-TERM	Duration of impact is short-term or temporary.
( ) none	Not short-term or no impact.
(o) operational	Short-term operational impact.
DIRECT	Impact occurs in direct response to an action.
( ) none	Not a direct impact.
(x) present	A direct impact results from an action. Example: effluent quality affects surface water quality.
INDIRECT	Impact occurs indirectly or as a result of a direct impact.
( ) none	Not an indirect impact.
(x) present	Indirect impact is secondary. Example: effluent quality affects stream quality and its recreational uses.
CUMULATIVE	Additive impacts, may be significant when combined with other impacts.
( ) none	Not a cumulative impact.
(x) present	Impacts may compound with other impacts.
CONSTRUCTION	Construction-related.
( ) none	Not construction-related.
(x) present	Construction-related.
IRREVERSIBLE/IRRETRIEVABLE	Irreversible and irretrievable commitment of resources caused by the action.
( ) none	None.
(x) present	A permanent impact.

5.2 RESIDUALS SOLIDS MANAGEMENT ALTERNATIVES CONSIDERED BY THE APPLICANT

Chapter 4 described the major environmental impacts of both the wastewater and residuals solids management alternatives. Section 5.1 and this section of Chapter 5 provide the supporting information for the impact analysis of wastewater and residuals solids management alternatives, respectively.

Section 5.2 is organized slightly differently than Section 5.1, due to the fact that each alternative has a different project area(s). Because of the different project areas it is necessary to treat each alternative as a separate entity so that they may be compared with each other.

Under each of the five alternative headings, the impact analysis is divided into five major environmental headings; water resources, physical resources, biological resources, socioeconomics, and cultural factors. For each of these, the existing conditions or baseline and the alternative evaluation are described. The alternative evaluations include discussions of direct and indirect and cumulative impacts and short and long-term impacts where found. Any irreversible and/or irretrievable impacts are also described. There is also an evaluation table for each alternative. A full summary table is given in Chapter 4. Construction impacts are noted with a "C" in the individual evaluation tables in this section. These are also summarized in Section 5.3. It should be noted that while RA-7 is the "marketing" alternative, each of the others represents a backup disposal/reuse method for marketing.

REGULATORY UPDATE

It should be noted that the Oklahoma State Department of Health distributed new regulations on solid waste management in June, after this alternative evaluation. These regulations, titled "Solid Waste Management Rules and Regulations Including Sludge Management Rules and Regulations" were adopted by the Oklahoma State Board of Health on March 27, 1982 and are effective July 1, 1982.

These regulations are somewhat more stringent than the Federal regulations "Criteria for Classification of Solid Waste Disposal Facilities and Practices", published in the Federal Register September 13, 1979. There are two primary effects that the new regulations have on this portion of the project.

One is the fact that dedicated land disposal would come under Section 7.0 "Sludge Landfills" of the new regulations, and a three (3) foot layer of earthen cover material would be required for a final cover. This provision was not required under Federal regulations and so no cost for the importation of a three foot cap was included during the Facility Planning process. Also, the environmental evaluation did not consider either the effects of including a three foot cap or where the soil would come from and the effects on that area.

This provision in the State Regulations would affect Alternative RA-1 and RA-5 significantly, and in fact would probably eliminate them completely. This is due to the excessive cost and difficulty of finding, buying and importing a three foot layer of soil for 130 and 50 acres of land respectively for RA-1 and RA-5. Dedicated land disposal requires no excavation, so no soil cover would be available onsite. The environmental impacts of those alternatives would be reduced, but it is doubtful if they would remain viable.

The second effect of the new State regulations is on the Preferred Alternative, which is beneficial reuse with a backup of abandoned strip mine reclamation at R-3 (RA-6). The regulations do not affect the backup alternative differently than anticipated, but they may slightly affect both marketing and agriculture reuse.

Marketing or giveaway is not currently regulated on the Federal level. EPA's Preproposal Draft Regulations on the Distribution and Marketing of Sewage Sludge Products were to be published in the Federal Register in late 1980, but they have been indefinitely postponed (personal communication, U.S. EPA, Office of Solid Waste, Washington D.C.). The EPA Preproposal regulations were used as a guideline in this analysis, however, and their requirements were similar to the new State regulations.

Essentially, a special permit will be required based on the specifics of the plan, and the sludge will have to be treated to a "Process to Further Reduce Pathogens" (PFRP) such as composting. Since the alternative was developed assuming these would be required, there should be no effect on marketing/giveaway.

For agricultural land application, the new regulations require a "Sludge Management Plan" with specific requirements and limits similar to the existing Federal regulations. The main difference is that the state requires that "Annual sludge application shall not exceed nitrogen and phosphorous fertilization rates for the crop grown..." The phosphorous limitation will hinder the use of low cadmium sludges such as Southsides' and Haikey Creeks', but will probably not affect agricultural reuse of Northside sludge. This is because sewage sludge has generally high levels of phosphorous and if the application rate is limited to the level actually required by crops, not enough nitrogen will be provided for crop needs. A special permit will be required by the State if the phosphorous levels are to be exceeded.

NO ACTION ALTERNATIVE

The No Action alternative, as discussed in Chapter 4, would involve a continuation of present trends and practices. Currently, sludge from the three treatment plants is handled separately. The Northside WWTP sewage sludge is digested and stored in lagoons. The thickened sludge is then disposed of by spreading on the ground on City-owned land near the treatment plant. The sewage sludge from the Southside WWTP is stored in lagoons after digestion and no disposal method exists. Haikey Creek sludge is dried on drying beds and then spread on the ground at the plant site or stored in lagoons and later injected as liquid.

Approximately 26-27 dry tons per day (tpd) total is currently produced from all three treatment plants. By 1985 there is projected to be 34.5 dry tpd which would represent the No Action wastewater management alternative. The increase is primarily due to the closure of the Flat Rock and Coal Creek WWTP's and diversion of their flow to Northside, involving an 11 MGD expansion there. If the preferred wastewater management alternative is implemented, 44.8 dry tpd would be produced from all three plants by the year 2005.

The No Action condition or alternative is not considered to be a viable or useable alternative because it is not a permitted disposal operation and because a lack of disposal capacity would prevent the method in any event.

Federal law under the "Criteria for Classification of Solid Waste Disposal Facilities and Practices" (40 CFR Part 257) requires that solid waste disposal facilities and practices comply with minimum criteria designed to prevent adverse effects on health or the environment. Essentially, any solid waste disposal facility or practice that is not conducted in a sanitary facility is classified as an open dump. While the current disposal of sludge may not come under the open dump classification, permanent storage as such probably would.

Oklahoma State Solid Waste Rules and Regulations (effective July 1, 1982) also require the disposal and/or storage of solid waste in a permitted facility, with specific requirements more stringent than those under Part 257.

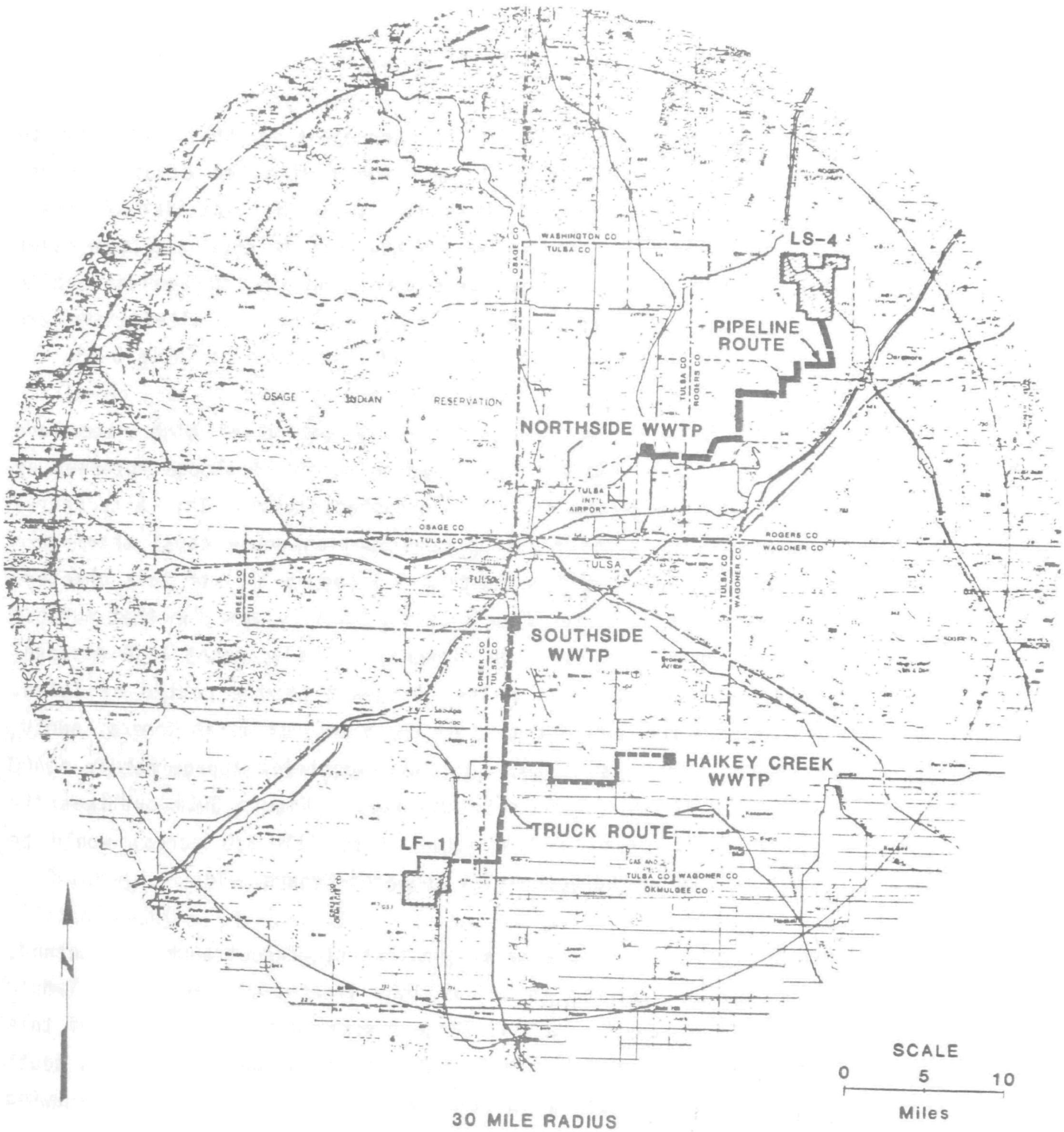
In addition to the above regulatory constraints, the No Action alternative would not be physically possible due to a lack of disposal area at any of the treatment plants. For these reasons, the No Action alternative is not utilized for comparison with other alternatives, but rather the five alternatives are compared against each other.

ALTERNATIVE RA-1

This alternative involves pipeline transport of Northside sludge to dedicated land disposal at Site LS-4; and the drying bed dewatering and trucking of Southside and Haikey Creek sludges to landfill at Site LF-1 (see Figure 5-13). A general description of the two methods and two sites involved is given in the following paragraphs, and then the existing site conditions and impacts on environmental factors from the alternative are given. An evaluation matrix of Alternative RA-1 is given on Table 5-23.

The term dedicated land disposal refers to a method of high rate land application of sludge by either the spreading of dried sludge followed by incorporation or the injection of liquid digested sludge. This alternative involves liquid sludge. The pipeline construction would cause short-term impacts such as those discussed in Section 5.3 (pg. 5-133) of this chapter. The term dedicated refers to the fact that the land is used for that purpose only, i.e., it is dedicated to waste disposal. The proposed land disposal site, LS-4, is approximately 24 miles northeast of the center of Tulsa. Figure 4-1 shows the regional location of the site. It is in Rogers County, lying just south of Oologah Lake. The site contains approximately 5,400 acres of which 110-320 acres would be utilized. Figure 5-14 outlines the potential area of the site. The actual site (110-320 acres) would be located somewhere within the boundaries shown on Figure 5-14.

The landfilling method in this alternative is a standard trench type method, where sludge would be layered in cells along trenches. Landfilling would produce construction impacts such as those discussed in Section 5.3 of this chapter. The proposed landfill site, LF-1, is approximately 21 miles south of the center of Tulsa. It is in both Okmulgee and Creek counties, lying just to the southwest of the town of Mounds. The site contains approximately 1,500 acres; 130 to 210 acres will be required. Figure 5-15 outlines the potential area of the site. Environmental factors are discussed below.



NORTHSIDE: Pipeline transport, dedicated land disposal, Site LS-4.

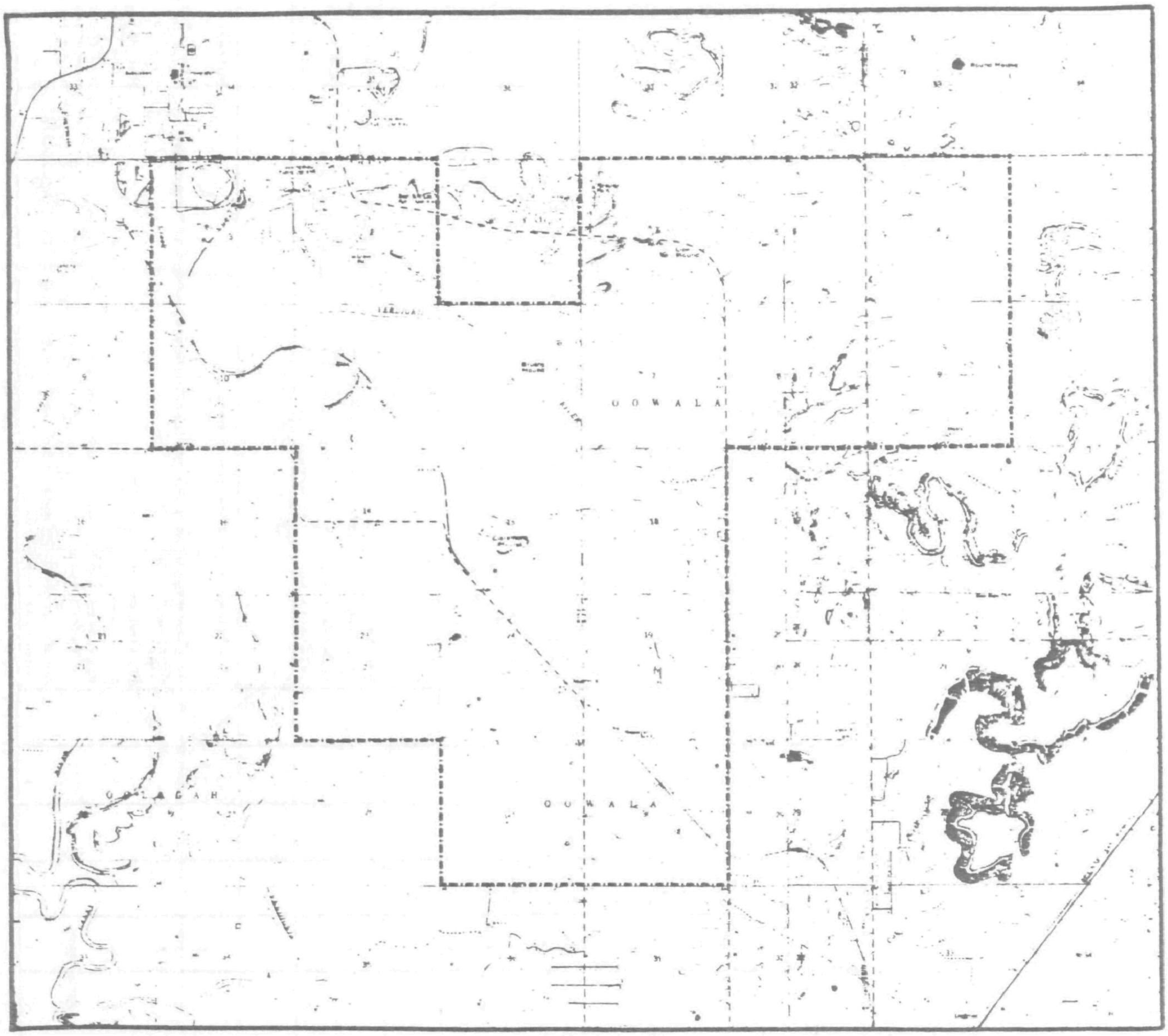
SOUTHSIDE and HAIKEY CREEK: Trucking, landfill, Site LF-1.

Figure 5-13 Alternative RA-1 Sites and Transportation Routes.

Table 5-23 SUMMARY EVALUATION OF ALTERNATIVE RA-1.

