Lincoln Wastewater Facilities Plan

UPDATE

April 2003

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CHAPTER 1

EXECUTIVE SUMMARY

Background

The City of Lincoln's last wastewater facilities plan update was completed in 1995. Since then, several regulations have been promulgated or are anticipated that will impact the City's wastewater treatment requirements. Lincoln's increasing population and the overall age of some wastewater system components are also driving the need for system improvements. The long-term capital projects required to address these issues will take several years to complete.

This updated Wastewater Facilities Plan was developed in conjunction with the 2002 Lincoln-Lancaster County Comprehensive Plan to proactively address wastewater issues and assure that the City is well prepared to meet wastewater service needs when they occur. Wastewater collection and treatment facilities required over the next 25 years have been identified to guide planning for both short and long-term improvements. The information contained in this report is to be used for general planning, identifying capital improvement projects, and determining funding requirements.

Planning Goals and Objectives

The overall goal of the 2003 Lincoln Wastewater Facilities Plan Update is to identify wastewater collection and treatment system modifications required to:

1. Provide efficient wastewater service,
2. Assure adequate protection of public health and the environment, and
3. Comply with all relevant local, state, and federal regulations.

Study Area Boundaries

The study area includes:

1. The entire City of Lincoln, Nebraska;
2. Portions of the Middle Creek and Haines Branch basins to the west;
3. Cardwell Branch, located in the southwest;
4. The Upper Salt Creek and Beals Slough areas to the south;
5. Little Salt Creek and Lynn Creek drainages to the north and northwest;
6. Northeast Salt Creek drainage to the north and northeast; and
7. Stevens Creek to the east.

Population Projections

Future wastewater utility needs for 25-year (Tier I) and 50-year (Tier II) planning horizons have been developed using population projections provided by the Lincoln-Lancaster County Planning Department. These projections are shown in Table 1-1.

Table 1-1. City / County Population Projections

Year	City of Lincoln	Annual % Increase	Lancaster County	Annual % Increase
2001	225,581	1.5	250,291	1.5
2005	243,015	1.5	269,634	1.5
2010	261,796	1.5	290,473	1.5
2015	282,029	1.5	312,922	1.5
2020	303,825	1.5	337,106	1.5
2025	327,306	1.5	363,159	1.5
2030	352,601	1.5	391,225	1.5
2035	379,852	1.5	421,460	1.5
2040	409,208	1.5	454,032	1.5
2045	440,833	1.5	489,122	1.5
2050	474,903	1.5	526,923	1.5

The population projections shown in Table 1-1 indicate that the historical growth trend is expected to continue. The result will be approximately 102,000 and 113,000 additional people in the City of Lincoln and Lancaster County respectively by the year 2025. This represents an annual growth rate of 1.5 percent.

Wastewater Collection

The existing Lincoln wastewater collection system service area covers 13 drainage basins encompassing over 50 square miles. These drainage basins include:

1. Salt Creek
2. West “O” Street
3. Beals Slough
4. Haines Branch
5. Middle Creek
6. Antelope Creek
7. East Campus
8. Oak Creek
9. Little Salt Creek
10. Lynn Creek

11. Deadmans Run
12. Havelock
13. Regent Heights (portion of West Stevens Creek drainage basin)

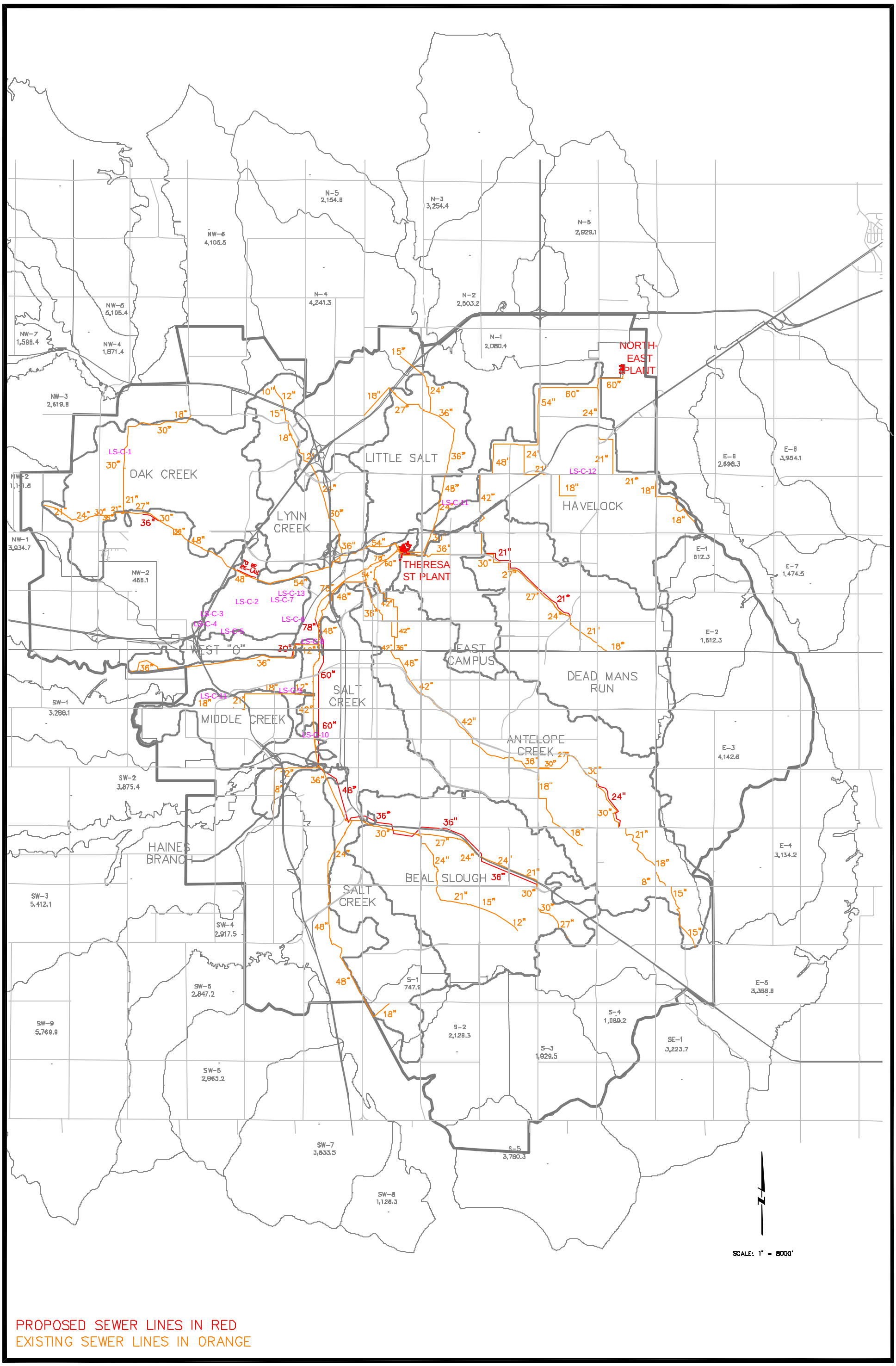
The Lincoln wastewater collection system includes over 800 miles of wastewater collection pipelines ranging in size from 8-inch to 90-inch in diameter. Flow through the system is predominantly by gravity, however some low elevation areas are served by wastewater lift (pumping) stations. There are a total of 14 lift stations located throughout the collection system. The existing wastewater collection system is shown in Figure 1-1.

Collection System Needs. Some portions of the collection system are hydraulically overloaded under current conditions. These include pipelines serving portions of the Salt Creek, Beals Slough, Deadmans Run, and West "O" drainage basins. In each of these cases, construction of new collection lines to parallel the existing overloaded lines is recommended. Improvements recommended to address these hydraulic problems are listed in Table 9-1 in this report. Some of these recommended improvements are already underway. In the case of the Deadmans Run pipeline, the existing line is quite deep and the overloaded condition does not appear to be creating any immediate functional problem. Before a parallel pipeline is constructed to alleviate the overloaded condition in Deadmans Run, additional monitoring and evaluation are recommended to determine the extent and impact of the existing loading conditions.

As population growth occurs within the service area, the system will have to be further upgraded and expanded to meet service needs. It is recommended that the gravity character of the Lincoln Wastewater Collection System be maintained to the extent possible as the system is expanded to accommodate future development.

The timing associated with future system improvements within each drainage basin will depend on the rate of development within the basin. For the purposes of this planning effort, development projections for "Tier I" and "Tier II" were taken from the 2002 Lincoln-Lancaster County Comprehensive Plan. Based on this information, wastewater collection system projects required to meet future service requirements have been identified in the Salt Creek, Antelope Creek, Beals Slough, Middle Creek, Little Salt Creek, Northeast Salt Creek, Oak Creek, and Stevens Creek basins. Specific wastewater collection system upgrade and expansion projects in these areas were identified based on the Tier I and Tier II development scenarios and are presented in Tables 9-1 and 9-2 of this report. The recommended Tier I improvements are shown in Figure 1-2. The recommended Tier I improvements have been categorized as Priority A or Priority B in a manner consistent with needs projected in the Comprehensive Plan. Tier II improvement recommendations are all considered together with no assigned priorities. As future development occurs, the wastewater collection service plan should be revised and updated to appropriately reflect changing conditions.

The Sevens Creek drainage area has substantial development potential, but the majority of the area is currently not served by the City's wastewater collection system. It is recommended that a detailed routing study be performed to identify the most logical pipeline routing configuration to serve this growth area with a gravity wastewater collection system.



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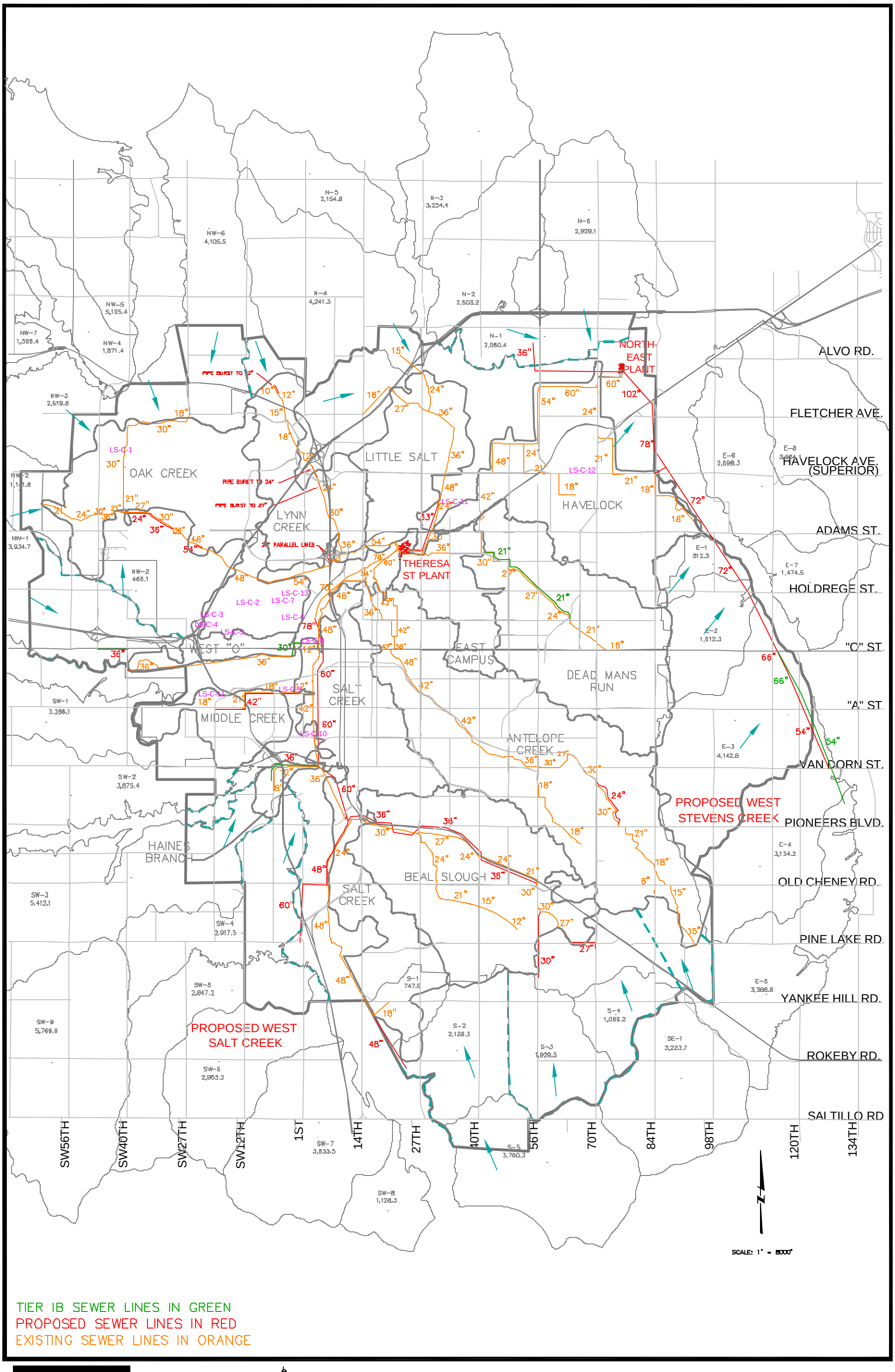
Lincoln Wastewater System Facilities Plan Update
CITY OF LINCOLN
SANITARY SEWER BASINS

Figure 1-1

EXISTING WASTEWATER COLLECTION SYSTEM



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Lincoln Wastewater System Facilities Plan Update
CITY OF LINCOLN
SANITARY SEWER BASINS

Figure 1-2

RECOMMENDED TIER I WASTEWATER COLLECTION SYSTEM IMPROVEMENTS

Wastewater Treatment

Wastewater Flows. Table 1-2 presents projected wastewater flows based on the year 2000 per capita flow rates, the service area population projections, and historical dry weather peaking factors.

Table 1-2. Wastewater Flow Projections (mgd)

		2000*	2010	2025	2050
Theresa Street WWTF					
	Daily Average (ADF)	16.8	19.5	24	36
	Maximum Month (MMF)	18.6	21.6	27	40
	Peak Day (PDF)	25.5	29.6	37	54
	Peak Hour (PHF)	32.4	37.7	47	69
Northeast WWTF					
	Annual Average (ADF)	6.8	7.9	10	15
	Maximum Month (MMF)	7.8	9.1	11	17
	Peak Day (PDF)	10.5	12.2	15	23
	Peak Hour (PHF)	13.3	15.4	19	28
Total Annual Average (ADF)		23.6	27.4	34	51
Total Maximum Month (MMF)		26.4	30.7	38	57
Total Peak Day (PDF)		36.0	41.8	52	77
Total Peak Hour (PHF)		45.7	53.1	66	97

*Actual Flow

It is recommended that the Lincoln Wastewater Treatment Facilities (WWTFs) be designed to treat projected peak hourly flows presented in Table 1-2. Wet weather flows in excess of these values should be handled using special wet weather flow facilities.

Existing Treatment Facilities. The Lincoln wastewater service area is currently served by two wastewater treatment facilities. The Theresa Street WWTF is the larger of the two facilities and is located at 2400 Theresa Street in Lincoln. The Theresa Street WWTF currently consists of preliminary treatment followed by three distinct treatment trains:

1. The Trickling Filter Train,
2. The West Side Activated Sludge Train, and
3. The East Side Activated Sludge Train.

Flows from all three treatment trains are combined prior to disinfection. The original design capacity of the Theresa Street WWTF, including all three treatment trains was 30 million gallons per day (mgd). This was based on treatment to meet only standard secondary treatment requirements.

The second facility, the Northeast WWTF, is located at 7000 North 70th Street in Lincoln. The Northeast WWTF consists of a single treatment train including preliminary treatment, primary treatment, secondary treatment using an activated biotower process, and disinfection. The original design capacity of the Northeast WWTF was 8 mgd based on treatment to meet standard secondary treatment requirements only.

Treatment Requirements. New effluent discharge limits proposed by the Nebraska Department of Environmental Quality (NDEQ) will require both the Theresa Street and Northeast WWTFs to meet effluent discharge limits for ammonia in addition to the standard secondary treatment requirements that have been required in the past. The City has worked with the NDEQ, the U.S. Environmental Protection Agency (US EPA), and other agencies over the last decade to establish effluent ammonia limits that will meet state surface water quality standards for protecting aquatic wildlife in Salt Creek, the creek to which effluent from both facilities is discharged. Though the final effluent ammonia limits have not yet been formally adopted, the anticipated limits are presented in Table 1-3.

Table 1-3. Anticipated Effluent Ammonia Limits*
(Calculated with 30-day Averaging Period for
Waste Load Allocation Long-Term Average Multiplier)

Treatment Facility	Spring		Summer		Winter	
	Monthly Avg	Daily Max	Monthly Avg	Daily Max	Monthly Avg	Daily Max
	mg/L – N	mg/L – N	mg/L – N	mg/L – N	mg/L – N	mg/L -N
Theresa Street						
2008	8.29	21.71	2.88	7.55	8.34	21.84
2013	8.20	21.46	2.75	7.21	8.27	21.64
2025	8.05	21.07	2.55	6.68	8.15	21.31
2050	6.93	18.14	2.23	5.84	7.96	20.85
Northeast						
2008	13.99	36.62	5.68	14.86	14.87	38.93
2013	13.50	35.53	4.98	13.03	14.35	37.56
2025	12.45	32.58	4.18	10.94	13.81	36.16
2050	7.45	19.51	2.48	6.49	8.21	21.50

* The effluent ammonia limits shown are not final and are based on the best information available at the time this report was prepared (March 2003).

In addition to meeting the effluent ammonia limits indicated in Table 1-3, it is expected that both treatment facilities will be required to treat peak wet weather flows sufficiently to meet secondary standards in accordance with the anticipated Sanitary Sewer Overflow (SSO) regulations.

Existing Treatment Capacities. As part of the facilities plan update, the capacities of the Theresa Street WWTF and the Northeast WWTF were evaluated in terms of their capability to meet the proposed effluent ammonia limits. These capacities are summarized in Table 1-4.

Table 1-4. Capacity Summary - Lincoln Wastewater Treatment Facilities

Facility	Hydraulic Capacity*	Nitrification Capacity**
Theresa Street WWTF	36 mgd	14.4 mgd
Northeast WWTF	37 mgd***	4.4 mgd

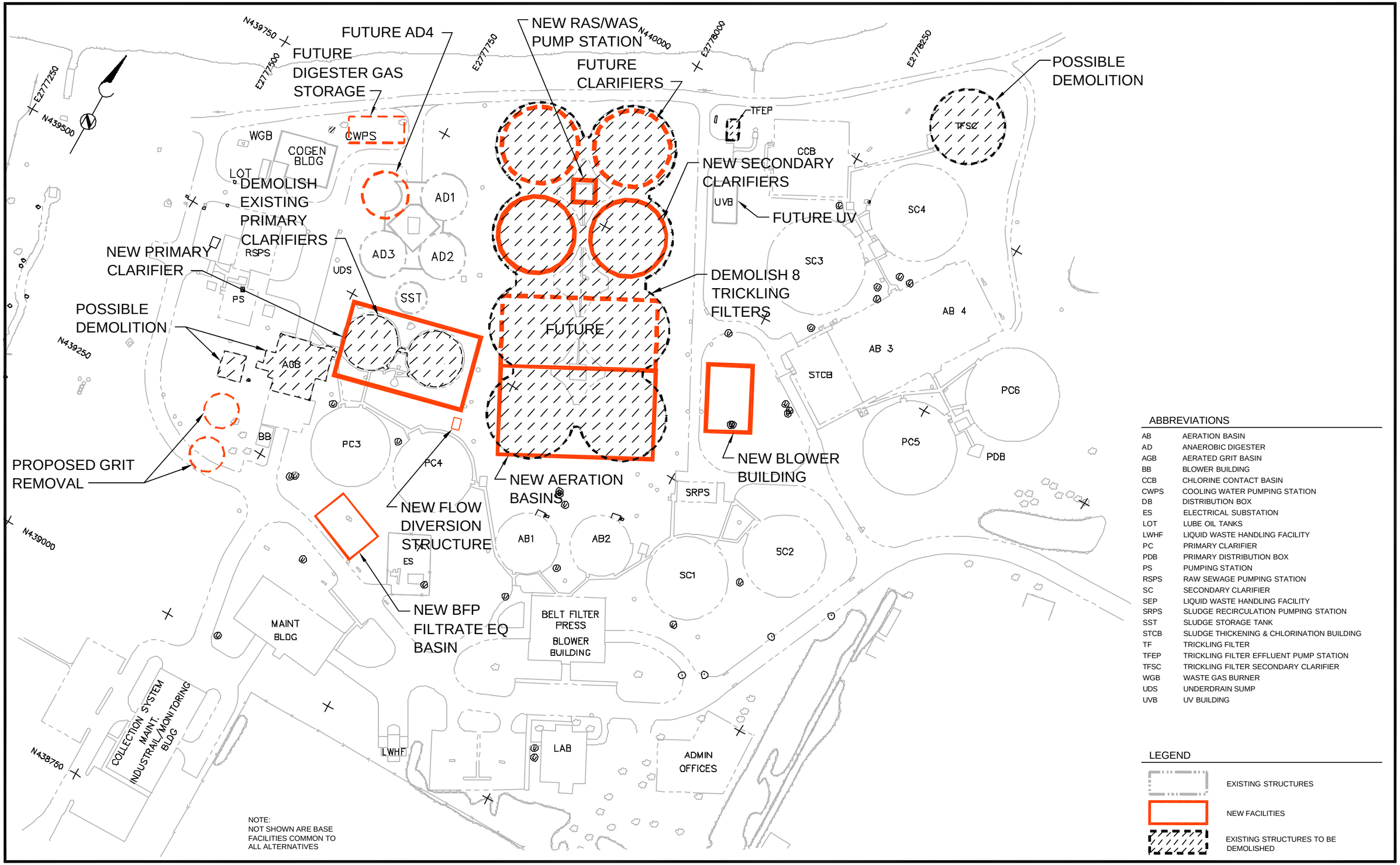
* The hydraulic capacity indicated represents the most hydraulically limiting segment of the treatment facility. For the Theresa Street facility the most limiting segments are the disinfection and outfall segments. For the Northeast facility the most limiting segments are the aeration basins and the chlorine contact basin.
** The nitrification capacity of both facilities is limited by the combination of aeration basin size and secondary clarifier sizes and is based on maximum monthly flow rates.
*** High flows experienced in 1993 indicate that Northeast WWTF hydraulic capacity is significantly less than 37 mgd. Further research should be conducted to identify the hydraulic limitations experienced in 1993.

These capacities are both significantly below the current wastewater flows received at the WWTFs, indicating that the treatment capacity of both facilities must be expanded to comply with treatment requirements for existing flows as well as projected future flows.

Preferred Treatment Alternatives. Alternative methods of providing the required treatment capacity at both the Theresa Street and Northeast WWTFs were identified and evaluated. The preferred method of providing the additional treatment capacity required at the Theresa Street WWTF involves replacing the existing trickling filter process train with a new activated sludge treatment train. The new activated sludge train should be designed to provide an additional nitrifying capacity of 13 mgd, bringing the total nitrifying treatment capacity at the Theresa Street WWTF to approximately 27 mgd. This is sufficient capacity to adequately treat the maximum 30-day wastewater flow expected at the Theresa Street facility through 2025. A site layout for the proposed Theresa Street WWTF is shown in Figure 1-3. Several system improvements not directly related to providing increased nitrification capacity at the Theresa Street WWTF are also recommended between 2002 and 2025.

The additional nitrifying capacity required at the Northeast WWTF should be provided by expanding the treatment capacity of the existing activated biotower system. An additional 6 mgd of nitrifying capacity should be provided through the expansion. It is recommended that this capacity expansion be accomplished in two separate phases. The first phase would involve rehabilitation of the biotowers and the subsequent phase would include expansion of the aeration basins and secondary clarifiers. This will bring the nitrifying capacity of the Northeast WWTF to approximately 11 mgd. This capacity will be sufficient to treat the maximum 30-day flows anticipated at the facility through 2025. A site layout for the proposed Northeast WWTF is shown in Figure 1-4. A number of improvements not related to providing increased nitrification capacity are also recommended at the Northeast WWTF.

Increased biosolids handling and land application capabilities will be required for both the Theresa Street and Northeast facilities. This will include primarily additional digester capacity at Theresa Street and application acreage at the Northeast facility.



ABBREVIATIONS

AB	AERATION BASIN
AD	ANAEROBIC DIGESTER
AGB	AERATED GRIT BASIN
BB	BLOWER BUILDING
CCB	CHLORINE CONTACT BASIN
CWPS	COOLING WATER PUMPING STATION
DB	DISTRIBUTION BOX
ES	ELECTRICAL SUBSTATION
LOT	LUBE OIL TANKS
LWHF	LIQUID WASTE HANDLING FACILITY
PC	PRIMARY CLARIFIER
PDB	PRIMARY DISTRIBUTION BOX
PS	PUMPING STATION
RSPS	RAW SEWAGE PUMPING STATION
SC	SECONDARY CLARIFIER
SEP	LIQUID WASTE HANDLING FACILITY
SRPS	SLUDGE RECIRCULATION PUMPING STATION
SST	SLUDGE STORAGE TANK
STCB	SLUDGE THICKENING & CHLORINATION BUILDING
TF	TRICKLING FILTER
TFEP	TRICKLING FILTER EFFLUENT PUMP STATION
TFSC	TRICKLING FILTER SECONDARY CLARIFIER
WGB	WASTE GAS BURNER
UDS	UNDERDRAIN SUMP
UVB	UV BUILDING

LEGEND

- EXISTING STRUCTURES
- NEW FACILITIES
- EXISTING STRUCTURES TO BE DEMOLISHED

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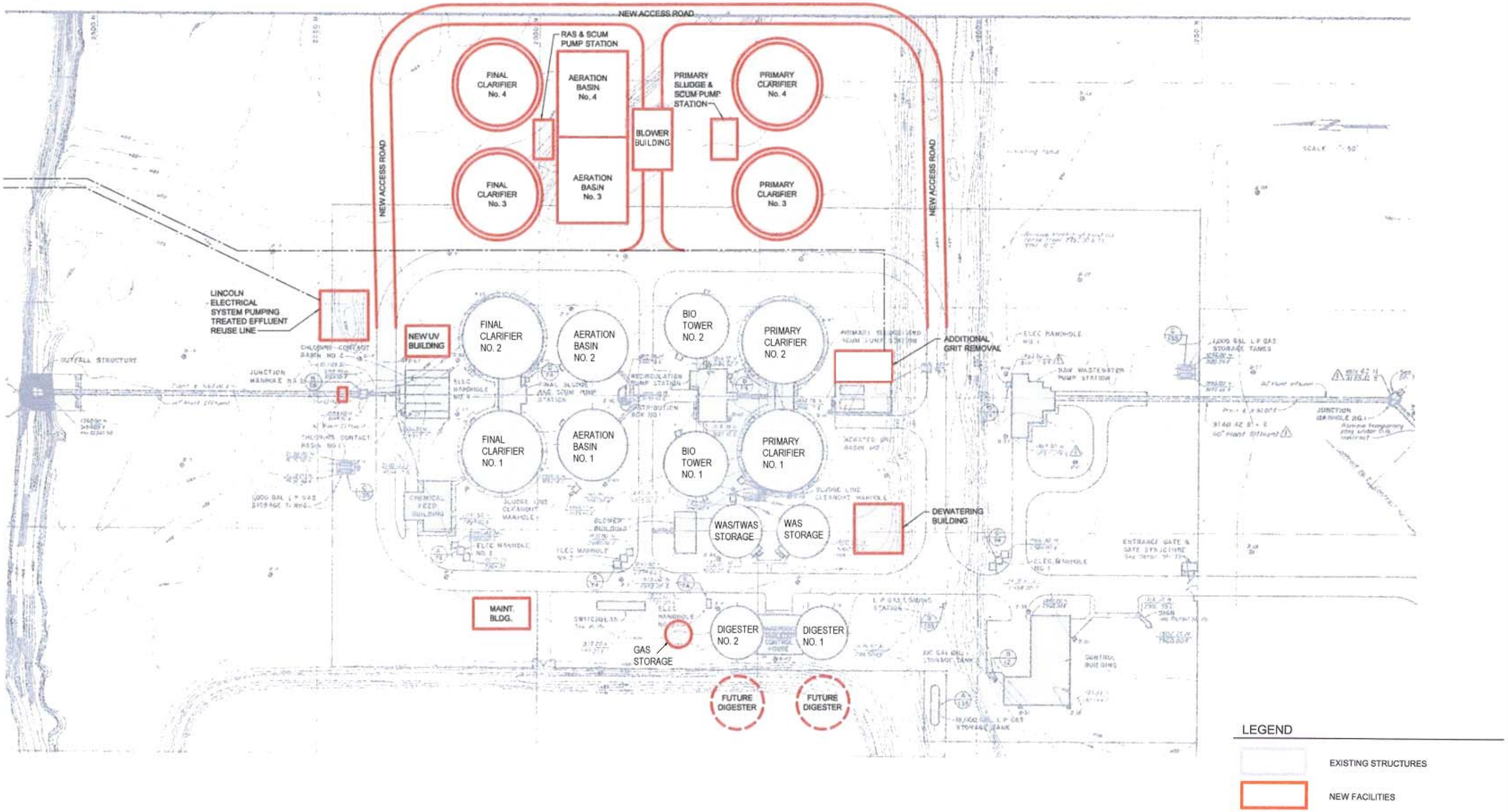
Lincoln Wastewater System Facilities Plan Update
CITY OF LINCOLN
THERESA STREET WASTEWATER TREATMENT PLANT

Figure 1-3
Proposed Site Layout for Theresa Street WWTF



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Lincoln Wastewater System Facilities Plan Update

CITY OF LINCOLN

NORTHEAST WASTEWATER TREATMENT PLANT

Figure 1 - 4

Proposed Site Layout for Northeast WWTF

Facilities to provide temporary storage of peak wet weather flows should be constructed at both the Theresa Street and Northeast WWTFs. The stored wastewater can then be treated through the standard treatment systems at both facilities after the peak flows have subsided. This will allow peak wet weather flows to receive adequate treatment without adversely affecting system performance during the peak flow periods.

New facilities at the Theresa Street and Northeast WWTFs should be designed to allow space to accommodate future capacity expansions and treatment upgrades that may be necessary.

Improvement Costs

The estimated costs associated with upgrading and expanding the Lincoln Wastewater Collection System to serve the projected Tier I needs is approximately $114,000,000. This includes the main Trunk Sewer improvements of $82,000,000 and miscellaneous smaller collection system improvements of $32,000,000.

Expansion of the Theresa Street WWTF to provide 27 mgd of nitrifying capacity is expected to cost approximately $23,000,000. Additional hydraulic capacity and other improvements to the Theresa Street facility not directly related to the additional nitrification capacity are expected to cost approximately $67,000,000.

Costs associated with providing an additional 6 mgd of nitrifying treatment capacity at the Northeast WWTF are expected to be approximately $12,000,000. Additional recommended improvements to the Northeast WWTF are expected to cost approximately $43,000,000.

The total cost of all identified capital improvements for the Lincoln wastewater collection and treatment facilities for the Tier I period is shown in Table 1-5. All dollars are 2002 dollars.

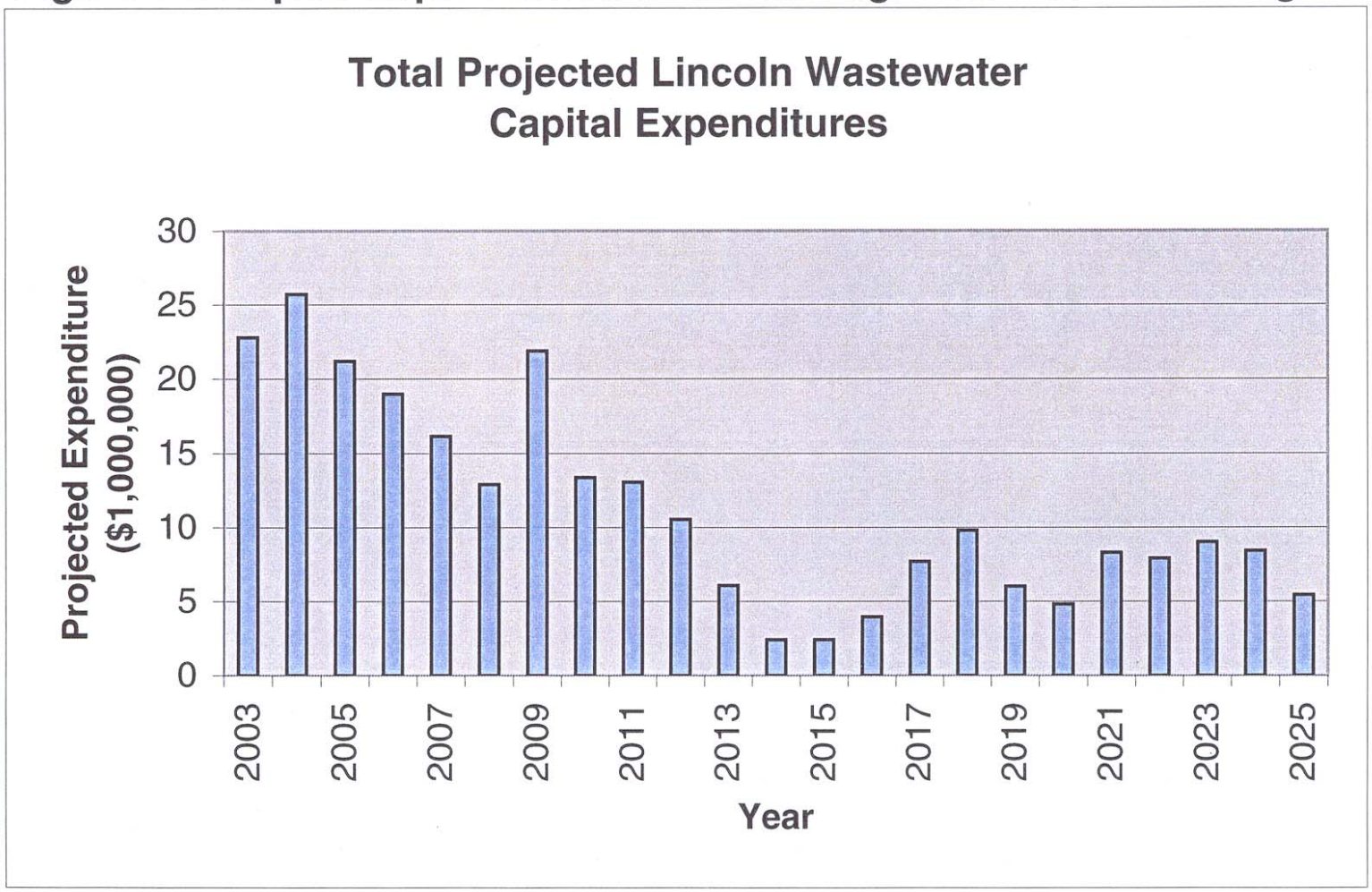
Table 1-5. Tier I Improvement Costs[1]

	Tier I (25-Year) Costs
Collection System Trunks Sewers	$82,000,000
Theresa Street WWTF Improvements	$90,000,000
Northeast WWTF Improvements	$55,000,000
General System Improvements	$32,000,000
Totals Costs	**$259,000,000**

[1] All costs are in 2002 dollars.

Expected distribution of the capital improvement costs associated with recommended collection system and treatment facility improvements through the Tier I planning period is shown graphically in Figure 1-5.

Figure 1-5 Capital Improvement Costs Through The Tier 1 Planning Period



CHAPTER 2

INTRODUCTION

Background

The City of Lincoln's last wastewater facilities plan update was completed in 1995. Lincoln's increasing population and the overall age of some wastewater system components are driving the need for system improvements. Several regulations have also been promulgated which impact the City's wastewater treatment requirements. The City of Lincoln Public Utilities Department initiated this update of the 1995 Facilities Plan to proactively address wastewater issues and assure that the City is well prepared to meet wastewater service needs when they occur.

This updated Wastewater Facilities Plan has been developed in conjunction with the 2002 update of the Lincoln-Lancaster County Comprehensive Plan. The study identifies the wastewater collection and treatment system improvements the City of Lincoln will require over the next 25 years and serves as a planning guide for both short (year 2025) and long-term (year 2050) improvements to the collection and treatment facilities. The information contained in this report will be used for general planning, identifying capital improvement projects, and determining funding requirements.

Factors Affecting the Facilities Planning Study

Since completion of the 1995 facilities plan update, a number of factors have arisen that impact the City's wastewater treatment requirements. These include:

- Regulatory changes,
- Population increase, and
- Aging facilities.

Regulatory Changes. Regulations affecting the City's wastewater treatment facilities include the following:

- The Clean Water Act (CWA),
- Title 117 - Nebraska Surface Water Quality Standards,
- The Clean Air Act (CAA), and
- 40 Code of Federal Regulations (CFR) Part 503.

Clean Water Act. The CWA impacts the City of Lincoln's wastewater treatment requirements in several ways. Proposed changes to Lincoln's National Pollutant Discharge Elimination System (NPDES) Discharge Permits will require removal of ammonia from the wastewater prior to its discharge to Salt Creek. The anticipated ammonia removal requirements will significantly reduce the capacity of existing treatment facilities and ultimately necessitate system expansion at both the Theresa Street and Northeast facilities.

It is anticipated that the concentration of chlorine allowed in the City of Lincoln's wastewater discharges will also be severely restricted. To address this issue the City is installing ultraviolet (UV) disinfection systems at both treatment facilities. The use of UV disinfection will eliminate the addition of chlorine to the wastewater under dry weather conditions.

New SSO requirements proposed under the CWA will prohibit sanitary sewer overflows or treatment system bypasses during wet weather periods. To comply with these regulations, Lincoln will be required to construct facilities to provide adequate treatment of all wet weather flows.

Title 117 – Nebraska Surface Water Quality Standards. These standards represent the State's policy to protect surface waters for a variety of uses. Recently revised standards for Salt Creek impact the quality of effluent allowed to be discharged from Lincoln's two wastewater treatment plants. The revised standards are more restrictive than the previous standards with respect to chlorine and ammonia.

Clean Air Act. This regulation deals with toxic air emissions from various sources, including wastewater treatment plants. Because wastewater treatment facilities typically have fugitive emissions which are toxic, such as hydrogen sulfide and methylmercaptans, the City of Lincoln may be impacted by this regulation and consequently have to implement a toxic air emissions reduction program.

40 CFR Part 503. In February 1993 the US EPA published 40 CFR Part 503 which deals with the use and disposal of municipal sewage sludges. These regulations are comprehensive and affect some the City's sludge handling and reuse practices.

Population Increase. The City of Lincoln's population has increased approximately 30 percent since the last expansion of the Theresa Street WWTF in 1973. Growth is expected to continue at a steady pace for the foreseeable future. This growth will tax existing wastewater collection and treatment facilities. In several areas, hydraulic loadings during peak rainfall events are approaching, or have already exceeded, the sewer system's capacity to transport wastewater flows.

Aging Facilities. The Lincoln wastewater collection system dates back to 1888 when the first sewer lines were installed in the Lincoln area. Some of the older sections of the system are badly deteriorated due to age or are simply out of date with respect to construction methods and materials. Replacement or rehabilitation of older sections of the system is necessary to assure continued reliable service and/or to reduce the quantity of storm water or ground water entering the system.

The original wastewater treatment facilities were constructed at the Theresa Street site in 1923. The system was upgraded and expanded in the 1940s to include the present trickling filters. Subsequent expansions in 1966 and 1973 added the West Side and East Side activated sludge facilities. The Northeast WWTFs were constructed in 1980 and placed into service in 1981. Because of age, some portions of the treatment facilities have deteriorated to the extent that they must be refurbished or replaced just to remain functional. Other units, such as the trickling filters at the Theresa Street facility, need to be replaced because they represent outdated technology that will no longer meet the City's treatment needs.

Planning Goals and Objectives

The overall goal of the 2003 Lincoln Wastewater Facilities Plan Update is to identify wastewater collection and treatment system modifications required to:

1. Provide efficient wastewater service,
2. Assure adequate protection of public health and the environment, and
3. Comply with all relevant local, state, and federal requirements.

A series of specific objectives have been identified for the wastewater facilities planning update. These objectives are:

1. Review the City's planning documents, including the Draft 2002 Lincoln-Lancaster County Comprehensive Plan, and the 1995 Wastewater Facilities Plan. Assess the findings and recommendations of these plans, and identify items that impact the City's wastewater collection and treatment systems.

2. Estimate future service area wastewater flows using the 2002 Lincoln-Lancaster Comprehensive Plan population projections and operations records provided by the City.

3. Review current and anticipated laws and regulations affecting wastewater management and identify specific requirements that impact Lincoln's wastewater program.

4. Identify applicable water quality and wastewater discharge standards.

5. Define the current capacities and treatment capabilities of the Theresa Street WWTF and Northeast WWTF.

6. Identify the most cost-effective, long-term configuration for the Lincoln wastewater system, including collection and treatment components.

7. Develop a phased plan and schedule for implementing required system improvements.

These specific objectives are addressed in detail in the following chapters of this report.

CHAPTER 3

PLANNING AREA CHARACTERISTICS

A plan to help guide the delivery of the City of Lincoln's wastewater system utility services to future development areas is a fundamental part of the facilities plan update. The amount of land area needed for development has a general correlation to population. Therefore, it can be assumed that as the City's population increases, a proportional amount of additional land will require wastewater service.

A 25-year planning period, beginning in 2000 and ending in 2025, was established in the Lincoln-Lancaster County Comprehensive Plan. Projected populations for a 50-year period, from the year 2000 through 2050, were developed based on supplemental information received from the Lincoln-Lancaster County Planning Department to provide the long term wastewater service information required for this facilities plan update. Based on projected population figures, land area growth requirements were estimated and associated improvements to the Lincoln wastewater collection and treatment systems were identified.

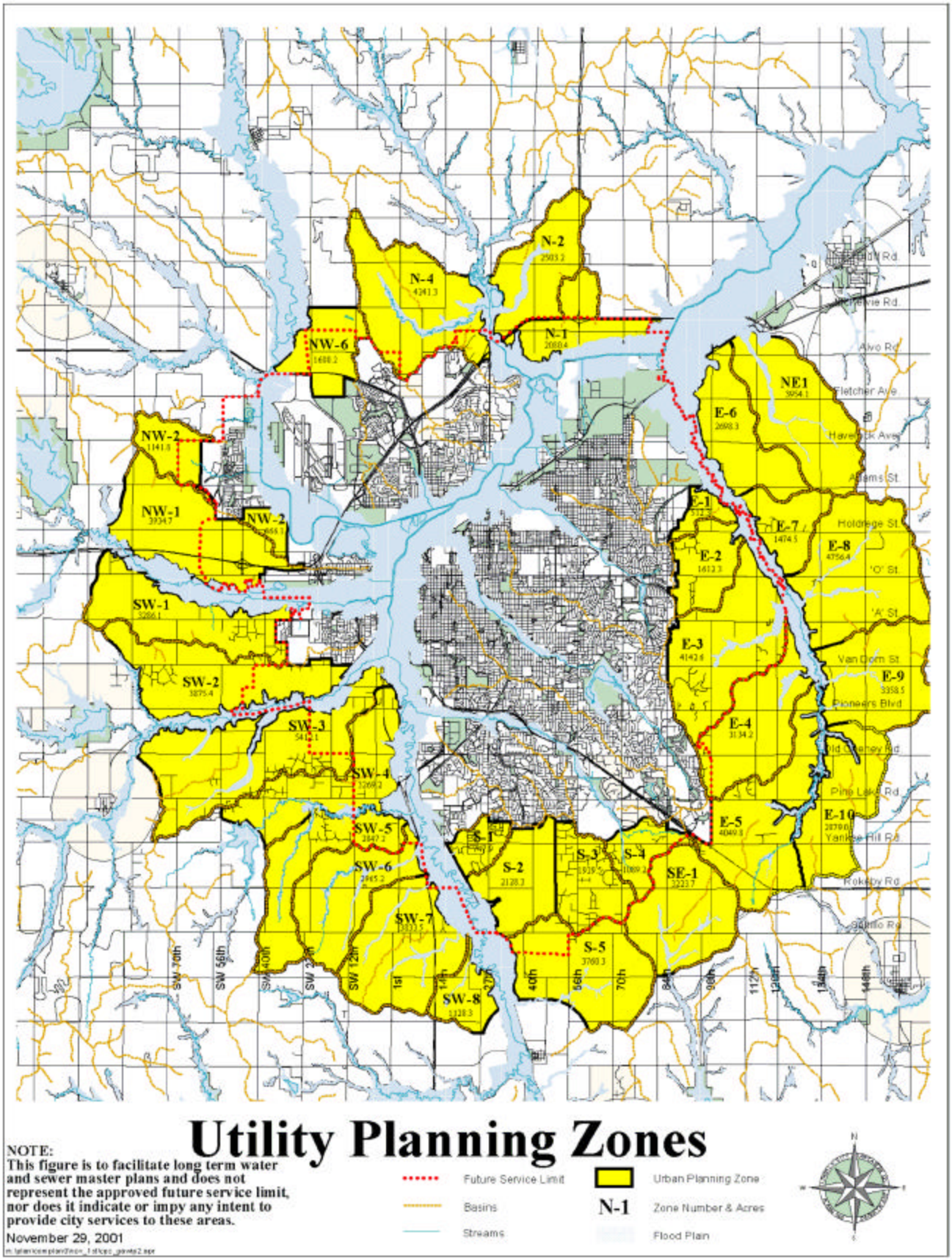
The anticipated growth pattern from 2000 to year 2025 was derived from projections made in the 2002 Lincoln-Lancaster County Comprehensive Plan. This chapter reviews existing population distribution and growth trends, and presents population projections and anticipated growth areas for the 25-year period beginning in 2000.

Study Area Boundaries

The study area includes:

1. The entire City of Lincoln, Nebraska;
2. Portions of the Middle Creek and Haines Branch basins to the west;
3. Cardwell Branch, located in the southwest;
4. The Upper Salt Creek and Beals Slough areas to the south;
5. Little Salt Creek and Lynn Creek drainages to the north and northwest;
6. Northeast Salt Creek drainage to the north and northeast; and
7. Stevens Creek to the east.

The study area is shown on Figure 3-1. The entire study area encompasses approximately 296 square miles, of which only about 79 square miles are presently served by the City's sanitary sewer system. Because future growth details cannot be known at this time, this facilities plan addresses future wastewater collection and treatment needs only in a general way.



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LincolnWastewaterSystem
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Figure3-1
StudyArea

Physical Characteristics

The City of Lincoln's wastewater collection system currently serves 13 drainage basins. These basins vary in size and type of land development. Wastewater generated in ten of these areas is treated at the Theresa Street WWTF located at 2400 Theresa Street. These areas include:

1. Salt Creek
2. West "O" Street
3. Beals Slough
4. Haines Branch
5. Middle Creek
6. Antelope Creek
7. East Campus
8. Oak Creek
9. Little Salt Creek
10. Lynn Creek

The Northeast WWTF, located at 7000 North 70th Street, handles wastewater generated in the remaining three basins:

1. Deadmans Run
2. Havelock
3. Regent Heights (portion of West Stevens Creek drainage basin)

Figure 3-2 shows the location of each of these drainage basins.

There is an interconnection between those portions of the collection system which transport wastewater to the Northeast WWTF and those portions of the system that convey wastewater to the Theresa Street WWTF. The connection is located in the Deadmans Run drainage and provides the capability to divert wastewater that would normally flow to the Northeast WWTF to the Theresa Street facility. Based on current wastewater flow rates, flows of up to about 4 mgd can be "redirected" from the Northeast WWTF to the Theresa Street WWTF using this interconnection.

Growth within the 25-year planning period is anticipated primarily in drainage basins currently being served by the wastewater system. As these basins become fully developed (e.g., Antelope, Beals Slough, and Lynn Creek) and as population growth continues, new service areas will need to be developed.

The 2002 Lincoln-Lancaster County Comprehensive Plan has divided projected wastewater service needs into Tier I and Tier II needs. Tier I needs represent those needs that are expected to occur from 2000 through 2025. Tier II needs are expected to occur between 2025 and 2050. Tier I needs have been further categorized as either Priority A or Priority B needs. Priority A needs being those that are expected to occur during the period from 2000 through 2012. Priority B needs are those that are expected to occur between 2013 and 2025. The Tier I Priority A and B service area needs are shown in Figure 3-3.

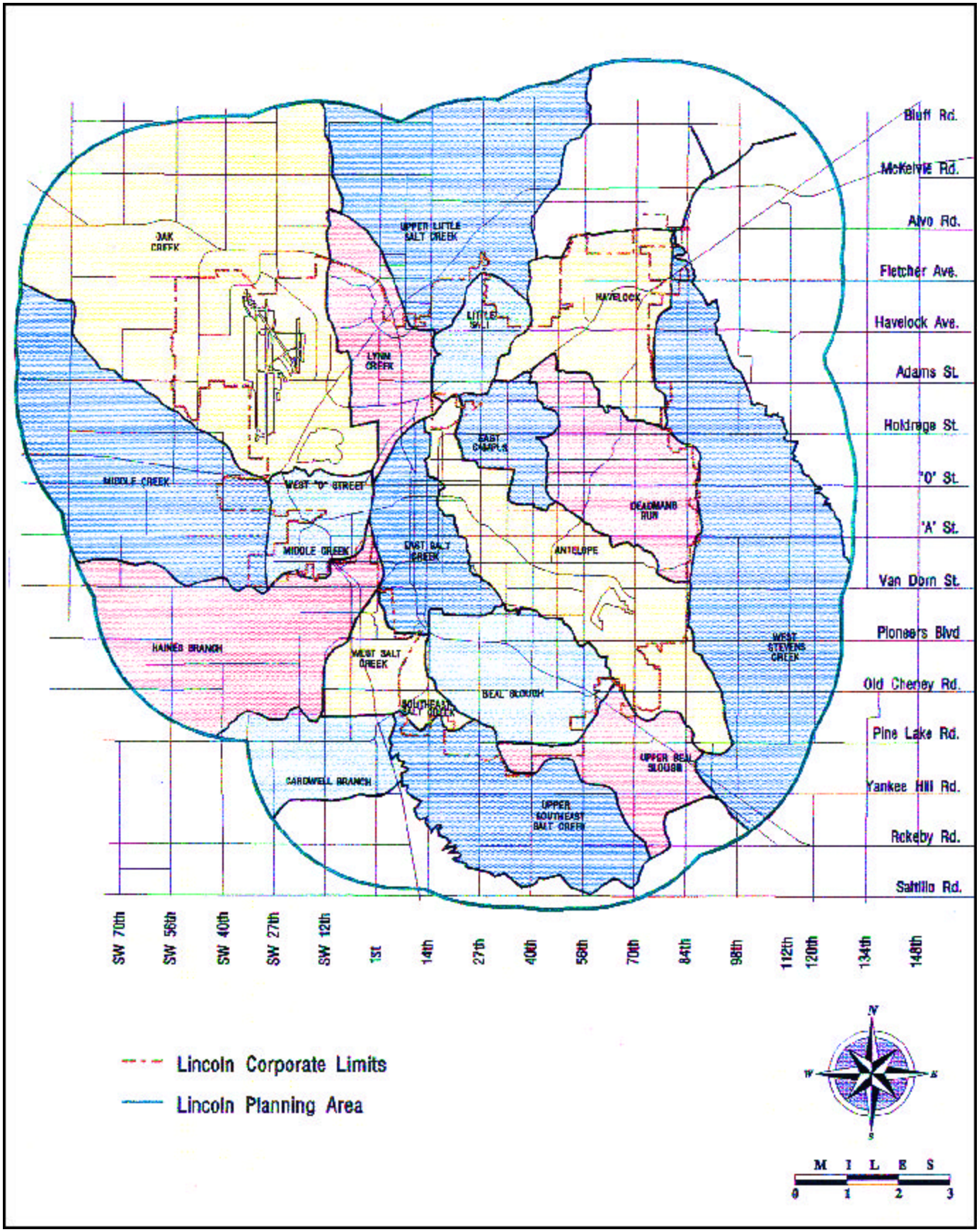

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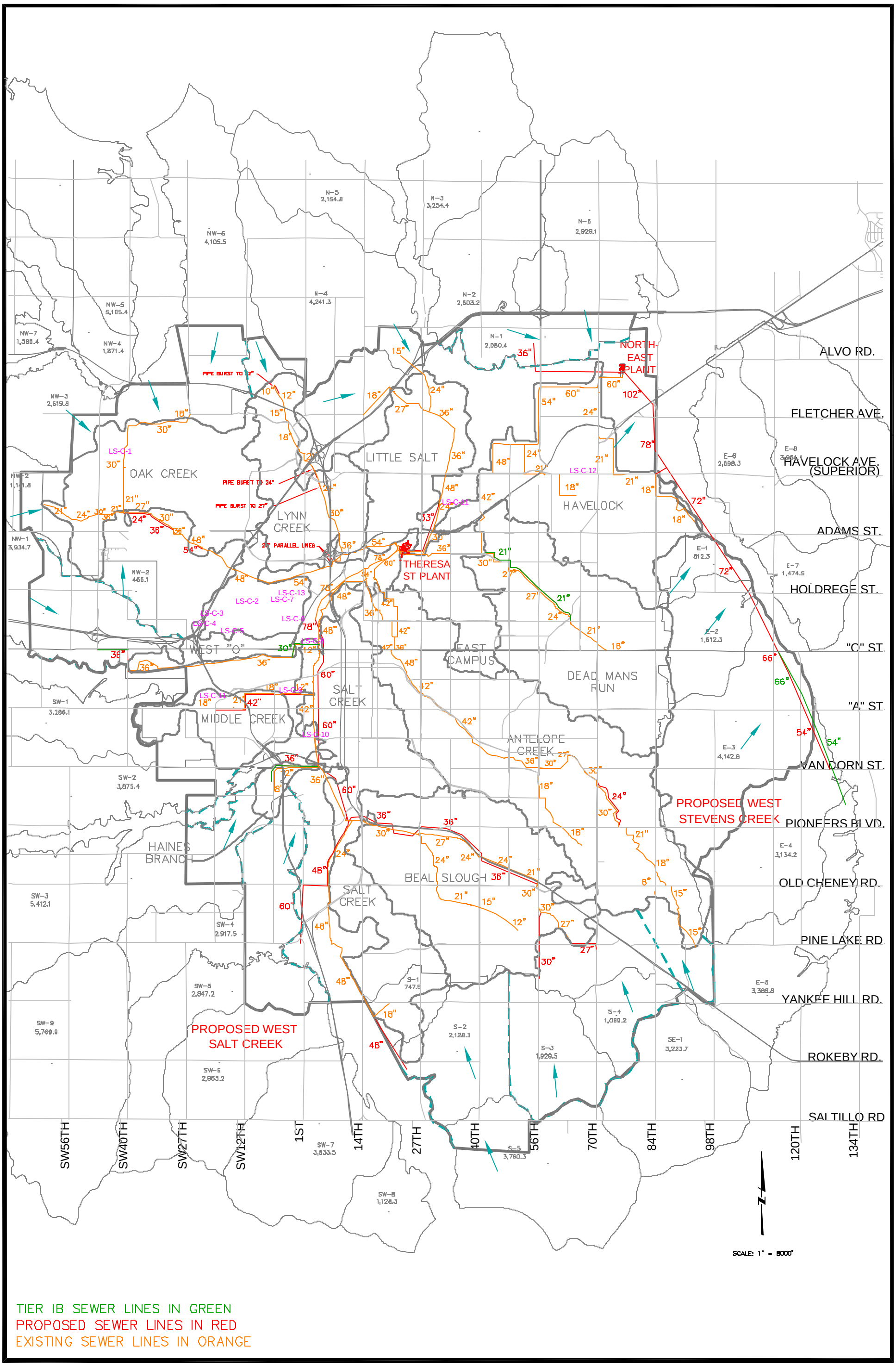
Figure3-2
Drainage Basins



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Lincoln Wastewater System Facilities Plan Update
CITY OF LINCOLN
SANITARY SEWER BASINS

Figure 3-3
TIER 1 PRIORITY A AND B NEEDS

100-Year Flood Plain Areas

The City of Lincoln has enacted a flood plain management program which restricts growth within the 100-year floodplain. This was accomplished by creating ordinances that prohibit the subdivision of land parcels or platting within the 100-year floodplain unless certain restrictive conditions are met. Zoning ordinances also prohibit encroachments in the floodway and impose certain construction requirements in the floodway fringe. In addition, the City of Lincoln has passed resolutions regulating the creation of special assessment districts in the 100-year floodplain for water, sanitary sewer, storm sewer, sidewalk, and ornamental lighting. The City has given jurisdictional authority to the Building and Safety Department to enforce these ordinances. Based on these regulations, it is anticipated that growth within the 100-year floodplain will be minimal in the foreseeable future.

Planning Agencies

The 2003 Wastewater Facilities Plan Update will be used by many different groups within the City, and certain agencies outside the City, to formulate plans to manage growth in the Lincoln area. During the formulation of this facilities plan update, a concerted effort was made to keep these groups and agencies involved. The groups include:

1. Lincoln-Lancaster County Planning Department
2. City of Lincoln Department of Public Works and Utilities
3. Nebraska Department of Environmental Quality (NDEQ)
4. U.S. Environmental Protection Agency (US EPA)

Existing Land Usage

The City of Lincoln and Lancaster County are using the Lincoln-Lancaster County Comprehensive Plan to guide their planning and land-use activities. The land-use plans reflect an approach to addressing the following basic concerns of the community:

1. Continued development of downtown as the heart of the community; a center of employment, culture, entertainment, and government; the clearly dominant multi-use center.

2. Development of a compact and generally contiguous urban form for the City of Lincoln.

3. Development of a roadway network around the perimeter of the City of Lincoln.

4. Development of infrastructure such as roads, water, sewer, parks, stormwater, schools, libraries, and open space concurrent with land development.

5. Development of detailed sub-area plans for developing areas of the City, the urban environment, and the rural environment.

6. Development of a close relationship between the comprehensive plan, land-use regulations, and the capital improvements program.

7. Development of multiple public-use corridors for trails, parks, stormwater drainage, utilities, etc.

8. Consideration of the natural and "man-made" environments in all development actions.

The existing and future land-use plans within the City of Lincoln will direct growth to specific drainage basins to ensure orderly expansion and to control expenditures for water and sewer infrastructure improvements. The plans acknowledge that Lincoln's existing neighborhoods are important resources that must be protected and, if necessary, revitalized. The plans seek to maximize benefits from land already within the urban area through infill development on underutilized sites. These strategies emphasize reliance on maximum feasible utilization of existing public facilities including roadways, utilities, schools, and libraries before constructing new public facilities in other locations. In some instances, rebuilding or expanding deficient facilities within the existing urban area will be necessary.

Population Growth

This section presents historical population growth trends and projects future population growth based on these trends.

Historical Populations. Historical population data were supplied by the Lincoln-Lancaster County Planning Department. The source for the population trends from 1880 to 2000 is the U.S. Bureau of Census. Historical population growth for the City of Lincoln and Lancaster County is shown in Table 3-1.

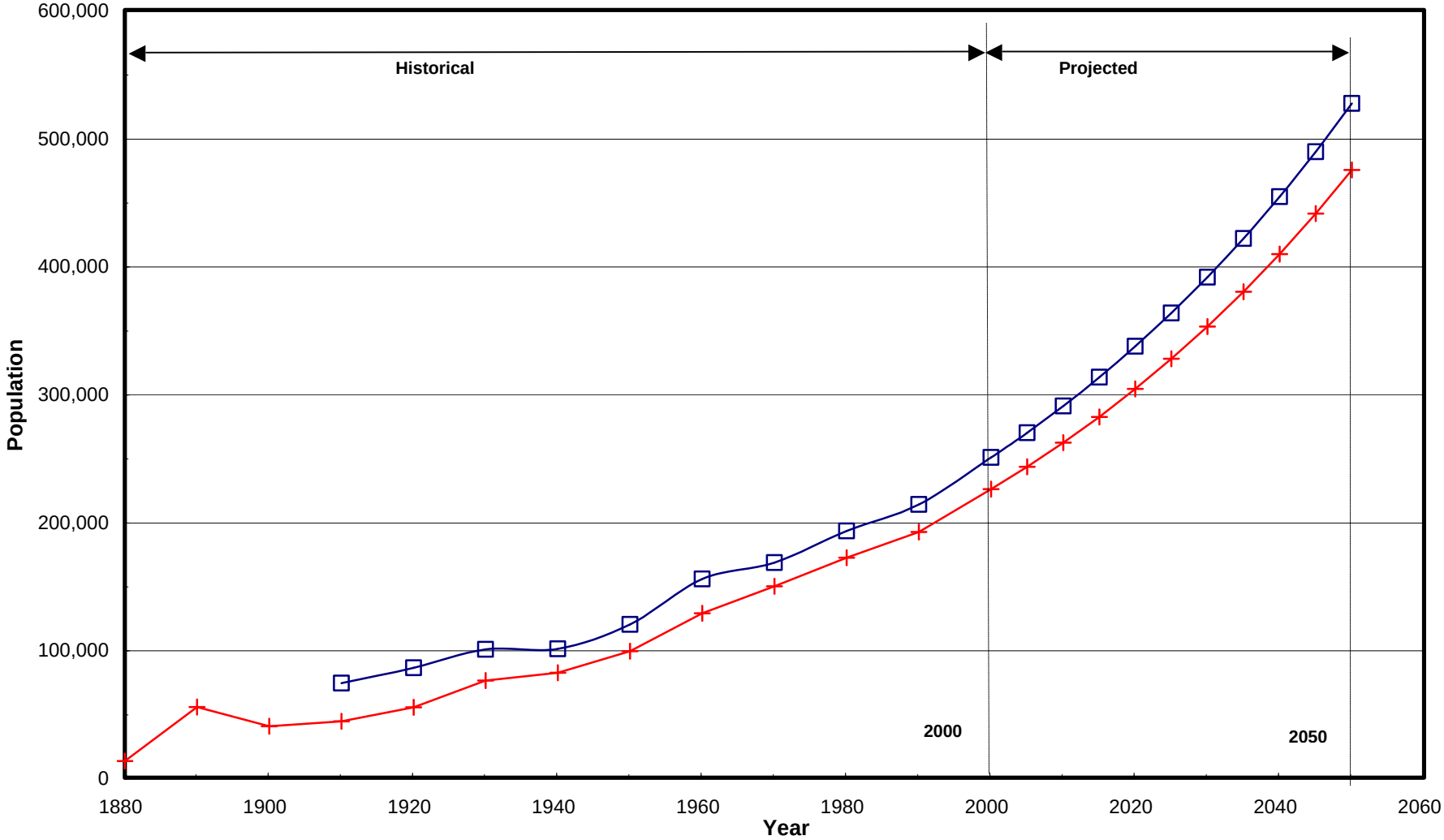
Table 3-1. Historical City/County Population Growth

Year	City of Lincoln	Annual % Increase	Lancaster County	Annual % Increase
1880	13,003	-		
1880-1890	13,003 - 55,154	15.6		
1890-1900	55,154 - 40,169	3.1		
1900-1910	40169 - 43,973	0.9	73,793	-
1910-1920	43,973 - 54,948	2.3	73,793 - 85,902	1.5
1920-1930	54,948 - 75,933	3.3	85, 902 - 100,324	1.6
1930-1940	75,933 - 81,984	0.8	100,324 - 100,585	0.0
1940-1950	81,984 - 98,884	1.9	100,585 - 119,742	1.8
1950-1960	98, 884 - 128,521	2.7	119,742 - 155,272	2.6
1960-1970	128,521 - 149,518	1.5	155,272 - 167,972	0.8
1970-1980	149,518 - 171,932	1.4	167,972 - 192,884	1.4
1980-1990	171, 932 - 191,972	1.1	192,884 - 213,461	1.0
1990-2000	191, 972 - 225,581	1.6	213,461 - 250,291	1.6

Table 3-1 shows that in recent years the City of Lincoln and Lancaster County have both sustained moderate population growth. The population growth rate for the last 30 years for the City of Lincoln has averaged 1.38 percent per year, and for Lancaster County 1.34 percent per year.

Population Projections. Because wastewater collection systems and some treatment plant components typically have 50-year design lives, it is advantageous to project population growth for a 50-year period. This report estimates future wastewater utility needs for 25-year and 50-year planning horizons using population projections provided by the Lincoln-Lancaster County Planning Department as shown in Table 3-2. Graphs of data in Table 3-1 and Table 3-2 are shown in Figure 3-4.

Figure 3-4
Historical and Projected Populations for the
City of Lincoln and Lancaster County



Legend
City of Lincoln
Lancaster County

Lincoln Wastewater System
Facilities Plan Update
CITY OF LINCOLN

Table 3-2. City/County Population Projections

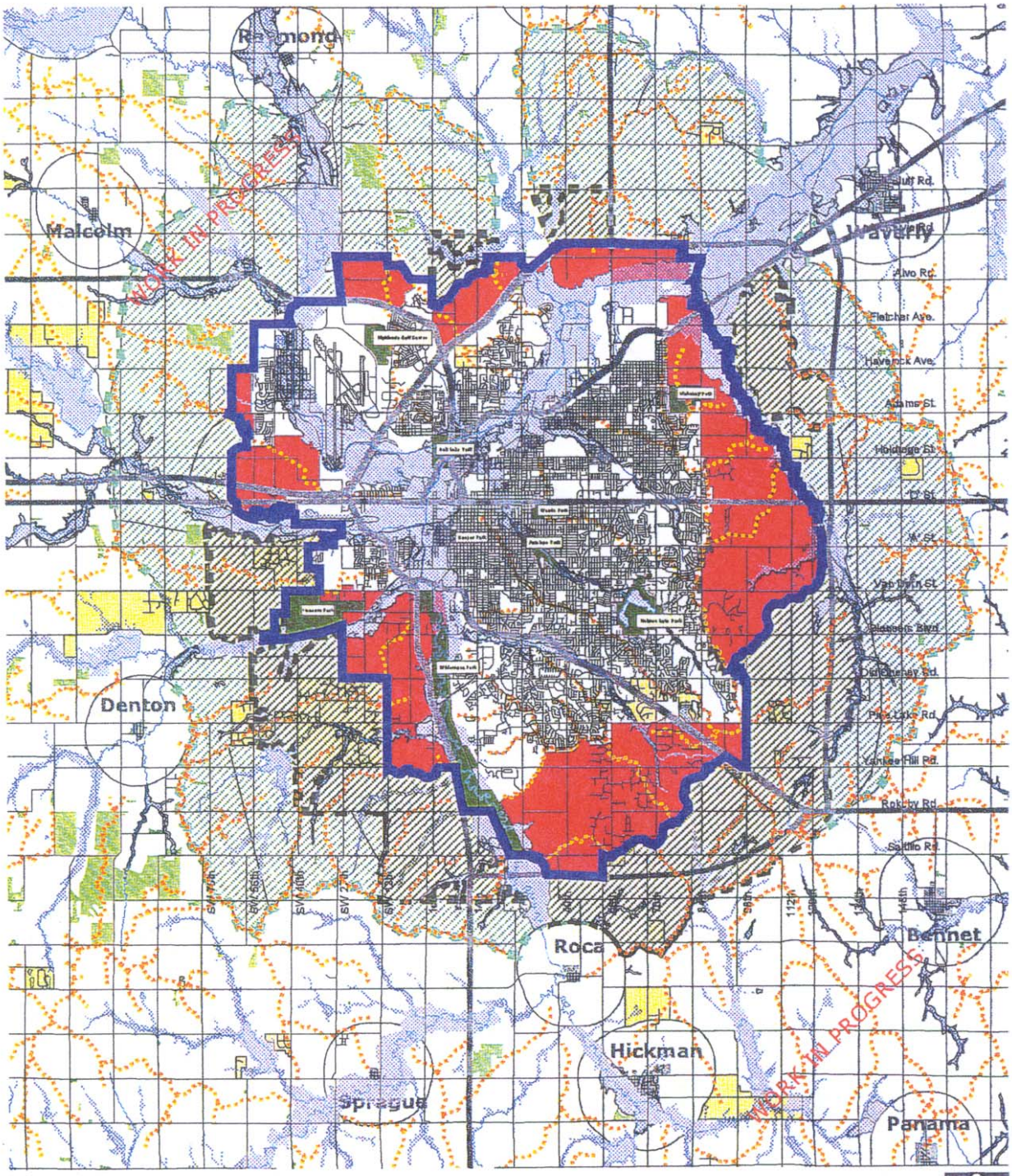
Year	City of Lincoln	Annual % Increase	Lancaster County	Annual % Increase
2001	225,581	1.5	250,291	1.5
2005	243,015	1.5	269,634	1.5
2010	261,796	1.5	290,473	1.5
2015	282,029	1.5	312,922	1.5
2020	303,825	1.5	337,106	1.5
2025	327,306	1.5	363,159	1.5
2030	352,601	1.5	391,225	1.5
2035	379,852	1.5	421,460	1.5
2040	409,208	1.5	454,032	1.5
2045	440,833	1.5	489,122	1.5
2050	474,903	1.5	526,923	1.5

The population projections provided by the Lincoln-Lancaster County Planning Department and shown in Table 3-2 indicate that the present growth trend is expected to continue. During the 25-year Tier I planning period, the result will be the addition of approximately 102,000 and 113,000 persons to the 2000 population for the City of Lincoln and Lancaster County respectively. Using a moderate annual growth rate of 1.5 percent, the calculated population increase from the year 2000 through the year 2050 is approximately 249,000 for the City of Lincoln, and 277,000 for Lancaster County. The projected service area for the year 2025, shown on Figure 3-5, was taken from the Lincoln-Lancaster County Comprehensive Plan.

Collection System Land-Use Plan

As the City's population has grown historically, new land areas have been developed to accommodate the growth. In planning for future growth in the City of Lincoln and its impact on the wastewater system, the land-use plan described in the Lincoln-Lancaster Comprehensive Plan was utilized. The population growth associated with this land-use plan served as the basis for projecting collection system improvements and treatment needs through the year 2025.

Total land area needed for future growth was derived using present demographic information obtained from the City planning department. Wastewater planning decisions should incorporate enough flexibility to accommodate possible variations in future growth conditions within the City. The Lincoln-Lancaster Comprehensive Plan addresses growth in detail and provides specific direction for planned growth.



Draft - Planning Commission - Urban Growth Tiers

Lincoln- Lancaster County Comprehensive Plan

Lincoln- Lancaster County, Nebraska

April 4, 2002
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TIER I
TIER II
TIER III
ACREAGES
PROPOSED FUTURE SERVICE LIMIT
PREVIOUS PROPOSED FUTURE SERVICE LIMIT
Basins
PRAIRIE
FLOODPLAIN

BROWN AND CALDWELL

MWH
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Figure 3-5
Projected Service Area - 2025

CHAPTER 4

EVALUATION OF EXISTING WASTEWATER FACILITIES

During the previous facility planning effort in 1995 the existing wastewater treatment facilities were evaluated for performance, capability for serving current and projected development, and ability to meet effluent quality discharge requirements. That analysis of the existing wastewater facilities has been updated to reflect new conditions or requirements and is presented in this chapter.

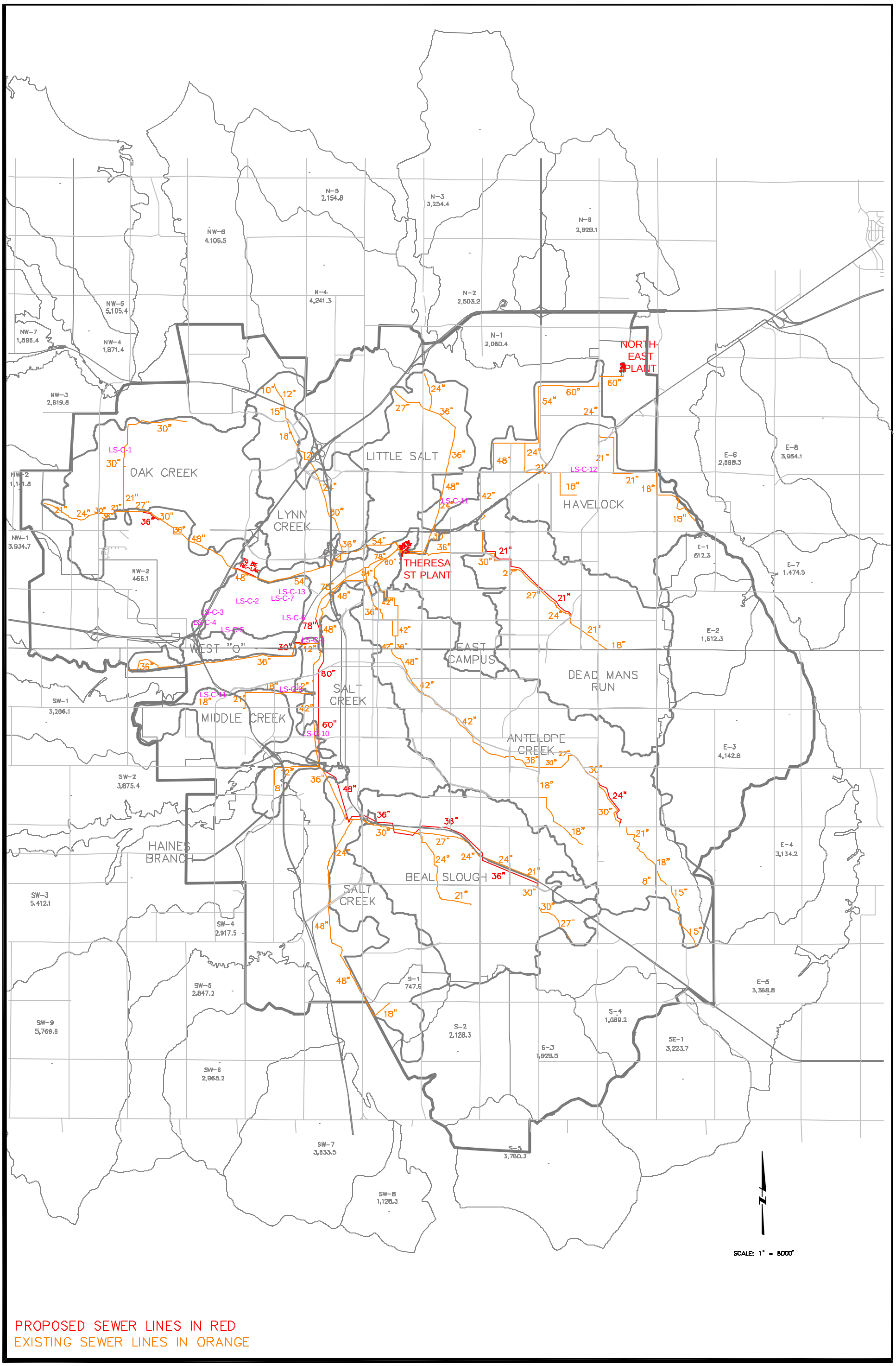
Description of Existing Collection System

The existing Lincoln wastewater collection is shown in Figure 4-1. As described in Chapter 3, the City of Lincoln wastewater collection system currently serves all or part of 13 drainage basins. Ten of these drainage basins are served by the Theresa Street WWTF. The drainage areas served by the Theresa Street facility include:

1. Salt Creek
2. West "O" Street
3. Beals Slough
4. Haines Branch
5. Middle Creek
6. Antelope Creek
7. East Campus
8. Oak Creek
9. Little Salt Creek
10. Lynn Creek

Salt Creek. The existing Salt Valley Trunk (SVT) Relief Sewer line, which represents the backbone of the sanitary sewer system, extends from the Theresa Street WWTF located near the intersection of Theresa Street and 27th Street, 8.6 miles to approximately the intersection of Yankee Hill Road and 14th Street. A six-phase plan for a relief sewer has been established, of which two phases have been completed. Phase I is designed for 17,000 acres of development and Phase IIA for 22,000 acres. Phase IIB is currently in the design phase. This relief sewer construction provides much needed capacity to the system.

West "O" Street. The existing sanitary sewer mains that flow west to east in West "O" Street were built in two segments. The first segment, which connects to the Salt Creek Trunk, consists of a 12-inch vitrified clay pipe (VCP) line that discharges to the "P" Street Lift Station (C-8). This lift station includes two suction lift pumps rated at 900 gallons per minutes (gpm) capacity each, which results in a total capacity of 4.0 cubic feet per second (cfs). To the west of the first segment is the second segment of the West "O" main, a newer 36-inch line that was constructed with the need for future capacity in mind. As the system currently exists, the 36-inch main discharges into the downstream 12-inch main.



PROPOSED SEWER LINES IN RED
EXISTING SEWER LINES IN ORANGE

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Lincoln Wastewater System Facilities Plan Update
CITY OF LINCOLN
SANITARY SEWER BASINS

Figure 4-1
EXISTING LINCOLN WASTEWATER COLLECTION SYSTEM

Beals Slough. The center of the Beals Slough Basin is at Old Cheney Road and 40th Street. The Beals Slough Basin is south of the Antelope Creek Basin and discharges flow to the Salt Creek Trunk sewer. The City map shows 5,370 acres of service area within the basin, which will generate an estimated 32.7 cfs of wastewater. This flow will overload selected sections of the Beals Slough trunk line. One location is at the intersection of 56th Street and Highway 2. A 24-inch line is planned to parallel the existing trunk at this location to mitigate this flow problem. Nevertheless, downstream capacity constraints will cause surcharging to extend upstream along almost the entire length of the Beals Slough Systems.

Haines Branch. (Included in the Salt Creek discussion.)

Middle Creek. The majority of existing 12-inch to 21-inch interceptor sewer serving the Middle Creek Basin is currently overloaded. The average overloading is about 2 cfs for the upstream segments of the line and more than 5 cfs for the last 1,739 linear feet (LF) of 18-inch pipe. Lift Station C-9 is located 2,823 LF upstream of the termination of the trunk line into the Salt Valley Trunk. The condition of the piping system has been described as fair.

Antelope Creek. Antelope Creek Basin includes 7,199 acres and generates approximately 42.6 cfs of wastewater that travels in a 42-inch pipe through the majority of the basin. Near the downstream end of the pipeline is a recently extended 15-inch line that reaches just south of Pine Lake Road. It was extended to serve a 403-acre development bound by 84th & 98th Street, and Pine Lake & Yankee Hill Road. Wastewater from the Antelope Creek basin are discharged into the Salt Creek trunk sewer.

