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REGIONAL WASTEWATER TREATMENT EVALUATION

Prepared for:

City of Terrell

In Conjunction with:

Texas Water Development Board

Freese and Nichols, Inc. Project: TER10191
City of Terrell Project: 09-11
TWDB Project: 1004831082

Regional Wastewater Treatment Evaluation

Prepared for:

City of Terrell

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDIX

EXECUTIVE SUMMARY

In May of 2010, Freese and Nichols (FNI) was retained by the City of Terrell, Texas in cooperation with the Texas Water Development Board (TWDB) to assess regional wastewater treatment options for the city of Terrell and surrounding entities. The first portion of this study was aimed at determining the condition and treatment capabilities of the existing King's Creek Wastewater Treatment Plant (WWTP), located in the City of Terrell (the City). These studies (included in the Appendix of this report), helped to identify areas of need at the existing treatment facility and to determine the ability of the existing facility to meet more stringent treatment requirements that are anticipated in the December 2012 Texas Pollutant Discharge Elimination System (TPDES) permit. The key findings of the condition and treatment evaluations were:

- The nitrification process, which is required to meet effluent ammonia discharge requirements, is the limiting process at the King's Creek WWTP.
- Treatment capacity expansion will be required by 2016 to meet treatment requirements and projected influent flow rates if permit does not change.
- Anticipated discharge permit requirements and increased flow rates beyond 2012 will result in the existing unit processes not being able to meet permit limits.
- If the anticipated permit changes are included in the 2012 TPDES permit, a two year implementation period is likely and process improvements would be needed by 2014.
- Due to age and obsoleteness of existing technologies, several existing unit processes will require improvements before 2016.

Based on the results of these evaluations, improvements will be necessary at the King's Creek WWTP in the next 2 to 3 years, regardless of whether the City of Terrell continues to treat the wastewater flows from the City, or if a regional system is pursued. The type of improvements and the implementation plan for these improvements will be dependent on the future direction of the wastewater system.

After assessing the existing King's Creek WWTP and determining the process needs of the current facilities, an evaluation of the long term wastewater system needs was completed. To address the future wastewater management needs for the City of Terrell and surrounding entities, three alternatives were evaluated:

- Alternative 1: Upgrade and expand the existing King's Creek WWTP
- Alternative 2: Construct new City of Terrell WWTP on existing site
- Alternative 3: Pursue a regional wastewater system and request participation in the North Texas Municipal Water District (NTMWD) regional system

These alternatives were evaluated through 2040. Each of these alternatives was evaluated for total capital investment through 2040 and total annual cost through 2040, which included operations and maintenance costs and any applicable NTMWD fees (only considered as part of Alternative 3). For Alternative 3, two options were evaluated:

- Option 1: Request participation in NTMWD's Forney Interceptor System (FIS)
- Option 2: Request participation in NTMWD's Lower East Fork Interceptor System (LEFIS)

Either regional option would involve the City of Terrell constructing a series of lift stations and force mains to convey flows from the King's Creek WWTP to the respective interceptor system. Either option will also entail the City paying a monthly fee to NTWMD for the treatment and conveyance of wastewater flows. A beneficial partnership would need to be developed between the City of Terrell and the NTMWD for effective implementation of a regional system.

The total projected costs through 2040 for the three alternatives evaluated for the City of Terrell and the surrounding entities are summarized in Table ES-1. All costs were determined in current dollars (2011 $) for comparison purposes.

Table ES-1 Comparison of total costs for evaluated alternatives

	Budgetary 30-Year Costs (2011 $)			
	Alternative 1 Upgrade Existing	Alternative 2 New WWTP	Alternative 3 Regional System	
			Option 1	Option 2
Total Capital Cost	$107.1 M	$87.5 M	$103.9 M	$124.2 M
Total Annual Costs	$126.0 M	$125.6 M	$83.1 M	$84.0 M
Total Cost	**$233.1 M**	**$213.1 M**	**$187.0 M**	**$208.2 M**

Alternative 2 resulted in the lowest total capital investment for the study period (2011-2040). Alternative 3 resulted in a higher capital investment; however, the regional alternative options evaluated as part of Alternative 3 had the lowest total cost for the study period due to the decreased annual costs associated with the regional system.

The recommended alternative for future wastewater needs for the City of Terrell and the surrounding entities is Alternative 3. The factors that contributed to this recommendation are:

- Lower cumulative annual cost for the evaluation period for Alternative 3.
- Continued savings of Alternative 3 beyond 2040.
- Comparable capital investment of Alternative 3 to Alternative 2.
- Due to the close total cost of Option 1 and Option 2 (less than 10% difference), there is not a strong economic driver for one option over the other.