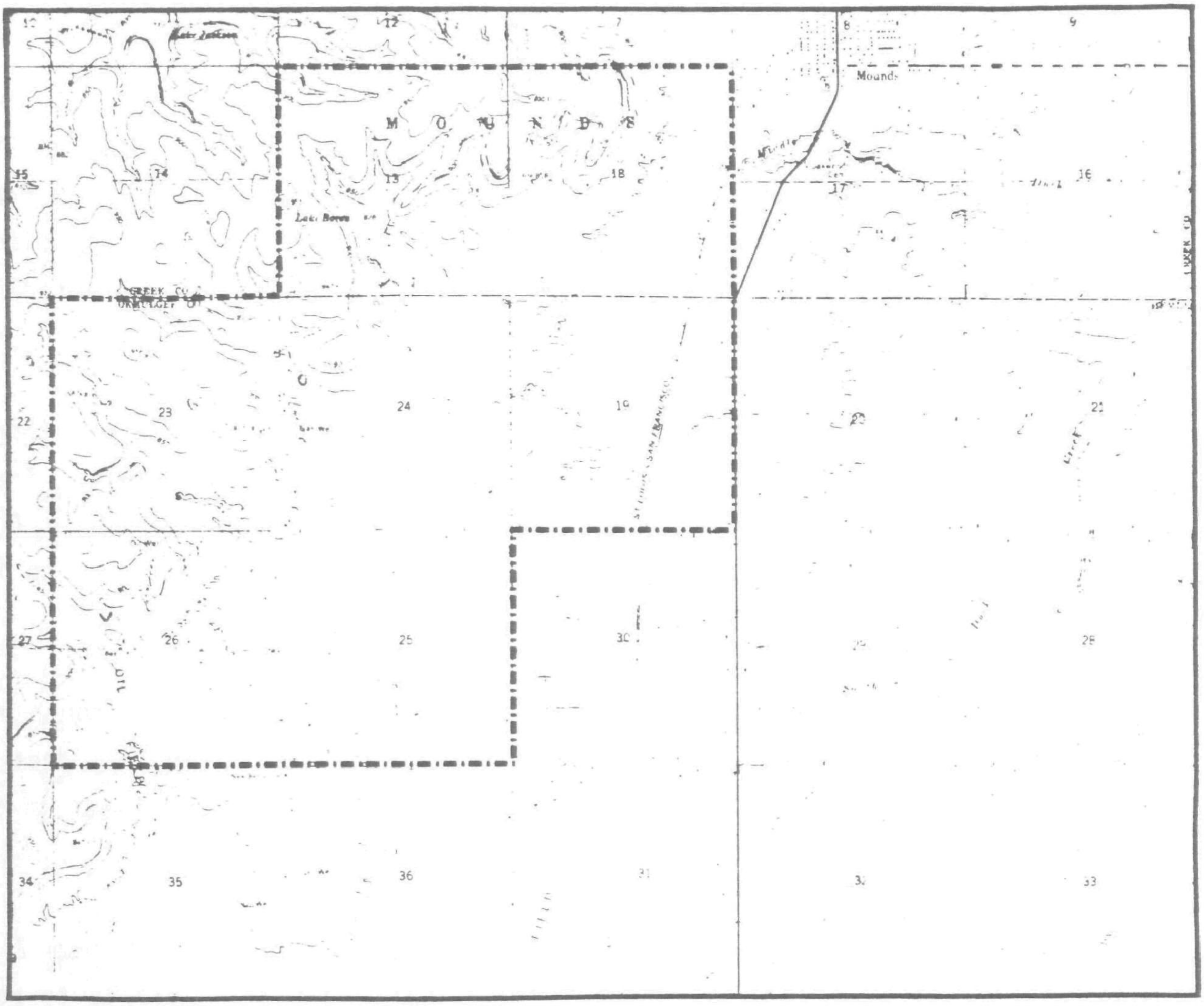
ENVIRONMENTAL PARAMETERS		BENEFICIAL	ADVERSE	LONG-TERM	SHORT-TERM	DIRECT	INDIRECT	CUMULATIVE	CONST.	IRREVERS. IRRETRIEV.	SUMMARY EVALUATION	MITIGATION MEASURES
WATER RESOURCES	SURFACE WATER		min.	X	C		X		X		Impacts minor if Verdigris soils at LS-4 avoided and run-off controlled. Long term, indirect siltation on Newtonia soils	Avoid Verdigris soils
	GROUNDWATER		maj.	X		X					Localized contamination groundwater may be severe but may not reach beyond site.	Reduce application rate on Newtonia soils Careful G.W. monitoring
	FLOOD HAZARDS										No impact if flood prone Verdigris soils on LS-4 avoided.	Use only e. portion of site.
PHYSICAL RESOURCES	GEOLOGY		min.	X			X	X			Some geology at LS-4 may not be suitable. Long-term cumulative contam. of other res. indirectly.	Careful siting; test borings
	SOILS		maj.	X	O,C	X	X		X	X	Direct clogging of Newtonia soils; indirect, permanent loss of prime farmlands at LS-4. Temp. loss of production at LF-1. May be erosion on Newtonia soils.	Reduce appl. rates at LS-4. Replace horizons & topsoil when closing LF-1.
	AIR QUALITY/ METEOROLOGY		min.	X	C		X		X		High rate injection at LS-4 may kill vegetation resulting in wind erosion indirectly.	Reduce rate to assure stable vegetation
SOCIOECONOMICS	POPULATION & LAND USE		maj.	X	C	X	X		X		Land use at LS-4 may be changed to waste disposal permanently, affecting both onsite and adjacent lands.	
	TRANS		min.	X	C	X			X		Small increase in local and area traffic especially at LF-1.	
	INSTITUTIONAL FACTORS		maj.		C	X			X		Implemenation could be difficult. Three different counties. Pipeline crossing difficult. If a final cover is required for LS-4 by State regulations, cost of soil importation could be prohibitive.	
	ECONOMICS		min.	X		X					Reduced land value of adjacent lands at both sites long-term.	Buffers
BIO. RES.	TERRESTRIAL FLORA & FAUNA		min.	X	C	X			X	poss.	On-site veg. removal at both sites. May be permanent loss of veg. due to hi-rate loading of soils at LS-4.	Reduce loading rate at LS-4 to assure veg. stability.
	AQUATIC FLORA & FAUNA				C				X		No effect expected if runoff controlled at both sites and Verdigris soils not used.	Avoid Verdigris soils
CULTURAL FACTORS	RECREATION		min.	X		X					LS-4 close to recreation areas.	Buffers
	ODOR & INSECTS		min.	X		X					On-site lagoon at LS-4 may create odors. Landfill may have odors and insects problems.	Avoid septic conditions in lagoon. Daily cover at landfill.
	AESTHETICS & NOISE		min.	X	C	X			X		Housing overlooks site	Buffer well
	PUBLIC HEALTH & SAFETY		min.	X	C	X			X		Dedicated land disposal does not contain the wastes as securely as landfilling.	Monitor carefully. Avoid Verdigris soils. Avoid local wells.
	ARCHAEOLOGY & HISTORICAL		min.		C	X			X		Known arch. sites near LS-4 may inhibit const. LF-1 has a high potential for sites.	Flexibility in siting.

*A summary keep may be found at the end of the section.



SCALE: 1"=6200'

Figure 5-14 Proposed Landspreading Site (LS-4).



SCALE: 1"=4200'

Figure 5-15 Proposed Landfill Site (LF-1).

WATER RESOURCES

Water resources include surface water and groundwater. These are described in terms of existing conditions first, followed by the alternative evaluation.

Existing Conditions

Surface Water. Site LS-4 is located adjacent to the winding channel of the Verdigris River as it leaves Oologah Dam. The entire site appears to drain into the Verdigris, which is a drinking water source downstream. Oologah Lake to the north (maximum capacity 1,020,000 acre feet) is also a municipal drinking water source.

Site LF-1 (Figure 5-15) is located near the headwaters of Duck Creek (South Duck and Middle Duck creeks), which is a tributary of Snake Creek. Snake Creek eventually drains into the Arkansas River. Middle and South Duck creeks are intermittent, receiving runoff primarily from the hills to the west of the site.

Lake Boren lies near the site in the hills to the west. Although not currently being used for public water supply, the town of Mounds does at times use the lake for a potable water supply along with Lake Jackson to the northwest.

Groundwater. The depth to water in wells near Site LS-4 ranges from 2 to 17 ft below the land surface. Most wells, however, have only fair to poor quality. This area is underlain by Pennsylvanian shale, siltstone, and sandstone, and by Mississippian limestone and shale above Boone Chert. Most groundwater in this area is hard or very hard and the yield is usually less than 25 gallons per minute. None of the towns in Rogers County are listed as using groundwater for municipal supplies.

The depth to the base of fresh water in the general area of LF-1 is listed as 200-500 ft; however, most wells in the area have had water of only fair to poor quality. The yield is generally less than 25 gallons per minute. Surrounding towns utilize surface water for municipal supplies.

Flood Hazards. The western portion of Site LS-4 is in a flood prone area. The flood prone area generally follows the Verdigris soils. Only the northeast portion of the site (Newtonia soils) is not flood prone.

Tributaries of Duck Creek (Middle Duck and South Duck) fringe into the general area to the east of Site LF-1. These are in a flood prone area according to the USGS Map of Flood Prone Areas, Lake Boren Quadrangle, 1980. These are not actually part of the site, however, since LF-1 is on Mason soils, which are above the floodplain.

Alternative Evaluation

Surface Water. Impacts on surface water from this alternative would be minor, as long as disposal and/or storage at LS-4 does not take place on the Verdigris soils which are in a flood prone area. At the high loading rates proposed, injection on permeable Verdigris soils would be likely to result in contamination of alluvial aquifers along the Verdigris, and subsequently indirect contamination of the Verdigris River which is a drinking water source. Also, storage lagoons should not be placed in the flood prone area as they could wash out. Disposal at LF-1 should not cause any surface water impacts as long as the groundwater is protected and runoff is controlled.

Groundwater. The impact of RA-1 on groundwater could be major adverse, even if the Verdigris soils are not utilized at Site LS-4. High rate application of sludge on the Verdigris soils would very likely pollute the alluvial aquifer below. On Newtonia soils, severe localized nitrate contamination of the groundwater is likely to occur. However, high rate application would probably clog the soils, preventing some of the pollution, but causing severe operational problems (see Soils).

Disposal of sludge from Southside and Haikey Creek plants at LF-1 would not be expected to cause any adverse effects on groundwater, since the landfill would be lined and waste contained.

Flood Hazards. As long as the flood prone western portion of LS-4 (primarily Verdigris soils)is not used, there should be no increase in flood hazards at either site.

PHYSICAL RESOURCES

This heading covers geology, soils, and air quality/meteorology.

Existing Conditions

Geology. Site LS-4 slopes toward the west, ranging from 570-580 ft above MSL near the Verdigris to 700 ft above MSL in the east side with several pronounced hills including Brushy Mound at 750 ft above MSL, Claremore Mound at 770 ft above MSL, and Lipe Mound at 830 ft above MSL.

The area is listed as Zone 2 by OGS, which means that it may locally contain bedrock units suitable for surface disposal of industrial wastes. There is an area of Zone 3, however, shown in the OGS map as just east of the site. Zone 3 is not likely to contain suitable units and because of the scale of the map, the actual site may or may not have suitable bedrock characteristics. The Zone 3 here is likely to be associated with alluvium along the Verdigris River. Alluvium consists of gravel, sand, silt, and clay, and along the Verdigris, yields small to moderate amounts of fair to good quality water locally. No geologic faults are noted in available maps.

Site LS-4 may be mostly located on Fort Scott Limestone to the east of the Verdigris. Fort Scott Limestone is limestone and shale and yields only small amounts of fair to poor quality water.

Very near to the east is the Senora Formation. This is a shale with thin and lenticular sandstone, minor limestone, and coal. This yields only small amounts of fair to poor quality water.

Site LF-1 is basically level, at approximately 725-750 ft above mean sea level (MSL). The hills to the west and northwest range in elevation from 930-1,003 feet above MSL.

The area is listed as Zone 1 by OGS, which means that it is likely to contain bedrock units suitable for surface disposal of wastes. The site lies in the Coffeyville Formation and Checkerboard Limestone. The Coffeyville Formation is 150 to 470 feet thick and is mainly shale interbedded with fine to medium-grained sandstone locally containing chert and limestone conglomerate and thin coal seams. Checkerboard Limestone, a crystalline limestone, is 2.5 to 5 feet thick. No faults have been noted.

Soils. Site LS-4 is on Verdigris clay loam and Newtonia silt loam. Verdigris clay loam is a nearly level soil in bottomlands that are flooded during wet seasons. Verdigris soils are formed in recent alluvium along major streams. Verdigris clay loam is used mostly for cultivated crops, and is suited to corn, small grain, sorghum, soybeans, tame pasture and pecan trees.

Newtonia silt loam is a level to gently sloping soil formed from limestone in upland prairies. Newtonia soils are generally susceptible to water erosion. Newtonia silt loam (0 to 1 percent and 1 to 3 percent slopes) is used mainly for cultivated crops although a few are used for native grass pasture or hay. The soil is well suited to soybeans, small grain, sorghum, alfalfa, corn, and tame and native grasses.

Both the Verdigris clay loam and Newtonia silt loam are listed as prime farmland by the Rogers County Soil Conservation Service.

Site LF-1 is on Mason Loam soils which are deep, nearly level soils that are on low terraces 5-30 feet above the floodplains of larger creeks. Mason loam is associated with Verdigris soils, which are on slightly lower terraces and are flooded occasionally. This soil is firm and compact when moist and very hard when dry. Mason series soils are used for cultivated crops, bermuda grass pasture and native grass pasture. Mason Loam is listed by Okmulgee County SCS as prime farmland.

Air Quality/Meteorology. Site LS-4 receives approximately 39 inches of precipitation annually, with the greatest amount occurring in May. The average annual temperature is 60.2°F with the first and last killing frosts generally on November 2nd and March 25th. The growing season is 220 days. prevailing surface winds in the general area are southerly during most of the year, averaging 5-7 mph, although it is not known how the lake affects this.

Site LF-1 also receives approximately 38-39 inches of precipitation annually, with 5-6 inches of runoff. The largest amount of moisture is received in the spring and fall, with May the wettest month (OGS, 1975). The meteorology in the area of LF-1 is similar to that of LS-4 with the exception of the added influence of the hills.

Alternative Evaluation

Geology. The effects of dedicated land disposal at LS-4 with respect to geologic factors are considered to be major adverse. It is questionable whether formations in this area are capable of containing the wastes. If not, contamination of other resources, such as groundwater, will be a concern. Part of the site to the west is Zone 3, considered least suitable for waste disposal by OGS. The eastern portion is more likely to have suitable bedrock units, but there may be operational problems with the Newtonia soils. No adverse impact would be expected from disposal at Site LF-1 since it is Zone 1 (probably suitable geological formations).

Soils. There also may be major adverse effects on soils. At Site LS-4, the soil associations are Newtonia-Sogn-Summit Association and Verdigris-Osage Association. The Verdigris silt loam (Vd) is probably marginally suitable, but is in the floodplain. Open areas of Newtonia silt loam (NaB) may be slightly more suitable but are subject to water erosion. The Newtonia series description, however, points to a silty clay loam substratum that may be prone to clogging. If the soil were to clog, ponding may occur and it could become physically difficult to apply the sludge. Newtonia soils are more alkaline and may be better suited for retaining heavy metals than the Verdigris soils, if high rates do not clog the soil and prevent application. No adverse effect on soils is expected from landfill disposal at Site LF-1 because the soil is relatively suitable.

The impact on prime farmland would be major adverse with the implementation of RA-1. At LF-1, about 100 acres plus a buffer at 55 percent would be temporarily taken out of agricultural production. These Class 1 prime farmlands (Mason Loam soils) would be removed from production for the 20 year site life. Proper closing of the site would allow its return to production, probably even for food chain crops. Care should be taken to segregate and retain the topsoil and soil horizons for later replacement. Because of subsidence problems after closure, the land is likely to return to agricultural use.

At LS-4, however, about 130 acres plus a buffer at 45 percent of prime farmlands (Newtonia series or Verdigris silt loam) would be temporarily removed and about 130 acres may be permanently removed from food chain crop production and possibly from any agricultural production. By definition, final cover is not normally placed on dedicated land disposal site as it is on a landfill, since there is no excavation and no topsoil to replace on top. The high rates will overload the site with cadmium and nutrients, so the growth of food chain crops would be prohibited by Federal law. Also, the proposed rate of application could potentially result in stunted or even lost plant growth, which could further result in wind and water erosion and siltation, dust blowing, etc.

Since the soils under consideration at LS-4 are prime farmlands, Federal policy may affect the use of this site. (See also Report V, July, 1981, Appendix A for Definition of Important Farmlands and Appendix B for EPA Policy on Prime Farmlands.)

<u>Air Quality/Meteorology</u>. Impacts on air quality for this alternative would be related to the sludge loading rate at Site LS-4. Normally, injection would not cause any adverse effect on air quality, however, the rates are high enough here that vegetation may be damaged by burning from ammonia nitrogen or compaction from numerous trips across the field. If a good cover of vegetation cannot be maintained on the injection site, wind erosion may cause locally adverse effects on air quality.

BIOLOGICAL RESOURCES

Biological resources are discussed in terms of terrestrial flora and fauna and aquatic flora and fauna.

Existing Conditions

Terrestrial Flora/Fauna. Site LS-4 is mostly farmlands, upland prairie, and bottomland woodlands. Farmlands include pasture and cultivated crops and native grasses. Wildlife likely to be found includes bobwhite quail, mourning doves, fox and gray squirrels, cottontail and swamp rabbits, opossums, coyotes, foxes, and numerous types of birds including waterfowl.

Much of site LF-1 is also in farmlands, with some woodlands. Farmlands include cultivated crops, rangeland, pasture and native meadow. Wildlife likely to be found include bobwhite quail, mourning dove, squirrel, deer, cottontail, racoon, mink, opossum, skunk, fox, coyote, hawks, and owls and many kinds of songbirds.

Aquatic Flora/Fauna. Aquatic habitat on the Verdigris River is good where the river has not been channelized, such as near LS-4. The quality of fishing is good, with largemouth bass, catfish, white bass, sunfish, crappie and others occurring.

The main drainageway near Site LF-1 is Middle Duck Creek, which probably exhibits a negligible aquatic habitat due to intermittency. Farm ponds, including Lake Boren, and Snake Creek, which Duck Creek feeds, may contain sunfish, channel catfish, bullheads, flatheads, carp, buffalofish and bass. Duck Creek itself is listed as containing sunfish and catfish.

Alternative Evaluation

Terrestrial Flora/Fauna. As at all sites, onsite vegetation such as farmlands and/or woodlands will be removed by construction at both LS-4 and LF-1. Local fauna will be displaced and some small animals may be killed constituting a minor adverse impact. While LF-1 (100 acres) may be returned to its original state shortly after closure, LS-4 (130 acres) may be severely damaged by the loading of nitrogen and heavy metals. This may delay the revegetation of LS-4. The major significance of this is the loss of prime farmlands (see Soils).

Aquatic Flora/Fauna. No effect would be expected if runoff is prevented from both sites, and as long as Verdigris soils are not used at LS-4. Use of these soils could result in alluvial groundwater contamination, resultant surface water contamination with nutrients, and finally eutrophication.

SOCIOECONOMICS

A number of environmental parameters are discussed here. They are population and land use, transportation, institutional factors, and economics.

Existing Conditions

Population and Land Use. Much of the LS-4 area is lightly populated. Rogers County has a total population of about 44,000. The largest city is Claremore with 12,000. Oologah, just northwest of the site has a population of 458. Sageeyah, in the southern portion of LS-4, does not list any unified population. Around the site area, land use is predominantly agricultural, light residential and some quarry and oil related activity. Strip mining occurs to the east.

The general area of LF-1 is also very lightly populated. Okmulgee County has a total population of about 39,000 with the largest city being Okmulgee to the south of LF-1.

The town of Mounds to the north in Creek County has a population of approximately 1,200. Around the Site LF-1 area, land use is predominantly pasture, woods, and oil related activities. Scattered farms are found in the valley portion with fringe suburban housing located in the hills to the west and north.

Transportation. Sludge trucked from the Northside Plant to LS-4 would utilize Highway 169. A portion of this route between Collinsville and Oologah has size and load restrictions for some vehicles.

The route to LF-1 would utilize I-75 south until it crosses into Okmulgee County. At that point, the trucks would travel due west along the first section line road to the site area (see Figure 5-13).

Institutional Factors. There are no county regulations or guidelines on landfilling or land application in Rogers County (Site LS-4). The Rogers County Planning Department in Claremore indicates that Site LS-4, or parts of it, may be subject to zoning restrictions. A special permit would probably be required.

According to the Okmulgee County Health Department, there are no county landfill regulations or guidelines with respect to LF-1. The State regulations are used. There is no county planner or planning agency and no zoning plans. Ownership would assist in determining a specific location within LF-1.

Economics. The LS-4 area is primarily agriculturally based, although the river area also has high recreation potential. A number of gravel pits occur in the area as well as some petroleum related activity. Strip mining for coal occurs to the east.

The LF-1 area is also based primarily on the agricultural economy, with some petroleum industry.

Alternative Evaluation

Population and Land Use. There would be little effect from LF-1, which is in an agricultural area and would probably return to that use after closure. LS-4 may permanently change the land use from agricultural to waste disposal and because the area is more populated, may somewhat change future land use patterns. This portion of RA-1 could have both direct and indirect major adverse impacts on onsite and adjacent land use patterns.