Further downstream a set of parallel pipes carry the flow of the trunk line. At 21st and "R" Streets a 36-inch line (Campus Line) splits off and runs up 20th Street while the main 42-inch trunk runs up 22nd Street. The Campus Line terminates at the Salt Valley Trunk Sewer while the Antelope Creek Trunk line continues all the way to the Theresa Street WWTF.

East Campus. (Included in the Little Salt Creek discussion.)

Oak Creek. The Oak Creek Trunk Line ranges in size from 8-inch to 54-inch and stretches northwest from the City through the Lincoln Municipal Airport. In its present state, there is overloading in the 27-inch and 30-inch portions of the line.

Little Salt Creek. Located immediately north of the Theresa Street WWTF, the Little Salt Creek Basin includes 2,251 acres of developed land, with more developable land to the north. The Little Salt Creek Interceptor ranges in size from 24- to 48-inches and was built in the 1970's.

Lynn Creek. The main line that serves Lynn Creek ranges in diameter from 18-inches to 36-inches. The line currently handles all of the present flows easily except in the 24-inch segment (where it currently has under 2 cfs of excess capacity for 503 LF) and in the 21-inch segment (where it currently has under 3 cfs of excess capacity for 1,330 LF and under 1 cfs of excess capacity for 7,809 LF). The total flow that the Lynn Creek sub-basins contribute to the trunk sewer line is about 10.0 cfs. This flow enters the Oak Creek Trunk line at MH#B6-265.

The remaining three drainage areas are served at least partially by the Northeast WWTF. These drainage areas include:

1. Deadmans Run
2. Havelock
3. Regent Heights (portion of West Stevens Creek drainage basin)

Deadmans Run. Wastewater flows from the Deadmans Run area initially were treated at the Theresa Street WWTF but now generally flow to the Northeast WWTF (see discussion in Chapter 3 about potentially diverting some of its flow to the Theresa Street WWTF). The Deadmans Run trunk line consists of pipe diameter ranging from 18-inch to 60-inch. Most of the segments with capacity problems are located at the west end of the run. (The 24-inch diameter and 30-inch diameter segments of the line are buried at an average depth of 15.7 feet.)

Havelock. The Havelock Basin is the second existing area that contributes wastewater flow to the Northeast WWTF. The components of the main Havelock line are VCP and PVC pipeline ranging in diameter from 18 to 24 inches. Two of its sub-basins (HV1 and HV10) contribute to the trunk line. Because of low existing flows and the high capacity of the line, there are no existing capacity problems.

Regent Heights. A ridge east of the Havelock, Deadmans Run, and Antelope Basins separates these basins from the West Stevens Creek Basin. There is currently no sanitary sewer infrastructure in the Stevens Creek Basin. The Regent Heights area, which is within the West Stevens Creek Basin, is currently served through the Havelock wastewater collection system.

Collection System Needs

The existing Lincoln wastewater collection system is generally adequate to serve current needs. Some areas of hydraulic overload such as the Salt Valley and Beals Slough areas or deteriorated facilities have been identified for correction. It is recommended that funding be provided to correct these conditions over the next 12 years. As population growth occurs within the service area, the system will have to be upgraded and expanded to continue to meet service needs. Specific upgrade and expansion recommendations are presented in Chapter 8.

Description of Existing Wastewater Treatment Facilities

This section describes the major components of the wastewater treatment facilities serving the City of Lincoln, including the Theresa Street WWTF and the Northeast WWTF. Figure 4-2 shows the locations of these facilities.

Theresa Street Wastewater Treatment Facility. The Theresa Street WWTF is the larger of the two facilities and is located at 2400 Theresa Street. The NDEQ presently considers the design capacity of the Theresa Street WWTF to provide standard secondary treatment to be 30 mgd as indicated in the existing discharge permit (a copy of the existing Theresa Street WWTF NPDES discharge permit is provided in Appendix A). Effluent from the Theresa Street facility is discharged to Salt Creek.

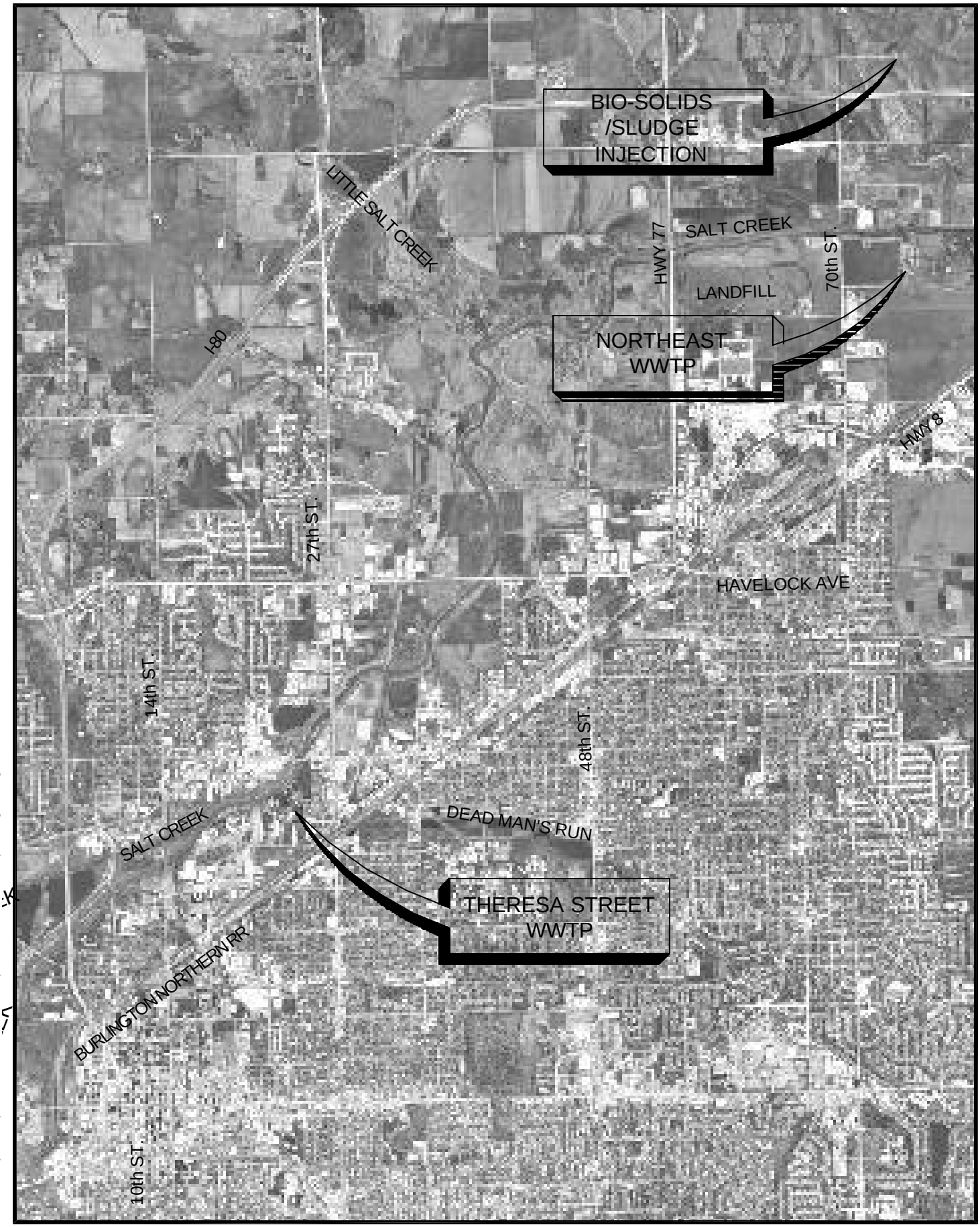

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Figure 4-2
Facility Location Map

The original wastewater treatment facilities at Theresa Street were constructed in 1923 and consisted of influent pumps and Imhoff tanks. In the 1930s, the system was upgraded and expanded to include fixed nozzle trickling filters, secondary clarifiers, and sludge drying beds. A 1940's upgrade included the addition of primary clarifiers and additional trickling filters. Major improvements were made with the construction of a 10-mgd activated sludge train in 1966, and a 15-mgd activated sludge train in 1973. As it currently exists, the Theresa Street WWTF consists of three distinct treatment trains:

1. The Trickling Filter Train,
2. The West Side Activated Sludge Train, and
3. The East Side Activated Sludge Train.

Since completion of the 1995 Wastewater Facilities Plan Update, the following improvements to the Theresa Street WWTF have been completed or are underway:

1. Screening of Raw Primary Sludge Added with Parkson Sieve Press (1997) – These improvements were made to remove plastics and other contaminants from the primary sludge prior to pumping it to the anaerobic digesters.

2. SCADA System Upgrade (1999) – The SCADA System Upgrade increased the capability and reliability of the process monitoring and control system.

3. Primary Clarifier Improvements (2000) – Intended to improve performance of these units, this project replaced the existing primary clarifier sludge collection mechanisms; primary clarifiers 3, 4, 5, and 6 were renovated with new mechanisms and weirs.

4. Headworks Improvements (2001) – Additional influent pumping capacity was installed along with new bar screen equipment. Influent Bar Screens 3 and 4 were replaced. The addition of new screenings conveyance and compaction equipment for headworks, and an additional raw sewage pump were also installed.

5. West Side Aeration Basin Improvements (2000) – This project reconfigured the aeration basins to improve the settling characteristics of the mixed liquor, increase the aeration efficiency and prepare for operating in a nitrification/denitrification configuration.

6. East Side Aeration Basin Improvements (2002)* – This project reconfigures the East Side aeration basins in a way similar to that of the West Side system.

7. ADA Improvements to Building A-16 (2002) – This project brings Building A-16 into compliance with requirements of the Americans with Disabilities Act (ADA).

8. Ultraviolet Disinfection (2002)* – This project replaces chlorine with UV light as the primary wastewater disinfectant.

9. Grit Removal (2002)* – This project replaces the existing aerated grit basins with new vortex type grit basins.

10. Odor Control Project (2002)* – Improvements include odor containment and scrubbing for the East Side System.

11. Secondary Electrical Feed (new transformer) (2002)* – Driven by the need for redundant power for the new East Side aeration blowers, the purpose of this project is to provide electrical back-up to the facility.

12. FEMA Flood Mitigation Project (2002)* – This project includes flood proofing of the electrical substation, area transformers, and key building locations.

13. West Side Blower Replacement (2003)* - Replace existing West Side blowers with new blowers to provide adequate oxygen for waste activated sludge systems.

14. Upgrade return activated sludge (RAS) pumping station for East Side activated sludge systems (2002)*.

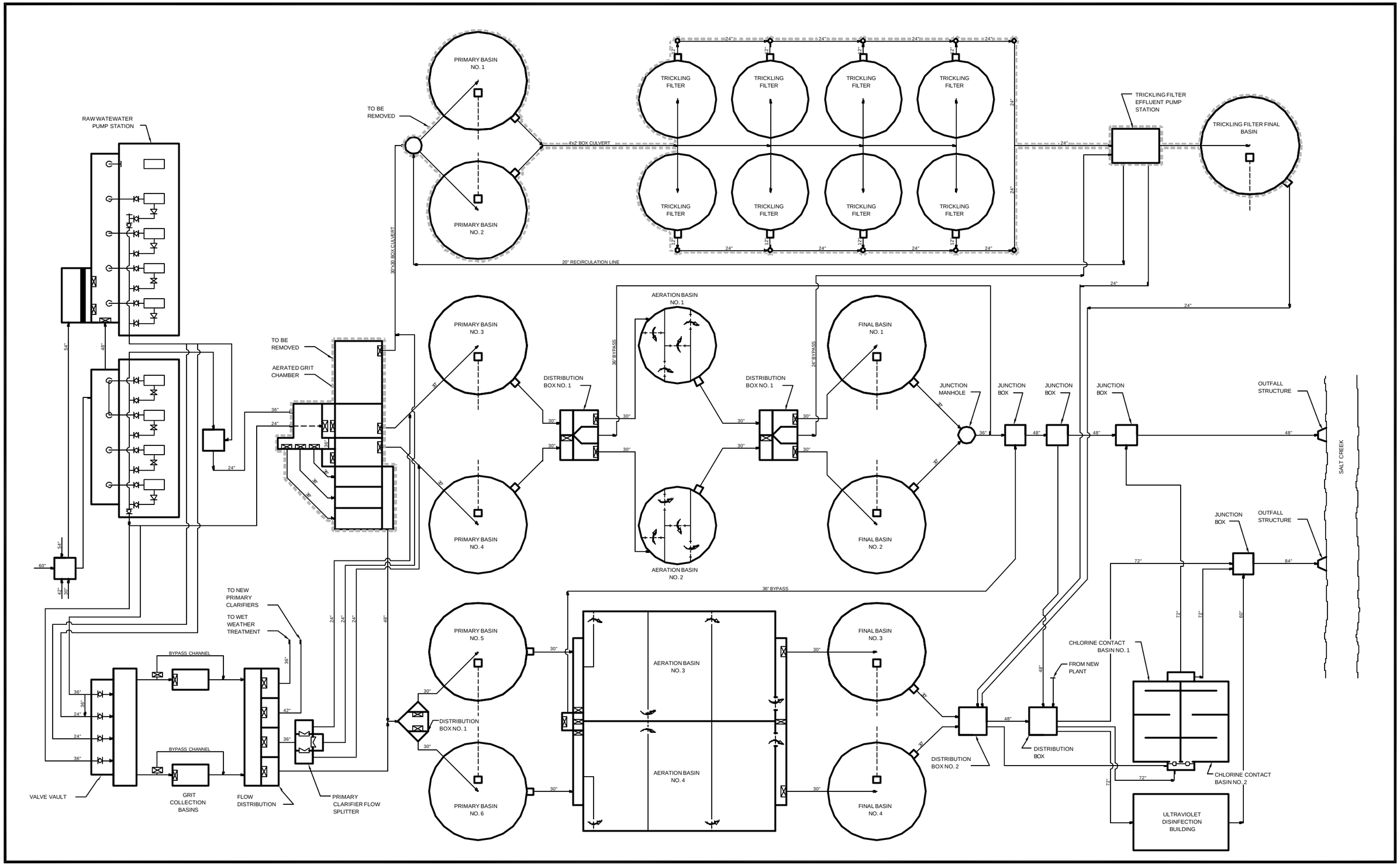
*currently underway.

Figure 4-3 presents a schematic diagram of the liquid stream treatment process at the Theresa Street WWTF. Flow entering the Theresa Street WWTF receives preliminary treatment (screening and grit removal) prior to being split among the three separate treatment trains. Each train employs primary sedimentation followed by secondary treatment via trickling filters or activated sludge. From April 1st through September, following secondary treatment, all wastewater is disinfected with chlorine prior to being discharged to Salt Creek. From October 1st through May, the secondary effluent is discharged directly to Salt Creek without disinfection. The ultraviolet disinfection project currently underway will replace the chlorine disinfection with UV disinfection. Appendix B contains a summary of key process data for the Theresa Street WWTF.

Figure 4-4 presents a schematic of the residuals handling facilities at the Theresa Street WWTF. The facilities treat five types of solids:

1. Screenings and grit,
2. Primary sludges,
3. Waste activated sludge and trickling filter sludge (humus),
4. Primary and secondary scum, and
5. Septage waste.

Egg-shaped anaerobic digesters were constructed in 1992 to treat the sludge, scum, and septage waste. Screenings and grit are disposed directly in the Lancaster County landfill. Methane gas produced by the anaerobic digestion process is used to heat the digesters and power two 450-kW engine driven generators which produce electric power. The electric power produced is introduced into the Lincoln area power grid and serves to offset electric power used at the WWTF to operate plant equipment.



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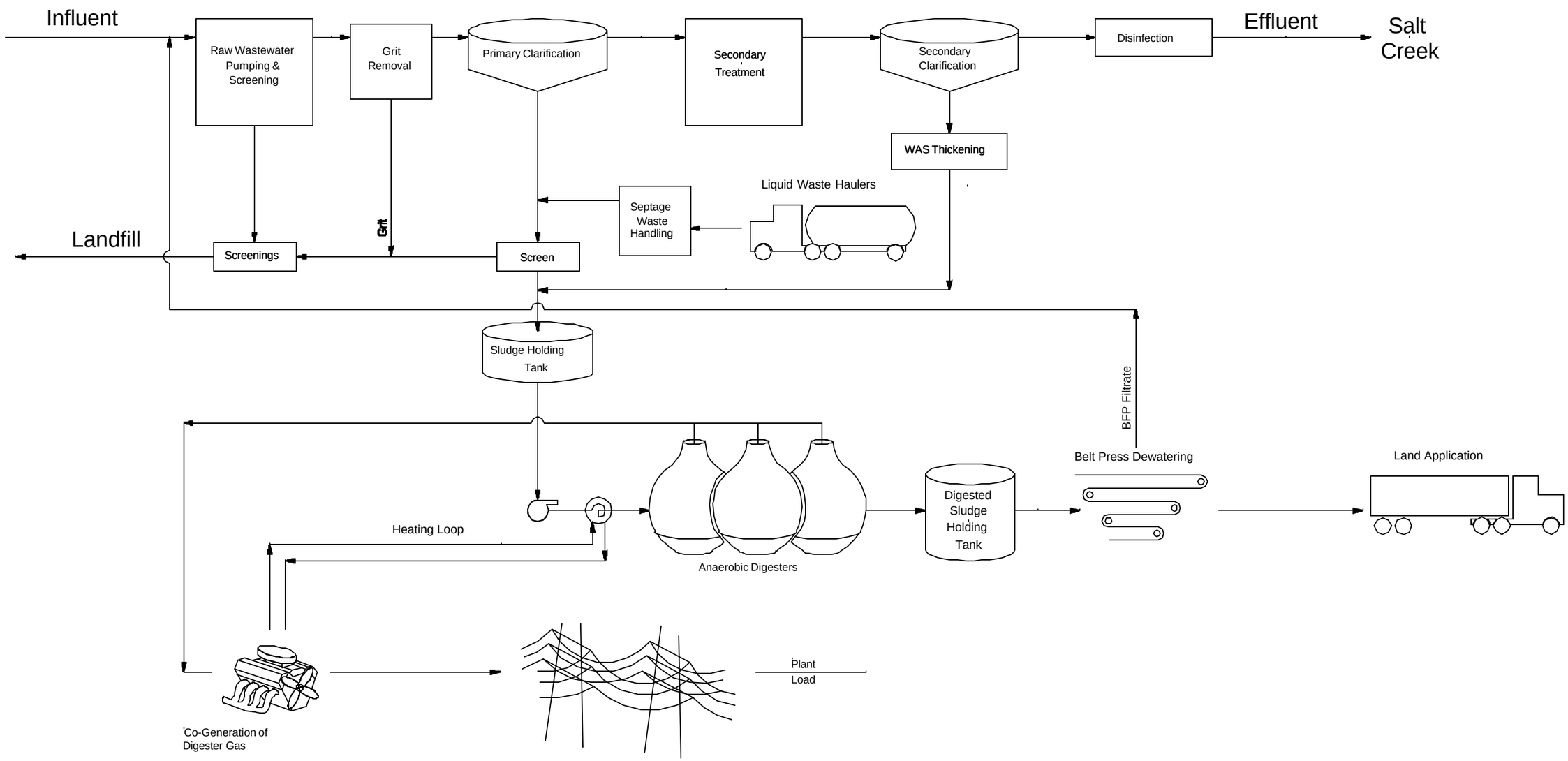
THERESA STREET WASTEWATER TREATMENT PLANT

Figure 4-3
Theresa Street WWTF Process Schematic



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CITY OF LINCOLN
THERESA STREET WASTEWATER TREATMENT PLANT

Figure 4-4
Theresa Street WWTF Solids Handling Schematic

Northeast Wastewater Treatment Facility. Construction of the Northeast WWTF was completed in November 1980. Preliminary treatment (screening and grit removal) is provided prior to primary and secondary treatment. The NDEQ currently considers the capacity of the Northeast WWTF to provide standard secondary treatment to be 8 mgd as indicated in the existing discharge permit (a copy of the Northeast WWTF NPDES discharge permit is provided in Appendix C). Secondary treatment at the Northeast WWTF is provided by an activated-biotower process which consists of biotowers, aeration basins, and secondary clarifiers. From May through September the final effluent is chlorinated prior to discharge to Salt Creek. From October through April the secondary effluent is discharged directly to Salt Creek without disinfection. Figure 4-5 presents a schematic diagram of the Northeast WWTF liquid stream treatment processes, and Figure 4-6 is a schematic diagram of the Northeast solids treatment system. Appendix D contains specific design data for the Northeast WWTF.

Primary sludge, secondary sludge, and scum generated at the Northeast WWTF are stabilized by anaerobic digestion prior to thickening and disposal at a dedicated land application site. All digested sludges are pumped about 2 miles offsite to a storage lagoon located at the land application site. Sludge from the storage lagoon is injected into City owned cropland adjacent to the lagoon. Supernatent from the sludge storage lagoon is returned to the Northeast WWTF for treatment.

Since completion of the 1995 Wastewater Facilities Plan Update, the following projects have been completed or are under construction at the Northeast Wastewater Treatment Facility:

1. Chemical Feed Facilities for Odor/Corrosion Control (1997) – This project included the construction of iron feed facilities to allow ferric chloride to be injected into the plant influent.

2. Headworks Rehabilitation (1997) – This project included the installation of new flow measurement equipment and repaired concrete grit handling structures which had deteriorated due to hydrogen sulfide attack.

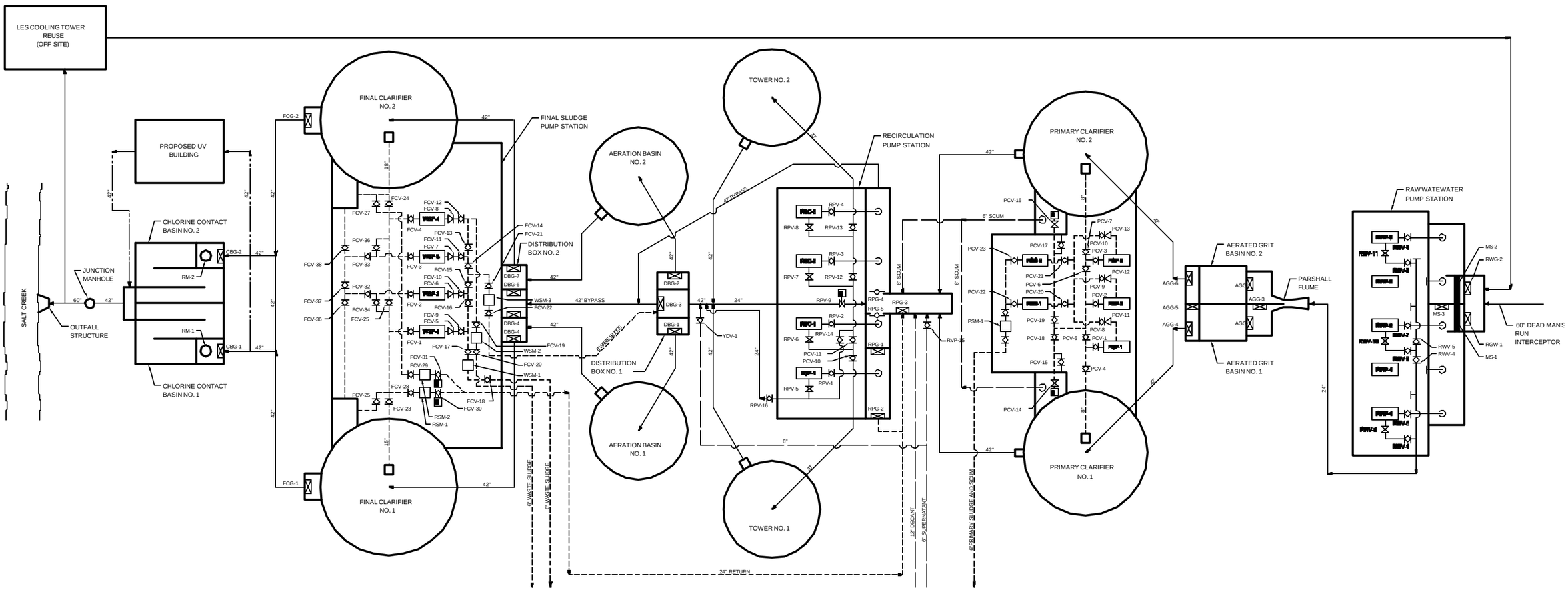
3. Aeration Basin Modifications (1998) – This project included the installation of fine-bubble diffusers in the existing aeration basins and converted the basins to a plug flow regime.

4. Flow Meter Replacement (1998) – An influent mag meter has been installed to replace an old Parshall flume.

5. Maintenance Shop Improvements (1998) – The project involved upgrading the maintenance shop with addition of a paint booth and added storage space.

6. Heating Water Loop Improvements (2002) – This project involved replacing corroded heating water piping with new fiberglass piping. The heating water system serves the recirculation pump station and the digester building.

7. Digester Upgrade (2002)* – This project will convert aerobic digesters to waste activated sludge (WAS) or thickened WAS storage tanks, add rotary drum thickeners, convert a secondary digester to a primary digester, and provide screening of primary sludge with a Parkson Sieve Press.



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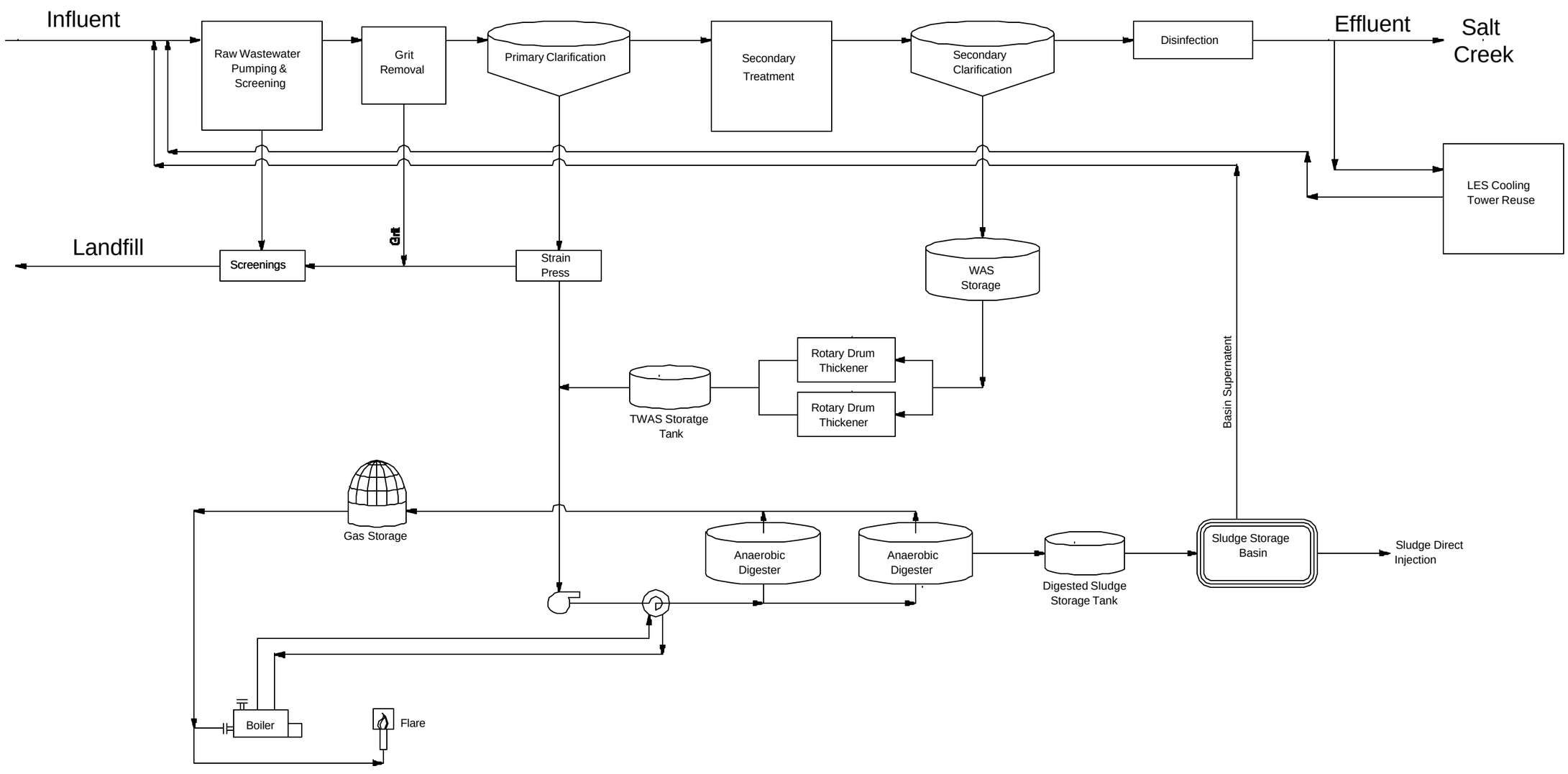
NORTHEAST WASTEWATER TREATMENT PLANT

Figure 4-5
Northeast WWTF Process Schematic



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NORTHEAST WASTEWATER TREATMENT PLANT

Figure 4-6
Northeast WWTF Solids Handling Schematic

8. Ultraviolet Disinfection (2002)* – This project will add ultraviolet disinfection facilities to the plant. UV disinfection will replace the chlorine disinfection as the primary method of disinfection at the Northeast WWTF.

9. Mechanical Screens (2002)* – This project will replace the existing mechanical screens with new units.

*currently underway

Existing Treatment Process Capacity Analysis

Techniques used to assess the process capacity of wastewater treatment facilities have improved significantly since the 1995 Wastewater Facilities Plan Update. These improvements have allowed a more accurate analysis of treatment system capacities to be performed as part of this facilities plan update. These techniques include:

1. Derivatives of the International Water Association Activated Sludge Model Number 1 incorporated into the BioWin™ simulator for the aeration basin system.

2. State Point Analysis (SPA) techniques for the secondary clarifier evaluation.

Anticipated changes in the discharge limits for ammonia at both the Theresa Street and Northeast facilities will have significant impacts on treatment system capacity.

A detailed facility rating of the Northeast WWTF was completed in November 1999. Similar modeling techniques were utilized as part of this facilities plan update to determine the capacities of the Theresa Street WWTF, and the 1999 evaluation of the Northeast WWTF was updated to reflect current conditions.

Factors Affecting Treatment Capacity. This section discusses the environmental and operational factors that affect the treatment capacity of an activated sludge system. This discussion is intended to promote a better understanding of the capacity analysis methodology used to evaluate treatment capacities and provide a basis for development of treatment alternatives.

Table 4-1 summarizes the primary factors that affect the capacity of an activated sludge facility.

Table 4-1. Primary Factors Affecting Treatment Capacity of an Activated Sludge System

Factor	Capacity Impact
Effluent Requirements	More stringent effluent requirements typically decrease facility capacity.
Temperature	Lower wastewater temperature typically decreases facility capacity.
Wastewater Characterization	Highly variable and strong influent wastewater typically decrease facility capacity.
Mixed Liquor Settling Characteristics	Poor mixed liquor settling characteristics typically decrease facility capacity.
Flow Peaking Factor	Large peaking factors typically decrease facility capacity.
Operator Expertise	Knowledgeable operators significantly increase wastewater facility capacity.

More information about each of these factors is presented in the following paragraphs:

Effluent Requirements. Effluent requirements establish the performance constraints within which an activated sludge facility must function. Generally, biochemical oxygen demand (BOD), ammonia, total nitrogen, and total phosphorus are the parameters that most significantly affect treatment capacity. Although specific ammonia limits are currently being negotiated between the City and the NDEQ, ammonia removal will require that the activated sludge system be operated at a solids retention time (SRT) sufficiently high to ensure the presence of nitrifying organisms. Effluent ammonia affects treatment capacity by dictating the minimum SRT required to ensure the presence of nitrifying organisms. Consequently, higher SRT requirements translate into a need for larger aeration basin sizes to treat a given quantity of wastewater and larger clarifiers to handle the resulting solids loads.

For the past 10 years the City of Lincoln, the NDEQ, the Water Environment Research Foundation, and several other interested parties participated in an extensive study to determine site-specific ammonia effluent criteria for Salt Creek. This process is ongoing and Lincoln expects a new NPDES permit in the near future (i.e., before the end of 2003). Table 4-2 presents the effluent ammonia requirements for the Theresa Street and Northeast WWTF that this facility plan update assumes will be implemented. Table 4-2 also presents anticipated future limits calculated with future flows and existing ammonia waste load allocations. For this facility plan analysis the treatment capacities are based on the projected 2025 ammonia limits.

**Table 4-2. Anticipated Effluent Ammonia Limits*
(Calculated With 30-Day Averaging Period For
Waste Load Allocation Long-Term Average Multiplier)**

Treatment Facility	Spring		Summer		Winter	
	Monthly Avg	Daily Max	Monthly Avg	Daily Max	Monthly Avg	Daily Max
	mg/L – N	mg/L – N	mg/L – N	mg/L – N	mg/L – N	mg/L -N
Theresa Street						
2008	8.29	21.71	2.88	7.55	8.34	21.84
2013	8.20	21.46	2.75	7.21	8.27	21.64
2025	8.05	21.07	2.55	6.68	8.15	21.31
2050	6.93	18.14	2.23	5.84	7.96	20.85
Northeast						
2008	13.99	36.62	5.68	14.86	14.87	38.93
2013	13.50	35.53	4.98	13.03	14.35	37.56
2025	12.45	32.58	4.18	10.94	13.81	36.16
2050	7.45	19.51	2.48	6.49	8.21	21.50

* The effluent ammonia limits shown are not final and are based on the best information available at the time this report was prepared (March 2003).

Effluent ammonia requirements, as prescribed by the expected permit limits, affect treatment capacity by dictating the minimum SRT required to ensure the presence of nitrifying organisms. The transition from the presence to the absence of nitrifying organisms occurs rapidly at an SRT value known as the washout SRT. Figure 4-7 presents the results of BioWin™ model simulations from the City of Lincoln East Side activated sludge system. The figure demonstrates how the effluent ammonia concentration decreases rapidly from approximately 30 mg/L to less than 2 mg/L with a one to two day change in SRT, dependent on the temperature. Figure 4-7 shows the aerobic SRTs required to reliably meet permit ammonia limits at each temperature.

Temperature. Figure 4-8 presents monthly average influent wastewater temperatures at the Theresa Street WWTF based on hourly average temperature measurements taken from 1987 through 1993. From this data, and the fact that lower temperatures tend to decrease facility capacity, the critical month in terms of nitrification capacity rating is determined to be March. Anticipated spring ammonia limits are relatively low, as shown in Table 4-2, and the monthly average temperature in March has been recorded as low as 13°C.

Wastewater Characteristics. Wastewater chemical oxygen demand (COD) impacts the capacity of the overall system, particularly through the required minimum SRT and oxygen supply requirements. Other wastewater characteristics also affect the biodegradation of compounds within the wastewater. During August and September of 2000, the City of Lincoln conducted a special sampling campaign designed to determine wastewater characteristics and factors required to calibrate the BioWin™ model. The sampling data were used to calibrate the BioWin™ simulation models of the Lincoln WWTFs, which were subsequently used to evaluate WWTF capacities and treatment alternatives for this facilities plan update. Various comparisons between model results and actual operating conditions

Figure 4-7
Effect of Aerobic SRT on Effluent Ammonia

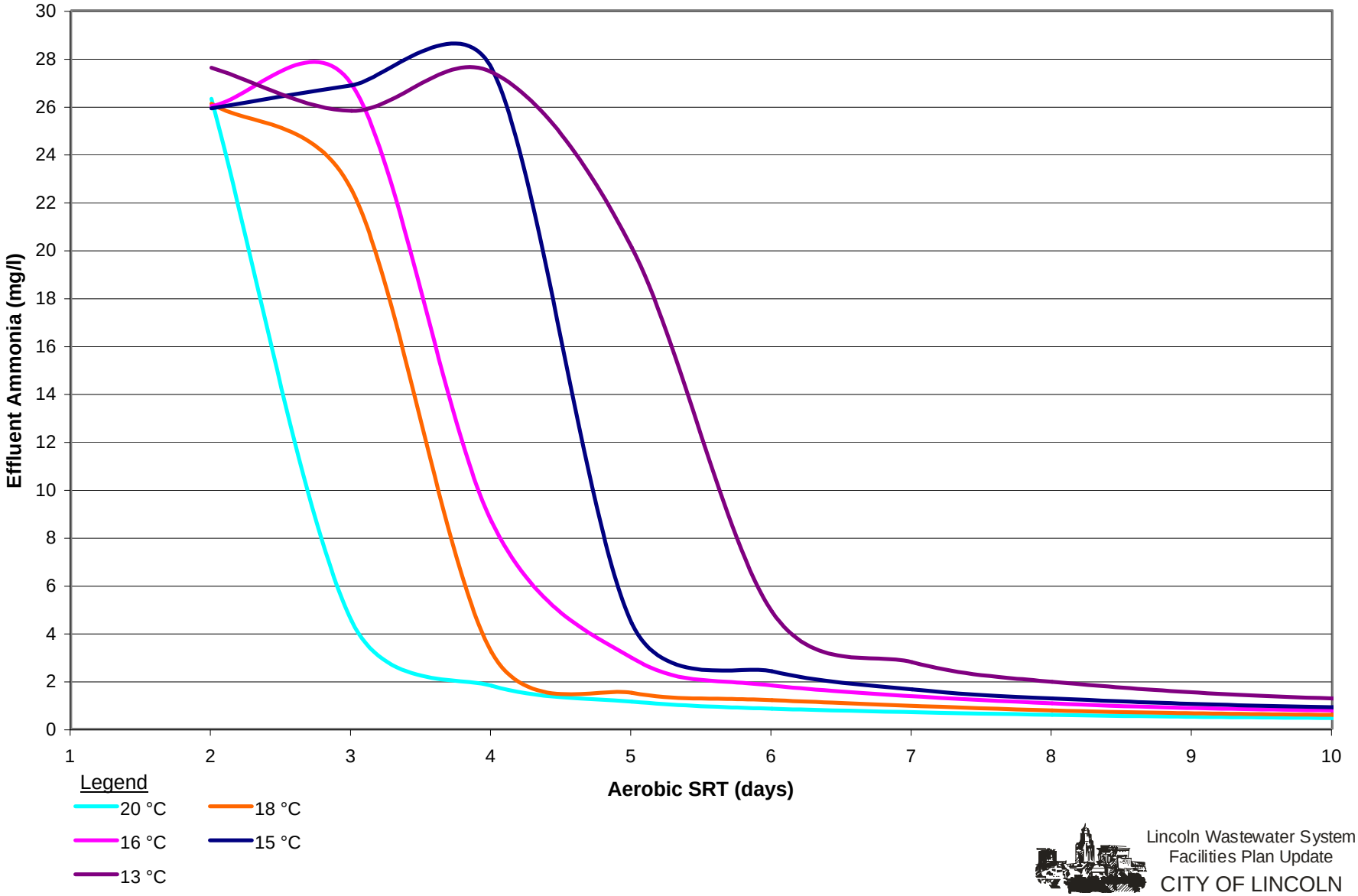

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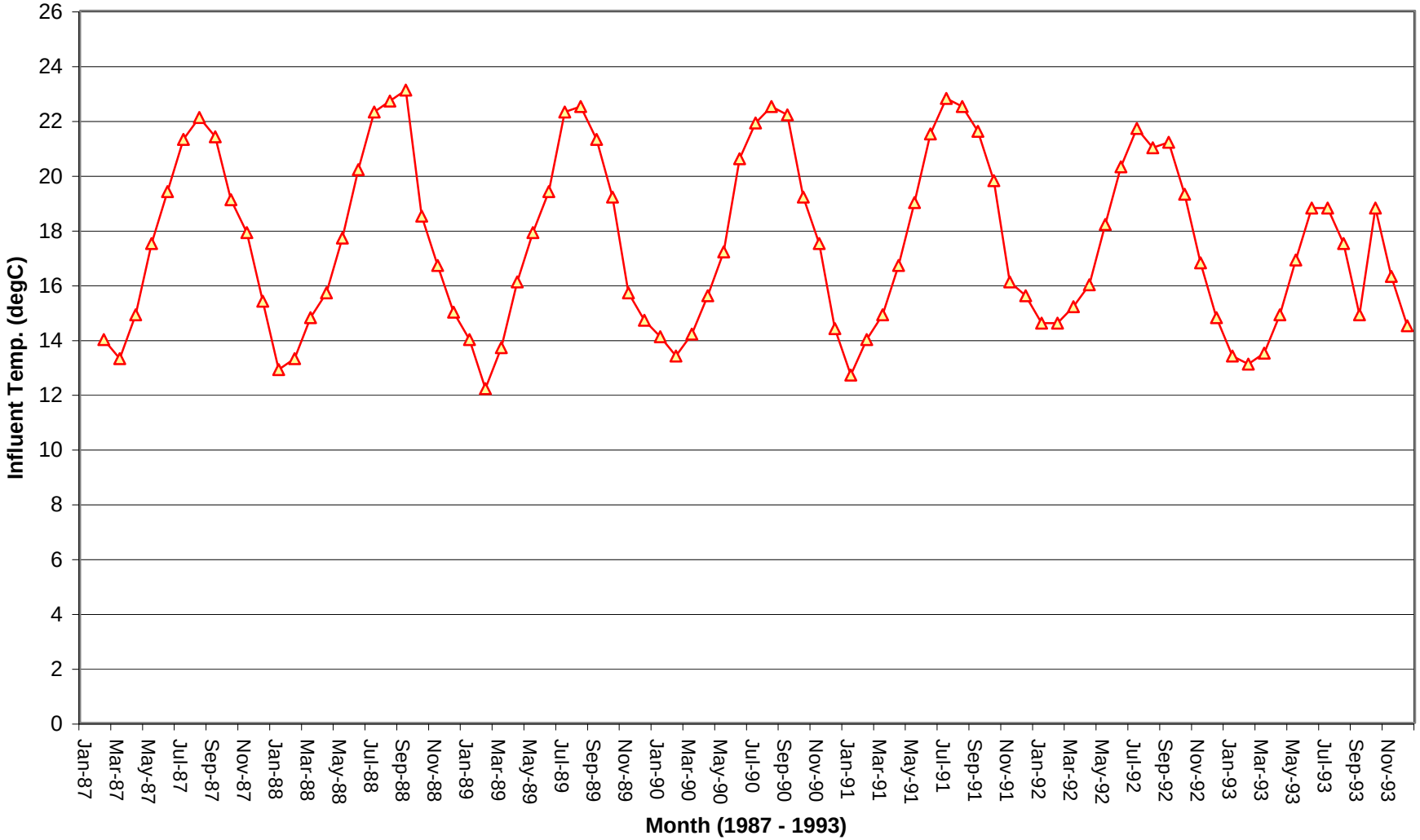
Figure 4-8
Monthly Average Influent Wastewater Temperatures
Theresa Street WWTF



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Tab: Fig4-8 Inf Temp

observed during the West Side stress testing period showed good correlation between model predictions and actual system performance. However, it is recommended that the City continue to improve the model calibration and wastewater characterization via additional sampling and field testing.

The COD introduced to the activated sludge treatment process is termed primary effluent (PE) COD. PE COD is a function of the plant influent COD and the performance of the primary clarifiers. Due to the presence of food product industries in the service area, the Theresa Street facility experiences a highly variable influent wastewater strength.

Figure 4-9 presents the daily and 30-day average PE COD at the Theresa Street facility from late 1999 through early 2002. In addition to the high daily variability, seasonal variation in influent COD results from variations in food manufacturers discharges.

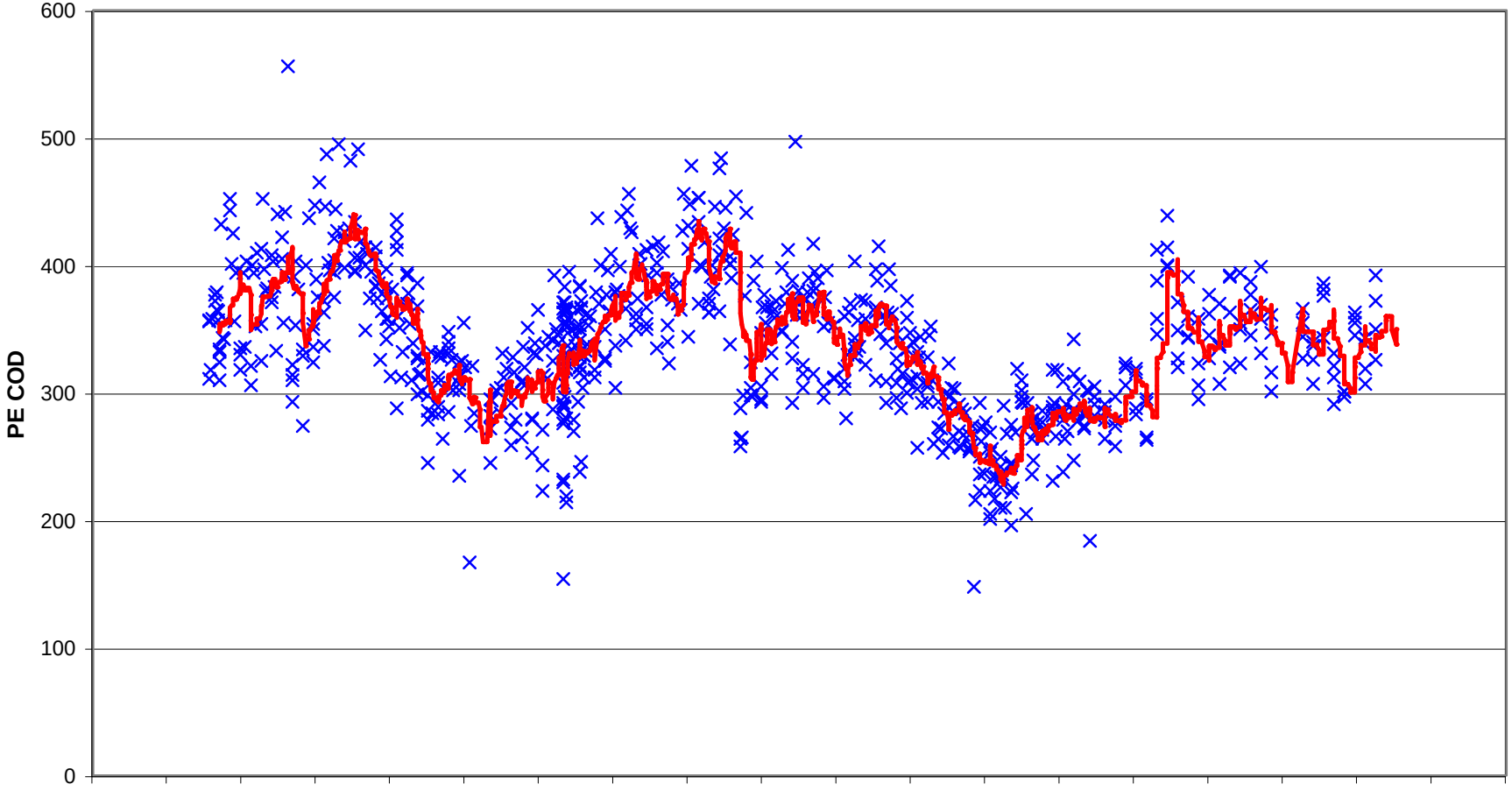
The data indicate that a monthly average PE COD of 450 mg/L is appropriate to use for the capacity analysis during the critical spring design period when the low wastewater temperatures can also occur.

The Northeast WWTF influent lacks the industrial wastewater component and therefore does not experience the same fluctuation in influent COD load as does the Theresa Street facility.

Mixed Liquor Settling Characteristics. Sludge settling characteristics play a significant role in establishing the capacity of an activated sludge system. Wastewater engineers and operators commonly utilize the sludge volume index (SVI) as an indication of the settling characteristics of the activated sludge solids. Settling characteristics affect the capacity by limiting the quantity of solids that can be applied to the secondary clarifiers while maintaining acceptable clarifier performance. WWTFs not specifically designed to control the sludge settling characteristics typically experience wider variations in settling characteristics than those designed to control sludge settleability. Such wide variations in sludge settling characterizations must be considered in evaluating system capacity. Many facilities chlorinate the RAS in an attempt to selectively kill the filamentous organisms believed to be responsible for most poor settling characteristics. Historically, the City of Lincoln has chlorinated the RAS to control settling characteristics.

Recently, the City of Lincoln constructed improvements to aeration basin design at both the Theresa Street and the Northeast WWTFs, incorporating features known to improve mixed liquor settling characteristics. These improvements have increased the capacity of these facilities without construction of new secondary clarifiers. Features such as anoxic selectors, plug flow reactor configurations, and fine-bubble aeration all improve settling characteristics by creating conditions that encourage the predominate growth of microorganisms known to settle well. These aeration system improvements have increased the capacity of the activated sludge systems by controlling the SVI without the use of chlorine.

Figure 4-9
Daily and 30-day Average Primary Effluent COD
Theresa Street WWTF



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Tab: Fig 4-9 PE COD

Flow Peaking Factor. The hydraulic peaking factor also affects the capacity of an activated sludge system. During the peak flow periods of the day, solids within the system tend to move from the aeration basin to the secondary clarifier at a higher rate than they can be returned. This condition results in an increase in the quantity of sludge in the clarifier and may negatively affect the facility performance. Excessive solids accumulation in the secondary clarifier may cause the following additional detrimental effects:

1. Enhanced growth of "low dissolved oxygen filaments" unable to be controlled through aeration basin improvements such as anoxic selectors. Lincoln may have experienced some of this during start-up of the West Side activated sludge system.

2. Decreased ammonia removal efficiency. This may occur when mixed liquor suspended solids (MLSS) concentrations decrease as solids migrate from the aeration basin to the clarifier. As the MLSS decreases, the nitrifier population under aeration also decreases. Lincoln operators have been measuring inventory distribution between the aeration basins and clarifiers. These measurements indicate that 15 to 25 percent of the solids inventory can be resident in the clarifier even prior to blanket accumulation.

Figures 4-10 and 4-11 present monthly average flows for the period of January 2000 through March 2002 for the Theresa Street and Northeast facilities respectively. The data for September 2001 through March 2002 are atypical and represent periods when flows were diverted from the Northeast facility to the Theresa Street facility.

Because the atypical data from September 2001 through December 2001 skew both the average and peak flow values for the entire year of 2001, only 2000 data was used to establish peak to average flow ratios for facility planning. These peak flow factors are represented in Table 4-3.

Table 4-3. Summary of Historical Peak Flow Factors

Peak Flow Factor[1]	Theresa Street WWTF	Northeast WWTF
	2000	2000
MMF to ADF[2]	1.11	1.15
PDF to ADF[2]	1.37	1.34
PHF to ADF[2]	1.93	1.95
PHF to MMF	1.74	1.70

[1]Includes wet weather flows occurring within the period indicated.
[2]See Chapter 5 for further definition of terms.
MMF = Maximum Monthly Average Daily Flow
PDF = Peak Daily Flow
PHF = Peak Hourly Flow
ADF = Annual Average Daily Flow

Figure 4-10
Theresa Street WWTF Monthly Average Flows

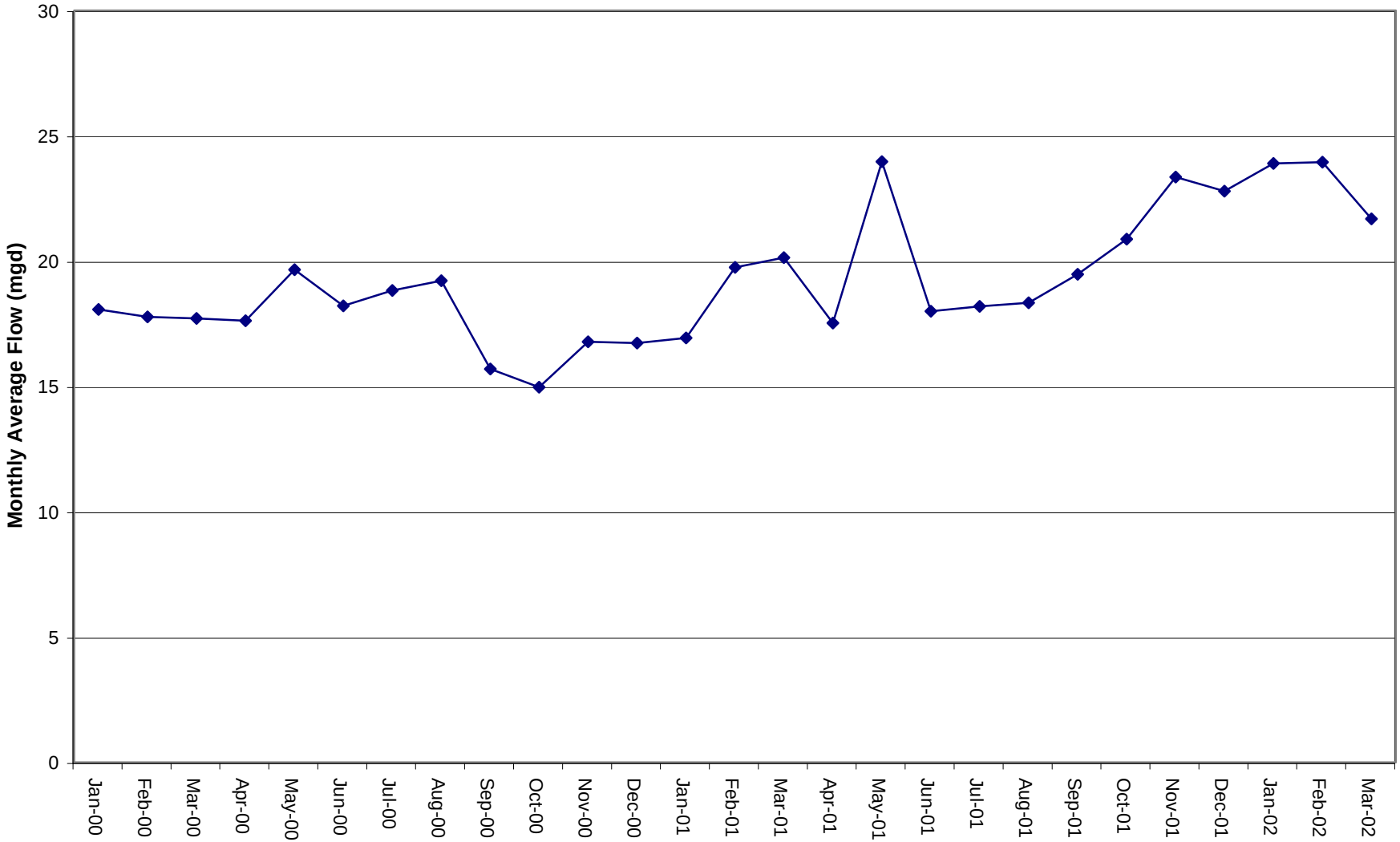

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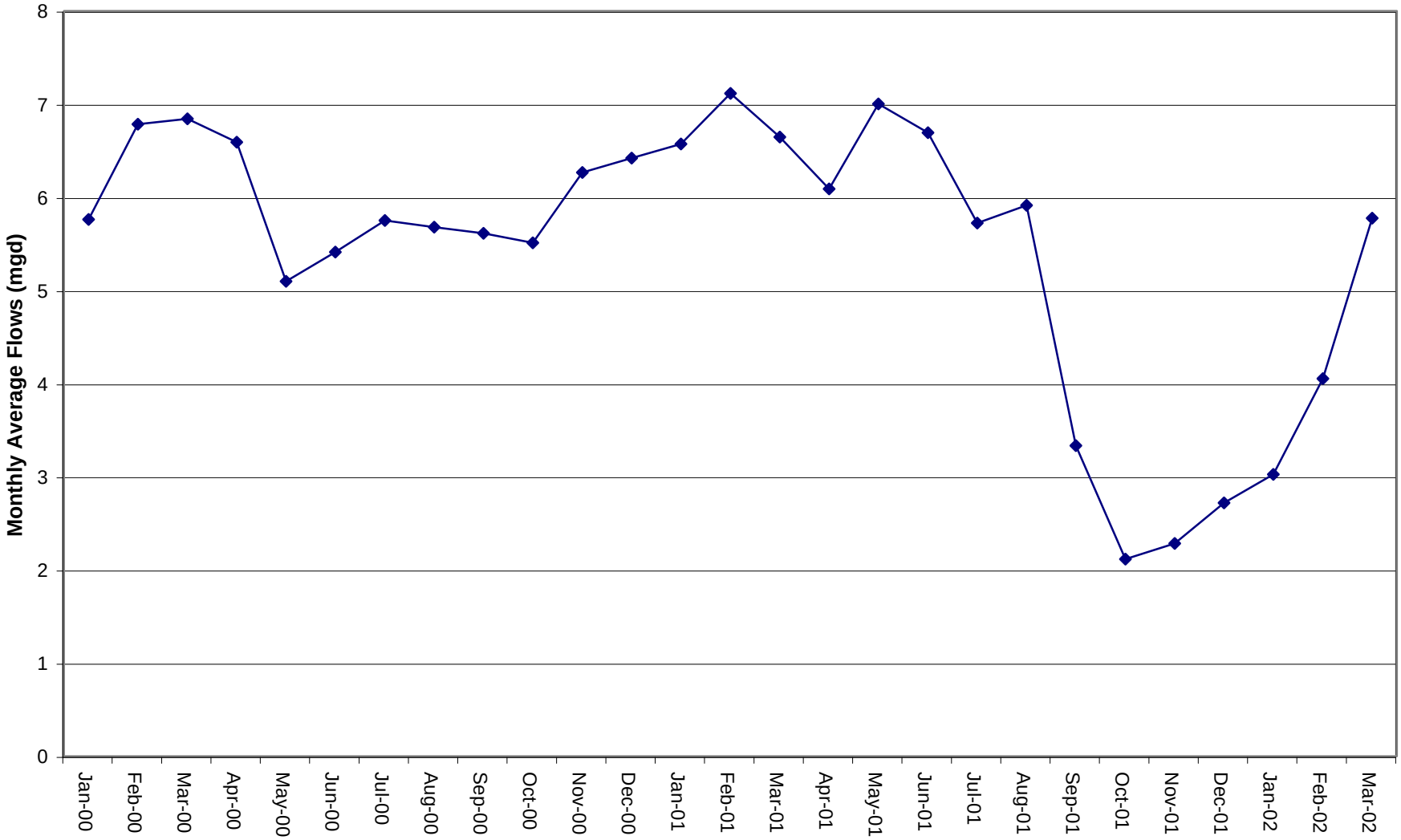
Figure 4-11
Northeast WWTF Monthly Average Flows
Note: Sept. 01 thru Feb. 02 reflect partial flows diverted to Theresa Street WWTF



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Tab: FIG 4-11

During some previous years, considerably higher peaks have occurred due to low probability rainfall events. The capacity estimates prepared for this facility plan update do not consider these rare peaks as they fall under new regulations being negotiated by the US EPA related to SSOs. Recent improvements to the collection system to reduce stormwater inflow may have decreased the highest peaking factors. Rating an activated sludge system to provide for such high peaking factors would severely reduce the capacity of the overall system and is considered uneconomical. For excessive peak flows, those significantly higher than the 1.74 and 1.70 peak hour to maximum month factors for Theresa Street and Northeast respectively, side-stream treatment or other alternative treatment scenarios should be applied. This issue is discussed further in Chapter 8.

Operator Expertise. Operator knowledge and experience is a critical, but often overlooked, factor in determining the realistic capacity of an activated sludge system. Experienced and knowledgeable operators can successfully operate a given WWTF at organic loads and flows much higher than can inexperienced operators. Lincoln conducted activated sludge training during the startup of the West Side activated sludge system. During that training, the factors influencing capacity presented in this chapter were presented and discussed. The Lincoln operations staff gained additional knowledge of system capacity limits during a stress testing period following the training. During the stress testing period the hydraulic and organic loading to the West Side system was increased almost to the system capacity limits. The knowledge of the Lincoln wastewater operations staff was taken into consideration when evaluating the capacity of the Lincoln WWTFs.

Capacity Estimate Methodologies. The above discussion indicates that numerous factors influence the capacity of an activated sludge system. The capacity estimating models applied to the Lincoln WWTFs account for each of these factors. The model provided considerable detail which allows the relative effect of each of these factors to be observed. This detailed model output promotes the development of alternative concepts and the data for the evaluation. This approach to capacity analysis avoids applying the most limiting value of each of the parameters concurrently, a common approach which can result in extremely conservative capacity estimates that do not represent situations likely to be experienced in actual facility operation.

Theresa Street WWTF Capacity Estimate. The capacity analysis applied the BioWin™ simulation model and Brown and Caldwell's State Point Analysis program to both the East Side and West Side activated sludge systems at the Theresa Street Facility. The trickling filter treatment train at Theresa Street is considered incapable of consistently removing ammonia during cold weather periods and therefore does not represent nitrifying capacity.

Assuming an average maximum month PE COD concentration of 450 mg/L, a temperature of 13°C and an SVI of 150 mL/g, Figures 4-12 and 4-13 present the capacity rating for operation to achieve nitrification sufficient to meet the ammonia limits shown in Table 4-2 for 2025 results for the West and East Side systems, respectively. Table 4-4 summarizes the results.

Figure 4-12
West Side Capacity Vs. MLSS Concentration

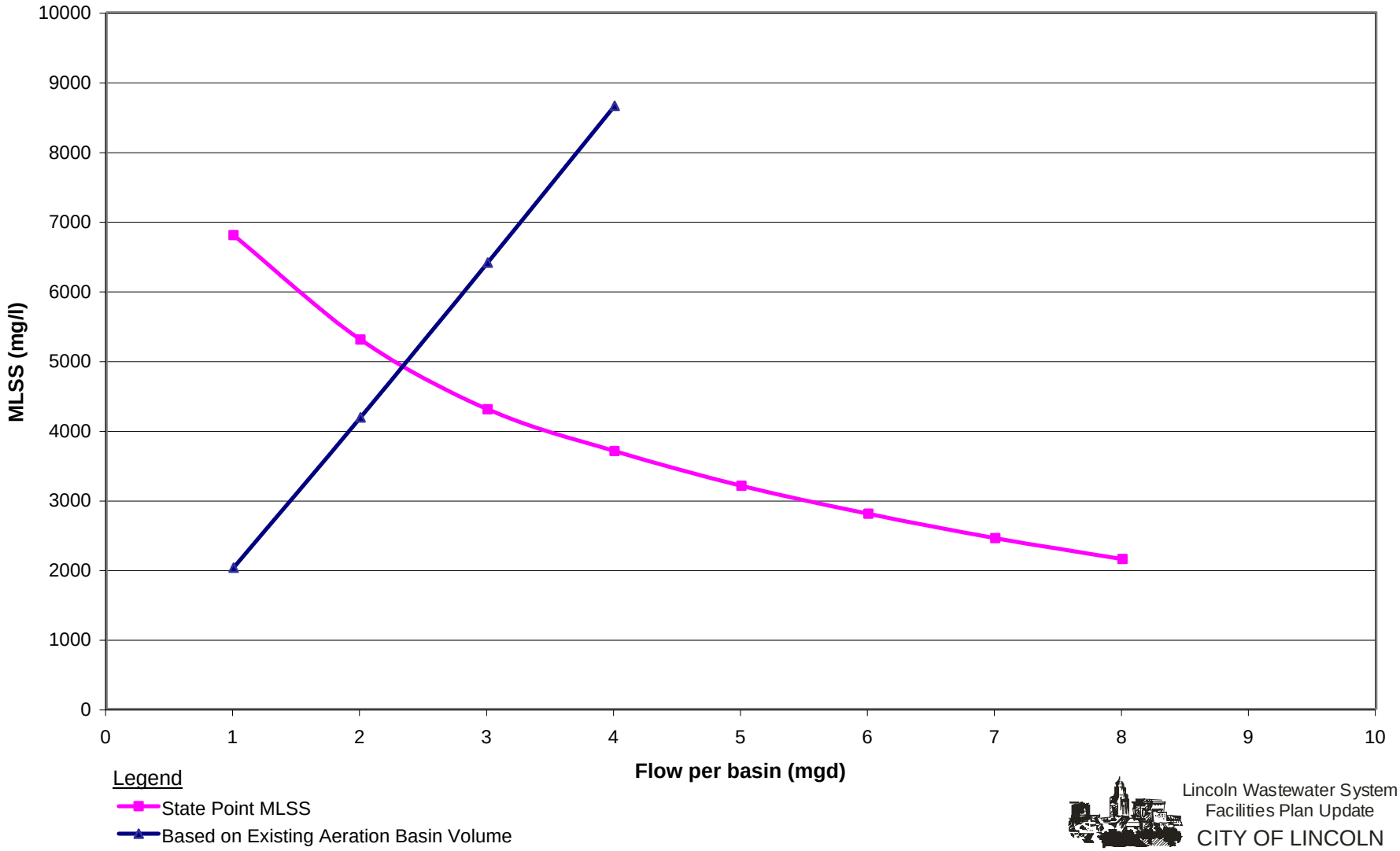

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Figure 4-13
East Side Capacity Vs. MLSS Concentration

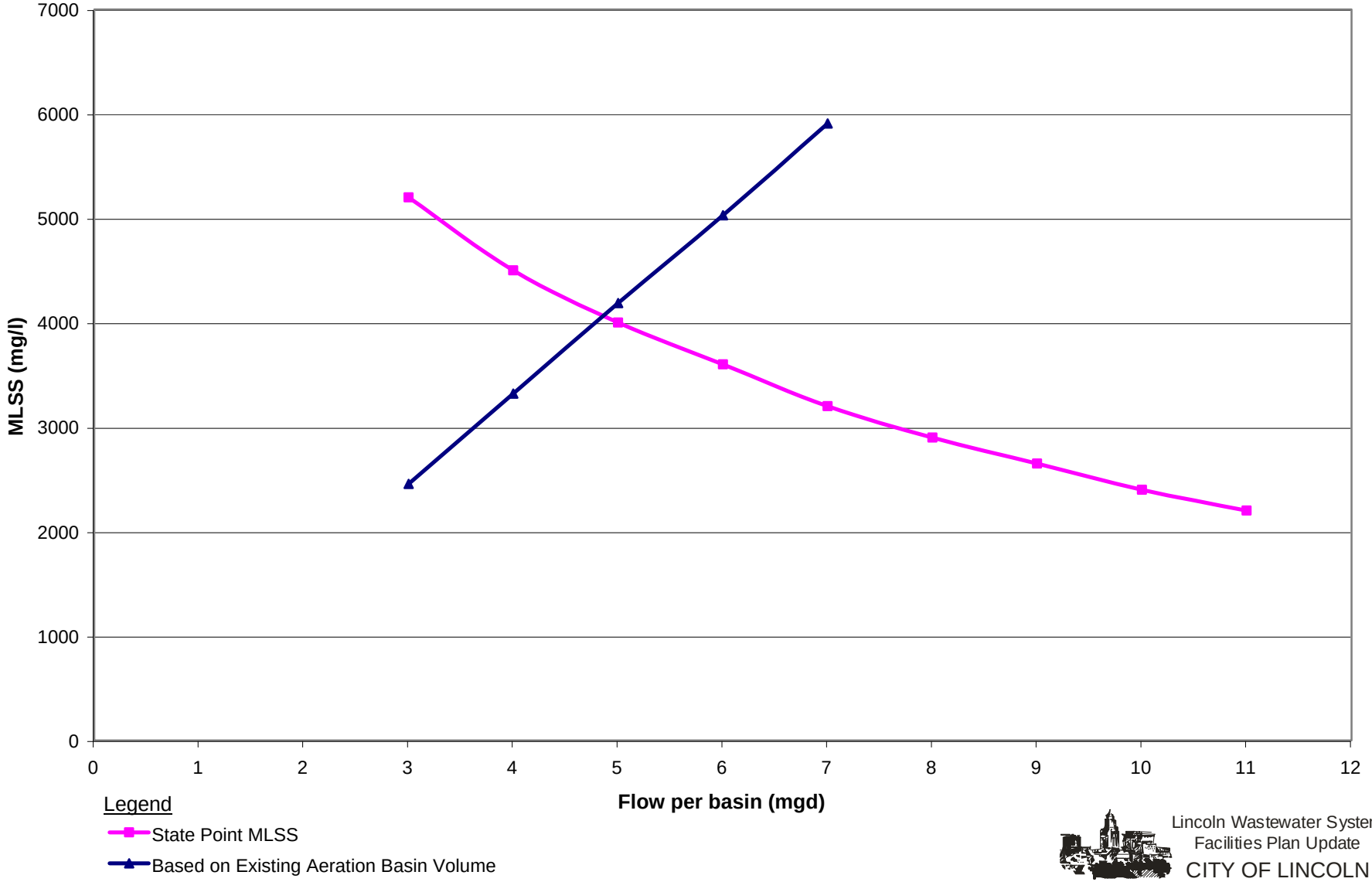

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Table 4-4. Nitrification Capacity Summary - Existing Theresa Street WWTF

Treatment System	Capacity* (mgd)
West (MMF)	4.7
East (MMF)	9.7
Total (MMF)	14.4

* Wastewater flows, loadings, and temperatures occurring during the month of March represent the capacity limiting considerations. The treatment capacity is limited by a combination of the aeration basin size, the clarifier solids loading rate and spring time (March) operating conditions.

As indicated in Table 4-4, the overall Theresa Street WWTF system nitrification capacity is rated at 14.4 mgd.

Northeast WWTF Capacity Estimate. In November 1999, Brown and Caldwell completed a process rating study to estimate the capacity of the Northeast WWTF. The study utilized the best available process data, including the data generated during two special sampling periods. The capacity evaluation approach utilized was similar to that used to rate the Theresa Street WWTF capacity. Due to available data limitations, assumptions for the capacity estimate were somewhat more conservative than the assumptions applied to the Theresa Street facility.

Assuming "maximum month" primary effluent COD concentration of 300 mg/L, a wintertime temperature of 15°C, and an SVI of 150 mL/g, the capacity of the Northeast WWTF was determined in the 1999 Study to be 4.0 mgd. This was based on the limiting solids loading rate for the final clarifiers.

As part of this Facility Plan Update, additional analysis of the Northeast WWTF nitrifying capacity was performed by comparing PE COD and aeration basin and clarifier capacities at the Northeast facility with those of the Theresa Street West Side facility. This comparison was made because the two facilities are similar in both size and configuration. The additional analysis was performed using the most recent ammonia discharge limit information and has been stress tested to confirm the limits of nitrifying capability. The comparison assumed that the Northeast facility could accommodate a food to microorganism ratio and specific clarifier solids loading rate similar to what the West Side facility can treat. The results of this comparison are shown in Table 4-5 and represent the system capacity under spring loading conditions.

Table 4-5. Nitrification Capacity Summary - Existing Northeast WWTF

Parameter	Capacity
Northeast WWTF	
Capacity (MMF)	4.4 mgd

* Wastewater flows, loadings, and temperatures occurring during the month of March represent the capacity limiting conditions The treatment capacity is limited by a combination of the aeration basin size, the clarifier solids loading rate and spring time (March) operating conditions.

The values presented for treatment capacity of the Northeast WWTF are considered to be the best available without further in-depth modeling and stress testing the facility.

Improving Capacity Estimates. The following parameters significantly impact the capacity estimates of the two plants and, because of the limited data available during facility planning, merit further study at both WWTFs during subsequent preliminary design:

1. Temperature: The data evaluated for the Northeast WWTF indicated a minimum wastewater temperature of 15°C during the winter. The critical month temperature assumed for the Theresa Street facility was 13°C. Heat loss in colder months through the biotowers at the Northeast plant suggest that Northeast temperatures would be expected to be lower than temperatures at the Theresa Street facility. More aeration basin temperature data should be obtained at both facilities to develop a more accurate temperature database.

2. Nitrifier Washout Solids Retention Time: Modeling completed for the Theresa Street facilities indicated that a 9.5 day SRT with 25 percent of the reactor volume unaerated, should be above the nitrifier washout SRT for all conditions. Modeling completed for the Northeast facility assumed that a 12.0 day SRT would be required in the aeration basins to prevent nitrifier washout. This assumption represents the major difference in the value of the capacity estimates and should be investigated through additional modeling efforts and field stress testing. The City of Lincoln has been operating the Northeast facility in a nitrification mode during relatively warm wastewater temperature periods. Additional experience during cold temperatures would be very useful in further refining the system capacity.

Hydraulic Capacity Analysis

Hydraulic Profile Modeling. Hydraulic and energy grade lines were calculated for the Theresa Street WWTF (East Side and West Side) and Northeast WWTF using Brown and Caldwell's software program called PROFILE. This program models flow through the WWTF by calculating the total energy grade (elevation head, pressure head and velocity head). When water surface elevation data were available, the model was calibrated for the given flow, and plant hydraulic capacity was determined by subsequent runs of the calibrated model at increased flow rates. When no elevation data were available, typical energy loss coefficients were used.

The WWTFs were assumed to have reached capacity when the water surface for a particular element came within 6 inches of the top of the wall or a controlling weir was submerged.

The hydraulic analysis was based upon record drawing information provided by the City of Lincoln. In order to accurately calibrate the model, field verification of all key hydraulic elements is needed. In the absence of this field verification, the hydraulic capacity estimates provided herein may vary significantly from actual capacities. The detailed results of the modeling effort are included in Appendix E.

Theresa Street WWTF. Hydraulic modeling was conducted only for the East and West Side systems at the Theresa Street WWTF. Decommissioning of the trickling filter system is planned for the near future, so hydraulic modeling of this system was not performed. A relative 100-year flood elevation of 1,147 feet above mean sea level (amsl) in Salt Creek was used initially in the modeling effort. The UV system designer provided headloss information through the proposed UV disinfection system.

East Side System. The hydraulic capacity of the East Side System was performed assuming concurrent flow through the West Side equal to one-half the flow through the East Side System.

The capacity of the East Side process train was reached at approximately 24 mgd as indicated by the water surface levels in the Final Junction Manhole, Chlorine Basin, Distribution Box (before the Chlorine Manhole), Final Clarifier, and the Aeration Basin. At 26 mgd the water surface is less than 6 inches from the top of the Final Manhole, and the top of the wall is surpassed in the Chlorine Contract Basin and Distribution Box. The launder in the Final Clarifier and final weir in the Aeration Basin are submerged at 26 mgd and the top of the wall of the Final Clarifier is surpassed at 33 mgd. The Primary Clarifier launder is submerged at 33 mgd. The Aerated Grit Basin appears to have a capacity of 30 mgd. The other major elements not mentioned have capacities in excess of 33 mgd.

The City has embarked on the design of a new grit removal system and a new UV disinfection system. These projects will include streamlining the flow through the headworks and the disinfection facilities. These improvements should mitigate the following flow restrictions through these facilities and accommodate future treatment trains and wet weather facilities. Factors limiting hydraulic capacity include:

- Piping between the outfall and the Chlorine Contact Basin: contributes to much of the headloss from the Distribution Box downstream.
- Initial channel in the Chlorine Contact Basin: generates high headloss and experiences high water levels.
- Piping and other elements between the Final Clarifier and the Aeration Basin: contributes to the submergence of the final weir in the Aeration Basin.
- Aerated Grit Basin inlet and discharge channels: generate high headlosses and high water levels. (This appears to be caused by both the piping and other elements between the Distribution Box and Aerated Grit Basin and the Aerated Grit Basin itself.)

West Side System. The model run assumed flow through the West Side System would equal to one-half of the flow through East Side System. The capacity for this process train was reached at 12 mgd as indicated by the water surface levels in the Chlorine Contact Basin and Distribution Box. The water surface in the Final Manhole exceeded the top of wall at 15 mgd. The Primary Clarifier launder became flooded at 15 mgd. All other elements appear to have capacities in excess of 15 mgd. Factors limiting hydraulic capacity include:

- Piping between the outfall and the Chlorine Contact Basin: contributes to much of the headloss from the Distribution Box downstream.

- Initial channel in the Chlorine Contact Basin: generates high headloss and experiences high water levels.

- Initial channel in the Aerated Grit Basin: generates high headloss and experiences high water levels.

New vortex grit basins and UV disinfection facilities are currently being planned for the Theresa Street WWTF. Construction of the new grit basins will not impact the hydraulic capacity of the East Side or the West Side Systems. Since the Chlorine Contact Basin and Distribution Box are limiting elements in the hydraulic capacity of both the East and West Side Systems, installation of the new UV disinfection system could serve to increase the hydraulic capacities of both systems. Design of the UV system should be directed toward substantially reducing the headloss through the disinfection system and thereby eliminating this hydraulic limitation.

Analysis was also performed to determine the impact of a 100-year flood level in Salt Creek at the point of the Theresa Street discharge. The 100-year flood elevation in Salt Creek at the point of the Theresa Street discharge is 1,147 feet amsl. The water level in Salt Creek at this elevation will cause major hydraulic problems at the Theresa Street facility. The top of the final junction manhole is 1,146 feet. A creek water surface elevation of 1,147 feet would be above the top of this manhole and the manhole would be totally submerged. The elevation of the top of the chlorine contact basin walls is 1,147.16 feet, just 2 inches above the creek water surface. At a wastewater flow of less than 10 mgd, wastewater would begin to flow over the top of the contact basin walls. Treatment processes prior to disinfection would be less drastically impacted.

Northeast WWTF. The hydraulic capacity of the Northeast WWTF was reached at 37 mgd as indicated by the water surface levels in the Chlorine Contact Basin and Aeration Basin. In the Chlorine Contact Basin and Aeration Basin the final weirs were submerged at this flow rate but the walls of the basins were not. Approximately 40 mgd can pass through the Primary Distribution Box and the Tower before the water surface exceeds the weir in the Primary Distribution Box or reaches the bottom of the media in the Tower. The Final Clarifier weir was submerged at flows of 50 mgd, but the water surface level did not surpass the top of the walls of the clarifier. All other units experienced no problems regarding high water surfaces at flows up to 50 mgd. Specific hydraulic limitations include:

- The flow restrictions in the Chlorine Contact Basin and downstream piping cause submergence of the final clarifier weirs; however, flow will still pass through up to at least 50 mgd without surpassing any walls.

- Piping and other elements between the Final Distribution Box and the Aeration Basin cause submergence of the final weir in the Aeration Basin.