The regional system will need to be a cooperative effort between the City of Terrell, its surrounding entities, and the NTMWD. The City will have to request permission to join one of the two NTMWD systems and receive approval from the NTMWD member entities before joining the system. If approval is granted to join the NTMWD system, the infrastructure for the regional system for the City of Terrell and its surrounding entities would be planned in two phases. The first phase would be constructed between 2013 and 2025 and would be designed for flows through 2025. The second phase would be constructed between 2025 and 2040 and would be designed for flows through 2040. The capital investment costs in 2013 and 2025 would consist of City of Terrell infrastructure and a capital fee for the NTMWD regional conveyance system. Budgetary capital costs for each of these phases for both Option 1 and Option 2 are shown in Table ES.2 and Table ES.3.

Table ES-2 Phasing of Alternative 3 - Option 1

	Implementation Year	Budgetary Cost (2011 $)
Option 1 – Phase I		
City of Terrell Infrastructure	2013-2025	$41.3 M
NTMWD Regional Infrastructure		$13.0 M
Total Capital Investment		$54.3 M
Option 1 – Phase II		
City of Terrell Infrastructure	2025-2040	$37.6 M
NTMWD Regional Infrastructure		$12.0 M
Total Capital Investment		$49.6 M
Total		**$103.9 M**

Table ES-3 Phasing of Alternative 3 - Option 2

	Implementation Year	Budgetary Cost (2011 $)
Option 2 – Phase I		
City of Terrell Infrastructure	2013-2025	$46.5 M
NTMWD Regional Infrastructure		$29.0 M
Total Capital Investment		$75.5 M
Option 2 – Phase II		
City of Terrell Infrastructure	2025-2040	$41.1 M
NTMWD Regional Infrastructure		$7.6 M
Total Capital Investment		$48.7 M
Total		**$124.2 M**

Securing funding, designing the improvements, and completing construction for the improvements included in Alternative 3 will take two to three years to complete. It is anticipated that the regional system can be in operation by the end of 2013 if the City receives approval to join one of the NTMWD systems in 2011 and planning and design of the infrastructure improvements are started in 2011. Even if this schedule is pursued, certain improvements will be required at the King's Creek WWTP due to the process limitations identified at the existing facility and the anticipated changes to the TPDES permit in December 2012. The transition plan to the regional system would require of several phased improvements to the King's Creek WWTP, and the number of these phased improvements would be dependent on the implementation timeline of the regional system. The improvements and phasing recommended minimize capital construction cost and prioritize treatment equipment that can be used once the King's Creek WWTP is decommissioned.

Interim improvements to the King's Creek WWTP that will be required as part of the implementation plan to help ensure continued regulatory compliance are:

- Phase I: addition of chemical facilities to provide for chemically enhanced primary treatment (CEPT), which will result in increased ammonia removal capabilities at the King's Creek WWTP and chemical phosphorus removal. These improvements would be needed by 2012, when a year-round effluent ammonia discharge limit of 3 mgN/L is anticipated to be included in the TPDES permit for King's Creek WWTP.
- Phase II: addition of tertiary filtration to meet the effluent phosphorus permit limit anticipated in the 2012 TPDES permit. Inclusion of phosphorus in the 2012 TPDES permit would include a 1 to 3 year implementation period, which is the reason for the implementation year for Phase II being 2014. While the chemical addition in Phase I would remove a significant amount of phosphorus, tertiary filtration would be required to assure meeting the anticipated discharge permit limits of 1 to 0.5 mgP/L of phosphorus. Tertiary filtration would provide relatively economical and quick improvements to help meet the new phosphorus permit.
- Phase III: addition of Salsnes Filters for increased treatment capacity. Chemical improvements from Phase I would be sufficient to meet a year-round effluent ammonia discharge limit of 3 mgN/L through 2016; however, increased treatment capacity would be required after 2016 to continue meeting this discharge requirement. Based on current flow projections, this would provide capacity through 2020.

The implementation plan for the interim improvements is shown in Table ES.4, along with budgetary costs. This plan assumes that the existing equipment will remain functional through 2016, which was a conclusion of the condition assessment. The implementation year is the year that the interim improvement would be anticipated to be completed by. It should be noted that if the regional system is in operation before 2014 as anticipated, the only improvement needed at the King's Creek WWTP would be Phase I. However, it was deemed prudent to develop an implementation strategy to assure that the treatment needs of the City of Terrell and the surrounding entities were met in the event that the regional system implementation timeline was extended.