Transportation. The hauling would be from the Southside and Haikey Creek plants to site LF-1. Oklahoma size and weight requirements limit a truck's gross weight to 20,000 lbs per axle. Due to the rural roads to the landfill site the truck capacity may be limited to 15 cubic yards, or a special permit may be required if 30 cubic yard trucks are used. This will provide approximately 25 truck trips (30 cubic yards) per week. The Residual Solids Management Plan discusses the need to upgrade county roads so that load limitations will not apply. If so, there would be five trips per day. In either case, the increased traffic may cause a minor adverse impact.

Institutional Factors. The greatest problem is that both sites are in counties other than Tulsa. LS-4 is in Rogers County, which may restrict this use by way of zoning provisions. Citizens in Okmulgee County and the town of Mounds in Creek County may object to the siting of LF-1. In addition, it may be very difficult to cross county lines with a pipeline such as that proposed to deliver the sludge to LS-4. Overall, there may be major negative impacts on institutional factors.

Economics. Both the operation at LS-4 and at LF-1 may have a slight negative impact on local business or its establishment and the value of the onsite and adjacent land. This will occur in two places rather than one, however, for Alternative RA-1.

CULTURAL FACTORS

This heading includes those factors which affect people and the quality of the environment in which they live, such as recreation, odor and insects, aesthetics and noise, public health and safety and archaeological and historical.

Existing Conditions

Recreation. LS-4 has high recreational value due to both the Verdigris River and the proximity of Oologah Dam. Fishing value of the river is considered high, and areas near the lake, including the public use area to the north, have high recreational value.

Recreational values of Site LF-1 are probably limited to small game hunting and fishing on small lakes and ponds throughout the area. There may be some farm related recreation. No specific recreation sites such as baseball fields or gun clubs were noted; however, any recreation potential will be noted when ownership factors are determined and a specific location is selected.

Odors and Insects. Prevailing winds at both sites are southerly. LS-4 has residential areas both to the north and south, while LF-1 contains residential areas to the northwest and the town of Mounds lies to the north. Most of the land use is agriculture.

Aesthetics and Noise. Most of Site LS-4 is overlooked by a residential area to the north and by some in the south as well as Claremore, Brushy, and Lipe Mounds. There is also a public use area to the north but a hill lies between the site and this public use area. The town of Sageeyah lies in the southern portion of the area, and other residential groupings lie in both the southeast and northern parts of the area. Other sensitive features include a public use area near the dam in the northwest.

Mason Loam soils on which LF-1 is located is on upper terraces of the valley. Hills overlook the site to the west and northwest and contain some fringe suburban housing.

Public Health and Safety. While groundwater resources are limited in the LS-4 area, some private wells do occur. Oologah Lake is a municipal drinking water source. The Verdigris River drains the site and is a drinking water source downstream. There are no airports in the vicinity of the site.

Groundwater resources are also listed as limited in the LF-1 area, some private drinking water or irrigation water wells may exist, however. Lake Boren lies northwest and uphill of the site and is sometimes used as a drinking water source for the town of Mounds in Creek County. The nearest private airport is about 3 miles southeast of the ara.

Archaeological/Historical. A copy of the LS-4 site map was sent to both the Oklahoma Historical Society and Archaeological Survey. A number archaeological sites and one historic site, Claremore Mounds, are located on or near the site. The archaeological sites range from 3000 B.C. up to as late as the 1930's (see Appendix A). There are at least five known historic period sites representing homesteads or locations identified with specific Native American groups. There are also at least ten prehistoric habitation and temporary camps.

A copy of the LF-1 site map was also sent to both the Oklahoma Archaeological Survey and the Oklahoma Historical Society. No known archaeological or historical sites are listed for the area (Appendix A) but the Archaeological Survey notes that few surveys have been done and there is a good potential for sites.

Alternative Evaluation

Recreation. As long as the sites are buffered, surface water pollution is prevented and odors are kept to a minimum, most impacts on recreation will be minimal, especially at LF-1, where no major recreational values now exist. However, at LS-4, there probably will be some minor adverse impact in that it is so close to recreation areas and prevailing winds are toward the major recreation areas of Oologah Lake.

Odors and Insects. As in noise below, impacts are minor adverse due to two sites rather than one. While injection of liquid sludge has little odor causing potential, onsite lagoons may cause odor problems and mosquito breeding. Landfilling always has the potential for causing both odor and insect problems, but these should be minimal with proper precautions.

Aesthetics and Noise. A minor adverse impact may result from the siting of LF-1 and LS-4 due to residential housing overlooking the sites, and from LS-4 because of a nearby public use area.

Alternative RA-1 may result in a minor adverse impact because there are two disposal sites rather than one, and localized transportation and construction impacts would be found in two areas.

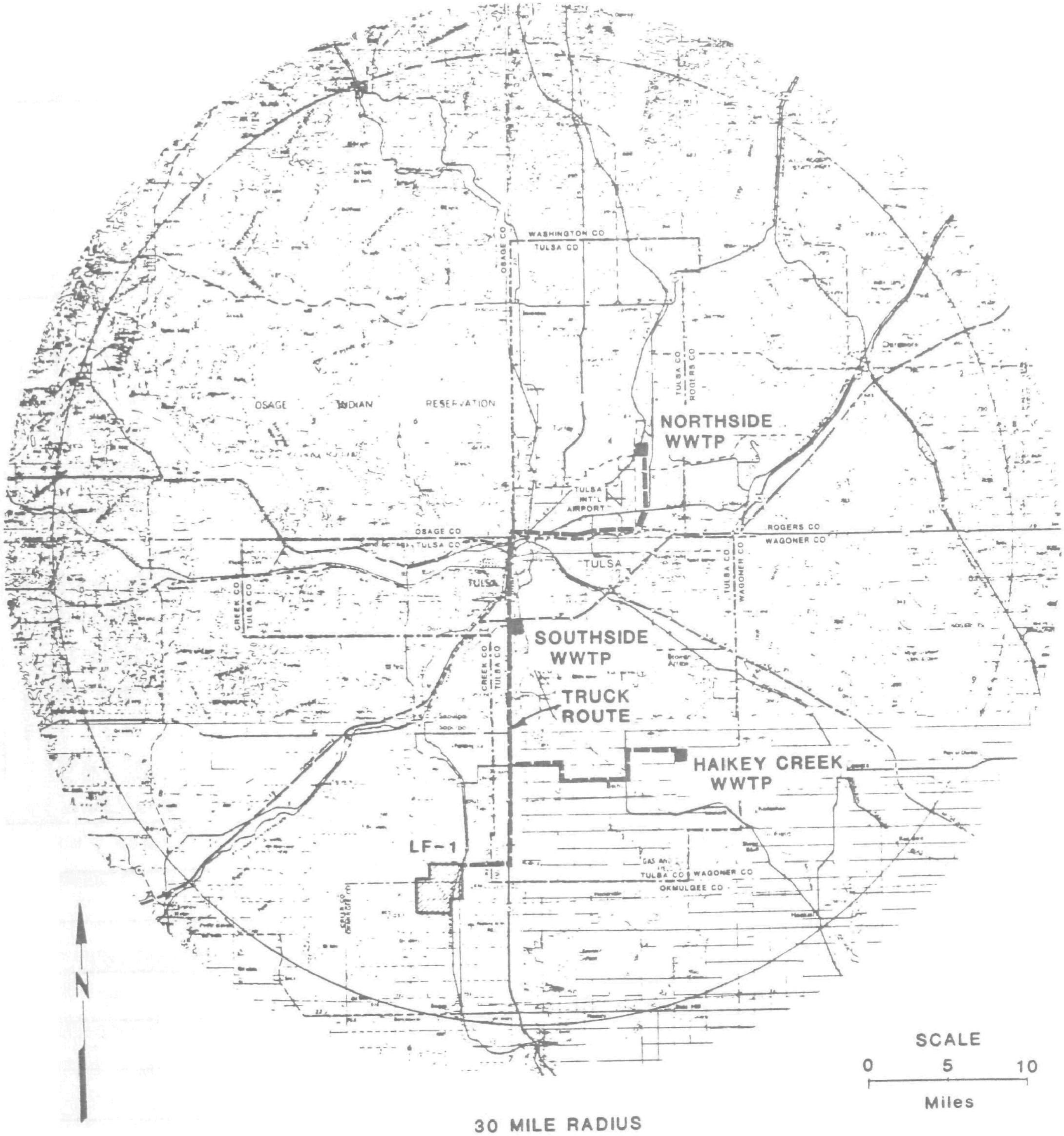
Public Health and Safety. There may be a minor negative effect on public health and safety from the dedicated land disposal operation at LS-4. This is because the wastes are not contained or controlled as well as at a sanitary landfill site. In other words, the potential is greater for contaminants to enter the environment. Public access and grazing would have to be controlled for one year and one month respectively after closure.

Archaeological/Historical. There are a number of known archaeological/historical sites on and near LS-4. Because the site is near a major river, more sites may yet be found. There is a good potential that sites may be found on LF-1, primarily because few surveys have ever been conducted in that area (refer to Appendix A). Because of the high potential for archaeological/historical sites at two places, this alternative may have a minor adverse impact.

ALTERNATIVE RA-3

This alternative entails the drying bed dewatering of all the sludge, followed by truck transport to landfill at Site LF-1 (see Figure 5-15 and 5-16). As discussed under RA-1, Site LF-1 is located about 21 miles south of the center of Tulsa. It lies in both Okmulgee and Creek counties, just to the southwest of the town of Mounds. While the site contains approximately 1,500 acres, only 130 to 210 acres will be required. Short-term impacts would be felt from the construction of the landfill (see Section 5.3 of this chapter, pg. 5-133).

The existing conditions or site factors at LF-1 were discussed under RA-1, however, they will be repeated here for continuity. An evaluation matrix of Alternative RA-3 is given on Table 5-24. The alternative evaluation for each type of resource follows existing conditions.



NORTHSIDE, SOUTHSIDE and HAIKEY CREEK: Trucking, landfill, Site LF-1.

Figure 5-16 Alternative RA-3 Sites and Transportation Routes.

Table 5-24 SUMMARY EVALUATION OF ALTERNATIVE RA-3.

ENVIRONMENTAL PARAMETERS		BENEFICIAL	ADVERSE	LONG-TERM	SHORT-TERM	DIRECT	INDIRECT	CUMULATIVE	CONST.	IRREVERS. IRRETRIEV.	SUMMARY EVALUATION	MITIGATION MEASURES
WATER RESOURCES	SURFACE WATER				C				X		No significant impact expected; landfill lined and runoff controlled.	
	GROUNDWATER										No significant impact expected; landfill lined and capped	
	FLOOD HAZARDS										No significant impact; not in a flood-prone area.	
PHYSICAL RESOURCES	GEOLOGY										No significant impact expected; Zone I bedrock suitable.	
	SOILS		min.		O,C		X		X		Temporary, indirect loss of ag. production; should be put back into unrestricted use after closure.	Segregate and retain top soil and soil horizons.
	AIR QUALITY/ METEOROLOGY				C				X		No significant impact expected.	
SOCIOECONOMICS	POPULATION & LAND USE				C				X		No significant impact. May be temporary change in onsite land use.	
	TRANS		min.	X	C	X			X		Small long-term increase in local and area traffic from plants.	
	INSTITUTIONAL FACTORS		min.		C	X			X		LF-1 is outside Tulsa County. Difficulty in implementation possible. Landfill regulations are well established, however.	
	ECONOMICS										Land value may be slightly reduced.	
BIO. RES.	TERRESTRIAL FLORA & FAUNA		min.		C	X			X		On-site veg. destroyed. Should be returned after closure.	
	AQUATIC FLORA & FAUNA				C				X		No significant impact expected.	
CULTURAL FACTORS	RECREATION										No significant impact expected.	
	ODOR & INSECTS										No significant impact expected as long as appropriate precautions, such as daily cover, are utilized.	
	AESTHETICS & NOISE		min.	X	C	X			X		Site may be overlooked by some housing, causing some long-term direct effect.	Buffer site.
	PUBLIC HEALTH & SAFETY				C				X		No significant impact expected as long as water wells are avoided and landfill operated correctly.	
	ARCHAEOLOGY & HISTORICAL		min.		C				X		Good likelihood of sites in area. May delay construction	

WATER RESOURCES

As in RA-1, this heading represents the environmental parameters of surface water, groundwater and flood hazards.

Existing Conditions

Surface Water. The site is located near the headwaters of Duck Creek (South Duck and Middle Duck creeks), which is a tributary of Snake Creek. Snake Creek eventually drains into the Arkansas River. Middle and South Duck creeks are intermittent, receiving runoff primarily from the hills to the west of the site.

Lake Boren lies near the site in the hills to the west. Although not currently being used for public water supply, the town of Mounds does at times use the lake for a potable water supply along with Lake Jackson to the northwest.

Groundwater. The depth to the base of fresh water in the general area is listed as 200-500 feet; however, most wells in the area have had water of only fair or poor quality. The yield is generally less than 25 gallons per minute. Surrounding towns utilize surface water for municipal supplies.

Flood Hazards. Tributaries of Duck Creek (Middle Duck and South Duck) fringe into the general area to the east. These are in a flood prone area according to the USGS Map of Flood Prone Areas, Lake Boren Quadrangle, 1980. These are not actually part of the site, however, since LF-1 is on Mason soils, which are above the floodplain.

Alternative Evaluation

Surface Water. Impacts should be negligible since the landfill would be lined and runoff would be controlled.

Groundwater. Because the landfill is lined and capped, no impact should occur. Monitoring wells are included in the design as an extra precaution.

Flood Hazards. There should be no impact since LF-1 is not in a flood prone area.

PHYSICAL RESOURCES

These include parameters of geology, soils and air quality/meteorology.

Existing Conditions

Geology. The site is basically level, at approximately 725-750 ft above mean sea level (MSL). The hills to the west and northwest range in elevation from 930-1,003 ft above MSL.

The area is listed as Zone 1 by OGS, which means that it is likely to contain bedrock units suitable for surface disposal of wastes. The site lies in the Coffeyville Formation and Checkboard Limestone. The Coffeyville Formation is 150 to 470 ft thick locally containing chert and limestone, is 2.5 to 5 ft thick. No faults have been noted.

Soils. The site is on Mason Loam soils which are deep, nearly level soils that are on low terraces 5-30 ft above the floodplains of larger creeks. Mason loam is associated with Verdigris soils, which are on slightly lower terraces and are flooded occasionally. This soil is firm and compact when moist and very hard when dry. Mason series soils are used for cultivated crops, bermudagrass pasture and native grass pasture. Mason loam is listed by the Okmulgee County SCS as prime farmland.

Air Quality/Meteorology. The site receives approximately 38-39 in. of precipitation annually, with 5-6 in. of runoff. The largest amount of moisture is received in the spring and fall, with May the wettest month (OGS, 1975).

The average annual temperature is 60.2°F (15.7°C) with the first and last killing frosts generally occurring on November 2nd and March 25th. The growing season is 220 days. Prevailing surface winds are southerly during most of the year, averaging 5-7 mph, although it is not known how the hills affect this.

Alternative Evaluation

Geology. OGS has designated this area as Zone 1, meaning that bedrock units are likely to be suitable. For this reason, no impact is expected.

Soils. The Mason loam soils are relatively suitable for landfills, with adequate depth to bedrock and no seasonally high water table close to the surface. Approximately 200 acres of prime farmland would be removed from production temporarily. These may be put back into production following capping and final cover. Proper closure would allow the site to return to unrestricted agricultural production, including food chain crops. The instability and potential for subsidence may limit the type of structures that can be built onsite, however, to small buildings.

Air Quality/Meteorology. There should be no measurable impact with proper operation of the landfill.

BIOLOGICAL RESOURCES

This heading includes the environmental parameters of terrestrial flora and fauna and aquatic flora and fauna.

Existing Conditions

Terrestrial Flora/Fauna. Much of the site is in farmlands, with some woodlands. Farmlands include cultivated crops, rangeland, pasture and native meadow. Wildlife likely to be found include bobwhite quail, mourning dove, squirrel, deer, cottontail, racoon, mink, opossum, skunk, fox, coyote, hawks, and owls and many kinds of songbirds.

Aquatic Flora/Fauna. The main drainageway near the site is Middle Duck Creek, which probably exhibits a negligible aquatic habitat due to intermittency. Farm ponds, including Lake Boren, and Snake Creek, which

Duck Creek feeds, may contain sunfish, channel catfish, bullheads, flatheads, carp, buffalofish, and bass. Duck Creek itself is listed as containing sunfish and catfish.

Alternative Evaluation

Terrestrial Flora/Fauna. Existing onsite vegetation would be destroyed by construction of the landfill, resulting in a minor adverse impact. It may be returned to its original state after closure, however. Local fauna will be displaced and some small animals may be killed. This would constitute a minor adverse impact.

Aquatic Flora/Fauna. No effect would be anticipated as long as runoff is prevented and the landfill is properly graded and reseeded after closure.

SOCIOECONOMICS

This heading includes the parameters of population and land use, transportation, institutional factors, and economics.

Existing Conditions

Population and Land Use. Most of the general area is very lightly populated. Okmulgee County has a total population of about 39,000 with the largest city being Okmulgee to the south of LF-1.

The town of Mounds to the north in Creek County has a population of approximately 1,200. Around the site area, land use is predominantly pasture, woods, and oil related activities. Scattered farms are found in the valley portion with fringe suburban housing located in the hills to the west and north.

Transportation. All three plants would carry the sludge south down I-75 until it crosses into Okmulgee County. At that point, the trucks would travel due west along the first section line road to the site area.

Institutional Factors. According to the Okmulgee County Health Department, there are no county landfill regulations or guidelines. The State regulations are used. There is no county planner or planning agency and no zoning plans.

Economics. The area is based primarily on an agricultural economy, with some petroleum industry.

Alternative Evaluation

Population and Land Use. There should be no significant impact except for the temporary change in onsite land use, from agriculture to waste disposal. This would involve 150 acres plus a buffer at 45 percent. A well-operated, well-buffered landfill should have little negative impact on adjacent agricultural lands.

Transportation. For this alternative, all three plants would be hauling a total of 46 tons per day of dried material. Utilizing 15 cubic yard capacity vehicles, twice the total number of truck trips per week would be required. If the roads are improved so that 30 cubic yard trucks can be used, 35 trips per week would be required. Since all of the sludge would be going to one site, traffic impacts may be heaviest near the site. Increased damage to roads and heavier traffic would constitute a minor adverse impact.

Institutional Factors. There may be a minor adverse impact due to the fact that LF-1 is not in Tulsa County. Citizens in Okmulgee County and the town of Mounds in Creek County may object to the siting of LF-1.

Economics. While there may be reduction in the value of onsite land, the impact should be relatively minor.

CULTURAL FACTORS

This section includes recreation, odor and insects, aesthetics and noise, public health and safety, and archaeological and historical factors.

Existing Conditions

Recreation. Recreational values of the site are probably limited to small game hunting and fishing on small lakes and ponds throughout the area. There may be some farm-related recreation. No specific recreation sites such as baseball fields or gun clubs were noted; however, any recreational potential should be noted when a specific location is selected.

Odors and Insects. Prevailing winds are southerly, with sensitive areas such as the town of Mounds and houses in the hills to the north and west.