- Piping and other elements between the Aeration Basin and the Tower cause the water level to exceed the weir in the Primary Distribution Box and submerge the bottom of the media in the Tower at flows of 40 mgd.

High flow experienced during a wet weather period in 1993 indicated that the hydraulic capacity of the Northeast WWTF was significantly less than these hydraulic calculations predict. It is recommended that a more detailed investigation of the Northeast WWTF be conducted to identify what structure, pipe, or piece of equipment limited the hydraulic capacity in 1993 to less than 37 mgd.

Lincoln Wastewater Residuals Management

Residuals are generated from several different treatment processes at the Lincoln Wastewater Treatment Facilities. The following sections discuss regulations relating to, and the disposal of, residuals resulting from:

- Influent Screening
- Grit Removal
- Primary Clarification
- Secondary Treatment

Screenings and Grit. The residuals generated from the screening and grit removal processes are disposed by trucking them to the Lancaster County landfill. The regulation governing this disposal practice is the Federal Resource Conservation and Recovery Act (40 CFR 258 or RCRA). The particular portion of the regulation involved is generally referred to as "Subtitle D". This regulation is discussed in greater detail in Chapter 6, Regulatory Requirements.

At both the Theresa Street and Northeast WWTFs, screenings and grit are of a character and sufficiently dewatered to meet the Subtitle D requirements.

Primary and Secondary Sludges

Biosolids generated in the primary and secondary treatment processes at the Lincoln WWTFs are applied to agricultural lands in the Lincoln area. At a minimum, the biosolids must meet:

1. The Pollutant Ceiling Limits for metals,
2. Class B requirements for Pathogen Reduction, and
3. Vector Attraction Reduction Requirements.

Biosolids from both treatment facilities are well within the Pollutant Ceiling Limits. Biosolids from the Theresa Street and Northeast facilities are treated with anaerobic digestion to meet both the Pathogen Reduction and Vector Attraction Reduction requirements. Vector Attraction Reduction Requirements can be met by either processing or with appropriate physical barriers at the application sites.

Theresa Street WWTF Digested Sludge Handling and Disposal

A summary of the sizes and treatment capacities of the anaerobic digesters at the Theresa Street WWTF is provided in Table 4-6.

Table 4-6. Theresa Street WWTF Anaerobic Digester Size and Loading Summary

Parameters	Value
No. of Digesters	3
Volume of each Digester	1,100,000 gallons
Total Digester Volume	3,300,000 gallons
Historical Sludge Production (maximum month)	8,062 gal/mg 2,609 lbs/mg
Historical Volatile Sludge Production (maximum month)	1,930 lbs VS/mg
Required Digester Hydraulic Detention Time	18 days
Design Digester Volatile Solids Loading	0.15 lbs VS/day/cu ft
Digester Design Capacity	23 mgd

Anaerobically digested sludge from the Theresa Street WWTF is dewatered by belt filter presses prior to hauling to the land application sites. A summary of the sludge dewatering facilities at the Theresa Street facility is provided in Table 4–7.

Table 4-7. Theresa Street Sludge Dewatering Facility Summary

Parameters	Value
No. of Belt Filter Presses	3
Average Dry Solids Produced (following anaerobic digestion)	25,881 lb/day (~1,500 lbs/MG of wastewater treated)
Typical operation time	32 hours/week (Mon., Tues., Thur., Fri.)
Capacity of each BFP	3,300 lbs/hr
Firm Sludge Dewatering Capacity (1 bfp out of service)	105,600 ppd (operated 16 hrs/day) ~70 mgd of wastewater treatment capacity
Typical Dewatered Sludge Solids Concentration	20.8%
Average BFP filtrate	625 gpm

The information presented in Table 4-7 indicates that the belt filter presses at the Theresa Street WWTF have adequate capacity to treat the sludge generated from all contemplated wastewater flows.

The historical nitrogen concentration of the anaerobically digested sludge from the Theresa Street WWTF is approximately 54,000 mg/L or 5.4 percent. The rate at which Theresa Street WWTF biosolids can be applied to agricultural lands depends on the crops grown and the quantity of biosolids or other nitrogen containing fertilizers applied previously. If corn is the primary crop grown and biosolids application has been occurring for several years at agronomic rates, approximately 5,900 pounds (lbs) of dry weight biosolids can be applied to each acre of cropland each year. This is based on an agronomic nitrogen requirement of 200 lbs per acre per year and the assumption that 50 lbs of the nitrogen is available from biosolids or other fertilizers previously applied. At an annual application rate of 5,900 lbs of dry sludge per acre, approximately 0.26 acres are required for every million gallons of wastewater treated. At this application rate approximately 1,600 acres are required for biosolids application at current flow rates and just over 2,300 acres will be required to accommodate 2025 biosolids production.

In addition to the agronomic rate limitations for biosolids application, total cumulative application limits are applied to biosolids not meeting the "high quality" criteria for metals concentration. A summary of the 40 CFR 503 requirements for metals and historical metal concentrations of Theresa Street biosolids are presented in Table 4-8.

Table 4-8. Theresa Street Biosolids Pollutant Concentration Data

Pollutant	Theresa Street Biosolids Concentration (mg/kg)	Ceiling Limits (mg/kg)	"High Quality" Limits (mg/kg)	Annual Loading Rate (kg/ha/yr)	Cumulative Loading Rate (kg/ha)
Arsenic	14.7	75	41	2.0	41
Cadmium	15.6	85	39	1.9	39
Chromium	107.2	3,000	1,200	150	3,000
Copper	650.4	4,300	1,500	75	1,500
Lead	69.5	840	300	15	300
Mercury	0.01	57	17	0.85	17
Molybdenum	20.4	75	18	0.90	18
Nickel	80.5	420	420	21	420
Selenium	2.8	100	36	5.0	100
Zinc	704.7	7,500	2,800	140	2,800

Based on the information presented in Table 4-8, the Theresa Street biosolids may be applied at rates up to about 6,500 kg/ha/yr (approximately 5,900 lbs/acre/yr), for over 100 years before any cumulative metal loading rates are reached. It should be noted that the biosolids generated at Theresa Street are within the requirements for "High Quality" biosolids with the exception of molybdenum. It is recommended that the source of molybdenum in the wastewater be identified to determine if its discharge to the wastewater collection system could be reduced to the level necessary to allow the Theresa Street biosolids to meet "High Quality" requirements.

The filtrate generated by the dewatering process at Theresa Street is returned to the wastewater treatment stream for treatment. This filtrate is high in ammonia and other pollutants and represents a significant load on the treatment system. In addition, since the belt filter processes are generally operated only during the day on week days and not at all on weekends, the recycle of filtrate also introduces significant "slug loads" or high strength intermittent loading on the liquid treatment process. Equalizing the filtrate return to the wastewater treatment system so it is returned constantly over a 24-hour period each day would significantly reduce its impact on the activated sludge treatment process. This or some other method of reducing the negative impact of this "side-stream" on the activated sludge process is recommended.

Northeast WWTF Digested Sludge Handling and Disposal

The solids handling system at the Northeast WWTF is currently under construction. Sludge is being hauled to the Theresa Street WWTF for treatment during the construction project. The construction project includes:

- Conversion of the existing secondary anaerobic digesters to submerged cover primary digesters,
- Installation of a double membrane gas storage system,
- Installation of a new boiler,
- Hot water loop replacement,
- Conversion of the existing aerobic digesters to WAS thickeners, and
- Addition of a dewatering building.

Under normal operating conditions digested sludge from the Northeast WWTF is pumped to holding lagoons near the land application site for storage prior to land application. Sludge from the lagoons is injected beneath the surface of City owned agricultural land near the lagoon site. Supernatent from the lagoon is returned to the WWTF.

Table 4-9 provides a summary of the sizes and treatment capacities of the anaerobic digesters at the Northeast WWTF.

Table 4-9. Northeast WWTF Anaerobic Digester Capacity Summary

Parameters	Value
No. of Digesters	2
Volume of each Digester	467,000 gallons
Total Digester Volume	934,000 gallons
Historical Sludge Production (maximum month)	5,613 gal/mg 1,813 lbs/mg
Historical Volatile Sludge Production (maximum month)	1,341 lbs VS/mg
Required Digester Hydraulic Detention Time	18 days
Design Digester Volatile Solids Loading	0.15 lbs VS/day/cu ft
Digester Design Capacity	9 mgd

A summary of the capacities of the land application facilities at the Northeast WWTF is provided in Table 4-10.

Table 4-10. Northeast WWTF Land Application Facilities

Parameters	Value
No. of Lagoons	1
Usable volume of Lagoon	289,080 gallons
Injection Field Size Number of field connections	 440 acres 30

The digested sludge generated at the Northeast WWTF has historically contained approximately 60,100 mg/L or 6 percent nitrogen. As with the Theresa Street WWTF, the rate at which Northeast WWTF biosolids are applied to agricultural lands depends on crops grown and the quantity of biosolids or other nitrogen containing fertilizers applied previously. If corn is the primary crop grown on the agricultural lands and biosolids application has been occurring for several years at agronomic rates, approximately 4,000 lbs of Northeast sludge can be applied to each acre of cropland each year. This is based on an agronomic nitrogen requirement of 200 lbs per acre per year and the assumption that 50 lbs of the nitrogen is available from biosolids or other fertilizers previously applied. At an annual application rate of 4,000 lbs of dry weight biosolids per acre, approximately 0.23 acres are required for every million gallons of wastewater treated. At this application rate approximately 575 acres of land are required for biosolids application at current flow rates and approximately 840 acres will be required in 2025.

The quantity of land required varies considerably with the crops grown, method of biosolids application, etc. Further evaluation of biosolids handling practices should be undertaken before determining how much additional land should be procured for biosolids application.

In addition to the agronomic rate limitations for biosolids application, total cumulative application limits are applied to biosolids not meeting the “high quality” criteria for metals concentration. A summary of the 40 CFR 503 requirements for metals and historical metal concentrations from Northeast biosolids are presented in Table 4-11.

Table 4-11. Northeast Biosolids Pollutant Concentration Data

Pollutant	Northeast Biosolids Pollutant Concentration (mg/kg)	Ceiling Limit (mg/kg)	"High Quality" Limit (mg/kg)	Annual Loading Rate (kg/ha/yr)	Cumulative Loading Rate (kg/ha)
Arsenic	12.8	75	41	2.0	41
Cadmium	8.1	85	39	1.9	39
Chromium	49.4	3,000	1,200	150	3,000
Copper	1330.4	4,300	1,500	75	1,500
Lead	132.0	840	300	15	300
Mercury	3.1	57	17	0.85	17
Molybdenum	63.1	75	18	0.90	18
Nickel	73.4	420	420	21	420
Selenium	9.7	100	36	5.0	100
Zinc	2744.6	7,500	2,800	140	2,800

Based on the information presented in Table 4-11, the Northeast biosolids may be applied at rates up to 4,500 kg/ha/yr (approximately 4,000 lbs/acre/yr) for over 50 years before the cumulative pollutant loading limits are reached. The biosolids generated at the Northeast WWTF meet the quality requirements for "High Quality" biosolids except for molybdenum. Zinc is also close to the "High Quality" limit. It is recommended that the sources of these two pollutants be identified to determine if their discharge to the wastewater collection system could be curtailed to the point that the "High Quality" limits could be met.

Supernatant from the biosolids lagoons is returned to the Northeast wastewater treatment stream for treatment. This supernatant is high in ammonia and other pollutants and represents a significant load on the treatment system. Since the same pipeline used to transport biosolids to the lagoons is used to return supernatant to the wastewater treatment process, supernatant return is typically accomplished in relatively large batches, which introduces significant ammonia "slug loads" on the wastewater treatment process. Constructing a separate pipeline to allow the constant return of supernatant from the lagoons to the wastewater treatment system would significantly reduce the impact of the supernatant return on the wastewater treatment process. This or some other method of reducing the negative impact of this side-stream load on the secondary/nitrification treatment process is recommended.

Identification of Needs

In addition to the need for increased nitrification capacities cited, the following list of "additional needs" has been developed for the Theresa Street and Northeast WWTFs. The Lincoln wastewater staff was instrumental in developing this list.

Theresa Street WWTF.

- Preliminary Treatment Improvements
  - South raw wastewater pumping station

- North raw wastewater pumping station
- Grit handling facilities

- Cogeneration facility improvements
- Anaerobic Digester complex improvements
  - Additional digester
  - Gas equalization or storage facility
  - Replace sludge valves on heating loop
  - Replace gas mixers/compressors
- West Side process improvements
  - Primary sludge pump replacement
  - Replace RAS pumps
  - New blowers
  - Secondary clarifier improvements
- East Side process improvements
  - Primary sludge pump replacement
  - Aeration system improvements
  - Secondary clarifier improvements
- DAF improvements
- Dewatering system improvements
- Maintenance shop rehabilitation
- Electrical improvements
- Collection system shop improvements
- Splitter structure improvements
- Administration building improvements
- Liquid waste handling facility improvements
- General system improvements
  - Wet weather flow facilities
  - Side-stream flow equalization
  - Hydraulic capacity improvements
- General plant/site improvements
  - Replace potable water distribution system
  - On-line process control instrumentation facilities
  - Plant site flood protection
  - Outside lighting improvements
  - Pavement rehabilitation
  - Gas line service replacements

Northeast WWTF.

- Upgrade operations control center
- Replace raw wastewater pumps 1, 2, and 3
- Improve grit removal facilities

- Primary Sludge Pumping Building & Clarifiers
  - Replace clarifier sludge collector assemblies in a 5-10 year period
  - Replace weirs
  - Scum pits need rehab due to corrosion.
- Refurbish biotowers
- Secondary clarifier improvements
- Maintenance shop improvements
- Sludge handling system improvements
  - Digester improvements
  - Sludge utilization system improvements
- General system improvements
  - Wet weather flow facilities
  - Sludge storage return flow equalization
- General plant/site improvements
  - Replace outside facility lighting – needs new conduit & circuit
  - Repair and replace sidewalks and roads as required
  - Upgrade entrance gate structure

The capital improvement program should incorporate these needs.

Treatment Facility Capacity Summary

When discussing the capacity of a treatment plant, it is important it be clear on the basis of the capacity being discussed. The discussion should indicate whether hydraulic or process capacity is involved and, when process capacity is being discussed, the influent quality, effluent limitations, and other key factors should be identified. Table 4-12 summarizes hydraulic and process or "Nitrification" capacities at each treatment facility.

Table 4-12. Nitrification Capacity Summary – Existing Lincoln Wastewater Treatment Facilities

Facility	Hydraulic Capacity*	Nitrification Capacity**
Theresa Street WWTF	36 mgd	14.4 mgd
Northeast WWTF	37 mgd***	4.4 mgd

* The hydraulic capacity indicated represents the most hydraulically limiting segment of the treatment facility. For the Theresa Street facility the most limiting segments are the disinfection and outfall segments. For the Northeast facility the most limiting segments are the aeration basins and the chlorine contact basin.
** The nitrification capacity of both facilities is limited by the combination of aeration basin size and clarifier sizes.
*** High flows experienced in 1993 indicate that Northeast WWTF hydraulic capacity is significantly less than 27 mgd. Further research should be conducted to identify hydraulic limitations experienced in 1993.

The rated capacity of a treatment plant is generally accepted as being the capacity of the most limiting hydraulic or process component within the system. The limiting component is the component with the lowest capacity rating.

As discussed previously in this chapter, the hydraulic capacity of the Theresa Street WWTF is limited by the capacity of chlorine contact basin and adjacent facilities. The limiting process at both Lincoln treatment plants is the nitrification process. As indicated in Table 4-12, the Theresa Street WWTF has an overall capacity of 14.4 mgd based only on the capacity of the East and West Side activated sludge systems. The Northeast WWTF capacity is also limited by the biological process and is rated at 4.4 mgd. In both cases, the capacities are based on the need to meet anticipated effluent ammonia limits during spring time weather conditions.

CHAPTER 5

WASTEWATER FLOW AND LOAD PROJECTIONS

This chapter summarizes the historical flows and loads entering the City's two wastewater treatment facilities and establishes flows and loading projections associated with anticipated growth.

Terminology

The terms and abbreviations used throughout this chapter and the remainder of this report are defined in the following paragraphs:

Average Daily Flow (ADF). The average daily flow that passes through a facility on an annual basis is expressed as the average daily flow (ADF). The ADF for a particular year is defined as the average of the 365 daily flows treated at the facility. ADFs typically vary from year to year depending on weather conditions and population growth trends. An indication of the overall trend of flows on an annual basis can be observed by plotting these values. The ADF is typically used to determine the long-range planning requirements for wastewater treatment systems.

Maximum Monthly Flow (MMF). The maximum monthly flow (MMF) is defined as the average daily flow rate for the 30-day period of maximum wastewater flow occurring within the evaluation period. The MMF is used in combination with the maximum month organic loading to determine design capacity of the organic treatment facilities. MMF is dependent on general climatic conditions, water use pattern in the community, size of the contributing population, and industrial water use patterns in the service area.

Peak Daily Flow (PDF). Peak daily flow (PDF) represents the maximum flow entering the treatment facility during a single day. The PDF is used in conjunction with wastewater characteristics to determine aeration system size requirements.

Peak Hourly Flow (PHF). The maximum flow entering the treatment facility over a one-hour period at any time during the evaluation period is defined as the peak hourly flow (PHF). Each storm event exhibits unique peak flow characteristics in the collection system that may affect the time and duration of the peak flow period at the treatment facility. The PHF is a combination of wet weather infiltration, direct storm water inflow (infiltration/inflow), and the normal contributions from domestic and industrial dischargers. This parameter is used to establish the hydraulic capacity requirements of pipes, lift stations, and treatment processes.

Infiltration and Inflow (I/I). Infiltration and inflow is a term which describes water entering a wastewater collection system as the result of groundwater leaking into the system through leaking pipe joints or manholes and surface water entering the system through leaking manhole covers, roof drains connected to the system, etc.

Peak Wet Weather Flow (PWWF). For this evaluation, extremely high flows that occur in conjunction with an unusually large precipitation event are referred to as peak wet weather flows. These flows are greater than typical PHFs and may be handled in a different manner.

Existing / Historical Flows

Historical flows at the Theresa Street WWTP and the Northeast WWTP from 1978 through 2001 are shown in Table 5-1.

Table 5-1. Historical Wastewater Flows

Year	Theresa Street WWTF Average Daily Flow, mgd	Northeast WWTF* Average Daily Flow, mgd	Total Average Daily Flow, mgd
1978	21.9	--	
1979	22.0	--	
1980	20.1	--	
1981	17.4	4.5	21.9
1982	18.3	6.8	25.1
1983	18.8	6.6	25.4
1984	20.4	7.7	28.1
1985	16.5	6.8	23.3
1986	17.6	6.0	23.6
1987	20.1	5.7	25.8
1988	16.6	5.2	21.8
1989	16.7	5.3	22
1990	17.3	5.5	22.8
1991	17.5	5.3	22.8
1992	17.0	5.7	22.7
1993	20.2	7.4	27.6
1994	17.4	5.4	22.8
1995	20.3	5.4	25.7
1996	19.9	7.3	27.2
1997	18.9	5.0	23.9
1998	20.6	5.1	25.7
1999	18.0	6.4	24.4
2000	16.8	6.8	23.6
2001	19.3	5.1	24.4

*The Northeast WWTF began service in 1981.

The flows shown represent ADF in mgd. Over the period from 1978 to 2001, ADFs at the Theresa Street WWTP declined slightly over this period due to a City program to reduce I/I, the Northeast WWTP coming on-line in 1981, and the cessation of operation by three large industrial dischargers. The low flows experienced from 1988 through 1992 may be attributed to the drought conditions experienced in the area during that time. The higher than normal flows in 1987 and 1993 were the result of significant rainfall events and generally wetter than normal conditions. These historical flows are shown graphically in Figure 5-1.

As illustrated in Figure 5-1, the average daily flows for both facilities combined have not increased significantly over the last twenty-two years; though the population has increased from 172,000 in 1980 to 226,000 in 2000. Assuming a typical wastewater contribution of 115 gallons per capita per day (gpcd), the total wastewater flow should have increased by approximately 6.2 mgd. As this did not occur, it is speculated that other contributors to wastewater flow must have decreased. Research confirms that I/I has decreased due to collection system repair efforts, per capita flows have decreased due to water conservation efforts, and industrial wastewater discharges have decreased. These factors have combined to produce the flow reductions observed.

Design dry weather flow rates have been developed based on historical flow data shown in Table 5-1, the current service population data, and the relationships between ADF and PHF presented in Table 4-3. These design dry weather flow values are shown in Table 5-2.

Table 5-2. Design Dry Weather Flow Values

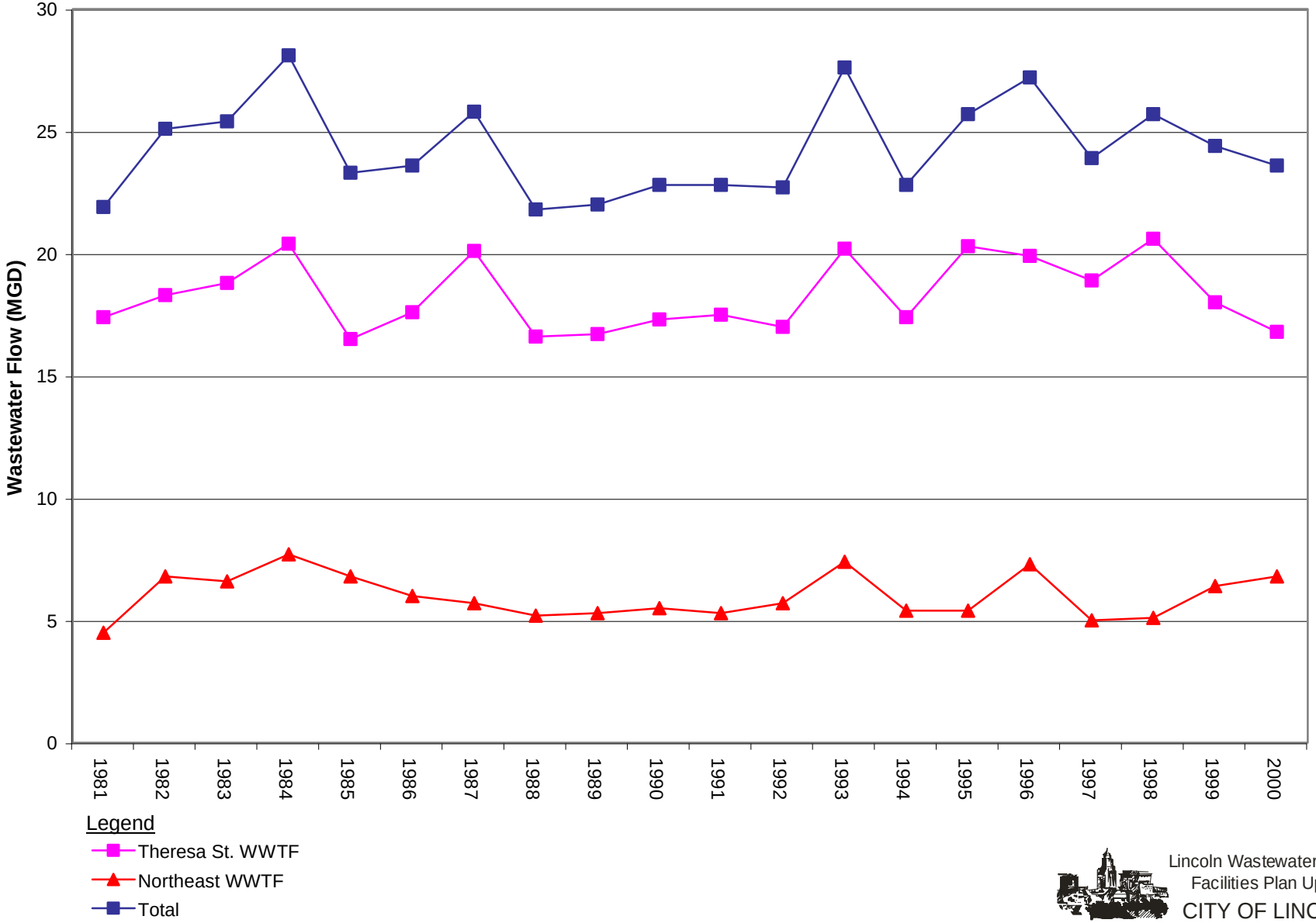
Parameter	Theresa Street WWTF	Northeast WWTF
Average Daily per Capita Dry Weather Flow	105	105
Maximum Month Peaking Factor (MMF/ADF)	1.11	1.15
Peak Hour Peaking Factor (PHF/MMF)	1.74	1.70

Wet Weather Flows

Even though considerable effort has been made to reduce I/I, large storm events still have a significant impact on the maximum flows at both wastewater treatment facilities. Over the past fifteen years, the PWWF received at both the Theresa Street and Northeast WWTFs occurred on July 24, 1993 following a rainstorm that produced 2.23 inches of precipitation. The PWWF received at the Theresa Street was approximately 83 mgd and at Northeast facilities it was about 24 mgd.

The PWWF experienced on July 24, 1993 resulted from a series of storm events. On July 23, 1993, the day before the PWWFs were recorded, Lincoln received approximately 1.75 inches of rainfall. As a result of the storm on the 23rd, it is estimated that Theresa Street was already receiving approximately 11 mgd above normal dry weather flows when the storm on the 24th occurred. The peak flow received at the Theresa Street facility on the 24th was estimated to be 83 mgd. Because the magnetic flow meter at the lift stations was set to read a maximum flow of 80 mgd, this peak flow was not precisely measured. The 83 mgd flow rate persisted for between one and two hours before subsiding to less than 80 mgd.

Figure 5-1
Average Annual Wastewater Flow



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File: Fig 5-1through 5-12.xls
Tab: Fig 5-1 AAWF

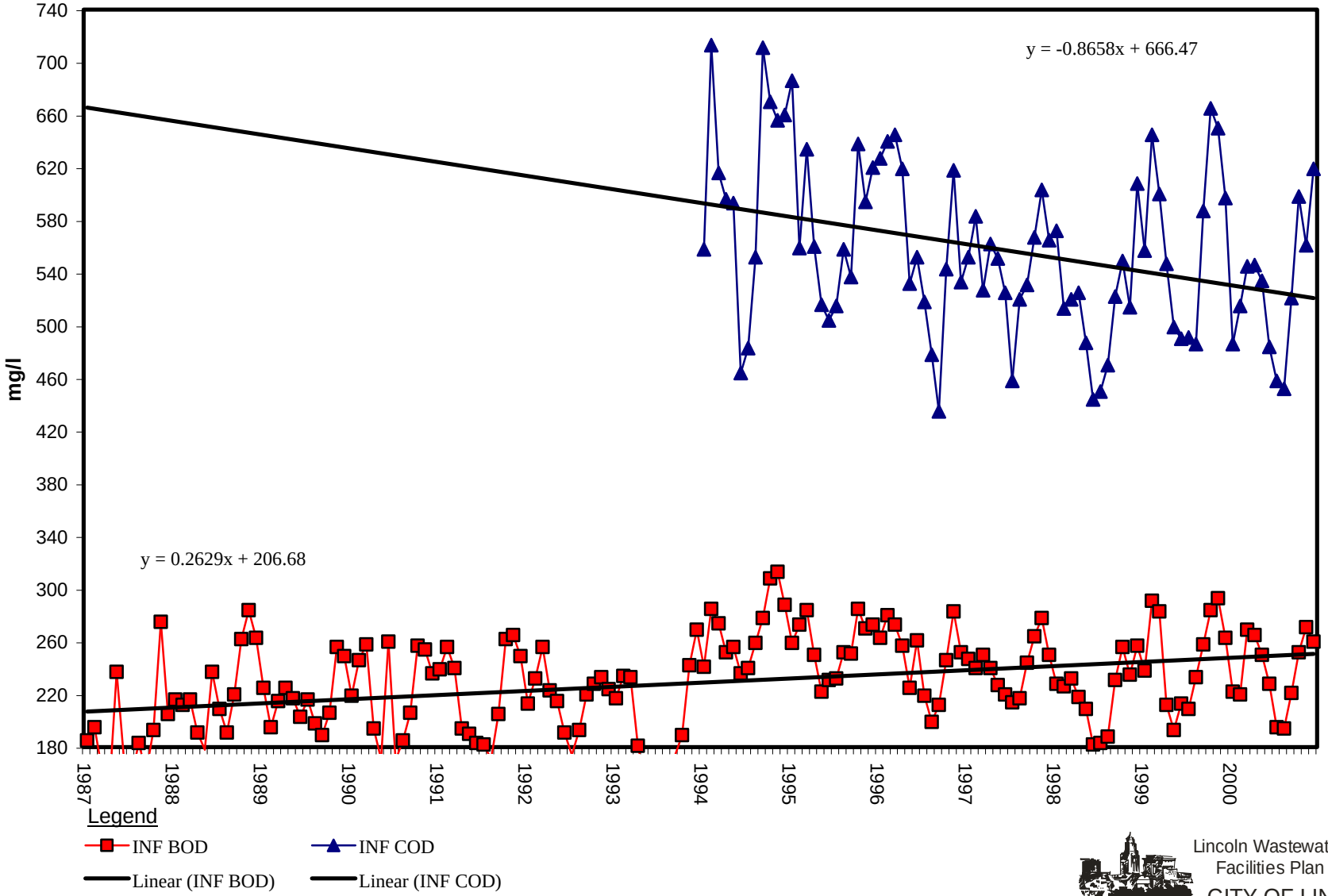
The flows experienced as a result of the July 24, 1993 storm indicate that the PWWF factors for both the Theresa Street and Northeast WWTFs can be over four times the ADF. Projecting future PWWF values based on the 1993 PWWFs is somewhat conservative because it assumes that the level of I/I experienced from the addition of new service areas will be similar to that which occurs within the historical service area. In fact, the level of I/I occurring within newly developed service areas will likely be significantly lower than that from older areas due to better materials and techniques used in new construction. For the purpose of establishing wastewater treatment facility design treatment capacities, it is recommended that the PHF to MMF ratios presented in Table 5-2 be used to establish treatment system capacities. Peak flows exceeding the design treatment system capacities should be handled separately with a peak wet weather flow system.

Historical Wastewater Composition

The most significant wastewater characteristics to consider when evaluating a wastewater treatment facility are the influent and effluent values for 5-day biochemical oxygen demand (BOD_5), total suspended solids (TSS), COD, and total Kjeldahl nitrogen (TKN). Information on these parameters is needed to evaluate specific process units within the overall treatment facility. Maximum BOD_5, TSS, and TKN loading must be determined to ensure proper sizing of treatment units. Maximum month BOD_5 loading is used as a design parameter to ensure the facility will meet its effluent permit limits for BOD_5. Determining a maximum day BOD_5 loading ensures that the aeration system is designed with sufficient capacity. Maximum month TSS loading must be determined to ensure that primary solids handling processes are properly sized. Determining maximum month TKN loading ensures that the facility is designed to meet its effluent permit limitations for ammonia. Finally, peak ammonia loading information is used to determine peak oxygen requirements for the aeration system. This section summarizes historical trends for each of these wastewater characteristics at the Theresa Street and Northeast WWTFs.

Theresa Street WWTF Influent Wastewater Composition. Figures 5-2 and 5-3 show the historical trends of influent BOD_5 at the Theresa Street facility from 1987 to the present. Figure 5-2 shows the monthly average influent BOD_5 concentration in mg/L. This plot shows a trend of increasing influent BOD_5 concentrations coinciding with drought conditions in 1987 and 1989. Figure 5-3 indicates the monthly average BOD_5 loading in terms of pounds per day. It shows that there has been an increase in BOD_5 loading to the facility over time. Figure 5-4 shows that monthly TSS loads have also been increasing; however, the rate of increase is not as extreme as that for BOD_5. The term BOD_5 loading refers to the quantity of BOD_5 entering the treatment facility on a daily basis.

Figure 5-2
Monthly Average Influent BOD & COD Concentrations
Theresa Street WWTP



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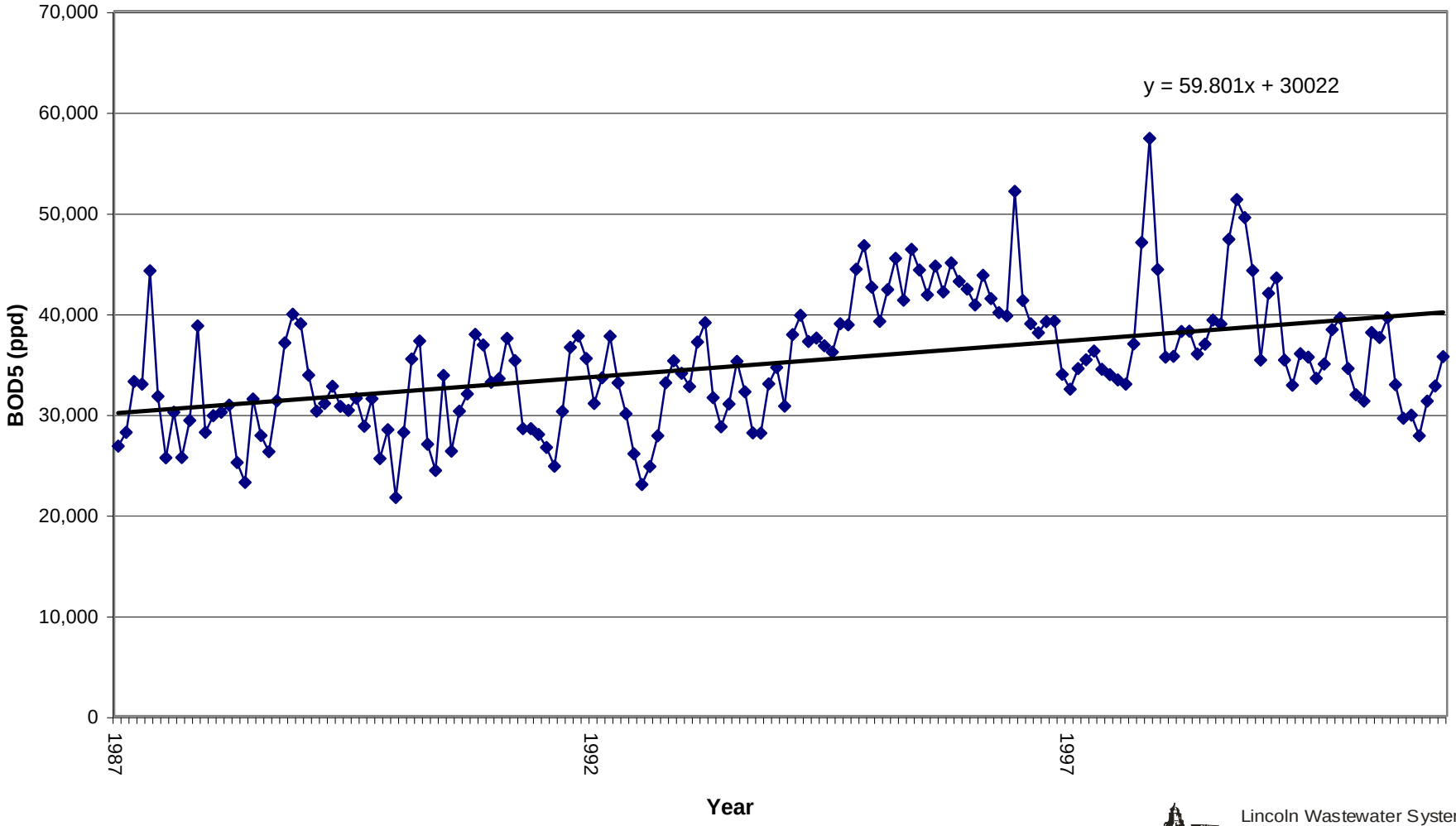
File: Fig 5-1through 5-12.xls
Tab: Fig 5-2 AIBOD-T Street

Figure 5-3
Historical BOD5 Monthly Average Loading
Theresa Street WWTP



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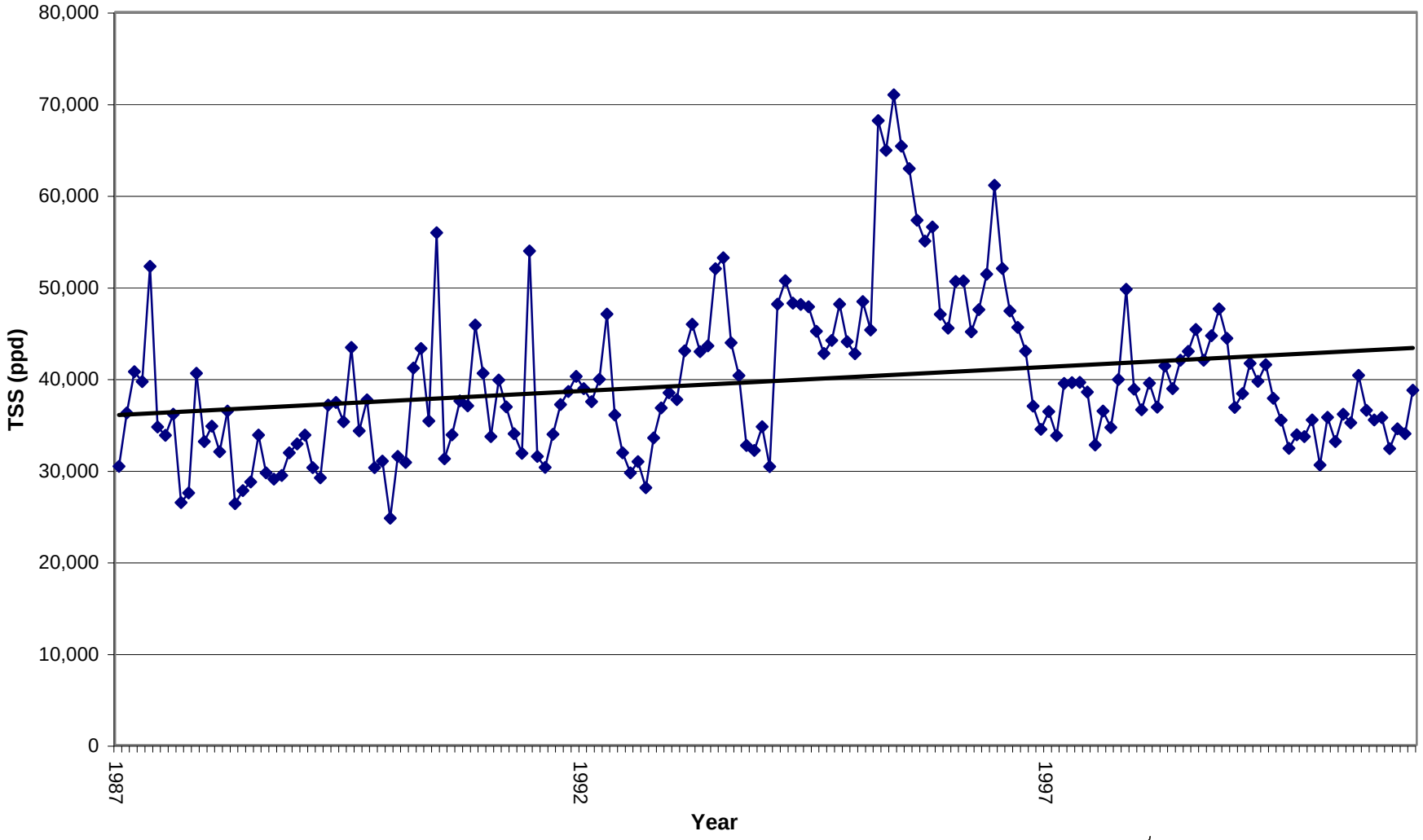
File: Fig 5-1through 5-12.xls
Tab: Fig 5-3 BOD5 - TS WWTF (ppd)

Figure 5-4
Historical TSS Monthly Average Loading
Theresa Street WWTF



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File: Fig 5-1through 5-12.xls
Tab: Fig 5-4 TSS (ppd) - Theresa St.

Average 1995-2001 BOD_5, TSS, and TKN data for the Theresa Street WWTF are shown in Table 5-3.

Table 5-3. 1995 - 2001 Theresa Street WWTF Influent Characteristics

Parameter	Values
BOD_5	
Annual Average	240 mg/L
Maximum 30-Day Average	300 mg/L
TSS	
Annual Average	270 mg/L
Maximum 30-Day Average	430 mg/L
TKN	
Annual Average	35 mg/L
Maximum 30-Day Average	45 mg/L

The values shown in Table 5-3 will be used in this facilities plan update to project future loading at the Theresa Street WWTF.

Northeast WWTF Influent Wastewater Composition. Figures 5-5 and 5-6 show the historical trends of influent BOD_5 and TSS concentrations entering the Northeast WWTP. Figures 5-7 and 5-8 show historical BOD_5 and TSS loading trends occurring between 1988 and 2000. Like the Theresa Street WWTP, influent BOD_5 loads at the Northeast WWTF have increased with time. In contrast with Theresa Street, TSS loads at Northeast have actually decreased over time.

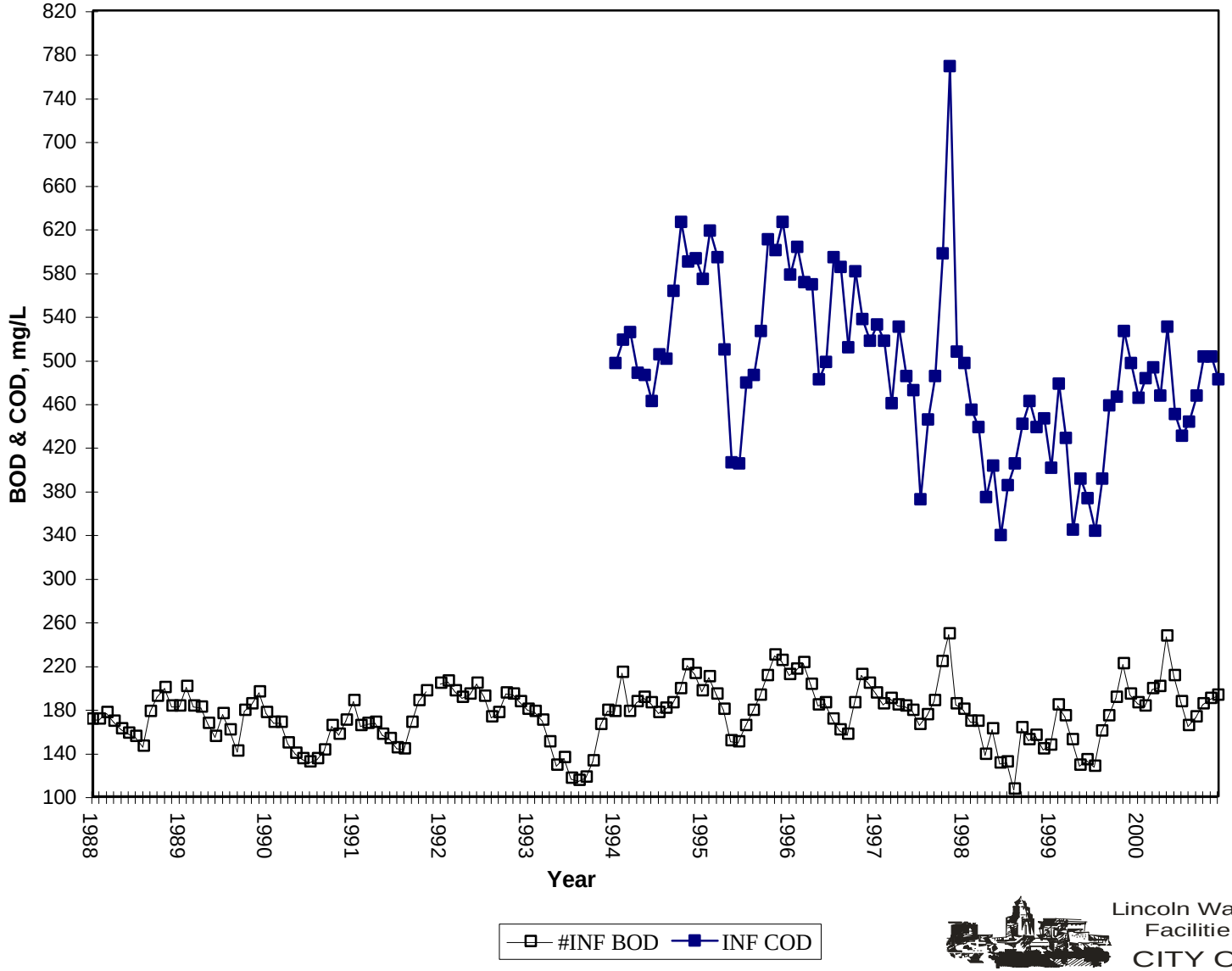
Average BOD_5, TSS, and TKN data for the time period from 1995 to 2001 at the Northeast WWTF are shown in Table 5-4.

Table 5-4. 1995 - 2001 Northeast WWTF Influent Characteristics

Parameter	Values
BOD_5	
Annual Average	180 mg/L
Maximum 30-Day Average	250 mg/L
TSS	
Annual Average	200 mg/L
Maximum 30-Day Average	400 mg/L
TKN	
Annual Average	30 mg/L
Maximum 30 Day Average	40 mg/L

The values shown in Table 5-4 will be used in this facilities plan update to project future loading at the Northeast WWTF.

Figure 5-5
Historical Monthly Average Influent BOD & COD Concentrations
Northeast WWTF



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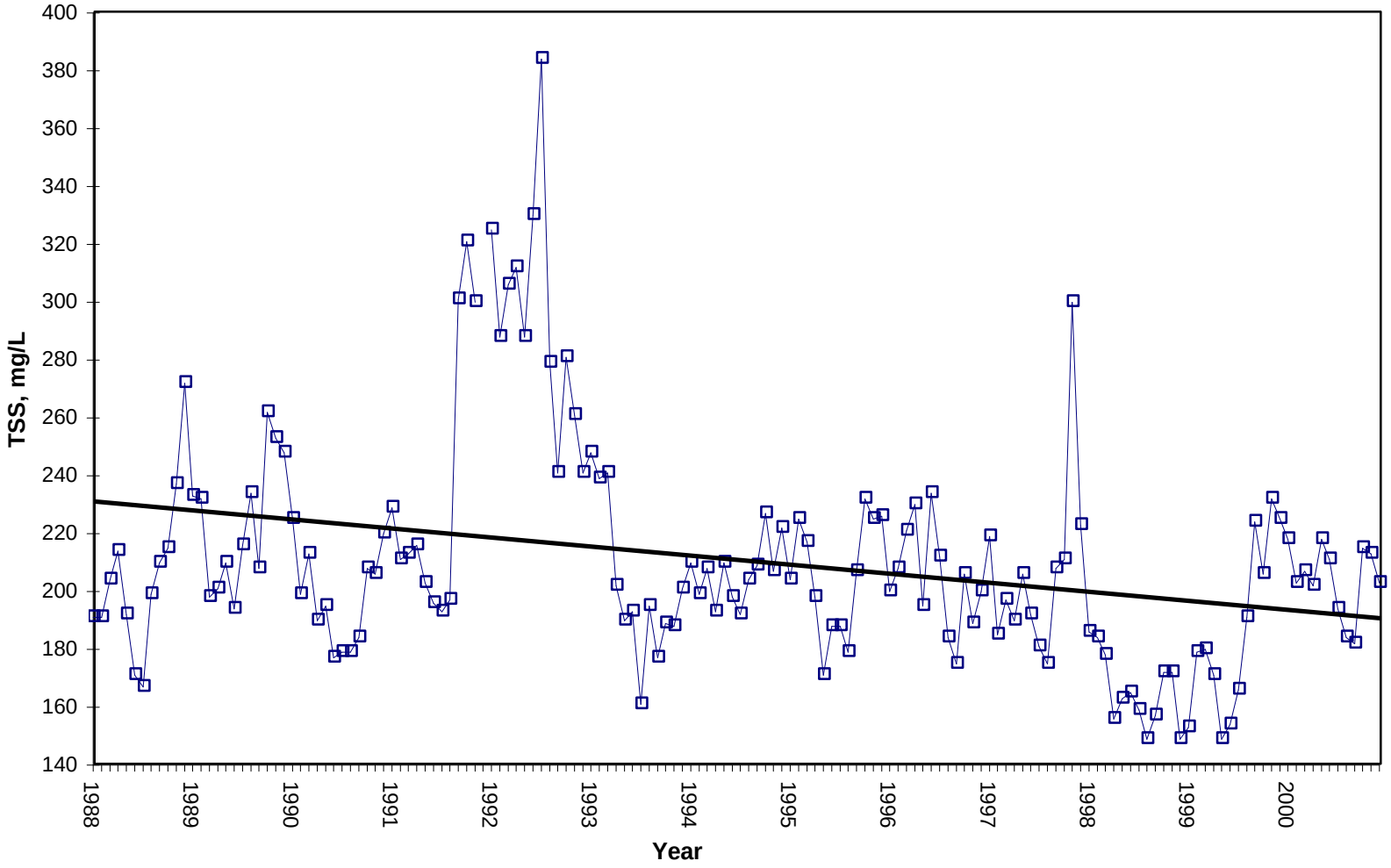
File: Fig 5-1through 5-12.xls
Tab: Fig 5-5 Infl BOD COD NE WWTP

Figure 5-6
Historical Monthly Average Influent TSS Concentrations
Northeast WWTF



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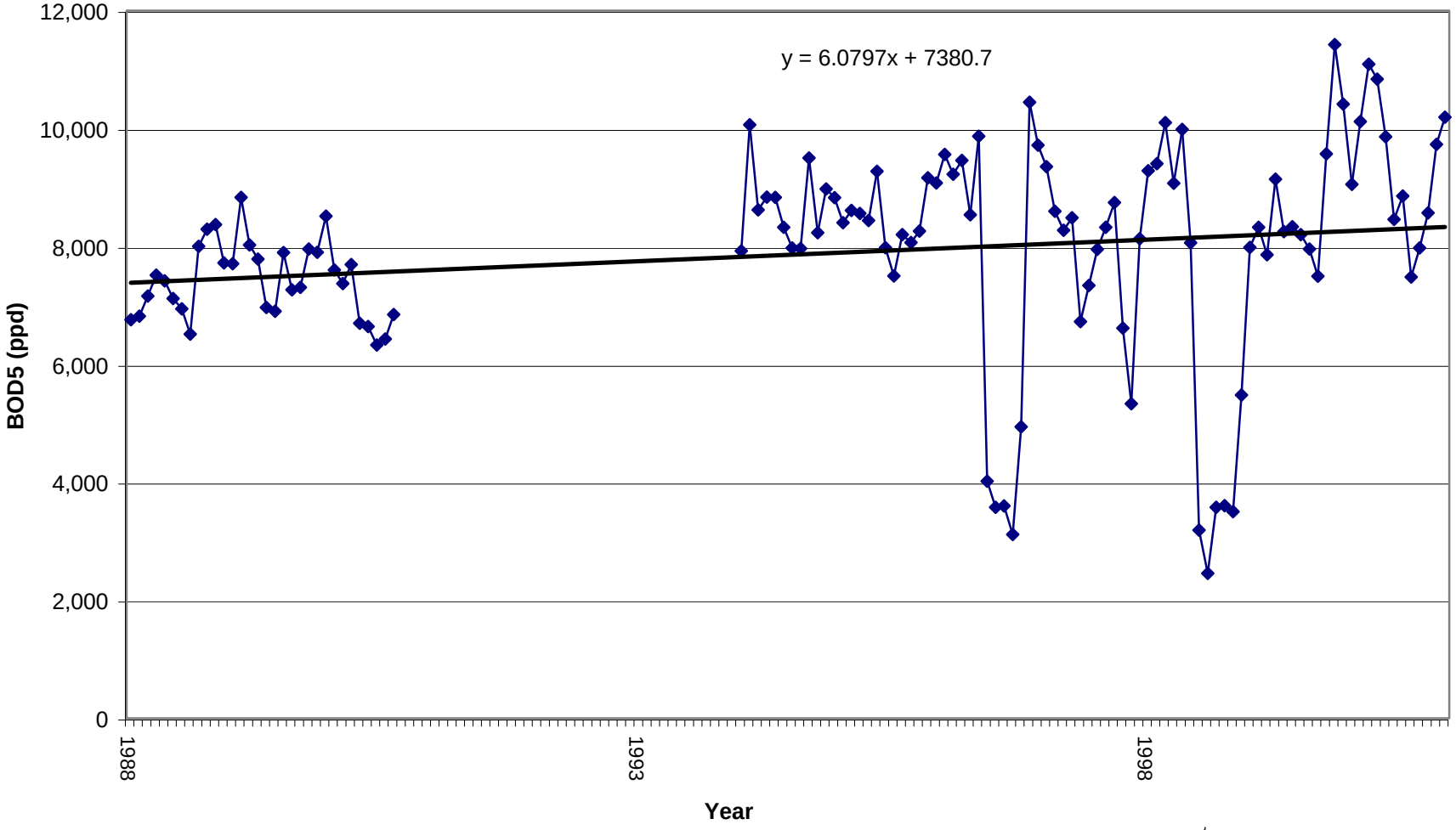
File: Fig 5-1through 5-12.xls
Tab: Fig 5-6 Inf TSS Northeast WWTP

Figure 5-7
Historical BOD5 Monthly Average Loading
Northeast WWTF



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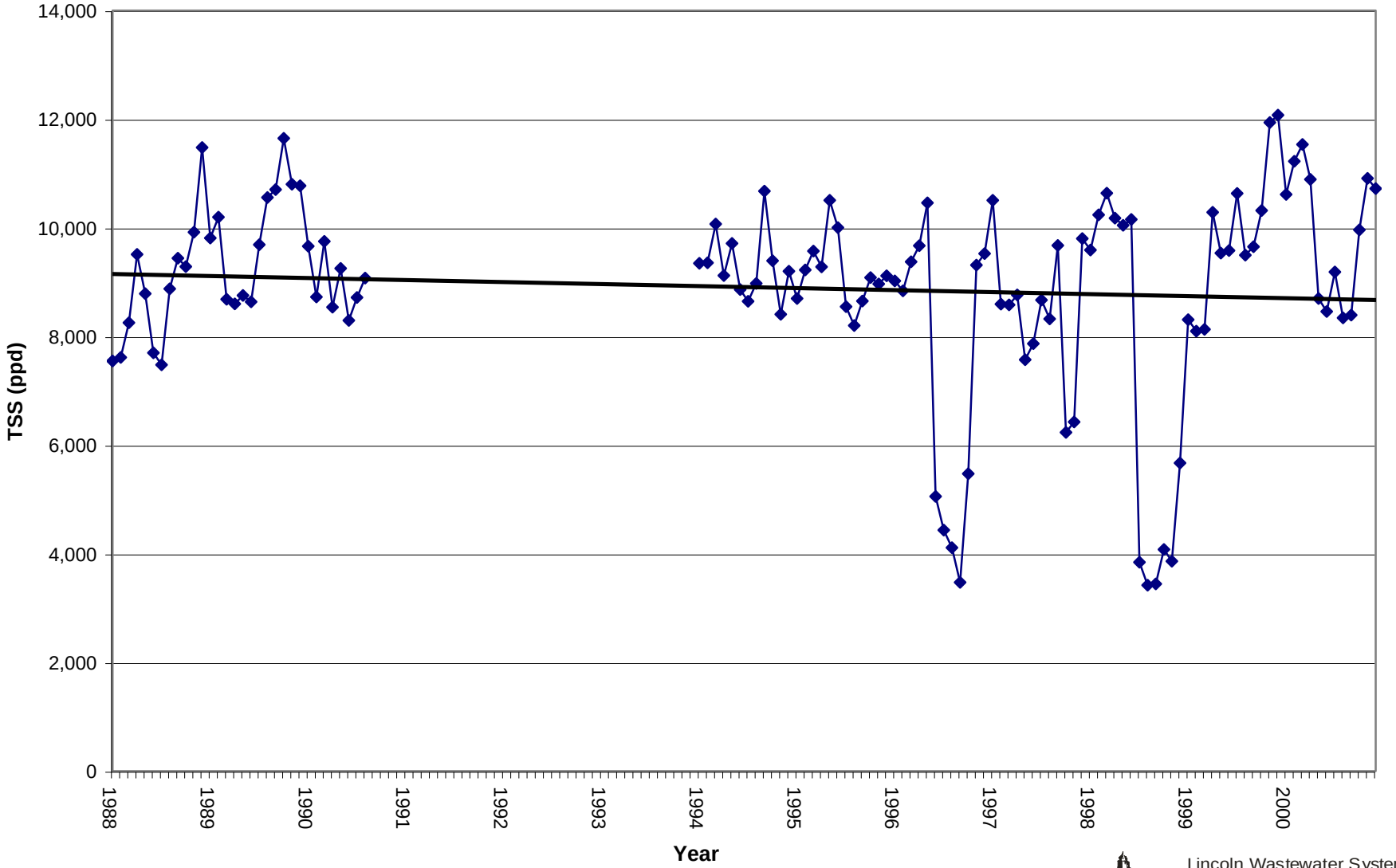
File: Fig 5-1through 5-12.xls
Tab: Fig 5-7 BOD5 ppd - Northeast

Figure 5-8
Monthly Average TSS Loadings
Northeast WWTF



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File: Fig 5-1through 5-12.xls
Tab: Fig 5-8 Northeast TSS (ppd)

Projected Waste Flows and Loads

This section presents projected wastewater flows and loads for the next fifty years for both the Theresa Street and Northeast WWTFs. These projections were based on historical data and the results of hydrologic modeling studies correlated with the City of Lincoln's population growth projections.

Projected Flow Rates. The annual average flow has not increased significantly since 1978, though the population has grown from 171,932 in 1980 to 225,581 in 2000. As illustrated in Figure 5-9, the flow per capita has shrunk from an average of 140 gpcd in 1978 to 105 gpcd in 2000. This phenomenon can be attributed to the success of the City's I/I reduction program, the use of low flow plumbing fixtures in newer homes, and better construction techniques and materials used to install new sewers.

The data indicate that the per capita flow in the year 2000 was 105 gpcd. This is the value that has been used to project wastewater flows through the year 2050. The flow projections were developed using the historical average flow rate of 105 gpcd and a projected population growth rate of 1.5 percent per year. Average daily flow (ADF) projections for the years 2000 - 2050 are presented in Figure 5-10.

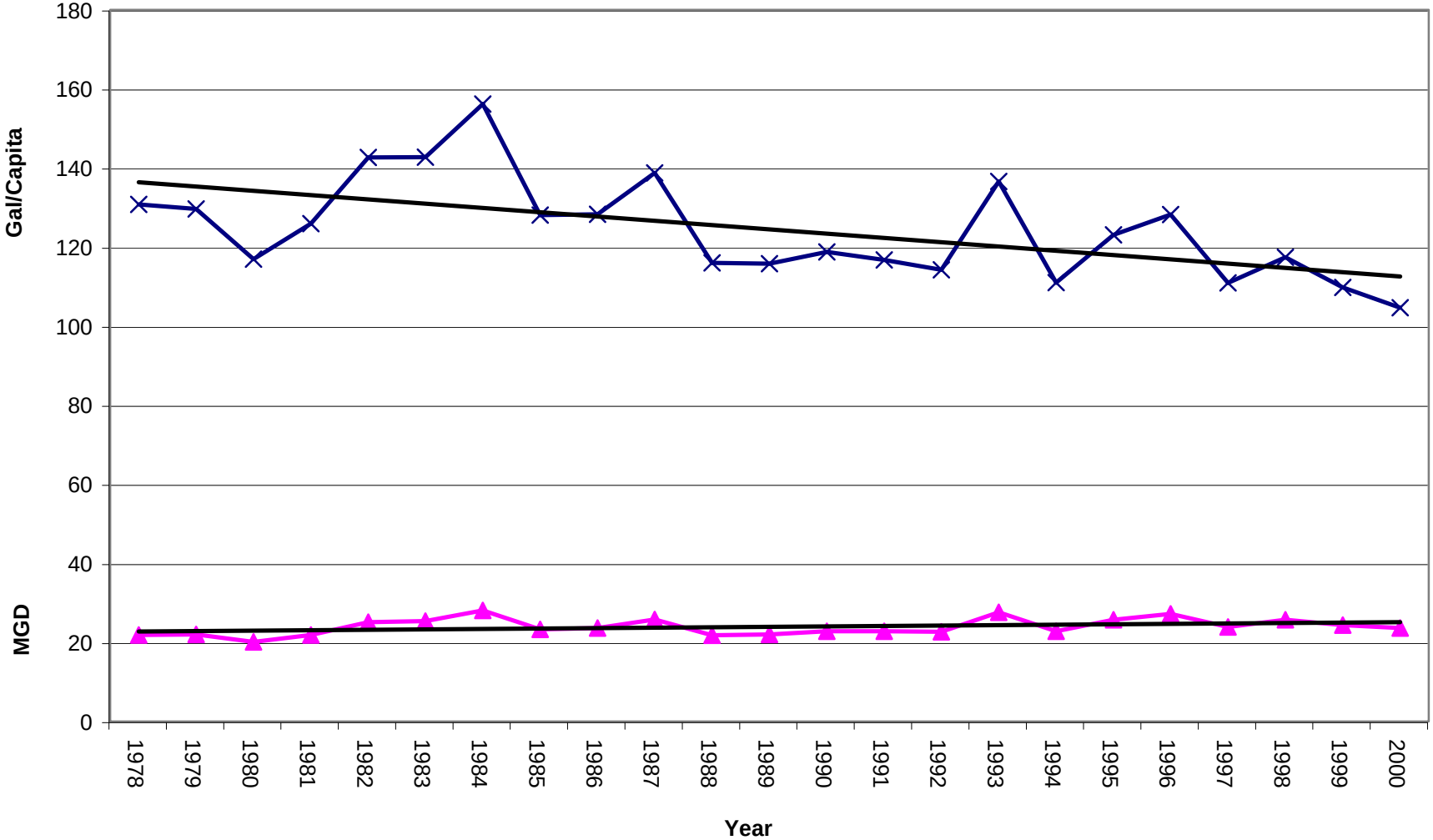
Table 5-5 presents projected wastewater flows based on 2000 per capita flow rates, the service area population projections presented in Chapter 3, and historical dry weather peaking factors.

Table 5-5. Wastewater Flow Projections (mgd)

		2000*	2010	2025	2050
Theresa Street WWTF					
	Daily Average (ADF)	16.8	19.5	24	36
	Maximum Month (MMF)	18.6	21.6	27	40
	Peak Day (PDF)	25.5	29.6	37	54
	Peak Hour (PHF)	32.4	37.7	47	69
Northeast WWTF					
	Annual Average (ADF)	6.8	7.9	10	15
	Maximum Month (MMF)	7.8	9.1	11	17
	Peak Day (PDF)	10.5	12.2	15	23
	Peak Hour (PHF)	13.3	15.4	19	28
Total Annual Average (ADF)		23.6	27.4	34	51
Total Maximum Month (MMF)		26.4	30.7	38	57
Total Peak Day (PDF)		36.0	41.8	52	77
Total Peak Hour (PHF)		45.7	53.1	66	97

*Actual Flow

Figure 5-9
Average Annual Flow and Flow per Capita



Legend

AAF (mgd)
Ave. Flow/Capita
Linear (Ave. Flow/Capita)
Linear (AAF (mgd))

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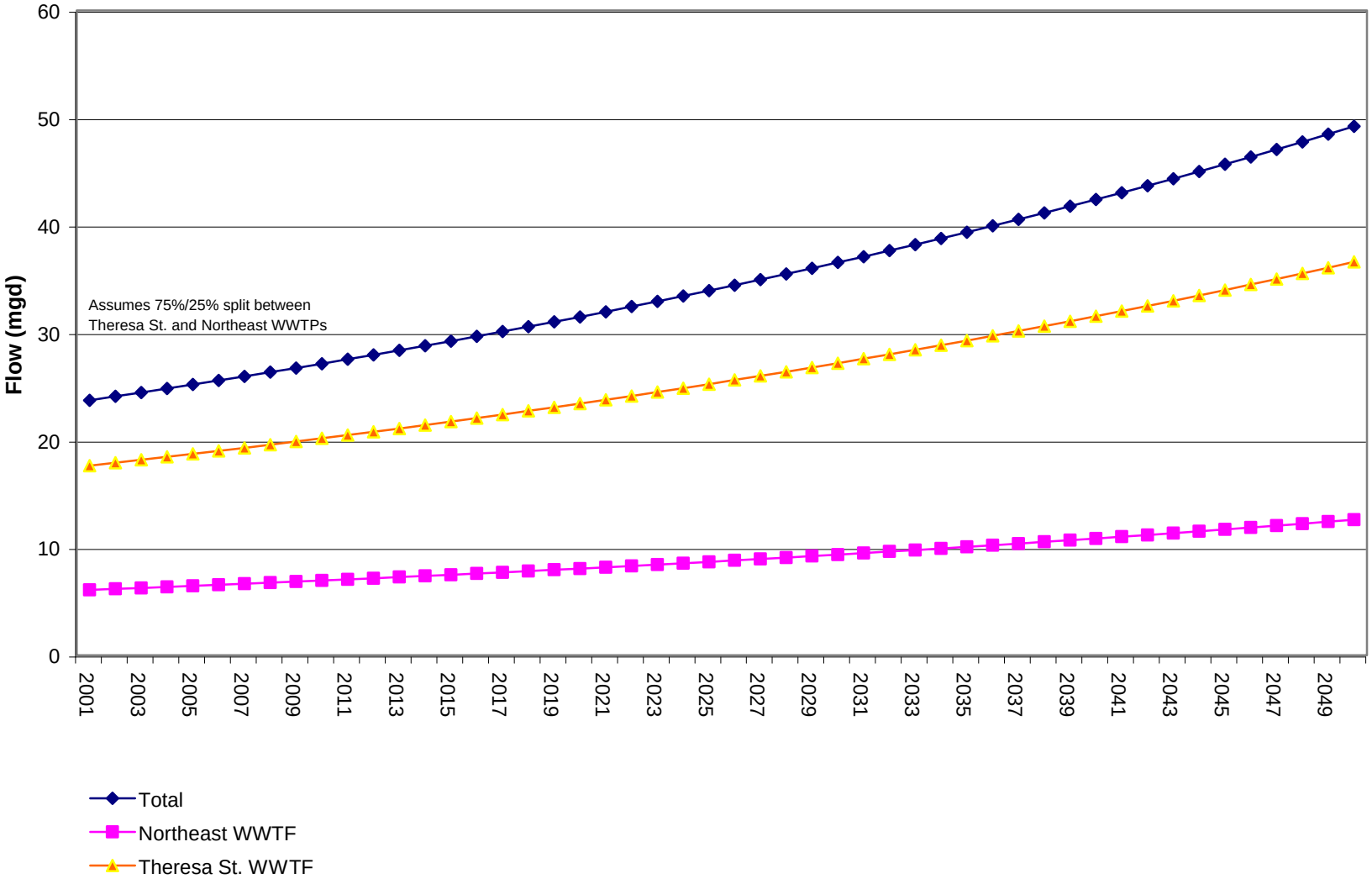
File: Fig 5-1through 5-12.xls
Tab: Fig 5-9 Per Capita Flow

Figure 5-10
Projected Annual Average Wastewater Flows



Projected Peak Wet Weather Flows

The City has established a design storm return interval of 25 years for use in planning to ensure adequate service and protect property. This means that the wastewater collection and treatment facilities are to be designed to accommodate the peak wet weather flow resulting from a storm event of a magnitude statistically expected to occur only four times each century, or once every 25 years. Based on the experiences of July 1993, it is obvious that total rainfall on any single day is not the only variable in predicting peak flow events. Antecedent I/I conditions, soil saturation level, and time of day also play a critical role in the PWWF. To attain the desired level of service, peak wet weather design flows are based on the sum of the individual PWWF components based on actual measurements under severe conditions. The components used to develop the design peak flows are listed below in Table 5-6.

Table 5-6. Peak Wet Weather Flow Components

Component	Measurement
Peak Dry Weather Flow for Theresa Street WWTF	1,035 gal/acre/day
Design Infiltration Rate	500 gal/acre/day
Design Inflow Rate	2,585 gal/acre/day
Total Peak Wet Weather Flow	**4,120 gal/acre/day**

The peak flows projected for the City's wastewater treatment facilities are based on historical levels for I/I and actual flow metering in the collection system.

By adding the dry weather peak flow to the design inflow rate an additional safety factor is attained. This implies that the design peak wet weather flow will coincide with the peak hourly dry weather flow. The peak wet weather flow design factor will be 4,120 gallons/acre/day, which correlates well with the historical wastewater flows received at the two wastewater treatment facilities. This peak flow, when compared to annual average, represents a peak flow to ADF ratio of approximately 4.6:1.

Based on the wet weather peaking factor of 4.6:1 (PWWF:ADF) and the wastewater flow projections presented in Table 5-5, the design PWWFs presented in Table 5-7 have been developed.

Table 5-7. Peak Wet Weather Design Flows (mgd)

	2000	2010	2025	2050
Theresa Street WWTF	77.3	90	110	166
Northeast WWTF	31.3	36	46	69
Total	108.6	126	156	235

It is recommended that the Lincoln WWTFs be designed to treat projected peak hourly flows determined using the PHF/MMF ratios presented in Table 4-3. Wet weather flows in excess of these values should be handled using special wet weather flow facilities.

Projected Wastewater Loadings

An analysis of the per capita BOD_5 and TSS contributions was conducted to aid in establishing a basis for long-term projections of organic loadings to Lincoln's wastewater treatment facilities. Table 5-8 presents historical and projected loading rates for the Theresa Street and Northeast WWTFs.

Table 5-8. WWTF Loading Rate Projections*

	2000	2010	2025	2050
Theresa Street WWTF				
BOD_5 (ppd)	46,500	54,000	67,500	98,000
TSS (ppd)	66,700	77,400	96,800	140,400
NH_3–N (ppd)	7,000	8,100	10,100	14,700
Northeast WWTF				
BOD_5 (ppd)	16,300	18,900	23,600	34,300
TSS (ppd)	26,000	30,200	37,800	54,800
NH_3–N (ppd)	2,600	3,000	3,800	5,500
Total				
BOD_5 (ppd)	62,800	72,900	91,100	132,300
TSS (ppd)	92,700	107,600	134,600	195,200
NH_3–N (ppd)	9,600	11,100	13,900	20,200
Population	225,581	261,796	327,306	474,903

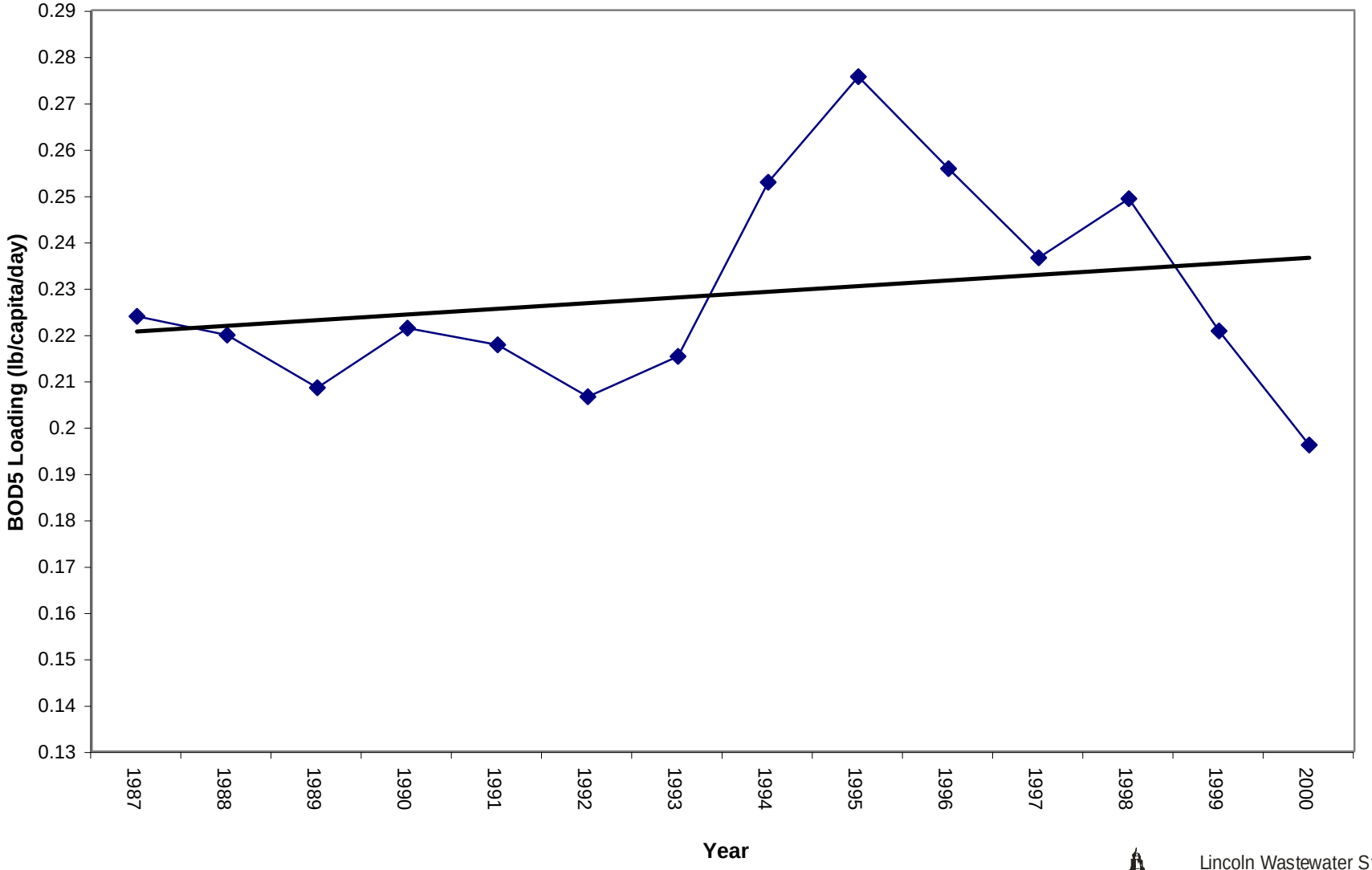
*Loading projections are based on maximum month conditions.

The values presented in Table 5-8 represent maximum month loading conditions and are based on the maximum month flows shown in Table 5-5 and the constituent concentrations presented in Tables 5-3 and 5-4. NH_3-N represents ammonia nitrogen. Figures 5-11 and 5-12 show the historical trends in per capita contributions for BOD_5 and TSS. These values were derived from trends established using historical flow and load data from 1987 through 2001. Since the City has made several changes to the wastewater system over the past few decades, data generated prior to 1987 are not considered to accurately represent current loading conditions.

As illustrated in Figure 5-11, the average BOD_5 load per capita has generally increased over time. The average BOD_5 load per capita during the year 2001 is approximately 0.228 lbs/capita/day.

Figure 5-12 shows the long-term trend in per capita TSS loadings. The average TSS loading for the period shown is approximately 0.26 lbs/capita/day.

Figure 5-11
Average Yearly BOD5 Loading per Capita
Theresa Street WWTP



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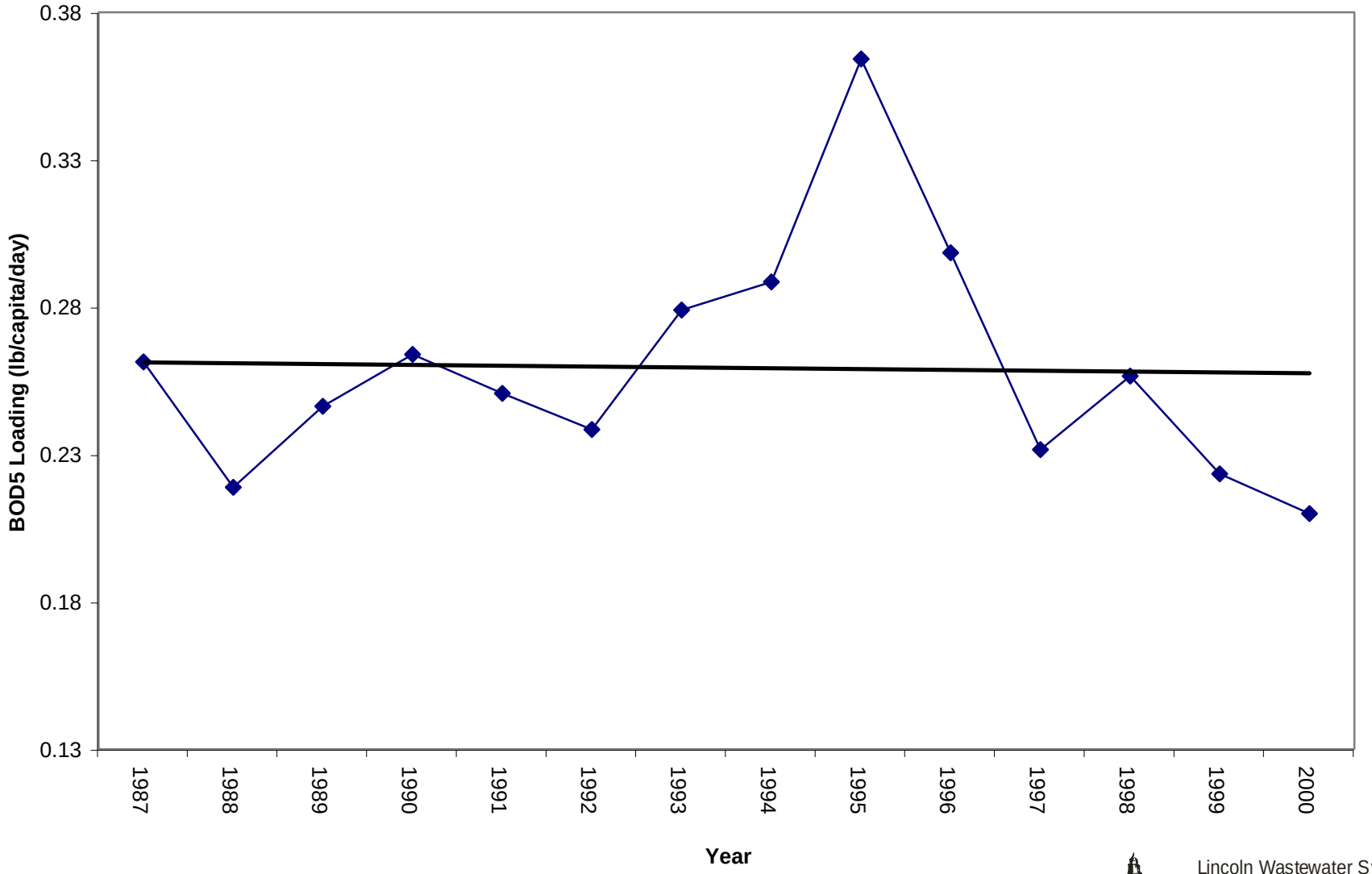
File: Fig 5-1through 5-12.xls
Tab: Fig 5-11 BOD Per Capita Graph

Figure 5-12
Average Yearly TSS Loading per Capita
Theresa Street WWTP



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File: Fig 5-1through 5-12.xls
Tab: Fig 5-12 TSS Per Capita Graph

Projected Wastewater Solids Production Rates

A projection of future wastewater solids production is necessary to predict when additional sludge handling facilities will be required. Future solids loading will not necessarily correspond to population growth. Loads from other sources such as industrial, commercial, and septage contributors can affect solids loading without an appreciable difference in the population served. Figure 5-13 presents projected solids loads for the Theresa Street WWTF from 2000-2050.