Table ES-4 Phasing of Implementation Plan

Interim Improvements	Implementation Year	Budgetary Cost[2]	
		(2011 $)	(Actual Year $)[1]
Phase I - Chemical Feed Facilities	2012	$0.45 M	$0.47 M
Phase II - Tertiary Filters[3]	*2014*	*$2.0 M*	*$2.3 M*
Phase III - Salsnes Filters[3]	*2016*	*$2.6 M*	*$3.2 M*
Total		**$5.1 M**	**$6.0 M**

[1]Assumes 5% inflation per year
[2]Sunken cost
[3]Improvements shown in red are optional based on the implementation timeline of a regional system

The impact of the interim improvements on the performance of the King's Creek WWTP was evaluated using a wastewater simulation and modeling program called BioWin. Simulated effluent ammonia concentrations for the interim improvements during cold weather conditions are shown in Figure ES-1. The interim improvements would increase the functional capacity of the King's Creek WWTP to 2.9 million gallons per day (MGD). This would be sufficient treatment capacity through 2019. This would give the City of Terrell sufficient time to request participation and implement improvements to convey flows to one of the NTMWD systems, secure funding for infrastructure improvements, and to determine if the growth in surrounding entities is more or less aggressive than current projections.

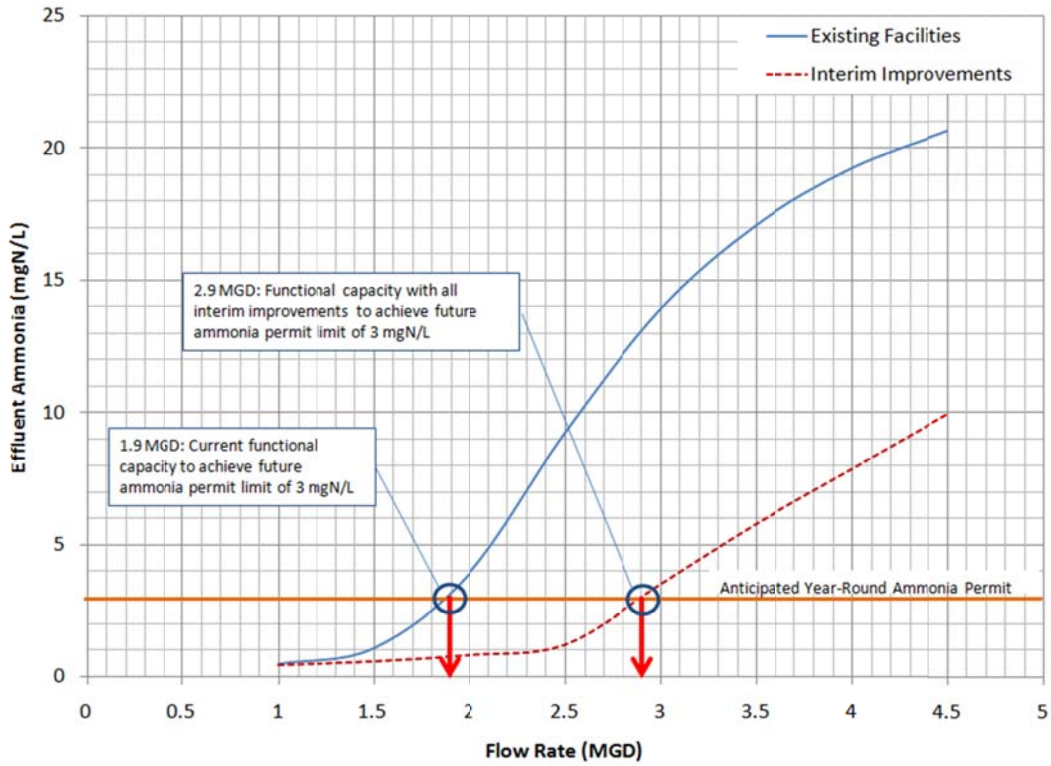

Figure ES-1 Impact of interim improvements on effluent ammonia

The next step for the regional wastewater system for the City of Terrell and the surrounding entities is to request participation in one of the NTMWD regional system. The City of Terrell should begin efforts to request participation within the first half of 2011 to ensure that a regional treatment option can be pursued. If participation in one of the NTMWD regional systems is approved, the next step would be to secure funding and to begin planning and design of both the regional interceptor system and Phase I of the implementation plan. For implementation of Phase I interim improvements, the next steps would be:

- Preliminary design of the chemical feed facilities for CEPT improvements by late 2011 (sunken cost in treatment facility)
- Design and construction of chemical feed facilities prior to December 2012

For the regional treatment facilities, the next steps would be:

- Determine if the City will pursue Option 1 or Option 2 for Alternative 3 by mid-year 2011

- Securing project funding during 2011
- Preliminary design of alignment for the regional pipeline by late 2011
- Design and land acquisition for regional pipeline during 2012
- Full implementation of regional pipeline before the end of 2013

If participation in one of the NTMWD regional systems is not approved by the NTMWD member entities, the City of Terrell would need to continue treating its wastewater. If this scenario were to occur, Alternative 2 would be recommended. To ensure that the improvements needed for Alternative 2 are in place prior to 2014 when the changes to the TPDES permit are anticipated, securing funding and beginning preliminary design for a new WWTP would be recommended to being in 2011.