Aesthetics and Noise. Mason loam on which the site would be located is on upper terraces of the valley. Hills overlook the site to the west and northwest and contain some fringe suburban housing.

Public Health and Safety. Although groundwater resources are listed as limited in the area, some private drinking water or irrigation water wells may exist. These should be noted when a location is selected by contacting nearby residents. Lake Boren lies northwest and uphill of the site and is sometimes used as a drinking water source for the town of Mounds in Creek County. The nearest private airport is about 3 miles southeast of the area.

Archeological/Historical. A copy of the site map was sent to both the Oklahoma Archaeological Survey and the Oklahoma Historical Society. No known archaeological or historical sites are listed for the area (Appendix A) but the Archaeological Survey notes that few surveys have been done and there is a good potential for sites.

Alternative Evaluation

Recreation. Impacts should be negligible.

Odors and Insects. There should be no significant problems with appropriate precautionary measures.

Aesthetics and Noise. There may be a minor adverse impact on residents whose homes overlook the site. This would be minimal if the site is well buffered. No significant impact would be expected to occur relative to other alternatives. There may be some localized operational noise but buffers should prevent most problems.

Public Health and Safety. A properly constructed and operated sanitary landfill should not produce any public health or safety impacts.

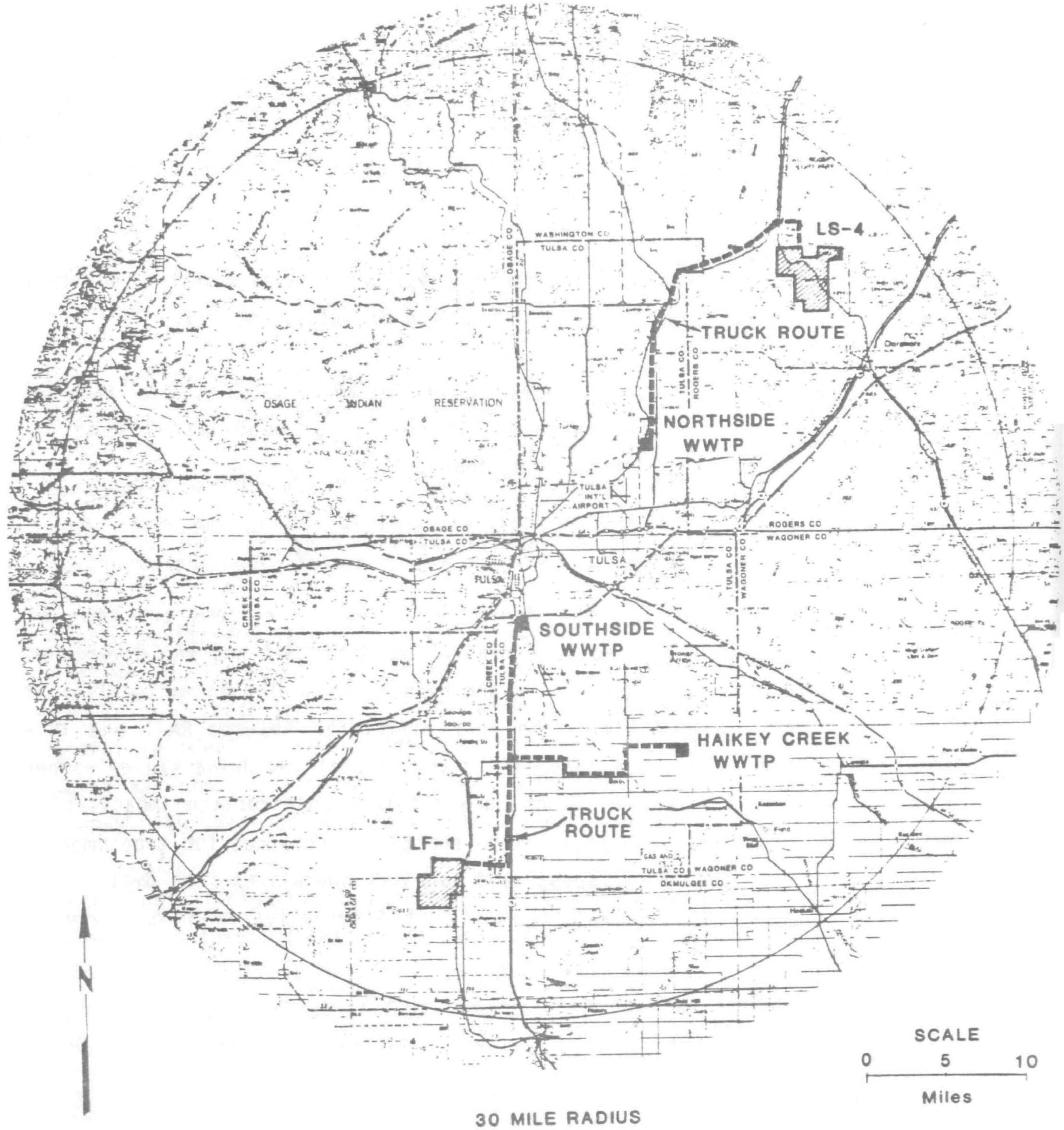
Archaeological/Historical. Impacts could be minor due to the lack of previous surveys in the area. There is a good likelihood of archaeological/historical sites being found.

ALTERNATIVE RA-5

This alternative involves the drying bed dewatering and trucking of Northside sludge to dedicated land diposal at Site LS-4 and the drying bed dewatering and trucking of Southside and Haikey Creek sludges to landfill at Site LF-1 (see Figure 5-17). The only difference between RA-1 and this alternative is that the dedicated land disposal utilizes dried sludge rather than liquid. Thus, there would be no short-term construction impacts of a pipeline, although there would still be short-term construction type impacts from opening both the land disposal and landfill operations (see Section 5.3 of this chapter). An evaluation matrix of Alternative RA-5 is given on Table 5-25.

Existing Conditions

The existing conditions for both LS-4 (Figure 5-14) and LF-1 (Figure 5-15) have been given under RA-1 (LS-4 and LF-1) and RA-3 (LF-1), and will not be repeated here. For the environmental evaluation, only the parameters of groundwater, soils, air quality, transportation, and institutional factors are different than in RA-1. These differences are described below.



NORTHSIDE: Trucking, dedicated land disposal, Site LS-4.

SOUTHSIDE and HAIKEY CREEK: Trucking, landfill, Site LF-1.

Figure 5-17 Alternative RA-5 Sites and Transportation Routes.

Table 5-25 SUMMARY EVALUATION OF ALTERNATIVE RA-5.

ENVIRONMENTAL PARAMETERS		BENEFICIAL	ADVERSE	LONG-TERM	SHORT-TERM	DIRECT	INDIRECT	CUMULATIVE	CONST.	IRREVERS. IRRETRIEV.	SUMMARY EVALUATION	MITIGATION MEASURES
WATER RESOURCES	SURFACE WATER		min.	X	C		X		X		As in RA-1, Table 5-23	
	GROUNDWATER		min.	X		X					Less significant than RA-1 because of lower loading rate and dried sludge rather than liquid.	
	FLOOD HAZARDS										As in RA-1, Table 5-23	
PHYSICAL RESOURCES	GEOLOGY		min.	X			X	X			As in RA-1, Table 5-23	
	SOILS		min.	X	C	X			X		Less impact than RA-1 because sludge is dry and less likely to clog the soil. Prime farmland still may be lost.	
	AIR QUALITY/ METEOROLOGY		maj.	X	C	X			X		Greater impact on air quality due to continuous disturbance for dried sludge incorporation.	
SOCIOECONOMICS	POPULATION & LAND USE		maj.	X	C	X	X		X		As in RA-1, Table 5-23	
	TRANS		min.	X	C	X			X		May be greater than RA-1 due to more trucks (no pipeline)	
	INSTITUTIONAL FACTORS		min.		C	X			X		Implementation might be slightly easier than RA-1 since there is no pipeline.	
	ECONOMICS		min.	X		X					As in RA-1, Table 5-23	
BIO. RES.	TERRESTRIAL FLORA & FAUNA		min.	X	C	X			X	poss.	As in RA-1, Table 5-23	
	AQUATIC FLORA & FAUNA				C				X		As in RA-1, Table 5-23	
CULTURAL FACTORS	RECREATION		min.	X		X					As in RA-1, Table 5-23	
	ODOR & INSECTS		min.	X		X					As in RA-1, Table 5-23	
	AESTHETICS & NOISE		min.	X	C	X			X		As in RA-1, Table 5-23	
	PUBLIC HEALTH & SAFETY		min.	X	C	X			X		As in RA-1, Table 5-23	
	ARCHAEOLOGY & HISTORICAL		min.		C	X			X		As in RA-1, Table 5-23	

WATER RESOURCES

Only the impacts on groundwater are different than in RA-1.

Alternative Evaluation

Groundwater. Impacts on the groundwater of LS-4 should be less significant in RA-5 because less nitrogen is added in the sludge with the lower loading rate and the sludge is dry rather than liquid.

PHYSICAL RESOURCES

The impacts on both soils and air quality are different than for RA-1.

Alternative Evaluation

Soils. There should be less impact on soils due to the fact that the sludge is dry and less likely to clog the soils. The dried sludge would provide organic matter and may decrease the bulk density of the soils (see also discussion of Prime Farmland under RA-1 "Soils").

Air Quality. The impact on air quality may be worse in RA-5 since dried sludge would always require incorporation into the soil. Because of the continuous disturbance of much of the site, wind erosion could be a significant factor.

SOCIOECONOMICS

Only the parameters of transportation and institutional factors might be expected to be different than under RA-1.

Alternative Evaluation

Transportation. Northside sludge would be hauled to land disposal site LS-4 by an average of 14 trips per week. A portion of Route 169 between Claremore and Oologah may require special permits if the larger 30 cubic yard trucks are used. This impact is not present for RA-1. Southside and Haikey Creek will require 25 trips per week to LF-1.

Institutional Factors. While RA-5 still involves two sites and three counties as does RA-1, it does not have a pipeline. It can be especially difficult to cross county and other political boundaries with pipelines. The impact in this case would be minor adverse.

ALTERNATIVE RA-6

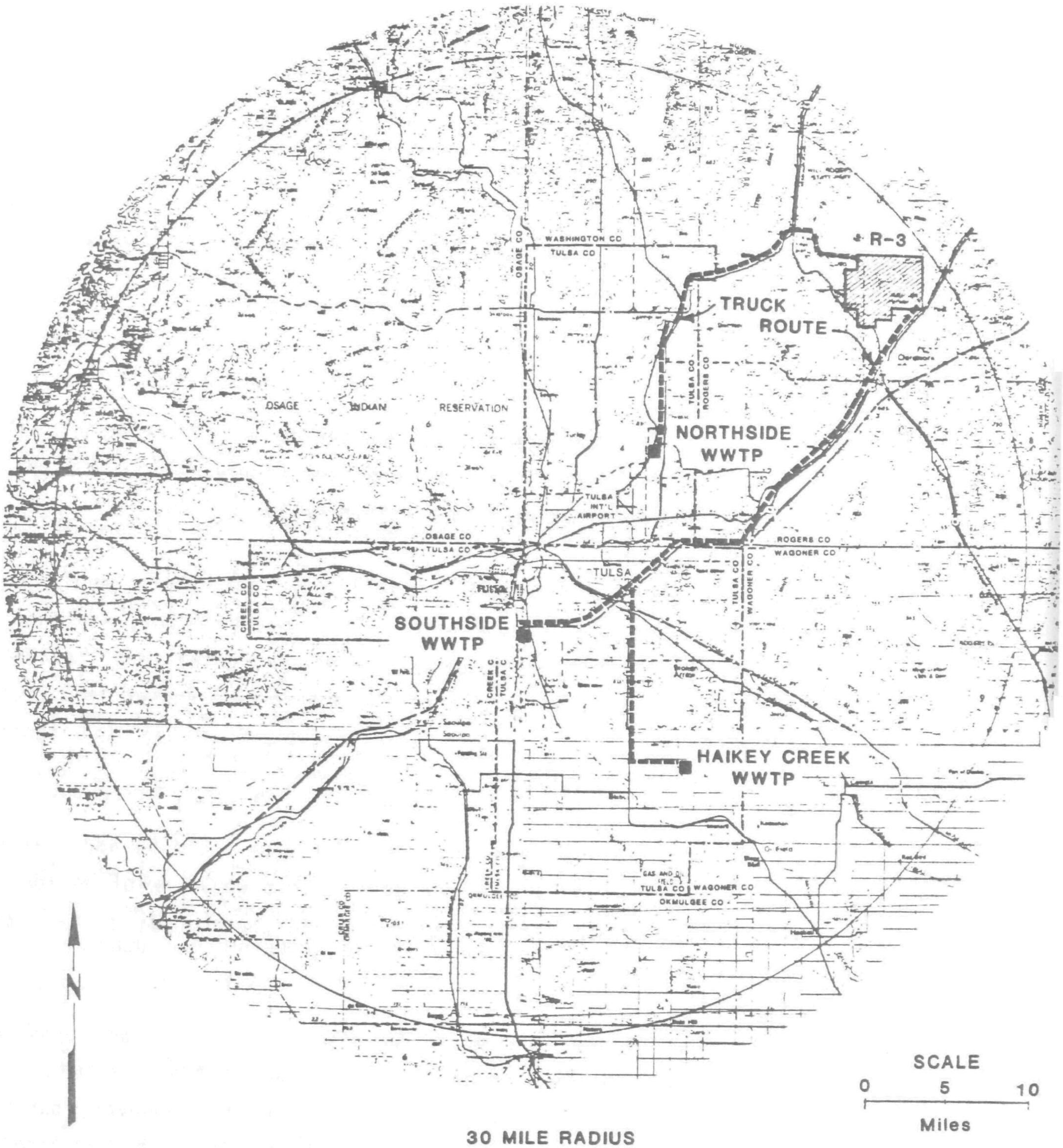
This alternative involves the drying bed dewatering and trucking of all sludges to strip mine reclamation at Site R-3 (see Figure 5-18 and 5-19). An evaluation matrix of Alternative RA-6 is given on Table 5-26.

This method would closely resemble landfilling, and there would be construction impacts from opening the site. These may be minor, and there would be no pipeline construction impacts. The sludge, dried to 40 percent solids, would be layered into the bottom of the abandoned trenches left from old strip mining operations. Alternating layers of sludge and spoil material would be built up until the area between the ridges is level.

A final cover of spoil material mixed with dried sludge would be added at a one time application rate of 50 tons per acre. This would help provide a substrate with a slow release organic nitrogen and phosphorous content to support vegetative growth.

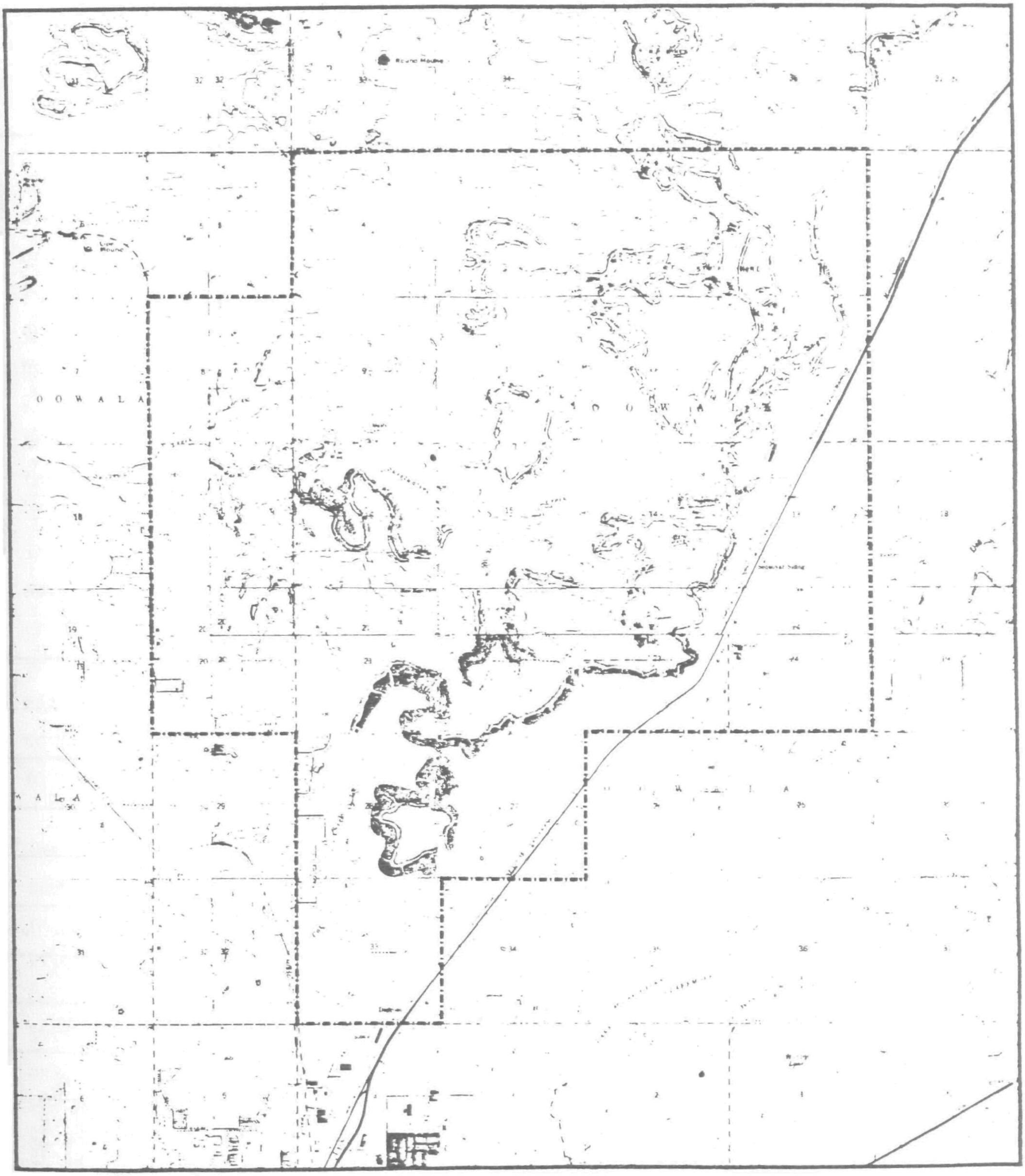
Like any operation where the land would be disturbed, runoff and erosion problems could result. Because of the nature of the abandoned mines, any regrading and revegetation could be viewed as a benefit. However, during operation proper drainage and sediment collection should be provided. Control of erosion would be especially important since this is a common problem at strip mines.

Because of the disturbed nature of the site the potential for groundwater contamination was examined closely. The disposal of sludge in a landfill would be considered a more controlled operation due to the availability of



NORTHSIDE, SOUTHSIDE and HAIKEY CREEK: Trucking, abandoned strip mine reclamation, Site R-3.

Figure 5-18 Alternative RA-6 Sites and Transportation Routes.



SCALE: 1"=5500'

Figure 5-19 Proposed Reclamation Site (R-3).

Table 5-26 SUMMARY EVALUATION OF ALTERNATIVE RA-6.