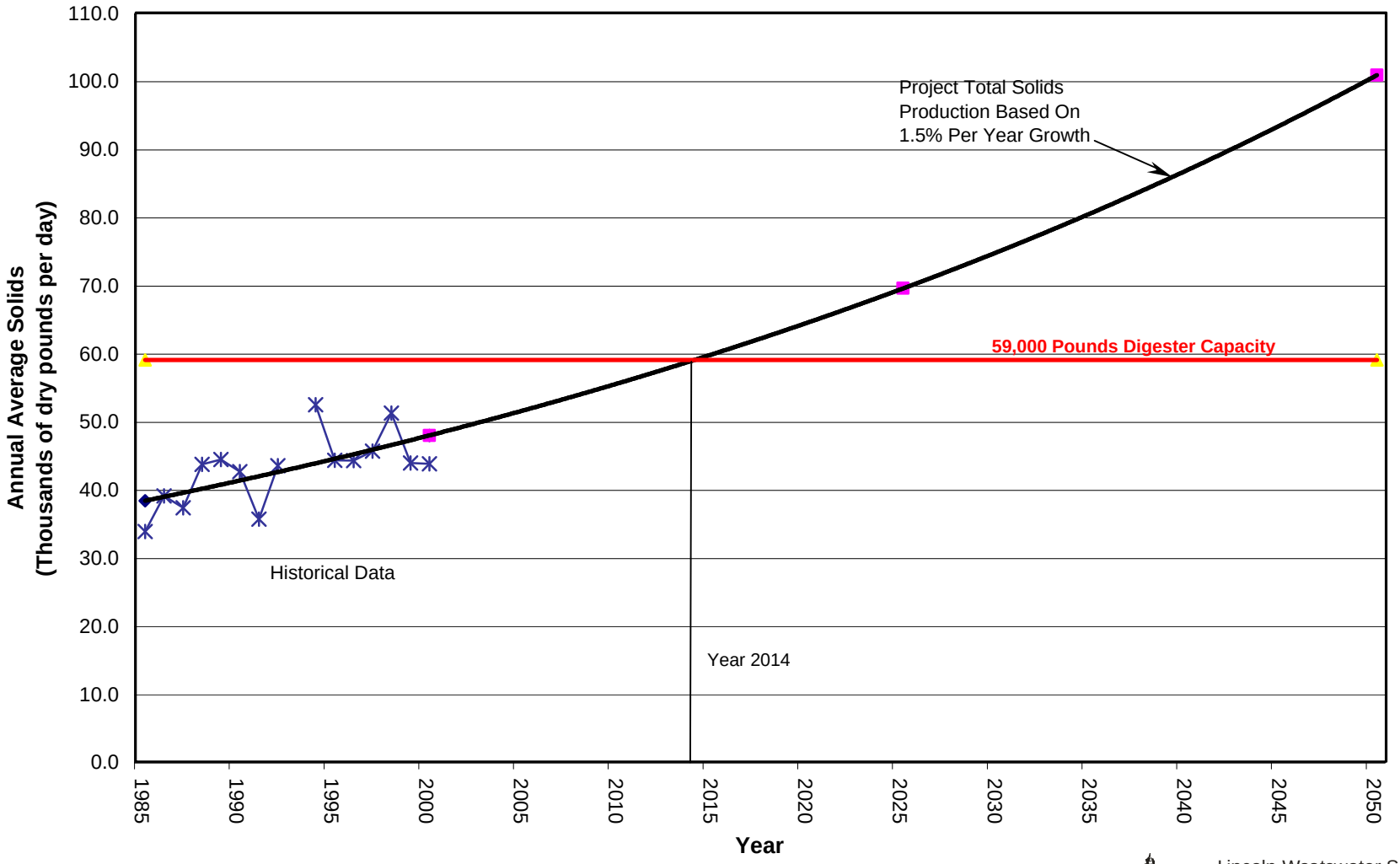
Projected solids production rates, measured in dry pounds per day, are based on historical production rates and wastewater flow projections. These values are presented in Table 5-9. TSS represents total suspended solids, and VSS represents volatile suspended solids.

Table 5-9. Projected Solids Production Rates

	2000	2010	2025	2050
Theresa Street WWTF				
TSS (ppd)	48,500	56,400	70,400	104,400
VSS (ppd)	35,900	41,700	52,100	77,200
Northeast WWTF				
TSS (ppd)	14,100	16,500	19,900	30,800
VSS (ppd)	10,500	12,200	14,800	22,800
Total				
TSS (ppd)	62,700	72,900	90,400	135,200
VSS (ppd)	46,400	53,900	66,900	100,000

The values shown in Table 5-9 are based on maximum month flows and loads and on historical solids production rates.

Figure 5-13
Digester Feed Sludge Projections (2000-2050)
Theresa Street WWTF



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File: Fig 5 - 14.SludgeForecastRegression.xls
Tab: Fig 5-14

Summary

Projected wastewater flows and loads for the Theresa Street and Northeast WWTFs are presented in Table 5-10.

Table 5-10. Summary of Projected Flows and Loads

	2000	2010	2025	2050
Population	225,581	261,796	327,306	474,903
Theresa Street				
Flow (max month)	18.6	21.6	27	40
BOD_5 (ppd)	46,500	54,000	67,500	98,000
TSS (ppd)	66,700	77,400	96,800	140,400
NH_3–N (ppd)	7,000	8,100	10,100	14,700
Northeast				
Flow (max month)	7.8	9.1	11	17
BOD_5 (ppd)	16,300	18,900	23,600	34,300
TSS (ppd)	26,000	30,200	37,800	54,800
NH_3–N (ppd)	2,600	3,000	3,800	5,500
Totals				
Flow (max month)	26.4	30.7	38	57
BOD_5 (ppd)	62,800	72,900	91,100	132,300
TSS (ppd)	92,700	107,600	134,600	195,200
NH_3–N (ppd)	9,600	11,100	13,900	20,200

CHAPTER 6

REGULATORY REQUIREMENTS

This chapter summarizes current and anticipated regulations that impact the City of Lincoln's wastewater treatment requirements.

Current Water Quality Standards

The State of Nebraska, in conjunction with the US EPA, established water quality classifications for all surface water in the state. Specific minimum water quality requirements have been established for each classification category to protect the water uses associated with that classification. These water quality requirements determine to a large degree the level of wastewater treatment required for surface discharges. Lincoln's two wastewater treatment facilities both discharge into segment LP2-20000 of Salt Creek. The quality of effluent allowed to be discharged from Lincoln's wastewater treatment facilities into the creek is dictated by the stream classification, seasonal flow condition, and secondary effluent standards through NPDES discharge permits issued by the NDEQ.

State Stream Use Classifications. In Nebraska, surface water quality is regulated under Title 117-Nebraska Surface Water Quality Standards. Title 117 establishes the public policy for Nebraska to protect and improve surface water quality for human consumption, aquatic life, industry, recreation, and other beneficial uses. The NDEQ has been delegated the responsibility of implementing this state program with oversight from Region VII of the US EPA.

The following surface water classifications have been established by the State of Nebraska:

- Aquatic Life
  - Coldwater (Class A and B)
  - Warm Water (Class A and B)
- Recreation (Class A and B)
- Water Supply
  - Public Drinking Water
  - Agricultural (Class A and B)
  - Industrial
- Aesthetics

Descriptions of the water quality standards associated with each use classification, and the specific classifications for individual water bodies or water body segments, are presented in the Title 117 regulations.

Salt Creek Classification. Use classifications, or beneficial uses, are assigned to all surface waters within the State of Nebraska. Assigned and existing use classifications are protected by the "Antidegradation Clause" and the narrative and numerical water quality criteria stated in Title 117. The Theresa Street and Northeast WWTFs both discharge into segment LP2-20000 of Salt Creek located in the Lower Platte River basin. The quality of all discharges into Salt Creek must be consistent with maintaining the quality of water in the creek at or above the quality levels established for the creek's classifications.

Surface water bodies are classified as either cold water or warm water based on their ability to support different types of aquatic life. The cold water classification is the most restrictive in terms of water quality requirements. The cold and warm water classifications are then assigned a sub-classification of A or B, with A being the most restrictive. Recreation classifications are based on suitability for recreation and human contact. Class A is the primary contact designation and indicates the waters are to be suitable for recreational activities involving full body contact. The agricultural use classification designates the water's suitability for irrigation of crops and ingestion by livestock. As with aquatic life and recreation classifications, agricultural Class A is more restrictive than Class B in terms of water quality requirements.

Segment LP2-20000 of Salt Creek (Beals Slough to Rock Creek) has been classified as follows:

- Aquatic Life, Warm Water Class A
  - Site-specific Ammonia Criteria
- Recreation, Class A (primary contact)
- Agricultural Use, Class B

Nebraska Discharge Permitting System

The NDEQ is required to regulate point source discharges under the NPDES program, and NPDES permits are issued and enforced through the NDEQ. A point source is defined as "any discernible, confined, and discrete conveyance...from which pollutants are or may be discharged" (US EPA, 1983). Pollutants regulated include liquid and solid wastes of chemical, biological, or physical nature which are discharged into surface waters.

An effluent discharge permit issued under the NPDES includes two main elements: specific effluent limits for each regulated pollutant being discharged, and effluent monitoring requirements. NPDES permits are developed by the NDEQ and must be renewed every five years, unless an administrative extension is granted.

Effluent limits in Nebraska NPDES permits reflect two levels of treatment requirements. The first level, referred to as technology-based limits, is based on technological treatment capabilities and establishes the minimum degree of treatment required before discharge. The second level of treatment requirements, termed water-quality-based effluent limits, may be imposed on municipal and industrial dischargers if technology-based limits are insufficient to protect and maintain designated water uses and meet water quality criteria. Point source water-quality-based effluent limits are defined as waste load allocations (WLA) under the Total Maximum Daily Load (TMDL) program (US EPA, 1999). A TMDL defines the maximum quantity of a pollutant which can be

assimilated by a receiving water without exceeding water quality standards.

Current Theresa Street WWTF NPDES Permit. The City of Lincoln was issued an NPDES permit, No. NE0036820, on April 9, 1986 which identified effluent limitations, monitoring requirements, and other conditions for wastewater discharge from the Theresa Street WWTF. This permit expired on April 9, 1989. However, the NDEQ has issued the City numerous administrative extensions to the permit since that time. Currently, all requirements listed in the April 9, 1986 permit still apply. Tables 6-1 and 6-2 present the permit limits and monitoring requirements of the current NPDES permit. This permit will remain effective through administrative extensions until a new NPDES permit is issued, which is expected to occur in 2003. A copy of the permit is located in Appendix D.

Table 6-1. NPDES Permit Limitations - Theresa Street WWTF

Constituent	Maximum Concentrations		
	30-day Average	7-day Average	Daily Maximum
BOD_5, mg/L (lb/day)	30 (7,506)	45 (11,259)	N/A
TSS, mg/L (lb/day)	30 (7,506)	45 (11,259)	N/A
Fecal Coliform, number/100 mL	200	400	N/A
Cadmium, mg/L (lb/day)	0.004 (1.0)	0.004 (1.0)	0.004 (1.0)
Flow, mgd	30	N/A	N/A
Cyanide, mg/L (lb/day)	N/A	N/A	N/A
Oil and Grease, mg/L (lb/day)	10.0 (2,502)	20 (5,004)	N/A

Notes:
1. pH - standard units shall remain between 6.5 and 9.0.
2. Biomonitoring shall indicate an organism mortality less than 10 percent.
3. Loadings based on a 30-mgd flow.
4. mL – milliliters.

Table 6-2. NPDES Permit Monitoring Requirements - Theresa Street WWTF

Constituent	Sampling Frequency	Influent Sample Type	Sludge Sample Type
Cyanide, total	Daily	Grab	Grab
Oil and Grease	Weekly, quarterly	Grab	--
Cadmium, total	Daily, quarterly	24-hour composite	Grab
Chromium, total	Quarterly	24-hour composite	Grab
Copper	Quarterly	24-hour composite	Grab
Lead	Quarterly	24-hour composite	Grab
Nickel	Quarterly	24-hour composite	Grab
Nitrogen, total	Quarterly	24-hour composite	Grab
Zinc	Quarterly	24-hour composite	Grab
BOD_5	Daily, annually	24-hour composite	--
TSS	Daily, annually	24-hour composite	--
pH - standard units	Daily, annually	Grab	Grab
Flow	Continuous	Metered	Metered
Fecal Coliform	Daily	Grab	N/A
Bio-monitoring	Annually	24-hour composite	N/A

Current Northeast WWTF NPDES Permit. Treated wastewater discharged from the Northeast WWTF is regulated by NPDES permit No. NE0112488. This permit was issued on December 4, 1987 and expired December 4, 1992. The NDEQ has also issued numerous administrative extensions to this permit since 1992. Currently, all requirements listed in the December 4, 1987 permit apply. The Northeast WWTF permit regulates effluent concentration of various parameters and defines monitoring requirements. The Northeast WWTF NPDES permit requirements are summarized in Tables 6-3 and 6-4. The 1987 NPDES permit will remain effective through administrative extensions until a new NPDES permit is issued, which is expected to occur in 2003.

The current Northeast WWTF NPDES permit also regulates biosolids application at the City-owned land application site and sets forth surface water and groundwater monitoring requirements. A copy of the Northeast WWTF NPDES permit is included in Appendix E.

Table 6-3. NPDES Permit Limitations - Northeast WWTF

Constituent	Maximum Concentration	
	30-day Average	7-day Average
BOD_5, mg/L (lb/day)	30 (2,001)	45 (3,002)
TSS, mg/L (lb/day)	30 (2,001)	45 (3,002)
Fecal Coliform, number/100 mL	200	400
Flow, mgd	8.0	N/A
Ammonia, mg/L (lb/day)	N/A	N/A
Oil and Grease, mg/L (lb/day)	N/A	10 (667)

Notes:
1. pH - standard units shall remain between 6.0 and 9.0.
2. Biomonitoring shall indicate an organism mortality less than 10 percent.
3. Loadings based on an 8 mgd flow.
4. mL – milliliters.

Table 6-4. NPDES Permit Monitoring Requirements - Northeast WWTF

Constituent	Sampling Frequency	Influent Sample Type
Oil and Grease	Daily	Grab
Ammonia, total as N	Daily, quarterly	24-hour composite
BOD_5	Daily, annually	24-hour composite
TSS	Daily, annually	24-hour composite
pH - standard units	Daily, annually	Grab
Flow	Continuous	Metered
Fecal Coliform	Daily	Grab
Total Residual Chlorine	Daily	Grab

Potential Future NPDES Permits. Since 1992 the City of Lincoln and NDEQ have been discussing new NPDES permits for both of the City's wastewater treatment facilities. It is anticipated that new NPDES permits will be issued in 2003 and that they will contain the same pollutant limits as the current permits plus new limits for constituents such as ammonia, residual chlorine, whole effluent toxicity, and possibly some metals. Of the possible new constituents to be regulated under the next NPDES permit, ammonia effluent limits could have the greatest impact to the Theresa Street and Northeast WWTFs with respect to required treatment upgrades. Potential ammonia effluent limits are discussed in more detail below.

Potential Ammonia Effluent Limits. In 1994 the City selected a technical consulting team to support efforts in determining appropriate chronic ammonia criteria applicable to Salt Creek Segment LP2-20000 and associated ammonia effluent limits for both the Theresa Street and Northeast WWTFs. Extensive chemical, biological, toxicity, and physical analysis of Salt Creek were initiated in 1994 under the Salt Creek Water Quality Studies (SCWQS) project. The intention of the SCWQS was to collect data for the development of site-specific seasonal chronic

ammonia criteria, which reflect some of the unique characteristics of Salt Creek and are protective of the biological community it supports. The City completed the final monitoring and data evaluation efforts in 2000 and the results are documented in various reports. The SCWQS-proposed chronic ammonia criteria and effluent limits are documented in the report titled *City of Lincoln, Nebraska Salt Creek Water Quality Studies, Site-Specific Chronic Ammonia Criteria Final Technical Report, June 16, 2000.*

As indicated in the Site-Specific Chronic Ammonia Criteria Final Technical Report (Table 5-2, Manuscript 5), seasonal chronic ammonia criteria were recommended based on bioassessment results, *in situ* study results, and an equal weighted combination of both.

As part of the SCWQS, a peer review team was organized through the Water Environment Research Foundation (WERF). The WERF Peer Review Team provided technical oversight and review of final results and recommendations for chronic ammonia criteria. The Peer Review Team also provided a final report to the City documenting their support in the City's efforts in developing chronic ammonia criteria. While the Peer Review Team's final report was supportive of the individual criteria and equal weighting of the bio-assessment-based criteria and the *in situ* criteria, the Peer Review Team could not support the use of the summer bio-assessment based criteria being used as a summer "floor" value. During discussions and negotiations with NDEQ, it was agreed by the City to base the site-specific chronic criteria on the *in situ* results only. The final site-specific criteria were approved by the Nebraska Environmental Quality Council in October 2002. The site-specific criteria were applied as three-season criteria (spring, summer, and winter) based on NDEQ-approved seasonal pH and temperature values.

Based on the chronic ammonia criteria developed through the SCWQS, chronic ammonia effluent limits were calculated for both the Theresa Street and Northeast WWTFs. Since final approval of the proposed criteria has not been provided by NDEQ, final limits may vary from the potential limits identified. The potential chronic ammonia effluent limits are presented in Table 6-5.

Table 6-5. Anticipated Effluent Ammonia Limits*
(Calculated with 30-day Averaging Period for
Waste Load Allocation Long-Term Average Multiplier)

	Spring		Summer		Winter	
	Monthly Avg	Daily Max	Monthly Avg	Daily Max	Monthly Avg	Daily Max
Treatment Facility	mg/L – N	mg/L – N	mg/L – N	mg/L – N	mg/L – N	mg/L -N
Theresa Street						
2008	8.29	21.71	2.88	7.55	8.34	21.84
2013	8.20	21.46	2.75	7.21	8.27	21.64
2025	8.05	21.07	2.55	6.68	8.15	21.31
2050	6.93	18.14	2.23	5.84	7.96	20.85
Northeast						
2008	13.99	36.62	5.68	14.86	14.87	38.93
2013	13.50	35.53	4.98	13.03	14.35	37.56
2025	12.45	32.58	4.18	10.94	13.81	36.16
2050	7.45	19.51	2.48	6.49	8.21	21.50

* The effluent ammonia limits shown are not final and are based on the best information available at the time this report was prepared (March 2003).

It should be noted that the City and its technical team are still negotiating the final chronic ammonia criteria applicable to Segment LP2-20000 of Salt Creek and the resultant final chronic ammonia effluent limits. It is anticipated that the final chronic ammonia criteria and effluent limits will be established in 2003.

Current Wastewater Residuals Disposal Regulations

Understanding and application of regulations relating to wastewater sludge utilization and disposal is necessary for evaluating existing sludge management practices, and for planning and evaluating future sludge treatment, utilization, and disposal alternatives. All relevant laws and regulations impacting current and potential future use and disposal, and critical elements of the laws and regulations which may constrain future sludge use and disposal should be considered.

Sludge use and disposal is controlled or affected by the following laws and regulations. While some are not directly applicable to wastewater sludge, they may impact the City's current and future sludge management program.

1. Standards for the Use and Disposal of Sewage Sludge, 40 CFR Part 503.
2. NDEQ proposed sludge regulations.
3. The Federal Clean Water Act. (CWA).
4. Resource Conservation and Recovery Act (RCRA) Subtitle D Municipal Solid Waste Regulations, 40 CFR Part 258.
5. RCRA Hazardous Waste Regulations, 40 CFR Part 261.
6. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Superfund requirements.
7. City of Lincoln and Lancaster County requirements and regulations.

Residuals are generated from several different treatment processes at the Lincoln Wastewater Treatment Facilities. These include:

- Influent Screening
- Grit Removal
- Primary Clarification
- Secondary Treatment

Screenings and Grit. The residuals generated from the screening and grit removal processes are hauled to the Lancaster County landfill for disposal. The regulation governing this practice is the Federal Resource Conservation and Recovery Act (40 CFR 258 or RCRA). The section of this regulation that applies to wastewater screenings and grit disposal is typically referred to as "Subtitle D". The requirements of the Subtitle D regulation are basically that the material not be "hazardous" and that it not contain free water. Wastes are considered hazardous if they exhibit corrosivity, toxicity, reactivity, or ignitability. Wastes are considered to contain no free water if they pass the "Paint Filter Test".

Generally, screenings and grit generated in domestic wastewater treatment facilities comply with the non-hazardous requirements, but treatment is generally required to eliminate free water. At both the Theresa Street and Northeast WWTFs, screenings and grit are de-watered sufficiently to meet the RCRA requirements.

Primary and Secondary Sludges. The primary federal regulations governing disposal of sewage sludge are regulations adopted by the US EPA under the Clean Water Act. These regulations were published as 40 CFR Part 503, and are commonly referred to as the "503 Regulations". The 503 Regulations govern the disposal of sewage sludge, or biosolids, by land application, surface disposal, and incineration. Land application refers to disposal of biosolids on land for beneficial use at agronomic rates. Agronomic rates means rates intended to supply the nitrogen requirements of the crops being grown, but rates that will not result in migration of nitrogen below the root zone. Surface disposal describes disposal on land at sites and rates not limited by the agronomic requirements of crops. This includes disposal practices such as sludge only landfills, sludge lagoons, and dedicated land disposal sites. The incineration practices covered by the 503 Regulations apply only to "sludge only" incinerators.

The 503 Regulations establish different site management and application practices for different qualities of biosolids. Biosolids quality is determined primarily on the basis of certain metal concentrations, the degree of treatment the biosolids receive prior to disposal, and the concentration of certain microorganisms in the biosolids at the time of disposal. The higher the quality level, the fewer the restrictions placed on disposal.

The 503 requirements that affect the City of Lincoln relate to biosolids disposal. A summary of the 503 Regulation requirements for biosolids applied to agricultural land is provided in Table 6-6.

Table 6-6. Summary of 503 Regulations Applicable to Land Application of Biosolids

Disposal Method	Metals Requirements	Pathogen Reduction Requirement	Vector Attraction Reduction Requirement	Restrictions
Sold or Given Away	Pollutant Limits for "High Quality" Sludge	Class A	Sludge Processing	These are "Exceptional Quality Biosolids" and no restrictions apply.
Applied in Bulk to Public Access Areas such as Parks or Golf Courses	Pollutant Ceiling Limits	Class A	Sludge Processing	Must comply with annual biosolids application limits and management practice requirements.
Applied to Agricultural Lands such as Crop Lands or Pasture Lands or Non-agricultural Lands such as Forests	Pollutant Ceiling Limits	Class B	Sludge Processing or Physical Barriers	Must comply with annual biosolids application limits and management practice requirements.

Biosolids are classified as either Class A or Class B under the 503 Regulations, depending on the quality of the biosolids and the type of treatment they have received prior to land application. The quality requirements associated with Class A and Class B biosolids are summarized in Tables 6-7 and 6-8.

Table 6-7. Summary of Class A Biosolids Criteria

Class A biosolids must comply with both requirements 1 and 2 below:	
Requirement 1 – Biosolids must meet one of the following criteria:	
Criteria 1A	Fecal Coliform Bacteria density less than 1,000 Most Probable Number (MPN) per gram of total dry solids (<1,000 MPN / gTs)
Criteria 1B	Salmonella density less than 3 MPN per 4 grams of total dry solids (<3 MPN/4gTs).
Requirement 2 – Biosolids must meet one of the following criteria	
Criteria 2A	Biosolids have been subjected to elevated temperatures according to requirements set forth in 503 Regulations.
Criteria 2B	Biosolids pH is raised to greater than 12 for at least 72 hours at temperatures specified in 503 Regulations and air dried to total solids by weight.
Criteria 2C	Biosolids complies with density requirements for Entric Viruses and Viable Helminth Ova as stipulated in the 503 Regulations.
Criteria 2D	The biosolids have been treated by a "Process to Further Reduce Pathogens" (PFRP) or a PFRP equivalent process as defined by the 503 Regulations. PFRPs include: ▪ Composting (55ºC) ▪ Heat Drying ▪ Heat Treatment ▪ Thermophilic Aerobic Digestion ▪ Beta Ray Irradiation ▪ Gamma Ray Irradiation ▪ Pasteurization

Table 6-8. Summary of Class B Biosolids Criteria

Class B biosolids must meet one of the following pathogen requirements:	
Requirement 1	Fecal Coliform Bacteria densities less than 2,000,000 MPN or Colony Forming Units (CFU) per gram of total dry solids (< 2,000,000 MPN or CFU/gTs).
Requirement 2	The Biosolids have been treated by a "Process to Significantly Reduce Pathogens" (PSRP) or a PSRP equivalent process as defined by the 503 Regulations. PSRPs include: ▪ Aerobic Digestion ▪ Air Drying ▪ Anaerobic Digestion ▪ Composting (40ºC) ▪ Lime Stabilization

Biosolids generated in the primary and secondary treatment processes at the Lincoln WWTFs are applied to agricultural lands in the Lincoln area. At a minimum they must meet the pollutant ceiling limits for metals, the Class B requirements for pathogen reduction, and the vector attraction reduction requirements either by processing or with appropriate physical barriers at the application sites. Biosolids from both facilities are treated with anaerobic digestion to meet both the pathogen reduction and vector attraction reduction requirements.

Monitoring requirements associated with the 503 Regulations vary depending on the quantity of sludge or biosolids produced. Monitoring generally ranges from monthly to annually.

Reporting Requirements. Reporting and record keeping requirements also vary with the quality of the sludge produced. The two examples described below illustrate the range of the requirements:

1. If the sludge meets the alternate pollutant levels, Class A pathogen levels, and vector attraction reduction requirements, then the sludge is classified "exceptional quality" and the record keeping requirements are:

    a. Pollutant concentrations,
    b. Description of how Class A requirements are met,
    c. Description of how vector attraction reduction requirements are met, and
    d. Certification statement that requirements are met as determined under the treatment facility supervisor's direction.

2. If the sludge meets the pollutant ceiling limits, Class B pathogen reduction, and vector attraction reduction requirements, then the record keeping requirements are:

    a. Location and size of application site,
    b. Date and time sludge is applied,
    c. Amount of each pollutant applied to each site,
    d. Amount of sludge applied to each site,
    e. Pollutant concentrations,
    f. Description of how pathogen reduction is met,
    g. Description of how vector attraction reduction is met,
    h. Description of how site restrictions for Class B sludge are met,
    i. Description of how management practices are met, and
    j. Certification statement that requirements are met as determined under the treatment facility supervisor's direction.

Given the current treatment levels and sludge quality at Lincoln's facilities, the more stringent record keeping and reporting requirements apply.

The 40 CFR Part 503 Regulations require sludge permits for all wastewater facilities generating sludge. The sludge permit requirements may be covered in a facility's NPDES permit. The permit application must be submitted six months before the expiration of the existing NPDES permits for the treatment facility. States may require a sludge permit application before NPDES permits expire.

The information required for the permit application includes:

1. Sludge monitoring data and annual volumes;

2. Available groundwater monitoring data for landfills or land application sites;

3. Description of sludge use or disposal practices including location of application or disposal sites, contractors who apply sludge, and distributors who market sludge; and

4. A land application plan for each site, including:

   a. Geographical area covered by plan,
   b. Site selection criteria,
   c. How the site will be managed, and
   d. Advance notice to permit authority, adjacent landowners and occupants, and the public (if required by the State).

Clean Water Act. The federal CWA establishes requirements for all discharges to surface waters through the NPDES permit process. The authority for 40 CFR Part 503 sludge regulations is also provided by the CWA.

All point source discharges are required to have an NPDES permit and to comply with the required effluent conditions established in the permit. Sludge management and disposal in compliance with 40 CFR Part 503 Regulations is typically part of the NPDES permit.

Industrial waste pretreatment requirements are also part of the CWA requirements. In establishing local limits for pretreatment, sludge use must be considered.

RCRA Hazardous Waste Regulations, 40 CFR Part 261. RCRA regulations define and control the handling of hazardous waste. Wastewater sludge is exempt from RCRA requirements unless it is determined to be a hazardous waste through testing of toxicity characteristics.

Hazardous waste is defined in 40 CFR Part 261 by the following criteria:

- Ignitability
- Reactivity
- Corrosivity (pH less than 2 or more than 12.5)
- Toxicity characteristics
- Listed hazardous waste

Toxicity characteristics are determined by analyzing the sludge for hazardous characteristic and contaminants using the Toxicity Characteristics Leaching Procedure (TCLP) test. Wastewater sludge usually does not exceed any of the maximum concentration levels but individual WWTF sludges should be analyzed to confirm this.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). CERCLA may be applied to require corrective actions to remove hazardous substances discharged to the environment. This legislation establishes liability and corrective actions for parties responsible for the discharge. The liability is extensive and comprehensive. Although remote, the application of CERCLA liability to wastewater sludge may be possible if hazardous substances are traced to the sludge. Further, if a landfill has been determined to be a hazardous waste source, liability can be attached to wastewater sludge that was disposed in it.

Failure to fully acknowledge all hazardous substances in wastewater sludge may incur CERCLA liability, especially if any unpermitted constituents are later determined to pose a threat to human health or the environment. The best protection is to ensure that all hazardous substances in the sludge are identified during the US EPA permitting process.

Evolving Regulations and Standards

From a planning perspective it is important to have knowledge of existing local, state, and federal regulations and requirements. It is also important to have a solid understanding of how these requirements may change or what new regulatory requirements are under development. Many new requirements or initiatives at the national level have evolved over the past few years and are making their way down to the state and local level. This section presents some of the current and future regulatory initiatives that could have an impact to the City of Lincoln.

Clean Water Act Reauthorization. Reauthorization of the Clean Water Act was expected to be completed in 1994. Congress did not act on reauthorization but is expected to do so in the future. Issues within the proposed reauthorized act included stormwater and other non-point discharges, sediment criteria, innovative approaches such as point/non-point source pollutant trading, and pollution prevention. An additional key element is encouragement for water quality agencies to develop and implement watershed management plans. There is also the potential for increased flexibility and funding for states in several programs, including the control of non-point source pollution.

Clean Water Action Plan. In 1997 the Clinton Administration directed US EPA and other agencies to develop a Clean Water Action Plan (CWAP) that defines a course toward fulfilling the original goal of the Clean Water Act. The CWAP also addresses drinking water safety, including both chemical and microbiological contamination potential. In 1998 the CWAP was finalized; its focus is on a cooperative approach to watershed protection among state, tribal, federal and local governments and the public. The first step is to identify those watersheds with the most critical water quality problems and work together to focus resources and implement effective strategies to solve these problems. The CWAP has three major goals:

- Enhance protection from public health threats posed by water pollution,
- More effectively control polluted runoff (non-point source), and
- Promote water quality protection on a watershed basis.

A watershed focus helps identify the most cost-effective pollution control strategies to meet clean water goals. Key elements of a watershed approach include:

- Unified watershed assessments,
- Watershed restoration action strategies,
- Watershed pollution prevention, and
- Watershed assistance grants.

Although the CWAP puts more focus on non-point source contributions to water pollution, point source dischargers likely will play a part in meeting the goals of the CWAP. Opportunities exist to include more input from non-point source contributors, and the CWAP emphasizes the importance of their involvement. Funding has been earmarked for this effort through the Clean Water and Watershed Restoration Budget Initiative.

National Criteria Revisions – Water Quality Criteria and Standards Plan. The US EPA Office of Science and Technology in the Office of Water developed the *Water Quality Criteria and Standards Plan – Priorities for the Future* to identify and communicate key scientific and technical priorities the agency plans to pursue, together with the states and tribes, to enhance and improve water quality criteria and standards programs across the country. This plan was developed to support the CWAP announced by President Clinton in February 1998.

The Water Quality Criteria and Standards Plan presents a "vision" and strategy for important new initiatives and improvements that could be made to the water quality criteria and standards program to better protect human health and maintain or enhance the quality of the nation's water bodies.

The seven new criteria and standards program initiatives that the US EPA is expected to take over the next decade include:

1. Maintaining and strengthening the existing ambient water quality criteria for water and sediments.
2. Developing nutrient criteria and assessment methods to better protect aquatic life and human health.
3. Developing criteria for microbial pathogens to better protect human health during water recreation.
4. Completing the development of biocriteria as an improved basis for aquatic life protection.
5. Developing improved methods for developing TMDLs and modeling to better translate water quality standards into implementable control strategies.
6. Evaluating possible criteria initiatives for sedimentation, flow, and wildlife.
7. Ensuring implementation of these new initiatives and improvements by the US EPA in partnership with the states and tribes.

The Water Quality Criteria and Standards Plan "Vision" states that:

> *"The water quality criteria and standards program will fully integrate biocriteria, nutrient criteria, and microbial pathogen control with improved chemical-specific criteria, whole effluent toxicity methods, and possible sedimentation, flow and wildlife criteria, into criteria and standards programs to better support watershed management for the protection of human health and the maintenance and improvement of the chemical, physical, and biological integrity of the Nation's waters. Future criteria initiatives for excessive sedimentation, flow and wildlife will be investigated."*

While this Plan strives to improve water quality, it does not replace the CWA or US EPA's regulations, nor is it a regulation itself.

TMDL Regulation. Under Section 303(d) of the 1972 Clean Water Act, states are required to develop lists of impaired and threatened waters that do not meet the state's water quality standards and update these lists every two years. This law also requires that the states establish priority rankings for the waters on the list and develop TMDLs for these waters. This is a process that the NDEQ implements and that may affect the acceptability of permitting new discharges or expansions at existing wastewater treatment facilities.

A TMDL identifies the maximum amount of pollutant that a water body can receive and still meet water quality standards. It then allocates this pollutant loading among point and non-point pollutant sources that affect the water body. Waste load allocations for point dischargers are established through the discharger's NPDES permit. The plan for implementing load allocations for waters with primarily non-point sources of pollution will include incentive-based, non-regulatory or regulatory measures, a public participation process, and recognition of watershed management processes and programs. A TMDL must also include a margin of safety and consideration of seasonal variations.

US EPA guidance suggests that TMDLs be developed expeditiously, or within 8 to 13 years after the original listing of the water body. By law, the US EPA must approve both the list and TMDL, or establish it based on federal guidelines. Although part of the original CWA, states and the US EPA did not initially fulfill their responsibility to develop Section 303(d) lists and TMDLs until citizen organizations began bringing legal actions against the US EPA. The US EPA is now under court order or consent decrees in many states to ensure that TMDLs are established, either by the state or by the US EPA.

In 1996 the US EPA began a comprehensive evaluation of Section CWA 303(d) implementation. The US EPA convened a Federal Advisory Committee, whose recommendations served to guide the development of proposed changes to the TMDL regulations issued by the US EPA. These changes were issued in draft form in August 1999. Following a comment period, the US EPA published the Final Rule in July 2000. Even though a Final Rule was promulgated, a congressional "rider" prohibited the US EPA from spending FY2000 or FY2001 money to implement the new rule. As a result, states are continuing to operate under the 1992 TMDL regulations.

In July 2001 the National Research Council (NRC) presented their review of the July 2000 TMDL Final Rule, which is documented in the report titled "*Assessing the TMDL Approach to Water Quality Management.*" In its review, the NRC recommended changes to the TMDL process, including:

1. Changes to the process of assessing water bodies for impairment and Section 303(d) listing,
2. Evaluation of the scientific basis for TMDL development, and
3. Implementation of the TMDL with emphasis on adaptive implementation, which is a more cost effective and streamline process.

In late July 2001 the US EPA placed an eighteen-month moratorium on the July 2000 TMDL Final Rule to allow time for additional review and possible revamping of the rule. With the moratorium, state agencies are expected to revert back to the initial TMDL rule. However, the moratorium is not likely to slow down the TMDL process and schedule that the NDEQ has set in place.

Nutrient Criteria. In 1999 the US EPA published two technical guidance manuals for the development of nutrient criteria for rivers and streams and for lakes and reservoirs. The purpose of the manuals was to provide scientifically defensible technical guidance to assist states and tribes in developing regionally based numeric criteria and algal criteria for river, stream, lake, and reservoir systems. The CWAP focuses attention on addressing nutrient enrichment problems. Some of the primary goals set in the US EPA guidance manuals include:

1. Identification of water quality needs and goals.
2. Selection of appropriate variables and development of a monitoring program.
3. Collection and analysis of data.
4. Development of criteria and implement nutrient controls.
5. Monitoring effectiveness of controls and reassessing validity of criteria.

The US EPA proposed various options to develop nutrient criteria. One option involved the use of percentile values based on actual data from groups of water bodies, including reference waters (minimal or no impact), or using a group of waters that would include some that are impaired. The US EPA also proposed a second method that advocated the refinement of trophic classification systems, use of models, and examination of system biological attributes to assess nutrient and algal variables. A third method provided several published nutrient/algal thresholds that may be used or modified as criteria.

In 2000 and early 2001 the US EPA developed and published recommended nutrient criteria for fourteen Ecoregions within the United States. These numeric criteria are based on the approach of using percentile values based on actual data from groups of water bodies within each Ecoregion. Most of the waters in the Lincoln area fall within Ecoregion VI – Corn Belt and Northern Great Plains. The Ecoregion VI criteria will apply unless the NDEQ adopts state specific criteria or some other accepted alternative for nutrient control. The US EPA's proposed criteria for Ecoregion VI are shown in Table 6-9.

Table 6-9. US EPA Proposed Nutrient Criteria for Ecoregion VI

Nutrient	EPA Recommended Criteria for Streams and Rivers	EPA Recommended Criteria for Lakes and Reservoirs
Total Phosphorus (TP), ug/l	76.25	37.5
Total Nitrogen (TN), mg/L	2.18	1.68
Chlorophyll-a, ug/l	7.33	8.59
Turbidity, NTU	9.89	N/A
Secchi Depth, m	N/A	1.36

Bacteria Standards. Current Nebraska water quality criteria for recreational uses are based on fecal coliforms. The US EPA has been evaluating the appropriateness of fecal coliforms as the bacteriological indicator of pathogens in surface waters. In the *1986 Ambient Water Quality Criteria for Bacteria*, the US EPA recommended criteria for *E. coli* (126/100 mL) and *Enterococci* (33/100 mL) for recreational waters because these organisms have a higher correlation with certain human disease outbreaks than fecal coliforms. Indicator organisms are currently used as criteria because direct analyses for pathogens are difficult and costly. In current permit renewals many states are initiating requirements for *E. coli* monitoring and comparisons between fecal coliform and *E. coli* to help develop a correlation between the two. In the near future, states are expected to require *E. coli* effluent limitations in place of fecal coliforms. However, fecal coliforms may continue to be a monitoring requirement since the *E. coli* test is more difficult and, to date, not as reliable (greater variability) as the fecal coliform tests.

Whole Effluent Toxicity. Since the US EPA's ruling adding whole effluent toxicity (WET) to 40 CFR Part 136, WET testing has come under much scrutiny for the uncertainty and variability in WET testing procedures and results. The primary concerns are that the US EPA is inconsistent in their methodology for WET testing requirements and the analysis of WET testing results. The probability of false positive results and inter-laboratory and intra-laboratory variability are also issues of concern. Litigation resulting from the US EPA's 1995 ruling yielded a settlement agreement committing the US EPA to undertake several actions. Among these actions are:

1. Conducting a comprehensive inter-laboratory validation study on all of its WET testing methods,
2. Issuing a number of rulemakings, and
3. Publishing several guidance documents.

When this work has been completed, the final revised policy will be published in the Federal Register, thus promulgating a new rule. The new rule will affect current state requirements for WET testing and application of WET effluent limitations.

Sanitary Sewer Overflows (SSO). SSO regulations are expected to be promulgated by the US EPA in the near future. These regulations are expected to prohibit sanitary sewer overflows and establish specific management, operation, and maintenance requirements for wastewater collection system operators. The most significant aspect of the SSO regulations, as they apply to Lincoln, is the prohibition of sanitary sewer overflows or treatment system bypasses during wet weather conditions.

Sediment Criteria. The US EPA is currently in the process of developing sediment quality criteria. The rationale for sediment quality criteria is that sediments act as sinks for many pollutants and often become a source of contaminants both to benthic organisms and to water column species. The criteria will be an additional tool to help accomplish a wide range of environmental goals including pollution prevention, contaminated sediment assessment, remediation evaluations, and ecological risk assessment. The final publication of the sediment quality criteria will provide national guidance to state water quality programs, US EPA programs, and other agencies. The final criteria may be incorporated, in some manner, into effluent discharge limitations.

Stormwater Discharge Regulation. In 1993 Lincoln submitted a Municipal - Part 2 NPDES Permit Application for a stormwater discharge permit. The NPDES Part 2 Permit Application is part of the federally mandated NPDES regulations promulgated on November 16, 1990 (55 CFR 47990). Origination of this legislation began with the Clean Water Act, which under 1987 amendments required the US EPA to establish requirements for stormwater discharges. The US EPA has authorized the NDEQ to administer NPDES applications for stormwater discharges for the State of Nebraska.

The National Urban Runoff Program has shown that stormwater from residential and commercial areas, along with industrial areas, can contain a variety of pollutants. Additional areas of concern include the potential for illicit discharges of untreated non-stormwater discharges, spills, and improperly disposed wastes. It has been determined in recent years that such stormwater discharges to receiving waters have been detrimental to receiving water quality.

Requirements of the NPDES stormwater permit include implementation of best management practices, monitoring, compliance with discharge limits for specific parameters, and investigation of illicit discharges under a stormwater management program.

Clean Air Act Amendments (CAAA). According to US EPA estimates, publicly owned treatment works (POTWs) emit approximately 11,000 tons of toxic air pollutants annually. Although this quantity amounts to less than 0.1 percent of all toxic air emissions in the U.S., the lack of progress in achieving National Ambient Air Quality Standards (NAAQS) in many urban areas has resulted in air quality regulations becoming significantly more stringent. Federal and state regulators are taking a closer look at air emissions from wastewater treatment facilities. Today, regulators are concerned with everything from fugitive odors and volatile organic compounds (VOCs) from treatment processes to emissions of toxic air contaminants (TACs) from digester gas combustion. To reduce emissions of TACs and VOCs, the 1990 CAAA require that emission controls be installed at larger existing wastewater treatment facilities. Additionally, the CAAA require that emissions from existing combustion equipment such as boilers and flares be controlled.

Title III of the CAAA requires that major sources of 189 listed hazardous air pollutants (HAPs) install maximum achievable control technology (MACT) to reduce HAP emissions. A "major" source is defined as a facility that has the potential to emit 10 tons per year of a single HAP, or 25 tons per year of combined HAPs. For existing facilities, MACT will be based on the average emissions limit achieved by the best performing 12 percent of existing sources across the country.

The US EPA has promulgated specific standards which identify MACT for 174 source categories. Furthermore, the US EPA has required each state to promulgate its own air quality permitting requirements. The NDEQ Air Quality Division has passed this responsibility on to the Lincoln/Lancaster County Health Department. Under these requirements the City must obtain a Class 1 operating permit at the Theresa Street facility and a Class 2 operating permit at the Northeast facility.

Class 1 operating permits are required for emissions of criteria pollutants of 100 tons per year (tpy) or more. Class 2 operating permits are required for emissions of 40 tpy or more. Criteria pollutants include:

- Carbon monoxide,
- Nitrogen oxides,
- Sulfur dioxide,
- Particulate matter - 10 microns (PM-10),
- Total suspended particulates,
- Ozone, and
- VOCs.

Incorporation of the current and anticipated regulatory requirements presented here is fundamental to development of an effective wastewater facilities plan for the City of Lincoln.

CHAPTER 7

BASIS OF PROJECT DEVELOPMENT

In addition to process design criteria, the economic evaluation of facility treatment alternatives is an important tool for project development and making wastewater management decisions. The economic evaluation methods described in this chapter have been used to help determine the most cost-effective wastewater program for the City of Lincoln. Many of the planning considerations documented in this chapter were developed in project workshop meetings with the City staff held during preparation of this report.

2002 Lincoln-Lancaster County Comprehensive Planning

The recently updated and revised Lincoln-Lancaster County Comprehensive Plan presents policies for future growth and helps guide future decisions and development within the community. The wastewater management systems developed and evaluated as part of this study are consistent with the 2002 Lincoln-Lancaster County Comprehensive Plan. It is intended that planning recommendations and costs identified in this document be used in future citywide planning efforts.

Design Period and Project Staging

Two planning periods were used in analyzing the cost of various treatment facility alternatives. A 25-year base planning period from 2000 through the year 2025 was used for planning wastewater treatment facilities. A 50-year period from 2000 through 2050 was also used for planning considerations because many facilities, particularly pipelines and structures, have a 50-year design life.

Economic Evaluation

Present Worth Analysis. Because some of the projected costs will be incurred today and some incurred in the future, a reasonable adjusting method must be used to reflect the fact that a dollar's purchasing power diminishes over time. Present worth analysis has been used to provide meaningful cost comparisons for alternative courses of action.

It should be recognized, however, that the economic life assigned to the various wastewater system components is only estimated to facilitate cost comparison and may not accurately reflect a component's true useful life. The following sections describe the cost estimating methods used in this report.

Assigning Costs. Where appropriate, costs from previous studies and the 1995 Lincoln Wastewater Facility Plan have been used in the development of this facility plan update. These data are footnoted to indicate the source of information. All costs have been adjusted to represent 2002 dollar values.

Capital Costs. Actual projects were used as a basis for much of the cost estimating data for wastewater treatment process equipment and various plant-wide improvements. Other cost sources include manufacturers, suppliers of material and equipment, local contractors, and project data provided by professional journals and construction publications. The previous facility plan, the 1991 Odor Evaluation, and previous estimates generated by Brown and Caldwell were used to estimate costs, where appropriate.

All costs presented in this report were derived using the same level of estimating accuracy and, therefore, are comparable. Actual construction costs may differ from the estimates presented, as a result of specific design requirements and the economic climate at the time a project is bid. Specific cost estimating factors are discussed in the following paragraphs.

Cost Index. Cost estimates were obtained from projects in different locations and in different years. In order to bring all costs to a common, comparable base, the *Engineering News-Record* (ENR) Construction Cost Index was used. This is a common, industry-accepted means for adjusting costs from different time periods and locations. The ENR Construction Cost Index tracks construction costs in twenty-two U.S. cities and is computed from construction, material, and labor costs.

Contingencies. Feasibility studies and master plans represent a relatively "rough" level of construction cost estimating. Pre-bid construction cost estimates, which are based on well-defined engineering drawings and specifications, represent a much more refined cost estimate.

The American Association of Cost Engineers (AACE) has developed levels of accuracy for various stages in construction cost estimation. The AACE cost estimation accuracies are presented in Table 7-1.

Table 7-1. Construction Cost Estimation

Type of Estimate	Anticipated Accuracy
Order of magnitude estimate (facilities plan)	+50% to –30%
Budget estimate	+30% to –15%
Definitive estimate	+15% to -5%

The AACE accuracy levels confirm that the fewer the unknowns and the closer to construction date, the more accurate the cost estimate becomes.

To adjust for the level of uncertainty associated with a particular project, contingency funds are commonly included. As a project becomes better defined, there become fewer unknowns and the magnitude of the contingency allocation decreases. In general, facility planning reports include contingencies of 20 to 30 percent of the total equipment and construction costs, whereas a design development document may only include a contingency of 10 to 20 percent.

The Theresa Street and Northeast WWTF sites are the expected areas for much of the anticipated construction. Actual alignments for new pipelines have not been identified. Therefore, physical land characteristics such as slope, groundwater depth, geotechnical characteristics, and utility conflicts are unknown and cannot be included in the current cost estimates. Such uncertainties are accounted for in the contingency allocation. Based on the level of unknowns associated with the projects identified in this facility plan update, a contingency factor of 25 percent has been included in the construction costs presented in this report.

Engineering, Legal, and Administration. Often times legal services are required to coordinate construction efforts with local government agencies, to facilitate land purchases, and easement and right-of-way transactions. Similarly, ancillary engineering services such as special investigations, surveys, foundation reports, location of interfering utilities, detailed design, preparation of plans and specifications, construction inspection and materials testing, start-up assistance, and operations and maintenance (O&M) manual preparation may be required. These potential legal fees and ancillary engineering services were not included in the construction cost estimates. Finally, administrative effort will also be required to coordinate the engineering and legal efforts of all projects. A contingency factor of 25 percent has been used to account for engineering, legal, and administrative costs for projects described in this report.

Collection System

Construction cost estimates for collection system projects were developed based on pipeline size, general character of the terrain, and historical cost for similar facilities in the Lincoln area. The cost for a particular pipeline may vary depending on the final route selected, the type of pipe used, and the method of construction.

The wastewater collection system improvement costs presented in this facilities plan are general planning level costs and should be refined during the preliminary design phase of implementation.

Treatment Facilities

Many of the construction cost estimates presented here are based on unit process costs derived from construction costs for other projects with similar wastewater treatment processes and adjusted appropriately to reflect specific conditions in Lincoln. For example, a typical secondary clarifier may be estimated to cost $75 per square foot of surface area. However, these unit costs can vary widely from project to project because of such factors as unit size, seismic design requirements, groundwater levels, foundation stability, mitigation factors, aesthetics, and owner

preferences. Considerable judgement is required to arrive at unit process costs that most closely reflect the conditions for the City of Lincoln.

Construction costs of general items are estimated as a percentage of the total cost since the necessary field studies and designs are not yet complete. This allows for a clearer definition of the required work as described below.

Site Work. Site work includes such items as clearing and grubbing, excavation, grading, major drainage facilities, roadways, curb and gutter, sidewalks, landscaping, and fencing. A 15 percent factor is applied to the total equipment and construction budget to cover site work expenses.

Foundations. Foundation needs are determined by detailed geotechnical investigations. Actual construction costs may include such items as preloading to hasten soil consolidation, imported materials, foundation piles, foundation backfill, and drainage requirements. A factor of 10 percent has been applied to the total equipment and construction budget to account for foundation costs.

Yard Piping. Yard piping generally includes all piping between structures. This piping may be water, sewer, gas, minor drainage, and telecommunications lines, as well as process piping. A factor of 15 percent times the total equipment and construction budget has been used to accommodate yard piping costs.

Electrical and Instrumentation. Electrical and instrumentation costs can vary widely from plant to plant depending on owner preferences and the complexity of the treatment processes, control systems, etc. Instrumentation costs are higher if the plant requires a high level of monitoring to control the process. The level of automation also affects instrumentation costs. A factor of 20 percent has been applied to the total equipment and construction cost to cover electrical and instrumentation items. This reflects a moderate level of instrumentation.

Treatment Facilities. Additional land for new treatment facilities required beyond 2025 was assumed to cost $10,000 per acre. This value only corresponds to the purchase of land itself, and does not reflect the cost of acquiring easements and rights-of-way for the pipelines required to convey wastewater to the facility site. No attempt has been made to estimate the amount or cost of land that may be purchased for use as a buffer around the facilities.

Land. The City owns the land required for expansion of treatment facilities to serve projected 2025 needs.

Collection Facilities. The cost of pipeline projects includes cost for right-of-way and easement acquisition. These costs were based on the following easement requirements:

- Trunk Lines (42-inch diameter and larger)
  Permanent Easement - 40 feet wide
  Temporary Construction Easement - 150 feet wide

- Collection Lines (36-inch diameter and smaller)
  Permanent Easement - 20 feet wide
  Temporary Construction Easement - 100 feet wide

The cost of permanent easements was taken to be $9,000/acre. The cost of temporary construction easements was taken to be $1,000/acre.

CHAPTER 8

DEVELOPMENT AND EVALUATION OF ALTERNATIVES

Previous chapters have presented background information and key factors that influence wastewater management planning for the City of Lincoln and Lancaster County. Wastewater flow rates and characteristics have been discussed. Population growth, distribution, and land-use development projections have been presented. Existing wastewater collection and treatment systems have been described and their capabilities defined. Regulatory and water quality criteria affecting effluent quality requirements have also been summarized. Finally, the basis for capital improvement project development including the planning process, design considerations, cost estimating, and procedures used to evaluate the alternatives have been presented.

During development of the 1995 Lincoln Wastewater Facilities Plan, several system-wide alternatives were evaluated. These evaluations addressed key questions the City had regarding wastewater handling. These questions, along with the answers developed in 1995, were:

Question: Should the City give serious consideration to a third wastewater treatment facility?

Answer: A third wastewater treatment facility in southwest Lincoln was evaluated and its cost along with issues regarding the acceptable siting of such a facility were compared to the cost of constructing a "Salt Creek Interceptor Relief Sewer." The decision was made to construct the Relief Sewer and not build a third treatment plant, at least within the Tier I planning period. Construction of the Salt Creek Relief Sewer is approximately thirty percent complete.

Question: If a third wastewater treatment facility is not selected, how should the Salt Valley interceptor system be upgraded?

Answer: This design has been completed using a gravity sewer.

Question: Should the solids generated at the Northeast WWTF be treated at the Northeast site or the Theresa Street site?

Answer: These alternatives were evaluated and it was determined that the capital cost of treating solids from the Northeast WWTF at the Theresa Street WWTF was approximately equal to continuing to handle these solids separately. Since there was no clear economic advantage, the decision was made to maintain separate solids handling facilities. The cost of land application of the Northeast WWTF biosolids has historically been substantially less than the cost for disposal of Theresa Street WWTF biosolids.

This update of the Wastewater Facility Plan will not address the above questions, but will deal with several new issues that have arisen since completion of the 1995 facilities plan, including questions such as:

Question: What changes must be made to the current wastewater interceptor sewer system, and what expansion plans must be implemented to accommodate projected population growth?

Question: What practical alternatives are available to achieve the type of treatment needed to meet anticipated effluent ammonia limits at the Theresa Street and Northeast WWTFs?

Question: What alternatives are available to handle peak wet weather events at the Theresa Street and Northeast WWTFs?

Question: What are the existing process deficiencies at the Theresa Street and the Northeast WWTFs?

These questions have been addressed through a multi-step approach that evaluated and compared system-wide wastewater management plans. These steps included:

1. Formulation of wastewater transportation and treatment alternatives to serve existing growth areas as defined by the 2002 Lincoln-Lancaster County Comprehensive Plan.
2. Identification of collection system needs.
3. Identification and evaluation of treatment alternatives.
4. Selection of the most favorable system-wide plan.
5. Economic analysis.

The wastewater collection system needs and wastewater treatment alternatives considered in this facilities plan update are described in the following paragraphs.

Anticipated Collection System Needs

City of Lincoln future wastewater collection system needs within each of the drainage areas served by the City have been separated into two phases or "Tiers". The different basins and interceptors were evaluated for the Tier I Priority A and B conditions (12 and 25 years into the future respectively) and the Tier II condition (50 years into the future). These "Tier" designations are consistent with those presented in the 2002 Lincoln-Lancaster County Comprehensive Plan

Recommendations are made in accordance with the sanitary sewer capacity needs of the different basins depending on where the existing trunk sewer lines are located and whether or not these lines need to be paralleled, upgraded, or extended. All of the recommendations include lengths and sizes

of the main lines needed but do not include any laterals required to convey the flow to the main lines. The City has developed the costs for lateral lines required for each basin.
The acreages for the future basin areas were provided on the Directional Growth Map with the acreages for the presently developed areas taken from the City map entitled *Physical Data on Sewer System Drainage Basins – December 1999*. The acreages presented in the December 1999 document are assumed to be the acreages currently contributing flow to the City's collection system. These acreages are then translated into peak flows utilizing the City's design flow equation:

$$Q\ (cfs) = 0.01726*(A)^{0.8} + 0.003(A)$$

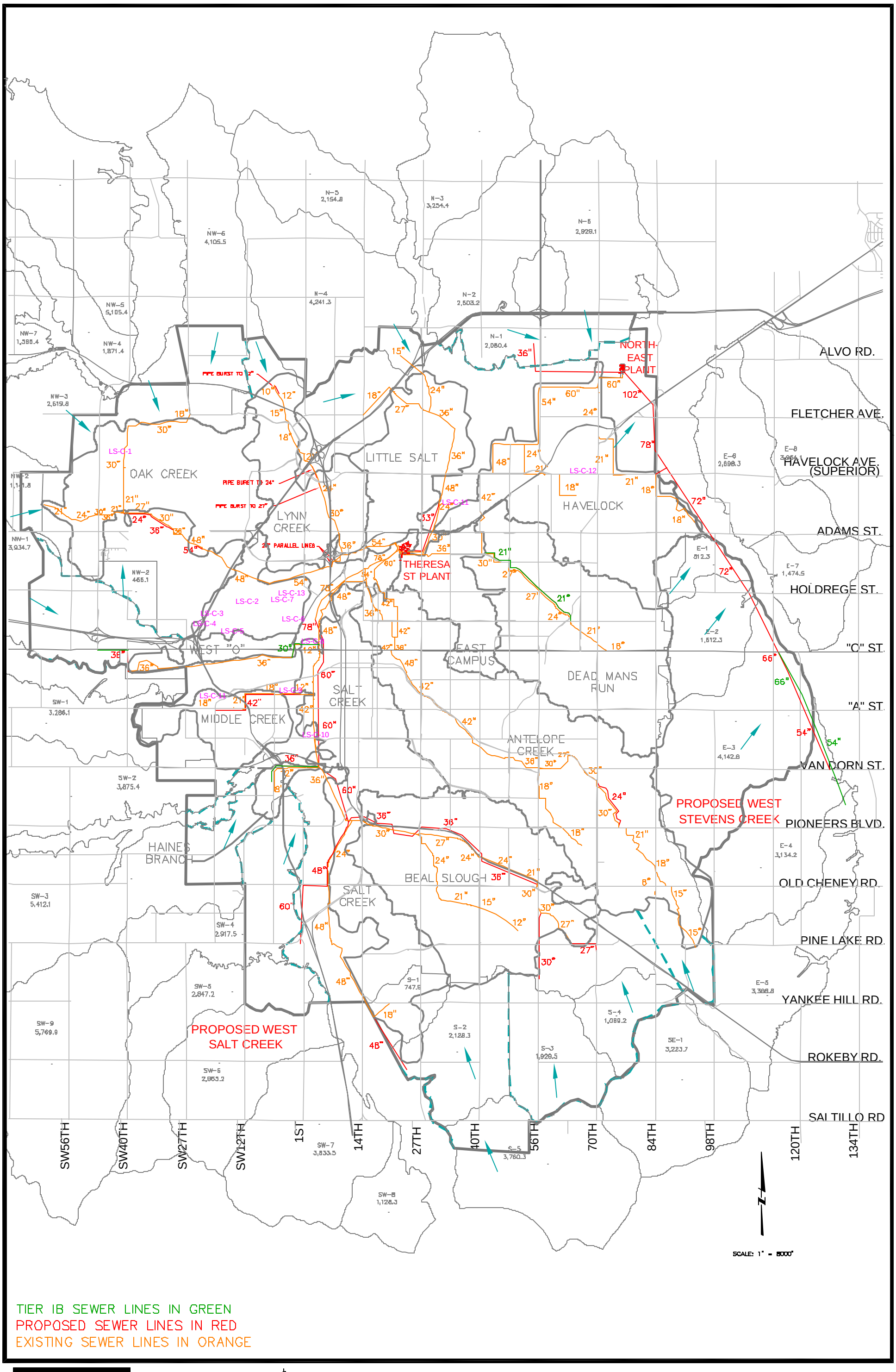
Figure 8-1, Tier I Improvements, and Figure 8-2, Tier II Improvements show the different sanitary sewer drainage basins, the wastewater lift stations, the locations of the City's two wastewater plants (the Northeast and the Theresa Street WWTFs), the existing trunk sewers in orange with pipe sizes, and the recommended main improvements in red (either paralleled, upgraded or extended) with recommended pipe sizes. Tier I improvements represent those anticipated to be needed between now and 2025. Tier II improvements are those that are expected to become necessary between 2025 and 2050.

The slope for all proposed line extensions used to determine needed pipeline sizes for both the 25-year and 50-year condition is assumed to be 0.0015 (or 0.15 percent) unless the pipe is being paralleled, in which case the slope would be the same as the paralleled pipe. Hydraulic calculations were performed using Mannings "n" values of 0.013.

In cases where pipelines are only one or two standard pipe sizes smaller than what is required to serve an area, it may be possible to upgrade the existing pipeline using a technology known as pipe bursting. The opportunity to upgrade pipelines through pipe bursting will depend on the soils around the pipe, the material of the pipe being burst, and the utilities found surrounding the pipe.

Salt Creek. In accordance with the City's flow equation, approximately 2.4 cfs of wastewater will be generated from the west and is conveyed through a 12-inch PVC pipe from the Haines Branch Basin. Since assuming that the slope is 0.15 percent and the pipe is not a pressurized system, 1.4 cfs is the maximum flow that the existing pipe can carry to the Salt Valley Trunk (SVT) Line (at MH#B2-101). The Haines Branch was built in the 1920's to serve the State Regional Center.

> **Tier I Condition**. Over the next 25 years, growth in the Salt Creek Basin is expected to occur in various places. First, some development is expected east of Salt Creek in basin S-2 and a portion of S-5. This area totals 2,766 acres and will contribute approximately 18.1 cfs of wastewater to the system. Second, a similar sized area is expected to be developed to the west of Salt Creek in the east portions of basins SW-4, SW-5, and SW-6. This area is located south of the Haines Branch area, has an area of 2,955 acres, and currently has no collection system. When fully developed, it will generate a flow of approximately 19.2 cfs. Third, the eastern portion of basin SW-3 is expected to be developed within 25 years and will add flow into the Haines Branch system. This projected development of 816 acres will generate a flow of about 6.1 cfs. The total area expected to contribute to the Salt Valley Trunk in 25 years is 26,070 acres.



Lincoln Wastewater System Facilities Plan Update

CITY OF LINCOLN

SANITARY SEWER BASINS

Figure 8-1

TIER I DEVELOPMENT

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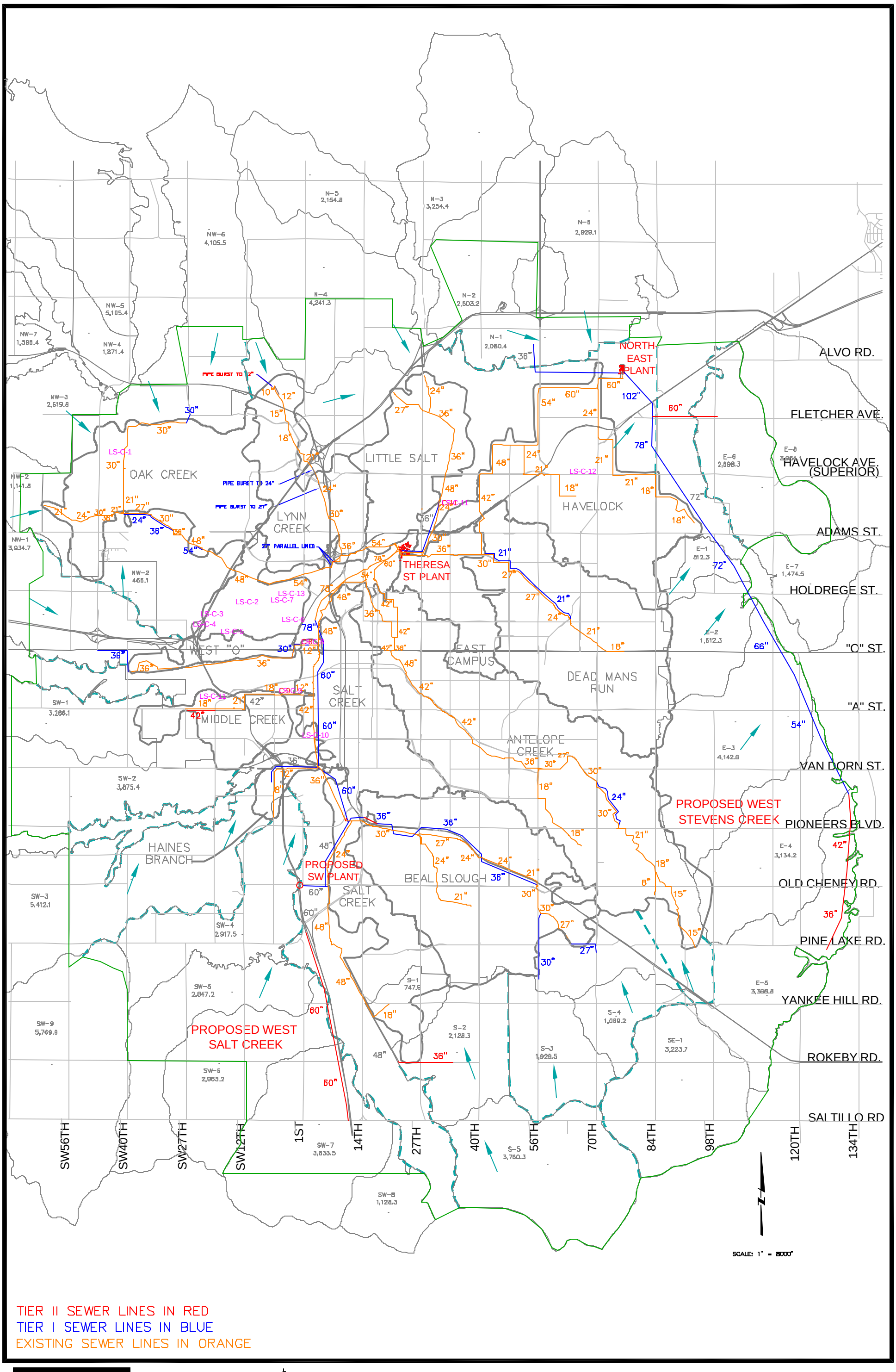

BROWN AND CALDWELL

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MONTGOMERY WATSON HARZA

Lincoln Wastewater System Facilities Plan Update
CITY OF LINCOLN
SANITARY SEWER BASINS

Figure 8-2
TIER II DEVELOPMENT

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Tier I Recommendations. As the previous sections are divided into three parts (Salt Creek, West Salt Creek, and Haines Branch), the recommendations presented in this section follow a similar format. The combination of all of this proposed development (26,070 acres) exceeds the design capacities of the first two phases of the SVT when it was built. To rectify this situation, the entire SVT (including the two phases that have been built) can be upsized to accommodate this new development.

The SVT Relief Sewer will follow the alignment to Old Cheney Road as described in the 1998 Salt Valley Trunk Relief Sewer - Phase I to V Report. See the Summary of Recommendations for a review of the lengths and sizes of this alignment. As basin S-2 and a portion of basin S-5 are developed, a 33-inch line will be needed to extend from the existing 48-inch line (Phase V of the SVT Relief Sewer) located at MH#B0s-37 to the south for approximately 5,000 LF. The average slope of the SVT Relief Sewer from Pioneers Boulevard to Yankee Hill Road was calculated to be 0.0019 or 0.19 percent, which is the slope assumed for this pipe.

Approximately 2,955 acres are expected to be developed on the west side of Salt Creek (according to the Future 25-year Condition). This area is referred to as the Proposed West Salt Creek Basin (WSC). Using the assumed slope of 0.0019 (0.19 percent), another 33–inch line is required to facilitate 100 percent development in this area.

With the Haines Basin service area expanding by 816 acres, the wastewater collection system will be required to carry 6.1 cfs of wastewater. The existing 12-inch pipe capacity is 1.4 cfs. Considering the age of this pipe, the recommendation is to replace the existing 12-inch line with a 24-inch line and extend it to a total length of 5,300 LF.

Tier II Condition. The design for the SVT Relief Sewer has assumed additional service area acreage of about 5,000 (for a total of 22,000 acres). The anticipated Future 50-year Condition includes a service area much larger than this (total of 41,732 acres). Tier II growth is expected to continue in the same three areas as projected for Tier I. The future service area in basin S-5 will continue to expand and the flows from this area (which include basin S-2 and totals approximately 5,900 acres) will ultimately contribute 35.6 cfs to the system. The area west of Salt Creek, which includes most of basins SW-4, SW-5, SW-6, and SW-7, has a developable area of approximately 8,539 acres and is expected to generate a flow of 49.7 cfs. Other basins that are expected to develop within 50 years will add flow into the Haines Branch. The east portion of basin SW-3 and the north portion of basin SW-4 together constitute close to 4,000 acres and represent a total flow potential of 25.1 cfs. That brings the total required capacity of the Haines Branch interceptor sewer to 27.5 cfs where it joins the SVT line at Pioneers Boulevard.

Tier II Recommendations. The current six-phase improvement plan for the SVT Relief Sewer needs to be completed, but the sizes of the Relief Sewer need to be discussed in relation to the decision to build another treatment plant. At the upstream end of the basin, a 48-inch line will be needed to extend from the end of the existing 48-inch line to the south for approximately 4,650 LF. A 36-inch line will also need to be extended to the east for 4,850 LF.

Toward the downstream area of the basin is where the design options present themselves. There are four that are listed on the "Lincoln Future Sanitary System – Tier II Condition," of which, the last two are recommended (#3 & #4). At the point of treating 41,000+ acres of development, a new treatment plant is strongly encouraged. The placement of this plant is the question at hand. The City of Lincoln has expressed their desire to place any future plant near the intersection of 1st and Old Cheney (option #4, which is shown on the Tier II figure). This would allow the flow of 26,349 acres of development pass on into the SVT (which would require additional upsizing – see discussion in Tier I). Option #3 places the proposed Southwest Plant near the intersection of 1st and Van Dorn. This adds flexibility to the system since it would be able to pick up any amount of flows from the Beals Slough Trunk and avoid the need to upsize any of the SVT lines downstream. The costs associated with a potential new Southwest WWTF are not included in the "Summary of Recommendations."

Second, approximately 8,539 acres are expected to develop in the West Salt Creek Basin. Using an assumed slope of 0.0019, a 36- to 48–inch line will be required to accommodate development in this area. About 5 miles of 60-inch line is shown on the map running to a new Southwest WWTF site. Cost information associated with building the Southwest WWTF has not been developed.

Third, the Haines Basin service area is expected to grow by 3,992 acres and the collection system pipeline servicing this area would be required to carry a total flow of 25.1 cfs. The capacity of the existing 12-inch pipe with a 0.15 percent slope is 1.4 cfs. The recommendation is to replace the existing 12-inch line with about a mile of new 36-inch pipe.

West "O" Street.

Tier I Condition. When the West "O" Street Basin reaches full development as represented in the Future 25-year Condition, an additional 1,900 acres of developed area will be added to the west side of the basin. This represents 12.9 cfs of future flow and causes one major problem. The capacity at the downstream end of the system is not sufficient to handle anticipated future flows.

Tier I Recommendations. Overloading of the 12-inch line can be alleviated by constructing 3,357 LF of 30-inch parallel line. If the 30-inch line is constructed with the same slope as the 12-inch VCP (0.004 ft/ft), it will provide adequate capacity to handle the 20.5 cfs of flow present when the area is 100 percent developed.

As for the Lift Station C-8, as of May 2002 it is pumping a dry weather average flow of 0.52 cfs, which represents only 6.8 percent of the theoretical flow that should be generated from this service area using the City's Design Equation. This is largely due to the fact that the area is mainly railroads and does not have a high residential population. If we were to use that same percentage of flow from using 15 percent of the City's Design Equation flows as was done with Middle Creek, the station would only require 3 cfs of pumping capacity. This capacity is available within the existing station. If wastewater from Lift Station C-9 is

diverted to this area, greater pumping capacity will be required. If this is the case, it is anticipated that 5.3 cfs of total pumping capacity would be required.

At the west end of the basin, a 36-inch extension needs to be built from the existing line west to serve the future developed area. This addition of 4,650 LF of 36-inch pipe will drain the future developed 1,897 acres with a minimum slope of 0.0005 ft.ft.

Tier II Condition and Recommendations. If the flows are diverted from C-9 to C-8, 8.7 cfs of pumping capacity will be required. A new pump station with two new 2,400 gpm pumps would need to be built with room enough for a third.

Beals Slough. The City map shows 5,370 acres of service area within the basin which will generate an estimated 32.7 cfs of wastewater. This flow will overload selected sections of the Beals Slough lateral. One location is the intersection of 56th Street and Highway 2. A 24-inch line is currently planned to parallel the existing trunk at this location and mitigate this flow problem. Nevertheless, downstream capacity constraints will cause surcharging to extend upstream along almost the entire length of the Salt Creek and Beals Slough Systems.

Tier I Condition. Future development in the Upper Beals Slough service area is expected to add about 4,411 acres to the area. This future developed area will contribute approximately 27.4 cfs to the upstream end of the existing sewer. With the exception of approximately 1,554 LF of pipeline, the entire Beals Slough Trunk Line will be overloaded with this additional flow.

Tier I Recommendations. The recommendation is for a relief sewer to be installed parallel to the entire Beals Slough Interceptor. At the upstream end, the future flows should be collected into the new line. A new 30-inch line should be extended from MH#D0-62 to the south on the east side of 56th Street. The pipe will be about 5,600 feet long and extend to Cavvy Road. The existing 27-inch line should be extended to the east to handle a portion of the future flows. It should extend east along Pine Lake Road to 70th Street for an approximate length of 2,900 LF. At the end of both of these lines, smaller diameter sewer lines should be constructed to collect future flows.

To provide the capacity necessary for the future development of Upper Beals Slough, a 36-inch line should be built to parallel the existing trunk along Highway 2. The proposed 36-inch line will connect into MH#C0-119 and run 18,800 LF to the west following the alignment suggested in the 1995 Facilities Plan.

Tier II Condition and Recommendations. Same as Tier I above.

Haines Branch. See Salt Creek discussion above.

Middle Creek.

Tier I Condition. The 25-year Tier I Condition shows additional development in the east portions of Basins SW-1 and SW-2 for a total of 704 acres of additional service area and a resulting future flow of 5.4 cfs.

Tier I Recommendations. One new 30-inch line with a slope of 0.25 percent would be able to transport the flows to the SVT. However, the existing line, if structurally sound, could provide some capacity and reduce the size required for the new parallel line. Additional information of the condition of the existing pipe is needed to determine if it should be replaced or paralleled.

The Lift Station C-9 currently has 4.5 cfs of pumping capacity and the basin's projected 2025 capacity requirement is 15.6 cfs according to the City's Design Equation for flow. The actual flow being pumped as of May 2002 is 1.2 cfs (as stated in *Lift Station Flow Records*, a spreadsheet provided by the City of Lincoln dated 16 May 2002). If it is assumed that only 15 percent of the City's Design Equation flow will pass through the station (based on historical flow records), only 2.3 cfs of pumping capacity will be required and sufficient capacity already exists. This assumes that the flow is not diverted to the north to Lift Station C-8. Not enough information was available to investigate siphon scenarios.

Tier II Condition. Per the information shown on the Future 50-year Condition maps, the east portions of Basins SW-1 and SW-2 are expected to develop. Together they represent a total of 4,472 acres of new development and a corresponding future flow of 27.8 cfs.

Tier II Recommendations. This large additional development will require a 42-inch line to transport the flows to the SVT. Again, additional information of the condition of the existing pipe is needed to see if it should be replaced or paralleled.

With the Tier II flows, the C-9 Lift Station would need one additional 800 gpm pump or one 2,400 gpm pump to replace the other three (depending on their condition) to pump the anticipated flow from this basin. The cost shown at the end of the report is for one 2,400 gpm pump to replace them all.

Antelope Creek.

Tier I Condition. In the year 2025 the projected total service area acreage in the Antelope Creek Basin will be 7,864 acres (to the southeast). The projected wastewater flows from this area will cause 5,704 LF of 30-inch VCP (material needs to be verified by the City) found between MH#D1-302 and MH#D2-42 to be overloaded and surcharge 4,276 LF of pipe upstream (MW, Feb 1998).

Tier I Recommendations. In the upstream portions of the sewer line, the existing 8- and 15-inch lines are adequate to convey the anticipated 5.1 cfs from the 665 acres additional service area to the south. Therefore, the only improvement needed is a relief sewer to parallel the existing 30-inch VCP. Assuming the same slope (0.00059), the 5,704 LF of 30-inch VCP will need to be paralleled by a new 24-inch line to provide the capacity needed.

Tier II Condition and Recommendations. Same as Tier I above

East Campus. Included in Little Salt Creek Discussion.

Oak Creek.

Tier I Condition. As Oak Creek Basin continues to grow, future development in sub-basin NW-2 will generate flow from the west (into OC-7) and sub-basins NW-3 and NW-6 will generate flows from the north (into OC-5 and the West Highlands Trunk Sewer). The Future 25-year Condition depicts about 1,100 and 1,865 acres of development respectively in these sub-basins with corresponding wastewater flows of 8.7 and 12.7 cfs. The current overloading conditions in the 27- and 30-inch lines will be exacerbated by the anticipated future growth.

Tier I Recommendations. The portions of NW-3 and NW-6 sub-basins that will contribute 12.7 cfs from the north can be handled in the existing 30-inch West Highlands Trunk Sewer. This assumes that its slope is at least 0.001 ft/ft. Once information has been provided for this line, the West Highlands Trunk Sewer can be properly analyzed for both present and future conditions.

The 27-inch and 30-inch pipes need to be paralleled to relieve the existing overloaded condition and to prepare for 21.4 cfs of future flows. Recommended new construction includes 2,196 LF of 24-inch line from MH#AA7-21 to 10, and 2,817LF of 36-inch pipe between MH#AA7-10 to 298. The slope on these pipes is assumed to be the same as the slope of the lines they parallel.