1.0 INTRODUCTION

In May of 2010, Freese and Nichols (FNI) was retained by the City of Terrell, Texas in cooperation with the Texas Water Development Board (TWDB) to assess regional wastewater treatment options for the City of Terrell (the City) and surrounding entities. The first portion of this study is aimed at determining the condition and treatment capabilities of the existing King's Creek Wastewater Treatment Plant (WWTP), located in the City of Terrell. After completion of these evaluations, three alternatives were evaluated for future wastewater management for the City of Terrell and surrounding entities:

- Alternative 1: Upgrade and expand the existing King's Creek WWTP
- Alternative 2: Construct new City of Terrell WWTP on existing site
- Alternative 3: Pursue a regional wastewater system and request participation in the North Texas Municipal Water District (NTMWD) regional system

These alternatives were evaluated through 2040. Each of these alternatives was evaluated for total capital investment through 2040 and total annual cost through 2040, which included operations and maintenance costs and any applicable NTMWD fees (only considered as part of Alternative 3). For Alternative 3, two options were evaluated:

- Option 1: Request participation in NTMWD's Forney Interceptor System (FIS)
- Option 2: Request participation in NTMWD's Lower East Fork Interceptor System (LEFIS)

A recommendation for future treatment infrastructure was made based on overall costs. An implementation plan was then developed for the recommended alternative to provide sufficient capacity to meet permit and flow requirements. Potential funding sources were also identified.

Location and map showing the City of Terrell, surrounding entities, and neighbor cities is presented in Figure 1-1.