ENVIRONMENTAL PARAMETERS \ EFFECTS		BENEFICIAL	ADVERSE	LONG-TERM	SHORT-TERM	DIRECT	INDIRECT	CUMULATIVE	CONST.	IRREVERS. IRRETRIEV.	SUMMARY EVALUATION	MITIGATION MEASURES
WATER RESOURCES	SURFACE WATER				C				X		No impact with controlled runoff and drainage, groundwater protection.	
	GROUNDWATER		min.	X		X					Minimal potential with lining and capping - also monitoring wells included.	Line trenches with crushed spoil material
	FLOOD HAZARDS										Not in the floodplain	
PHYSICAL RESOURCES	GEOLOGY										No significant effect expected.	
	SOILS	maj.		X	C	X	X	X	X		Direct long-term improvement in spoil material's physical properties. Indirect cumulative benefit of Not removing any prime farmlands from production.	
	AIR QUALITY/ METEOROLOGY				C				X		No significant impact expected.	
SOCIOECONOMICS	POPULATION & LAND USE	min.		X	C	X			X		Possible future land uses of site expanded.	
	TRANS		min.	X	C	X			X		Increased local and area traffic from plants to site.	
	INSTITUTIONAL FACTORS	min.		X	C	X			X		Abandoned mines easier to utilize for reclamation than active agricultural lands, etc.	
	ECONOMICS	maj.		X		X	X				Direct increase in value of onsite land; indirect enhancement of adjacent land value.	
BIO. RES.	TERRESTRIAL FLORA & FAUNA	min.		X	C	X			X		Abandoned mines restored to productivity.	
	AQUATIC FLORA & FAUNA				C				X		No significant impact expected.	
CULTURAL FACTORS	RECREATION	min.		X		X					Dependent on end use of site, may be beneficial.	
	ODOR & INSECTS										No significant effect assuming layers are covered daily.	
	AESTHETICS & NOISE	min.		X	C	X			X		Grading and revegetation should provide aesthetic improvement.	
	PUBLIC HEALTH & SAFETY				C				X		Public access controlled for 1 year - grazing for one month.	
	ARCHAEOLOGY & HISTORICAL	min.			C	X		X	X		Any sites already destroyed by strip mining. No new lands would be disturbed.	

mitigation measures such as liners. In reclamation, however, the physical nature of the geology and spoil material and the methods of operation may assist in controlling contaminants.

In any disposal operation the potential for leachate production and subsequent groundwater pollution is dependent on the moisture content of the waste material, rainfall percolation, storm water runoff intrusion, and drainage. Sites with little standing water were considered better because it is not known whether the water in the mine trenches was runoff water or groundwater, and groundwater would be difficult to drain off. Ponding, however, may very well indicate a high level of impervious material and the site's suitability for water (leachate) retention and control. To evaluate this potential, the available data on subsurface geology was assessed with the results provided below.

The reclamation process would utilize dried sludge which provides two advantages; 1) the removal of moisture from the disposal material that could produce leachate, and 2) the removal of the liquid fraction eliminates most of the ammonia-nitrogen which readily converts to nitrate. The remaining nitrogen is in the organic form and because of the probable anaerobic condition of the layered material, it would not convert as easily to nitrate.

The other potential for leachate comes from heavy metals, however, mine spoils in the area are reported to be alkaline, and a high pH would assist in immobilizing these contaminants. The proposed strip mine reclamation site is approximately 25 mi northeast of Tulsa's center. It is in Rogers County, just southeast of Oologah Lake and adjacent and overlapping with Site LS-4. The whole potential area occupies about 10,000 acres, of which only 130 acres would be required. The environmental features of the site are described below.

WATER RESOURCES

Water resources include surface water, groundwater and flood hazards.

Existing Conditions

Surface Water. Site R-3 has a number of both active and abandoned strip mines in a rather large area. The drainage of the site is complex. Beginning in the northeast portion of abandoned mines, drainage is both west to Oologah Lake and east to Dog Creek since the mines are essentially on a ridge. In the middle of the site, drainage is both west to the Verdigris via Sweetwater Creek and east to Dog Creek. In the south, drainage is southward along Cat Creek which goes around the west side of Claremore to Dog Creek. Some drainage in the southern portion goes directly to Lake Claremore. The most important feature is that almost all the mines drain outward rather than being catch basins or drainage paths. Both Oologah Lake and Lake Claremore are municipal drinking water sources, as is the Verdigris River. Surface water occurs in the trenches of many mines. It may be either groundwater or runoff water. Because the mines are highly susceptible to erosion, the water quality may not be optimal. R-3 has very few water-filled trenches, however, because of the drainage patterns.

Groundwater. The depth to water in wells in the vicinity ranges from 2-19 ft below the land surface. Because the wells are at lower elevations, however, these depths do not necessarily represent the depth to water below the mines, which is probably much greater.

Most wells in the area have only fair to poor quality. This area is underlain by Pennsylvanian shale, siltstone and sandstone, and by Mississippian limestone and shale above the Boone chert. Most groundwater in this area is hard or very hard. Water from shale, particularly shale such as this containing coal beds, is often highly mineralized (OGS, 1971). The quality of the groundwater near the mines is not known, but it may be degraded due to leachate from spoil piles.

Flood Hazards. None of R-3 is within a flood prone area.

Alternative Evaluation

Surface Water. As in landfilling, runoff would be controlled to protect surface water. Since the last trench of abandoned mines often contains water, this might require drainage. Concern has been expressed over the contamination of surface water via polluted groundwater; however, this is not likely (see groundwater below).

Groundwater. The potential for leachate production and groundwater pollution is probably negligible depending on the exact location of the disposal area. Most of the coal-bearing formations have relatively impermeable layers below the coal. Drilling logs show a very deep (50 foot) layer of shale underneath the pits in most of the area. Depending on the particular underlying strata, there are several steps that can prevent any problems. One mitiqation measure that may prevent problems is the provision for lining trenches with worked spoil material (shale).

Flood Hazards. The site is not in or near any floodplain.

PHYSICAL RESOURCES

This heading includes the parameters of geology, soils and air quality/meteorology.

Existing Conditions

Geology. Orphan mines in Oklahoma usually consist of alternating ridges and troughs. Fifty feet usually separates the 25 ft high ridqes. Site R-3 consists of a long (5-6 mi) series of orphaned mines along a ridge, so the mines are generally at a hiqher elevation than the surrounding country.

This area is listed as Zone 2 by OGS, which means that it may locally contain bedrock units suitable for surface disposal of industrial wastes. No geologic faults are noted on available maps. Site R-3 appears to be located mostly on the Senora Formation. This formation consists of shale with thin and lenticular sandstone, minor limestone and coal. The coal seam is Crowberg or Broken Arrow Coal. This yields only small amounts of fair to poor quality water.

Soils. Because of the strip mining activities, there is no defined soil type. The spoil piles are probably composed of well-mixed shale, sandstone and the original mantle of soil stripped from coalbeds. Runoff is rapid and the areas are susceptible to water erosion (SCS, 1966).

Most abandoned mines are idle, although a few older mines support native grasses where a source of seed was near. These steep, irregularly sloping dumps of spoil are listed as wasteland by SCS in their Prime Farmland Inventory.

Air Quality/Meteorology. The site receives approximately 39 in. of precipitation annually, with the greatest amount occurring in May. The average annual temperature is 60.2°F with the first and last killing frosts generally occurring on November 2nd and March 25th. The growing season is 220 days. Prevailing surface winds in the general area are southerly during most of the year, averaging 5-7 mph.

Alternative Evaluation

Geology. There should be no effect on geologic factors.

Soils. There should be a positive effect on soils, in that the spoil is a mixture of materials that are not generally conducive to water retention, do not have a real soil-like structure, and are deficient in nutrients. The dried sludge mixed with spoil in the final cover should significantly improve its physical properties.

Unlike other alternatives, RA-6 does not remove any land from agricultural productivity providing an indirect and cumulative beneficial effect. Most orphan mines are idle and are listed as wasteland in SCS's Prime Farmlands Inventory.

Air Quality/Meteorology. There should be no measurable impact with proper operation of the site.

BIOLOGICAL RESOURCES

These include both terrestrial and aquatic flora and fauna.

Existing Conditions

Terrestrial Flora/Fauna. Most abandoned strip mines were left without any effort at revegetation or regrading. For that reason, many have severely eroded before gradually becoming revegetated over the years. Early vegetation is generally of the invasive type, such as weeds, pioneer trees and native grasses where seed is available. If left long enough (several decades) the mine may eventually return to a semi-natural state.

Aquatic Flora/Fauna. Where mine trenches are water filled, that water may be either runoff or groundwater. While some value has been reported for these ponds, those are probably the oldest ponds. Due to the highly erodable spoil piles, younger mines are unlikely to have good quality water in their trenches. Most of Site R-3 has very little water in any of the trenches, however.

Alternative Evaluation

Terrestrial Flora/Fauna. There should be a beneficial impact in that wastelands can be restored to productivity.

Aquatic Flora/Fauna. Some water filled mine trenches may be drained and filled. There should be no significant impact, however, since aquatic habitat in the mine trenches is likely to be minimal In addition, there are few water filled trenches on Site R-3.

SOCIOECONOMICS

Included here are population and land use, transportation, institutional factors and economics.

Existing Conditions

Population and Land Use. The mines are often used for light pasture. The area surrounding R-3 is extremely lightly populated and used mainly for agriculture and strip mining.

Transportation. As discussed under LS-4, the transport of Northside sludge up Route 169 may require special weight permitting. Southside and Haikey Creek sludge would travel up unrestricted Route 66.

Institutional Factors. Because the mines under consideration are abandoned, there are probably few institutional constraints, especially since reclamation is a positive and beneficial land use.

Economics. The current value of the site and adjacent lands is depressed due to the abandoned condition of the mines. Around the mines, there is very little activity that is not related to either agriculture or strip mining.

Alternative Evaluation

Population and Land Use. This alternative may have a slightly beneficial effect from the reclamation of abandoned strip mines in that the mines may be returned to some productive use rather than their current idle state.

Transportation. Because of the concern for rural roads and the load limitations on Route 169, a special permit may be required if the larger 30 cubic yard trucks are used. Presently, approximately 40 truck trips per week are expected.

Institutional Factors. Relative to the disposal methods in other alternatives, RA-6 may have a beneficial effect on institutional factors in that the City of Tulsa would be benefitting another county by its reclamation activities.

Economics. The impact on economics should be highly beneficial in that the land value of the mine and adjacent areas could be significantly increased by a good reclamation program.

CULTURAL FACTORS

Includes recreation, odors and insects, aesthetics and noise, public health and safety, and archaeological and historical.

Existing Conditions

Recreation. Recreational value is probably limited to small game hunting and fishing in area ponds.

Odors and Insects. The mines are generally isolated and at a higher elevation than surrounding lands at this site.

Aesthetics and Noise. The site is at a higher elevation than surrounding areas, so activity would not be obvious. In addition the aesthetic value of the abandoned mines is poor at present. Most of R-3 is isolated from any residential development. The major activity occurring near the site is active strip mining.

Public Health and Safety. The groundwater resources are limited and possibly highly mineralized. However, there may be groundwater connections with Oologah Lake and/or Lake Claremore. There are no airports in the vicinity of the site.

Archaeological/Historical. Any archaeological/historical sites have already been destroyed by previous strip mining.

Alternative Evaluation

Recreation. Dependent on the end use of the reclaimed area, any impacts would probably be beneficial. Reseeding to a recreational use such as parklands would be especially beneficial.

Odors and Insects. There should be no significant impact assuming layers of sludge are covered daily.

Aesthetics and Noise. There would be a highly beneficial effect on aesthetics in the long-term, since the reclaimed area would be revegetated and possibly turned into parkland or some other recreational area. There should be no significant impact with respect to noise. Most activities in the area of R-3 involve strip mining.

Public Health and Safety. There should be no impact on public health and safety as long as appropriate measures are utilized. Public access would have to be controlled for a year after closure and grazing for one month. The annual cadmium limitation for food chain crops would be exceeded, but the cumulative amount would not.

Archaeological/Historical. With respect to other alternatives, RA-6 should have a beneficial impact on archaeological/historical resources in that any artifacts on R-3 have already been destroyed by strip mining and no new lands would be disturbed. No survey would be required.

ALTERNATIVE RA-7

This alternative involves drying bed dewatering of all sludge with sale to strip mine operators for use in mine reclamation, for agricultural land application, or as a soil conditioner/fertilizer product for giveaway/sale. The evaluation below applies to any agricultural or reclamation reuse where the end use is known, and rates are controlled by cadmium and/or nitrogen loadings. This discussion does not utilize a specific marketing site, since this type of reuse is not necessarily site specific. There would be no construction impacts from the marketing portion of the alternative. It may be used practically anywhere within certain limitations and as long as rates are adjusted to site conditions. Also included is a backup method of disposal which could be any of the other four alternatives. An evaluation matrix of Alternative RA-7 is shown on Table 5-27.

The alternatives developed for sludge marketing (Tech. Memo. IV-5) focused on the beneficial reuse of sludge as a soil builder and fertilizer. However, without knowledge of specific product recipients, points or methods of distribution it is not possible to determine localized environmental impacts. Therefore, an evaluation based on a product by product comparison of a commercial fertilizer with the sludge products is a more practical approach. It provides a useful comparison of conditions which exist now, and the conditions which will occur if sludge replaced part of the commercial fertilizer market.

The Tulsa wastewater sludges in a stabilized liquid or dewatered form will have approximately 6.3 percent organic nitrogen, 0.6 percent phosphorus (as P) and 0.6 percent potassium (as K). These nutrients, along with the high organic content of sludge, make it a useful agricultural product. The comparison with a typical commercial product is provided below for the alternative evaluation. Since this type of reuse is not site specific, no existing conditions are given.

WATER RESOURCES

This includes surface water, groundwater and flood hazards.

Alternative Evaluation

Surface Water. The improper application of either product could cause contamination of adjacent surface waters through extensive loading of nutrients. There may be less potential for runoff contamination with sludge since the sludge tends to improve the soils aggregation characteristics and permeability, thus reducing runoff potential. Slope should ideally be less than 6 percent, although for injection of sludge, it may be up to 12 percent without creating excessive runoff. Drainage and permeability of the soil

Table 5-27 SUMMARY EVALUATION OF ALTERNATIVE RA-7.

ENVIRONMENTAL PARAMETERS		BENEFICIAL	ADVERSE	LONG-TERM	SHORT-TERM	DIRECT	INDIRECT	CUMULATIVE	CONST.	IRREVERS. IRRETRIEV.	SUMMARY EVALUATION	MITIGATION MEASURES
WATER RESOURCES	SURFACE WATER										No impact as long as rates controlled and nitrogen is never applied in excess of crop requirements.	
	GROUNDWATER										As above.	
	FLOOD HAZARDS										Low rate agricultural reuse is allowed to occur in the flood-plain since it poses no hazard	
PHYSICAL RESOURCES	GEOLOGY										No effect.	
	SOILS	maj.		X	0	X	X	X			Organic matter improves soil texture, etc. As long as cadmium limitations are not exceeded, impact may be major beneficial. No prime farmlands removed from production.	
	AIR QUALITY/ METEOROLOGY										No effect since the sludge is replacing commercial products.	
SOCIOECONOMICS	POPULATION & LAND USE										No impact.	
	TRANS		min.	X		X					Minor adverse effect since sludge has a greater volume to transport than commercial products.	
	INSTITUTIONAL FACTORS										No effect as long as all regulations followed.	
	ECONOMICS										No significant impact expected.	
BIO. RES.	TERRESTRIAL FLORA & FAUNA										No significant effect.	
	AQUATIC FLORA & FAUNA										No effect; rates controlled so that nutrients do not enter surface water.	
CULTURAL FACTORS	RECREATION										No impact expected.	
	ODOR & INSECTS										A well-digested dried sludge has little odor or insect attractant value.	
	AESTHETICS & NOISE										No significant effect expected.	
	PUBLIC HEALTH & SAFETY										No impact expected as long as regulations are followed.	
	ARCHAEOLOGY & HISTORICAL	min.			c	X					Existing agricultural and reclamation operations used so no new sites opened or disturbed.	

SUMMARY EVALUATION KEY FOR TABLES 5-23 THROUGH 5-27

Impact	Meaning
BENEFICIAL	Impact is positive.
( ) no impact	Impact, if any, is not large enough to be significant and/or discernable.
(min.) minor	Impact is small but discernable. In some cases, it may be the lack of a common negative impact.
(maj.) major	Impact is highly significant, adds positive factors to the alternative.
ADVERSE	Impact is negative.
( ) no impact	Impact, if any, is not large enough to be significant and/or discernable.
(min.) minor	A small but discernable impact, probably mitigatable, that should be noted but is unlikely to affect the alternative significantly.
(maj.) major	An impact which is significant enough that it could affect the alternative. In some cases, it may be an unmitigatable adverse impact or it may be one which is mitigatable only by drastic changes in the alternative.
LONG-TERM	Duration of impact is permanent or indefinite.
( ) none	Not long-term or no impact.
(x) present	Impact is long-term in duration.
SHORT-TERM	Duration of impact short-term and temporary.
( ) none	Not short-term or no impact.
(C) construction	Short-term impacts may be either construction or operation related. Construction related impacts occur for the short-term and are described at the end of this section.
(O) operation	Operation related impacts occur in some alternatives where construction-like activities may cause short-term effects.
DIRECT	Impact occurs in direct response to action.
( ) none	Not a direct impact.
(x) present	Impact occurs as a direct result of the action. Example: groundwater pollution which occurs below a waste disposal site.
INDIRECT	Impact occurs indirectly, but in response to an action.
( ) none	Not an indirect impact.
(x) present	Impact occurs as an indirect result of the action. Example: surface water pollution which occurs because the surface water was interconnected with groundwater which become polluted directly.
CUMULATIVE	Additive impacts. May only be signficant when in combination with another impact.
( ) none	Not a cumulative impact.
(x) present	Impact is additive with another impact.
CONST.	Construction related impacts such as noise, dust, etc.
( ) none	Construction does not affect parameter.
(x) present	Construction activities do affect parameter. Impacts are described at the end of the section under "Construction Impacts".
IRREVERS/IRRESTRIEV.	Irreversible and irretrievable commitments of resources caused by the action.
( ) none	
(x) present	There are irreversible/irretrievable committments.
(poss.) possible	There is a possibility that source irreversible/irretrievable committment of resources may occur.

should be moderate also. If it is assumed that good agronomic practices will be followed with either fertilizer, there should be no significant impact.

Groundwater. Both nutrient products are applied to the land at rates compatible with the required crop nutrient uptake rate. The general limiting factor is the nitrogen content. In sludge, the majority of the nitrogen is organic with the remainder in the ammonium phase. An advantage of sludge is that it acts like a slow release fertilizer, with the ammonium nitrogen providing an initial input of nutrient at the time of application while the organic nitrogen remains bound in the soil providing a long term release.