The 48-inch reinforced concrete pipe (RCP) system starting one manhole further downstream has two problem areas. The first segment between MH#A6-209 and 208 is 98 LF and has a capacity 20.7cfs short of that required to meet future needs. This flow can be handled by installing a parallel a 54-inch pipe at the same low slope – 0.0001. The second problem segment is 687 LF with a slope of 0.000029 and does not have adequate capacity for the 25-year flow condition. If the 1,888 LF segment between MH#A6-199 and 196 could be unearthed and re-laid with a uniform slope, it would have the capacity needed (39.1cfs). A concern with this scenario is that the pipe may have been originally installed with an inconsistent slope due to utility conflicts.

The existing 54-inch RCP segment of the line also needs a minor improvement to convey the future flows. From MH#B6-321 to B6-319, 6.5 cfs of capacity is needed to accommodate future flows. A 27-inch parallel line is recommended to provide the future capacity required for this 438 LF segment of line.

Tier II Condition and Recommendations. Same as Tier I above.

Little Salt Creek.

Tier I Condition. As development occurs to the north, about 1,661 acres of service area will be added in current Basin LS-5. This area has a potential to contribute 11.5 cfs to the system. This additional flow will overload the existing system from the C-11 pump station to the plant. It is evident that the current infrastructure cannot handle all potential development in the Northeast Salt Creek Basin (the rest of N-4 and N-5).

Future development in the East Campus may contribute 6.5 cfs at MH#C6-349, which is just half a mile east of the Theresa Street WWTF. This, combined with potentially 7.8 cfs from Deadmans Run, if flows are diverted from the Northeast WWTF, will mean the 36-inch East Campus Trunk will be carrying 14.3 cfs. When combined with the upstream flows of Little Salt Creek (currently 13.0 cfs) at the mentioned manhole, the Little Salt Creek Trunk will have reached its capacity of 27.3 cfs. This potential diversion of 7.8 cfs from Deadmans Run does not provide any sewer capacity for development to the north of the existing Little Salt Creek sub-basins.

Tier I Recommendations. When the future flow of 11.5 cfs is combined with the current flow at Lift Station C-11 (13.0 cfs), the total flow will be 24.5 cfs. Currently, the station has two pumps with a total capacity of 10.7 cfs. The lift station does have room for four more pumps. Therefore, if three 2,400 gpm rated pumps were installed (16 cfs), the new capacity could accommodate the future flows (24.5 cfs). This size of pump is preferred due to the commonality of parts with the existing pumps.

As this wastewater is pumped into the gravity system, additional capacity to the Theresa Street WWTF will be needed. A new 33-inch pipe parallel to the existing 7,427 LF of 36-inch trunk line is recommended to provide the needed capacity.

Tier II Condition. In 50 years it is anticipated that an additional 1,017 acres will be developed in Basin N-4. This area has a potential to contribute an additional 6.1 cfs to the system for a total future flow of 17.6 cfs.

Tier II Recommendations. As this future flow (17.6 cfs) combines with the current flow at Lift Station C-11 (13.0 cfs) they form a total of 30.6 cfs. A 36-inch pipe should be installed parallel to the existing trunk line from the lift station to the Theresa Street WWTF to handle this flow.

As far as pump capacity is concerned, four 2,400 gpm rated pumps would need to be installed to accommodate the future flows (30.6 cfs).

Lynn Creek.

Tier I Condition. Due to the topography of the surrounding basins, Oak Creek and Little Salt Creek will collect sewage from the future development areas to the north. According to the anticipated Future 50-year Condition, Lynn Creek Basin laterals will need to be extended to serve 354 acres of future development (a portion of Basin NW-6), but no major flows from the north are anticipated.

Tier I Recommendations. Due to the relatively small area of anticipated development in the Lynn Creek Basin, there are only three segments of the existing interceptor with insufficient capacity to handle future flows. Fortunately, the additional capacity can probably be achieved through pipe bursting rather than more expensive means such as paralleling or replacement. Starting at the upstream end, the 200 LF of 10-inch pipe between MH#A9-63 and 62 should be expanded to an inside diameter of 12 inches. (It is assumed in this area that the slope of the existing 12-inch line upstream of MH#A9-56 is equal to or greater than 0.008.) The 780 LF of 21-inch pipe between MH#B8-67 to B7-343 needs to be enlarged to a 24-inch pipe. Finally, between MH#B7-341 and 340 there is 503 LF of 24-inch VCP that needs to be expanded to 27-inches in diameter to allow for the additional flow of 3 cfs.

Tier II Condition and Recommendations. Same as Tier I above.

Deadmans Run.

Tier I Condition. The areas to the east of the plant do not affect the flow of the Deadmans Run Trunk Sewer. The Deadmans Run and Havelock Basins have a ridge as their eastern border that prevents flow from any future developments further east from entering the Deadmans Run Trunk Sewer. To the north of the Northeast WWTF, portions of sub-basins N-1 and N-2 (1,434 total acres) will add 10.3 cfs of wastewater once they are developed.

The Havelock Basin will pick up an additional 6.0 cfs of wastewater from future development and Deadmans Run Trunk Sewer must carry that flow from MH#D9-70 to the Northeast WWTF. The only segment that will have problems transporting this flow is the pipe immediately downstream from that manhole. All of the subsequent piping has sufficient capacity.

Tier I Recommendations. Hydraulic calculations indicate that three segments of the Deadmans Run Trunk Sewer downstream of Theresa Street WWTF will experience an overloaded condition when the anticipated Tier I development occurs. The first problem involves 18-inch RCP between MH#D4-486 and D5-45. The average capacity needed in this 1,949 LF stretch of pipe is 0.7 cfs. Although the line could be modified by pipe bursting to a final diameter of 21 inches, the recommendation is to do nothing since the costs outweigh the benefits.

The second portion of pipe that is under capacity is between MH#D5-121 and 152. This 21-inch RCP is barely overloaded with an average need of 0.4 cfs. Again, this should not be a concern as the resulting surcharging is not expected to create any problems.

The third segment is where improvements need to be made. The sanitary sewer line from MH#D5-153 to C6-195, with the exception of two segments, is currently overloaded with the design constraints. This line ranges from 24 to 30 inches in diameter and runs for 11,265 LF. A new 21-inch pipeline paralleling the existing sewer line will provide the capacity needed between MH#D5-153 and C6-195. This would aid in transporting the increasing I/I that has been reported in the basin's sewer system. It may be prioritized as a

secondary improvement due to the depth of the line as a result of which additional static head is granted to the area.

For future conditions, additional improvements will be required. The development anticipated north of the Northeast WWTF around the intersection of I-80 and 56th Avenue is expected to generate 10.3 cfs. This wastewater flow, if discharged to the existing 60-inch line west of the plant, would overload it. Therefore, a separate new 27-inch line beginning southeast of the intersection and extending eastward to the Northeast WWTF is recommended.

Tier II Condition. The only change from the Tier I Condition to the Tier II Condition is in basins N-1 and N-2. These sub-basins will continue to grow to 2,695 total developed acres and will add an additional 17.7 cfs to the sanitary sewer flow.

Tier II Recommendations. To accommodate the Tier II conditions, a 33-inch line will be required instead of the 27-inch line to convey flows from the I-80 and 56th Avenue intersection to the Northeast WWTF.

Havelock.

Tier I Condition. The Tier I Condition shows no new development areas that would contribute flows to the Havelock Interceptor.

Tier I Recommendations. Because both the present and future conditions do not present any capacity problems for the trunk line, no action is recommended.

Tier II Condition and Recommendations. Same as Tier I above.

West Stevens Creek.

Tier I Condition. In 25 years it is projected that 7,520 acres will be developed in the Stevens Creek Basin. This development is expected to generate 45 cfs according to the City's Flow Equation. It is anticipated that all of this flow will be directed to the east along the west side of Stevens Creek.

Tier I Recommendations. The new trunk line will need to be constructed along the west side of Stevens Creek to collect the flows generated in this area. The required diameters for the proposed pipe will be 48 inches and below, assuming a 0.0015 slope.

Tier II Condition. The Tier II Condition anticipates the development of an additional 12,428 acres within the Stevens Creek Basin, with an accompanying wastewater flow of 62.4 cfs. All of the flow will be directed to the east along the west side of Stevens Creek.

Tier II Recommendations. Recommendations for the Tier II Condition have already been made by the City via an inter-department communication dated March 12, 2002 from the Engineering Department to the Planning Department.

Summary of Collection System Needs

A summary of the recommended existing wastewater collection system needs is provided in Table 8-1. Tier I and Tier II service area sizes are presented in Tables 8-2 and 8-3.

Theresa Street WWTF

Description of Alternatives. Two factors affect treatment capacity at the Theresa Street WWTF, namely the facility's biological treatment capability and the system hydraulic capacity.

Process modeling indicates that the existing Theresa Street East Side and West Side biological treatment trains can provide secondary treatment plus nitrification (ammonia removal) to meet the anticipated permit limits for flows up to about 14 mgd. The projected maximum month flow rate for year 2025 is 27.0 mgd and for 2050 is 40.0 mgd (see Chapter 5). Therefore, approximately 26 mgd of additional treatment capacity will be required at the Theresa Street facility by 2050. For planning purposes it is assumed that the additional capacity will be provided in two approximately equally sized segments or phases.

Hydraulic modeling indicates that the Theresa Street East Side and West Side treatment trains can hydraulically pass 36 mgd. The primary clarifiers can hydraulically pass 48 mgd. The projected peak flow for design of in-plant structures for the year 2025 is 1.7 times the maximum month flow (see Chapter 4) or 47 mgd. Flows above 47 mgd should be handled by separate wet weather facilities. Expansion of the Theresa Street WWTF to handle the 2025 flow of 27 mgd should include modifications to increase the facility hydraulic capacity to 47 mgd.

Sizing for wet weather facilities was based on historical flow data from 1990 to present. This data indicates that a future wet weather peaking factor of 4.6:1 is reasonable (see Chapter 5). This is higher than the peaking factor used for design of hydraulic components within the treatment system. Consequently, wet weather facilities must be designed to accommodate the peak flows that exceed the 47 mgd hydraulic capacity. A twelve million-gallon equalization basin appears to be adequate to equalize the resulting peak wet weather flows. It is recommended that the wet weather peaking parameters be assessed in greater detail during preliminary design of the wet weather facilities.

After identifying factors that either limited capacity or increased treatment demand at the Theresa Street WWTF, four alternative methods of producing additional capacity were investigated. These alternatives include:

Alternative 1: Pretreat the largest industrial discharge (Cook Foods discharge) off-site to reduce pollutant loading at the Theresa Street WWTF and expand the Theresa Street WWTF to provide the remainder of the required treatment capacity.

Alternative 2: Utilize a side-stream treatment process to reduce the pollutant loading from the solids treatment processes and expand the Theresa Street WWTF to provide the remainder of the required treatment capacity.

Table 8-1. Summary of Recommendations for Existing Collection System

Basin	Upstream Manhole	Downstream Mahole	Existing Line Diameter (in)	Length (ft)	Unit Cost ($/ft)	Total $	Notes
Salt Creek	Old Cheney Rd	Pioneer Blvd	24	5572	220	1,230,000	Construction of 48" pipe to parallel this line (Phase V)
Salt Creek	Pioneer Blvd	Van Dorn Pkwy	36	6350	220	1,400,000	Construction of 60" pipe to parallel this line (Phase IV)
Salt Creek	Van Dorn Pkwy	"M" St	42	9396	225	2,110,000	Construction of 60" pipe to parallel this line (Phase III)
Salt Creek	"M" St	Vine St	48	4635	135	630,000	Construction of 78" pipe to parallel this line (Phase IIB)
Beal Slough	C0-119	SVT Relief Sewer	varies	18,800	165	3,100,000	Construction of 36" pipe to parallel this line
Oak Creek	AA7-10	AA7-6	27	452	195	90,000	Construction of 36" pipe to parallel this line
Oak Creek	A6-199	A6-196	48	1888	100	190,000	Unearth and re-bury at a consistent slope
West "O"	A4-66	B5-57	12	3357	220	740,000	Construction of 30" pipe to parallel this line
Dead Mans Run	D5-153	C6-195	varies	11,265	140	1,580,000	Construction of 21" pipe to parallel this line
Other Improvments						21,000,000	Includes Replacements, Lift Stations, and Manholes
Totals:				61,715		32,070,000	

Table 8-2. Lincoln Future Wastewater Collection System Acreages Served (25 year - Tier I)

Basin	Antelope Creek	Beals Slough	Dead-mans Trunk	East Campus	Haines Branch	Havelock	Lynn Creek	Little Salt Creek	Middle Creek	Oak Creek	Salt Creek	West "O" Street	West Stevens Creek	West Salt Creek	Total
Existing acreage served	7,199	5,370	4,536	865	283	3,401	2,314	2,251	1,456	3,661	4,370	1,042			36,748
Additional acreage served 25-yrs - Tier I	665	4,411	1,434		816		354	1,661	704	2,961	2,766	1,897	7,520	2,955	28,144
Total	7,864	9,781	5,970	865	1,099	3,401	2,668	3,912	2,160	6,622	7,136	2,939	7,520	2,955	64,892
Trunk line	Antelope Creek Trunk	Beals Slough Trunk	Dead-mans Trunk	Dead-mans Trunk	Salt Valley Trunk	Dead-mans Trunk	Oak Creek Trunk	Dead-mans Trunk	Salt Valley Trunk	Oak Creek Trunk	Salt Valley Trunk	Salt Valley Trunk	West Stevens Creek	Salt Valley Trunk	

	Antelope Creek Trunk	Beals Slough Trunk	Dead-mans Trunk	Oak Creek Trunk	Salt Valley Trunk	West Stevens Trunk	Total
Tier 1 acreages served by each trunk line	7,864	9,781	14,148	9,290	16,289	7,520	64,892

Table 8-3. Lincoln Future Wastewater Collection System Service Acreages (50 year - Tier II)

Basin	Antelope Creek	Beals Slough	Dead-mans Run	East Campus	Haines Branch	Havelock	Lynn Creek	Little Salt Creek	Middle Creek	Oak Creek	Salt Creek	West "O" Street	West Stevens Creek	West Salt Creek	Total
Existing acreage served	7,199	5,370	4,536	865	283	3,401	2,314	2,251	1,456	3,661	4,370	1,042			36,748
Additional acreage served 50-yrs - Tier II	665	4,411	2,695		3,992		354	2,678	4,472	2,961	5,900	1,897	19,948	8,539	58,512
TOTAL	7,864	9,781	7,231	865	4,275	3,401	2,668	4,929	5,928	6,622	10,270	2,939	19,948	8,539	95,260
Trunk line	Antelope Creek Trunk	Beals Slough Trunk	Dead-mans Trunk	Dead-mans Trunk	Salt Valley Trunk	Dead-mans Trunk	Oak Creek Trunk	Dead-mans Trunk	Salt Valley Trunk	Oak Creek Trunk	Salt Valley Trunk	Salt Valley Trunk	West Stevens Trunk	Salt Valley Trunk	

	Antelope Creek Trunk	Beals Slough Trunk	Dead-mans Trunk	Oak Creek Trunk	Salt Valley Trunk	West Stevens Trunk	Total
Tier 2 acreages served by each trunk line	7,864	9,781	16,426	9,290	31,951	19,948	95,260

Alternative 3: A modified combination of Alternatives #1 and #2.

Alternative 4: Expand the Theresa Street WWTF to provide all of the required treatment capacity.

These alternatives are summarized in Table 8-4. Note that all four scenarios assume that the trickling filter train is no longer in service.

Table 8-4. Treatment Capacity Scenarios to Meet Year 2025 and Projected Wastewater Flows at the Theresa Street WWTF

Treatment Location	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Existing Capacity @ Theresa St WWTF (mgd)	14	14	14	14
New Capacity @ Cook Foods (mgd)	*	--	*	--
New Capacity @ Solids Side-stream (mgd)	--	*	*	--
New Capacity @ Theresa St WWTF (mgd)	13	13	13	13
Total (mgd)	27	27	27	27

* These treatment facilities will reduce the organic and solids loadings on the Theresa Street WWTF but will not reduce the hydraulic capacity required at the facility and therefore do not contribute to the total capacity values shown.

Common Alternative Components. Components common to all alternatives have been identified and defined as follows:

New Nitrification Capacity at the Theresa Street WWTF. These improvements include the facilities needed to treat the projected waste loads to meet nitrification limits anticipated in the new discharge permit. They include hydraulic structures, process units, and other treatment units. For the possible off-site pretreatment of Cook Foods waste, an anaerobic upflow reactor has been proposed, with operations staffing from the Theresa Street WWTF. Side-stream treatment of flows from solids handling could be accomplished with a side-stream activated sludge treatment process, but no additional staff would be necessary.

Wet Weather Treatment for the Theresa Street WWTF. These improvements will provide the capability to treat 100 percent of the projected peak wet weather flow. Although this is not presently required, it is expected to be a requirement of the anticipated SSO regulations.

Correcting Existing Deficiencies at the Theresa Street WWTF. These deficiencies are described later in this chapter.

Each of these components is addressed as part of each treatment alternative.

Key Treatment Issues

There are three key treatment-related issues at the Theresa Street WWTF:

1. Treatment to provide nitrification capacity to meet expected permit limits,
2. Treatment of currently by-passed "wet weather" flows, and
3. Treatment to accommodate sludge handling return flows.

All of these issues are addressed by each of the treatment alternatives evaluated.

Theresa Street Alternative 1 - Pretreatment of Cook Foods Wastewater

Alternative 1 involves upgrading the Theresa Street WWTF to handle a maximum month flow of 27 mgd, and a peak hourly flow of 47 mgd. The plant would require additional nitrifying treatment capacity of approximately 13 mgd. The Cook Foods COD would be reduced by approximately 90 percent in an anaerobic upflow reactor system. This anaerobic upflow treatment system would be located at the Cook Foods plant site (or adjacent to it), and be operated by personnel from the Theresa Street WWTF. Pretreatment of the Cook Foods waste would decrease the needed organic capacity of the Theresa Street WWTF due to the reduction of the organic strength of the incoming wastewater. It would not, however, affect the required hydraulic capacity of the Theresa Street facility.

Wet weather flows above 47 mgd would be temporarily stored in an equalization basin and then treated by the Theresa Street facility when influent flows returned to normal dry weather levels. The predicted maximum wet weather flow rate at the Theresa Street WWTF in 2025 is based on a peak flow of about 110 mgd (see Table 5-7).

This alternative would reduce the amount of biosolids produced at the Theresa Street WWTF and would delay the need for a fourth anaerobic digester. It would also delay the requirement for an additional belt press. Biosolids produced at the Cook Foods pretreatment facility would be treated at that site.

Table 8-5 lists the improvements required during the planning period under this alternative. Figure 8-3 shows a conceptual site plan for this alternative.

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Figure 8-3
Alternative 1 - Conceptual Site Plan

Table 8-5. Theresa Street Alternative 1 – Year 2025 Required Improvements

Treatment Component	Description
Anaerobic Upflow Reactor	▪ Construct anaerobic upflow reactor at Cook Foods. ▪ Construct biogas fired reactor heating system, including gas storage and flare at Cook Foods. ▪ Provide associated chemical feed systems, including phosphoric acid, urea, and soda ash at Cook Foods. ▪ Hire 1 additional staff to operate anaerobic system.
Increased nitrifying treatment capacity	▪ Construct 13 mgd of increased primary clarifier capacity. ▪ Construct 13 mgd of aeration basin and blower capacity. ▪ Construct 13 mgd of secondary clarifier capacity.

The estimated total project cost of the facilities listed in Table 8-5 is $19,900,000. This cost is based on the estimated capital cost of the required facilities. Detailed cost estimates are presented in Appendix F.

Theresa Street Alternative 2 - Treat Side-Streams from Solids Processing

Alternative 2 involves upgrading the Theresa Street WWTF to handle an average annual flow of 27 mgd, and a peak hourly flow of 47 mgd. The side-stream from solids handling would be treated with a separate treatment process to reduce the organic load and oxidize the ammonia. This side-stream process provides an additional source of nitrifiers that would allow the Theresa Street activated sludge process to be operated at a lower SRT.

The representative side-stream process would include an equalization basin, activated sludge basin, secondary clarifier, a sodium bicarbonate buffering system, and RAS and WAS pumping facilities, as well as the associated piping and pumping facilities to divert solids dewatering filtrate to the side-stream process. Other processes could be utilized for this alternative and should be investigated during preliminary design if Alternative 2 is implemented.

Wet weather flows above 47.0 mgd would be temporarily stored in an equalization basin and then treated by the Theresa Street facility when influent flows returned to normal dry weather levels. The predicted maximum flow rate to the Theresa Street influent is based on a peak flow of approximately 110 mgd (see Table 5-7).

Table 8-6 lists the improvements required during the planning period under this alternative. Figure 8-4 shows a conceptual site plan for this alternative.

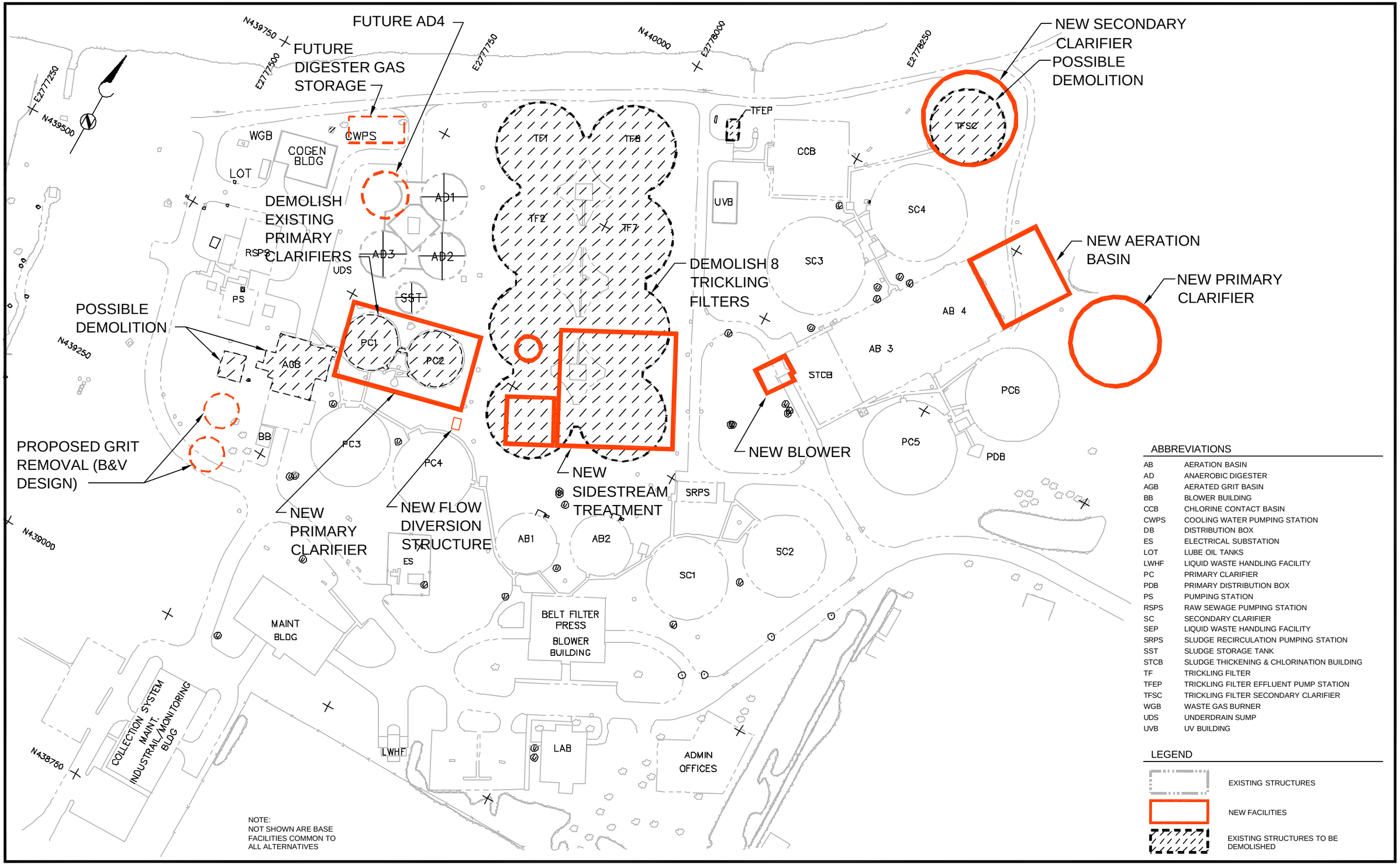

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Figure 8-4
Alternative 2 - Conceptual Site Plan

Table 8-6. Theresa Street Alternative 2 – Year 2025 Required Improvements

Treatment Component	Description
Side-Stream Treatment	▪ Construct separate process for treatment of side-stream from solids handling.
Increased nitrifying treatment capacity	▪ Construct 13 mgd of increased primary clarifier capacity. ▪ Construct 13 mgd of aeration basin and blower capacity. ▪ Construct 13 mgd of secondary clarifier capacity.

The estimated total project cost of the facilities listed in Table 8-6 is $20,700,000. This cost is based on the estimated capital cost of the required facilities. A detailed cost estimate is included in Appendix F.

Theresa Street Alternative 3 - Pretreat Cook Foods and Ammonia Side-Stream Treatment

Alternative 3 is essentially a modified, scaled-down combination of Alternatives 1 and 2 and includes upgrades to the Theresa Street WWTF to handle an average annual flow of 27 mgd and a peak hourly flow of 47 mgd. The Cook Foods COD would be reduced by approximately 90 percent with an anaerobic upflow reactor system. This anaerobic upflow treatment system would be located at the Cook Foods plant site (or adjacent to it), and be operated by personnel from the Theresa Street WWTF. The side-streams from solids handling would be treated with a separate treatment system to reduce the organic load and oxidize the ammonia. This would provide an additional source of nitrifiers that would allow the activated sludge process to be operated at a lower SRT.

Wet weather flows above 47.0 mgd would be temporarily stored in an equalization basin and then brought back into the Theresa Street facility when influent flows returned to normal dry weather levels. The predicted maximum flow rate to the Theresa Street influent is based on a peak flow of approximately 110 mgd (see Table 5-7).

This third alternative would reduce the amount of biosolids produced at the Theresa Street WWTF and would delay the need for a fourth anaerobic digester. This alternative would also delay the requirement for an additional belt press.

Table 8-7 lists the improvements required during the planning period under this alternative. Figure 8-5 shows a conceptual site plan for this alternative.

Table 8-7. Theresa Street Alternative 3 – Year 2025 Required Improvements

Treatment Component	Description
Anaerobic Upflow Reactor	▪ Construct anaerobic up-flow reactor at Cook Foods. ▪ Construct biogas fired reactor heating system, including gas storage and flare at Cook Foods. ▪ Provide associated chemical feed systems, including phosphoric acid, urea, and soda ash at Cook Foods. ▪ Hire 1 additional staff to operate anaerobic system.
Side-Stream Treatment	▪ Construct treatment reactors, alkalinity feed system, line from solids dewatering effluent, effluent pumping station, and RAS/WAS pumping station.
Increased Nitrifying Treatment Capacity	▪ Construct 13 mgd of increased primary clarifier capacity. ▪ Construct 13 mgd of aeration basin and blower capacity. ▪ Construct 13 mgd of secondary clarifier capacity.

The estimated total project cost of the facilities listed in Table 8-7 is $19,400,000. This cost is based on the estimated capital cost of the required facilities. A detailed cost estimate is included in Appendix F.

Theresa Street Alternative 4 – Expand Activated Sludge System

Alternative 4 requires that the Theresa Street WWTF handle a maximum month flow of 27.0 mgd, and a peak hourly flow of 47.0 mgd. The plant would require additional secondary treatment capacity of 13.0 mgd.

Wet weather flows above 47.0 mgd would be temporarily stored in an equalization basin and be brought back into the Theresa Street facility when influent flows returned to normal dry weather levels. The predicted maximum wet weather flow rate to the Theresa Street WWTF in 2025 is based on a peak flow of approximately 110 mgd (see Table 5-7).

This alternative would not impact the amount of biosolids produced at the Theresa Street WWTF since an aerobic process would still be used to treat the side-stream.

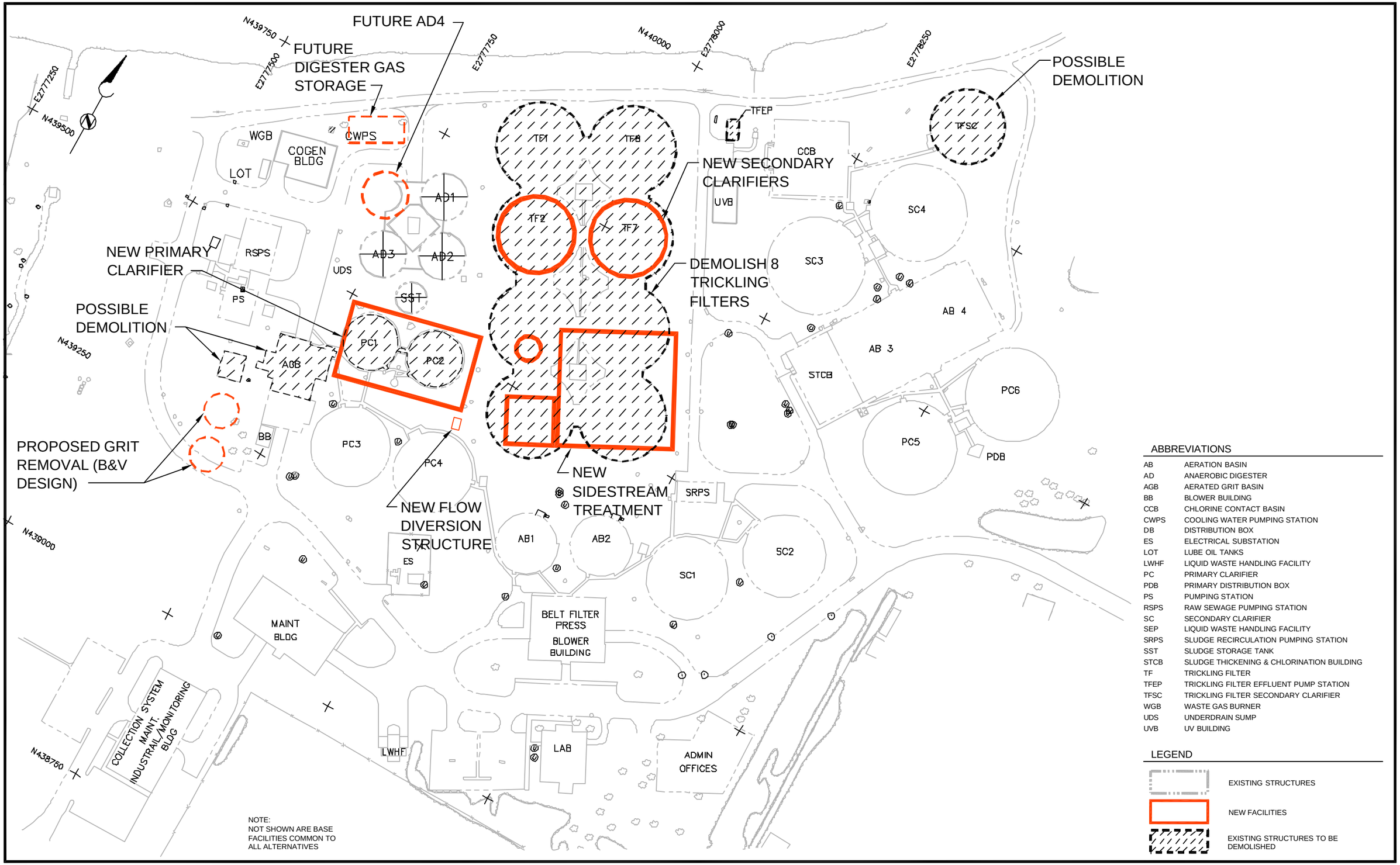

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Figure 8-5
Alternative 3 - Conceptual Site Plan

Table 8-8 lists the improvements required during the planning period under this alternative. Figure 8-6 shows a conceptual site plan for this alternative.

Table 8-8. Theresa Street Alternative 4 – Year 2025 Required Improvements

Treatment Component	Description
Increased secondary treatment capacity	▪ Construct 13 mgd of increased primary clarifier capacity. ▪ Construct 13 mgd of aeration basin and blower capacity. ▪ Construct 13 mgd of secondary clarifier capacity.

The estimated total project cost of the facilities listed in Table 8-8 is $22,700,000. This cost is based on the estimated capital cost of the required facilities. A detailed cost estimate is included in Appendix F.

Summary of Theresa Street WWTF Alternatives

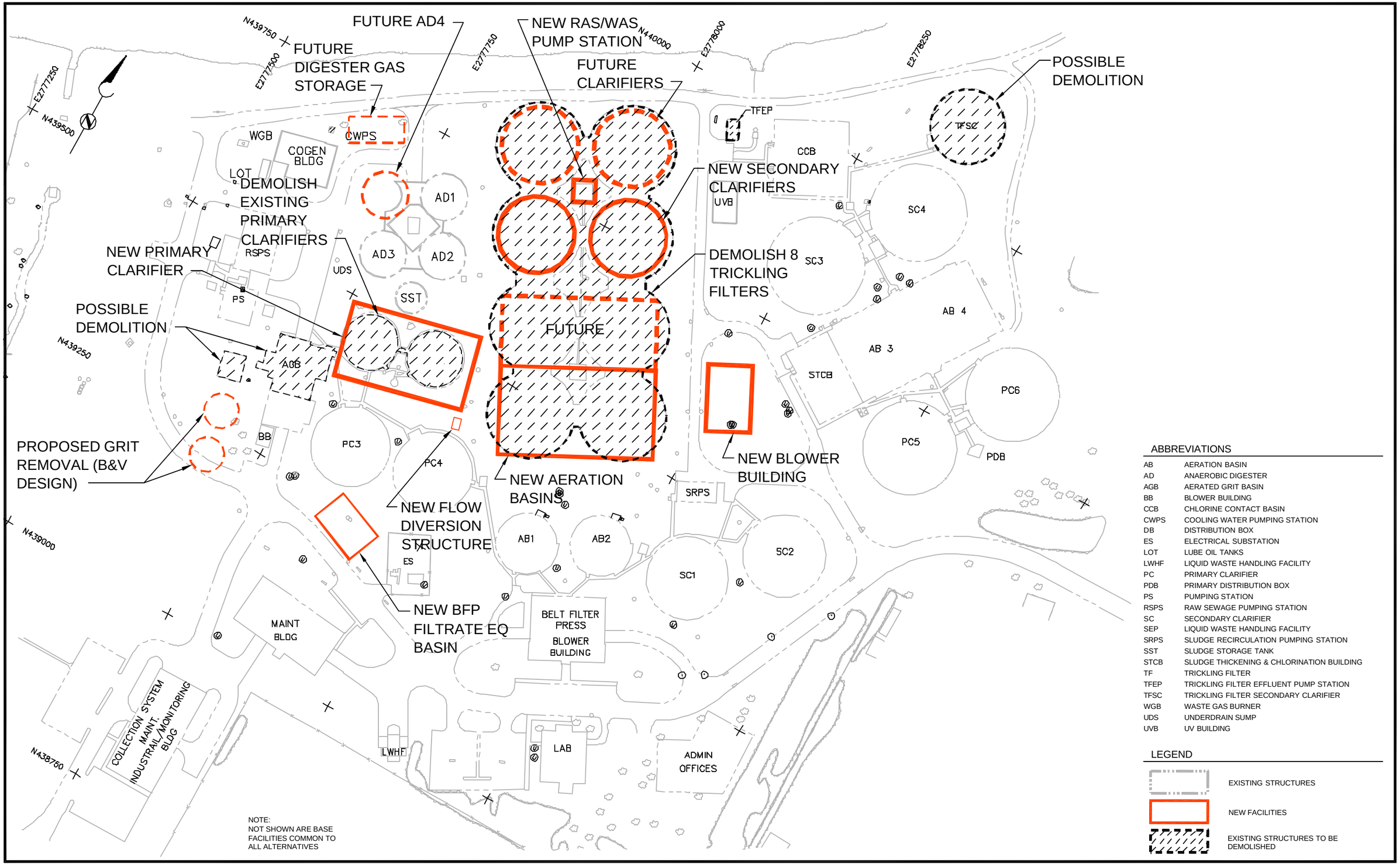
A comparison of the estimated costs for each of the alternatives considered is shown in Table 8-9 and include only those costs associated with the facilities unique to the specific alternatives. Other improvements common to all of the alternatives are presented later in this chapter.

Table 8-9. Alternative Capital Cost Summary

Alternative	Description	Total Project Cost
1	Pretreatment @ Cook Foods	$19,900,000
2	Side-stream Treatment of Filtrate Return	$20,700,000
3	Pretreatment @ Cook Foods and Side-stream Treatment of Filtrate Return	$19,400,000
4	All treatment @ Theresa Street WWTF	$22,700,000

Although the capital costs suggest that the alternatives that include pretreatment at Cook Foods or solids side-stream treatment are more economical than the more conventional wastewater treatment plant upgrade, the costs are reasonably close given the accuracy of the estimates and there are several mitigating issues that must be considered in selecting the preferred alternative.

Both Alternative 1 and Alternative 3 involve the construction and operation of dedicated, off-site treatment facilities. This condition involves substantial risk on the part of the City. If for some reason Cook Foods were to go out of business or leave Lincoln, the capital investment in the off-site treatment facilities could be lost. In addition, there is a substantial increase in operation and maintenance costs associated with operation of a separate off-site facility.



ABBREVIATIONS

AB	AERATION BASIN
AD	ANAEROBIC DIGESTER
AGB	AERATED GRIT BASIN
BB	BLOWER BUILDING
CCB	CHLORINE CONTACT BASIN
CWPS	COOLING WATER PUMPING STATION
DB	DISTRIBUTION BOX
ES	ELECTRICAL SUBSTATION
LOT	LUBE OIL TANKS
LWHF	LIQUID WASTE HANDLING FACILITY
PC	PRIMARY CLARIFIER
PDB	PRIMARY DISTRIBUTION BOX
PS	PUMPING STATION
RSPS	RAW SEWAGE PUMPING STATION
SC	SECONDARY CLARIFIER
SEP	LIQUID WASTE HANDLING FACILITY
SRPS	SLUDGE RECIRCULATION PUMPING STATION
SST	SLUDGE STORAGE TANK
STCB	SLUDGE THICKENING & CHLORINATION BUILDING
TF	TRICKLING FILTER
TFEP	TRICKLING FILTER EFFLUENT PUMP STATION
TFSC	TRICKLING FILTER SECONDARY CLARIFIER
WGB	WASTE GAS BURNER
UDS	UNDERDRAIN SUMP
UVB	UV BUILDING

LEGEND

- EXISTING STRUCTURES
- NEW FACILITIES
- EXISTING STRUCTURES TO BE DEMOLISHED

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Figure 8-6
Alternative 4 - Conceptual Site Plan

Alternatives 2 and 3 involve a separate side-stream treatment process to treat sludge dewatering return flows prior to their re-introduction into the main liquid treatment stream. This would reduce the organic and ammonia loading on the main liquid stream treatment system. As a result, some components of the main system could be smaller. The primary disadvantage of this separate side-stream system is that it represents a totally separate treatment system that would require separate operation and maintenance. It also represents a relatively new and therefore experimental process whose performance and subsequent impacts on the main treatment system are difficult to accurately quantify.

Theresa Street WWTF Basic Improvements

The following list identifies basic facility improvements required at the Theresa Street WWTF during the planning period regardless of the treatment alternative selected:

- Preliminary Treatment Improvements
  - South raw wastewater pumping station
  - North raw wastewater pumping station
  - Grit handling facilities
- Cogeneration facility improvements
- Anaerobic Digester complex improvements
  - Additional digester
  - Gas equalization or storage facility
  - Replace sludge valves on heating loop
  - Replace gas mixers/compressors
- West Side process improvements
  - Primary sludge pump replacement
  - Replace RAS pumps
  - New blowers
  - Secondary clarifier improvements
- East Side process improvements
  - Primary sludge pump replacement
  - Aeration system improvements
  - Secondary clarifier improvements
- DAF improvements
- Dewatering system improvements
- Maintenance shop rehabilitation
- Electrical improvements
- Collection system shop improvements
- Splitter structure improvements
- Administration building improvements
- Liquid waste handling facility improvements

- General system improvements
  - Wet weather flow facilities
  - Side-stream flow equalization
  - Hydraulic capacity improvements
- General plant/site improvements
  - Replace potable water distribution system
  - On-line process control instrumentation facilities
  - Plant site flood protection
  - Outside lighting improvements
  - Pavement rehabilitation
  - Gas line service replacements

The total project cost for these improvements is estimated to be approximately $51,800,000. A detailed breakdown of this estimate is included in Appendix F.

Northeast WWTF

As with the Theresa Street WWTF, the capacity of the Northeast WWTF may be limited by two different factors; biological treatment capability and hydraulic capacity. The evaluation performed as part of this facility planning process determined that the biological treatment capability of the Northeast WWTF is limited to approximately 4.4 mgd by the system's ability to remove ammonia at low wastewater temperatures. For the purposes of this evaluation, the existing Northeast WWTF capacity has been rounded to 5 mgd. The hydraulic capacity of the existing Northeast WWTF is estimated to be approximately 37 mgd.

The projected maximum 30-day flow for year 2025 is approximately 11 mgd, and for 2050 is 17 mgd (see Chapter 5). Therefore, approximately 6 mgd of additional treatment capacity will be required at the Northeast WWTF by 2025 and another 6 mgd of capacity will be required to accommodate 2050 flows. It is assumed that the additional capacity will be provided in two expansion phases.

Two alternatives for expanding nitrification capacity at the Northeast WWTF have been considered. The first involves elimination of the existing biotowers and expanding the activated sludge system to provide the required nitrification capacity. The second alternative involves continuing use of the biotowers prior to activated sludge to provide the necessary nitrification capacity. A preliminary evaluation indicates that the biotowers provide significant BOD_5 reduction as well as contribute to the stability and enhance the nitrification rate realized in the activated sludge process. Based on this preliminary information, it is recommended that the biotowers be refurbished and retained as a component of the Northeast wastewater treatment process. Preliminary design for the Northeast WWTF expansion should further investigate continued use of the biotowers.

Return flow from the sludge storage basin represents a significant ammonia loading at the Northeast facility that has historically occurred only on an intermittent basis. This intermittent ammonia loading promotes inconsistency in the effectiveness of ammonia removal and can negatively impact effluent quality. Two alternatives were considered to mitigate the negative impact of this return flow:

1. Construct a separate pipeline from the sludge storage basin to the Northeast facility to allow the return flow to be returned to the treatment process on a constant basis.

2. Construction of flow equalization facilities at the Northeast WWTF to allow the return flow to be introduced into the treatment process at a constant rate.

A return pipeline is currently planned to return cooling water from the new Lincoln Electric Power Generation Facility to the Northeast WWTF. It is recommended that this pipeline be utilized to return supernatent from the sludge storage basin to the Northeast WWTF. This will minimize the capital cost of facilities associated with returning supernatent at a consistent rate.

The estimated cost associated with expansion of the Northeast WWTF to provide nitrification capacity to accommodate the projected 2025 flows is presented in Table 8-10.

Table 8-10. Northeast WWTF Phase I Expansion Cost

Description	Estimated Cost
1st Phase Expansion	$11,600,000

A detailed breakdown of these costs is provided in Appendix G.

The projected peak design flow for the year 2025 is 1.75 times the average daily flow, or about 14 mgd. Even though the Northeast facilities have the hydraulic capacity to handle peak flows in excess of 14 mgd, it is recommended that peak flows above that flow be handled with the wet weather facilities to avoid the process upsets that may result from extreme hydraulic surges.

Sizing for wet weather equalization facilities was based on historical flow data from 1990 to the present. From this data a 2025 peak wet weather flow of 46 mgd was identified for the Northeast WWTF (see Chapter 5). The design parameters for wet weather flow facilities should be assessed in more detail during preliminary design of the wet weather facilities.

As indicated in Chapter 4, the Northeast WWTF currently produces more sludge than can be agronomically applied at the disposal site. At the current sludge production and agronomic loading rates, it is anticipated that over 550 acres of land are required for Northeast sludge injection. The facility currently has only 440 acres; therefore, action to obtain more land for sludge disposal or adopt some other mechanism for disposing of sludge from the Northeast WWTF should be taken soon. In the interim, sludge may be hauled to the Theresa Street WWTF for dewatering.

At 2025 sludge production rates, it is expected that over 800 acres will be required for agronomic application of biosolids generated at the Northeast facility. If adequate agricultural land can be obtained at the Northeast biosolids site to accommodate future biosolids application requirements, it is recommended that dedicated land application of Northeast biosolids continue. If adequate agricultural land at or near the existing site is not available, an alternative biosolids handling method should be adopted.

One alternative for a long-term dewatering operation is to construct a sludge drying bed adjacent to the sludge storage basin. Sludge could be pumped from the storage basin into the sludge drying bed during the summer and hauled to application sites on private agricultural lands in the fall. Paved drying beds for the Northeast WWTF with concrete containment walls and no underdrain system are estimated to cost approximately $5.5 million.

Other options for handling Northeast sludge include constructing mechanical dewatering facilities at the Northeast WWTF or pumping or trucking liquid sludge from the Northeast WWTF to the Theresa Street facility for handling prior to land application with the Theresa Street biosolids. Sludge drying beds have been evaluated only to determine a cost for additional sludge handling facilities and are not necessarily recommended. Further evaluation of sludge handling alternatives should be undertaken as part of the preliminary design for the Northeast WWTF improvements.

Northeast WWTF Basic Improvements

In addition to the basic need to provide additional nitrification and sludge handling capacity, the Lincoln wastewater management staff has identified several other improvements necessary at the Northeast WWTF.

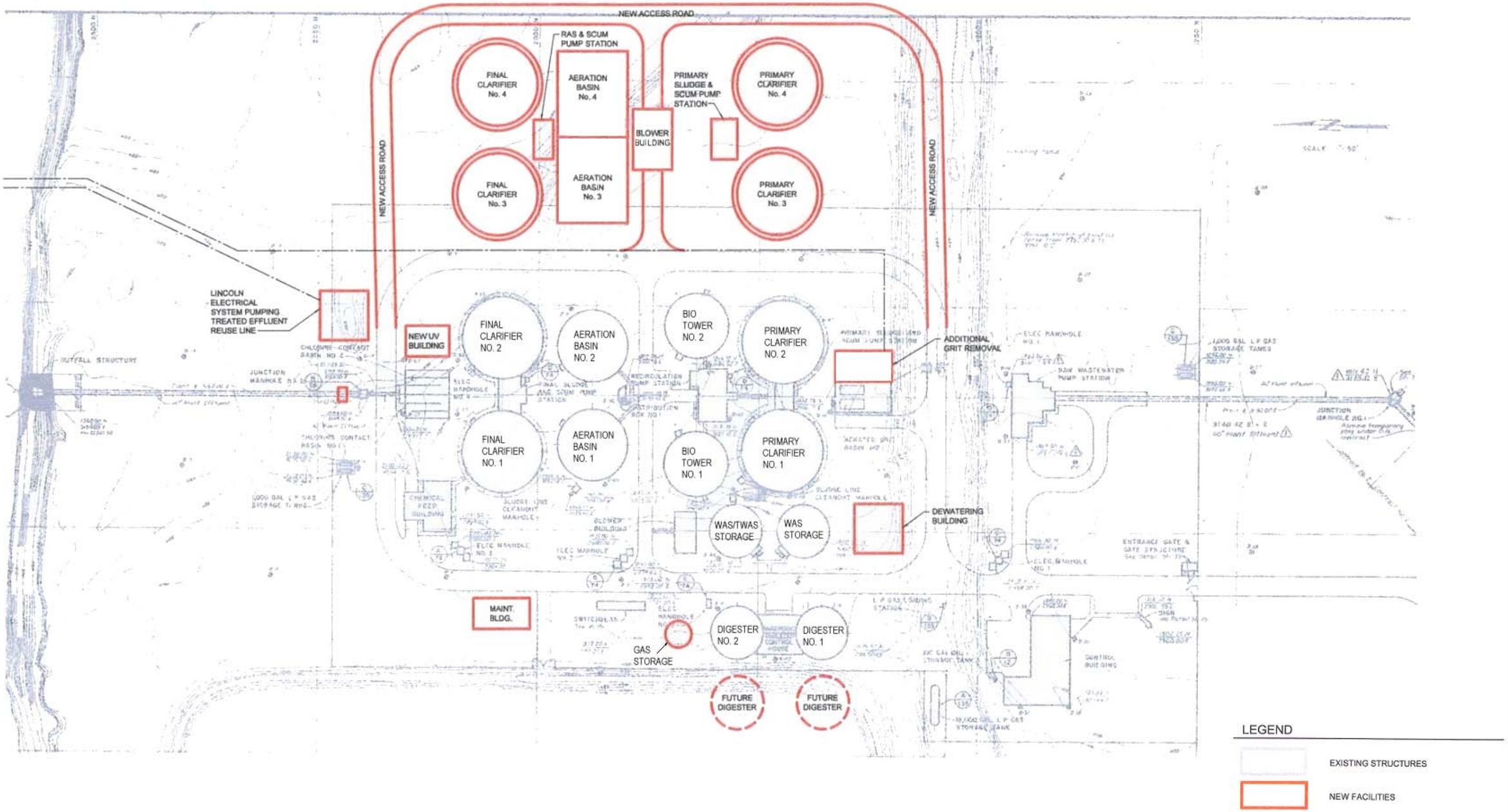
Based on information provided by Lincoln wastewater management staff, the following basic improvements need to be addressed at the Northeast WWTF during this planning period.

- Upgrade operations control center
- Replace raw wastewater pumps 1, 2, and 3
- Improve grit removal facilities
- Primary Sludge Pumping Building & Clarifiers
  - Replace clarifier sludge collector assemblies in a 5-10 year period
  - Replace weirs
  - Scum pits need rehab due to corrosion.
- Refurbish biotowers
- Secondary clarifier improvements
- Maintenance shop improvements
- Sludge handling system improvements
  - Digester improvements
  - Sludge utilization system improvements
- General system improvements
  - Wet weather flow facilities
  - Sludge storage return flow equalization
- General plant/site improvements
  - Replace outside facility lighting – needs new conduit & circuit
  - Repair and replace sidewalks and roads as required
  - Upgrade entrance gate structure

A proposed site layout for the Northeast WWTF is shown in Figure 8-7.

The estimated total project cost of these basic improvements is $26,900,000. A detailed breakdown of this estimate is included in the Appendix G.

Further discussion of the alternatives for expanding and upgrading the Theresa Street and Northeast WWTFs and planning recommendations for each facility are presented in Chapter 9.



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Lincoln Wastewater System Facilities Plan Update

CITY OF LINCOLN

NORTHEAST WASTEWATER TREATMENT PLANT

Figure 8 - 7

Northeast WWTF Conceptual Site Plan

CHAPTER 9

PREFERRED WASTEWATER MANAGEMENT SYSTEM

The discussion in this chapter is based on the assumption that the NDEQ will impose ammonia limits on the City of Lincoln. It is assumed that these requirements will become effective with the issuance of new discharge permits for both the Theresa Street and Northeast WWTFs, which are expected sometime in 2003. It is also assumed that a compliance period will be allowed before compliance with the new standards is required. An additional assumption is that the SSO regulations will be adopted in a form similar to that currently proposed.

Preferred System Description

The preferred or recommended wastewater management system for the City of Lincoln to provide wastewater collection and treatment services through 2025 includes:

1. Upgraded and expanded wastewater collection facilities to accommodate existing needs and serve areas of new development within the Lincoln wastewater service area.
2. Upgrade and expansion of the Theresa Street WWTF to provide full nitrification treatment capacity for a maximum month flow of 27 mgd plus peak wet weather capacity to handle flows of 110 mgd.
3. Upgrade and expansion of the Northeast WWTF to provide full nitrification treatment capacity for a maximum month flow of approximately 11 mgd plus peak wet weather capacity to handle flows of 46 mgd.

Details regarding each aspect of the preferred system are presented in subsequent paragraphs.

The pipeline alignments and wastewater treatment facility descriptions included herein were developed for planning purposes only. Design assumptions and specific criteria should be further investigated and defined when specific project implementation begins. Although the final design features may deviate from those described herein, these facilities are representative of the facilities needed by the City of Lincoln and can be used reliably for long-range planning.

Collection System Improvements. A number of improvements to the existing wastewater collection system are recommended. These recommendations are summarized in Table 8-1 in Chapter 8.

The Lincoln wastewater collection system must also be expanded to accommodate anticipated growth. The costs associated with the collection system improvements and upgrades recommended to serve future growth are summarized in Tables 9-1 and 9-2. Table 9-1 summarizes the collection system improvements and upgrades recommended to meet service needs within the next 25 years.

Table 9-1. Summary of Recommended Trunk Sewer Improvements to Serve Tier I Needs (A & B Priority).

Basin	Upstream Manhole	Downstream Manhole	Existing Line Diameter (in)	Length (ft)	Total $	Notes
Priority A						
Antelope Creek	D1-302	D2-42	30	5,704	770,000	24" pipe to parallel this line
Beals Slough	B1-239	SVT Relief Sewer	varies	7,400	1,740,000	36" pipe to parallel this line (Phase I)
Beals Slough	C0-119	B1-239	varies	13,000	3,060,000	36" pipe to parallel this line (Phase II)
Beals Slough	extends to the east	new manhole	27	2,900	480,000	Extension of 27" line
Beals Slough	extends to the south	D0-62	30	5,600	1,090,000	Extension of 30" line
Little Salt Creek	C7-343	C7-342	varies	NA	200,000	3-2400 gpm pumps needed
Little Salt Creek	Lift station C-11	TSP	varies	7,427	1,750,000	36" pipe to parallel this line
Lynn Creek	A9-63	A9-62	10	200	30,000	Pipe burst to a minimum 12" diameter
Lynn Creek	B8-67	B7-342	21	780	200,000	Pipe burst to a minimum 24" diameter
Lynn Creek	B7-341	B7-340	24	503	140,000	Pipe burst to a minimum 27" diameter
NE Salt Creek	extends to the north	NEP	NA	10,025	2,360,000	Stubout of 36" line to the north
Oak Creek	AA7-10	AA7-6	27	452	90,000	36" pipe to parallel this line
Oak Creek	extends to the north	AA8-166	30	840	160,000	Stubout of 30" line to the north
Oak Creek	AA7-21	AA7-10	27	2,196	300,000	24" pipe to parallel this line
Oak Creek	AA7-6	AA7-298	30	2,365	560,000	36" pipe to parallel this line
Oak Creek	A6-209	A6-208	48	98	40,000	54" pipe to parallel this line
Oak Creek	B6-321	B6-319	54	438	70,000	27" pipe to parallel this line
Oak Creek	B6-318	B6-76	27	119	20,000	27" pipe to parallel 54" line
Salt Creek	Old Cheney Rd	Pioneer Blvd	24	5572	1,730,000	48" pipe to parallel this line (Phase V)
Salt Creek	Pioneer Blvd	Van Dorn Pkwy	36	6350	2,950,000	60" pipe to parallel this line (Phase IV)
Salt Creek	Van Dorn Pkwy	"M" St	42	9396	4,370,000	60" pipe to parallel this line (Phase III)
Salt Creek	"M" St	Vine St	48	4635	3,480,000	78" pipe to parallel this line (Phase IIB)
Salt Creek	extends to the south	B0s-37	48	5,000	1,550,000	Construct 48" pipe
West "O" Street	extends to the west	new manhole	36	4,650	1,090,000	Stubout of 36" line to the west
West Salt Creek	extends to the south	B0-151	NA	7,500	3,490,000	New construction of 60" pipe
West Stevens Creek	NA	NA	NA	11,000	6,820,000	New construction of 72" pipe
West Stevens Creek	NA	NA	NA	7,000	5,040,000	New construction of 78" pipe
West Stevens Creek	NA	NA	NA	4,500	4,500,000	New construction of 102" pipe
Other Improvements					10,000,000	
					58,080,000	
Priority B						
Deadmans Run	D5-153	C6-195	varies	11,265	1,580,000	21" pipe to parallel this line
Haines Branch	extends to the south	B3-472	8 & 12	5,300	2,170,000	Replace with 36" line
Middle Creek	A3-191	A4-21	varies	10,000	4,650,000	Replace or parallel with new 42" pipe
West "O"	A4-66	B5-57	12	3357	740,000	30" pipe to parallel this line
West Stevens Creek	NA	NA	NA	8,000	3,120,000	New construction of 54" pipe
West Stevens Creek	NA	NA	NA	10,000	5,400,000	New construction of 66" pipe
Other Improvements					6,500,000	
					24,160,000	
				Total:	82,240,000	

NA = Not Applicable.

Table 9-2. Summary of Recommended Collection System Improvements to Serve Tier II Needs

Basin	Upstream Manhole	Downstream Manhole	Existing Line Diameter (in)	Length (ft)	Unit Cost* ($)	Total $	Notes
Little Salt Creek	C7-343	C7-342	varies	NA	65,000	65,000	1 additional pump needed to fill out ex. sta. (C-11 - 2400gpm)
Middle Creek	AA3-11	A3-191	varies	2,610	465	1,214,000	Replace or parallel line with new 42" pipe
Middle Creek	A4-21	A4-206	21	NA	65,000	65,000	One 2400 gpm pump in lift station (C-9) if there is room
Salt Creek	extends to the east	prop. 48" line	NA	4,850	235	1,140,000	New construction of 36" pipe
West "O" Street	A5-141	A5-42	varies	NA	NA	400,000	New lift station (replacing C-8) with two pumps rated at 2400 gpm
West Salt Creek	extends to the south	prop. 60" line	NA	16,700	465	7,766,000	New construction of 60" pipe
West Stevens Creek	NA	NA	NA	7,000	235	1,645,000	New construction of 36" pipe
West Stevens Creek	NA	NA	NA	9,000	285	2,565,000	New construction of 42" pipe
West Stevens Creek	NA	NA	NA	5,700	465	2,650,500	New construction of 60" pipe to serve East Stephens Creek
					Tier II total	**$ 17,510,500**	

**NA = Not Applicable.

All costs are presented in 2002 dollars. Future development in the Lincoln service area may vary in both timing and location from what is projected in this report. As development occurs, the wastewater collection service plan should be revised and updated appropriately.

Theresa Street WWTF Improvements. For the Theresa Street WWTF, Alternative 4 as presented in Chapter 8 is the preferred alternative. Alternatives 1 and 3 were ruled out primarily because of the risk of implementing capital improvements at a remote facility (Cook Foods) and then having that facility close for some reason in the future. Alternatives 2 and 3 include the implementation of a side-stream treatment train to reduce the organic and ammonia loading on the main treatment facility. Although this is a viable alternative and worth investigating, it is only experimental at this time and the precise impact on the main treatment facility is uncertain. There are few operating facilities that treat strictly an ammonia laden side-stream. A more conventional method of handling the side-stream would be flow equalization to allow consistent return of the dewatering filtrate to the main process flow stream. This approach has been incorporated into Alternative 4. Therefore, Alternative 4 is identified as the most prudent approach to provide long-term nitrification capacity at the Theresa Street WWTF at this time.

Northeast WWTF Improvements. It is recommended that the additional nitrification capacity required at the Northeast WWTF be provided through refurbishing the biotowers and expansion of the activated sludge system. There is a question of the cost effectiveness of rehabilitating the existing biotowers, and it is recommended that this issue be investigated thoroughly as part of the preliminary design effort for the Northeast WWTF nitrification expansion project.

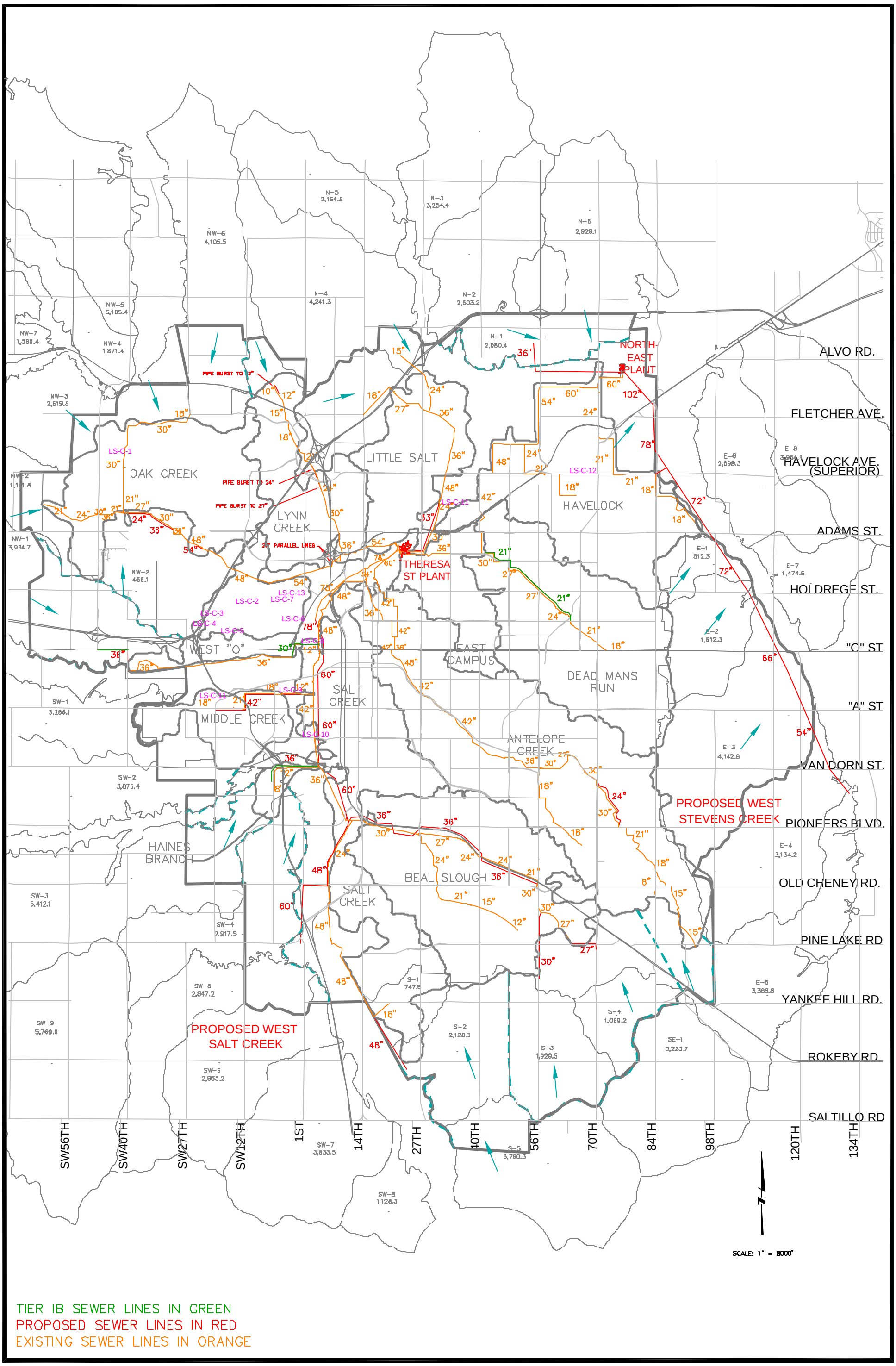
Wet Weather Flows. For both the Theresa Street and Northeast WWTFs, it is recommended that excess wet weather flows be handled with off-line storage or other facilities that will allow the degree of treatment required by the SSO regulations without excessively oversizing the wastewater treatment facilities.

Figure 9-1 shows the recommended collection system facilities associated with the preferred system (Tier I improvements) and Figures 9-2 and 9-3 depict general site plans for the recommended Theresa Street and Northeast treatment facilities respectively.

General Considerations

In implementing the specific improvements indicated for the WWTFs, it is recommended that consideration be given to the following issues:

1. Odor Control – It is anticipated that odor control will become an increasingly important aspect of wastewater treatment for the City of Lincoln. It is recommended that all projects involving improvements to potentially odor generating wastewater treatment processes include installation of appropriate odor mitigation measures. Air pollution control requirements should also be addressed in conjunction with odor control.



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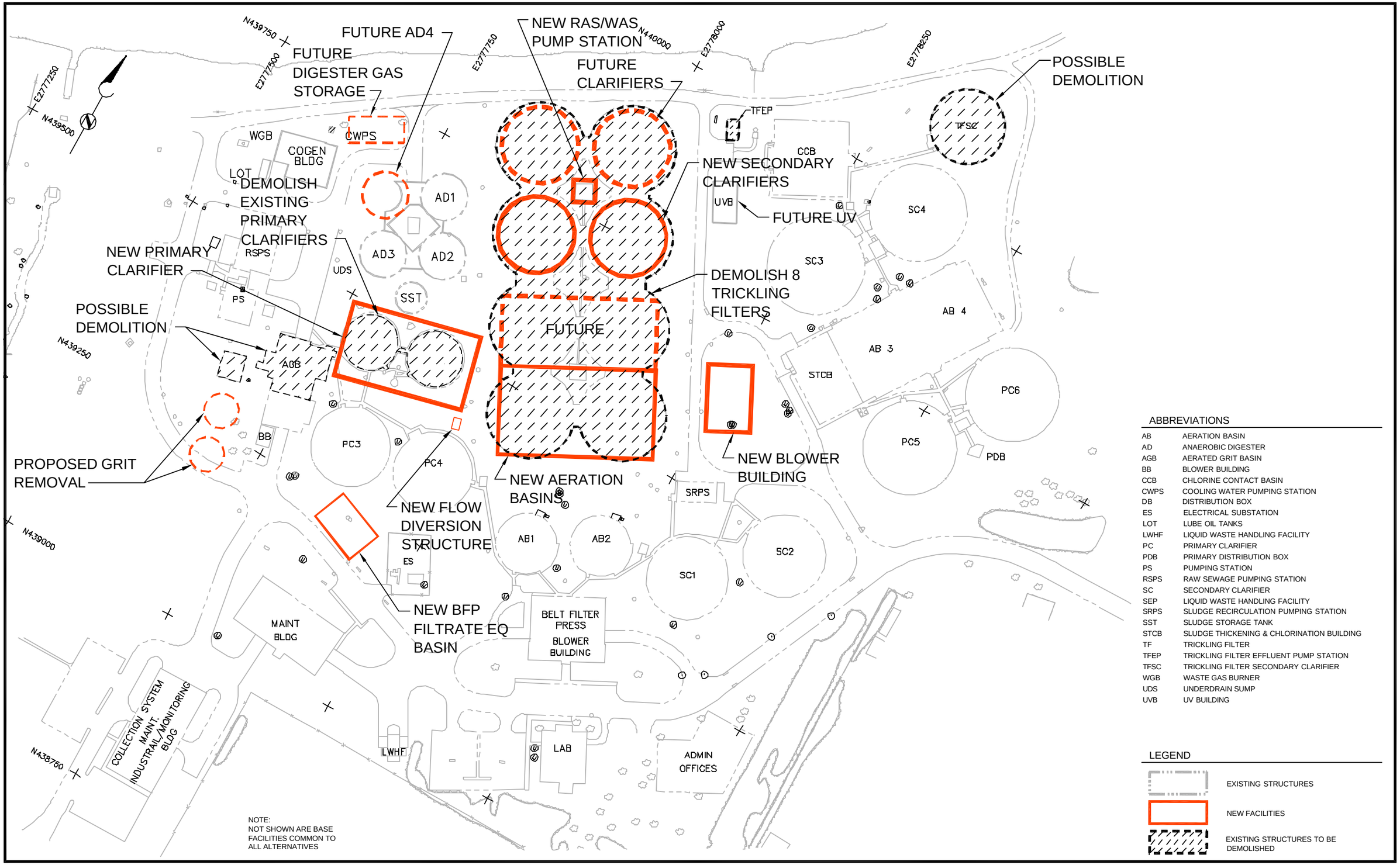
Lincoln Wastewater System Facilities Plan Update
CITY OF LINCOLN
SANITARY SEWER BASINS

Figure 9-1
RECOMMENDED TIER I COLLECTION SYSTEM IMPROVEMENTS



ABBREVIATIONS

AB	AERATION BASIN
AD	ANAEROBIC DIGESTER
AGB	AERATED GRIT BASIN
BB	BLOWER BUILDING
CCB	CHLORINE CONTACT BASIN
CWPS	COOLING WATER PUMPING STATION
DB	DISTRIBUTION BOX
ES	ELECTRICAL SUBSTATION
LOT	LUBE OIL TANKS
LWHF	LIQUID WASTE HANDLING FACILITY
PC	PRIMARY CLARIFIER
PDB	PRIMARY DISTRIBUTION BOX
PS	PUMPING STATION
RSPS	RAW SEWAGE PUMPING STATION
SC	SECONDARY CLARIFIER
SEP	LIQUID WASTE HANDLING FACILITY
SRPS	SLUDGE RECIRCULATION PUMPING STATION
SST	SLUDGE STORAGE TANK
STCB	SLUDGE THICKENING & CHLORINATION BUILDING
TF	TRICKLING FILTER
TFEP	TRICKLING FILTER EFFLUENT PUMP STATION
TFSC	TRICKLING FILTER SECONDARY CLARIFIER
WGB	WASTE GAS BURNER
UDS	UNDERDRAIN SUMP
UVB	UV BUILDING

LEGEND

EXISTING STRUCTURES

NEW FACILITIES

EXISTING STRUCTURES TO BE DEMOLISHED

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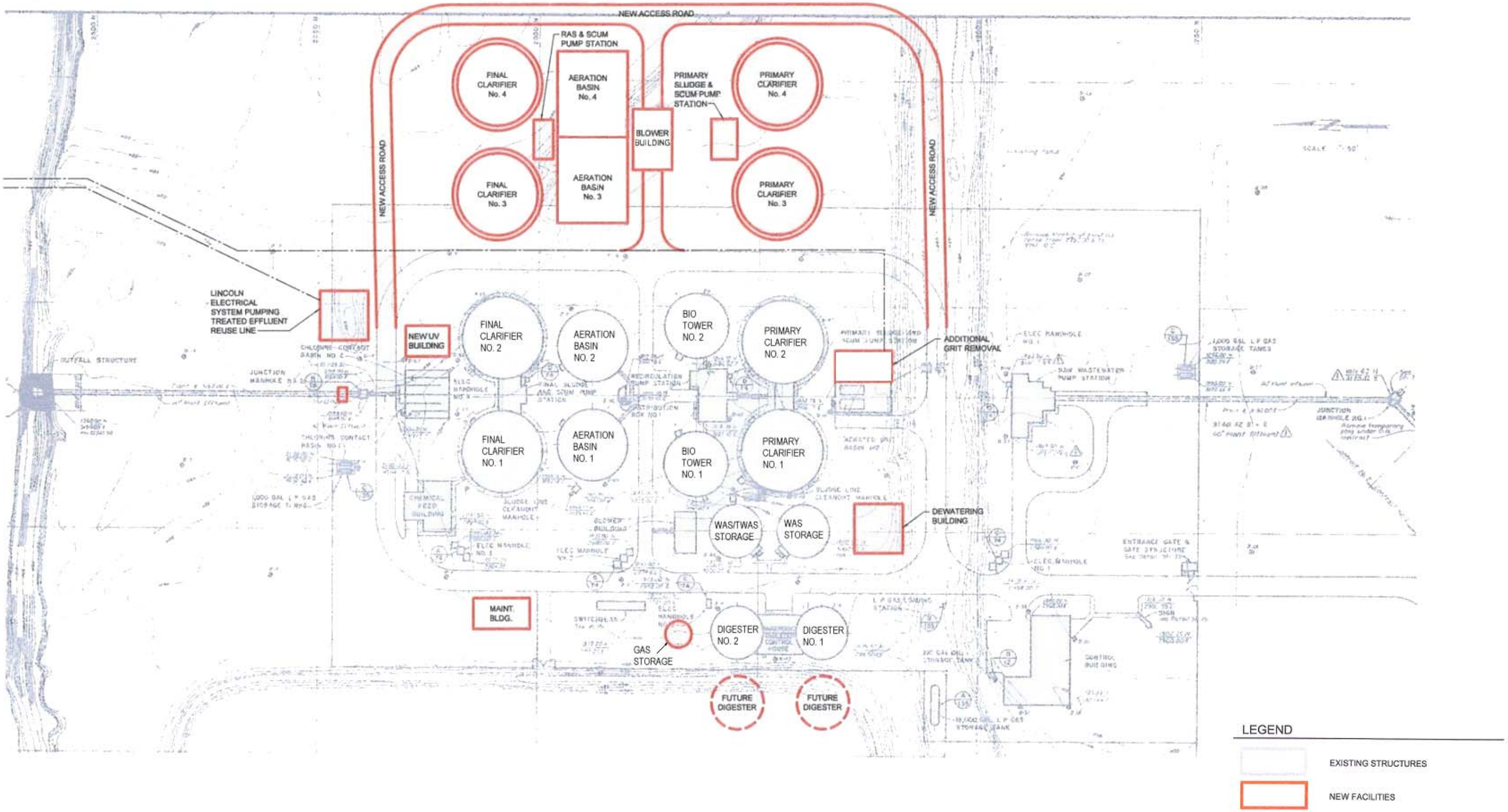
Lincoln Wastewater System Facilities Plan Update
CITY OF LINCOLN
THERESA STREET WASTEWATER TREATMENT PLANT

Figure 9-2
Recommended Conceptual Theresa Street Site Plan



Lincoln Wastewater System Facilities Plan Update

CITY OF LINCOLN

NORTHEAST WASTEWATER TREATMENT PLANT

Figure 9 - 3

Recommended Conceptual Northeast Site Plan

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2. Additional Nitrification Capacity – As indicated by the population projections presented in Chapter 3 and the wastewater flow and loading projections presented in Chapter 5, it is anticipated that the population of the Lincoln Wastewater Service area will continue to grow beyond 2025. For this reason, it is recommended that consideration be given in all improvement projects at both the Theresa Street and Northeast WWTFs to the need for facilities to accommodate wastewater treatment capacity requirements beyond 2025.

3. Future Treatment Requirements – As discussed in Chapter 6, it is anticipated that nutrient limits may be placed on discharges from both the Theresa Street and Northeast WWTFs at some point in the future. Planning for any additional treatment or auxiliary facilities at the Theresa Street or Northeast WWTF sites should give consideration to the space and hydraulic requirements of facilities that may be required in the future to accommodate nutrient removal. It may be necessary to purchase additional land adjacent to the existing treatment sites to accommodate this recommendation. Figures 9-4 and 9-5 show possible locations and site area requirements associated with facilities to accommodate potential future treatment requirements.

Preferred Treatment System Costs

Tables 9-3 and 9-4 summarize the estimated capital costs of the treatment facilities recommended to meet future needs from 2002 through 2025. The costs in these tables are total project costs and include allowances for planning, pre-design, design, bidding, construction, construction management, start-up, legal, and administration costs. All costs are stated in terms of 2002 dollars.

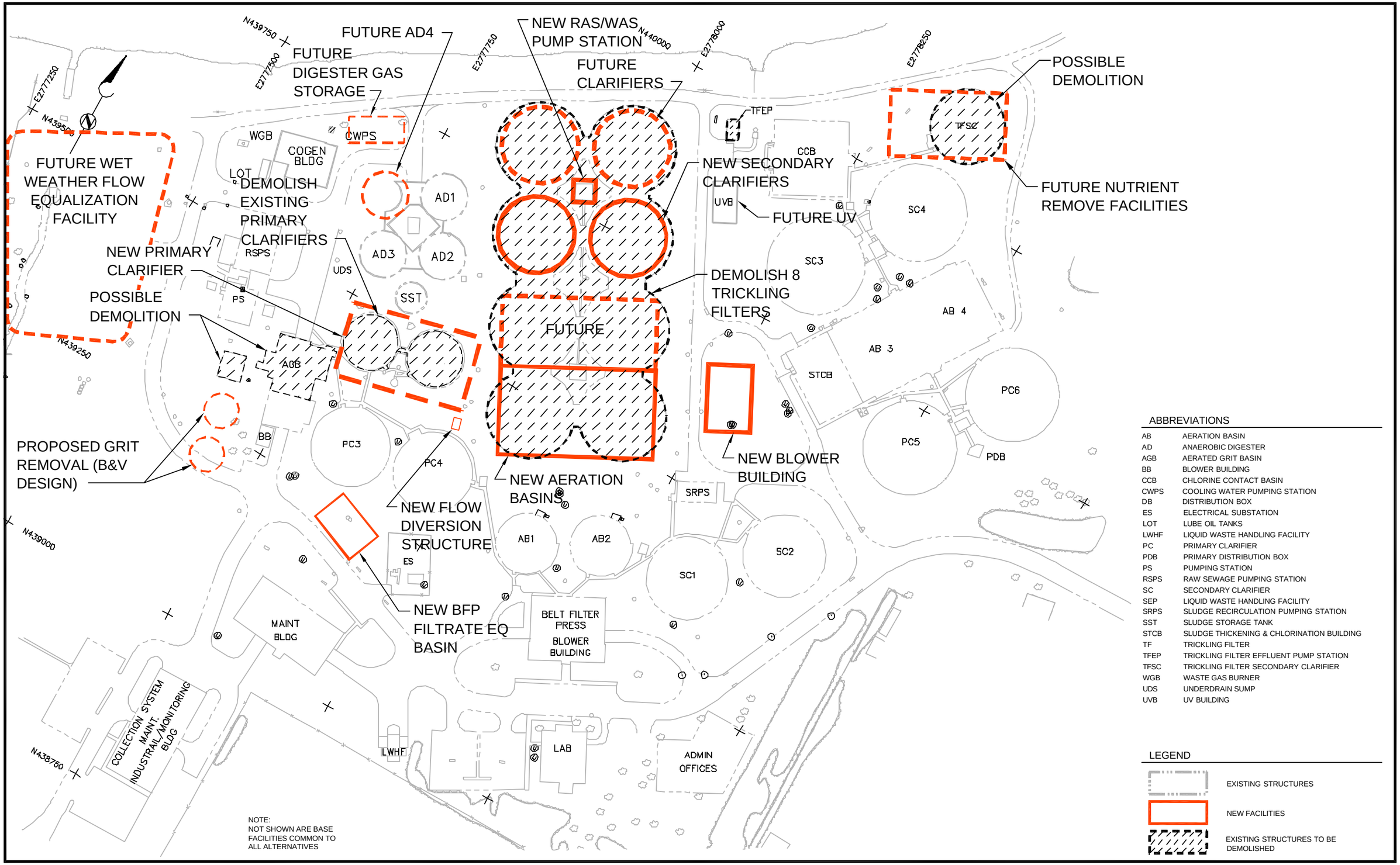
Implementation of Preferred System

It is recommended that the preferred system be implemented in stages over multiple years. The timing for construction of the recommended facilities system is contingent upon promulgation of future regulations and service area population growth rates. Adjustments to the timing of facilities construction may be required as future development occurs and regulations and discharge limits are adopted.