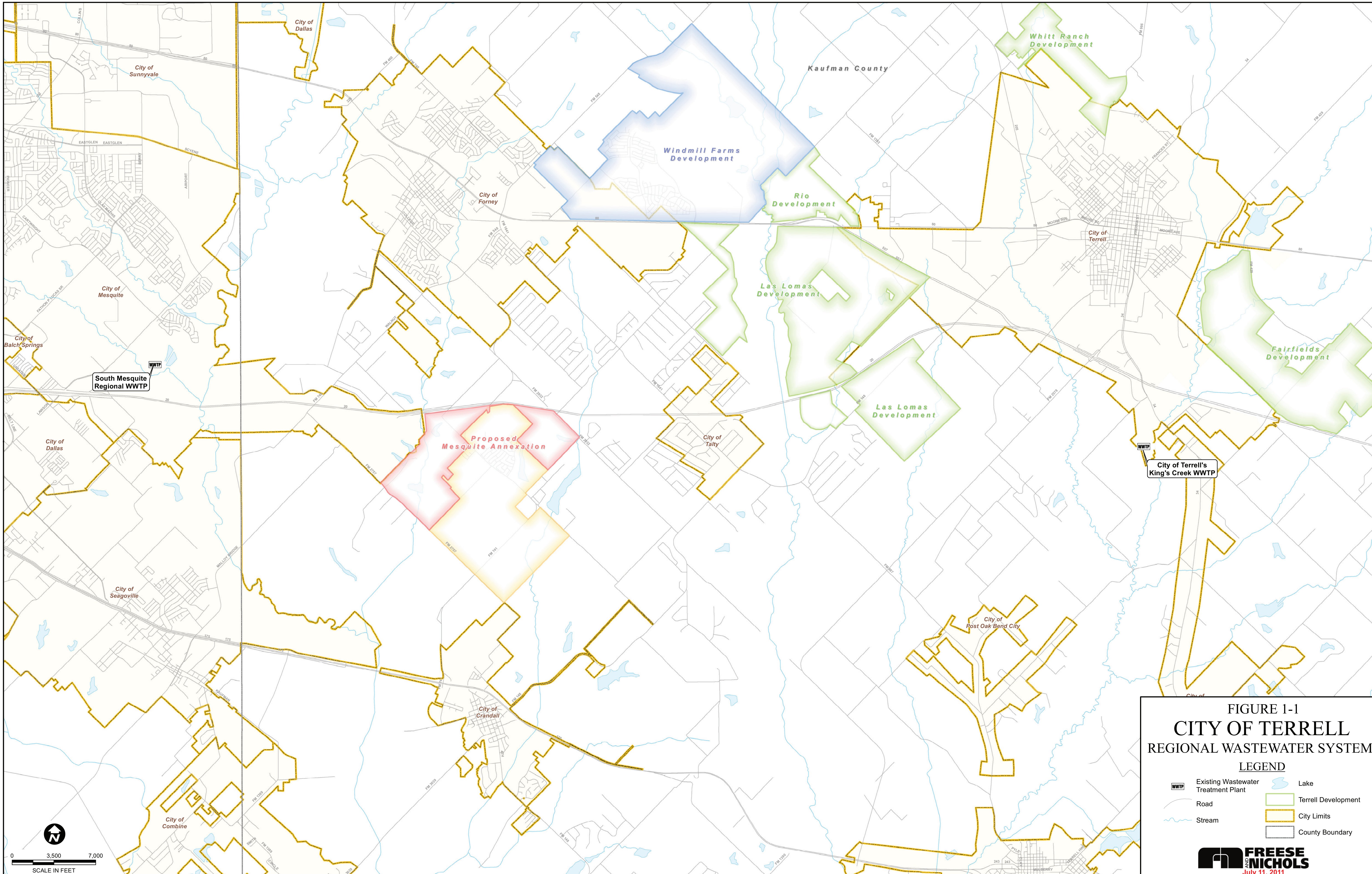

FIGURE 1-1
CITY OF TERRELL
REGIONAL WASTEWATER SYSTEM

2.0 WASTEWATER FLOW AND CHARACTERISTICS

For the three alternatives evaluated for future management of wastewater in the City of Terrell, common factors to be considered are the future flow rates, the projected wastewater influent characteristics, future Texas Commission on Environmental Quality (TCEQ) permit requirements, and the industrial pretreatment requirements.

2.1 WASTEWATER FLOW RATES

Projected wastewater flow rates for the City of Terrell and several surrounding entities (Fairfield, Whitt Ranch, Las Lomas, and Rio) were developed using the same assumptions as in previous City of Terrell studies (Impact Fee Analysis, April 2009). Population projections were available for each of these entities through 2025. The total area population was available through 2040 in Region C Water Plan, which was approved by the Texas Water Development Board (TWDB). These population projections are shown in Table 2-1 and Figure 2-1. These population projections were used to project dry weather and wet weather flow rates for the King's Creek Wastewater Treatment Plant (WWTP) area.

Table 2-1 Population Projections for the City of Terrell and surrounding areas

	Populations					
Year	Fairfield[1]	Whitt Ranch[1]	Las Lomas[1]	Rio[2]	Terrell[3]	Total
2010	-	-	-	-	16,185	16,185
2015	-	612	-	-	17,694	18,306
2020	300	2,487	6,150	462	20,018	29,417
2025	3,900	5,019	10,308	2,772	23,546	45,545
2040	Not Available	Not Available	Not Available	Not Available	43,943	85,000[4]

[1]As provided by participating partners in August 2010
[2]As provided by Rio, updated by City of Terrell
[3]As provided in City of Terrell CIP 2009
[4]From Region C Water Plan