A commercial product, such as anhydrous ammonia, does not have the residual organic nitrogen found in sludge. In the event of a long rainfall, the converted ammonium-nitrogen (nitrate) in the commercial product could be carried through the soil to the groundwater. The sludge organic nitrogen is more likely to remain in the soil, where it is usable by the plants. This would be more pronounced in sandy soils.

In addition, EPA's regulations on land application are designed to prevent the contamination of groundwater by heavy metals by utilizing the soil's capacity to retain them. There should be no impact as long as rates are controlled so that nitrogen and/or cadmium do not exceed set limits or crop needs.

Flood Hazards. The only stipulations for the reuse of sludge in a floodplain involves the physical restriction of a stream or river's flow capacity to handle a 100 year storm. This is the same for both commercial fertilizer and sludge and is not expected to have any significant impact on flood hazards. Since the sludge is to be incorporated into the soil, there will probably be negligible effects of sludge application on floodplain soils.

PHYSICAL RESOURCES

These include geology, soils and air quality/ meteorology.

Alternative Evaluation

Geology and Soils. With respect to soils, there are several major differences between the use of sludge and commercial fertilizers. First, sludge provides a number of micronutrients required for plant growth and/or desirable from the standpoint of consumers of the crop. These are not generally contained in commercial products. Sludge also contains heavy metals which are not contained in commercial fertilizer. The application rate limits for sludge were established by EPA to take into account the soil characteristics and their relation to heavy metals. For example, the soil pH, if not naturally high, must be maintained at 6.5 or higher since heavy metals tend to be held in the soil at a higher pH. Another factor is the soil depth, which should be at least 2 feet to bedrock and to seasonal high groundwater in order to provide enough soil interface to retain the heavy metals.

The soil Cation Exchange Capacity (CEC) is related to the soil's capacity to retain metals, so the cumulative loading rates for sludge, at a soil pH of 6.5 or greater, are dependent on the CEC of the soils at a specific site. This must be determined prior to application.

Because EPA's regulations are designed to use the soil's binding capacity to prevent the excessive uptake of heavy metals by crops, there should be no significant difference between the use of sludge and commercial fertilizer, provided good agronomic practices, proper site conditions and proper sludge loading rates are followed. The primary difference will be that sludge will improve the physical characteristics of the soil and provide micronutrients in which the soil might be deficient. There may be a highly beneficial impact on soils as long as food chain cadmium limits are followed for prime farmland soils and pasture crop cadmium limits for strip mines and non prime soils. This is due to the organic matter in the sludge which can improve soil tilth and productivity. Cadmium limitations for food chain crops should not be exceeded for prime farmlands. As long as the most stringent regulations are followed when applying sludge on prime farmlands, no effect should occur.

Air Quality/Meteorology. The potential effect on air quality from sludge or commercial fertilizer is related to dust from the application of either product and is dependent on dryness of the soil. For a liquid or dewatered sludge with incorporation into the soil, this effect should be negligible.

BIOLOGICAL RESOURCES

These include terrestrial flora/fauna and aquatic flora/fauna.

Alternative Evaluation

Terrestrial Flora/Fauna. As discussed under groundwater, the application of either a commercial or sludge derived fertilizer will depend on the nitrogen loading requirements for the specific crop to be grown. Both products contain other nutrients important to plant growth specifically phosphorus and potassium, whereas sludge also has a relatively high organic content and introduces micronutrients not generally found in commercial fertilizer. The organic or carbon portion of sludge is highly beneficial particularly in poorer sandy or clay soils, because it improves the soil's texture and water retention capabilities. The micronutrients found in sludge, such as zinc and copper are essential since crops grown on soils that are depleted of these micronutrients exhibit a decreased crop yield.

Some restrictions exist regarding the access to lands upon which sludge has been applied. Sludge for land application must be treated to the level of a "Process to Significantly Reduce Pathogens" (PSRP), as stipulated under 40 CFR 257.3-6. At this level, public access to the site must be controlled for 12 months, and grazing by animals whose products are consumed by humans are restricted for one month. Commercial fertilizers are not subject to this restriction.

It should be noted that game animals cannot be restricted for the required period. However, it is unlikely that these animals will obtain their entire diet from sludge amended fields, or that they will contribute a significant portion to the human diet.

If it became necessary to avoid any access restrictions, a "Process to Further Reduce Pathogens" (PFRP) can be used, producing a sludge derived fertilizer comparable with a commercial product in terms of pathogens. In terms of prime and unique farmlands classifications, this evaluation assumes the most restrictive application rates for sludge, so there should be no significant impact on the classification of these lands.

Aquatic Flora/Fauna. Because of the influx of excessive nutrients, the improper application of either type of fertilizer can cause contamination of adjacent waters by runoff. Sludge, because of its organic content, can reduce the water's dissolved oxygen level to a greater extent than a commercial fertilizer. There should be no discernable effect, however, since rates would be carefully controlled and nutrients would not enter surface waters.

SOCIOECONOMICS

This includes the factors of population and land use, transportation, institutional factors and economics.

Alternative Evaluation

Population and Land Use. Since the most restrictive rate for application of sludge is assumed throughout the evaluation, no land use impacts are expected. Further, the Southside and Haikey Creek sludges are nitrogen limited for most types of crops, so the total cadmium application will be less than the allowable rates. Because of this, it is unlikely that any adverse effects on land use will occur due to the use of the sludge.

Transportation. Specific transportation routes cannot be evaluated until specific users have been determined. In general, a larger number of trucks would be used to transport sludge than would be used for commercial fertilizer, based on the sludges' greater volume. In addition there is the potential for accidental spills in transporting either one.

Most of the travel can be expected to occur on a seasonal basis and is dependent on weather, the type of crop, and cultivation schedules. It may be desirable for application trucks to use high flotation tires to prevent soil compaction of fields. These tires do not travel well for long distances on roads, however. For this reason, it is desirable to keep application sites as close as possible to the origin of the sludge.

No hauling restrictions pertaining specifically to sludge transportation are contained in the State of Oklahoma's "Size and Weight Statutory Requirements and Department of Safety Rules and Regulations", July 1981.

Institutional Factors. County and local ordinances such as zoning laws may affect the sale of sludge for land application in some counties. Osage and Rogers counties, for instance, have zoning and solid waste plans affecting sludge use. The practical effect of local and county land use regulations should be evaluated for specific sites. Local nuisance laws would probably apply only if the sludge application caused odor or noise problems for nearby homes or businesses, however, such problems would be unlikely in a rural, commercial agriculture area.

Economics. The total tonnage of available nitrogen generated by the Tulsa area wastewater treatment plants, (266 to 472 dry tons per year) will only comprise 1.0 to 2.0 percent of the present nitrogen market in the area (Tech. Memo. IV-5). Because of this, the economic impacts in the sales of commercial fertilizer and associated labor market from a sludge reuse program will be minimal.

While the application of the sludge requires more energy than does commercial fertilizer, the commercial product consumes greater amounts of energy during production. In addition, the sludge is sold in close proximity to its point of origin, while the commercial products generally are distributed nationally and are more energy intensive in that respect.

CULTURAL FACTORS

This includes recreation, odor and insects, aesthetics and noise, public health and safety, and archaeological and historical factors.

Alternative Evaluation

Recreation. Based on the Marketing Survey (Tech. Memo. IV-5), parks, golf courses etc. had a low level of interest in a sludge derived soil additive.

Odors and Insects. One of the advantages of sludge over a commercial product for agricultural use is organic content of the sludge. However, the organic content can also cause an odor problem if the sludge is left uncovered and decomposition continues. To alleviate this problem, the sludge product, whether in a liquid or dewatered state, must go through a process of stabilization. Stabilization converts the volatile organics reducing the odor potential of the sludge, as well as reducing the pathogens.

The major limiting factor to odors produced by land applying sludge results from incorporating the product into the soil. A primary purpose of this procedure, however, is to prevent the loss of nitogen. When sludge is applied to the land surface, approximately 50 percent of the ammonium-nitrogen is lost to the atmosphere through volatilization. This reduces the sludge's available nitrogen from 3.2 percent to 2.4 percent (Tech. Memo. IV-5). Incorporation of the sludge into the soil alleviates both the odor problem and the potential loss of nutrient value.

Aesthetics and Noise. The aesthetic effects are site specific in nature, and cannot be evaluated here. The concern of odor production from the use of sludge is discussed separately (see above). Essentially, aesthetics impacts from sludge should be no different than those from commercial fertilizer.

A specific evaluation relating to the effects of noise on adjacent land is not possible at this time. However, the expected areas of use and methods of application for a sludge derived soil additive will be comparable to a commercial product.

Public Health and Safety. Prior to application, the sludge must undergo "A Process to Significantly Reduce Pathogens" (PSRP) such as aerobic or anaerobic digestion. Some of the pathogenic organisms may still be viable after stabilization, however, so the access to the site must be restricted as discussed previously. Using either this method or "A Process to Further Reduce Pathogens" (PFRP) such as heat drying, composting, etc., there should be no more impact from sludge than from the use of commercial fertilizers.

As an extra measure of precaution, the sludge should not be applied on growing vegetables or other crops which are consumed directly without processing because sludge particles may adhere to the crop and might be directly ingested. The sludge should instead by applied prior to or at the time of planting and should be injected or incorporated into the soil.

5.3 CONSTRUCTION IMPACTS

Most of the alternatives for both wastewater and residuals management involve some types of construction impacts. Usual types of impacts include siltation of local surface waters as a result of erosion from disturbed and denuded areas and settling of fugitive dust. Soils may be compacted and disturbed during excavations and general construction and operations, mixing the topsoil and soil horizons. Air quality may be affected by fugitive dust and increased truck and machinery traffic.

Onsite vegetation is generally destroyed, and dust may settle on nearby vegetation, reducing photosynthesis. Terrestrial organisms may be displaced or killed directly, while aquatic organisms may be indirectly affected by siltation of surface waters.

Construction impacts generally also include temporary effects on transportation due to increased local truck traffic and occasionally some negative effects on local population and land use. The increased traffic may result in higher noise levels and a greater possibility of accidents. These impacts are summarized on Table 5-28.

5.4 RARE, THREATENED, AND ENDANGERED SPECIES

Bird Creek

No Federally endangered species are known to inhabit the immediate vicinity of Northside or along Bird Creek below Northside. It is possible, however, that endangered bald eagles (Haliaeetus leucocephalus) could occasionally visit the local riparian communities. If this does occur, they are protected by Federal law, making it unlawful to harass, harm, capture or kill them. The American peregrine falcon (Falco peregrinus anatum) is also listed as endangered and could pass over the area. Neither bird inhabits the area at this time, however.

The Eskimo curlew (Numenius borealis) was at one time very common in fields and pastures in Oklahoma, but is now listed as endangered. It is unlikely to be sighted.

Another bird of interest is the greater prairie chicken (Tympanuchus cupido), which occurs in the remnant tall grass prairie, located southeast of the Northside Treatment Plant. This bird is rare in Tulsa County but abundant in neighboring Osage County, where limited hunting is allowed. Several other birds are not Federally listed but are considered to be rare in Oklahoma. These are the prairie falcon, white-faced ibis and the ferruginous hawk (Department of Wildlife Conservation). These may infrequently be seen in the area.

Of the endangered mammals, only the Indiana bat (Myotis sodalis) could potentially occur in this area. It is not likely, however, since its range is primarily to the east of Oklahoma.

A rare mammal in the Tulsa area is the swamp rabbit (Sylvilagus aquaticus), although it is not necessarily rare elsewhere. Its habitat has been reduced

Table 5-28 SHORT-TERM CONSTRUCTION IMPACTS

Parameter	Potential Impacts	Comments	Mitigation Measures
WATER RESOURCES			
Surface Water	minor negative (localized)	Runoff from disturbed lands is high in sediment and could increase the turbidity of adjacent waterways.	Provide diversion berms along site periphery. Onsite drainage collection in siltation basins is required.
PHYSICAL RESOURCES			
Soils	minor negative (localized)	Localized compaction, disturbance and mixing of topsoil and soil horizons in excavation.	On prime agricultural lands, disturbance should be minimized as much as possible. Where appropriate, segregate and retain topsoil and soil horizons.
Air Quality	minor negative (local & areawide)	Localized fugitive dust impacts from increased truck and machinery traffic locally and in the general area.	Hold disturbed lands to a minimum. Utilize water trucks to keep fugitive dust down.
BIOLOGICAL RESOURCES			
Terrestrial Flora/Fauna	minor negative (localized)	Destruction of onsite vegetation and loss of soil stability would increase dust and runoff problems. Displacement of fauna.	Regrade and reseed site as soon as possible. Protect soils as above. Reduce fugitive dust by water spraying.
Aquatic Flora/Fauna	minor negative (localized)	Siltation may adversely affect aquatic life.	As in surface water.
SOCIOECONOMICS			
Transportation	minor negative (local & areawide)	Temporary increase in local truck traffic.	Off peak hours should be used. Truck size should match legal street load limitations.
Population and Land Use	minor negative (adjacent)	Nearby residents & other sensitive land uses may be adversely affected by construction noise, dust, traffic, etc.	Buffer zone around sites. Existing rights-of-way and easements should be used for pipelines.
CULTURAL			
Aesthetics and Noise	minor negative (local & areawide)	As above.	Buffer zone.
Public Health and Safety	minor negative (local & areawide)	May be increased possibility of accidents both from increased traffic & construction activities.	
Archaeological/ Historical	possible negative	Clearance must be obtained; presence of sites may delay construction.	Prior check for existing sites; flexibility in specific site.

through channelization, flood control projects and agricultural projects impinging on the riparian habitat.

Two reptiles are also considered rare in the Tulsa area: the map turtle (Graptemys geographica), found in aquatic habitats; and the scarlet snake (Cemophora coccinea) (Couch, 1977).

Several plants are considered to be rare in the study area, especially some of those found in the Red Bud Valley Preserve and along the limestone bluffs of lower Bird Creek. However, none of these are listed as endangered in the U.S. Federal Register.

It is not expected that any of the terrestrial species will be affected by either the No Action, Out-of-Basin Transfer, or AWT alternatives. Only semi-aquatic species or species that utilize the stream might be affected. Species such as the bald eagle, the white-faced ibis, and the map turtle would probably not be significantly affected by No Action but might be slightly benefitted by the improved water quality from Out-of-Basin Transfer and AWT alternatives. This would be indirect; through an improvement in the fish population numbers and diversity.

Sensitive or Unusual Areas. Several sensitive or unusual areas exist within an approximately two-mile wide area that follows the last mile of Mingo Creek and the last 13 miles of Bird Creek. Their special nature is explained in the text that follows, focusing on the remnant tall grass prairie, the Red Bud Valley Nature Preserve, and the local limestone cliffs. Additional areas of interest are also mentioned due to their regional proximity.

- Remnant Tall Grass Prairie - A stand of tall grass prairie is located immediately north of Interstate 244, between Garnett Road and 149th Street East. It provides habitat for the greater prairie chicken, a bird whose population numbers have severely declined in the last 50 years. It also provides a glimpse of a plant association that was once dominant in the greater Tulsa area.

* Red Bud Valley Nature Preserve - The Red Bud Valley Nature Preserve is located along lower Bird Creek in the SW 1/2 of the SW 1/4 of Section 10 and the east 1/2 of Section 15, T20N, R14E. It covers approximately 80 acres and contains a unique array of habitats, including cliffs, caves, and springs. A particularly important habitat is the north-facing limestone bluff, which borders the Bird Creek floodplain. This area supports a disjunct community that is normally found in the Ozark region of northeast Oklahoma. The vegetation in this community includes walking ferm (Camptosarus rhizophyllus), Jack-in-the-pulpit (Arisaema atrorubens), Dutchman's britches (Dicentra cucullaria), American smoke tree (Cotinus obovatus), sugar maple (Acer saccharum), blue ash (Fraxinus quadrangulata) and American columbine (Aquilegia canadensis).

  The preserve is owned by the Nature Conservancy and entrusted to the University of Tulsa. It is located 12 miles from downtown Tulsa and is frequently used as an outdoor laboratory by youth groups and students.

* Limestone Bluffs - Most of the limestone bluffs along the lower Bird Creek floodplain are considered unique. They provide valuable habitat for disjunct populations of upland forest deciduous forests that are not typically found further west. They also provide excellent wildlife habitat due to their quality as an ecotone, or ecological transition area.

* Other Areas of Interest - Additional sensitive areas are located in Mohawk Park, the Arkansas River below Keystone Dam, and the bald eagle wintering area near Keystone Lake. All of these areas have been studied and are protected to varying degrees. While there are likely to be some wetlands in northeastern Oklahoma, the State has not completed a survey or inventory, so identification must be on an individual, site-specific basis. No wetlands were noted in the Bird Creek study area.

It is not expected that any of the above areas would be measurably affected by the No Action, Out-of-Basin Transfer or AWT alternatives.

Residuals Solids Disposal Sites

As discussed above, several species of both Federally and State listed rare, threatened, and endangered species may potentially occur in northeast Oklahoma. None of these have been specifically recorded from the vicinity of LF-1, LS-4, or R-3, but in general the same species may be potentially present. Although not officially listed, one unique and rare species of fish, the Kiamichi Shiner, may be present in the Verdigris River near Oologah Dam.

In general, none of the alternatives, RA-1, 3, 5, 6 & 7, should affect any aquatic species if appropriate measures are utilized to prevent water pollution, siltation, etc.

With respect to terrestrial species, none of the sites are well enough defined so that specific sections of critical habitat can be defined. When a definite site is selected, the U.S. FWS, the Department of Wildlife Conservation, and the Office of Endangered Species should be contacted, so that any critical habitat, wetlands, etc. can be avoided.

5.5 ALTERNATIVES AVAILABLE TO EPA

Based on final review and approval of the 201 Facilities Plan and EIS, EPA has several available options. These options are discussed below along with the impacts they might be expected to have.

1) Appropriate funds for the remaining Step 3 portions of the Grants Program for the preferred management alternatives.

   This option would provide the Grantee with the necessary funding to meet the Administrative Order as well as the State Water Quality Standards and permit requirements.

2) Award funds based on a modified alternative or approach to the project's implementation.

3) Denial of further grant funds.

   This could postpone the implementation of improvements to wastewater treatment at the Northside plant, but the Grantee would still be responsible for implementation.

   This would postpone the implementation of an area-wide residuals solids management plan. Sludge would continue to be disposed and stored until the point where no more space is available. Some form of permitted disposal would be required.

5.6 ALTERNATIVES AVAILABLE TO OTHERS

The State of Oklahoma maintains a funding program for public works projects. Grants are awarded based on a priority system. In that system, secondary treatment plant projects are given priority over AWT projects. How is funding relates to the Residuals Management Plan has not been established, but the availability of these funds has been taken into account through the phasing approach to implementation.

In June of 1982, the Oklahoma State Department of Health sent out revised solid waste regulations. These regulations control the handling, disposal, and reuse of sewage sludge, and will require permitting of any facilities.

The Oklahoma Water Resources Board is presently reviewing the State's Water Quality Standards. Changes in the regulations that result in reclassification of Bird Creek could affect its water quality and beneficial use designations. This review process has not been completed at the time of this writing, however.