Figure 9-6 depicts the anticipated implementation schedule for the selected improvements. The schedule includes the time required for total project implementation beginning with preliminary design and concluding with start-up. The implementation schedule is divided into three categories:

1. Collection System,
2. Theresa Street WWTF, and
3. Northeast WWTF.

Each of these categories is discussed individually in the following paragraphs:



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ES	ELECTRICAL SUBSTATION
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LWHF	LIQUID WASTE HANDLING FACILITY
PC	PRIMARY CLARIFIER
PDB	PRIMARY DISTRIBUTION BOX
PS	PUMPING STATION
RSPS	RAW SEWAGE PUMPING STATION
SC	SECONDARY CLARIFIER
SEP	LIQUID WASTE HANDLING FACILITY
SRPS	SLUDGE RECIRCULATION PUMPING STATION
SST	SLUDGE STORAGE TANK
STCB	SLUDGE THICKENING & CHLORINATION BUILDING
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TFSC	TRICKLING FILTER SECONDARY CLARIFIER
WGB	WASTE GAS BURNER
UDS	UNDERDRAIN SUMP
UVB	UV BUILDING

LEGEND

- EXISTING STRUCTURES
- NEW FACILITIES
- EXISTING STRUCTURES TO BE DEMOLISHED

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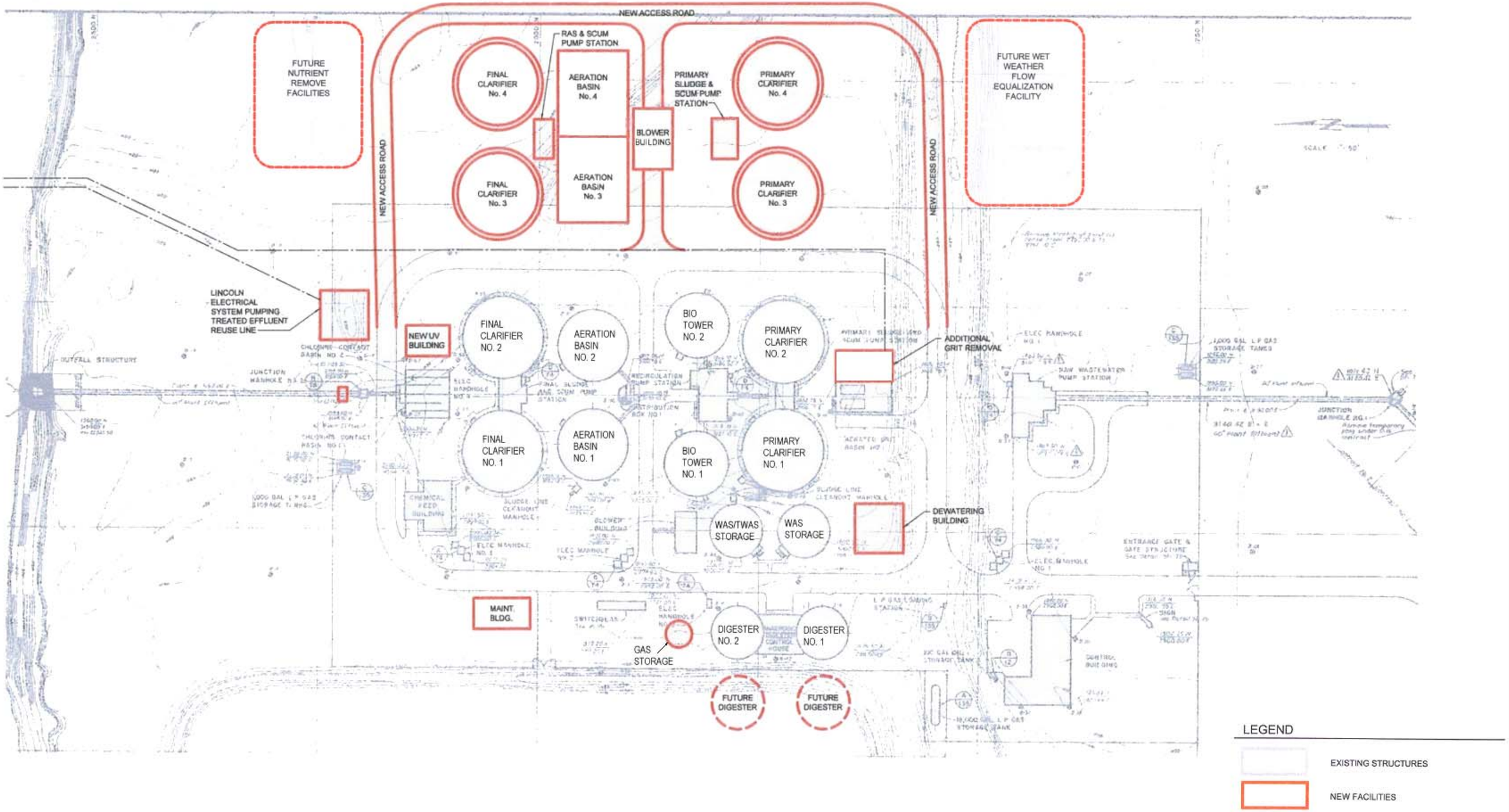
Lincoln Wastewater System Facilities Plan Update
CITY OF LINCOLN
THERESA STREET WASTEWATER TREATMENT PLANT

Figure 9-4
Theresa Steet WWTF Conceptual Site Plan-Future



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Lincoln Wastewater System Facilities Plan Update

CITY OF LINCOLN

NORTHEAST WASTEWATER TREATMENT PLANT

Figure 9 - 5

Northeast WWTF Conceptual Site Plan - Future

Figure 9-6 Lincoln Capital Improvement Schedule

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Collection System Improvements	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Theresa Street WWTF																							
1 Nitrification Capacity	■	■	■	■	■																		
2 Preliminary Treatment Improvements	■	■																					
3 Cogeneration facility improvements								■															
4 Anaerobic digester complex improvements									■	■	■												
5 West Side Process Imrpovements	■																						
6 East Side Process Improvements	■																						
7 DAF Improvements							■	■	■														
8 Dewatering system improvements							■										■	■	■				
9 Maintenance Shop										■													
10 Electrical improvements														■									
11 Upgrade collection system shop																■							
12 Admin bldg improvements															■								
13 Liquid Waste Handling Facilities							■	■															
14 General system improvements					■	■	■	■															
15 Site improvements					■							■	■										
Northeast WWTF																							
1 Nitrification Capacity	■	■	■			■	■	■	■	■													
2 Replace raw wastewater pumps							■																
3 Grit removal improvements		■	■																				
4 Primary Clarifiers & Sludge Pumping				■																			
5 Final Clarifiers & Sludge Pumping			■																				
6 Maintenance Shop Improvements					■																		
7 Sludge handling system improvements							■	■	■														
8 General system improvements									■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
9 Site improvements									■	■													

Table 9-3. Theresa Street WWTF Estimated Capital Improvement Costs (2003 through 2025)

Item	Total Project Cost
13 mgd Additional Nitrification Capacity	$22,700,000
Preliminary Treatment Improvements	$6,400,000
Cogeneration Facility Improvements	$300,000
Anaerobic Digester Complex	$6,600,000
West Side Process Train	$2,600,000
East Side Process Train	$6,600,000
Dissolved Air Flotation	$2,500,000
Sludge Dewatering System Improvements	$5,800,000
Maintenance Shop Rehabilitation	$600,000
Electrical System Improvements	$500,000
Collection System Shop Upgrade	$500,000
Administration Building Improvements	$600,000
Liquid Waste Handling Facility Improvements	$1,300,000
General Hydraulic and System Improvements	$30,500,000
General Plant Site	$2,500,000
Total Estimated Project Cost	**$90,000,000**

Table 9-4. Northeast WWTF Estimated Capital Improvement Costs (2003 through 2025)

ITEM	Total Project Cost
6 mgd Nitrification Capacity	$11,600,000
Operations Center Upgrade	$3,100,000
Raw Wastewater Pumps Replacement	$1,500,000
Grit Removal Improvements	$1,000,000
Primary Sludge Clarifiers and Pumping Improvements	$1,200,000
Refurbish Biotowers	$2,500,000
Secondary Clarifier Improvements	$1,200,000
Maintenance Shop Improvements	$300,000
Sludge Handling System Improvements	$9,000,000
General Hydraulic and System Improvements	$23,000,000
General Site Improvements	$600,000
Total Estimated Project Cost	**$55,000,000**

Collection System. The timing of collection system improvements is driven by capacity needs. The downstream section of the Salt Valley system is in need of relief in the near future. Other interceptor sections of the Salt Valley system, along with the Little Salt Creek collection facilities, are projected to need relief capacity within the next 6 years. Due to the potential increase in service area identified in the 2002 Lincoln/Lancaster County Comprehensive Plan, significant investments in the Salt Valley relief sewer may again be required in 5 to 7 years and again in 12 to 18 years.

The collection system improvements are driven by growth. Therefore, any change in anticipated growth patterns or rates will necessitate a subsequent change in the required timing of the collection system improvements. In addition to the needs identified herein, the City also must repair and/or replace other portions of the collection system that fail due to age, damage, or unforeseen circumstances. An allowance should be provided in the capital improvement budget to address these situations when they occur.

Theresa Street WWTF. Since the Theresa Street WWTF does not have sufficient nitrification capacity to handle current or projected flows, significant improvements will be required as soon as effluent ammonia limits are imposed and final compliance dates are established. These include demolishing the trickling filter system and replacing it with a new nitrifying activated sludge system. This new system should provide sufficient nitrifying capacity so the entire Theresa Street WWTF can comply with ammonia limits through 2025.

Because of the expected timing of a national policy regarding SSOs, it is recommended that construction of any facilities related to treatment of peak wet weather flows be deferred until the policy is adopted. However, it is recommended that preliminary engineering begin as soon as possible to define the type, size, and location of facilities necessary to handle peak wet weather flows. Any changes to the treatment system undertaken before the SSO policy is adopted should be designed to accommodate the planned peak wet weather flow facilities.

Northeast WWTF. As with the Theresa Street WWTF, the Northeast WWTF does not have adequate nitrification capacity to treat existing or projected wastewater flows. Therefore, expansion of the Northeast wastewater treatment capacity should be considered as soon as effluent ammonia limits are imposed.

The City of Lincoln does have the capability to divert a portion (up to 4 mgd) of the wastewater normally treated at the Northeast WWTF to the Theresa Street WWTF for treatment. This capability provides the City of Lincoln the opportunity to defer the capital investment required to increase the nitrification capacity of the Northeast WWTF for some period of time, probably 5 to 10 years. This capability may be limited to some extent by the digester capacity available at Theresa Street WWTF. However, the seasonal loading variations typically experienced are expected to result in sufficient digester capacity loading available at Theresa Street to accommodate Northeast diversion requirements through 2012.

It is recommended that the City utilize this flow diversion capability to defer the major capital improvements required to increase the nitrifying capacity of the Northeast WWTF. This will allow the City to spread the needed capital improvements over a longer period of time and subsequently reduce the immediate capital outlay.

Immediate improvements recommended at the Northeast WWTF include the installation of facilities to reduce the impact of sludge supernatent return flows on the wastewater treatment process, acquisition of more land for sludge utilization or other provisions to increase sludge disposal capacity, and renovation of the existing biotowers. The other improvements identified in Chapter 8 for the Northeast WWTF should be implemented as the needs develop.

As discussed above, the expected timing of a national policy regarding SSOs suggests deferring any projects related to treatment of peak flows until the policy is available. It is recommended that preliminary engineering begin as soon as possible to define the type, size, and location of facilities to handle peak wet weather flows and that any treatment system improvements implemented before the SSO regulations are promulgated be designed to accommodate the planned peak flow facilities.

Cooling water from the new Lincoln Electric Power generation facility is to be returned to the Northeast WWTF for treatment. Information on the quantity, quality, and temperature of this return flow was not available at the time of this writing. The preliminary design for any improvements at the Northeast WWTF should address the issue of this return flow.

As discussed previously, it may be possible to utilize the pipeline that returns the power plant cooling water to the Northeast WWTF to convey supernatent from the sludge storage lagoon to the Northeast WWTF as well. This possibility should be investigated more thoroughly during preliminary design.

Anticipated Capital Expenditures

The projected Tier I collection system trunk sewer improvements are presented in Table 9-1. The schedule for implementing these improvements depends largely on the timing and location of growth within the Lincoln wastewater service area. The Tier I collection system trunk sewer improvements are expected to cost approximately $82,000,000 and to be implemented between 2003 and 2025. In addition to the specific costs identified for the collection system trunk lines, other system capital costs of $32,000,000 are also anticipated for the period from 2003 to 2025. These costs have been incorporated into the costs presented in Figure 9-7.

The anticipated capital costs for the Theresa Street and Northeast WWTFs over the period from 2003 to 2025 are expected to be $90,000,000 and $55,000,000, respectively.

These anticipated capital costs are summarized in Table 9-5.

Table 9-5. Tier I Improvement Costs[1]

	Tier I (25-Year) Costs
Collection System Trunks Sewers	$82,000,000
Theresa Street WWTF Improvements	$90,000,000
Northeast WWTF Improvements	$55,000,000
General System Improvements	$32,000,000
Totals Costs	**$259,000,000**

[1] All costs are in 2002 dollars.

Figures 9-8 and 9-9 present the anticipated capital improvement funding requirements for the Theresa Street and Northeast WWTF improvements respectively. These figures represent a schedule of the expenditures necessary to implement the preferred system according to the schedule shown on Figure 9-6.

Figure 9-10 presents the anticipated combined capital expenditures for the collection system and the Theresa Street and Northeast WWTFs for the period from 2003 through 2025. All of the values shown in Figures 9-7, 9-8, 9-9, and 9-10 are presented in 2002 dollars.

Figure 9-7 Lincoln WW Collection System Projected Capital Expenditures

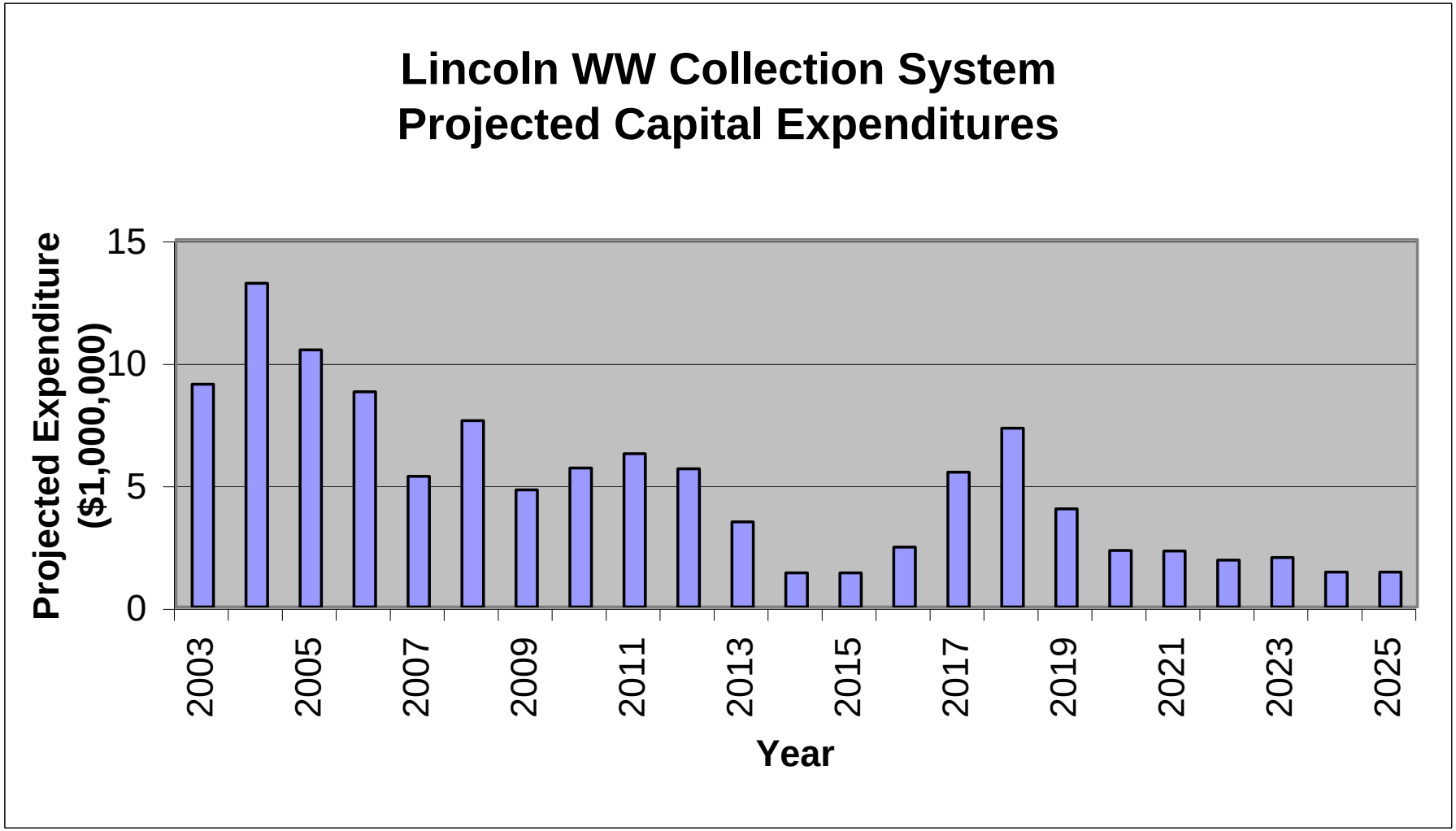


Figure 9-8 Theresa Street WWTF Projected Capital Expenditures

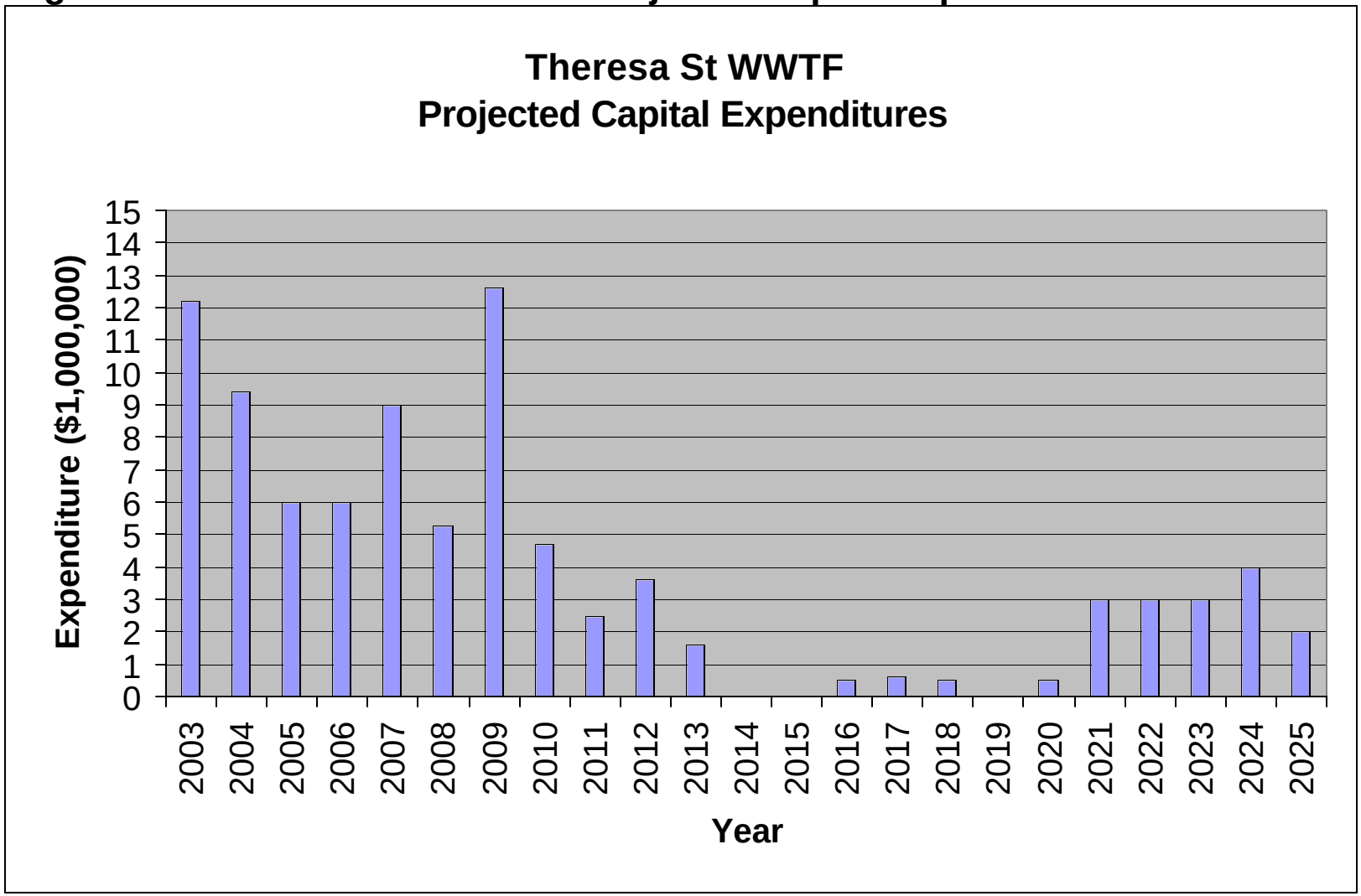


Figure 9-9 Northeast WWTF Projected Capital Expenditures

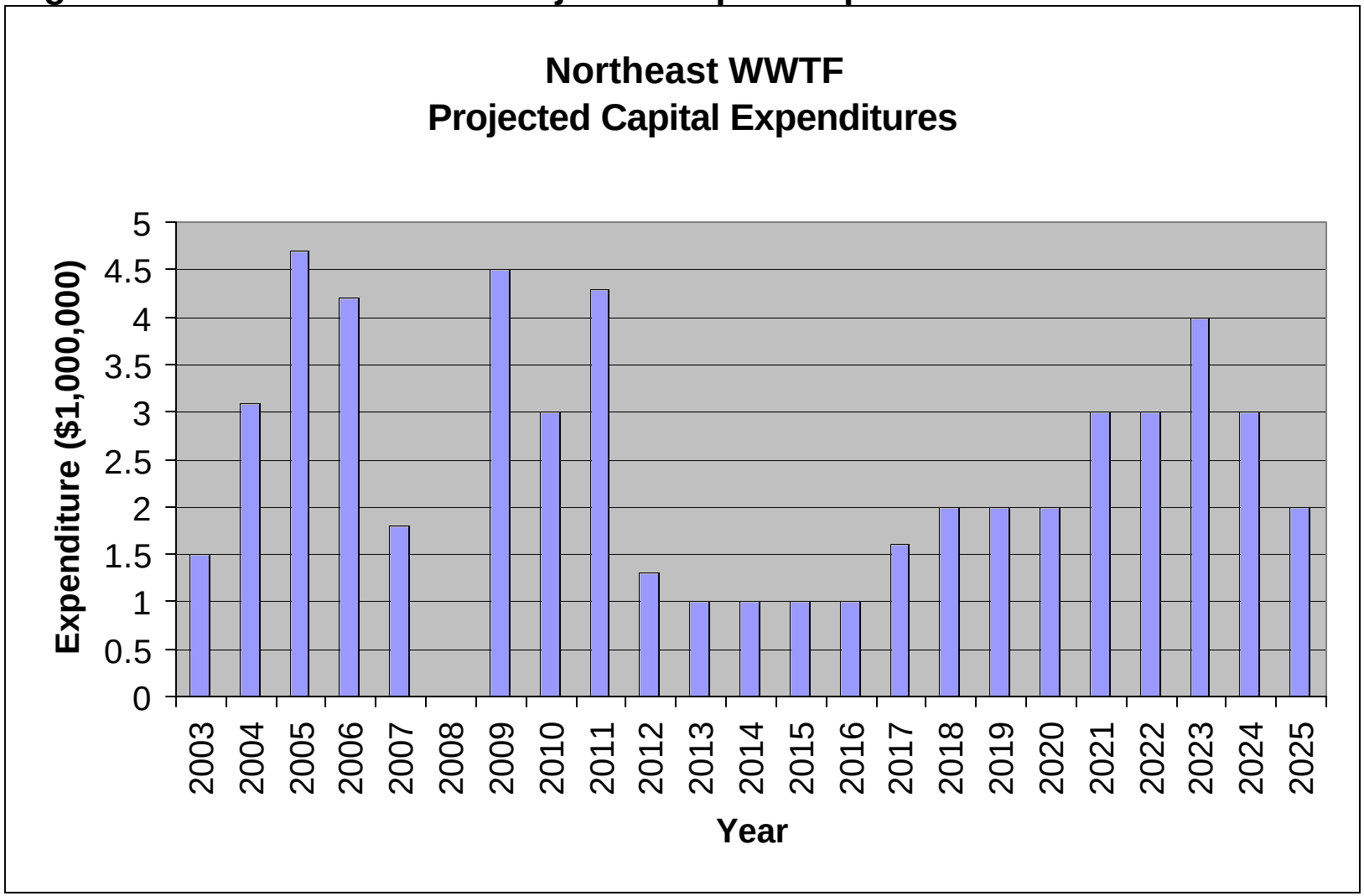
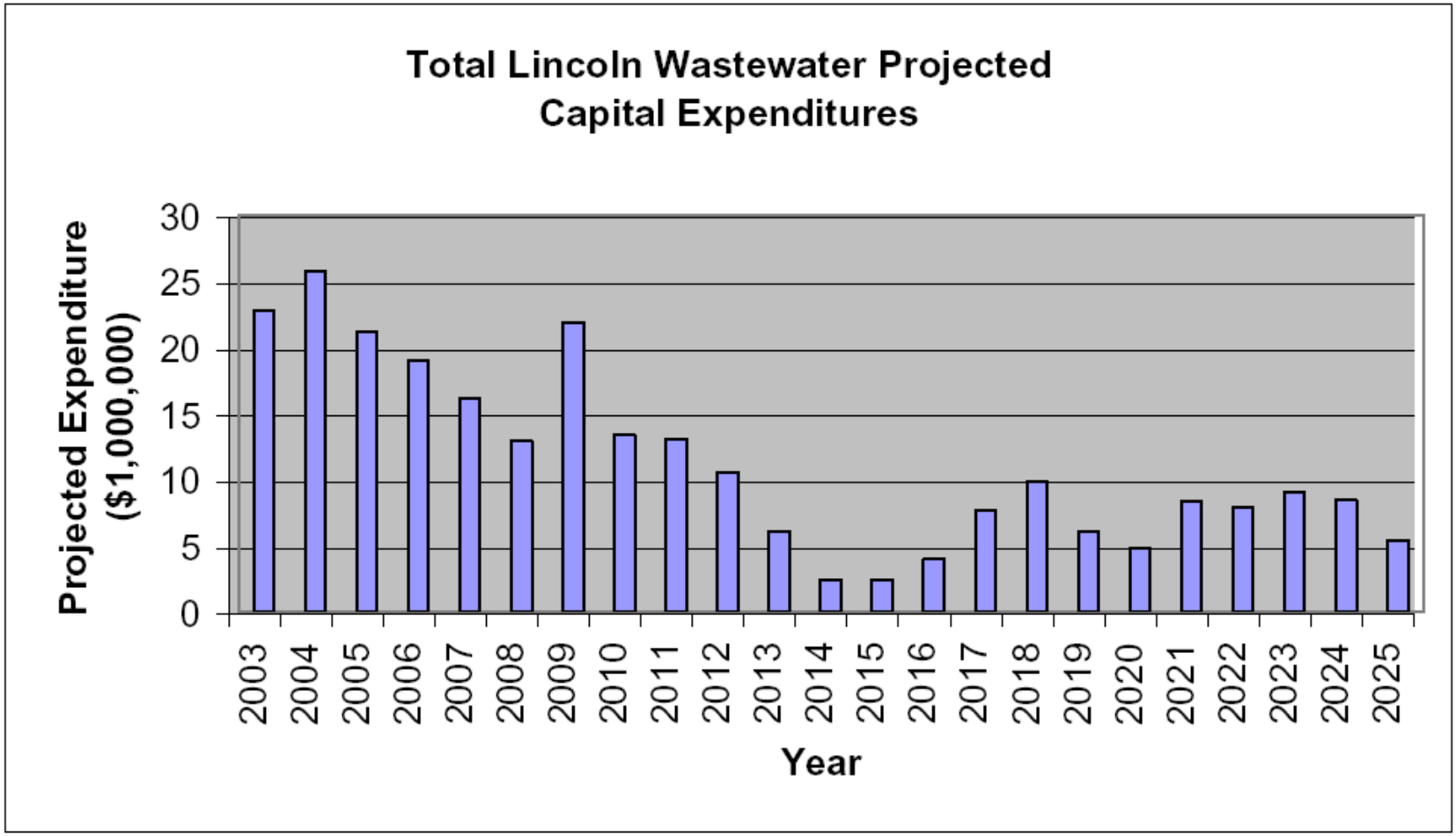


Figure 9-10 Total Lincoln Wastewater Projected Capital Expenditures



GLOSSARY

AACE	American Association of Cost Engineers
acres/mgd	Acres per Million Gallons per Day
ADA	Americans with Disabilities Act
ADF	Average Daily Flow
BOD_5	5-Day Biochemical Oxygen Demand
BFP	Belt Filter Press
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
CFU	Colony Forming Units
CFU/gTs	Colony Forming Units per Gram of Total Solids
CIP	Capital Improvement Plan
City	City of Lincoln
COD	Chemical Oxygen Demand
CWA	Clean Water Act
CWAP	Clean Water Action Plan
ENR	Engineering News-Record
EPA	Environmental Protection Agency
gal/acre/day	Gallons per Acre per Day
gal/capita/day	Gallons per Capita per Day
gal/mg	Gallons per Million Gallons
gpcd	Gallons per Capita per Day
gpd	Gallons per Day
gpd/ft^2	Gallons per Day per Square Foot
gpm	Gallons per Minute
gts	Gram of Total Solids
HAP	Hazardous Air Pollutant
HRT	Hydraulic Retention Time
I/I	Infiltration and Inflow
kg/ha/yr	Kilograms per Hectare per Year
kW	Kilowatts
lbs/acre/yr	Pounds per Acre Per Year
lbs/capita/day	Pounds per Capita Per Day
lb/day	Pounds per Day
lbs/hr	Pounds per Hour
lbs/MG	Pound per Million Gallons
lf	Linear Feet
MACT	Maximum Achievable Control Technology
mgd	Millions of Gallons per Day
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Liter
mL	Milliliter
ml/g	Milliters per Gram

MLSS	Mixed Liquor Suspended Solids
MMF	Maximum Monthly Flow
MPM/gTs	Most Probable Number per Gram of Total Solids
NAAQS	National Ambient Air Quality Standards
N/acre/yr	Nitrogen per Acre per Year
NDEQ	Nebraska Department of Environmental Quality
NH_3–N	Ammonia Nitrogen
N/L	Nitrogen per Liter
NPDES	National Pollutant Discharge Elimination System
NRC	National Research Council
NTU	Nephelometric Turbidity Units
O&M	Operation and Maintenance
PDF	Peak Daily Flow
PE	Primary Effluent
PFRP	Process to Further Reduce Pathogens
PM	Particulate Matter
POTWs	Publicly Owned Treatment Works
ppd	Pounds per Day
PVC	Polyvinyl Chloride (Plastic)
PWWF	Peak Wet Weather Flow
RAS	Return Activated Sludge
RAS/WAS	Return Activated Sludge/Waste Activated Sludge
RCP	Reinforced Concrete Pipe
RCRA	Resource Conservation and Recovery Act
SCWQS	Salt Creek Water Quality Studies
SPA	State Point Analysis
SRT	Solids Retention Time
SSO	Sanitary Sewer Overflow
SVI	Sludge Volume Index
TACs	Toxic Air Contaminants
TCLP	Toxicity Characteristics Leaching Procedure
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
tpy	Tons per Year
TSS	Total Suspended Solids
ug/l	Micrograms per Liter
USEPA	U.S. Environmental Protection Agency
UV	Ultraviolet
VOC	Volatile Organic Compound
VS/day/cu ft	Volatile Solids per Day per Cubic Feet
VS/mg	Volatile Solids per Million Gallons
VSS	Volatile Suspended Solids
WAS	Waste Activated Sludge
WERF	Water Environment Research Foundation
WET	Whole Effluent Toxicity
WLA	Wasteload Allocations
WWTF	Wastewater Treatment Facility

Appendix A – Theresa Street NPDES Permit

STATE OF NEBRASKA

ROBERT KERREY • GOVERNOR • DENNIS GRAMS • DIRECTOR

Bruce Pam
Steve Sy
Lyle
Scott

April 9, 1986

RECEIVED
APR 10 1986
DIRECTOR
PUBLIC WORKS/
UTILITIES

WQD-P/C

RETURN RECEIPT REQUESTED

Mr. Richard Erixson
Director of Public Works
Lincoln Theresa Street WWTP
555 South Tenth Street
Lincoln, NE 68508

NPDES Number NE 0036820
Location: Lincoln, Nebraska
Receiving Waters: Salt Creek

Dear Mr. Erixson:

Pursuant to the Federal Water Pollution Control Act, as amended (33 U.S.C. 466 et. seq.), the Nebraska Environmental Protection Act (Secs. 81-1504(11), (Reissue, 1981) and the State of Nebraska Department of Environmental Control, Rules and Regulations Pertaining to the Issuance of Permits Under the National Pollutant Discharge Elimination System, we have reissued and are enclosing your National Pollutant Discharge Elimination System (NPDES) Authorization to Discharge.

Your NPDES Authorization to Discharge includes general and special conditions which must be followed to remain in compliance with the requirements of the above-mentioned statutes and Rules and Regulations. Monitoring reports prescribed in the special conditions are required on a periodic basis. Questions and requests for additional monitoring reports should be directed to Department of Environmental Control, Permits and Compliance Section, (402) 471-2186.

Issuance of an NPDES Authorization to Discharge by the Department of Environmental Control does not relieve you of other duties and responsibilities under the Nebraska Environmental Protection Act or as amended, or any Rules and Regulations promulgated pursuant thereto.

Your continued cooperation in helping to improve and maintain the quality of Nebraska's waters is much appreciated.

Sincerely,

Dennis Grams

Dennis Grams, P.E.

JR/at

Enclosure

Permit Number NE 0036820

DEPARTMENT OF ENVIRONMENTAL CONTROL
AUTHORIZATION TO DISCHARGE UNDER THE STATE OF NEBRASKA
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Water Pollution Control Act, as amended (33 U.S.C. 466 et. seq.), the Nebraska Environmental Protection Act [Neb. Rev. Stat. Secs. 81-1504(15)(25), 81-1505(3)(4)(5)(6) and (7), 81-1510(2), (Reissue 1981)], and the Rules and Regulations promulgated pursuant thereto,

Lincoln Theresa Street WWTP
Lincoln, Nebraska

is authorized to discharge from a facility located at

NE¼NW¼, Section 13, Township 10N, Range 6E, Lancaster County

to receiving waters named

Salt Creek

in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts I, II, and III hereof.

This permit shall become effective on April 9, 1986.

This permit and the authorization to discharge shall expire at midnight, April 8, 1989.

Signed this 9th day of April, 1986.

Director

PART I.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning April 9, 1986 and lasting through April 8, 1989 the permittee is authorized to discharge from all outfalls.

The discharge limitations are based on a flow of 30 million gallons per day (mgd).

Such discharges shall be limited and monitored by the permittee as specified below:

	DISCHARGE LIMITATIONS				MONITORING REQUIREMENTS	
	Concentration in Mg/l		Kg/Day (Lbs/Day)		Measurement	Sample
EFFLUENT CHARACTERISTIC	30 Day Average	7 Day Maximum	30 Day Average	7 Day Maximum	Frequency	Type
Biochemical Oxygen Demand (5-day)	30	45	3404.7(7506.0)	5107.0(11259.9)	Daily	24-Hr Composite
Suspended Solids	30	45	3404.7(7506.0)	5107.0(11259.9)	Daily	24-Hr Composite
Flow - MGD	--	--	--	--	Continuous	Metered
Cadmium, Total	0.004	0.004	0.45(1.0)	0.45(1.0)	Daily	24-Hr Composite
Oil and Grease	10	20	1134.9(2502.0)	2269.8(5004.0)	Weekly	Grab
Cyanide, Total	--	--	--	--	Daily	Grab
*Fecal Coliform Colonies/100 ml	200	400	--	--	Daily	Grab

*Required April 1 through September 30 of each year.

The pH shall be maintained between the range of 6.0 - 9.0 Standard Units. The value(s) shall be determined from a grab sample taken daily.

Sample taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): where the flow exits the treatment facility.

PART I.

B. INFLUENT AND SLUDGE MONITORING REQUIREMENTS

During the period beginning April 9, 1986 and lasting through April 8, 1989, the permittee shall monitor the plant influent and the plant waste sludge as specified below:

MONITORING CHARACTERISTIC	SAMPLING FREQUENCY	INFLUENT SAMPLE TYPE	SLUDGE SAMPLE TYPE
Cyanide, Total	Daily	Grab	Grab
Oil and Grease	Quarterly	Grab	--
Cadmium, Total	Quarterly	24-Hr. Composite	Grab
Chromium, Total	Quarterly	24-Hr. Composite	Grab
Copper	Quarterly	24-Hr. Composite	Grab
Lead	Quarterly	24-Hr. Composite	Grab
Nickel	Quarterly	24-Hr. Composite	Grab
Nitrogen, Total	Quarterly	24-Hr. Composite	Grab
Zinc	Quarterly	24-Hr. Composite	Grab
Biochemical Oxygen Demand (5-Day)	Annually	24-Hr. Composite	--
Suspended Solids	Annually	24-Hr. Composite	--
pH - Standard Units	Annually	Grab	Grab

The sample shall be collected for analysis prior to discharge or disposal.

A. OTHER REQUIREMENTS

1. By December 31, 1986, submit a laboratory analysis on all of the significant contributing industrial discharges as identified in the Memorandum of Agreement (MOA) to the POTW. The analysis shall be designed to detect those pollutants as identified for that particular industrial category either through the survey or existing literature. The analysis shall include metals and exclude total toxic organics.

2. By December 31, 1987, submit a laboratory analysis on all of the significant contributing industrial discharges to the POTW. The analysis shall be designed to detect those pollutants as identified for that particular industrial category either through the survey, through existing literature or the previous year's analysis results. The analysis shall include both metal and total toxic organics.

3. There shall be no discharge of floating solids or visible foam in other than trace amounts.

4. Sludge shall be disposed of or utilized in a manner approved by the Department of Environmental Control.

5. The 30 day average percent removal shall not be less than 85% as defined in Title 121, Chapter 3, Subsection 001.06.

STANDARD CONDITIONS FOR NEBRASKA DEPARTMENT OF ENVIRONMENTAL CONTROL WATER AND WASTE MANAGEMENT PERMITS

SECTION A. MONITORING AND RECORDS

1. Representative Sampling

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge. All samples shall be taken at the monitoring points specified in this permit and, unless otherwise specified, before the effluent joins or is diluted by any other wastestream, body of water or substance. Monitoring points shall not be changed without notification to and the approval of the Director.

2. Flow Measurements

Appropriate flow measurement devices and methods consistent with accepted scientific practices shall be selected and used to insure the accuracy and reliability of measurements of the volume of monitored discharges. The devices shall be installed, calibrated and maintained to insure that the accuracy of the measurements are consistent with the accepted capability of that type of device. Devices selected shall be capable of measuring flows with a maximum deviation of less than ± 10% from true discharge rates throughout the range of expected discharge volumes. Guidance in selection, installation, calibration and operation of acceptable flow measurement devices can be obtained from the the following references:

1) "Water Measurement Manual", U. S. Dept. of Interior, Bureau of Reclamation, Second Edition, Revised Reprint, 1974, 327 pp. (Available from the U. S. Government Printing Office, Washington, D.C. 20402. Order by Catalog No. I27.19/2:W29/2, Stock No. S/N 24003-0027.)

2) "Flow Measurement in Open Channels and Closed Conduits", U. S. Department of Commerce, National Bureau of Standards, NBS Special Publication 484, October 1977, 982 pp. (Available in paper copy or microfiche from National Technical Information Service (NTIS), Springfield, VA, 22151. Order by NTIS No. PB-273 535/5ST.

3) "NPDES Compliance Sampling Manual", U. S. Environmental Protection Agency, Office of Water Enforcement, Publication MCD-51, 1977, 140 pp. (Available from the General Services Administration (8FFS), Centralized Mailing Lists Services, Building 41, Denver Federal Center, Denver, CO, 80225.

3. Reporting of Monitoring Results

Reporting Period: Calendar Quarter

Monitoring results obtained during the Reporting Period shall be summarized and reported on a Nebraska Department of Environmental Control Discharge Monitoring Report Form postmarked no later than the 28th day of the month following the completed reporting period.

Reports due: January 28; April 28; July 28; October 28

Signed copies of these Reports shall be submitted to the Nebraska Department of Environmental Control at the following address:

Nebraska Department of Environmental Control
P. O. Box 94877, Statehouse Station
301 Centennial Mall South
Lincoln, NE 68509

4. Test Procedures

Test procedures for the analysis of pollutants shall conform to Nebraska Department of Environmental Control Rules and Regulations for Test Procedures for the Analysis of Pollutants Under the National Pollutant Discharge Elimination System. If those Rules and Regulations do not specify test procedures for any pollutant required to be monitored by this permit and until such Rules and Regulations are promulgated, sampling and analytical methods used to meet the monitoring requirements specified in this permit shall, unless otherwise specified by the Director conform to the latest edition of the following references:

Standard Methods for the Examination of Water and Wastewaters, 15th Edition, 1980, American Public Health Association, New York, NY, 10019.

A.S.T.M. Standards, Part 31, Water, 1975, American Society for Testing and Materials, Philadelphia, Pennsylvania, 19103.

Methods for Chemical Analysis of Water and Wastes, March, 1979, Environmental Protection Agency Water Quality Office, Analytical Quality Control Laboratory, NERC, Cincinnati, OH, 45268.

5. Additional Monitoring by the Permittee

If the permittee monitors any pollutant more frequently than required by this permit, using approved test procedures or as specified in this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR. Such increased frequency shall also be indicated.

6. Averaging of Measurements

Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified by the Director in the permit.

Retention of Records

The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least three years from the date of the sample, measurement, report or application. This period may be extended by request of the Director at any time.

8. Record Contents

Records of monitoring information shall include:

a) The date, exact place, time and methods of sampling or measurements;
b) Who performed the sampling or measurements;
c) The date(s) analyses were performed;
d) Who performed the analyses;
e) The analytical techniques or methods used; and
f) The results of such analyses.

SECTION B. OPERATION AND MAINTENANCE

1. Proper Operation and Maintenance

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems only when necessary to achieve compliance with the conditions of the permit.

2. Duty to Halt or Reduce Activity

Upon reduction, loss or failure of the treatment facility, the permittee shall, to the extent necessary to maintain compliance with its permit, control production or all discharges or both until the facility is restored or an alternative method of treatment is provided. This requirement applies, for example, when the primary source of power of the treatment facility fails or is reduced or lost. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

3. Bypassing

Any diversion from or bypass of the treatment facilities is prohibited unless:

(a) It is unavoidable to prevent loss of live, personal injury or severe property damage.

(b) No feasible alternative exists, i.e. retention of untreated wastes.

(c) The permittee submits notice to the Director within 24 hours of becoming aware of the bypass, or if the bypass is anticipated the Director is notified ten (10) days prior to the bypass.

(d) The bypass is conducted under conditions determined to be necessary by the Director to minimize any adverse effects.

If the bypass is needed for regular preventative maintenance for which backup equipment should be provided, the bypass will not be allowed. When a bypass occurs, the burden is on the permittee to demonstrate compliance with items (a) through (d) above.

4. Removed Substances

Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall be disposed of at a site and in a manner approved by the Nebraska Department of Environmental Control.

SECTION C. REPORTING REQUIREMENTS

1. Change in Discharge

All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit. Any anticipated facility expansions, production increase, or process modifications which will result in new, different, or increased discharges or pollutants must be reported by the permittee in 180 days prior to the expansion, increases, or modifications, by submission of a new permit application or, if such changes will not violate the effluent limitations specified in this permit, by notice to the permit issuing authority of such changes. Following such notice, the permit may be modified to specify and limit any pollutants not previously limited.

2. Noncompliance Notification

If, for any reason, the permittee does not comply with or will be unable to comply with any daily maximum or weekly average effluent limitation specified in this permit, the permittee shall report to the Department of Environmental Control on a Noncompliance Report Form, within seven (7) days of becoming aware of such conditions, and in the case of any discharge subject to any applicable toxic pollutant effluent standards under Section 307(a) of the Federal Act or other discharges which constitute a threat to human health, welfare, or the environment, shall report to the Department of Environmental Control on a Noncompliance Report Form within 24 hours from the time the permittee becomes aware of the circumstances.

The permittee shall provide:

(a) A description of the discharge and cause of noncompliance; and

(b) The period of noncompliance, including exact dates and times; or if not corrected, the anticipated time the noncompliance is expected to continue, and steps taken to reduce, eliminate, and prevent recurrence of the noncomplying discharge.

3. Twenty-Four Hour Reporting

The permittee shall report any noncompliance which may endanger health or the environment. Any information shall be provided orally within 24 hours from the time the permittee becomes aware of the circumstances. A written submission shall also be provided within five days of the time the permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance. The Director may waive the written report on a case-by-case basis if the oral report has been received within 24 hours.

The following shall be included as information which must be reported within 24 hours:

a) Any unanticipated bypass which exceeds any effluent limitation in the permit.

b) Any upset which exceeds any effluent limitation in the permit.

c) Violation of a maximum daily discharge limitation for any of the pollutants listed by the Director in Part I of the permit.

4. Other Noncompliance

The permittee shall report all instances of noncompliance to the Department within seven (7) days on a Nebraska Department of Environmental Control Noncompliance Report Form.

5. Changes in Discharges of Toxic Substances

The permittee shall notify the Director as soon as it knows or has reason to believe:

a) That any activity has occurred or will occur which would result in the discharge of any toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels":

(1) One hundred micrograms per liter (100 ug/l);

(2) Two hundred micrograms per liter (200 ug/l) for acrolein and acrylonitrile; five hundred micrograms per liter (500 ug/l) for 2,4-dinitrophenol and for 2-methyl-4, 6-dinitrophenol; and one milligram per liter (1 mg/l) for antimony;

(3) Five (5) times the maximum concentration value reported for that pollutant in the permit application;

(4) The level established in Part I of the permit by the Director.

b) That they have begun or expect to begin to use or manufacture as an intermediate or final product or byproduct any toxic pollutant which was not reported in the permit application.

SECTION D. MANAGEMENT REQUIREMENTS

1. Duty to Provide Information

The permittee shall furnish to the Director, within a reasonable time, any information which the Director may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the Director, upon request, copies of records required to be kept by this permit.

2. Duty to Reapply

If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and obtain a new permit. The application should be submitted at least 180 days before the expiration date of this permit. The Director may grant permission to submit an application less than 180 days in advance.

3. Signatory Requirements

All applications, reports or information submitted to the Director shall be signed and certified.

a) All permit applications shall be signed as follows:

(1) For a corporation: by a principal executive officer of at least the level of vice-president;

(2) For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or

(3) For a municipality, State, Federal or other public agency: by either a principal executive officer or ranking elected official.

b) All reports required by the permit and other information requested by the Director shall be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if:

(1) The authorization is made in writing by a person described above.

(2) The authorization specified either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of plant manager, operator of a well or a well field, superintendent, or position of equivalent responsibility. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.); and

(3) Certification. Any person signing a document under this section shall make the following certification:

"I certify that I am familiar with the information contained in this report and that to the best of my knowledge and belief such information is true, complete and accurate."

SECTION E. GENERAL CONDITIONS

1. Information Available

Except for data determined to be confidential under 40 CFR Part 2, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Department. As required by the Federal Act, permit applications, permits and effluent data shall not be considered confidential.

2. Duty to Comply

The permittee must comply will all conditions of this permit. Failure to comply with the requirements these regulations may be grounds for administrative action, or enforcement proceedings including injective relief by the county attorney or Attorney General.

3. Duty to Mitigate

The permittee shall take all reasonable steps to minimize or correct any adverse impact on the environment resulting from noncompliance with this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

4. Permit Actions

This permit may be modified, revoked and reissued, or terminated for cause including, but not limited to, the following:

a) Violation of any terms or conditions of this permit;

b) Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts; or

c) A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

5. Toxic Pollutants

If a toxic effluent standard or prohibition is established and adopted by the Council under Sections 301(b) (2) (C), 301(b) (2) (D), 304(b) (2) and 307 (a) (2) of the Federal Act for a toxic pollutant which is present in the permittee's discharge and such standard or prohibition is more stringent than any limitations upon such pollutant in the permit, the Director shall revise or modify the permit in accordance with the toxic effluent standard or prohibition and so notify the permittee.

6. Oil and Hazardous Substance Liability

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Section 311 of the Federal Act.

7. Property Rights

The issuance of this permit does not convey any property rights of any sort, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

8. Severability

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

9. Other Rules and Regulations Liability

The issuance of this permit in no way relieves the obligation of the permittee to comply with any and all other Department Rules and Regulations.

10. Inspection and Entry

The permittee shall allow the Director, or an authorized representative, upon the presentation of credentials and other documents as may be required by law, to:

a) Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;

b) Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;

c) Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit;

d) Sample or monitor, at reasonable times, for the purposes of assuring permit compliance, any substances or parameters at any location.

e) Inspect any production, manufacturing, fabricating or storage area where pollutants, regulated under the permit, could originate.

DEFINITIONS

Anticipated Bypass--when the permittee knows in advance of the need for a bypass.

Daily Average--Discharge means the total discharge by weight during a calendar month divided by the number of days in the month that the production or facility was operating. Where less than daily sampling is required by this permit, the daily average discharge shall be determined by the summation of all the measured daily discharges by weight divided by the number of days during the calendar month when the measurements were made.

Daily Maximum--Discharge means the total discharge by weight during any calendar day.

Maximum Concentration--The maximum concentration is the concentration in any single grab sample.

Grab Sample--An individual sample collected in less than 15 minutes.

Composite Sample--A combination of individual samples obtained at regular intervals over a time period. Either the volume of each individual sample is proportional to flow rate during sample period (flow composite) or constant volume samples are collected at equal time intervals during composite period (time composite).

Cooling Water--Uncontaminated: Water used for cooling purposes only which has no direct contact with any raw material, intermediate, or final product and which does not contain a level of contaminants detectably higher than that of the intake water. Contaminated: Water used for cooling purposes only which may become contaminated either through the use of water treatment chemicals used for corrosion inhibitors or biocides, or by direct contact with process materials and/or wastewater.

Monthly Average--Other than for fecal coliform bacteria, is the arithmetic mean of the values for effluent samples collected in a period of 30 consecutive days. The monthly average for fecal coliform bacteria is the geometric mean of the value of the effluent samples collected in a period of 30 consecutive days.

Weekly Average--Other than for fecal coliform bacteria, is the arithmetic mean of the values for effluent samples collected in a period of seven consecutive days. The weekly average for fecal coliform bacteria is the geometric mean of the values for effluent samples collected in a period of seven consecutive days.

Bi-Weekly--Once every other week.

Bi-Monthly--Once every other month.

Compatible Pollutants--Are biochemical oxygen demand, suspended solids, pH and fecal coliform bacteria, plus additional pollutants identified in the NPDES permit if the publicly owned treatment works was designed to treat such pollutants, and in fact does remove such pollutants to a substantial degree, e.g., nitrogen and phosphorus.

Incompatible Pollutant--Is any pollutant which is not a compatible pollutant as defined above.

Major Contributing Industry--Is a wastewater source that:

(a) has a flow of 50,000 gallons or more per average workday;

(b) has a flow greater than five percent of the flow carried by the municipal system receiving the waste;

(c) has in its waste a toxic pollutant in toxic amounts; or

(d) has significant impact, either singly or in combination with other contributing industries on the treatment works or the quality of its effluent.

Severe Property Damage--Means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable. Severe property damage does not mean economic loss caused by delays in production.

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

Upset--Means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee, excluding such factors as operational error, improperly designed or inadequate treatment facilities, or improper operation and maintenance or lack thereof.

Bypass--Means the intentional diversion of wastes from any portion of a treatment facility.

Waters of the State--Means all waters within the jurisdiction of this state including all streams, lakes, ponds, impounding reservoirs, marshes, watercourses, waterways, wells, springs, irrigation systems, drainage systems, all other bodies or accumulations of water, surface and underground, natural or artificial, public or private, situated wholly or partly within or bordering upon the state.

Appendix B – Summary of Theresa Street Treatment System Process Information

Table B-1 Theresa Street WWTP Liquid Stream Process Data

Existing Treatment Units	Design Data[a]
PRELIMINARY TREATMENT	
Bar Screens	
Number	4
Clear opening, inch	1/2
Raw Wastewater Pumping	
Number	3
Capacity, mgd	10
Number	3
Capacity, mgd	15
Number	1
Capacity, mgd	12
Number	1
Capacity, mgd	25
Aerated Grit Basins	
Number	6
Design flow per basin, mgd	5
Side water depth, ft	13.75
Detention time, min	24
Air flow per lin ft basin, cfm	3.1
Compressors	3
Number	3
Capacity, scfm	500
PRIMARY TREATMENT	
Primary Clarifiers	
Units 1 and 2	
Diameter, ft	70
Side water depth, ft	13.5
Weir loading rate, gpd per lin ft	11,368
Detention time, hr	3.7
Units 3 and 4	
Diameter, ft	100
Side water depth, ft	13.0
Weir loading rate, gpd per lin ft	15,915
Detention time, hr	3.7
Units 5 and 6	
Diameter, ft	125
Side water depth, ft	12.5
Weir loading rate, gpd per lin ft	10,150
Detention time, hr	3.7
SECONDARY TREATMENT	
Trickling Filters	8
Number	0.625

Table B-1 Theresa Street WWTP Liquid Stream Process Data

Existing Treatment Units	Design Data[a]
Design flow per unit, mgd	120
Diameter, ft	1.1
Recirculation ratio	
Trickling Filter Recirculation/Effluent Pumping Station	
Number of units	3
Rated head, ft	34
Rated capacity at rated head, mgd	5.0
Motor size, hp	40
Unit 5 Final Clarifier	
Diameter, ft	100
Side water depth, ft	12.25
Weir loading rate, gpd per lin ft	8,500
Detention time, hr	3.4
Aeration Basins	
West Side	
Design flow per unit, mgd	5
Diameter, ft	80
Depth, ft	17
Detention time, hr	3.0
Aerator type	Fine Bubble Diffusion
Blowers	
Number	3
Capacity, each, scfm	3,000
Number	1
Capacity each, scfm	5,000
Aeration Basins	
East Side (to be completed in 2003)	
Design flow per unit, mgd	7.5
Unit size, ft	105 x 105
Depth, ft	20
Detention time, hr	5.0
Number of aerators per basin	Fine Bubble Diffusion
Blowers	
Number	2
Capacity, scfm	19,000
Secondary Clarifiers	
Units 1 and 2	
Diameter, ft	110
Side water depth, ft	10
Weir loading rate, gpd per lin ft	7,879
Detention time, hr	3.41
Unit 3 and 4	
Diameter, ft	130
Side water depth, ft	12.0

Table B-1 Theresa Street WWTP Liquid Stream Process Data

Existing Treatment Units	Design Data[a]
Weir loading rate, gpd per lin ft	9,660
Detention time, hr	3.8
Return Sludge Pumps	
Secondary Clarifiers 1 and 2	
Number	3
Rated head, ft	9
Rated capacity at rated head, mgd	5.0
Motor size, hp	20
Secondary Clarifiers 3 and 4	
Number	3
Rated head, ft	20
Rated capacity at rated head, mgd	7.5
Motor size, hp	40
DISINFECTION	
Chlorine Contact Basin	
Number	2
Design flow per unit, mgd	15
Unit size, ft	100 x 50
Depth, ft	10
Detention time, min	35

Table B-2 Solids Handling and Disposal Facilities at Theresa Street WWTP

Existing unit process	Design data
Primary Sludge and Scum Pumps	
Primary Clarifiers 1 and 2	
Number	2
Rated capacity, gpm	85
Motor size, hp	5
Primary Clarifiers 3 and 4	
Rated head, ft	2
Rated capacity at rated head, gpm	80
Motor size, hp	5
Primary Clarifiers 5 and 6	
Rated head, ft	3
Rated capacity at rated head, gpm	100
Motor size, hp	125
	15
Waste Activated Sludge Pumps	
Number	5
Rated head, ft	14
Rated capacity at rated head, gpm	200
Motor size, hp	2
Secondary Sludge and Scum Pumps	
Number	4
Rated head, ft	23.5
Rated capacity at rated head, gpm	100
Motor size, hp	2
Flotation Thickeners	
Number	3
Size, ft	11.5 x 41
Effective surface area per basin, sq ft	400
Thickened Sludge Pumps	
Number	2
Rated head, ft	100
Rated capacity at rated head, gpm	50-125
Motor size, hp	10
Anaerobic Digesters	
Number	3
Capacity, mg	1.1
Sludge Dewatering	
Belt Filters Press	
Number	3
Capacity, pounds per hour	3,300
Size, meter	3

Appendix C – Northeast NPDES Permit

STATE OF NEBRASKA

DEPARTMENT OF ENVIRONMENTAL CONTROL

KAY A. ORR
GOVERNOR

DENNIS GRAMS
DIRECTOR

RECEIVED

DEC 10 1987

Lincoln Wastewater
System

Steven
Gary
Scott

RECEIVED
DEC 8 1987
LINCOLN
PUBLIC WORKS
UTILITIES

December 4, 1987

WCD-P/C

RETURN RECEIPT REQUESTED

Mr. Richard Erixson
Director of Public Works
Lincoln Northeast WWTP
555 South Tenth Street
Lincoln, NE 68508

NPDES Number NE0112488
Location: Lincoln, Nebraska
Receiving Waters: Salt Creek

Dear Mr. Erixson:

Pursuant to the Federal Water Pollution Control Act, as amended (33 U.S.C. 466 et. seq.), the Nebraska Environmental Protection Act (Secs. 81-1504(11), (Reissue, 1981) and the State of Nebraska Department of Environmental Control, Rules and Regulations Pertaining to the Issuance of Permits Under the National Pollutant Discharge Elimination System, we have reissued and are enclosing your National Pollutant Discharge Elimination System (NPDES) Authorization to Discharge.

Your NPDES Authorization to Discharge includes general and special conditions which must be followed to remain in compliance with the requirements of the above-mentioned statutes and Rules and Regulations. Monitoring reports prescribed in the special conditions are required on a periodic basis. Questions and requests for additional monitoring reports should be directed to Department of Environmental Control, Permits and Compliance Section, (402) 471-2186.

Issuance of an NPDES Authorization to Discharge by the Department of Environmental Control does not relieve you of other duties and responsibilities under the Nebraska Environmental Protection Act or as amended, or any Rules and Regulations promulgated pursuant thereto.

Your continued cooperation in helping to improve and maintain the quality of Nebraska's waters is much appreciated.

Sincerely,

Dennis Grams, P.E.

JR/at

Enclosure

Permit Number NE0112488

DEPARTMENT OF ENVIRONMENTAL CONTROL
AUTHORIZATION TO DISCHARGE UNDER THE STATE OF NEBRASKA
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Water Pollution Control Act, as amended (33 U.S.C. 466 et. seq.), the Nebraska Environmental Protection Act [Neb. Rev. Stat. Secs. 81-1504(15)(25), 81-1505(3)(4)(5)(6) and (7), 81-1510(2), (Reissue 1981)], and the Rules and Regulations promulgated pursuant thereto.

Lincoln Northeast Wastewater Treatment Facility
Lincoln, Nebraska

is authorized to discharge from a facility located at

NE¼NW¼, Section 34, Township 11 North, Range 7 East, Lancaster County

to receiving waters named

Salt Creek

in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts I, II, and III hereof.

This permit shall become effective on December 5, 1987.

This permit and the authorization to discharge shall expire at midnight, December 4, 1992.

Signed this 4th day of December, 1987.

Director

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning December 5, 1987 and lasting through December 4, 1992 the permittee is authorized to discharge from all outfalls.

The discharge limitations are based on a flow of 8.0 million gallons per day (mgd).

Such discharges shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS Concentration in Mg/l 30 Day Average	7 Day Maximum	Kg/Day (Lbs/Day) 30 Day Average	7 Day Maximum	MONITORING REQUIREMENTS Measurement Frequency	Sample Type
Flow	-	-	-	-	Once Each Weekday (M-F)	Recorder
Biochemical Oxygen Demand (5-Day)	30	45	907.6(2001.6)	1361.6(3002.4)	Daily (1) Annually (2)	24-Hr Composite 24-Hr Composite
Total Suspended Solids	30	45	907.6(2001.6)	1361.6(3002.4)	Daily (1) Annually (2)	24-Hr Composite 24-Hr Composite
Fecal Coliform Colonies/100 ml	200	400	-	-	Daily (2)	Grab
Oil and Grease	-	10	-	302.6(667.2)	Daily	Grab
Total Residual Chlorine	-	-	-	-	Daily (2)	Grab
Ammonia as N	-	-	-	-	Daily	Grab

The pH shall be maintained between the range of 6.0 - 9.0 Standard Units. The value(s) shall be determined from a grab sample taken daily (1) and annually (2).

Sample taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Where the flow enters and exits the treatment facility.

Footnotes: Refer to Part I, B

B. FOOTNOTE(S)

The arithmetic mean of the values for effluent samples measuring biochemical oxygen demand (5-day) and suspended solids collected in a period of 30 consecutive days shall not exceed 15 percent of the arithmetic mean of the values for influent samples collected at approximately the same times during the same period (85 percent removal. minimum).

1. This is the minimum required measurement frequency for influent sampling.

2. To be taken at the designated measurement frequency during the disinfection season. The disinfection season is April 1 through September 30 of each year. During this period, effluent disinfection is required.

B. DISGESTED SLUDGE MONITORING FOR ULTIMATE DISPOSAL

During the period beginning December 5, 1987 and lasting through December 4, 1992 the permittee is authorized to discharg from all outfall(s).

Such discharge shall be limited and monitored by the permittee as specified below:

	DISCHARGE LIMITATIONS				MONITORING REQUIREMENTS	
	Concentration in mg/l		Kg/Day (Lbs/Day)		Measurement*	Sample
EFFLUENT CHARACTERISTIC	Daily Average	Daily Maximum	Daily Average	Daily Maximum	Frequency	Type
mmonia NH_3-N	-	-	-	-	As Injected	Grab
itrogen, Total	-	-	-	-	As Injected	Grab
itrate NO_3-N	-	-	-	-	As Injected	Grab
otassium K	-	-	-	-	As Injected	Grab
hosphorus PO_4 Ortho	-	-	-	-	As Injected	Grab
otal Solids	-	-	-	-	As Injected	Grab
admium Cd	-	-	-	-	Monthly	Grab
opper Cu	-	-	-	-	Monthly	Grab
hromium Cr	-	-	-	-	Monthly	Grab
ron Fe	-	-	-	-	Monthly	Grab
ead Pb	-	-	-	-	Monthly	Grab
ercury Hg	-	-	-	-	Monthly	Grab
ickel Ni	-	-	-	-	Monthly	Grab
inc An	-	-	-	-	Monthly	Grab
arium Ba	-	-	-	-	Annually	Grab
oron B	-	-	-	-	Annually	Grab
l Chloride ion	-	-	-	-	Annually	Grab
olybdenum Mo	-	-	-	-	Annually	Grab
odium Na	-	-	-	-	Annually	Grab
ulfur S	-	-	-	-	Annually	Grab

he pH shall be maintained between the range of 6.0 - 9.0 Standard Units. The value(s) shall be determined from a grab ample taken monthly.

ample taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): amples of digested sludge are to be obtained from the tap discharge of the injection sludge pump.

Sample only during months of injection.

C. SURFACE MONITORING REQUIREMENTS FOR SLUDGE DISPOSAL SYSTEM

During the period beginning December 5, 1987 and lasting through December 4, 1992 the permittee is authorized to discharg from all outfall(s).

Such discharge shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS Concentration in mg/l Daily Average	Daily Maximum	Kg/Day (Lbs/Day) Daily Average	Daily Maximum	MONITORING REQUIREMENTS Measurement Frequency	Sample Type
Chlorides	-	-	-	-	*Sample during ALL runoff events in which a sampler is activated.	Composite during on runoff event.
Total Organic Carbon TOC	-	-	-	-	"	"
Chemical Oxygen Demand COD	-	-	-	-	"	"
Ammonia NH_3	-	-	-	-	"	"
Nitrate NO_3	-	-	-	-	Annually	"
Phosphorus PO_4-Ortho	-	-	-	-	"	"
Total Suspended Solids	-	-	-	-	"	"
Copper Cu	-	-	-	-	"	"
Zinc Zn	-	-	-	-	"	"
Cadmium Cd	-	-	-	-	"	"
Iron Fe	-	-	-	-	"	"
Nickel Ni	-	-	-	-	"	"
Lead Pb	-	-	-	-	"	"

*Sample only during months of injection.

The pH shall be maintained between the range of 6.0 - 9.0 Standard Units. The value(s) shall be determined from a grab sample taken annually.

Sample taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): the site is divided into three plots: number I, II and III. Site activity will rotate between crop, injection and open. Samples will be taken from each of the three separate plots as required.

C. SURFACE MONITORING REQUIREMENTS FOR SLUDGE DISPOSAL SYSTEM

MONITORING ADDITIONS	ACTIVITY (Crop, Inject, Open)	CROP TYPE	MINIMUM MONITORING REQUIREMENTS Measurement Frequency	Sample Type
Plots I	Report Activity	Report Crop	Monthly	-
Plots II	Report Activity	Report Crop	Monthly	-
Plots III	Report Activity	Report Crop	Monthly	-
Rainfall	-	-	Monthly	Grab

The injection fields shall be protected from erosion by the residue from the previous crop or seeded to oats or Sudan grass during the summer to insure ground cover and to help control weed growth.

D. GROUNDWATER MONITORING

During the period beginning December 5, 1987 and lasting through December 4, 1992 the permittee shall sample the groundwater monitoring wells as specified below:

MONITORING CHARACTERISTIC	MONITORING REQUIREMENTS Measurement Frequency	Sample Type
Water Levels	Quarterly	Pump well for
pH	Quarterly	5 minutes, grab
NO_3 Nitrates	Quarterly	sample
PO_4 Phosphorus-Ortho	Quarterly	"
K Potassium	Quarterly	"
Fecals	Quarterly	"
Conductivity	Quarterly	"
Chloride Cl	Annually	"
Calcium Ca	Annually	"
Magnesium Mg	Annually	"
Alkalinity	Annually	"
Boron B	Annually	"
Sodium Na	Annually	"
Sulfur S	Annually	"
Barium Ba	Annually	"
Nickel Ni	Annually	"
Iron Fe	Annually	"

ample taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): bservation wells 1 through 5.

D. GROUNDWATER MONITORING

During the period beginning December 5, 1987 and lasting through December 4, 1992 the permittee shall sample the groundwater monitoring wells as specified below:

Such discharge shall be limited and monitored by the permittee as specified below:

MONITORING CHARACTERISTIC	MONITORING REQUIREMENTS Measurement Frequency	Sample Type
Mercury Hg	Annually	Pump well for 5
Lead Pb	Annually	minutes, grab
Cadmium Cd	Annually	sample
Zinc Zn	Annually	"
Copper Cu	Annually	"
Chromium Cr	Annually	"
Molybdenum Mo	Annually	"
Arsenic As	Annually	"
Selenium Se	Annually	"

Sample taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): observation wells 1 through 5.

A. OTHER REQUIREMENTS

1. The arithmetic mean of the values for effluent sampling measuring biochemical oxygen demand (5-day) and suspended solids collected in a period of 30 consecutive days shall not exceed 15 percent of the arithmetic mean of the values for influent sampled collected at approximately the same times during the same period (85 percent removal- minimum).

2. There shall be no discharge of floating solids or visible foam in other than trace amounts.

3. Sludge shall be disposed of or utilized in a manner approved by the Department of Environmental Control.

APPENDIX A - NPDES (Part III)

STANDARD CONDITIONS FOR NEBRASKA DEPARTMENT OF ENVIRONMENTAL CONTROL WATER AND WASTE MANAGEMENT PERMITS

SECTION A. MONITORING AND REPORTS

1. Representative Sampling

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge. All samples shall be taken at the monitoring points specified in this permit and, unless otherwise specified, before the effluent joins or is diluted by any other wastestream, body of water or substance. Monitoring points shall not be changed without notification to and the approval of the Director.

2. Flow Measurements

Appropriate flow measurement devices and methods consistent with accepted scientific practices shall be selected and used to insure the accuracy and reliability of measurements of the volume of monitored discharges. The devices shall be installed, calibrated and maintained to insure that the accuracy of the measurements are consistent with the accepted capability of that type of device. Devices selected shall be capable of measuring flows with a maximum deviation of less than ± 10% from true discharge rates throughout the range of expected discharge volumes. Guidance in selection, installation, calibration and operation of acceptable flow measurement devices can be obtained from the the following references:

1) "Water Measurement Manual". U. S. Dept. of Interior, Bureau of Reclamation, Second Edition, Revised Reprint, 1974, 327 pp. (Available from the U. S. Government Printing Office, Washington, D.C. 20402. Order by Catalog No. I27.19/2:W29/2, Stock No. S/N 24003-0027.)

2) "Flow Measurement in Open Channels and Closed Conduits". U. S. Department of Commerce, National Bureau of Standards, NBS Special Publication 484, October 1977, 982 pp. (Available in paper copy or microfiche from National Technical Information Service (NTIS), Springfield, VA, 22151. Order by NTIS No. PB-273 535/5ST.

3) "NPDES Compliance Sampling Manual". U. S. Environmental Protection Agency, Office of Water Enforcement, Publication MCD-51, 1977, 140 pp. (Available from the General Services Administration (SFFS), Centralized Mailing Lists Services, Building 41, Denver Federal Center, Denver, CO. 80225.

3. Reporting of Monitoring Results

Reporting Period: Calendar Quarter

Monitoring results obtained during the Reporting Period shall be summarized and reported on a Nebraska Department of Environmental Control Discharge Monitoring Report Form postmarked no later than the 28th day of the following the completed reporting period.

Reports due: January 28; April 28; July 28; October 28

Signed copies of these Reports shall be submitted to the Nebraska Department of Environmental Control at the following address:

Nebraska Department of Environmental Control
P. O. Box 94877, Statehouse Station
301 Centennial Mall South
Lincoln, NE 68509

4. Test Procedures

Test procedures for the analysis of pollutants shall conform to Nebraska Department of Environmental Control Rules and Regulations for Test Procedures for the Analysis of Pollutants Under the National Pollutant Discharge Elimination System. If those Rules and Regulations do not specify test procedures for any pollutant required to be monitored by this permit and until such Rules and Regulations are promulgated, sampling and analytical methods used to meet the monitoring requirements specified in this permit shall, unless otherwise specified by the Director, conform to the latest edition of the following references:

Standard Methods for the Examination of Water and Wastewater, 15th Edition, 1980, American Public Health Association, New York, NY, 10019.

A.S.T.M. Standards, Part 31, Water, 1975, American Society for Testing and Materials, Philadelphia, Pennsylvania, 19103.

Methods for Chemical Analysis of Water and Wastes, March, 1979, Environmental Protection Agency Water Quality Office, Analytical Quality Control Laboratory, NERC, Cincinnati, OH, 45268.

5. Additional Monitoring by the Permittee

If the permittee monitors any pollutant more frequently than required by this permit, using approved test procedures or as specified in this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR. Such increased frequency shall also be indicated.

6. Averaging of Measurements

Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified by the Director in the permit.

7. Retention of Records

The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least three years from the date of the sample, measurement, report or application. This period may be extended by request of the Director at any time.

8. Record Contents

Records of monitoring information shall include:

a) The date, exact place, time and methods of sampling or measurements;
b) Who performed the sampling or measurements;
c) The date(s) analyses were performed;
d) Who performed the analyses;
e) The analytical techniques or methods used; and
f) The results of such analyses.

SECTION B. OPERATION AND MAINTENANCE

1. Proper Operation and Maintenance

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems only when necessary to achieve compliance with the conditions of the permit.

2. Duty to Halt or Reduce Activity

Upon reduction, loss or failure of the treatment facility, the permittee shall, to the extent necessary to maintain compliance with its permit, control production or all discharges or both until the facility is restored or an alternative method of treatment is provided. This requirement applies, for example, when the primary source of power of the treatment facility fails or is reduced or lost. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

3. Bypassing

Any diversion from or bypass of the treatment facilities is prohibited unless:

(a) It is unavoidable to prevent loss of life, personal injury or severe property damage.

(b) No feasible alternative exists, i.e. retention of untreated waste.

(c) The permittee submits notice to the Director within 24 hours of becoming aware of the bypass, or if the bypass is anticipated the Director is notified ten (10) days prior to the bypass.

(d) The bypass is conducted under conditions determined to be necessary by the Director to minimize any adverse effects.

If the bypass is needed for regular preventative maintenance for which backup equipment should be provided, the bypass will not be allowed. When a bypass occurs, the burden is on the permittee to demonstrate compliance with items (a) through (d) above.

4. Removed Substances

Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall be disposed of at a site and in a manner approved by the Nebraska Department of Environmental Control.

SECTION C. REPORTING REQUIREMENTS

1. Change in Discharge

All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit. Any anticipated facility expansions, production increase, or process modifications which will result in new, different, or increased discharges or pollutants must be reported by the permittee in 180 days prior to the expansion, increases, or modifications, by submission of a new permit application or, if such changes will not violate the effluent limitations specified in this permit, by notice to the permit issuing authority of such changes. Following such notice, the permit may be modified to specify and limit any pollutants not previously limited.

2. Noncompliance Notification

If, for any reason, the permittee does not comply with or will be unable to comply with any daily maximum or weekly average effluent limitation specified in this permit, the permittee shall report to the Department of Environmental Control on a Noncompliance Report Form, within seven (7) days of becoming aware of such conditions, and in the case of any discharge subject to any applicable toxic pollutant effluent standards under Section 307(a) of the Federal Act or other discharges which constitute a threat to human health, welfare, or the environment, shall report to the Department of Environmental Control on a Noncompliance Report Form within 24 hours from the time the permittee becomes aware of the circumstances.

The permittee shall provide:

(a) A description of the discharge and cause of noncompliance; and

(b) The period of noncompliance, including exact dates and times; or if not corrected, the anticipated time the noncompliance is expected to continue, and steps taken to reduce, eliminate, and prevent recurrence of the noncomplying discharge.

have access to and copy, at reasonable times, any records that
ired under the conditions of this permit;

) Inspect at reasonable times any facilities, equipment (including
ring and control equipment), practices, or operations regulated or
ed under this permit;

) Sample or monitor, at reasonable times, for the purposes of
ng permit compliance, any substances or parameters at any location.

) Inspect any production, manufacturing, fabricating or storage
here pollutants, regulated under the permit, could originate.

tions

ass bypass--when the permittee knows in advance of the need for a

Average--Discharge means the total discharge by weight during a
ar month divided by the number of days in the month that the
tion or facility was operating. Where less than daily sampling
uired by this permit, the daily average discharge shall be deter-
by the summation of all the measured daily discharges by weight
d by the number of days during the calendar month when the measure-
were made.

Maximum--Discharge means the total discharge by weight during any
ar day.

m Concentration--The maximum concentration is the concentration in
ngle grab sample.

ample--An individual sample collected in less than 15 minutes.

ite Sample--A combination of individual samples obtained at regular
als over a time period. Either the volume of each individual
is proportional to flow rate during sample period (flow composite)
stant volume samples are collected at equal time intervals during
ite period (time composite).

Water--Uncontaminated: Water used for cooling purposes only
s no direct contact with any raw material, intermediate, or final
, and which does not contain a level of contaminants detectably
than that of the intake water. Contaminated: Water used for
g purposes only which may become contaminated either through the
water treatment chemicals used for corrosion inhibitors or biocides,
direct contact with process materials and/or wastewater.

y Average--Other than for fecal coliform bacteria, is the arithmetic
f the values for effluent samples collected in a period of 30 con-
ve days. The monthly average for fecal coliform bacteria is the
etric mean of the value of the effluent samples collected in a period
consecutive days.

Average--Other than for fecal coliform bacteria, is the arithmetic
f the values for effluent samples collected in a period of seven
utive days. The weekly average for fecal coliform bacteria is
metric mean of the values for effluent samples collected in a
of seven consecutive days.

ly--Once every other week.

nly--Once every other month.

ble Pollutants--Are biochemical oxygen demand, suspended solids,
fecal coliform bacteria, plus additional pollutants identified
NPDES permit if the publicly owned treatment works was designed
t such pollutants, and in fact does remove such pollutants to a
ntial degree, e.g., nitrogen and phosphorus.

ttable Pollutant--Is any pollutant which is not a compatible
nt as defined above.

Contributing Industry--Is a wastewater source that:

) has a flow of 50,000 gallons or more per average workday;

) has a flow greater than five percent of the flow carried by the
al system receiving the waste;

) has in its waste a toxic pollutant in toxic amounts; or

) has significant impact, either singly or in combination with
contributing industries on the treatment works or the quality of
fluent.

Property Damage--Means substantial physical damage to property, damage
treatment facilities which causes them to become inoperable. Severe
damage does not mean economic loss caused by delays in production.

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

Upset--Means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee, excluding such factors as operational error, improperly designed or inadequate treatment facilities, or improper operation and maintenance or lack thereof.

Bypass--Means the intentional diversion of wastes from any portion of a treatment facility.