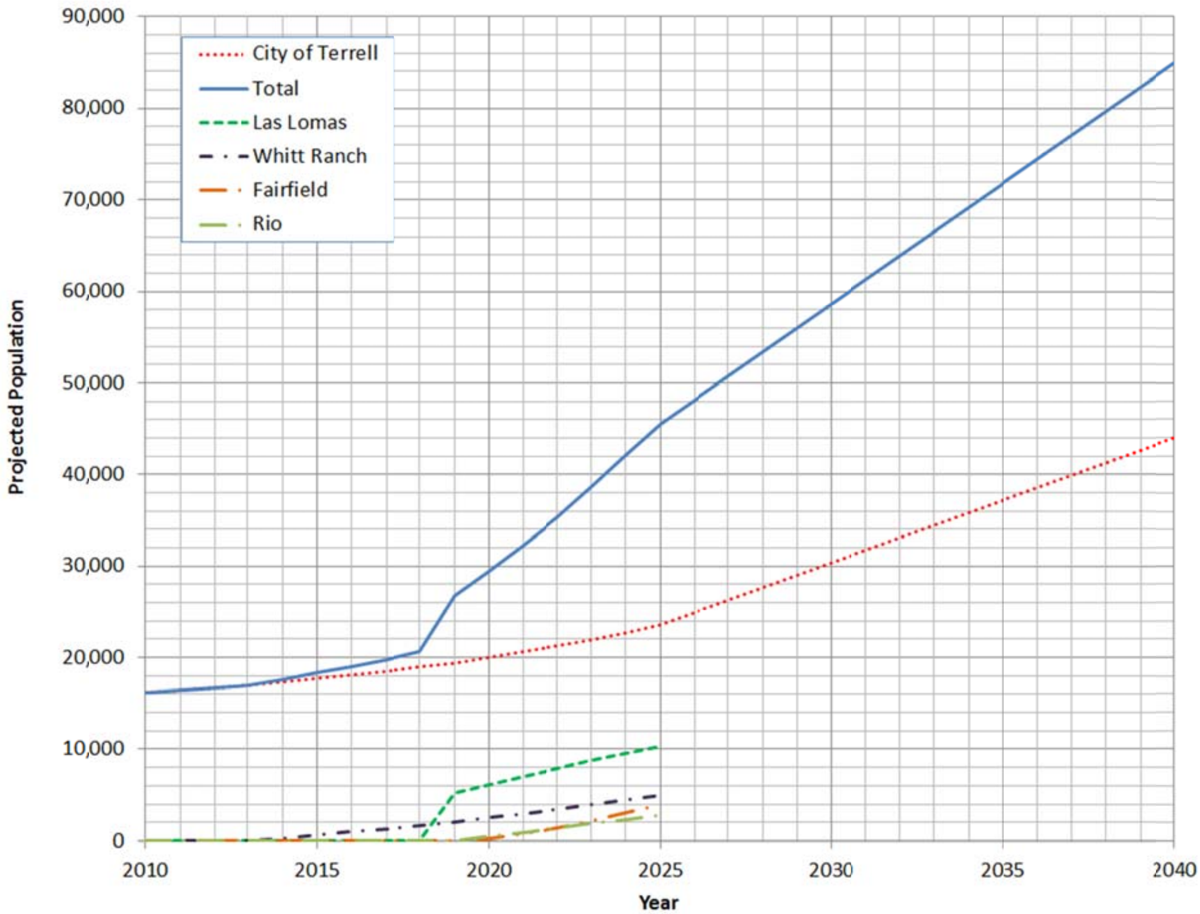

Figure 2-1 Population projections

2.1.1 Dry Weather Flow Projections

Dry weather flow projections are based on an assumed per capita wastewater production rate, which is the same as used in previous reports. Assuming a per capita wastewater production rate of 115 gallon/capita-day, the resulting dry weather flow rate projections are shown in Figure 2-2. Based on the flow projections in Figure 2-2, the majority of flow increase for the City of Terrell wastewater system will be from surrounding developments over the next 30 years. Typically, dry weather flow rates are the main driver for process expansion at wastewater treatment plants.