The Army Corps of Engineers is presently in the process of constructing a reservoir on Hominy Creek, a tributary of Bird Creek. One potential use of excess available water stored in this reservoir is for flow augmentation to maintain good water quality during low-flow conditions, however, this is not expected to be allowed by the State. The reservoir has not been completed and no completion date or schedule has been set at this time.

Chapter 6

CHAPTER 6
COORDINATION
(Including EIS Mailing List)

6.1 PUBLIC PARTICIPATION ACTIVITIES

The purpose of this section is to summarize the public participation program that was conducted as a part of the Facilities Planning process and EIS. The program included general public involvement as well as participation through a citizens' group or Public Advisory Committee (PAC).

Public information activities included the development of a mailing list, mailing materials, preparing a fact sheet, obtaining media coverage, conducting workshops, publishing briefing papers, presenting slide shows, and preparing and distributing meeting notices, holding public meetings, and maintaining a depository for project documents.

INFORMATION DISTRIBUTION

A mailing list including the names of approximately 100 persons and 90 organizations was developed and used during the project. This list includes the names of the project's Public Advisory Committee (PAC) members, and may be found at the end of this Chapter. Notices of the first and third public meetings were mailed to persons and organizations on the mailing list. The notice of the second public meeting was distributed with City utility bills. A letter of invitation was sent with the notice of the third public meeting to groups who had viewed the slide show. Utility bills were also used in mailing a questionnaire requesting information on infiltration/inflow.

Monthly and sometimes semi-monthly mailings have been made regularly through the project for all PAC members and have contained the minutes of the previous meeting, announcements and agenda of the next meeting, as well as any other notices. Information and notices of meetings have also been mailed to agencies directly concerned with the project's planning process, including EPA; the Oklahoma State Health Department; the Indian Nations

Council of Governments (INCOG); the Corps of Engineers, Tulsa District; and the Tulsa City-County Health Department.

Early in the process fact sheet describing the project was prepared for use by the media. The Tulsa World and the Tulsa Tribune have provided continuing newspaper coverage, including news stories, editorials, public notices, and one letter to the editor about the project. Generally, the news stories and notices have appeared before and after a public meeting or at critical points in the plan's development, e.g., the identification, screening, and selection of alternatives and project cost estimates.

Several stories and an editorial were written about the impact of the Cherokee Industrial District on the capacity of the Northside Plant. A news story, including a map, was published in July 1981 about alternative sludge disposal sites. News stories also appeared in the Verdigris Valley edition of the Tulsa papers, reporting concern on the part of the Rogers County Commissioners and the director of the Claremore-Rogers County Metropolitan Area Planning Commission over the selection by Tulsa of a strip mine area in Rogers County as a land reclamation site to be reclaimed through the combined use of sludge and mine spoils. Items appearing in the newspapers are included in the public participation documentation report. Notices of public meetings were also sent to the media.

Television coverage was provided at some of the public meetings. There have also been television interviews with the consultants and the staff, as well as news stories about the Northside Plant, its expansion, how wastewater is now treated, the alternative treatment processes by which the required effluent quality for the Northside Plant can be achieved, and the alternatives for meeting sludge disposal needs and requirements including the opposition in Rogers County to the proposed use of strip mines in Rogers County for reclamation sites.

An orientation workshop for PAC members was held in March 1980 by the Department. In January 1981, the Department, together with CH2M Hill, engineering consultants for the project, held a workshop to inform industries about current regulations pertaining to industries directly discharging industrial wastes into the public sewer system. This workshop was attended by 180 persons. A second workshop, on financing of Tulsa's industrial waste program, was held on November 3, 1981. It was attended by 15 persons.

Four briefing papers have been published to date for the purpose of aiding the public's understanding of the need for improvements at the Northside Plant and for management of residuals solids. These papers provided background information on the project, described the data and the criteria used in developing and evaluating the alternatives, and provided cost information on the alternatives selected for final consideration. A fifth briefing paper describes the plan. These papers have been distributed at public meetings, mailed to persons and groups on the mailing list, and delivered to the media and interested officials.

A slide show was produced for the project identifying needs and discussing alternatives to encourage public participation in the decision-making process. Ninety organizations were telephoned requesting program time for the project's public participation coordinator to present the show at one of their meetings. Twenty-three presentations were scheduled from mid-December 1981 through April 1982.

A total of 760 persons viewed the slide show at the meetings. Questionnaires were utilized at each of the showings as a means of collecting public opinion data regarding wastewater and sludge disposal management alternatives. The slide show presentations, therefore, served to provide information to the public and also as a means for consulting members of the public regarding their opinion of the alternatives.

Notices of all project public meetings have appeared in both Tulsa newspapers. In addition to news stories about the meetings, one-page notices of each meeting containing project information have been widely distributed. Public service announcements of each public meeting were sent to all radio stations.

PUBLIC INPUT

Methods utilized to obtain information from the public include questionnaires, the Public Advisory Committee, public meetings, meetings with officials, agency representatives, and a public hearing.

Questionnaires were used to obtain industrial waste discharge data, information on the location of overloaded sewers, and public opinion regarding the proposed wastewater and sludge management alternatives, as well as to evaluate the first and second public meetings.

In the summer of 1980, a questionnaire was sent to 1800 industries requesting information on types and amounts of industrial waste directly discharged into the public sewer system. Responses were received from over 60 percent of those contacted. This data was then used in developing Tulsa's industrial waste pretreatment program.

In March 1981, a questionnaire briefly outlining the Facilities Planning process was distributed with the City's utility bills to 125,000 customers requesting information on backed-up sanitary and storm sewers. The Department received 5,000 completed questionnaires. This information was used in identifying places where groundwater or rain seeps into the sewer system, causing overloading of the system. These data were used in projecting flows and determining sewer sizing.

Questionnaires on wastewater and sludge disposal alternatives were distributed at slide show presentations and were completed by 107 members of a variety of organizations at which the slide show was presented. Initially, four categories of wastewater alternatives were listed in the evaluation questionnaire. As alternatives were screened by the consultants, two of these categories were dropped and the evaluation questionnaire was revised accordingly. The two wastewater alternatives were (1) advanced treatment with continued discharge into Bird Creek, and (2) secondary treatment with discharge into the Arkansas River at a point in the vicinity of the Haikey Creek treatment plant. Twice as many people (86) were of the opinion that continued discharge into Bird Creek was acceptable or very acceptable as compared with 43 persons who regarded discharge into the Arkansas River as acceptable or very acceptable.

Regarding the four sludge disposal alternatives, 90 of the 107 persons regarded agricultural reuse as acceptable or very acceptable, followed closely by 88 persons who so regarded sludge use for site reclamation. However, a greater number of persons (68) regarded agricultural reuse as very acceptable as compared with 52 persons who believed site reclamation was very acceptable.

Opinion was evenly divided regarding dedicated land disposal and landfill, with 65 and 67 persons, respectively, regarding these alternatives as acceptable or very acceptable. However, with respect to both of these alternatives, more people regarded them as acceptable rather than very acceptable.

Of the 39 persons attending the first public meeting, 3 completed questionnaires. Of the 36 persons attending the second public meeting, 16 completed questionnaires. The evaluation obtained from these is incorporated in the response summary for these meetings, included in the Department's public participation documentation report.

A Public Advisory Committee (PAC) for this project was officially appointed in 1979, it consisted of 40 persons equally representing four categories of the public – public officials, public interest groups, private citizens, and economic interest groups. The purpose of the PAC is to review, comment, and recommend to the City's Water and Sewer Department's staff on the plan and its development, to help keep the public informed on the plan, and to bring community concerns and opinions to the Department's attention.

Since its first meeting on August 21, 1979, 33 months ago, the PAC has met 33 times through April 1982 and it will meet several more times before the project is completed. Almost half of the original members are still serving on the Committee; the others were replaced as vacancies occurred to maintain the balance of public representation.

Prior to the execution of the contract for the project, the PAC was involved in finalizing the scope of work, particularly with respect to the environmental impact statement. Also during this time, subcommittees were established, and available data (population and physical characteristics) were reviewed and reported in Committee.

Since October 21, 1980, when work on the project started, the PAC has reviewed and commented on all reports, programs, and schedules that have been produced for this project. To date (April 1982), this includes 33 published technical reports of varying degrees of complexity. Copies of the reports were distributed at the PAC meetings and were mailed upon request. Reports were summarized by the consultants at the meeting at which the reports were distributed. Sometimes several reports were presented in one meeting. Reports were assigned by the PAC chairman to subcommittees or the Committee as a whole for review and recommendation, to be reported upon at the following meeting. Questions resulting from review of reports were generally resolved by staff or the consultants during the meeting. Questions that were not readily resolved have been identified as issues. They are described in a later subsection of this report. Comments obtained were generally noted in subsequent technical reports prepared throughout the course of the project.

Four public meetings on this project have been held. The first held prior to contract negotiation on May 15, 1980, was called by EPA for the purpose of finalizing the scope of the "piggyback" environmental impact statement.

After work started on the project, three public meetings were held as follows: (1) April 7, 1981 to introduce the project and discuss its financial impacts, 39 persons attended; (2) November 18, 1981 to describe the alternatives, 39 persons attended; and (3) April 2, 1981 to describe and discuss the selected alternatives, 37 persons attended.

Meetings with the Utility Board and the City Commission were held on April 9, 1981, November 18, 1981, and April 7, 1982 for the purpose of informing these decision makers of the plan's progress and development and to seek their opinions. A separate meeting was held with the City Commission on

April 13, 1982 to describe the small array of alternatives prior to the selection of the final alternatives. In addition, two work sessions were also held with PAC representatives and decision makers to explain the PAC's concern that the Northside Plant's planned treatment capacity did not adequately allow for potential growth in the Cherokee Industrial District and the impact on the Grantee's finances, if expansion at the plant must be made without benefit of Federal funds. As a result of these meetings, an agreement was reached to increase the Northside's projected flows on the basis of an assumed level of development of the Cherokee Industrial District during the planning period.

A public hearing will be held in September 1982 on the final Facilities Plan and the sludge management plan.

ISSUES AND COMMENTS

Identified by the PAC

Questions and comments (as differentiated from issues) made by the PAC focused on (1) sampling procedures for dry-weather I/I and for sludge quality and (2) the scope of the downstream baseline environmental assessment. Some PAC members said they believed that (1) the original screening brainstorming sessions should have involved the PAC together with the technicians and professionals, and (2) evaluation of the alternatives reflects too much emphasis on present worth estimated cost and not enough on environmental issues.

Issues identified by the PAC are summarized as follows:

- Impact of development in the Cherokee Industrial District on the plant's treatment capacity.
- Adverse impact on prime agricultural land (Mason soils) with respect to:
    - using past growth trends in facility planning, thus perpetuating southerly and southeasterly development and its encroachment on prime agricultural land

- its use for sludge disposal sites

- Difficulty in obtaining sludge disposal sites within Tulsa County (most the alternative sites are located outside Tulsa County).

- Possible adverse impact of sludge disposal failsafe alternatives on water supplies.

- The desirability of agriculture reuse of sludge in spite of unstable market conditions.

- Concern for environmental impacts of breakpoint chlorination.

- Implementation priorities at the Northside Plant. Should plant capacity be constructed before wastewater treatment improvements are made or vice versa?

Comments From Civic Organizations

Comments received from persons attending slide show presentations as to what the City should do are summarized as follows:

- Provide for more information, particularly cost and financing information, including amortization of costs and the effect of these costs on millage rates.

- Stop industry from discharging untreated industrial wastes directly into the public sewer system.

- Sale or give away of sludge should be considered. Utilize methane gas for fuel for pumps, compressors, etc.

- Make printed brochures available explaining alternatives in laymen's language.

- Expensive delay should be avoided.

Comments with respect to how the slide show could be improved indicated that it was well received and regarded. Several wanted more time for discussion. A few complained that it was hard to hear the tape and speaker. Many said more information was needed.

Comments and Questions From Public Meetings

Comments made and questions asked at public meetings are included in the Department's public participation documentation report.

Comments from the Utility Board and City Commission

With respect to both the selected wastewater and residual solids management alternatives, the Utility Board voiced concern about the financial impact on the City of a project of this magnitude and agreed that implementation should be phased in order to spread the financial burden over as long a time period as practical. The Board was also concerned that nothing be built in the early stages of the project's implementation that might have to be abandoned at a later time because of possible changes in Federal or State requirements for the Northside Plant (April 21, 1982 meeting). At its meeting of April 23, 1982, the City Commission also expressed concern regarding the project's financial impact on the City and the need for phasing project implementation over a period of time.

RESPONSES BY THE WATER AND SEWER DEPARTMENT

The Department responded to comments received from persons seeing the slide show by referring the comments to the consultants for their consideration during the development and selection of the alternatives.

Comments from the Utility Board and City Commission were reflected in the recommendations officially adopted by each and are contained in Tech. Memo. III-8, pages 20 through 22.

Responses by the Water and Sewer Department to issues raised by the PAC have resulted in the following actions:

- Impact of the Cherokee District issue. Projected flows were increased assuming a certain level of development at Cherokee Industrial District.

- Prime agricultural land issue. EPA has mandated the procedure for projecting population for facility planning purposes, and Tulsa is obliged to use this method, in spite of its effect on the perpetuation of growth to south and southeast Tulsa. With regard to the use of Class 1 soils for sludge disposal sites, sites containing these soils are to be considered only if no other alternative is possible.

- Out-of-county sludge disposal sites. The political problems are recognized by Tulsa City and County officials, and efforts are being made to make a more intensive search for sites in Tulsa County, to develop other disposal alternatives, and to work with officials in other counties in an effort to find mutually satisfactory solutions.

- Agricultural reuse. Because of strong public support for this alternative, sludge drying methods were changed from mechanical, which was first recommended, to the use of drying beds which results in a product easier to handle. Also, a "failsafe" alternative has been selected as a backup for such time when the market cannot absorb all the sludge produced.

- Breakpoint chlorination. Because of the PAC's strong concern over this alternative, the next most cost-effective alternative was selected using biological filtration as the AWT process.

- Scheduling of construction at the Northside plant. The final plan will include scheduling recommendations.

RECOMMENDED FINAL ALTERNATIVES

The process by which the final alternative was recommended for both wastewater and residual solids management is generally described as follows:

- preparation by CH2M Hill of reports describing their detailed analysis and generalized cost estimates of each of the small array of alternatives

- preparation of reports by CDM describing their assessment of the environmental impact of each of the small array alternatives

- review and discussion of this analysis and assessment by the PAC as a whole at its March and April meetings

- review by the Utility Board at its April 7, 1982 meeting

- formulation by the TWSD staff at a April 15, 1982 meeting of its recommendations to the Utility Board and the City Commission to adopt MA-16 and RA-6 as the final alternatives

- review by the PAC at its April 20, 1982 meeting of the staff's recommendations

- adoption by the PAC at the above meeting of motions that the PAC recommend MA-16 and RA-6 as well as of a motion that landfilling on Class 1 soils be used as a last resort after the City has exhausted all other options

- adoption by the Utility Board at its April 21, 1982 meeting of the staff's recommendations with the following stipulations:

  - landfilling of sludge in areas containing Class 1 soils should be considered only as a last resort, as recommended by the PAC

  - when implementation and scheduling details of the selected alternatives are developed, the Utility Board will review them for approval

- approval by the City Commission on April 23, 1982 of the selection of MA-16 and RA-6 as the final alternatives as recommended by the Utility Board

In addition to the above recommendations, both the Utility Board and the City Commission requested that project implementation be phased over a reasonable period of time to (1) reduce the financial impact on the City, and (2) avoid building facilities that might be abandoned at a later date because of possible Federal or State changes in the requirements for the Northside Plant.

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Chapter 7

CHAPTER 7

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Chapter 8

CHAPTER 8

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Chapter 9

CHAPTER 9

GLOSSARY OF TERMS

Activated Sludge - A process that removes organic matter from sewage by saturating it with air and adding biologically active sludge.

Advanced Wastewater Treatment; AWT - A method of providing high levels of water quality. In this study it refers to achieving 5 mg/l BOD, 5 mg/l SS and 3 mg/l NH_3 effluent limitations.

Aerobic Digestion - A method of stabilizing sludge by reducing its organic content using aerobic microorganisms and extended aeration.

Aerosols - Mists or water droplets that become airborne and may contain pathogens or other infectious agents.

Algal - Referring to algae; aquatic nonvascular plants.

Alluvial Aquifer - Water bearing substrate containing material such as sand, silt, or clay deposited along streams.

Anaerobic Digestion - A method of stabilizing sludge by reducing its organic content using anaerobic microorganisms in an environment devoid of oxygen.

Aquatic - Consisting of or pertaining to water.

Assimilative Capacity - Generally relates to stream flow vs. wastewater loadings, or the ability of a stream to accept pollution without serious degradation.

Association, soil - A group of soils geographically associated in characteristics repeating patterns and defined and delineated as a single map unit.

Ammonia - A compound of nitrogen found in wastewater, predominately in two forms; ionized (NH_3) and un-ionized (NH_3).

Benthic Organisms - Organisms that live on the bottoms of water bodies.

Biotic Community - An assemblage of populations (plant and animal) occupying a particular area or physical habitat.

Biochemical Oxygen Demand (BOD) - The amount of dissolved oxygen required for the decomposition of organic matter in water. BOD is used as a measure to determine the efficiency of a sewage treatment plant or to determine the potential of an effluent to degrade a stream. The lower the BOD measurement, the cleaner the effluent. Termed as 5-day BOD (BOD_5) or the amount of oxygen required during a 5-day test.

Breakpoint Chlorination - A method of removing ammonia from wastewater by converting it to nitrogen gas, involving a series of chemical reactions as chlorine is added at a ratio of 7.6 parts Cl_2 to 1 part NH_3.

Cadmium - A heavy metal often found in sewage sludge as a result of industrial discharges to the system. Levels of cadmium are used to determine the uses of sludge.

Carbonaceous BOD - The level of oxygen demanded by the organic material.

CFS (cubic feet per second) - A unit of measure used to describe volume of stream flow, equal to 1 cubic foot in 1 second (also called "second-foot").

DAF Thickener - Dissolved air flotation thickener, a process by which air bubbles are attached to particles causing them to float, where they are scraped off the surface.

Dedicated Land Disposal - A method of disposing of municipal sludge on the land surface, by either liquid injection or incorporation, at such high rates that the levels of potential toxic substances precludes the use of that land for other purposes.

Density - Demographic term referring to the number of people in a specified area.

Depletion - The measure of the amount of water removed from the water supply system for a use; synonymous with "consumptive use."

Dissolved Oxygen - Gaseous oxygen in an aqueous solution.

D.O. Sag - The point of drop in the downstream dissolved oxygen profile as a result of higher organic loadings.

Ecology - The relationships of organisms and their environment.

Ecosystem - A system formed by the interaction of a community of organisms with its environment.

Effluent - The liquid that comes out of a wastewater treatment plant after completion of the treatment process.

Effluent Disinfection - The process of killing the larger portion of the microorganisms in the effluent, with the probability that all disease-causing bacteria are killed by the agent used.

Environment - "Everything else but me." This all-embracing term generally includes natural (physical and biological) elements and human (socioeconomic and cultural) elements.

Environmental Assessment - A study to determine harmful or beneficial changes to the human and natural environmental system resulting directly or indirectly from changes imposed on that system.