Waters of the State--Means all waters within the jurisdiction of this state including all streams, lakes, ponds, impounding reservoirs, marshes, watercourses, waterways, wells, springs, irrigation systems, drainage systems, all other bodies or accumulations of water, surface and underground, natural or artificial, public or private, situated wholly or partly within or bordering upon the state.

Appendix D – Summary of Northeast Treatment System Process Information

Table D-1 Northeast WWTP Design Data Summary

Existing treatment units	Design data[a]
PRELIMINARY TREATMENT	
Bar Screens	
Number	2
Clear opening, inch	0.75
Influent Pumping	
Number	3
Capacity, mgd	8
Aerated Grit Basins	
Number	2
Design flow per unit, mgd	5
Unit size, ft	15W x 25L x 13.25SWD
PRIMARY TREATMENT	
Primary Settling Tanks	
Number	2
Diameter, ft	90
Side water depth, ft	11.9
Weir loading rate, gpd per lin ft	7,717
Redwood Towers	
Number	2
Total media area, sf	3,630
Media depth, ft	14
Average daily biological loading lb/1000cf	154
SECONDARY TREATMENT	
Aeration Basins	
Number	2
Diameter, ft	79
Side water depth, ft	16
Detention time:	
One basin in operation	1.75
Two basins in operation	3.50
Aerator type	Fine Bubble Diffusion
Blower Building (Compressed Air System)	
Aeration	3
Capacity per unit, scfm	1.325
Motor size, hp	125
Final Settling Tanks	
Number	2
Diameter, ft	90
Side water depth, ft	10
Total weir perimeter, lin ft	264
Weir loading, gpd/lin ft	15,158

Table D-1 Northeast WWTP Design Data Summary

Existing treatment units	Design data[a]
Recirculation Pumping Station	
Number	3
Rated head, ft	33
Rated capacity at rated head, mgd	10.0
Motor size, hp	100
Return Sludge Pumps	
Number	3
Rated head, ft	9
Rated capacity at rated head, mgd	5.0
Motor size, hp	20
DISINFECTION	
Chlorine Contact Basin	
Number	2
Design flow per unit, mgd	6
Depth, ft	10
Volume, cu ft	23,040
Rapid mixers	2
Motor, hp	5
SOLIDS PROCESSING EQUIPMENT	
Primary Sludge and Scum Pumps	
Number	3
Rated capacity, gpm	50
Motor size, hp	5
Sludge Grinders	
Number	2
Line size connection, inch	6
Motor size, hp	7.5
Waste Activated Sludge Pumps	
Number	4
Rated head, ft	14.5
Rated capacity at rated head, gpm	350
Motor size, hp	3
WAS Storage	
Number	1
Volume	284,300 gal
Thickener Feed Pumps	
Number	2
Type	Progressive Cavity
Rated capacity at rated head, gpm	400
Max speed	250
WAS Thickeners	
Number	2

Table D-1 Northeast WWTP Design Data Summary

Existing treatment units	Design data[a]
Type	Rotary Drum
Rated capacity, gpm	400
TWAS Storage	
Number	1
Volume	71,100 gal
Anaerobic Digesters	
Primary digester, number	2
Diameter, ft	55
Sidewall depth, ft	23'-1"
Normal sidewater depth, ft	25
Cover type	submerged fixed cover
Sludge Mixing	
Number Total (1 ea digester)	2
Motor	20 HP, explosion proof
Mixer type	slow speed turbine
Rotation speed, rpm	17, reversible
Sludge Heat Heating	
Sludge HEX	
Number	2
Type	concentric tube
Capacity, BTU/hr	700,000
Rotation speed, rpm	17, reversible
Boilers	
Number	2
Type	
Capacity, BTU/hr	1,260,000
Digested Sludge Pumps	
Number	4
Type	progressing cavity
Rated total head, ft	92
Capacity at rated head, gpm	275
Operating speed, rpm	175
Motor size, hp	20
Digested Gas Storage	
Number	1
Type	double membrane
Capacity	35,000
Sludge Injector	
Tractor	
Fuel	diesel
Rated power (drawbar), hp	60
Track width, inch	30

Table D-1 Northeast WWTP Design Data Summary

Existing treatment units	Design data[a]
Plow-Injector	
Number	14
Injection Field	
Size, acres (ha)	440 (178)
Number of field connections	30
Sludge Holding Basin	
Number	1
Diameter, ft	60
Sidewall depth, ft	16
Usable sidewall depth, ft	13
Usable volume, gal	289,080
Sludge Storage Lagoon	
Area, sq ft	107,400
Max operating liquid depth, ft	12.5
Capacity, mil gal	8
Sludge Injection Pump	
Number	1
Rated total head, ft	162
Capacity at rated head, gpm	700
Motor size, hp	50
Dredge Pump	
Number	1
Type	vertical centrifugal
Rated total head, ft	20
Capacity at rated head, gpm	1,100
Motor size, hp	25

Red indicates capacities to be verified.

Appendix E – Hydraulic Modeling Information

TECHNICAL MEMORANDUM

RE: Hydraulic Profiles for Theresa Street and Northeast WWTP

TO: Drury Whitlock

FROM: Mark Richards

DATE: August 28, 2001

Theresa Street – East Side

Calibration: Calibration was performed at 22.5 mgd through existing system. (15 mgd through Eastside and 7.5 mgd though Westside)

RAS: 50 percent RAS flow of baseflow was assumed.

Aeration Recirculation:. No aeration recirculation was included for calibrations. 8-mgd aeration recirculation was used for the capacity runs.

Capacity: Capacity runs were performed at 16.6,20,26.6, and 33.4 mgd through the Eastside.

Conclusion: This section was very difficult to calibrate. Many of the water surfaces in the hydraulic profile appear to be speculative, and require entering friction coefficients well outside of the range of normal operations.

Summary of Results

Element	Flow (mgd)	Weir Elev. (ft)	Top of Wall Elev. (ft)	Water Surface (ft)
Final Junction MH	16.6		46	45.06
	20			45.18
	26.6			45.69
	33.4			45.92
Final Channel in Chlorine Tank (below weir)	16.6	45.33	47.5	45.71
	20			46.13
	26.6			47.37
	33.4			48.53
Initial Channel in Chlorine Tank	16.6		47.5	46.49
	20			46.90
	26.6			47.94
	33.4			49.10
Distribution Box No. 2	16.6		48	46.93
	20			47.38
	26.6			48.77
	33.4			50.43
Launder in Final Clarifier (below weir)	16.6	48	49.5	47.08
	20			47.56
	26.6			49.07
	33.4			50.91
Weir in Final Clarifier (above weir)	16.6	48	49.5	47.97
	20			47.98
	26.6			49.07
	33.4			50.91

Element	Flow (mgd)	Weir Elev. (ft)	Top of Wall Elev. (ft)	Water Surface (ft)
End of Aeration Basin (below weir)	16.6	50.33	56.5	48.65
	20			48.96
	26.6			50.82
	33.4			53.64
Initial Basin in Aeration Basin	16.6		56.5	51.44
	20			51.50
	26.6			51.66
	33.4			53.65
Launder in Primary Clarifier (below weir)	16.6	54.0	55.5	52.34
	20			52.46
	26.6			52.67
	33.4			54.48
Weir in Primary Clarifier (above weir)	16.6	54.0	55.5	53.94
	20			53.94
	26.6			53.96
	33.4			54.48
Distribution Box No. 1	16.6	56.75	61.5	54.34
	20			54.53
	26.6			55.00
	33.4			56.11
Final Channel in Aerated Grit Basin (below weir)	16.6	58.75	61.5	58.61
	20			59.28
	26.6			60.95
	33.4			63.05
Initial Channel in Aerated Grit Basin (above weir)	16.6	60.5	61.5	61.40
	20			61.52
	26.6			61.89
	33.4			63.38

Major Elements:

Final Junction MH

Channel in Chlorine Tank : water surface was less that 0.5 from top of wall at 26.6 mg d

Final Clarifier : the water surface was within 0.5 ft top of wall at 26.6 mgd and overflowed wall at 33.4 mgd. The initial channel overflowed wall at 20 mgd.

Distribution Box No. 2: water surface overflowed wall at 26.6 mgd

Final Clarifier : water surface was within 0.5 ft from top of wall at 26.6 mgd and overflowed wall at 33.4 mgd . Launder and weir are submerged at 26.6 mgd

Aeration Basin: final weir is submerged at 26.6 mgd

Primary Clarifier Launder and weir are submerged at 33.4 mgd

Distribution Box No. 1: no problems at 33.4 mgd

Aerated Grit Basin . Final weir is submerged at 20 mgd and water surface overflowed top of wall at 20 mgd in the initial channel.

Theresa Street – West Side

Calibration: no calibration was performed, as there was no water surface data against which to calibrate.

RAS: 50 percent RAS flow of baseflow was assumed.

Aeration Recirculation: Assuming no internal recirculation

Capacity: Capacity Runs were performed at 7.5, 10.0, 12.5, and 15.0 mgd.

Conclusion: Since no data was available from which to calibrate, the results of the is hydraulic profile should no be used for design or operation purposes. Typical friction loss coefficient values were chosen.

Summary of Results

Element	Flow (mgd)	Weir Elev. (ft)	Top of Wall Elev. (ft)	Water Surface (ft)
Final Junction MH	7.5		46	45.0
	10.0			45.18
	12.5			45.42
	15.0			45.70
Final Channel in Chlorine Tank (below weir)	7.5	45.33	47.5	45.53
	10.0			46.13
	12.5			46.89
	15.0			47.82
Initial Channel in Chlorine Tank	7.5		47.5	46.38
	10.0			46.90
	12.5			47.52
	15.0			48.39
Distribution Box No.1	7.5		48	46.73
	10.0			47.38
	12.5			48.27
	15.0			49.47
Junction Box (after Final Clarifier)	7.5			46.75
	10.0			47.42
	12.5			48.33
	15.0			49.55
Launder in Final Clarifier (below weir)	7.5	49.25	51.0	47.52
	10.0			47.56
	12.5			48.44
	15.0			49.69
Weir in Final Clarifier (above weir)	7.5	49.25	51.0	49.21
	10.0			49.22
	12.5			49.22
	15.0			49.69
Channel Junction Box (next to overflow)	7.5	53.0	55.0	49.44
	10.0			49.63
	12.5			49.87
	15.0			50.62
End of Aeration Basin (below weir)	7.5	53	55.0	49.60
	10.0			49.92
	12.5			50.32
	15.0			51.27

Element	Flow (mgd)	Weir Elev. (ft)	Top of Wall Elev. (ft)	Water Surface (ft)
Initial Basin in Aeration Basin (below weir)	7.5		55.0	53.5
	10.0			53.63
	12.5			53.76
	15.0			53.88
Distribution Box above Aeration Basin (next to overflow)	7.5	55.5	57.5	53.55
	10.0			53.71
	12.5			53.89
	15.0			54.07
Launder in Primary Clarifier (below weir)	7.5	57.4	58.5	56.11
	10.0			56.21
	12.5			56.31
	15.0			56.42
Weir in Primary Clarifier (above weir)	7.5	57.4	58.5	57.41
	10.0			57.42
	12.5			57.43
	15.0			57.43
Final Channel in Aerated Grit Basin (below weir)	7.5		60.86	57.50
	10.0			57.57
	12.5			57.66
	15.0			57.77
Initial Aerated Grit Basin	7.5		60.86	60.83
	10.0			60.91
	12.5			60.98
	15.0			61.06

Major Elements

Final Junction MH : water surface is less 0.5-ft from top of wall at 15.0 mgd

Chlorine Tank : water surface in main channel overflowed wall at 15.0 mgd and overflowed wall at 12.5 mgd in initial channel

Distribution Box No.1: water surface overflowed wall at 12.5 mgd

Junction Box (after Final Clarifier): more data on top of wall elevation is needed.

Final Clarifier launder and weir are submerged at 15.0 mgd

Channel Junction Box: no problem at 15.0 mgd

Aeration Basin : no problem at 15.0 mgd

Distribution Box : no problem at 15.0 mgd

Primary Clarifier : no problem at 15.0 mgd

Aerated Grit Basin : water surface overflowed wall at 10.0 mgd

Northeast WWTP

Calibration: calibration was performed at 16 and 8 mgd against the flows shown on the hydraulic profile.

RAS: A 50 percent RAS flow rate of the base flow was assumed through the aeration basins.

Aeration Recirculation: No recirculation though the aeration was used.

Tower Recirculation : 12 mgd recirculation through the tower was run with 8 mgd and 4 mgd was run with 16-mgd baseflow. For the capacity runs 25 percent of the baseflow was used.

Capacity: Capacity runs were run for 20 ,35, and 50 mgd. Area highlighted in yellow are problem areas.

Conclusion: This process train calibrated well when typical friction loss coefficients were used.

Summary of Results:

Element	Flow (mgd)	Weir Elev. (ft)	Top of Wall Elev. (ft)	Water Surface (ft)
Final Junction MH	20		33.5	31.84
	35			32.01
	50			32.28
Final Channel in Chlorine Tank (below weir)	20	33.25	35.75	32.16
	35			33.01
	50			34.32
Mixing Channel in Chlorine Tank	20		35.75	33.90
	35			34.20
	50			34.77
Launder in Final Clarifier (below weir)	20	35.75	37.25	34.32
	35			34.83
	50			35.64
Weir in Final Clarifier (above weir)	20	35.75	37.25	35.81
	35			35.87
	50			35.91
Channel in Final Distr. Box	20		41.0	36.03
	35			36.52
	50			37.24
End of Aeration Basin (below weir)	20	37.25	40.2	36.23
	35			37.15
	50			38.53
Prim. Distribution Box (below weir)	20	38.5	42.0	37.51
	35			37.94
	50			40.02
Tower (water above floor)	20		Bottom of media = 42.0	40.68
	35			41.32
	50			43.62
Launder in Primary Clarifier (below weir)	20	39.75	41.25	38.46
	35			39.03
	50			39.51
Weir in Primary Clarifier (above weir)	20	39.75	41.25	39.74
	35			39.77
	50			39.81

Element	Flow (mgd)	Weir Elev. (ft)	Top of Wall Elev. (ft)	Water Surface (ft)
Final Channel in Aerated Grit Basin (below weir)	20	40.75	42.5	39.84
	35			40.08
	50			40.42
Aerated Grit Basin (above weir)	20	40.75	42.5	41.24
	35			41.46
	50			41.65
Parshall Flume	20		45	43.91
	35			45.05
	50			46.06

Major Elements

Final Junction MH : Appears to have no problem at 50 mgd

Chlorine Tank: final weir was submerged at 50 mgd

Final Clarifier : Launder and weir are submerged at 50 mgd

Final Distribution. Box : no problem at 50 mgd

Aeration Basin : final weir is submerged at 50 mgd

Primary Distribution Box : weir is submerged at 50.0 mgd

Tower: water surface is greater than bottom of media at 50 mgd

Primary Clarifier : no problems at 50.0 mgd

Aerated Grit Basin : no problems at 50 mgd

Parshall Flume: water surface upstream of flume is greater than top of wall at 35.0 mgd.

HYDRAULIC ANALYSIS - PROFILE® MODEL

Theresa Street Eastside 22.5 MGD Model Input (Example)
Theresa Street Eastside 22.5 MGD Detailed Output (Example)
Theresa Street Eastside 22.5 MGD Summary Output
Theresa Street Eastside 25.0 MGD Summary Output
Theresa Street Eastside 30.0 MGD Summary Output
Theresa Street Eastside 40.0 MGD Summary Output
Theresa Street Eastside 50.0 MGD Summary Output
Theresa Street Westside 7.5 MGD Summary Output
Theresa Street Westside 10.0 MGD Summary Output
Theresa Street Westside 12.5 MGD Summary Output
Theresa Street Westside 15.0 MGD Summary Output
Northeast Influent to Before Tower 8.0 MGD Summary Output
Northeast Influent to Before Tower 16.0 MGD Summary Output
Northeast Influent to Before Tower 20.0 MGD Summary Output
Northeast Influent to Before Tower 35.0 MGD Summary Output
Northeast Influent to Before Tower 50.0 MGD Summary Output
Northeast Tower to Outfall 8.0 MGD Summary Output
Northeast Tower to Outfall 16.0 MGD Summary Output
Northeast Tower to Outfall 20.0 MGD Summary Output
Northeast Tower to Outfall 35.0 MGD Summary Output
Northeast Tower to Outfall 50.0 MGD Summary Output

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BBBBB      CCC      BROWN AND CALDWELL
BBBBBB    CCCCC     Consulting Engineers
BB  BBB  CCC CCC
BB   BB  CC   CC    PROFILE        SERIAL NO. 9901
BB  BBB  CC   CC    Version 2.00
BBBBBB   CC
BBBBB    CC         File name: C:\PROFIL~2\EASTSI~1.SUM
BBBBBB   CC         Data file: C:\PROFIL~2\EASTSI~1.PRO
BB  BBB  CC   CC    THERESA STREET WWTP
BB   BB  CC   CC    EAST SIDE 1971
BB  BBB  CC   CC    LINCOLN
BBBBBB    CCCCC
BBBBB      CCC      8/13/01              By:MARK RICHARDS
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PLANT FLOW = 38.68 CFS OR 25.00 MGD

DOWNSTREAM CONDITIONS:
ENERGY GRADE = 44.77 FEET
HYDRAULIC GRADE = 44.77 FEET

ELEMENT	DESCRIPTION		HYDRAULIC GRADE	ENERGY GRADE
A740	FIRST CHANNEL IN GRIT CHAM		61.40	61.40
A650	CHANNEL IN AERATED GRIT TANK		59.76	59.76
A610	FINAL CHAN IN AERATED GRIT CHA		58.61	58.61
A580	FIRST CHANNEL IN DIST BOX #1		57.22	57.22
A565	CHANNEL AFTER WEIR IN DIST BOX		54.34	54.34
A510	WEIR PLATE IN PRIMARY CLR		53.94	53.94
	FREE DISCHARGE, FREEBOARD	1.49		
	V-NOTCH INVERT	53.83		
A500	EFFLUENT LAUNDER IN PRIMARY CL		52.34	52.34
A490	DROP BOX AFTER PRIM CLR		51.61	51.61
A450	ZONE#1 IN AEARATION BASIN		51.42	51.44
A380	ZONE 3 IN AEARION BASIN		50.65	50.65
A320	MIXED LIQUOR CH IN AERATION BA		48.65	48.65
A270	WEIR PLATE IN FINAL CHL		47.97	47.97
	FREE DISCHARGE, FREEBOARD	.75		
	V-NOTCH INVERT	47.83		
A260	COLLECTION LAUNDER IN FINAL CH		47.08	47.08

A255	DROP BOX AFTER FINAL CLR	47.02	47.02
A210	DIST BOX #2	46.92	46.93
A180	FIRST CHANNEL IN CHL TANK	46.59	46.59
A150	1ST PASS IN CHL TANK	46.49	46.49
A80	FINAL CHANNEL IN CHL TANK	45.71	45.71
A40	JUNCTION BOX BEFORE CREEK	45.05	45.06

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BBBBB      CCC      BROWN AND CALDWELL
BBBBBB    CCCCC     Consulting Engineers
BB  BBB  CCC CCC
BB   BB  CC   CC    PROFILE        SERIAL NO. 9901
BB  BBB  CC   CC    Version 2.00
BBBBBB   CC
BBBBB    CC         File name: C:\PROFIL~2\EASTSI~2.SUM
BBBBBB   CC         Data file: C:\PROFIL~2\EASTSI~3.PRO
BB  BBB  CC   CC    THERESA STREET WWTP
BB   BB  CC   CC    EAST SIDE 1971
BB  BBB  CC   CC    LINCOLN
BBBBBB    CCCCC
BBBBB      CCC      8/13/01              By:MARK RICHARDS
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PLANT FLOW = 46.42 CFS OR 30.00 MGD

DOWNSTREAM CONDITIONS:
ENERGY GRADE = 44.77 FEET
HYDRAULIC GRADE = 44.77 FEET

ELEMENT	DESCRIPTION		HYDRAULIC GRADE	ENERGY GRADE
A740	FIRST CHANNEL IN GRIT CHAM		61.52	61.52
A650	CHANNEL IN AERATED GRIT TANK		59.99	59.99
A610	FINAL CHAN IN AERATED GRIT CHA		59.28	59.28
A580	FIRST CHANNEL IN DIST BOX #1		57.28	57.28
A565	CHANNEL AFTER WEIR IN DIST BOX		54.53	54.53
A510	WEIR PLATE IN PRIMARY CLR		53.94	53.94
	FREE DISCHARGE, FREEBOARD	1.37		
	V-NOTCH INVERT	53.83		
A500	EFFLUENT LAUNDER IN PRIMARY CL		52.46	52.46
A490	DROP BOX AFTER PRIM CLR		51.74	51.75
A450	ZONE#1 IN AEARATION BASIN		51.48	51.50
A380	ZONE 3 IN AEARION BASIN		50.72	50.72
A320	MIXED LIQUOR CH IN AERATION BA		48.96	48.96
A270	WEIR PLATE IN FINAL CHL		47.98	47.98
	FREE DISCHARGE, FREEBOARD	.27		
	V-NOTCH INVERT	47.83		
A260	COLLECTION LAUNDER IN FINAL CH		47.56	47.56

A255	DROP BOX AFTER FINAL CLR	47.52	47.52
A210	DIST BOX #2	47.38	47.38
A180	FIRST CHANNEL IN CHL TANK	46.90	46.90
A150	1ST PASS IN CHL TANK	46.75	46.75
A80	FINAL CHANNEL IN CHL TANK	46.12	46.13
A40	JUNCTION BOX BEFORE CREEK	45.18	45.18

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BBBBB      CCC      BROWN AND CALDWELL
BBBBBB    CCCCC     Consulting Engineers
BB  BBB  CCC CCC
BB   BB  CC   CC    PROFILE        SERIAL NO. 9901
BB  BBB  CC   CC    Version 2.00
BBBBBB   CC
BBBBB    CC         File name: C:\PROFIL~2\EASTSI~3.SUM
BBBBBB   CC         Data file: C:\PROFIL~2\EASTSI~4.PRO
BB  BBB  CC   CC    THERESA STREET WWTP
BB   BB  CC   CC    EAST SIDE 1971
BB  BBB  CC   CC    LINCOLN
BBBBBB    CCCCC
BBBBB      CCC      8/13/01              By:MARK RICHARDS
```

PLANT FLOW = 61.89 CFS OR 40.00 MGD

DOWNSTREAM CONDITIONS:
ENERGY GRADE = 44.77 FEET
HYDRAULIC GRADE = 44.77 FEET

ELEMENT	DESCRIPTION		HYDRAULIC GRADE	ENERGY GRADE
A740	FIRST CHANNEL IN GRIT CHAM		61.89	61.89
A650	CHANNEL IN AERATED GRIT TANK		61.14	61.14
A610	FINAL CHAN IN AERATED GRIT CHA		60.94	60.95
A580	FIRST CHANNEL IN DIST BOX #1		57.39	57.39
A565	CHANNEL AFTER WEIR IN DIST BOX		54.99	55.00
A510	WEIR PLATE IN PRIMARY CLR		53.96	53.96
	FREE DISCHARGE, FREEBOARD	1.16		
	V-NOTCH INVERT	53.83		
A500	EFFLUENT LAUNDER IN PRIMARY CL		52.67	52.67
A490	DROP BOX AFTER PRIM CLR		52.09	52.11
A450	ZONE#1 IN AEARATION BASIN		51.63	51.66
A380	ZONE 3 IN AEARION BASIN		51.05	51.05
A320	MIXED LIQUOR CH IN AERATION BA		50.82	50.82
A270	WEIR PLATE IN FINAL CHL		49.07	49.07
	WEIR SUBMERGED, W.S. DS	49.07		
	V-NOTCH INVERT	47.83		
A260	COLLECTION LAUNDER IN FINAL CH		49.07	49.07

A255	DROP BOX AFTER FINAL CLR	49.00	49.01
A210	DIST BOX #2	48.76	48.77
A180	FIRST CHANNEL IN CHL TANK	47.91	47.91
A150	1ST PASS IN CHL TANK	47.65	47.65
A80	FINAL CHANNEL IN CHL TANK	47.35	47.37
A40	JUNCTION BOX BEFORE CREEK	45.68	45.69

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BBBBB      CCC      BROWN AND CALDWELL
BBBBBB    CCCCC     Consulting Engineers
BB  BBB  CCC CCC
BB   BB  CC   CC    PROFILE        SERIAL NO. 9901
BB  BBB  CC   CC    Version 2.00
BBBBBB   CC
BBBBB    CC         File name: C:\PROFIL~2\EASTSI~4.SUM
BBBBBB   CC         Data file: C:\PROFIL~2\EAF5C5~1.PRO
BB  BBB  CC   CC    THERESA STREET WWTP
BB   BB  CC   CC    EAST SIDE 1971
BB  BBB  CC   CC    LINCOLN
BBBBBB    CCCCC
BBBBB      CCC      8/13/01              By:MARK RICHARDS
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PLANT FLOW = 77.36 CFS OR 50.00 MGD

DOWNSTREAM CONDITIONS:
ENERGY GRADE = 44.77 FEET
HYDRAULIC GRADE = 44.77 FEET

ELEMENT	DESCRIPTION		HYDRAULIC GRADE	ENERGY GRADE
A740	FIRST CHANNEL IN GRIT CHAM		63.37	63.38
A650	CHANNEL IN AERATED GRIT TANK		63.10	63.10
A610	FINAL CHAN IN AERATED GRIT CHA		63.04	63.05
A580	FIRST CHANNEL IN DIST BOX #1		57.49	57.49
A565	CHANNEL AFTER WEIR IN DIST BOX		56.10	56.11
A510	WEIR PLATE IN PRIMARY CLR		54.48	54.48
	WEIR SUBMERGED, W.S. DS	54.48		
	V-NOTCH INVERT	53.83		
A500	EFFLUENT LAUNDER IN PRIMARY CL		54.48	54.48
A490	DROP BOX AFTER PRIM CLR		54.37	54.38
A450	ZONE#1 IN AEARATION BASIN		53.66	53.68
A380	ZONE 3 IN AEARION BASIN		53.65	53.65
A320	MIXED LIQUOR CH IN AERATION BA		53.64	53.64
A270	WEIR PLATE IN FINAL CHL		50.91	50.91
	WEIR SUBMERGED, W.S. DS	50.91		
	V-NOTCH INVERT	47.83		
A260	COLLECTION LAUNDER IN FINAL CH		50.91	50.91

A255	DROP BOX AFTER FINAL CLR	50.80	50.81
A210	DIST BOX #2	50.43	50.43
A180	FIRST CHANNEL IN CHL TANK	49.09	49.10
A150	1ST PASS IN CHL TANK	48.68	48.68
A80	FINAL CHANNEL IN CHL TANK	48.51	48.53
A40	JUNCTION BOX BEFORE CREEK	45.90	45.92

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BBBBB      CCC      BROWN AND CALDWELL
BBBBBB    CCCCC     Consulting Engineers
BB  BBB  CCC CCC
BB   BB  CC   CC    PROFILE        SERIAL NO. 9901
BB  BBB  CC   CC    Version 2.00
BBBBBB   CC
BBBBB    CC         File name: C:\PROFIL~2\EASTSIDE.det
BBBBBB   CC         Data file: C:\PROFIL~2\EASTSIDE.pro
BB  BBB  CC   CC    THERESA STREET WWTP
BB   BB  CC   CC    EAST SIDE 1971
BB  BBB  CC   CC    LINCOLN
BBBBBB    CCCCC
BBBBB      CCC      8/13/01              By:MARK RICHARDS


PLANT FLOW =     34.81 CFS OR     22.50 MGD

DOWNSTREAM CONDITIONS:
    ENERGY GRADE =        44.77 FEET
    HYDRAULIC GRADE =     44.77 FEET



F10
FULL FLOW THROUGH PLANT
 FLOW PERCENT
    FLOW =    34.81 CFS OR     22.50 MGD
           100.00 PERCENT OF TOTAL PLANT FLOW.

A10
OUTFALL AT SALT CREEK
"K"LOSS IN FULL ROUND PIPE
    LOSS COEFFICIENT K =   1.000
    PIPE DIAMETER =        48.00 INCHES
    INVERT ELEVATION =    24.500

    VELOCITY =    2.77 FT/SEC
    ENERGY LOSS, FEET =    .119
    ENERGY GRADE =       44.889
    HYDRAULIC GRADE =    44.770

A20
48" PIPE FROM JB TO OUTFALL
DARCY-WEISBACH FRICTION
    PIPE DIAMETER =    48.0000INCHES
    ROUGHNESS =       .0025 FEET
    LENGTH =   100.0000 FEET

    VELOCITY, FPS =    2.77
    REYNOLDS NUMBER =    910530.
    DARCY-WEISBACH FRICTION FACTOR =     .0184
    EQUIVALENT HAZEN WILLIAMS C =     122.
    EQUIVALENT MANNING COEFFICIENT =   .0126
    ENERGY LOSS, FEET =    .055
    ENERGY GRADE =       44.944
    HYDRAULIC GRADE =    44.825
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A30
EXIT FROM JB
"K"LOSS IN FULL ROUND PIPE
LOSS COEFFICIENT K = .500
PIPE DIAMETER = 48.00 INCHES
INVERT ELEVATION = 30.000

VELOCITY = 2.77 FT/SEC
ENERGY LOSS, FEET = .060
ENERGY GRADE = 45.004
HYDRAULIC GRADE = 44.884

A40
JUNCTION BOX BEFORE CREEK
RECTANGULAR CONDUIT
HEIGHT = 16.00 FEET
WIDTH = 4.00 FEET
LENGTH= 6.00 FEET
MANNING ROUGHNESS = .0130
SLOPE = .00000 FEET/FOOT
NUMBER OF ANALYSIS SECTIONS = 20.00
INVERT ELEV AT OUTLET = 30.000

SUBCRITICAL FLOW

STATION FEET	WATER DEPTH FEET	VELOCITY FT/SEC	FRICTION FACTOR FT/FOOT	AVERAGE FRICTION FACTOR FT/FOOT	FRICTION LOSS FEET	HYDRAULIC GRADE	ENERGY GRADE
.000	14.998	.580	.00001			44.998	45.004
.300	14.998	.580	.00001	.00001	.000	44.998	45.004
.600	14.998	.580	.00001	.00001	.000	44.998	45.004
.900	14.998	.580	.00001	.00001	.000	44.998	45.004
1.200	14.998	.580	.00001	.00001	.000	44.998	45.004
1.500	14.998	.580	.00001	.00001	.000	44.998	45.004
1.800	14.998	.580	.00001	.00001	.000	44.998	45.004
2.100	14.998	.580	.00001	.00001	.000	44.998	45.004
2.400	14.998	.580	.00001	.00001	.000	44.998	45.004
2.700	14.998	.580	.00001	.00001	.000	44.998	45.004
3.000	14.998	.580	.00001	.00001	.000	44.998	45.004
3.300	14.998	.580	.00001	.00001	.000	44.998	45.004
3.600	14.998	.580	.00001	.00001	.000	44.998	45.004
3.900	14.998	.580	.00001	.00001	.000	44.998	45.004
4.200	14.998	.580	.00001	.00001	.000	44.998	45.004
4.500	14.998	.580	.00001	.00001	.000	44.998	45.004
4.800	14.998	.580	.00001	.00001	.000	44.998	45.004
5.100	14.998	.580	.00001	.00001	.000	44.998	45.004
5.400	14.998	.580	.00001	.00001	.000	44.998	45.004
5.700	14.998	.580	.00001	.00001	.000	44.998	45.004
6.000	14.998	.580	.00001	.00001	.000	44.998	45.004

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    CRITICAL SLOPE, FT/FT = .0044
    CRITICAL DEPTH, FEET =   1.33
    CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET =  .000
    ENERGY LOSS, FEET =   .000

    INLET CONDITIONS:
       ENERGY GRADE =       45.004
       HYDRAULIC GRADE =    44.998

F15
FULL FLOW FROM BOTH TRAINS
 FLOW PERCENT
    FLOW =    34.81 CFS OR     22.50 MGD
           100.00 PERCENT OF TOTAL PLANT FLOW.

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A50
ENTRANCE INTO JB
"K"LOSS IN FULL ROUND PIPE
    LOSS COEFFICIENT K =   2.200
    PIPE DIAMETER =        48.00 INCHES
    INVERT ELEVATION =    37.000

    VELOCITY =    2.77 FT/SEC
    ENERGY LOSS, FEET =    .262
    ENERGY GRADE =       45.266
    HYDRAULIC GRADE =    45.147

A60
48" PIPE FROM CHL TANK TO JB
DARCY-WEISBACH FRICTION
    PIPE DIAMETER =    48.0000INCHES
    ROUGHNESS =      .0055 FEET
    LENGTH =    15.0000 FEET

    VELOCITY, FPS =    2.77
    REYNOLDS NUMBER =    910530.
    DARCY-WEISBACH FRICTION FACTOR =     .0219
    EQUIVALENT HAZEN WILLIAMS C =     111.
    EQUIVALENT MANNING COEFFICIENT =   .0137
    ENERGY LOSS, FEET =    .010
    ENERGY GRADE =       45.276
    HYDRAULIC GRADE =    45.156

A63
90 TURN IN PIPE
"K"LOSS IN FULL ROUND PIPE
    LOSS COEFFICIENT K =    .550
    PIPE DIAMETER =        48.00 INCHES
    INVERT ELEVATION =    37.000

    VELOCITY =    2.77 FT/SEC
    ENERGY LOSS, FEET =    .066
    ENERGY GRADE =       45.341
    HYDRAULIC GRADE =    45.222
```

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A67
48" PIPE BETWEEN CHL AND JB
DARCY-WEISBACH FRICTION
PIPE DIAMETER = 48.0000INCHES
ROUGHNESS = .0055 FEET
LENGTH = 20.0000 FEET

VELOCITY, FPS = 2.77
REYNOLDS NUMBER = 910530.
DARCY-WEISBACH FRICTION FACTOR = .0219
EQUIVALENT HAZEN WILLIAMS C = 111.
EQUIVALENT MANNING COEFFICIENT = .0137
ENERGY LOSS, FEET = .013
ENERGY GRADE = 45.354
HYDRAULIC GRADE = 45.235

A70
48" EXIT FROM CHL TANK
"K"LOSS IN FULL ROUND PIPE
LOSS COEFFICIENT K = 1.500
PIPE DIAMETER = 48.00 INCHES
INVERT ELEVATION = 37.000

VELOCITY = 2.77 FT/SEC
ENERGY LOSS, FEET = .179
ENERGY GRADE = 45.533
HYDRAULIC GRADE = 45.414

A80
FINAL CHANNEL IN CHL TANK
RECTANGULAR CONDUIT
HEIGHT = 9.60 FEET
WIDTH = 7.00 FEET
LENGTH= 25.00 FEET
MANNING ROUGHNESS = .0130
SLOPE = .00000 FEET/FOOT
NUMBER OF ANALYSIS SECTIONS = 20.00
INVERT ELEV AT OUTLET = 37.000

SUBCRITICAL FLOW

STATION FEET	WATER DEPTH FEET	VELOCITY FT/SEC	FRICTION FACTOR FT/FOOT	AVERAGE FRICTION FACTOR FT/FOOT	FRICTION LOSS FEET	HYDRAULIC GRADE	ENERGY GRADE
.000	8.528	.583	.00001			45.528	45.533
1.250	8.528	.583	.00001	.00001	.000	45.528	45.533
2.500	8.528	.583	.00001	.00001	.000	45.528	45.533
3.750	8.528	.583	.00001	.00001	.000	45.528	45.533
5.000	8.528	.583	.00001	.00001	.000	45.528	45.533
6.250	8.528	.583	.00001	.00001	.000	45.528	45.533

7.500	8.528	.583	.00001	.00001	.000	45.528	45.533
8.750	8.528	.583	.00001	.00001	.000	45.528	45.533
10.000	8.528	.583	.00001	.00001	.000	45.528	45.533
11.250	8.528	.583	.00001	.00001	.000	45.528	45.533
12.500	8.528	.583	.00001	.00001	.000	45.528	45.533
13.750	8.528	.583	.00001	.00001	.000	45.528	45.533
15.000	8.528	.583	.00001	.00001	.000	45.528	45.533
16.250	8.528	.583	.00001	.00001	.000	45.528	45.533
17.500	8.528	.583	.00001	.00001	.000	45.528	45.533
18.750	8.528	.583	.00001	.00001	.000	45.528	45.533
20.000	8.528	.583	.00001	.00001	.000	45.528	45.533
21.250	8.528	.583	.00001	.00001	.000	45.528	45.533
22.500	8.528	.583	.00001	.00001	.000	45.528	45.533
23.750	8.528	.583	.00001	.00001	.000	45.528	45.533
25.000	8.528	.583	.00001	.00001	.000	45.528	45.533

```
    CRITICAL SLOPE, FT/FT = .0035
    CRITICAL DEPTH, FEET =    .92
    CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET =  .000
    ENERGY LOSS, FEET =   .000

    INLET CONDITIONS:
       ENERGY GRADE =       45.533
       HYDRAULIC GRADE =    45.528

BROWN AND CALDWELL          PROFILE        SERIAL NO. 9901
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F20
1/2 TOTAL FLOW THROUGH CHL TANK
 FLOW PERCENT
    FLOW =    17.41 CFS OR     11.25 MGD
            50.00 PERCENT OF TOTAL PLANT FLOW.

A85
SHARP CRESETED WEIR IN CHR TANK
SHARP-CRESTED WEIR
    WEIR CREST ELEVATION =    45.330
    WEIR DISCHARGE =    17.41 CFS
    LENGTH =     5.00 FEET

    NO END CONTRACTIONS

    ************ WEIR SUBMERGED ************
    CALCULATED C VALUE =  3.339
    HEIGHT OF WATER OVER WEIR =  1.050
    ENERGY LOSS, FEET =    .847
    ENERGY GRADE =       46.380
    HYDRAULIC GRADE =    46.380

A90
4TH PASS IN CHL TANK
RECTANGULAR CONDUIT
    HEIGHT =  10.60 FEET
    WIDTH =  10.00 FEET
    LENGTH=     50.00 FEET
```

MANNING ROUGHNESS = .0130
SLOPE = .00000 FEET/FOOT
NUMBER OF ANALYSIS SECTIONS = 20.00
INVERT ELEV AT OUTLET = 36.000

SUBCRITICAL FLOW

STATION FEET	WATER DEPTH FEET	VELOCITY FT/SEC	FRICTION FACTOR FT/FOOT	AVERAGE FRICTION FACTOR FT/FOOT	FRICTION LOSS FEET	HYDRAULIC GRADE	ENERGY GRADE
.000	10.379	.168	.00000			46.379	46.380
2.500	10.379	.168	.00000	.00000	.000	46.379	46.380
5.000	10.379	.168	.00000	.00000	.000	46.379	46.380
7.500	10.379	.168	.00000	.00000	.000	46.379	46.380
10.000	10.379	.168	.00000	.00000	.000	46.379	46.380
12.500	10.379	.168	.00000	.00000	.000	46.379	46.380
15.000	10.379	.168	.00000	.00000	.000	46.379	46.380
17.500	10.379	.168	.00000	.00000	.000	46.379	46.380
20.000	10.379	.168	.00000	.00000	.000	46.379	46.380
22.500	10.379	.168	.00000	.00000	.000	46.379	46.380
25.000	10.379	.168	.00000	.00000	.000	46.379	46.380
27.500	10.379	.168	.00000	.00000	.000	46.379	46.380
30.000	10.379	.168	.00000	.00000	.000	46.379	46.380
32.500	10.379	.168	.00000	.00000	.000	46.379	46.380
35.000	10.379	.168	.00000	.00000	.000	46.379	46.380
37.500	10.379	.168	.00000	.00000	.000	46.379	46.380
40.000	10.379	.168	.00000	.00000	.000	46.379	46.380
42.500	10.379	.168	.00000	.00000	.000	46.379	46.380
45.000	10.379	.168	.00000	.00000	.000	46.379	46.380
47.500	10.379	.168	.00000	.00000	.000	46.379	46.380
50.000	10.379	.168	.00000	.00000	.000	46.379	46.380

CRITICAL SLOPE, FT/FT = .0036
CRITICAL DEPTH, FEET = .46
CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET = .000
ENERGY LOSS, FEET = .000

INLET CONDITIONS:
ENERGY GRADE = 46.380
HYDRAULIC GRADE = 46.379

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A100
180 TURN IN CHL TANK
"K" LOSS IN RECTANGULAR OPEN CHANNEL
WIDTH = 10.00 FEET
INVERT ELEV. = 36.000 FEET
SIDEWALL = 10.60 FEET
LOSS COEFFICIENT "K" = .60

VELOCITY = .17 FT/SEC

ENERGY LOSS, FEET = .000
ENERGY GRADE = 46.380
HYDRAULIC GRADE = 46.380

A110
3RD PASS IN CHL TANK
RECTANGULAR CONDUIT
HEIGHT = 10.60 FEET
WIDTH = 29.50 FEET
LENGTH= 50.00 FEET
MANNING ROUGHNESS = .0130
SLOPE = .00000 FEET/FOOT
NUMBER OF ANALYSIS SECTIONS = 20.00
INVERT ELEV AT OUTLET = 36.000

SUBCRITICAL FLOW

STATION FEET	WATER DEPTH FEET	VELOCITY FT/SEC	FRICTION FACTOR FT/FOOT	AVERAGE FRICTION FACTOR FT/FOOT	FRICTION LOSS FEET	HYDRAULIC GRADE	ENERGY GRADE
.000	10.380	.057	.00000			46.380	46.380
2.500	10.380	.057	.00000	.00000	.000	46.380	46.380
5.000	10.380	.057	.00000	.00000	.000	46.380	46.380
7.500	10.380	.057	.00000	.00000	.000	46.380	46.380
10.000	10.380	.057	.00000	.00000	.000	46.380	46.380
12.500	10.380	.057	.00000	.00000	.000	46.380	46.380
15.000	10.380	.057	.00000	.00000	.000	46.380	46.380
17.500	10.380	.057	.00000	.00000	.000	46.380	46.380
20.000	10.380	.057	.00000	.00000	.000	46.380	46.380
22.500	10.380	.057	.00000	.00000	.000	46.380	46.380
25.000	10.380	.057	.00000	.00000	.000	46.380	46.380
27.500	10.380	.057	.00000	.00000	.000	46.380	46.380
30.000	10.380	.057	.00000	.00000	.000	46.380	46.380
32.500	10.380	.057	.00000	.00000	.000	46.380	46.380
35.000	10.380	.057	.00000	.00000	.000	46.380	46.380
37.500	10.380	.057	.00000	.00000	.000	46.380	46.380
40.000	10.380	.057	.00000	.00000	.000	46.380	46.380
42.500	10.380	.057	.00000	.00000	.000	46.380	46.380
45.000	10.380	.057	.00000	.00000	.000	46.380	46.380
47.500	10.380	.057	.00000	.00000	.000	46.380	46.380
50.000	10.380	.057	.00000	.00000	.000	46.380	46.380

CRITICAL SLOPE, FT/FT = .0041
CRITICAL DEPTH, FEET = .22
CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET = .000
ENERGY LOSS, FEET = .000

INLET CONDITIONS:
ENERGY GRADE = 46.380
HYDRAULIC GRADE = 46.380

A120
180 TURN IN CHL TANK

"K" LOSS IN RECTANGULAR CONDUIT
WIDTH = 29.50 FEET
INVERT ELEV. = 36.000 FEET
SIDEWALL = 10.60 FEET
LOSS COEFFICIENT "K" = .60

VELOCITY = .06 FT/SEC
ENERGY LOSS, FEET = .000
ENERGY GRADE = 46.380
HYDRAULIC GRADE = 46.380

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Consulting Engineers Version 2.00

A130
2ND PASS IN CHL TANK
RECTANGULAR CONDUIT
HEIGHT = 10.60 FEET
WIDTH = 29.50 FEET
LENGTH= 50.00 FEET
MANNING ROUGHNESS = .0130
SLOPE = .00000 FEET/FOOT
NUMBER OF ANALYSIS SECTIONS = 20.00
INVERT ELEV AT OUTLET = 36.000

SUBCRITICAL FLOW

STATION FEET	WATER DEPTH FEET	VELOCITY FT/SEC	FRICTION FACTOR FT/FOOT	AVERAGE FRICTION FACTOR FT/FOOT	FRICTION LOSS FEET	HYDRAULIC GRADE	ENERGY GRADE
.000	10.380	.057	.00000			46.380	46.380
2.500	10.380	.057	.00000	.00000	.000	46.380	46.380
5.000	10.380	.057	.00000	.00000	.000	46.380	46.380
7.500	10.380	.057	.00000	.00000	.000	46.380	46.380
10.000	10.380	.057	.00000	.00000	.000	46.380	46.380
12.500	10.380	.057	.00000	.00000	.000	46.380	46.380
15.000	10.380	.057	.00000	.00000	.000	46.380	46.380
17.500	10.380	.057	.00000	.00000	.000	46.380	46.380
20.000	10.380	.057	.00000	.00000	.000	46.380	46.380
22.500	10.380	.057	.00000	.00000	.000	46.380	46.380
25.000	10.380	.057	.00000	.00000	.000	46.380	46.380
27.500	10.380	.057	.00000	.00000	.000	46.380	46.380
30.000	10.380	.057	.00000	.00000	.000	46.380	46.380
32.500	10.380	.057	.00000	.00000	.000	46.380	46.380
35.000	10.380	.057	.00000	.00000	.000	46.380	46.380
37.500	10.380	.057	.00000	.00000	.000	46.380	46.380
40.000	10.380	.057	.00000	.00000	.000	46.380	46.380
42.500	10.380	.057	.00000	.00000	.000	46.380	46.380
45.000	10.380	.057	.00000	.00000	.000	46.380	46.380
47.500	10.380	.057	.00000	.00000	.000	46.380	46.380
50.000	10.380	.057	.00000	.00000	.000	46.380	46.380

CRITICAL SLOPE, FT/FT = .0041

CRITICAL DEPTH, FEET = .22
CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET = .000
ENERGY LOSS, FEET = .000

INLET CONDITIONS:
ENERGY GRADE = 46.380
HYDRAULIC GRADE = 46.380

A140
180 TURN IN CHL TANK
"K" LOSS IN RECTANGULAR OPEN CHANNEL
WIDTH = 29.50 FEET
INVERT ELEV. = 36.000 FEET
SIDEWALL = 10.60 FEET
LOSS COEFFICIENT "K" = .60

VELOCITY = .06 FT/SEC
ENERGY LOSS, FEET = .000
ENERGY GRADE = 46.380
HYDRAULIC GRADE = 46.380

A150
1ST PASS IN CHL TANK
RECTANGULAR CONDUIT
HEIGHT = 10.60 FEET
WIDTH = 29.50 FEET
LENGTH= 50.00 FEET
MANNING ROUGHNESS = .0130
SLOPE = .00000 FEET/FOOT
NUMBER OF ANALYSIS SECTIONS = 20.00
INVERT ELEV AT OUTLET = 36.000

SUBCRITICAL FLOW

STATION FEET	WATER DEPTH FEET	VELOCITY FT/SEC	FRICTION FACTOR FT/FOOT	AVERAGE FRICTION FACTOR FT/FOOT	FRICTION LOSS FEET	HYDRAULIC GRADE	ENERGY GRADE
.000	10.380	.057	.00000			46.380	46.380
2.500	10.380	.057	.00000	.00000	.000	46.380	46.380
5.000	10.380	.057	.00000	.00000	.000	46.380	46.380
7.500	10.380	.057	.00000	.00000	.000	46.380	46.380
10.000	10.380	.057	.00000	.00000	.000	46.380	46.380
12.500	10.380	.057	.00000	.00000	.000	46.380	46.380
15.000	10.380	.057	.00000	.00000	.000	46.380	46.380
17.500	10.380	.057	.00000	.00000	.000	46.380	46.380
20.000	10.380	.057	.00000	.00000	.000	46.380	46.380
22.500	10.380	.057	.00000	.00000	.000	46.380	46.380
25.000	10.380	.057	.00000	.00000	.000	46.380	46.380
27.500	10.380	.057	.00000	.00000	.000	46.380	46.380
30.000	10.380	.057	.00000	.00000	.000	46.380	46.380
32.500	10.380	.057	.00000	.00000	.000	46.380	46.380
35.000	10.380	.057	.00000	.00000	.000	46.380	46.380
37.500	10.380	.057	.00000	.00000	.000	46.380	46.380
40.000	10.380	.057	.00000	.00000	.000	46.380	46.380

42.500	10.380	.057	.00000	.00000	.000	46.380	46.380
45.000	10.380	.057	.00000	.00000	.000	46.380	46.380
47.500	10.380	.057	.00000	.00000	.000	46.380	46.380
50.000	10.380	.057	.00000	.00000	.000	46.380	46.380

```
    CRITICAL SLOPE, FT/FT = .0041
    CRITICAL DEPTH, FEET =    .22
    CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET =  .000
    ENERGY LOSS, FEET =   .000

    INLET CONDITIONS:
       ENERGY GRADE =       46.380
       HYDRAULIC GRADE =    46.380

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A155
90 TURN IN CHL
"K" LOSS IN RECTANGULAR CONDUIT
    WIDTH =  29.50 FEET
    INVERT ELEV. =    36.000 FEET
    SIDEWALL =  10.60 FEET
    LOSS COEFFICIENT "K" =   2.00

    VELOCITY =     .06 FT/SEC
    ENERGY LOSS, FEET =    .000
    ENERGY GRADE =       46.380
    HYDRAULIC GRADE =    46.380

A170
SUB ORIFICE IN CHL TANK (?)
SUBMERGED RECTANGULAR ORIFICE
    NO OF ORIFICES =     1
    ORIFICE HEIGHT =   4.00 FEET
    ORIFICE WIDTH =   4.00 FEET
    DISCHARGE COEFFICIENT =    .470

    FLOW PER ORIFICE =   17.41 CFS
    VELOCITY THROUGH ORIFICE, FPS =   1.09
    ENERGY LOSS, FEET =    .083
    ENERGY GRADE =       46.464
    HYDRAULIC GRADE =    46.464

F30
FULL FLOW IN CHL TANK
 FLOW PERCENT
    FLOW =    34.81 CFS OR     22.50 MGD
           100.00 PERCENT OF TOTAL PLANT FLOW.

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A180
FIRST CHANNEL IN CHL TANK
RECTANGULAR CONDUIT
```

HEIGHT = 15.50 FEET
WIDTH = 8.00 FEET
LENGTH= 16.00 FEET
MANNING ROUGHNESS = .0130
SLOPE = .00000 FEET/FOOT
NUMBER OF ANALYSIS SECTIONS = 20.00
INVERT ELEV AT OUTLET = 31.000

SUBCRITICAL FLOW

STATION FEET	WATER DEPTH FEET	VELOCITY FT/SEC	FRICTION FACTOR FT/FOOT	AVERAGE FRICTION FACTOR FT/FOOT	FRICTION LOSS FEET	HYDRAULIC GRADE	ENERGY GRADE
.000	15.462	.281	.00000			46.462	46.464
.800	15.462	.281	.00000	.00000	.000	46.462	46.464
1.600	15.462	.281	.00000	.00000	.000	46.462	46.464
2.400	15.462	.281	.00000	.00000	.000	46.462	46.464
3.200	15.462	.281	.00000	.00000	.000	46.462	46.464
4.000	15.462	.281	.00000	.00000	.000	46.462	46.464
4.800	15.462	.281	.00000	.00000	.000	46.462	46.464
5.600	15.462	.281	.00000	.00000	.000	46.462	46.464
6.400	15.462	.281	.00000	.00000	.000	46.462	46.464
7.200	15.462	.281	.00000	.00000	.000	46.462	46.464
8.000	15.462	.281	.00000	.00000	.000	46.462	46.464
8.800	15.462	.281	.00000	.00000	.000	46.462	46.464
9.600	15.462	.281	.00000	.00000	.000	46.462	46.464
10.400	15.462	.281	.00000	.00000	.000	46.462	46.464
11.200	15.462	.281	.00000	.00000	.000	46.462	46.464
12.000	15.462	.281	.00000	.00000	.000	46.462	46.464
12.800	15.462	.281	.00000	.00000	.000	46.462	46.464
13.600	15.462	.281	.00000	.00000	.000	46.462	46.464
14.400	15.462	.281	.00000	.00000	.000	46.462	46.464
15.200	15.462	.281	.00000	.00000	.000	46.462	46.464
16.000	15.462	.281	.00000	.00000	.000	46.462	46.464

CRITICAL SLOPE, FT/FT = .0034
CRITICAL DEPTH, FEET = .84
CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET = .000
ENERGY LOSS, FEET = .000

INLET CONDITIONS:
ENERGY GRADE = 46.464
HYDRAULIC GRADE = 46.462

A185
60" ENTRANCE INTO CHL TANK
"K"LOSS IN FULL ROUND PIPE
LOSS COEFFICIENT K = 3.000
PIPE DIAMETER = 60.00 INCHES
INVERT ELEVATION = 31.000

VELOCITY = 1.77 FT/SEC
ENERGY LOSS, FEET = .146

```
    ENERGY GRADE =        46.610
    HYDRAULIC GRADE =     46.561

A190
60" PIPE BETWEEN DIST BOX AND CHL TANK
DARCY-WEISBACH FRICTION
    PIPE DIAMETER =    60.0000INCHES
    ROUGHNESS =       .0060 FEET
    LENGTH =    55.0000 FEET

    VELOCITY, FPS =    1.77
    REYNOLDS NUMBER =    728424.
    DARCY-WEISBACH FRICTION FACTOR =     .0213
    EQUIVALENT HAZEN WILLIAMS C =     114.
    EQUIVALENT MANNING COEFFICIENT =   .0140
    ENERGY LOSS, FEET =     .011
    ENERGY GRADE =        46.621
    HYDRAULIC GRADE =     46.573

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A200
60" PIPE EXIT FROM DIST BOX
"K"LOSS IN FULL ROUND PIPE
    LOSS COEFFICIENT K =   2.300
    PIPE DIAMETER =        60.00 INCHES
    INVERT ELEVATION =    31.000

    VELOCITY =    1.77 FT/SEC
    ENERGY LOSS, FEET =     .112
    ENERGY GRADE =        46.734
    HYDRAULIC GRADE =     46.685

F30
FULL FLOW WITH 1965 TRAIN
 FLOW PERCENT
    FLOW =    34.81 CFS OR     22.50 MGD
           100.00 PERCENT OF TOTAL PLANT FLOW.

A210
DIST BOX #2
RECTANGULAR CONDUIT
    HEIGHT =  27.00 FEET
    WIDTH =   8.00 FEET
    LENGTH=      8.00 FEET
    MANNING ROUGHNESS =   .0200
    SLOPE =   .00000 FEET/FOOT
    NUMBER OF ANALYSIS SECTIONS =   20.00
    INVERT ELEV AT OUTLET =    31.000


    SUBCRITICAL FLOW

                                          AVERAGE
              WATER            FRICTION  FRICTION  FRICTION
    STATION   DEPTH  VELOCITY   FACTOR    FACTOR     LOSS   HYDRAULIC    ENERGY
```

FEET	FEET	FT/SEC	FT/FOOT	FT/FOOT	FEET	GRADE	GRADE
.000	15.733	.277	.00000			46.733	46.734
.400	15.733	.277	.00000	.00000	.000	46.733	46.734
.800	15.733	.277	.00000	.00000	.000	46.733	46.734
1.200	15.733	.277	.00000	.00000	.000	46.733	46.734
1.600	15.733	.277	.00000	.00000	.000	46.733	46.734
2.000	15.733	.277	.00000	.00000	.000	46.733	46.734
2.400	15.733	.277	.00000	.00000	.000	46.733	46.734
2.800	15.733	.277	.00000	.00000	.000	46.733	46.734
3.200	15.733	.277	.00000	.00000	.000	46.733	46.734
3.600	15.733	.277	.00000	.00000	.000	46.733	46.734
4.000	15.733	.277	.00000	.00000	.000	46.733	46.734
4.400	15.733	.277	.00000	.00000	.000	46.733	46.734
4.800	15.733	.277	.00000	.00000	.000	46.733	46.734
5.200	15.733	.277	.00000	.00000	.000	46.733	46.734
5.600	15.733	.277	.00000	.00000	.000	46.733	46.734
6.000	15.733	.277	.00000	.00000	.000	46.733	46.734
6.400	15.733	.277	.00000	.00000	.000	46.733	46.734
6.800	15.733	.277	.00000	.00000	.000	46.733	46.734
7.200	15.733	.277	.00000	.00000	.000	46.733	46.734
7.600	15.733	.277	.00000	.00000	.000	46.733	46.734
8.000	15.733	.277	.00000	.00000	.000	46.733	46.734

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CRITICAL SLOPE, FT/FT = .0080
CRITICAL DEPTH, FEET =    .84
CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET =  .000
ENERGY LOSS, FEET =   .000

INLET CONDITIONS:
   ENERGY GRADE =       46.734
   HYDRAULIC GRADE =    46.733

BROWN AND CALDWELL          PROFILE        SERIAL NO. 9901
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F40
1/2 FLOW THROUGH PRC TRAIN 1971
 FLOW PERCENT
    FLOW =    11.49 CFS OR      7.43 MGD
            33.00 PERCENT OF TOTAL PLANT FLOW.

A230
30" ENTRANCE INTO DISTR BOX #2
"K"LOSS IN FULL ROUND PIPE
    LOSS COEFFICIENT K =    .500
    PIPE DIAMETER =        30.00 INCHES
    INVERT ELEVATION =    41.790

    VELOCITY =    2.34 FT/SEC
    ENERGY LOSS, FEET =    .043
    ENERGY GRADE =       46.776
    HYDRAULIC GRADE =    46.691

A240
30" PIPE FROM FINAL BASIN TO DISTR BOX#2
```

DARCY-WEISBACH FRICTION
PIPE DIAMETER = 30.0000INCHES
ROUGHNESS = .0020 FEET
LENGTH = 25.0000 FEET

VELOCITY, FPS = 2.34
REYNOLDS NUMBER = 480760.
DARCY-WEISBACH FRICTION FACTOR = .0197
EQUIVALENT HAZEN WILLIAMS C = 124.
EQUIVALENT MANNING COEFFICIENT = .0120
ENERGY LOSS, FEET = .017
ENERGY GRADE = 46.793
HYDRAULIC GRADE = 46.708

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A250
30" PIPE ENTRANCE AFTER FINAL CLR
"K"LOSS IN FULL ROUND PIPE
LOSS COEFFICIENT K = .200
PIPE DIAMETER = 30.00 INCHES
INVERT ELEVATION = 41.790

VELOCITY = 2.34 FT/SEC
ENERGY LOSS, FEET = .017
ENERGY GRADE = 46.810
HYDRAULIC GRADE = 46.725

A255
DROP BOX AFTER FINAL CLR
RECTANGULAR CONDUIT
HEIGHT = 7.47 FEET
WIDTH = 7.00 FEET
LENGTH= 3.00 FEET
MANNING ROUGHNESS = .0100
SLOPE = .00000 FEET/FOOT
NUMBER OF ANALYSIS SECTIONS = 20.00
INVERT ELEV AT OUTLET = 42.030

SUBCRITICAL FLOW

STATION FEET	WATER DEPTH FEET	VELOCITY FT/SEC	FRICTION FACTOR FT/FOOT	AVERAGE FRICTION FACTOR FT/FOOT	FRICTION LOSS FEET	HYDRAULIC GRADE	ENERGY GRADE
.000	4.778	.343	.00000			46.808	46.810
.150	4.778	.343	.00000	.00000	.000	46.808	46.810
.300	4.778	.343	.00000	.00000	.000	46.808	46.810
.450	4.778	.343	.00000	.00000	.000	46.808	46.810
.600	4.778	.343	.00000	.00000	.000	46.808	46.810
.750	4.778	.343	.00000	.00000	.000	46.808	46.810
.900	4.778	.343	.00000	.00000	.000	46.808	46.810
1.050	4.778	.343	.00000	.00000	.000	46.808	46.810
1.200	4.778	.343	.00000	.00000	.000	46.808	46.810

1.350	4.778	.343	.00000	.00000	.000	46.808	46.810
1.500	4.778	.343	.00000	.00000	.000	46.808	46.810
1.650	4.778	.343	.00000	.00000	.000	46.808	46.810
1.800	4.778	.343	.00000	.00000	.000	46.808	46.810
1.950	4.778	.343	.00000	.00000	.000	46.808	46.810
2.100	4.778	.343	.00000	.00000	.000	46.808	46.810
2.250	4.778	.343	.00000	.00000	.000	46.808	46.810
2.400	4.778	.343	.00000	.00000	.000	46.808	46.810
2.550	4.778	.343	.00000	.00000	.000	46.808	46.810
2.700	4.778	.343	.00000	.00000	.000	46.808	46.810
2.850	4.778	.343	.00000	.00000	.000	46.808	46.810
3.000	4.778	.343	.00000	.00000	.000	46.808	46.810

CRITICAL SLOPE, FT/FT = .0022
CRITICAL DEPTH, FEET = .44
CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET = .000
ENERGY LOSS, FEET = .000

INLET CONDITIONS:
ENERGY GRADE = 46.810
HYDRAULIC GRADE = 46.808

A260
COLLECTION LAUNDER IN FINAL CHL

RECTANGULAR LAUNDER
UPSTREAM WIDTH = 2.50 FEET
DOWNSTREAM WIDTH = 2.50 FEET
LAUNDER SIDEWALL HEIGHT = 2.00 FEET
LENGTH = 194.80 FEET
MANNINGS ROUGHNESS = .0100FEET
SLOPE = .00000 FEET/FOOT
INVERT ELEV AT OUTLET = 45.800
DISCHARGE AT OUTLET = 3.71 MGD

STATION	DELTA DEPTH ASSUMED	WATER DEPTH	FLOW CFS	VELOCITY FT/SEC	MOMENTUM DELTA DEPTH	FRICTION LOSS	DELTA DEPTH CALC	HYDRAULIC GRADE	ENERGY GRADE
.00		.914	5.74	2.51				46.714	46.810
6.49	.013	.927	5.55	2.40	.015	.004	.019	46.727	46.816
12.99	.012	.939	5.36	2.28	.014	.004	.018	46.739	46.820
19.48	.011	.950	5.17	2.18	.013	.003	.016	46.750	46.824
25.97	.011	.961	4.98	2.07	.012	.003	.015	46.761	46.828
32.47	.010	.971	4.79	1.97	.011	.003	.014	46.771	46.831
38.96	.009	.981	4.60	1.87	.010	.002	.013	46.781	46.835
45.45	.009	.989	4.40	1.78	.010	.002	.012	46.789	46.839
51.95	.008	.998	4.21	1.69	.009	.002	.011	46.798	46.842
58.44	.008	1.006	4.02	1.60	.008	.002	.010	46.806	46.845
64.93	.007	1.013	3.83	1.51	.008	.002	.009	46.813	46.849
71.43	.007	1.020	3.64	1.43	.007	.001	.009	46.820	46.852
77.92	.006	1.026	3.45	1.34	.007	.001	.008	46.826	46.854
84.41	.006	1.033	3.25	1.26	.006	.001	.007	46.833	46.857
90.91	.006	1.038	3.06	1.18	.006	.001	.007	46.838	46.860
97.40	.005	1.043	2.87	1.10	.005	.001	.006	46.843	46.862
103.89	.005	1.048	2.68	1.02	.005	.001	.006	46.848	46.864

110.39	.004	1.053	2.49	.95	.005	.001	.005	46.853	46.867
116.88	.004	1.057	2.30	.87	.004	.001	.005	46.857	46.869
123.37	.004	1.061	2.11	.79	.004	.000	.004	46.861	46.870
129.87	.003	1.064	1.91	.72	.003	.000	.004	46.864	46.872
136.36	.003	1.067	1.72	.65	.003	.000	.003	46.867	46.874
142.85	.003	1.070	1.53	.57	.003	.000	.003	46.870	46.875
149.35	.002	1.072	1.34	.50	.002	.000	.003	46.872	46.876
155.84	.002	1.074	1.15	.43	.002	.000	.002	46.874	46.877
162.33	.002	1.076	.96	.36	.002	.000	.002	46.876	46.878
168.83	.001	1.077	.77	.28	.001	.000	.001	46.877	46.879
175.32	.001	1.078	.57	.21	.001	.000	.001	46.878	46.879
181.81	.001	1.079	.38	.14	.001	.000	.001	46.879	46.880
188.31	.000	1.080	.19	.07	.000	.000	.000	46.880	46.880
194.80	.000	1.080	.00	.00				46.880	46.880

CRITICAL DEPTH, FEET = .55
WATER DEPTH AT UPSTREAM END OF LAUNDER = 1.08
CHANGE IN HYDRAULIC GRADE WITHIN LAUNDER = .166
ENERGY LOSS, FEET = .070

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A270
WEIR PLATE IN FINAL CHL
V-NOTCH WEIR PLATE
WEIR: DISCHARGE = 11.49 CFS
LENGTH = 389.56 FEET
TOP OF PLATE ELEV = 48.000
V-NOTCH: SPACING = 6.00 INCHES
ANGLE = 90.00 DEGREES
DEPTH = 2.00 INCHES
INVERT = 47.833
WS ELEV DOWNSTREAM OF WEIR = 46.880

FREEBOARD = .953
ENERGY LOSS, FEET = 1.082
ENERGY GRADE = 47.962
HYDRAULIC GRADE = 47.962

F67
1/2 FLOW WITH 1/2 RAS
FLOW PERCENT
FLOW = 17.41 CFS OR 11.25 MGD
50.00 PERCENT OF TOTAL PLANT FLOW.

A280
30" PIPE OPENING
"K"LOSS IN FULL ROUND PIPE
LOSS COEFFICIENT K = 1.000
PIPE DIAMETER = 30.00 INCHES
INVERT ELEVATION = 28.920

VELOCITY = 3.55 FT/SEC
ENERGY LOSS, FEET = .195
ENERGY GRADE = 48.157
HYDRAULIC GRADE = 47.962

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A300
90 DEGREE ELBOW UNDER FINAL CHL
"K"LOSS IN FULL ROUND PIPE
LOSS COEFFICIENT K = .600
PIPE DIAMETER = 30.00 INCHES
INVERT ELEVATION = 28.920

VELOCITY = 3.55 FT/SEC
ENERGY LOSS, FEET = .117
ENERGY GRADE = 48.274
HYDRAULIC GRADE = 48.079

A302
30" PIPE FROM AERATION BASIN TO FINAL CLR
DARCY-WEISBACH FRICTION
PIPE DIAMETER = 30.0000INCHES
ROUGHNESS = .0042 FEET
LENGTH = 80.0000 FEET

VELOCITY, FPS = 3.55
REYNOLDS NUMBER = 728424.
DARCY-WEISBACH FRICTION FACTOR = .0231
EQUIVALENT HAZEN WILLIAMS C = 110.
EQUIVALENT MANNING COEFFICIENT = .0130
ENERGY LOSS, FEET = .144
ENERGY GRADE = 48.418
HYDRAULIC GRADE = 48.223

A310
30" ENTRANCE AFTER AERATION BASIN
"K"LOSS IN FULL ROUND PIPE
LOSS COEFFICIENT K = .500
PIPE DIAMETER = 30.00 INCHES
INVERT ELEVATION = 31.510

VELOCITY = 3.55 FT/SEC
ENERGY LOSS, FEET = .098
ENERGY GRADE = 48.516
HYDRAULIC GRADE = 48.321

BROWN AND CALDWELL PROFILE SERIAL NO. 9901
Consulting Engineers Version 2.00

A320
MIXED LIQUOR CH IN AERATION BASIN
RECTANGULAR CONDUIT
HEIGHT = 24.50 FEET
WIDTH = 3.00 FEET
LENGTH= 56.00 FEET
MANNING ROUGHNESS = .0130
SLOPE = .00000 FEET/FOOT
NUMBER OF ANALYSIS SECTIONS = 20.00
INVERT ELEV AT OUTLET = 31.500

SUBCRITICAL FLOW

STATION FEET	WATER DEPTH FEET	VELOCITY FT/SEC	FRICTION FACTOR FT/FOOT	AVERAGE FRICTION FACTOR FT/FOOT	FRICTION LOSS FEET	HYDRAULIC GRADE	ENERGY GRADE
.000	17.014	.341	.00001			48.514	48.516
2.800	17.014	.341	.00001	.00001	.000	48.514	48.516
5.600	17.014	.341	.00001	.00001	.000	48.514	48.516
8.400	17.014	.341	.00001	.00001	.000	48.514	48.516
11.200	17.014	.341	.00001	.00001	.000	48.514	48.516
14.000	17.014	.341	.00001	.00001	.000	48.514	48.516
16.800	17.014	.341	.00001	.00001	.000	48.514	48.516
19.600	17.014	.341	.00001	.00001	.000	48.514	48.516
22.400	17.014	.341	.00001	.00001	.000	48.514	48.516
25.200	17.014	.341	.00001	.00001	.000	48.514	48.516
28.000	17.014	.341	.00001	.00001	.000	48.514	48.516
30.800	17.014	.341	.00001	.00001	.000	48.514	48.516
33.600	17.014	.341	.00001	.00001	.000	48.514	48.516
36.400	17.015	.341	.00001	.00001	.000	48.515	48.516
39.200	17.015	.341	.00001	.00001	.000	48.515	48.516
42.000	17.015	.341	.00001	.00001	.000	48.515	48.516
44.800	17.015	.341	.00001	.00001	.000	48.515	48.516
47.600	17.015	.341	.00001	.00001	.000	48.515	48.516
50.400	17.015	.341	.00001	.00001	.000	48.515	48.516
53.200	17.015	.341	.00001	.00001	.000	48.515	48.516
56.000	17.015	.341	.00001	.00001	.000	48.515	48.516

CRITICAL SLOPE, FT/FT = .0049
CRITICAL DEPTH, FEET = 1.01
CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET = .000
ENERGY LOSS, FEET = .000

INLET CONDITIONS:
ENERGY GRADE = 48.516
HYDRAULIC GRADE = 48.515

A330
180 TURN IN AERATION
"K" LOSS IN RECTANGULAR CONDUIT
WIDTH = 44.00 FEET
INVERT ELEV. = 47.790 FEET
SIDEWALL = 24.50 FEET
LOSS COEFFICIENT "K" = .60

VELOCITY = .55 FT/SEC
ENERGY LOSS, FEET = .003
ENERGY GRADE = 48.519
HYDRAULIC GRADE = 48.515

A340
WEIR #4 IN AERATION
SHARP-CRESTED WEIR
WEIR CREST ELEVATION = 50.000

WEIR DISCHARGE = 17.41 CFS
LENGTH = 20.00 FEET

NO END CONTRACTIONS
FREEBOARD = 1.485
CALCULATED C VALUE = 3.330
HEIGHT OF WATER OVER WEIR = .409
ENERGY LOSS, FEET = 1.889
ENERGY GRADE = 50.409
HYDRAULIC GRADE = 50.409

BROWN AND CALDWELL PROFILE SERIAL NO. 9901
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A350
ZONE #4 IN AEARION BASIN
RECTANGULAR CONDUIT
HEIGHT = 24.50 FEET
WIDTH = 44.00 FEET
LENGTH= 92.00 FEET
MANNING ROUGHNESS = .0130
SLOPE = .00000 FEET/FOOT
NUMBER OF ANALYSIS SECTIONS = 20.00
INVERT ELEV AT OUTLET = 31.500

SUBCRITICAL FLOW

STATION FEET	WATER DEPTH FEET	VELOCITY FT/SEC	FRICTION FACTOR FT/FOOT	AVERAGE FRICTION FACTOR FT/FOOT	FRICTION LOSS FEET	HYDRAULIC GRADE	ENERGY GRADE
.000	18.909	.021	.00000			50.409	50.409
4.600	18.909	.021	.00000	.00000	.000	50.409	50.409
9.200	18.909	.021	.00000	.00000	.000	50.409	50.409
13.800	18.909	.021	.00000	.00000	.000	50.409	50.409
18.400	18.909	.021	.00000	.00000	.000	50.409	50.409
23.000	18.909	.021	.00000	.00000	.000	50.409	50.409
27.600	18.909	.021	.00000	.00000	.000	50.409	50.409
32.200	18.909	.021	.00000	.00000	.000	50.409	50.409
36.800	18.909	.021	.00000	.00000	.000	50.409	50.409
41.400	18.909	.021	.00000	.00000	.000	50.409	50.409
46.000	18.909	.021	.00000	.00000	.000	50.409	50.409
50.600	18.909	.021	.00000	.00000	.000	50.409	50.409
55.200	18.909	.021	.00000	.00000	.000	50.409	50.409
59.800	18.909	.021	.00000	.00000	.000	50.409	50.409
64.400	18.909	.021	.00000	.00000	.000	50.409	50.409
69.000	18.909	.021	.00000	.00000	.000	50.409	50.409
73.600	18.909	.021	.00000	.00000	.000	50.409	50.409
78.200	18.909	.021	.00000	.00000	.000	50.409	50.409
82.800	18.909	.021	.00000	.00000	.000	50.409	50.409
87.400	18.909	.021	.00000	.00000	.000	50.409	50.409
92.000	18.909	.021	.00000	.00000	.000	50.409	50.409

CRITICAL SLOPE, FT/FT = .0045

```
    CRITICAL DEPTH, FEET =     .17
    CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET =  .000
    ENERGY LOSS, FEET =   .000

    INLET CONDITIONS:
       ENERGY GRADE =        50.409
       HYDRAULIC GRADE =     50.409

A360
180 TUNE IN AEARATION BASIN
"K" LOSS IN RECTANGULAR CONDUIT
    WIDTH =  44.00 FEET
    INVERT ELEV. =     31.500 FEET
    SIDEWALL =  24.50 FEET
    LOSS COEFFICIENT "K" =     .60

    VELOCITY =      .02 FT/SEC
    ENERGY LOSS, FEET =     .000
    ENERGY GRADE =        50.409
    HYDRAULIC GRADE =     50.409

A370
WEIR #3 IN AEARATION BASIN
SHARP-CRESTED WEIR
    WEIR CREST ELEVATION =     49.830
    WEIR DISCHARGE =     17.41 CFS
    LENGTH =     20.00 FEET

    NO END CONTRACTIONS

    ************ WEIR SUBMERGED ************
    CALCULATED C VALUE =  3.331
    HEIGHT OF WATER OVER WEIR =    .647
    ENERGY LOSS, FEET =     .068
    ENERGY GRADE =        50.477
    HYDRAULIC GRADE =     50.477

BROWN AND CALDWELL          PROFILE        SERIAL NO. 9901
Consulting Engineers        Version 2.00

A380
ZONE 3 IN AEARION BASIN
RECTANGULAR CONDUIT
    HEIGHT =  24.50 FEET
    WIDTH =  23.00 FEET
    LENGTH=     92.00 FEET
    MANNING ROUGHNESS =    .0130
    SLOPE =    .00000 FEET/FOOT
    NUMBER OF ANALYSIS SECTIONS =   20.00
    INVERT ELEV AT OUTLET =    31.500


    SUBCRITICAL FLOW

                                                AVERAGE
                WATER              FRICTION  FRICTION  FRICTION
    STATION     DEPTH  VELOCITY     FACTOR    FACTOR     LOSS   HYDRAULIC    ENERGY
```

FEET	FEET	FT/SEC	FT/FOOT	FT/FOOT	FEET	GRADE	GRADE
.000	18.977	.040	.00000			50.477	50.477
4.600	18.977	.040	.00000	.00000	.000	50.477	50.477
9.200	18.977	.040	.00000	.00000	.000	50.477	50.477
13.800	18.977	.040	.00000	.00000	.000	50.477	50.477
18.400	18.977	.040	.00000	.00000	.000	50.477	50.477
23.000	18.977	.040	.00000	.00000	.000	50.477	50.477
27.600	18.977	.040	.00000	.00000	.000	50.477	50.477
32.200	18.977	.040	.00000	.00000	.000	50.477	50.477
36.800	18.977	.040	.00000	.00000	.000	50.477	50.477
41.400	18.977	.040	.00000	.00000	.000	50.477	50.477
46.000	18.977	.040	.00000	.00000	.000	50.477	50.477
50.600	18.977	.040	.00000	.00000	.000	50.477	50.477
55.200	18.977	.040	.00000	.00000	.000	50.477	50.477
59.800	18.977	.040	.00000	.00000	.000	50.477	50.477
64.400	18.977	.040	.00000	.00000	.000	50.477	50.477
69.000	18.977	.040	.00000	.00000	.000	50.477	50.477
73.600	18.977	.040	.00000	.00000	.000	50.477	50.477
78.200	18.977	.040	.00000	.00000	.000	50.477	50.477
82.800	18.977	.040	.00000	.00000	.000	50.477	50.477
87.400	18.977	.040	.00000	.00000	.000	50.477	50.477
92.000	18.977	.040	.00000	.00000	.000	50.477	50.477

```
CRITICAL SLOPE, FT/FT = .0040
CRITICAL DEPTH, FEET =    .26
CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET =  .000
ENERGY LOSS, FEET =   .000

INLET CONDITIONS:
   ENERGY GRADE =       50.477
   HYDRAULIC GRADE =    50.477

A390
180 TURN IN AERATION BASIN
"K" LOSS IN RECTANGULAR CONDUIT
    WIDTH =  23.00 FEET
    INVERT ELEV. =    31.500 FEET
    SIDEWALL =  24.50 FEET
    LOSS COEFFICIENT "K" =    .60

    VELOCITY =     .04 FT/SEC
    ENERGY LOSS, FEET =    .000
    ENERGY GRADE =       50.477
    HYDRAULIC GRADE =    50.477

A400
WEIR #2 IN AEARATION BASIN
SHARP-CRESTED WEIR
    WEIR CREST ELEVATION =    50.180
    WEIR DISCHARGE =    17.41 CFS
    LENGTH =    20.00 FEET