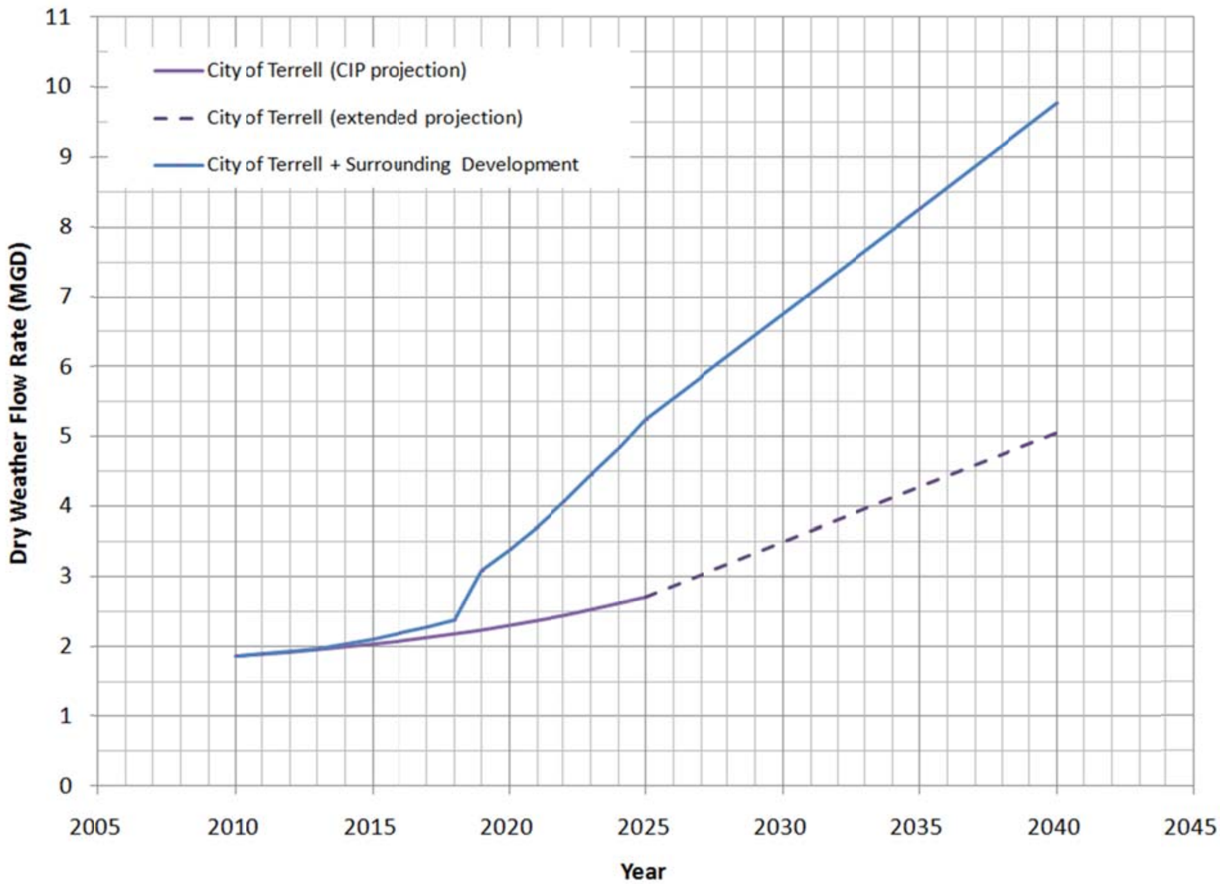

Figure 2-2 Dry weather flow projections

2.2.2 Wet Weather Flow Projections

Wet weather flow rates are typically the limiting hydraulic condition in both collection systems and wastewater treatment plant piping systems. The wet weather flow rates are determined from a selected peaking factor and an infiltration/inflow (I/I) allowance. For the City of Terrell and surrounding areas, the following wet weather flow projection equation was used for wet weather flow projections:

Wet Weather Flow = 3*(Per Capita Flow* Population) + I/I Allowance Factor* Population

OR

Wet Weather Flow = 3.9*Dry Weather Flow

The per capita flow rate and population are the same as used for the dry weather flow projections. The assumed I/I allowance factor for this study was 100 gallons/capita-day. Using the equation, the projected wet weather flow rates are shown in Figure 2-3. These projected wet weather flows were used for sizing of any regional pipelines in this evaluation. If the City of Terrell pursues a regional wastewater system and is approved for participation in the NTMWD treatment system, peak flow peaking factors would be required to meet the North Texas Municipal Water District (NTMWD) requirements and collection system improvements to reduce I/I flows may be required.