Environmental Impact - Effect of an action upon the physical, biological and socioeconomic characteristics of an area.

Evaporation - The process of converting a liquid to a vapor.

Fauna - Animals or animal life of a region.

Fecal Coliform - A group of generally enteric organisms that are used as a standard indicator of fecal contamination of water.

Floodplain - A land area adjoining a river, stream, or watercourse that has been or may be covered by floodwater.

Floodway - The channel of a river or other watercourse and the adjacent land areas required to carry and discharge a flood of a given magnitude.

Flora - Plants of a given region.

Fugitive Dust - Dust particles that become airborne as a result of wind or construction-related activities, usually occuring on land without sufficient vegetative cover.

Granular Media Filtration - A method of removing particulates from water by filtering it through a sand or multi-media filter. In this project the process is required to achieve an effluent level of suspended solids of 5 mg/l.

Gravity Thickeners - A method of concentrating sludge to remove excess water before further treatment.

Groundwater - The body of water beneath the surface of the ground, found in aquifers. It is made up primarily of water that has seeped down from the surface.

Habitat - The environment in which the life needs of a plant or animal are supplied.

Heavy Metal - A group of elements of the periodic table that for the purposes of this study are used to indicate contamination primarily from industries.

Impoundment - A basin or other area surrounded by physical structure(s) in which water is contained.

Indicator Species - Either terrestrial or aquatic flora and fauna that may be utilized to indicate effects on the ecosystem as a whole, because of habitat, food or other requirements.

Infiltration/Inflow - The intrusion of percolated storm water and/or groundwater into sewage collector systems, resulting in higher flows to the plant.

Influent - Sewage flowing into a treatment plant.

Intermittent - Streams that may stop flowing at sometimes of the year or produce flows of less than 1 cfs.

Inversion - An increase in air temperature with an increase in altitude. An event associated with air pollution.

Irreversible or Irretrievable Impact - An impact which could not be changed or "undone", the effects of which will be lasting upon the environment.

Land Application (Sludge) - A method of reusing sludge for agricultural purposes by applying the sludge to the land at rates that supply sufficient nutrients, for crops and limits the build-up of toxics, allowing for annual application to take place.

Leach - An action which separates soluble components, such as salts, out of a medium, such as soil, by the action of percolating water.

Leachate - The liquid, including chemical components, which is a product of the leaching process.

Linear Best Fit - A mathematical technique which takes a series of data points and provides an average or best straight line through those points that would be used to indicate where additional data points would most likely fall.

Macroinvertebrates - Organisms without spinal columns, generally found along stream channels, used in this case to indicate water quality. Generally, containing a group of organisms collected with a Surber sampler.

Mesophilic - A group of organisms that grow best in a 20-40°C temperature range.

Microorganism - Minute organism, either plant or animal; invisible or barely visible to the naked eye.

Mitigate - To alleviate or modify adverse or negative impacts resulting from a specific action.

Mitigative Measure - A step taken to moderate the severity of the effects of a proposed action.

Nitrates - A compound of nitrogen (NO_3) sampled in potable waters, that can cause metahemoglobanemia at levels in excess of 10 mg/l.

Nitrification - A biological process of converting ammonia (NH_3) to nitrate (NO_3) in the presence of oxygen.

Nitrifiers - Nitrosomas and nitrobacter bacteria that conduct nitrification.

Nitrogenous BOD - Refers to the amount of oxygen required to nitrify ammonia, 4.6 parts O_2 per 1 part NH_3.

Non-attainment Areas - Areas selected for their level of air quality based on specific pollutants designed to prevent new source pollution.

Non-point Source - Generalized discharge of waste into a water system which cannot be located as to a specific source. Examples are street runoff, agricultural irrigation return flow, etc.

NPDES (National Pollution Discharge Elimination System) - An environmental program, administered by EPA, in accordance with the Federal Water Pollution Control Act (PL 92-500), as amended, to control discharge of wastes into waters of the United States.

Organic - Pertaining to or derived from living organisms, or compounds of carbon and hydrogen.

Organic Loading - The level of organic material discharged to a system such as a stream.

Oxidation - Addition of oxygen which breaks down organic wastes or chemicals in sewage by bacterial and chemical means.

Oxygen Transfer - The rate at which oxygen forced into an aeration vessel is converted from vapor (gas) to the dissolved state.

Particulate - Of or pertaining to particles occurring as minute particles.

Percolation - Movement of water through subsurface soil layers, usually continuing downward to the groundwater table.

Periphyton - Aquatic plants such as algae that grow attached to surfaces.

Perennial - A stream that flows continuously with a minimum classified as the 7-day, 2-year low flow value.

Piggyback - An approach to conducting an EIS concurrently with the Facilities Plan.

pH - A value ranging from 1 to 14, where 1 is acid, 7 is neutral, and 14 is basic.

PL 92-500 - Water Pollution Control Act Amendments of 1972. An act passed by the Congress of the United States and signed by the President, to control pollution of the nation's waters and improve their quality.

Point-source Discharge - A man-made structure such as a pipe or spillway that discharges to a natural waterway.

Potable Water - Drinkable water.

Point Source - A stationary, readily identifiable source of pollution.

PPM - Parts per million.

Preliminary Treatment - In the treatment process, unit operations, such as screening and comminution, that prepare the liquor for subsequent major operations.

Prime Farmland - Specific soil types classified by the Soil Conservation Service as the best available soils for agriculture.

Primary Clarifier - The first tank in the process train, in which material heavier than water is settled and removed.

Process Train - The order in which sewage is treated as it flows through a treatment plant.

Regression Analysis - a mathematical technique used to develop a linear best fit.

Residuals - The solids by-product from wastewater treatment processes.

Secondary Treatment - A level of effluent water quality, in this project it is 20 mg/l BOD and 30 mg/l SS with no nitrification.

Septic - A condition of sewage or sludge where it is devoid of oxygen, usually resulting in the production of the gases methane (CH_4) and hydrogen sulfide (H_2S), which causes "rotten-egg" smell.

Sewage - Wastewater that flows to sewers from residential, commercial, and industrial establishments and is carried in the sewers to wastewater treatment plants.

Sewer - Pipe, conduit, or other physical facility used to carry wastewater.

Sewerage - System of sewers, and physical facilities employed to transport, treat, and discharge sewage.

Site-specific - Pertaining only to indivicual areas; in this report the term refers to impacts.

Sludge - Solid matter in sewage that settles to the bottom, floats, or becomes suspended in sedimentation tanks during wastewater treatment. Sludge must be disposed of by filtration and incineration or by transport to appropriate disposal sites.

Standardized Distance - A numerical ranking of species diversification in a stream segment, used to indicate water quality.

Stream Bed - Channel that contains the stream's waters; all the space ordinarily covered by water and lying between the lands on each side of the stream.

Subsidence - Settling of the surface of the ground to a new level.

Terrestrial - Consisting of or pertaining to the land.

Trihalomethane - A chlorinated-hydrocarbon that results from the addition of chlorine for the purposes of disinfection in the presence of organic precursors; a suspected carcinogen.

Total Suspended Solids (TSS) - The level of suspended particulate matter in effluent.

208 Plan - An area-wide waste treatment management plan developed under Section 208 of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500).

201 Plan - A plan developed under Section 201 of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500) for constructing and operating wastewater treatment facilities.

Ultimate BOD - The total oxygen demand exerted by the carbonaceous and nitrogenous BOD over a 20-30 day time period.

Waste Activated Sludge - The portion of the sludge from the secondary clarifier which is removed from the liquid stream for solids treatment.

Waste Load Allocations - The allowable loadings to a stream that do not exceed its assimilative capacity.

Wastewater - Any water derived from one or more previous uses.

Wastewater Treatment Plant (WWTP) - A facility consisting of a series of tanks, screens, filters, and other components that process wastewater so that pollutants are removed.

Watershed - The drainage area of the stream that accomodates storm water runoff.

Water Rights - Legally defined ownership of the water in a specific area.

Water Supply - A volume of water that is ready for use, either in its natural state or through treatment.

Water Table - The upper limit of the portion of the ground wholly saturated with water.

ENGLISH UNIT/METRIC UNIT CONVERSION FACTORS

Multiply (English Units) English Unit	Abbreviation	by Conversion	To obtain (Metric Units) Abbreviation	Metric Unit
acre	ac	0.405	ha	hectares
acre - feet	ac ft	1233.5	cu m	cubic meters
British Thermal Unit	BTU	0.252	kg cal	kilogram - calories
British Thermal Unit/pound	BTU/lb	0.555	kg cal/kg	kilogram calories/kilogram
cubic feet/minute	cfm	0.028	cu m/min	cubic meters/minute
cubic feet/second	cfs	1.7	cu m/min	cubic meters/minute
cubic feet	cu ft	0.028	cu m	cubic meters
cubic feet	cu ft	28.32	l	liters
cubic inches	cu in	16.39	cu cm	cubic centimeters
degree Fahrenheit	F	0.555 (°F-32)*	°C	degree centigrade
feet	ft	0.3040	m	meters
gallon	gal	3.785	l	liters
gallon/minute	gpm	0.0631	l/sec	liters/second
horsepower	hp	0.7457	kw	kilowatts
inches	in	2.54	cm	centimeters
inches of mercury	in Hg	0.03342	atm	atmospheres
pounds	lb	0.454	kg	kilograms
million gallons/day	mgd	3,785	cu m/day	cubic meters/day
mile	mi	1.609	km	kilometer
pound/square inch (gauge)	psig	(0.06805 psig + 1)*	atm	atmospheres (absolute)
square feet	sq ft	0.0929	sq m	square meters
square inches	sq in	6.452	sq cm	square centimeters
tons (short)	t	0.907	kkg	metric tons (1000 kilograms)
yard	y	0.9144	m	meters

* Actual conversion, not a multiplier

Source: McCandless, Lee C., and Robert B. Shaver. 1978. Assessment of coal cleaning technology: first annual report, U.S. Environmental Protection Agency, Office of Research and Development, Industrial Environmental Research Laboratory, Research Triangle Park NC, EPA-600/7-78-150, 153 p.

Appendix A

APPENDIX A

ARCHAEOLOGICAL/HISTORICAL

The
University of Oklahoma at Norman

Oklahoma Archaeological Survey

March 20, 1981

Jeremiah P. O'Brien, ACIP
Camp Dresser & McKee, Inc.
6060 North Central Expressway
Suite 770
Dallas, Texas 75206

Re: Environmental impacts of Tulsa sewage disposal plant operation and possible expansion; Cultural Resources of the affected area.

Dear Mr. O'Brien:

As per your request, the sewage disposal plant locations you sent us have been reviewed against our files of recorded sites in Tulsa County, and cultural resource surveys have been conducted on these areas on March 17 and 18, 1981.

One of the plant locations, the Northside Sewage Treatment Plant, contained a previously recorded site, 34Tu-21. This site was found by archeological survey for the City of Tulsa and the Corps of Engineers along Mingo Creek about four years back. It has subsequently been destroyed by construction of two new clarifiers. No other archeological or historical resources were located in this extensively disturbed area by my survey.

The Coal Creek Sewage Plant had no previously recorded sites. At the time I arrived for the survey, a fresh coat of sludge had been spread over the high terrace areas that would have been most likely to have relatively undisturbed cultural resources. I did not conduct a survey of this area. The land to the west and north of the plant is currently used as a dump and is extensively disturbed.

The Flat Rock Plant did not contain previously recorded archeological resources. Survey of this extensively disturbed area, and the land in the immediate vicinity on each side of the creek proved negative.

The Southside sewage treatment plant in the vicinity of Jenks had no undisturbed areas left to survey for archeological remains.

1335 South Asp Avenue, Norman, Oklahoma 73019 (405) 325-1028

The South Arkansas Regional Waste Water Facility (Haikey Creek Plant) contained no previously recorded archeological sites. From a standpoint of physiographic location, the 620 ft. contour the main part of the plant is on looked favorable to contain archeological remains. The plant manager, Doug Stevens, reported none of his employees nor any locals he knew of had ever found any "arrowheads" or other artifacts. He reported that plans to expand the plant to the west were in the works, and I walked out this area. Some slight indications of a historic period, and post 1915 occupation, were present, but severe disturbance by sludge injection was evident. The other part of the 300 acres not currently occupied by the plant was undergoing sludge injection at the time of my survey. Since the earth was freshly turned, and there has been soil accretion for several years, I did not conduct any work in this area, nor do I perceive any need for such.

In summary, the operation and maintenance of the various plants have, in one case, destroyed one recorded site, and have extensively disturbed other areas that had a good probability of containing archeological remains. It would appear that the damage has been done, however, and that as long as operations remain in the current areas of disturbance there should be no further effect on Oklahoma's cultural resources.

Your understanding of the general procedure followed in review of projects requiring a no-effect determination is correct as far as it goes; however, the State Historic Preservation Officer also reviews the project for its effects on historic remains (standing structures and state owned or leased property) as well.

Most filea surveys are carried out on private property or property under lease or easement. We prefer your people have such access cleared; however, we do make initial contact ourselves. In the cases where there are no occupants at home on a piece of property, we leave a card and carry out the survey. An attempt at least is usually made to contact the land owner. If the land owner does not want the survey done on his property, it will not be done and will be so noted on the report.

As to your request for a list of sites within 30 miles of Tulsa, I believe a refinement might be in order. First, such a list would include the very large number of sites contained in Lakes Keystone, Skiatook, Birch, Oologah, and part of the Arkansas River Navigation System. All these are Corps of Engineers promects, and I am not sure they would be of use to you in your planning as they are numerous and localized.

Secondly, the list can only be a list of site names and numbers. The location information of sites are kept confidential due to the need to protect the sites from vandalism. Legal locations are released to planners only when a project area or alternate location might affect a recorded site.

In view of the foregoing, I would recommend that you modify your planning to delete all Corps of Engineers project locations within your study area. This should drop the number of sites to a more manageable 40 - 60 in number, and possibly less. However, the best legal location we would be able to give you on such a general scale would be by Township/Range, or within six square miles. Please let me know what you decide.

Thank you for contacting us on these projects. Please let me know if I can be of further help to you in your planning.

Sincerely,

Larry Neal
Assistant State Archeologist

cc: State Historic Preservation Officer

The
University of Oklahoma *at Norman*

Oklahoma Archaeological Survey

July 15, 1981

Eileen Pannetier
Camp Dresser & McKee, Inc.
6060 N. Central Expressway
Suite 770
Dallas, TX 75206

Re: Site file search for potential sludge landfill and land spreading areas; Okmulgee, Muskogee, Rogers, and Washington Counties.

Dear Ms. Pannetier:

A site file search has been completed for the areas submitted in your letter of 8 July 1981. The bulk of the areas falls within Okmulgee County, a county which has had very few cultural resource surveys to date. The site file search results by specific areas are:

Land Fill #1 - No sites recorded
Land Fill #2 - No sites recorded
Land Fill #3 - No sites recorded
Land Fill #4 - Site Og-15 (Prehistoric Indian)
Land Fill #5 - No sites recorded
Land Fill #6 - No sites recorded
Land Fill #7 - No sites recorded
Land Fill #8 - No sites recorded
Land Spread #1 - No sites recorded
Land Spread #2 - No sites recorded
Land Spread #3 - No sites recorded
Land Spread #4 - Sites Ro-34 and Ro-35 (Historic homesteads)

Enclosed are xerox copies of maps showing some of the proposed areas. When specific site areas are determined please indicate on the enclosed maps and return to this office. I would also suggest that each specific site area selected be accompanied with an alternate location. The preferred and alternate locations can then be surveyed for cultural resources simultaneously thereby speeding our review process. If any further information is needed, please call on me at any time.

Sincerely,

Charles Neel
Staff Archaeologist

CDN/rw

P.S. Locational information of archaeological sites is confidential. This is necessary in order to prevent vandalism.

Attachments - Maps (9)

1335 South Asp Avenue, Norman, Oklahoma 73019 (405) 325-1028

OKLAHOMA HISTORICAL SOCIETY

Historical Building
Oklahoma City, Oklahoma 73105

July 17, 1981

Ms. Eileen Pannetier
Camp Dresser & McKee Inc.
6060 North Central Expressway, Suite 770
Dallas, Texas 75206

Re: Potential sludge landfill and landspreading sites, 30 mile radius

Dear Ms. Pannetier:

There are no sites on either the National Register of Historic Places or the Oklahoma Landmarks Inventory within the referenced project area. Pending compliance with recommendations of the Oklahoma Archeological Survey, the State Historic Preservation Office has no objections to completion of the referenced project.

Sincerely,

C. Earle Metcalf
State Historic Preservation Officer

CEM:kt

The University of Oklahoma

OKLAHOMA ARCHAEOLOGICAL SURVEY
1808 Newton Drive
Norman Oklahoma 73019
(405) 325-7211

February 2, 1982

Eileen Pannetier
Camp Dresser & McKee, Inc.
11455 West 48th Avenue
Wheat Ridge, CO 80033

Re: Landfill/land disposal sites for Tulsa's sewage sludge - locations LF-1 in Creek and Okmulgee counties and LS-4 in Rogers County, Oklahoma.

Dear Ms. Pannetier:

I have received and reviewed the maps depicting the referenced project areas, comparing them against the locations of recorded sites in the area. I have also marked the locations of sites listed in your study areas on the maps which I am returning for your reference. These locations are for planning only and are not to be published. Some are on government property and some are on private land.

There are no recorded sites in the LF-1 study area, but there is some potential for archeological resources. One cursory survey of roadsides for a rural water line was conducted, but this cannot be considered an adequate survey for the amount of land in the study area.

There are a number of sites in the LS-4 location. Many of these are the result of surveys on Oologah Lake caused by the Corps of Engineers. To aid in your interpretation, those sites with an "H" following the number are historic period sites and represent homesteads or locations identified with specific Native American groups. Several have question marks and even alternate locations. These problems come from very early site reports that were lacking sufficient information to accurately relocate them. A case in point is Ro-20 which has a probable and two alternate locations.

The sites in LS-4 range in time from 3,000 B.C. up to as late as the 1930s. Those without the "H" are prehistoric habitation and temporary camps. Very few were excavated and all have some research potential remaining.

If you need information other than what I have given you, please let me know.

Sincerely,

Larry Neal
Staff Archeologist II

LN:ng

Enclosure: Maps

OKLAHOMA HISTORICAL SOCIETY
Historical Building
Oklahoma City, Oklahoma 73105-4997

February 22, 1982

Eileen Pannetier
Camp Dresser & McKee Inc.
11455 West 48th Ave
Wheat Ridge, Colorado 80033

Re: Site LF-1 in Creek and Okmulgee Co. and Ls-4 in Rogers

Dear Ms. Pannetier:

This letter is to inform you that there is indeed a site of historical signifiance in the referenced areas, that being the Claremore Mounds. There are other archeological sites in the area and any activities should be cleared with the Oklahoma Archaeological Survey. When a more exact location is decided on, please inform both this office and the Oklahoma Archeological Survey for a opinion on the cultural resources.

Sincerely,

CEMetcalf
Earle Metcalf
State Historic Preservation Officer

CEM:kt

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