    NO END CONTRACTIONS

    ************ WEIR SUBMERGED ************
```

CALCULATED C VALUE = 3.331
HEIGHT OF WATER OVER WEIR = .480
ENERGY LOSS, FEET = .183
ENERGY GRADE = 50.660
HYDRAULIC GRADE = 50.660

BROWN AND CALDWELL PROFILE SERIAL NO. 9901
Consulting Engineers Version 2.00

A410
ZONE #2 IN AEARATION BASIN
RECTANGULAR CONDUIT
HEIGHT = 24.50 FEET
WIDTH = 24.00 FEET
LENGTH= 92.00 FEET
MANNING ROUGHNESS = .0130
SLOPE = .00000 FEET/FOOT
NUMBER OF ANALYSIS SECTIONS = 20.00
INVERT ELEV AT OUTLET = 31.500

SUBCRITICAL FLOW

STATION FEET	WATER DEPTH FEET	VELOCITY FT/SEC	FRICTION FACTOR FT/FOOT	AVERAGE FRICTION FACTOR FT/FOOT	FRICTION LOSS FEET	HYDRAULIC GRADE	ENERGY GRADE
.000	19.160	.038	.00000			50.660	50.660
4.600	19.160	.038	.00000	.00000	.000	50.660	50.660
9.200	19.160	.038	.00000	.00000	.000	50.660	50.660
13.800	19.160	.038	.00000	.00000	.000	50.660	50.660
18.400	19.160	.038	.00000	.00000	.000	50.660	50.660
23.000	19.160	.038	.00000	.00000	.000	50.660	50.660
27.600	19.160	.038	.00000	.00000	.000	50.660	50.660
32.200	19.160	.038	.00000	.00000	.000	50.660	50.660
36.800	19.160	.038	.00000	.00000	.000	50.660	50.660
41.400	19.160	.038	.00000	.00000	.000	50.660	50.660
46.000	19.160	.038	.00000	.00000	.000	50.660	50.660
50.600	19.160	.038	.00000	.00000	.000	50.660	50.660
55.200	19.160	.038	.00000	.00000	.000	50.660	50.660
59.800	19.160	.038	.00000	.00000	.000	50.660	50.660
64.400	19.160	.038	.00000	.00000	.000	50.660	50.660
69.000	19.160	.038	.00000	.00000	.000	50.660	50.660
73.600	19.160	.038	.00000	.00000	.000	50.660	50.660
78.200	19.160	.038	.00000	.00000	.000	50.660	50.660
82.800	19.160	.038	.00000	.00000	.000	50.660	50.660
87.400	19.160	.038	.00000	.00000	.000	50.660	50.660
92.000	19.160	.038	.00000	.00000	.000	50.660	50.660

CRITICAL SLOPE, FT/FT = .0040
CRITICAL DEPTH, FEET = .25
CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET = .000
ENERGY LOSS, FEET = .000

INLET CONDITIONS:

ENERGY GRADE = 50.660
HYDRAULIC GRADE = 50.660

A420
180 TURN IN AEATION BASIN
"K" LOSS IN RECTANGULAR CONDUIT
WIDTH = 23.00 FEET
INVERT ELEV. = 31.500 FEET
SIDEWALL = 24.50 FEET
LOSS COEFFICIENT "K" = .60

VELOCITY = .04 FT/SEC
ENERGY LOSS, FEET = .000
ENERGY GRADE = 50.660
HYDRAULIC GRADE = 50.660

A430
WEIR #1 IN AEARATION BASIN
SHARP-CRESTED WEIR
WEIR CREST ELEVATION = 48.000
WEIR DISCHARGE = 17.41 CFS
LENGTH = 20.00 FEET

NO END CONTRACTIONS

********** WEIR SUBMERGED **********
CALCULATED C VALUE = 3.347
HEIGHT OF WATER OVER WEIR = 2.661
ENERGY LOSS, FEET = .001
ENERGY GRADE = 50.661
HYDRAULIC GRADE = 50.661

BROWN AND CALDWELL PROFILE SERIAL NO. 9901
Consulting Engineers Version 2.00

A450
ZONE#1 IN AEARATION BASIN
RECTANGULAR CONDUIT
HEIGHT = 24.50 FEET
WIDTH = 8.00 FEET
LENGTH= 42.00 FEET
MANNING ROUGHNESS = .0130
SLOPE = .00000 FEET/FOOT
NUMBER OF ANALYSIS SECTIONS = 20.00
INVERT ELEV AT OUTLET = 47.790

SUBCRITICAL FLOW

STATION FEET	WATER DEPTH FEET	VELOCITY FT/SEC	FRICTION FACTOR FT/FOOT	AVERAGE FRICTION FACTOR FT/FOOT	FRICTION LOSS FEET	HYDRAULIC GRADE	ENERGY GRADE
.000	2.862	.760	.00002			50.652	50.661
2.100	2.862	.760	.00002	.00002	.000	50.652	50.661
4.200	2.862	.760	.00002	.00002	.000	50.652	50.661

6.300	2.862	.760	.00002	.00002	.000	50.652	50.661
8.400	2.862	.760	.00002	.00002	.000	50.652	50.661
10.500	2.862	.760	.00002	.00002	.000	50.652	50.661
12.600	2.862	.760	.00002	.00002	.000	50.652	50.661
14.700	2.862	.760	.00002	.00002	.000	50.652	50.661
16.800	2.862	.760	.00002	.00002	.000	50.652	50.661
18.900	2.862	.760	.00002	.00002	.000	50.652	50.661
21.000	2.862	.760	.00002	.00002	.000	50.652	50.661
23.100	2.862	.760	.00002	.00002	.000	50.652	50.661
25.200	2.862	.760	.00002	.00002	.000	50.652	50.661
27.300	2.862	.760	.00002	.00002	.000	50.652	50.661
29.400	2.862	.760	.00002	.00002	.000	50.652	50.661
31.500	2.862	.760	.00002	.00002	.000	50.652	50.661
33.600	2.862	.760	.00002	.00002	.000	50.652	50.661
35.700	2.863	.760	.00002	.00002	.000	50.653	50.661
37.800	2.863	.760	.00002	.00002	.000	50.653	50.662
39.900	2.863	.760	.00002	.00002	.000	50.653	50.662
42.000	2.863	.760	.00002	.00002	.000	50.653	50.662

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CRITICAL SLOPE, FT/FT = .0036
CRITICAL DEPTH, FEET =    .53
CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET =  .001
ENERGY LOSS, FEET =   .001

INLET CONDITIONS:
   ENERGY GRADE =       50.662
   HYDRAULIC GRADE =    50.653

F80
HALF FLOW WITH NO RAS NO RECYCLE
 FLOW PERCENT
    FLOW =    11.49 CFS OR      7.43 MGD
            33.00 PERCENT OF TOTAL PLANT FLOW.

A460
30" PIPE ENTRANCE
"K"LOSS IN FULL ROUND PIPE
    LOSS COEFFICIENT K =   1.000
    PIPE DIAMETER =        30.00 INCHES
    INVERT ELEVATION =    47.790

    VELOCITY =    2.34 FT/SEC
    ENERGY LOSS, FEET =    .085
    ENERGY GRADE =       50.747
    HYDRAULIC GRADE =    50.662

BROWN AND CALDWELL          PROFILE        SERIAL NO. 9901
Consulting Engineers        Version 2.00

A470
30" PIPE BETWEEN PRIM BASIN AND AERATION BASIN
ROUND CONDUIT
    DIAMETER =  30.00 INCHES
    LENGTH=     10.00 FEET
    MANNING ROUGHNESS =   .0130
    SLOPE =   .00000 FEET/FOOT
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    NUMBER OF ANALYSIS SECTIONS =   20.00
    INVERT ELEV AT OUTLET =    47.790


    SUBCRITICAL FLOW
    CONDUIT OUTLET SUBMERGED
    FULL CONDUIT FLOW THROUGHOUT LENGTH
    FRICTION FACTOR =  .00078 FT/FT
    VELOCITY =   2.3 FT/SEC
    CRITICAL SLOPE, FT/FT = .0048
    CRITICAL DEPTH, FEET =   1.11
    CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET =  .008
    ENERGY LOSS, FEET =   .008

    INLET CONDITIONS:
       ENERGY GRADE =       50.755
       HYDRAULIC GRADE =    50.669

A473
45 TURN IN 30" PIPE
"K" LOSS IN RECTANGULAR CONDUIT
    WIDTH =   2.50 FEET
    INVERT ELEV. =    47.790 FEET
    SIDEWALL =   2.50 FEET
    LOSS COEFFICIENT "K" =    .20

FULL FLOW IN RECTANGULAR CONDUIT
    VELOCITY =    1.84 FT/SEC
    ENERGY LOSS, FEET =    .010
    ENERGY GRADE =       50.765
    HYDRAULIC GRADE =    50.713

A477
30" PIPE BETWEEN PRIM CLR AND AERATION BASIN
ROUND CONDUIT
    DIAMETER =  30.00 INCHES
    LENGTH=     15.00 FEET
    MANNING ROUGHNESS =   .0130
    SLOPE =   .00000 FEET/FOOT
    NUMBER OF ANALYSIS SECTIONS =   20.00
    INVERT ELEV AT OUTLET =    47.790


    SUBCRITICAL FLOW
    CONDUIT OUTLET SUBMERGED
    FULL CONDUIT FLOW THROUGHOUT LENGTH
    FRICTION FACTOR =  .00078 FT/FT
    VELOCITY =   2.3 FT/SEC
    CRITICAL SLOPE, FT/FT = .0048
    CRITICAL DEPTH, FEET =   1.11
    CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET =  .012
    ENERGY LOSS, FEET =   .012

    INLET CONDITIONS:
       ENERGY GRADE =       50.777
       HYDRAULIC GRADE =    50.692
```

BROWN AND CALDWELL PROFILE SERIAL NO. 9901
Consulting Engineers Version 2.00

A480
30" PIPE ENTRANCE AFTER PRIM CLR
"K" LOSS IN RECTANGULAR CONDUIT
WIDTH = 2.50 FEET
INVERT ELEV. = 47.790 FEET
SIDEWALL = 2.50 FEET
LOSS COEFFICIENT "K" = .50

FULL FLOW IN RECTANGULAR CONDUIT
VELOCITY = 1.84 FT/SEC
ENERGY LOSS, FEET = .026
ENERGY GRADE = 50.803
HYDRAULIC GRADE = 50.751

A490
DROP BOX AFTER PRIM CLR
RECTANGULAR CONDUIT
HEIGHT = 7.00 FEET
WIDTH = 5.00 FEET
LENGTH= 2.50 FEET
MANNING ROUGHNESS = .0130
SLOPE = .00000 FEET/FOOT
NUMBER OF ANALYSIS SECTIONS = 20.00
INVERT ELEV AT OUTLET = 47.790

SUBCRITICAL FLOW

STATION FEET	WATER DEPTH FEET	VELOCITY FT/SEC	FRICTION FACTOR FT/FOOT	AVERAGE FRICTION FACTOR FT/FOOT	FRICTION LOSS FEET	HYDRAULIC GRADE	ENERGY GRADE
.000	3.004	.765	.00003			50.794	50.803
.125	3.004	.765	.00003	.00003	.000	50.794	50.803
.250	3.004	.765	.00003	.00003	.000	50.794	50.803
.375	3.004	.765	.00003	.00003	.000	50.794	50.803
.500	3.004	.765	.00003	.00003	.000	50.794	50.803
.625	3.004	.765	.00003	.00003	.000	50.794	50.803
.750	3.004	.765	.00003	.00003	.000	50.794	50.803
.875	3.004	.765	.00003	.00003	.000	50.794	50.803
1.000	3.004	.765	.00003	.00003	.000	50.794	50.803
1.125	3.004	.765	.00003	.00003	.000	50.794	50.803
1.250	3.004	.765	.00003	.00003	.000	50.794	50.803
1.375	3.004	.765	.00003	.00003	.000	50.794	50.803
1.500	3.004	.765	.00003	.00003	.000	50.794	50.803
1.625	3.004	.765	.00003	.00003	.000	50.794	50.803
1.750	3.004	.765	.00003	.00003	.000	50.794	50.803
1.875	3.004	.765	.00003	.00003	.000	50.794	50.803
2.000	3.004	.765	.00003	.00003	.000	50.794	50.803
2.125	3.004	.765	.00003	.00003	.000	50.794	50.803
2.250	3.004	.765	.00003	.00003	.000	50.794	50.803
2.375	3.004	.765	.00003	.00003	.000	50.794	50.803
2.500	3.004	.765	.00003	.00003	.000	50.794	50.803

CRITICAL SLOPE, FT/FT = .0039
CRITICAL DEPTH, FEET = .55
CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET = .000
ENERGY LOSS, FEET = .000

INLET CONDITIONS:
ENERGY GRADE = 50.803
HYDRAULIC GRADE = 50.794

A500
EFFLUENT LAUNDER IN PRIMARY CLR

RECTANGULAR LAUNDER
UPSTREAM WIDTH = 2.50 FEET
DOWNSTREAM WIDTH = 2.50 FEET
LAUNDER SIDEWALL HEIGHT = 2.00 FEET
LENGTH = 186.92 FEET
MANNINGS ROUGHNESS = .0130FEET
SLOPE = .00000 FEET/FOOT
INVERT ELEV AT OUTLET = 51.300
DISCHARGE AT OUTLET = 3.71 MGD

FREE FALL OUTLET CONDITION

STATION	DELTA DEPTH ASSUMED	WATER DEPTH	FLOW CFS	VELOCITY FT/SEC	MOMENTUM DELTA DEPTH	FRICTION LOSS	DELTA DEPTH CALC	HYDRAULIC GRADE	ENERGY GRADE
.00		.394	5.74	5.83				51.694	52.121
9.35	.491	.886	5.46	2.46	.460	.066	.526	52.186	52.280
18.69	.019	.905	5.17	2.28	.023	.010	.032	52.205	52.286
28.04	.018	.923	4.88	2.12	.020	.008	.028	52.223	52.292
37.38	.016	.938	4.60	1.96	.018	.007	.025	52.238	52.298
46.73	.014	.953	4.31	1.81	.016	.006	.022	52.253	52.304
56.08	.013	.966	4.02	1.66	.014	.005	.019	52.266	52.309
65.42	.012	.978	3.73	1.53	.013	.004	.017	52.278	52.314
74.77	.011	.989	3.45	1.39	.011	.003	.015	52.289	52.319
84.11	.010	.998	3.16	1.27	.010	.003	.013	52.298	52.323
93.46	.009	1.007	2.87	1.14	.009	.002	.011	52.307	52.327
102.81	.008	1.015	2.58	1.02	.008	.002	.010	52.315	52.331
112.15	.007	1.021	2.30	.90	.007	.001	.008	52.321	52.334
121.50	.006	1.027	2.01	.78	.006	.001	.007	52.327	52.337
130.84	.005	1.032	1.72	.67	.005	.001	.006	52.332	52.339
140.19	.004	1.036	1.44	.55	.004	.001	.005	52.336	52.341
149.54	.003	1.040	1.15	.44	.003	.000	.004	52.340	52.343
158.88	.003	1.043	.86	.33	.003	.000	.003	52.343	52.344
168.23	.002	1.044	.57	.22	.002	.000	.002	52.344	52.345
177.57	.001	1.046	.29	.11	.001	.000	.001	52.346	52.346
186.92	.000	1.046	.00	.00				52.346	52.346

CRITICAL DEPTH, FEET = .55
WATER DEPTH AT UPSTREAM END OF LAUNDER = 1.05
CHANGE IN HYDRAULIC GRADE WITHIN LAUNDER = .652
ENERGY LOSS, FEET = 1.543

Consulting Engineers Version 2.00

A510
WEIR PLATE IN PRIMARY CLR
V-NOTCH WEIR PLATE
WEIR: DISCHARGE = 11.49 CFS
LENGTH = 747.69 FEET
TOP OF PLATE ELEV = 54.000
V-NOTCH: SPACING = 6.00 INCHES
ANGLE = 90.00 DEGREES
DEPTH = 2.00 INCHES
INVERT = 53.833
WS ELEV DOWNSTREAM OF WEIR = 52.346

FREEBOARD = 1.487
ENERGY LOSS, FEET = 1.586
ENERGY GRADE = 53.932
HYDRAULIC GRADE = 53.932

A520
ENTRANCE IN PRIM CLR
SUBMERGED ROUND ORIFICE
NO OF ORIFICES = 1
ORIFICE DIAMETER = 30.00 INCHES
DISCHARGE COEFFICIENT = 1.00

FLOW PER ORIFICE = 11.49 CFS
VELOCITY THROUGH ORIFICE, FPS = 2.34
ENERGY LOSS, FEET = .085
ENERGY GRADE = 54.017
HYDRAULIC GRADE = 54.017

A540
30" ELBOW UNDER PRIM CLR
"K"LOSS IN FULL ROUND PIPE
LOSS COEFFICIENT K = .600
PIPE DIAMETER = 30.00 INCHES
INVERT ELEVATION = 32.000

VELOCITY = 2.34 FT/SEC
ENERGY LOSS, FEET = .051
ENERGY GRADE = 54.068
HYDRAULIC GRADE = 53.983

BROWN AND CALDWELL PROFILE SERIAL NO. 9901
Consulting Engineers Version 2.00

A550
30" PIPE FROM PRIM DIST BOX #1 TO PRIM CLR
DARCY-WEISBACH FRICTION
PIPE DIAMETER = 30.0000INCHES
ROUGHNESS = .0060 FEET
LENGTH = 10.0000 FEET

VELOCITY, FPS = 2.34
REYNOLDS NUMBER = 480760.
DARCY-WEISBACH FRICTION FACTOR = .0254

```
    EQUIVALENT HAZEN WILLIAMS C =     108.
    EQUIVALENT MANNING COEFFICIENT =   .0137
    ENERGY LOSS, FEET =    .009
    ENERGY GRADE =       54.077
    HYDRAULIC GRADE =    53.992

A552
45 TURN IN 30" PIPE
"K"LOSS IN FULL ROUND PIPE
    LOSS COEFFICIENT K =    .800
    PIPE DIAMETER =        30.00 INCHES
    INVERT ELEVATION =    49.000

    VELOCITY =    2.34 FT/SEC
    ENERGY LOSS, FEET =    .068
    ENERGY GRADE =       54.145
    HYDRAULIC GRADE =    54.060

A556
30" PIPE BETWEEN DISTR BOX AND PRIM CLR
DARCY-WEISBACH FRICTION
    PIPE DIAMETER =    30.0000INCHES
    ROUGHNESS =      .0060 FEET
    LENGTH =    75.0000 FEET

    VELOCITY, FPS =    2.34
    REYNOLDS NUMBER =    480760.
    DARCY-WEISBACH FRICTION FACTOR =     .0254
    EQUIVALENT HAZEN WILLIAMS C =     108.
    EQUIVALENT MANNING COEFFICIENT =   .0137
    ENERGY LOSS, FEET =    .065
    ENERGY GRADE =       54.210
    HYDRAULIC GRADE =    54.125

BROWN AND CALDWELL          PROFILE        SERIAL NO. 9901
Consulting Engineers        Version 2.00

A560
30" PIPE EXIT FROM DIST BOX #1
"K" LOSS IN RECTANGULAR CONDUIT
    WIDTH =   2.50 FEET
    INVERT ELEV. =    49.000 FEET
    SIDEWALL =   2.50 FEET
    LOSS COEFFICIENT "K" =   1.00

FULL FLOW IN RECTANGULAR CONDUIT
    VELOCITY =    1.84 FT/SEC
    ENERGY LOSS, FEET =    .052
    ENERGY GRADE =       54.262
    HYDRAULIC GRADE =    54.210

A565
CHANNEL AFTER WEIR IN DIST BOX #1
RECTANGULAR CONDUIT
    HEIGHT =  12.50 FEET
    WIDTH =   5.00 FEET
    LENGTH=      5.00 FEET
```

MANNING ROUGHNESS = .0130
SLOPE = .00000 FEET/FOOT
NUMBER OF ANALYSIS SECTIONS = 20.00
INVERT ELEV AT OUTLET = 49.000

SUBCRITICAL FLOW

STATION FEET	WATER DEPTH FEET	VELOCITY FT/SEC	FRICTION FACTOR FT/FOOT	AVERAGE FRICTION FACTOR FT/FOOT	FRICTION LOSS FEET	HYDRAULIC GRADE	ENERGY GRADE
.000	5.259	.437	.00001			54.259	54.262
.250	5.259	.437	.00001	.00001	.000	54.259	54.262
.500	5.259	.437	.00001	.00001	.000	54.259	54.262
.750	5.259	.437	.00001	.00001	.000	54.259	54.262
1.000	5.259	.437	.00001	.00001	.000	54.259	54.262
1.250	5.259	.437	.00001	.00001	.000	54.259	54.262
1.500	5.259	.437	.00001	.00001	.000	54.259	54.262
1.750	5.259	.437	.00001	.00001	.000	54.259	54.262
2.000	5.259	.437	.00001	.00001	.000	54.259	54.262
2.250	5.259	.437	.00001	.00001	.000	54.259	54.262
2.500	5.259	.437	.00001	.00001	.000	54.259	54.262
2.750	5.259	.437	.00001	.00001	.000	54.259	54.262
3.000	5.259	.437	.00001	.00001	.000	54.259	54.262
3.250	5.259	.437	.00001	.00001	.000	54.259	54.262
3.500	5.259	.437	.00001	.00001	.000	54.259	54.262
3.750	5.259	.437	.00001	.00001	.000	54.259	54.262
4.000	5.259	.437	.00001	.00001	.000	54.259	54.262
4.250	5.259	.437	.00001	.00001	.000	54.259	54.262
4.500	5.259	.437	.00001	.00001	.000	54.259	54.262
4.750	5.259	.437	.00001	.00001	.000	54.259	54.262
5.000	5.259	.437	.00001	.00001	.000	54.259	54.262

CRITICAL SLOPE, FT/FT = .0039
CRITICAL DEPTH, FEET = .55
CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET = .000
ENERGY LOSS, FEET = .000

INLET CONDITIONS:
ENERGY GRADE = 54.262
HYDRAULIC GRADE = 54.259

A570
WEIR IN DIST BOX #1
SHARP-CRESTED WEIR
WEIR CREST ELEVATION = 56.750
WEIR DISCHARGE = 11.49 CFS
LENGTH = 12.00 FEET

NO END CONTRACTIONS
FREEBOARD = 2.491
CALCULATED C VALUE = 3.332
HEIGHT OF WATER OVER WEIR = .435
ENERGY LOSS, FEET = 2.923

ENERGY GRADE = 57.185
HYDRAULIC GRADE = 57.185

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F70
FULL FLOW THROUGH EAST SIDE
FLOW PERCENT
FLOW = 22.98 CFS OR 14.85 MGD
66.00 PERCENT OF TOTAL PLANT FLOW.

A580
FIRST CHANNEL IN DIST BOX #1
RECTANGULAR CONDUIT
HEIGHT = 11.92 FEET
WIDTH = 16.00 FEET
LENGTH= 16.00 FEET
MANNING ROUGHNESS = .0130
SLOPE = .00000 FEET/FOOT
NUMBER OF ANALYSIS SECTIONS = 20.00
INVERT ELEV AT OUTLET = 47.330

SUBCRITICAL FLOW

STATION FEET	WATER DEPTH FEET	VELOCITY FT/SEC	FRICTION FACTOR FT/FOOT	AVERAGE FRICTION FACTOR FT/FOOT	FRICTION LOSS FEET	HYDRAULIC GRADE	ENERGY GRADE
.000	9.855	.146	.00000			57.185	57.185
.800	9.855	.146	.00000	.00000	.000	57.185	57.185
1.600	9.855	.146	.00000	.00000	.000	57.185	57.185
2.400	9.855	.146	.00000	.00000	.000	57.185	57.185
3.200	9.855	.146	.00000	.00000	.000	57.185	57.185
4.000	9.855	.146	.00000	.00000	.000	57.185	57.185
4.800	9.855	.146	.00000	.00000	.000	57.185	57.185
5.600	9.855	.146	.00000	.00000	.000	57.185	57.185
6.400	9.855	.146	.00000	.00000	.000	57.185	57.185
7.200	9.855	.146	.00000	.00000	.000	57.185	57.185
8.000	9.855	.146	.00000	.00000	.000	57.185	57.185
8.800	9.855	.146	.00000	.00000	.000	57.185	57.185
9.600	9.855	.146	.00000	.00000	.000	57.185	57.185
10.400	9.855	.146	.00000	.00000	.000	57.185	57.185
11.200	9.855	.146	.00000	.00000	.000	57.185	57.185
12.000	9.855	.146	.00000	.00000	.000	57.185	57.185
12.800	9.855	.146	.00000	.00000	.000	57.185	57.185
13.600	9.855	.146	.00000	.00000	.000	57.185	57.185
14.400	9.855	.146	.00000	.00000	.000	57.185	57.185
15.200	9.855	.146	.00000	.00000	.000	57.185	57.185
16.000	9.855	.146	.00000	.00000	.000	57.185	57.185

CRITICAL SLOPE, FT/FT = .0036
CRITICAL DEPTH, FEET = .40
CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET = .000

```
    ENERGY LOSS, FEET =    .000

    INLET CONDITIONS:
       ENERGY GRADE =        57.185
       HYDRAULIC GRADE =     57.185

A585
48" PIPE EXIT INTO DIST BOX #1
"K"LOSS IN FULL ROUND PIPE
    LOSS COEFFICIENT K =   2.500
    PIPE DIAMETER =        48.00 INCHES
    INVERT ELEVATION =    47.330

    VELOCITY =    1.83 FT/SEC
    ENERGY LOSS, FEET =    .130
    ENERGY GRADE =       57.315
    HYDRAULIC GRADE =    57.263

BROWN AND CALDWELL          PROFILE        SERIAL NO. 9901
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A590
48" PIPE FROM AERATED GRIT CHAM TO DIST BOX #1
DARCY-WEISBACH FRICTION
    PIPE DIAMETER =    48.0000INCHES
    ROUGHNESS =       .0100 FEET
    LENGTH =  1470.0000 FEET

    VELOCITY, FPS =    1.83
    REYNOLDS NUMBER =    600950.
    DARCY-WEISBACH FRICTION FACTOR =     .0256
    EQUIVALENT HAZEN WILLIAMS C =     105.
    EQUIVALENT MANNING COEFFICIENT =   .0148
    ENERGY LOSS, FEET =    .489
    ENERGY GRADE =       57.804
    HYDRAULIC GRADE =    57.752

A595
ALL TURNS IN 48" BETWEEN GRIT CHAM AND DISTR BOX
"K"LOSS IN FULL ROUND PIPE
    LOSS COEFFICIENT K =   8.000
    PIPE DIAMETER =        48.00 INCHES
    INVERT ELEVATION =    47.330

    VELOCITY =    1.83 FT/SEC
    ENERGY LOSS, FEET =    .415
    ENERGY GRADE =       58.220
    HYDRAULIC GRADE =    58.168

A600
48" PIPE ENTRANCE AFTER AERATED GRIT CHAM
"K"LOSS IN FULL ROUND PIPE
    LOSS COEFFICIENT K =   1.800
    PIPE DIAMETER =        48.00 INCHES
    INVERT ELEVATION =    45.250

    VELOCITY =    1.83 FT/SEC
```

ENERGY LOSS, FEET = .093
ENERGY GRADE = 58.313
HYDRAULIC GRADE = 58.261

BROWN AND CALDWELL PROFILE SERIAL NO. 9901
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A610
FINAL CHAN IN AERATED GRIT CHAM
RECTANGULAR CONDUIT
HEIGHT = 15.75 FEET
WIDTH = 10.00 FEET
LENGTH= 34.00 FEET
MANNING ROUGHNESS = .0450
SLOPE = .00000 FEET/FOOT
NUMBER OF ANALYSIS SECTIONS = 20.00
INVERT ELEV AT OUTLET = 44.200

SUBCRITICAL FLOW

STATION FEET	WATER DEPTH FEET	VELOCITY FT/SEC	FRICTION FACTOR FT/FOOT	AVERAGE FRICTION FACTOR FT/FOOT	FRICTION LOSS FEET	HYDRAULIC GRADE	ENERGY GRADE
.000	14.113	.163	.00000			58.313	58.313
1.700	14.113	.163	.00000	.00000	.000	58.313	58.313
3.400	14.113	.163	.00000	.00000	.000	58.313	58.313
5.100	14.113	.163	.00000	.00000	.000	58.313	58.313
6.800	14.113	.163	.00000	.00000	.000	58.313	58.313
8.500	14.113	.163	.00000	.00000	.000	58.313	58.313
10.200	14.113	.163	.00000	.00000	.000	58.313	58.313
11.900	14.113	.163	.00000	.00000	.000	58.313	58.313
13.600	14.113	.163	.00000	.00000	.000	58.313	58.313
15.300	14.113	.163	.00000	.00000	.000	58.313	58.313
17.000	14.113	.163	.00000	.00000	.000	58.313	58.313
18.700	14.113	.163	.00000	.00000	.000	58.313	58.313
20.400	14.113	.163	.00000	.00000	.000	58.313	58.313
22.100	14.113	.163	.00000	.00000	.000	58.313	58.313
23.800	14.113	.163	.00000	.00000	.000	58.313	58.313
25.500	14.113	.163	.00000	.00000	.000	58.313	58.313
27.200	14.113	.163	.00000	.00000	.000	58.313	58.313
28.900	14.113	.163	.00000	.00000	.000	58.313	58.313
30.600	14.113	.163	.00000	.00000	.000	58.313	58.313
32.300	14.113	.163	.00000	.00000	.000	58.313	58.313
34.000	14.113	.163	.00000	.00000	.000	58.313	58.313

CRITICAL SLOPE, FT/FT = .0414
CRITICAL DEPTH, FEET = .55
CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET = .000
ENERGY LOSS, FEET = .000

INLET CONDITIONS:
ENERGY GRADE = 58.313
HYDRAULIC GRADE = 58.313

F80
1/3 FLOW THROUGH EASTSIDE
FLOW PERCENT
FLOW = 7.66 CFS OR 4.95 MGD
22.00 PERCENT OF TOTAL PLANT FLOW.

A620
90 TURN IN AERATED GRIT CHAM
"K" LOSS IN RECTANGULAR CONDUIT
WIDTH = 17.00 FEET
INVERT ELEV. = 45.250 FEET
SIDEWALL = 17.30 FEET
LOSS COEFFICIENT "K" = .40

VELOCITY = .03 FT/SEC
ENERGY LOSS, FEET = .000
ENERGY GRADE = 58.313
HYDRAULIC GRADE = 58.313

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A640
WEIR AFTER AERATED GRIT CHAM
SHARP-CRESTED WEIR
WEIR CREST ELEVATION = 58.750
WEIR DISCHARGE = 7.66 CFS
LENGTH = 2.50 FEET

NO END CONTRACTIONS
FREEBOARD = .437
CALCULATED C VALUE = 3.334
HEIGHT OF WATER OVER WEIR = .945
ENERGY LOSS, FEET = 1.382
ENERGY GRADE = 59.695
HYDRAULIC GRADE = 59.695

A650
CHANNEL IN AERATED GRIT TANK
RECTANGULAR CONDUIT
HEIGHT = 17.30 FEET
WIDTH = 17.00 FEET
LENGTH= 54.00 FEET
MANNING ROUGHNESS = .0200
SLOPE = .00000 FEET/FOOT
NUMBER OF ANALYSIS SECTIONS = 20.00
INVERT ELEV AT OUTLET = 44.200

SUBCRITICAL FLOW

STATION FEET	WATER DEPTH FEET	VELOCITY FT/SEC	FRICTION FACTOR FT/FOOT	AVERAGE FRICTION FACTOR FT/FOOT	FRICTION LOSS FEET	HYDRAULIC GRADE	ENERGY GRADE

.000	15.495	.029	.00000			59.695	59.695
2.700	15.495	.029	.00000	.00000	.000	59.695	59.695
5.400	15.495	.029	.00000	.00000	.000	59.695	59.695
8.100	15.495	.029	.00000	.00000	.000	59.695	59.695
10.800	15.495	.029	.00000	.00000	.000	59.695	59.695
13.500	15.495	.029	.00000	.00000	.000	59.695	59.695
16.200	15.495	.029	.00000	.00000	.000	59.695	59.695
18.900	15.495	.029	.00000	.00000	.000	59.695	59.695
21.600	15.495	.029	.00000	.00000	.000	59.695	59.695
24.300	15.495	.029	.00000	.00000	.000	59.695	59.695
27.000	15.495	.029	.00000	.00000	.000	59.695	59.695
29.700	15.495	.029	.00000	.00000	.000	59.695	59.695
32.400	15.495	.029	.00000	.00000	.000	59.695	59.695
35.100	15.495	.029	.00000	.00000	.000	59.695	59.695
37.800	15.495	.029	.00000	.00000	.000	59.695	59.695
40.500	15.495	.029	.00000	.00000	.000	59.695	59.695
43.200	15.495	.029	.00000	.00000	.000	59.695	59.695
45.900	15.495	.029	.00000	.00000	.000	59.695	59.695
48.600	15.495	.029	.00000	.00000	.000	59.695	59.695
51.300	15.495	.029	.00000	.00000	.000	59.695	59.695
54.000	15.495	.029	.00000	.00000	.000	59.695	59.695

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CRITICAL SLOPE, FT/FT = .0105
CRITICAL DEPTH, FEET =    .19
CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET =  .000
ENERGY LOSS, FEET =   .000

INLET CONDITIONS:
   ENERGY GRADE =       59.695
   HYDRAULIC GRADE =    59.695

A670
36" PIPE ENTRANCE TO AERATED GRIT CHAM
"K"LOSS IN FULL ROUND PIPE
    LOSS COEFFICIENT K =   1.000
    PIPE DIAMETER =        36.00 INCHES
    INVERT ELEVATION =    51.000

    VELOCITY =    1.08 FT/SEC
    ENERGY LOSS, FEET =    .018
    ENERGY GRADE =       59.713
    HYDRAULIC GRADE =    59.695

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A690
36" PIPE IN AERATED GRIT TANK
DARCY-WEISBACH FRICTION
    PIPE DIAMETER =    36.0000INCHES
    ROUGHNESS =      .0025 FEET
    LENGTH =    72.0000 FEET

    VELOCITY, FPS =    1.08
    REYNOLDS NUMBER =    267089.
    DARCY-WEISBACH FRICTION FACTOR =     .0204
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    EQUIVALENT HAZEN WILLIAMS C =      127.
    EQUIVALENT MANNING COEFFICIENT =   .0126
    ENERGY LOSS, FEET =    .009
    ENERGY GRADE =       59.722
    HYDRAULIC GRADE =    59.704

A690
2 45 TURNS  IN 36" PIPE
"K"LOSS IN FULL ROUND PIPE
    LOSS COEFFICIENT K =    .400
    PIPE DIAMETER =        36.00 INCHES
    INVERT ELEVATION =    51.000

    VELOCITY =    1.08 FT/SEC
    ENERGY LOSS, FEET =    .007
    ENERGY GRADE =       59.730
    HYDRAULIC GRADE =    59.711

A700
36" PIPE ENTRANCE IN AERATED GRIT CHAM
"K"LOSS IN FULL ROUND PIPE
    LOSS COEFFICIENT K =    .500
    PIPE DIAMETER =        36.00 INCHES
    INVERT ELEVATION =    51.500

    VELOCITY =    1.08 FT/SEC
    ENERGY LOSS, FEET =    .009
    ENERGY GRADE =       59.739
    HYDRAULIC GRADE =    59.721

BROWN AND CALDWELL          PROFILE        SERIAL NO. 9901
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A705
WEIR IN BEGIN OF AERATED GRIT TANK
SHARP-CRESTED WEIR
    WEIR CREST ELEVATION =    60.500
    WEIR DISCHARGE =     7.66 CFS
    LENGTH =     3.00 FEET

    NO END CONTRACTIONS
    FREEBOARD =   .779
    CALCULATED C VALUE =  3.336
    HEIGHT OF WATER OVER WEIR =   .837
    ENERGY LOSS, FEET =   1.598
    ENERGY GRADE =       61.337
    HYDRAULIC GRADE =    61.337

F100
FULL FLOW
 FLOW PERCENT
    FLOW =    22.98 CFS OR     14.85 MGD
            66.00 PERCENT OF TOTAL PLANT FLOW.

A720
CHAMBER IN AERATED GRIT CHAM
RECTANGULAR CONDUIT
```

HEIGHT = 10.00 FEET
WIDTH = 10.00 FEET
LENGTH= 5.00 FEET
MANNING ROUGHNESS = .0130
SLOPE = .00000 FEET/FOOT
NUMBER OF ANALYSIS SECTIONS = 20.00
INVERT ELEV AT OUTLET = 51.500

SUBCRITICAL FLOW

STATION FEET	WATER DEPTH FEET	VELOCITY FT/SEC	FRICTION FACTOR FT/FOOT	AVERAGE FRICTION FACTOR FT/FOOT	FRICTION LOSS FEET	HYDRAULIC GRADE	ENERGY GRADE
.000	9.836	.234	.00000			61.336	61.337
.250	9.836	.234	.00000	.00000	.000	61.336	61.337
.500	9.836	.234	.00000	.00000	.000	61.336	61.337
.750	9.836	.234	.00000	.00000	.000	61.336	61.337
1.000	9.836	.234	.00000	.00000	.000	61.336	61.337
1.250	9.836	.234	.00000	.00000	.000	61.336	61.337
1.500	9.836	.234	.00000	.00000	.000	61.336	61.337
1.750	9.836	.234	.00000	.00000	.000	61.336	61.337
2.000	9.836	.234	.00000	.00000	.000	61.336	61.337
2.250	9.836	.234	.00000	.00000	.000	61.336	61.337
2.500	9.836	.234	.00000	.00000	.000	61.336	61.337
2.750	9.836	.234	.00000	.00000	.000	61.336	61.337
3.000	9.836	.234	.00000	.00000	.000	61.336	61.337
3.250	9.836	.234	.00000	.00000	.000	61.336	61.337
3.500	9.836	.234	.00000	.00000	.000	61.336	61.337
3.750	9.836	.234	.00000	.00000	.000	61.336	61.337
4.000	9.836	.234	.00000	.00000	.000	61.336	61.337
4.250	9.836	.234	.00000	.00000	.000	61.336	61.337
4.500	9.836	.234	.00000	.00000	.000	61.336	61.337
4.750	9.836	.234	.00000	.00000	.000	61.336	61.337
5.000	9.836	.234	.00000	.00000	.000	61.336	61.337

CRITICAL SLOPE, FT/FT = .0035
CRITICAL DEPTH, FEET = .55
CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET = .000
ENERGY LOSS, FEET = .000

INLET CONDITIONS:
ENERGY GRADE = 61.337
HYDRAULIC GRADE = 61.336

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A725
4.5 FT CHAN OPENING
"K" LOSS IN RECTANGULAR CONDUIT
WIDTH = 4.50 FEET
INVERT ELEV. = 51.500 FEET
SIDEWALL = 9.75 FEET

LOSS COEFFICIENT "K" = 1.00

FULL FLOW IN RECTANGULAR CONDUIT
VELOCITY = .52 FT/SEC
ENERGY LOSS, FEET = .004
ENERGY GRADE = 61.341
HYDRAULIC GRADE = 61.337

A730
90 TURN IN AERATED GRIT CHAM
"K" LOSS IN RECTANGULAR CONDUIT
WIDTH = 10.00 FEET
INVERT ELEV. = 51.500 FEET
SIDEWALL = 10.00 FEET
LOSS COEFFICIENT "K" = .30

VELOCITY = .23 FT/SEC
ENERGY LOSS, FEET = .000
ENERGY GRADE = 61.341
HYDRAULIC GRADE = 61.340

A740
FIRST CHANNEL IN GRIT CHAM
RECTANGULAR CONDUIT
HEIGHT = 9.75 FEET
WIDTH = 16.00 FEET
LENGTH= 8.00 FEET
MANNING ROUGHNESS = .0130
SLOPE = .00000 FEET/FOOT
NUMBER OF ANALYSIS SECTIONS = 20.00
INVERT ELEV AT OUTLET = 51.750

SUBCRITICAL FLOW

STATION FEET	WATER DEPTH FEET	VELOCITY FT/SEC	FRICTION FACTOR FT/FOOT	AVERAGE FRICTION FACTOR FT/FOOT	FRICTION LOSS FEET	HYDRAULIC GRADE	ENERGY GRADE
.000	9.591	.150	.00000			61.341	61.341
.400	9.591	.150	.00000	.00000	.000	61.341	61.341
.800	9.591	.150	.00000	.00000	.000	61.341	61.341
1.200	9.591	.150	.00000	.00000	.000	61.341	61.341
1.600	9.591	.150	.00000	.00000	.000	61.341	61.341
2.000	9.591	.150	.00000	.00000	.000	61.341	61.341
2.400	9.591	.150	.00000	.00000	.000	61.341	61.341
2.800	9.591	.150	.00000	.00000	.000	61.341	61.341
3.200	9.591	.150	.00000	.00000	.000	61.341	61.341
3.600	9.591	.150	.00000	.00000	.000	61.341	61.341
4.000	9.591	.150	.00000	.00000	.000	61.341	61.341
4.400	9.591	.150	.00000	.00000	.000	61.341	61.341
4.800	9.591	.150	.00000	.00000	.000	61.341	61.341
5.200	9.591	.150	.00000	.00000	.000	61.341	61.341
5.600	9.591	.150	.00000	.00000	.000	61.341	61.341
6.000	9.591	.150	.00000	.00000	.000	61.341	61.341
6.400	9.591	.150	.00000	.00000	.000	61.341	61.341

6.800	9.591	.150	.00000	.00000	.000	61.341	61.341
7.200	9.591	.150	.00000	.00000	.000	61.341	61.341
7.600	9.591	.150	.00000	.00000	.000	61.341	61.341
8.000	9.591	.150	.00000	.00000	.000	61.341	61.341

CRITICAL SLOPE, FT/FT = .0036
CRITICAL DEPTH, FEET = .40
CHANGE IN HYDRAULIC GRADE WITHIN CONDUIT, FEET = .000
ENERGY LOSS, FEET = .000

INLET CONDITIONS:
ENERGY GRADE = 61.341
HYDRAULIC GRADE = 61.341

```
THERESA STREET WWTP
EAST SIDE 1971
LINCOLN

MARK RICHARDS
8/13/01
     22.50       44.77       44.77

 0

F10
FULL FLOW THROUGH PLANT
 2
      100.00,        0.00,

A10
OUTFALL AT SALT CREEK
 5
       48.00,           1,       24.50,        0.00,

A20
48" PIPE FROM JB TO OUTFALL
 4
       48.00,      0.0025,      100.00,        0.00,

A30
EXIT FROM JB
 5
       48.00,         0.5,       30.00,        0.00,

A40
JUNCTION BOX BEFORE CREEK
12
       20.00,        6.00,       16.00,        4.00,       0.013,           0,
30.00,        1.00,

F15
FULL FLOW FROM BOTH TRAINS
 2
      100.00,        0.00,

A50
ENTRANCE INTO JB
 5
       48.00,         2.2,       37.00,        0.00,

A60
48" PIPE FROM CHL TANK TO JB
 4
       48.00,      0.0055,       15.00,        0.00,

A63
90 TURN IN PIPE
 5
       48.00,        0.55,       37.00,        0.00,

A67
```

48" PIPE BETWEEN CHL AND JB
4
48.00, 0.0055, 20.00, 0.00,

A70
48" EXIT FROM CHL TANK
5
48.00, 1.5, 37.00, 0.00,

A80
FINAL CHANNEL IN CHL TANK
12
20.00, 25.00, 9.60, 7.00, 0.013, 0,
37.00, 1.00,

F20
1/2 TOTAL FLOW THROUGH CHL TANK
2
50.00, 0.00,

A85
SHARP CRESETED WEIR IN CHR TANK
3
5.00, 45.33, 0.00, 36.00, 0.00,

A90
4TH PASS IN CHL TANK
12
20.00, 50.00, 10.60, 10.00, 0.013, 0,
36.00, 0.00,

A100
180 TURN IN CHL TANK
16
0.6, 10.00, 36.00, 1.00, 10.60, 0.00,

A110
3RD PASS IN CHL TANK
12
20.00, 50.00, 10.60, 29.50, 0.013, 0,
36.00, 0.00,

A120
180 TURN IN CHL TANK
16
0.6, 29.50, 36.00, 0.00, 10.60, 0.00,

A130
2ND PASS IN CHL TANK
12
20.00, 50.00, 10.60, 29.50, 0.013, 0,
36.00, 0.00,

A140
180 TURN IN CHL TANK
16
0.6, 29.50, 36.00, 1.00, 10.60, 0.00,

```
A150
1ST PASS IN CHL TANK
12
       20.00,       50.00,       10.60,       29.50,       0.013,            0,
36.00,        1.00,

A155
90 TURN IN CHL
16
           2,       29.50,       36.00,        0.00,       10.60,        0.00,

A170
SUB ORIFICE IN CHL TANK (?)
18
        1.00,        4.00,        4.00,        0.47,        0.00,

F30
FULL FLOW IN CHL TANK
 2
      100.00,        0.00,

A180
FIRST CHANNEL IN CHL TANK
12
       20.00,       16.00,       15.50,        8.00,       0.013,            0,
31.00,        1.00,

A185
60" ENTRANCE INTO CHL TANK
 5
       60.00,           3,       31.00,        0.00,

A190
60" PIPE BETWEEN DIST BOX AND CHL TANK
 4
       60.00,       0.006,       55.00,        0.00,

A200
60" PIPE EXIT FROM DIST BOX
 5
       60.00,         2.3,       31.00,        0.00,

F30
FULL FLOW WITH 1965 TRAIN
 2
      100.00,        0.00,

A210
DIST BOX #2
12
       20.00,        8.00,       27.00,        8.00,        0.02,            0,
31.00,        1.00,

F40
1/2 FLOW THROUGH PRC TRAIN 1971
 2
```

```
      33.00,        0.00,

A230
30" ENTRANCE INTO DISTR BOX #2
 5
      30.00,         0.5,       41.79,        0.00,

A240
30" PIPE FROM FINAL BASIN TO DISTR BOX#2
 4
      30.00,       0.002,       25.00,        0.00,

A250
30" PIPE ENTRANCE AFTER FINAL CLR
 5
      30.00,         0.2,       41.79,        0.00,

A255
DROP BOX AFTER FINAL CLR
12
      20.00,        3.00,        7.47,        7.00,        0.01,           0,
42.03,        1.00,

A260
COLLECTION LAUNDER IN FINAL CHL
 7
      30.00,      194.80,        2.50,        2.50,        2.00,        0.01,
0,       45.80,        0.50,        0.00,        1.00,

A270
WEIR PLATE IN FINAL CHL
 8
     389.56,        6.00,       90.00,       48.00,        2.00,        1.00,

F67
1/2 FLOW WITH 1/2 RAS
 2
      50.00,        0.00,

A280
30" PIPE OPENING
 5
      30.00,           1,       28.92,        0.00,

A300
90 DEGREE ELBOW UNDER FINAL CHL
 5
      30.00,         0.6,       28.92,        0.00,

A302
30" PIPE FROM AERATION BASIN TO FINAL CLR
 4
      30.00,      0.0042,       80.00,        0.00,

A310
30" ENTRANCE AFTER AERATION BASIN
 5
```

30.00, 0.5, 31.51, 0.00,

A320
MIXED LIQUOR CH IN AERATION BASIN
12
20.00, 56.00, 24.50, 3.00, 0.013, 0,
31.50, 1.00,

A330
180 TURN IN AERATION
16
0.6, 44.00, 47.79, 0.00, 24.50, 0.00,

A340
WEIR #4 IN AERATION
3
20.00, 50.00, 0.00, 31.50, 0.00,

A350
ZONE #4 IN AEARION BASIN
12
20.00, 92.00, 24.50, 44.00, 0.013, 0,
31.50, 0.00,

A360
180 TUNE IN AEARATION BASIN
16
0.6, 44.00, 31.50, 0.00, 24.50, 0.00,

A370
WEIR #3 IN AEARATION BASIN
3
20.00, 49.83, 0.00, 31.50, 0.00,

A380
ZONE 3 IN AEARION BASIN
12
20.00, 92.00, 24.50, 23.00, 0.013, 0,
31.50, 1.00,

A390
180 TURN IN AERATION BASIN
16
0.6, 23.00, 31.50, 0.00, 24.50, 0.00,

A400
WEIR #2 IN AEARATION BASIN
3
20.00, 50.18, 0.00, 31.50, 0.00,

A410
ZONE #2 IN AEARATION BASIN
12
20.00, 92.00, 24.50, 24.00, 0.013, 0,
31.50, 0.00,

A420

180 TURN IN AEATION BASIN
16
0.6, 23.00, 31.50, 0.00, 24.50, 0.00,

A430
WEIR #1 IN AEARATION BASIN
3
20.00, 48.00, 0.00, 31.50, 0.00,

A450
ZONE#1 IN AEARATION BASIN
12
20.00, 42.00, 24.50, 8.00, 0.013, 0,
47.79, 1.00,

F80
HALF FLOW WITH NO RAS NO RECYCLE
2
33.00, 0.00,

A460
30" PIPE ENTRANCE
5
30.00, 1, 47.79, 0.00,

A470
30" PIPE BETWEEN PRIM BASIN AND AERATION BASIN
12
20.00, 10.00, 30.00, 0.00, 0.013, 0,
47.79, 0.00,

A473
45 TURN IN 30" PIPE
16
0.2, 2.50, 47.79, 0.00, 2.50, 0.00,

A477
30" PIPE BETWEEN PRIM CLR AND AERATION BASIN
12
20.00, 15.00, 30.00, 0.00, 0.013, 0,
47.79, 0.00,

A480
30" PIPE ENTRANCE AFTER PRIM CLR
16
0.5, 2.50, 47.79, 0.00, 2.50, 0.00,

A490
DROP BOX AFTER PRIM CLR
12
20.00, 2.50, 7.00, 5.00, 0.013, 0,
47.79, 1.00,

A500
EFFLUENT LAUNDER IN PRIMARY CLR
7

```
      20.00,      186.92,        2.50,        2.50,        2.00,        0.013,
0,       51.30,        0.50,        0.00,        1.00,

A510
WEIR PLATE IN PRIMARY CLR
 8
     747.69,        6.00,       90.00,       54.00,        2.00,        1.00,

A520
ENTRANCE IN PRIM CLR
18
       1.00,       30.00,        0.00,           1,        0.00,

A540
30" ELBOW UNDER PRIM CLR
 5
      30.00,         0.6,       32.00,        0.00,

A550
30" PIPE FROM PRIM DIST BOX #1 TO PRIM CLR
 4
      30.00,       0.006,       10.00,        0.00,

A552
45 TURN IN 30" PIPE
 5
      30.00,         0.8,       49.00,        0.00,

A556
30" PIPE BETWEEN DISTR BOX AND PRIM CLR
 4
      30.00,       0.006,       75.00,        0.00,

A560
30" PIPE EXIT FROM DIST BOX #1
16
          1,        2.50,       49.00,        0.00,        2.50,        0.00,

A565
CHANNEL AFTER WEIR IN DIST BOX #1
12
      20.00,        5.00,       12.50,        5.00,       0.013,           0,
49.00,        1.00,

A570
WEIR IN DIST BOX #1
 3
      12.00,       56.75,        0.00,       49.00,        0.00,

F70
FULL FLOW THROUGH EAST SIDE
 2
      66.00,        0.00,

A580
FIRST CHANNEL IN DIST BOX #1
12
```

```
      20.00,       16.00,       11.92,       16.00,       0.013,           0,
47.33,        1.00,

A585
48" PIPE EXIT INTO DIST BOX #1
 5
      48.00,        2.5,       47.33,        0.00,

A590
48" PIPE FROM AERATED GRIT CHAM TO DIST BOX #1
 4
      48.00,       0.01,     1470.00,        0.00,

A595
ALL TURNS IN 48" BETWEEN GRIT CHAM AND DISTR BOX
 5
      48.00,          8,       47.33,        0.00,

A600
48" PIPE ENTRANCE AFTER AERATED GRIT CHAM
 5
      48.00,        1.8,       45.25,        0.00,

A610
FINAL CHAN IN AERATED GRIT CHAM
12
      20.00,       34.00,       15.75,       10.00,       0.045,           0,
44.20,        1.00,

F80
1/3 FLOW THROUGH EASTSIDE
 2
      22.00,        0.00,

A620
90 TURN IN AERATED GRIT CHAM
16
        0.4,       17.00,       45.25,        0.00,       17.30,        0.00,

A640
WEIR AFTER AERATED GRIT CHAM
 3
       2.50,       58.75,        0.00,       45.25,        0.00,

A650
CHANNEL IN AERATED GRIT TANK
12
      20.00,       54.00,       17.30,       17.00,        0.02,           0,
44.20,        1.00,

A670
36" PIPE ENTRANCE TO AERATED GRIT CHAM
 5
      36.00,          1,       51.00,        0.00,

A690
36" PIPE IN AERATED GRIT TANK
```

```
 4
       36.00,       0.0025,       72.00,        0.00,

A690
2 45 TURNS  IN 36" PIPE
 5
       36.00,          0.4,       51.00,        0.00,

A700
36" PIPE ENTRANCE IN AERATED GRIT CHAM
 5
       36.00,          0.5,       51.50,        0.00,

A705
WEIR IN BEGIN OF AERATED GRIT TANK
 3
        3.00,        60.50,        0.00,       51.50,        0.00,

F100
FULL FLOW
 2
       66.00,        0.00,

A720
CHAMBER IN AERATED GRIT CHAM
12
       20.00,        5.00,       10.00,       10.00,       0.013,           0,
51.50,        0.00,

A725
4.5 FT CHAN OPENING
16
           1,        4.50,       51.50,        0.00,        9.75,        0.00,

A730
90 TURN IN AERATED GRIT CHAM
16
         0.3,       10.00,       51.50,        0.00,       10.00,        0.00,

A740
FIRST CHANNEL IN GRIT CHAM
12
       20.00,        8.00,        9.75,       16.00,       0.013,           0,
51.75,        1.00,
```

```
BBBBB      CCC      BROWN AND CALDWELL
BBBBBB    CCCCC     Consulting Engineers
BB  BBB  CCC CCC
BB   BB  CC   CC    PROFILE        SERIAL NO. 9901
BB  BBB  CC   CC    Version 2.00
BBBBBB   CC
BBBBB    CC         File name: C:\PROFIL~2\EASTSIDE.sum
BBBBBB   CC         Data file: C:\PROFIL~2\EASTSIDE.pro
BB  BBB  CC   CC    THERESA STREET WWTP
BB   BB  CC   CC    EAST SIDE 1971
BB  BBB  CC   CC    LINCOLN
BBBBBB    CCCCC
BBBBB      CCC      8/13/01              By:MARK RICHARDS
```

PLANT FLOW = 34.81 CFS OR 22.50 MGD

DOWNSTREAM CONDITIONS:
ENERGY GRADE = 44.77 FEET
HYDRAULIC GRADE = 44.77 FEET

ELEMENT	DESCRIPTION		HYDRAULIC GRADE	ENERGY GRADE
A740	FIRST CHANNEL IN GRIT CHAM		61.34	61.34
A650	CHANNEL IN AERATED GRIT TANK		59.70	59.70
A610	FINAL CHAN IN AERATED GRIT CHA		58.31	58.31
A580	FIRST CHANNEL IN DIST BOX #1		57.19	57.19
A565	CHANNEL AFTER WEIR IN DIST BOX		54.26	54.26
A510	WEIR PLATE IN PRIMARY CLR		53.93	53.93
	FREE DISCHARGE, FREEBOARD	1.49		
	V-NOTCH INVERT	53.83		
A500	EFFLUENT LAUNDER IN PRIMARY CL		52.35	52.35
A490	DROP BOX AFTER PRIM CLR		50.79	50.80
A450	ZONE#1 IN AEARATION BASIN		50.65	50.66
A380	ZONE 3 IN AEARION BASIN		50.48	50.48
A320	MIXED LIQUOR CH IN AERATION BA		48.51	48.52
A270	WEIR PLATE IN FINAL CHL		47.96	47.96
	FREE DISCHARGE, FREEBOARD	.95		
	V-NOTCH INVERT	47.83		
A260	COLLECTION LAUNDER IN FINAL CH		46.88	46.88

A255	DROP BOX AFTER FINAL CLR	46.81	46.81
A210	DIST BOX #2	46.73	46.73
A180	FIRST CHANNEL IN CHL TANK	46.46	46.46
A150	1ST PASS IN CHL TANK	46.38	46.38
A80	FINAL CHANNEL IN CHL TANK	45.53	45.53
A40	JUNCTION BOX BEFORE CREEK	45.00	45.00

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BBBBB      CCC      BROWN AND CALDWELL
BBBBBB    CCCCC     Consulting Engineers
BB  BBB  CCC CCC
BB   BB  CC   CC    PROFILE        SERIAL NO. 9901
BB  BBB  CC   CC    Version 2.00
BBBBBB   CC
BBBBB    CC         File name: C:\PROFIL~2\NE_GRI~3.SUM
BBBBBB   CC         Data file: C:\PROFIL~2\NE_GRI~3.PRO
BB  BBB  CC   CC    NORTHEAST WWTP
BB   BB  CC   CC    FROM PARSHALL FLUME TO PS BEFORE TOWER
BB  BBB  CC   CC    LINCOLN
BBBBBB    CCCCC
BBBBB      CCC      8/14/01              By:MARK RICHARDS
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PLANT FLOW = 30.94 CFS OR 20.00 MGD

DOWNSTREAM CONDITIONS:
ENERGY GRADE = 33.00 FEET
HYDRAULIC GRADE = 33.00 FEET

ELEMENT	DESCRIPTION		HYDRAULIC GRADE	ENERGY GRADE
A260	CHANNEL BEFORE PARSHALL FLUME		43.50	43.91
A250	CHANNEL DOWNSTREAM OF PARSHALL		41.25	41.25
A240	LARGE CHANNEL IN AERATED GRIT		41.24	41.24
A230	WEIR IN AERATED GRIT TANK		41.24	41.24
	WS DOWNSTREAM OF WEIR	39.84		
	TOP OF WEIR	40.75		
A210	SHORT CHANNEL IN AERATED GRIT		39.84	39.84
A130	WIER IN PRIM CLR		39.74	39.74
	FREE DISCHARGE, FREEBOARD	1.15		
	V-NOTCH INVERT	39.61		
A110	DROP BOX AFTER PRIM CLR		33.06	33.08

```
BBBBB      CCC      BROWN AND CALDWELL
BBBBBB    CCCCC     Consulting Engineers
BB  BBB  CCC CCC
BB   BB  CC   CC    PROFILE        SERIAL NO. 9901
BB  BBB  CC   CC    Version 2.00
BBBBBB   CC
BBBBB    CC         File name: C:\PROFIL~2\NE_GRI~4.SUM
BBBBBB   CC         Data file: C:\PROFIL~2\NEED3D~1.PRO
BB  BBB  CC   CC    NORTHEAST WWTP
BB   BB  CC   CC    FROM PARSHALL FLUME TO PS BEFORE TOWER
BB  BBB  CC   CC    LINCOLN
BBBBBB    CCCCC
BBBBB      CCC      8/14/01              By:MARK RICHARDS
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PLANT FLOW = 54.15 CFS OR 35.00 MGD

DOWNSTREAM CONDITIONS:
ENERGY GRADE = 33.00 FEET
HYDRAULIC GRADE = 33.00 FEET

ELEMENT	DESCRIPTION		HYDRAULIC GRADE	ENERGY GRADE
A260	CHANNEL BEFORE PARSHALL FLUME		44.65	45.05
A250	CHANNEL DOWNSTREAM OF PARSHALL		41.49	41.50
A240	LARGE CHANNEL IN AERATED GRIT		41.46	41.46
A230	WEIR IN AERATED GRIT TANK		41.46	41.46
	WS DOWNSTREAM OF WEIR	40.08		
	TOP OF WEIR	40.75		
A210	SHORT CHANNEL IN AERATED GRIT		40.08	40.08
A130	WIER IN PRIM CLR		39.77	39.77
	FREE DISCHARGE, FREEBOARD	.58		
	V-NOTCH INVERT	39.61		
A110	DROP BOX AFTER PRIM CLR		33.17	33.24

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BBBBB      CCC      BROWN AND CALDWELL
BBBBBB    CCCCC     Consulting Engineers
BB  BBB  CCC CCC
BB   BB  CC   CC    PROFILE        SERIAL NO. 9901
BB  BBB  CC   CC    Version 2.00
BBBBBB   CC
BBBBB    CC         File name: C:\PROFIL~2\NEF121~1.SUM
BBBBBB   CC         Data file: C:\PROFIL~2\NE_GRI~4.PRO
BB  BBB  CC   CC    NORTHEAST WWTP
BB   BB  CC   CC    FROM PARSHALL FLUME TO PS BEFORE TOWER
BB  BBB  CC   CC    LINCOLN
BBBBBB    CCCCC
BBBBB      CCC      8/14/01              By:MARK RICHARDS
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PLANT FLOW = 77.36 CFS OR 50.00 MGD

DOWNSTREAM CONDITIONS:
ENERGY GRADE = 33.00 FEET
HYDRAULIC GRADE = 33.00 FEET

ELEMENT	DESCRIPTION		HYDRAULIC GRADE	ENERGY GRADE
A260	CHANNEL BEFORE PARSHALL FLUME		45.42	46.06
A250	CHANNEL DOWNSTREAM OF PARSHALL		41.72	41.73
A240	LARGE CHANNEL IN AERATED GRIT		41.65	41.65
A230	WEIR IN AERATED GRIT TANK		41.65	41.65
	WS DOWNSTREAM OF WEIR	40.42		
	TOP OF WEIR	40.75		
A210	SHORT CHANNEL IN AERATED GRIT		40.42	40.42
A130	WIER IN PRIM CLR		39.81	39.81
	FREE DISCHARGE, FREEBOARD	.10		
	V-NOTCH INVERT	39.61		
A110	DROP BOX AFTER PRIM CLR		33.37	33.49

```
BBBBB      CCC      BROWN AND CALDWELL
BBBBBB    CCCCC     Consulting Engineers
BB  BBB  CCC CCC
BB   BB  CC   CC    PROFILE        SERIAL NO. 9901
BB  BBB  CC   CC    Version 2.00
BBBBBB   CC
BBBBB    CC         File name: C:\PROFIL~2\NE_GRI~2.SUM
BBBBBB   CC         Data file: C:\PROFIL~2\NE_GRI~2.PRO
BB  BBB  CC   CC    NORTHEAST WWTP
BB   BB  CC   CC    FROM PARSHALL FLUME TO PS BEFORE TOWER
BB  BBB  CC   CC    LINCOLN
BBBBBB    CCCCC
BBBBB      CCC      8/14/01              By:MARK RICHARDS
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PLANT FLOW = 12.38 CFS OR 8.00 MGD

DOWNSTREAM CONDITIONS:
ENERGY GRADE = 33.00 FEET
HYDRAULIC GRADE = 33.00 FEET

ELEMENT	DESCRIPTION		HYDRAULIC GRADE	ENERGY GRADE
A260	CHANNEL BEFORE PARSHALL FLUME		42.78	43.03
A250	CHANNEL DOWNSTREAM OF PARSHALL		41.02	41.02
A240	LARGE CHANNEL IN AERATED GRIT		41.02	41.02
A230	WEIR IN AERATED GRIT TANK		41.02	41.02
	WS DOWNSTREAM OF WEIR	39.72		
	TOP OF WEIR	40.75		
A210	SHORT CHANNEL IN AERATED GRIT		39.72	39.72
A130	WIER IN PRIM CLR		39.70	39.70
	FREE DISCHARGE, FREEBOARD	1.71		
	V-NOTCH INVERT	39.61		
A110	DROP BOX AFTER PRIM CLR		33.01	33.01

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BBBBB      CCC      BROWN AND CALDWELL
BBBBBB    CCCCC     Consulting Engineers
BB  BBB  CCC CCC
BB   BB  CC   CC    PROFILE        SERIAL NO. 9901
BB  BBB  CC   CC    Version 2.00
BBBBBB   CC
BBBBB    CC         File name: C:\PROFIL~2\NE_GRI~1.SUM
BBBBBB   CC         Data file: C:\PROFIL~2\NE_GRI~1.PRO
BB  BBB  CC   CC    NORTHEAST WWTP
BB   BB  CC   CC    FROM PARSHALL FLUME TO PS BEFORE TOWER
BB  BBB  CC   CC    LINCOLN
BBBBBB    CCCCC
BBBBB      CCC      8/14/01              By:MARK RICHARDS
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PLANT FLOW = 24.76 CFS OR 16.00 MGD

DOWNSTREAM CONDITIONS:
ENERGY GRADE = 33.00 FEET
HYDRAULIC GRADE = 33.00 FEET

ELEMENT	DESCRIPTION		HYDRAULIC GRADE	ENERGY GRADE
A260	CHANNEL BEFORE PARSHALL FLUME		43.21	43.62
A250	CHANNEL DOWNSTREAM OF PARSHALL		41.18	41.18
A240	LARGE CHANNEL IN AERATED GRIT		41.17	41.17
A230	WEIR IN AERATED GRIT TANK		41.17	41.17
	WS DOWNSTREAM OF WEIR	39.79		
	TOP OF WEIR	40.75		
A210	SHORT CHANNEL IN AERATED GRIT		39.79	39.79
A130	WIER IN PRIM CLR		39.73	39.73
	FREE DISCHARGE, FREEBOARD	1.32		
	V-NOTCH INVERT	39.61		
A110	DROP BOX AFTER PRIM CLR		33.04	33.05

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BBBBB      CCC      BROWN AND CALDWELL
BBBBBB    CCCCC     Consulting Engineers
BB  BBB  CCC CCC
BB   BB  CC   CC    PROFILE        SERIAL NO. 9901
BB  BBB  CC   CC    Version 2.00
BBBBBB   CC
BBBBB    CC         File name: C:\PROFIL~2\WESTSI~2.SUM
BBBBBB   CC         Data file: C:\PROFIL~2\WESTSI~1.PRO
BB  BBB  CC   CC    THERESA STREET WWTP
BB   BB  CC   CC    WEST SIDE 1965
BB  BBB  CC   CC    LINCOLN
BBBBBB    CCCCC
BBBBB      CCC      8/13/01              By:MARK RICHARDS
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PLANT FLOW = 15.47 CFS OR 10.00 MGD

DOWNSTREAM CONDITIONS:
ENERGY GRADE = 44.77 FEET
HYDRAULIC GRADE = 44.77 FEET

ELEMENT	DESCRIPTION		HYDRAULIC GRADE	ENERGY GRADE
A720	CHAMBER IN AERATED GRIT CHAM		60.91	60.91
A610	FINAL CHAN IN AERATED GRIT CHA		57.57	57.57
A510	WEIR PLATE IN PRIMARY CLR		57.42	57.42
	FREE DISCHARGE, FREEBOARD	1.07		
	V-NOTCH INVERT	57.28		
A500	EFFLUENT LAUNDER IN PRIMARY CL		56.21	56.21
A490	DROP BOX AFTER PRIM CLR		53.86	53.87
A459	CHANNEL IN JUCNTION BOX		53.71	53.71
A450	ZONE#1 IN AEARATION BASIN		53.63	53.63
A320	EFFLUENT CH IN AERATION BASIN		49.92	49.92
A304	CHANNEL IN DISTR BOX		49.63	49.63
A270	WEIR PLATE IN FINAL CHL		49.22	49.22
	FREE DISCHARGE, FREEBOARD	1.56		
	V-NOTCH INVERT	49.13		
A265	COLLECTION LAUNDER IN FINAL CH		47.56	47.56
A260	DROP BOX AFTER FINAL CLR		47.47	47.47
A255	JUNCTION MANHOLE #1		47.42	47.42

A219	JUNCTION BOX #2	47.39	47.39
A215	JUNCTION BOX #3	47.39	47.39
A210	DIST BOX #2	47.38	47.38
A180	FIRST CHANNEL IN CHL TANK	46.90	46.90
A150	1ST PASS IN CHL TANK	46.75	46.75
A80	FINAL CHANNEL IN CHL TANK	46.12	46.13
A40	JUNCTION BOX BEFORE CREEK	45.18	45.18

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BBBBB      CCC      BROWN AND CALDWELL
BBBBBB    CCCCC     Consulting Engineers
BB  BBB  CCC CCC
BB   BB  CC   CC    PROFILE        SERIAL NO. 9901
BB  BBB  CC   CC    Version 2.00
BBBBBB   CC
BBBBB    CC         File name: C:\PROFIL~2\WESTSI~3.SUM
BBBBBB   CC         Data file: C:\PROFIL~2\WESTSI~2.PRO
BB  BBB  CC   CC    THERESA STREET WWTP
BB   BB  CC   CC    WEST SIDE 1965
BB  BBB  CC   CC    LINCOLN
BBBBBB    CCCCC
BBBBB      CCC      8/13/01              By:MARK RICHARDS
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PLANT FLOW = 19.34 CFS OR 12.50 MGD

DOWNSTREAM CONDITIONS:
ENERGY GRADE = 44.77 FEET
HYDRAULIC GRADE = 44.77 FEET

ELEMENT	DESCRIPTION		HYDRAULIC GRADE	ENERGY GRADE
A720	CHAMBER IN AERATED GRIT CHAM		60.98	60.98
A610	FINAL CHAN IN AERATED GRIT CHA		57.66	57.66
A510	WEIR PLATE IN PRIMARY CLR		57.43	57.43
	FREE DISCHARGE, FREEBOARD	.97		
	V-NOTCH INVERT	57.28		
A500	EFFLUENT LAUNDER IN PRIMARY CL		56.31	56.31
A490	DROP BOX AFTER PRIM CLR		54.13	54.13
A459	CHANNEL IN JUCNTION BOX		53.89	53.89
A450	ZONE#1 IN AEARATION BASIN		53.76	53.76
A320	EFFLUENT CH IN AERATION BASIN		50.32	50.32
A304	CHANNEL IN DISTR BOX		49.87	49.87
A270	WEIR PLATE IN FINAL CHL		49.22	49.22
	FREE DISCHARGE, FREEBOARD	.68		
	V-NOTCH INVERT	49.13		
A265	COLLECTION LAUNDER IN FINAL CH		48.44	48.44
A260	DROP BOX AFTER FINAL CLR		48.41	48.41
A255	JUNCTION MANHOLE #1		48.33	48.33

A219	JUNCTION BOX #2	48.29	48.29
A215	JUNCTION BOX #3	48.28	48.28
A210	DIST BOX #2	48.27	48.27
A180	FIRST CHANNEL IN CHL TANK	47.52	47.52
A150	1ST PASS IN CHL TANK	47.29	47.29
A80	FINAL CHANNEL IN CHL TANK	46.88	46.89
A40	JUNCTION BOX BEFORE CREEK	45.40	45.42

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BBBBB      CCC      BROWN AND CALDWELL
BBBBBB    CCCCC     Consulting Engineers
BB  BBB  CCC CCC
BB   BB  CC   CC    PROFILE        SERIAL NO. 9901
BB  BBB  CC   CC    Version 2.00
BBBBBB   CC
BBBBB    CC         File name: C:\PROFIL~2\WESTSI~1.SUM
BBBBBB   CC         Data file: C:\PROFIL~2\WESTSI~3.PRO
BB  BBB  CC   CC    THERESA STREET WWTP
BB   BB  CC   CC    WEST SIDE 1965
BB  BBB  CC   CC    LINCOLN
BBBBBB    CCCCC
BBBBB      CCC      8/13/01              By:MARK RICHARDS
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PLANT FLOW = 23.21 CFS OR 15.00 MGD

DOWNSTREAM CONDITIONS:
ENERGY GRADE = 44.77 FEET
HYDRAULIC GRADE = 44.77 FEET

ELEMENT	DESCRIPTION		HYDRAULIC GRADE	ENERGY GRADE
A720	CHAMBER IN AERATED GRIT CHAM		61.06	61.06
A610	FINAL CHAN IN AERATED GRIT CHA		57.77	57.77
A510	WEIR PLATE IN PRIMARY CLR		57.43	57.43
	FREE DISCHARGE, FREEBOARD	.85		
	V-NOTCH INVERT	57.28		
A500	EFFLUENT LAUNDER IN PRIMARY CL		56.42	56.42
A490	DROP BOX AFTER PRIM CLR		54.41	54.42
A459	CHANNEL IN JUCNTION BOX		54.07	54.07
A450	ZONE#1 IN AEARATION BASIN		53.88	53.88
A320	EFFLUENT CH IN AERATION BASIN		51.27	51.27
A304	CHANNEL IN DISTR BOX		50.61	50.62
A270	WEIR PLATE IN FINAL CHL		49.69	49.69
	WEIR SUBMERGED, W.S. DS	49.69		
	V-NOTCH INVERT	49.13		
A265	COLLECTION LAUNDER IN FINAL CH		49.69	49.69
A260	DROP BOX AFTER FINAL CLR		49.67	49.67
A255	JUNCTION MANHOLE #1		49.55	49.55

A219	JUNCTION BOX #2	49.49	49.49
A215	JUNCTION BOX #3	49.48	49.48
A210	DIST BOX #2	49.46	49.47
A180	FIRST CHANNEL IN CHL TANK	48.38	48.39
A150	1ST PASS IN CHL TANK	48.05	48.05
A80	FINAL CHANNEL IN CHL TANK	47.80	47.82
A40	JUNCTION BOX BEFORE CREEK	45.68	45.70

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BBBBB      CCC      BROWN AND CALDWELL
BBBBBB    CCCCC     Consulting Engineers
BB  BBB  CCC CCC
BB   BB  CC   CC    PROFILE        SERIAL NO. 9901
BB  BBB  CC   CC    Version 2.00
BBBBBB   CC
BBBBB    CC         File name: C:\PROFIL~2\WESTSIDE.sum
BBBBBB   CC         Data file: C:\PROFIL~2\WESTSIDE.pro
BB  BBB  CC   CC    THERESA STREET WWTP
BB   BB  CC   CC    WEST SIDE 1965
BB  BBB  CC   CC    LINCOLN
BBBBBB    CCCCC
BBBBB      CCC      8/13/01              By:MARK RICHARDS
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PLANT FLOW = 11.60 CFS OR 7.50 MGD

DOWNSTREAM CONDITIONS:
ENERGY GRADE = 44.77 FEET
HYDRAULIC GRADE = 44.77 FEET

ELEMENT	DESCRIPTION		HYDRAULIC GRADE	ENERGY GRADE
A720	CHAMBER IN AERATED GRIT CHAM		60.83	60.83
A610	FINAL CHAN IN AERATED GRIT CHA		57.50	57.50
A510	WEIR PLATE IN PRIMARY CLR		57.41	57.41
	FREE DISCHARGE, FREEBOARD	1.16		
	V-NOTCH INVERT	57.28		
A500	EFFLUENT LAUNDER IN PRIMARY CL		56.11	56.11
A490	DROP BOX AFTER PRIM CLR		53.63	53.64
A459	CHANNEL IN JUCNTION BOX		53.55	53.55
A450	ZONE#1 IN AEARATION BASIN		53.50	53.50
A320	EFFLUENT CH IN AERATION BASIN		49.60	49.60
A304	CHANNEL IN DISTR BOX		49.44	49.44
A270	WEIR PLATE IN FINAL CHL		49.21	49.21
	FREE DISCHARGE, FREEBOARD	1.61		
	V-NOTCH INVERT	49.13		
A265	COLLECTION LAUNDER IN FINAL CH		47.52	47.52
A260	DROP BOX AFTER FINAL CLR		46.78	46.78
A255	JUNCTION MANHOLE #1		46.75	46.75

A219	JUNCTION BOX #2	46.74	46.74
A215	JUNCTION BOX #3	46.74	46.74
A210	DIST BOX #2	46.73	46.73
A180	FIRST CHANNEL IN CHL TANK	46.46	46.46
A150	1ST PASS IN CHL TANK	46.38	46.38
A80	FINAL CHANNEL IN CHL TANK	45.53	45.53
A40	JUNCTION BOX BEFORE CREEK	45.00	45.00

Appendix F – Alternative Cost Information for Theresa Street WWTF

Theresa Street WWTF Improvement Costs

Nitrification capacity expansion		$22,700,000
Preliminary Treatment		
South raw wastwater pumping station	$1,000,000	
North raw wastewater pumping station	$900,000	
Grit handling facilities	$4,500,000	$6,400,000
Cogeneration facility improvements		$300,000
Anaerobic digester complex imporvements		
Additional digester	$3,500,000	
Gas equalization or storage	$2,000,000	
Replace sludge valves on heating loop	$500,000	
Replace gas mixers and compressors	$600,000	$6,600,000
West Side Process improvements		
Primary sludge pump replacement	$400,000	
Replace RAS pumps	$600,000	
New blowers	$900,000	
Secondary clarifier improvements	$700,000	$2,600,000
East Side Process Improvements		
Primary sludge pump replacement	$600,000	
Aeration system improvements	$5,000,000	
Secondary clarifier improvements	$1,000,000	$6,600,000
DAF Improvements		$2,500,000
Dewatering system Improvements		$5,800,000
Maintenance Shop rehabilitation		$600,000
Electrical improvements		$500,000
Collection system shop improvements		$500,000
Administration building improvements		$600,000
Liquid waste handling facility improvements		$1,300,000
General system improvements		
Wet weather flow equalization facilities	$9,800,000	
Equalization of side stream flows	$1,200,000	
Hydraulic Capacity Improvements	$3,700,000	
General System Upgrades	$15,800,000	$30,500,000
General site improvements		
Replace potable water distribution system	$400,000	
On-line process control facilities	$400,000	
Flood protection	$1,200,000	
Outdoor lighting	$200,000	
Pavement rehabilitation	$200,000	
Gas line service replacement	$100,000	$2,500,000
TOTAL:		$90,000,000

Appendix G –Cost Information for Northeast WWTF

Northeast WWTF Improvements Costs

Nitrification capacity expansion		$11,600,000
Upgrade operations control center		$3,100,000
Replace raw wastewater pumps 1, 2, & 3		$1,500,000
Improve grit removal facilities		$1,000,000
Primary sludge pumping builiding anc clarifiers		
Replace clarifier sludge collectors	$800,000	
Replace weirs	$200,000	
Scum pit rehibilitation	$200,000	$1,200,000
Refurbish biotowers		$2,500,000
Secondary clarifier improvements		$1,200,000
Maintenance shop improvements		$300,000
Sludge handling system improvements		
Digester improvements	$3,600,000	
Sludge utilization system improvements	$5,400,000	$9,000,000
General system improvements		
Wet weather flow equalization facilities	$4,100,000	
Equalization of side stream flows	$2,400,000	
General system upgrades	$16,500,000	$23,000,000
General site improvements		
Replace outside facility lighting	$100,000	
Repair and replace sidewalks and roads	$300,000	
Upgrade entrance gate	$200,000	$600,000
	TOTAL:	$55,000,000