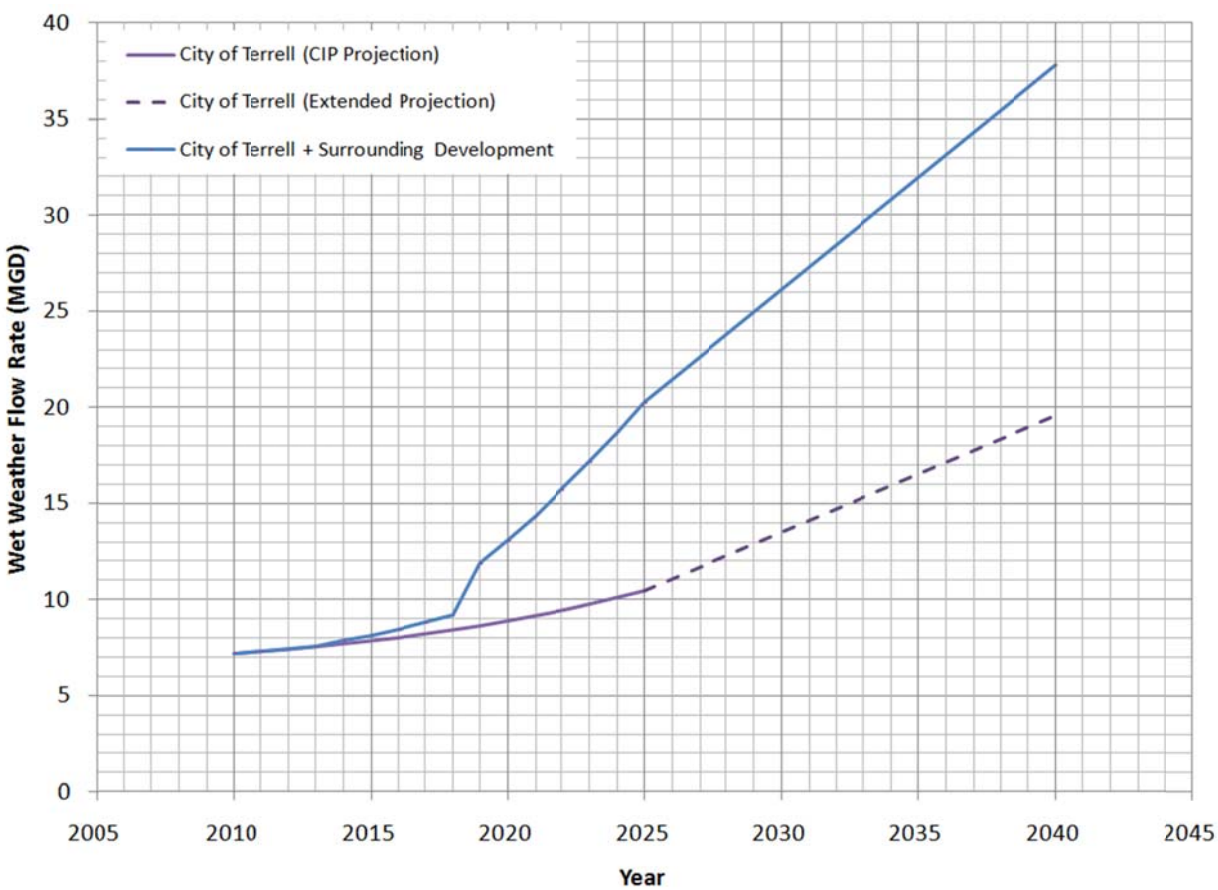

Figure 2-3 Wet weather flow projections

2.2 INDUSTRIAL PRETREATMENT REQUIREMENTS

Industrial pretreatment requirements are included in municipal codes to prevent overloading of biochmical oxygen demand (BOD) and total suspended solids (TSS) at the wastewater treatment plant and to limit the toxic compounds entering receiving streams. The BOD and TSS loadings are governed by the facility's ability to handle the organic loading. For toxic and trace compounds, the industrial discharge requirements are developed based on both the receiving stream quality and the ability of the treatment processes to treat/absorb the toxic and trace compounds in the liquid stream. If the City of Terrell pursues a regional treatment system and is approved for participation in the NTMWD system (Alternative 3) or if a new activated sludge WWTP is constructed (Alternative 2), a new Technically Based Local Limits (TBLL) evaluation would need to be completed for the City of Terrell. Changes to the organic loading industrial discharge requirements and the toxic and trace compound industrial discharge concentrations will be highly dependent on the alternative selected for future wastewater treatment needs.

2.2.1 Organic Loading

The industrial discharge BOD and TSS concentrations are developed based on the total treatment capacity of the wastewater treatment plant. A combination of an industrial surcharge rate and industrial pretreatment is typically implemented. Each industrial waste is evaluated, and is either permitted for a pretreatment requirement or charged a fee based on the pounds of BOD and pounds of TSS contributed to the system over the average waste from a residential property. The fees and allowable loadings for industries would have to be determined by an updated TBLL for the chosen treatment alternative. Changes to the hauled waste requirements would likely be implemented if the City of Terrell joined the NTMWD system.

2.2.2 Toxic and Trace Compounds

The permitted industrial discharge concentrations for toxic and trace compounds are based on receiving stream characteristic and the treatment units. King's Creek is an intermittent stream that discharges into Cedar Creek Reservoir. These conditions result in stringent industrial discharge concentrations for toxic and trace compounds. Discharging to a different stream could significantly impact these industrial discharge concentrations.

If King's Creek WWTP is continued to be utilized for wastewater treatment for the City of Terrell and its surrounding areas, the existing industrial discharge concentrations would be maintained unless the facility converted to a different process for treatment. If Alternative 2 is pursued, which involves conversion to an activated sludge WWTP, the industrial discharge concentrations would likely increase as the activated sludge process has a higher potential removal rate for these compounds. A full TBLL study will need to be completed to determine new industrial discharge concentrations for the NTMWD system or an activated sludge facility at the Kings' Creek WWTP site once the new facility is operational.

2.3 WASTEWATER CHARACTERISTICS

It is not anticipated that the wastewater characteristics of the City of Terrell wastewater will change significantly over the next 30 years. Water conservation is typically the main driver for wastewater characteristic changes, as reductions in water usage results in increased concentrations in the wastewater. However, these water usage reductions are often offset by increased I/I due to aging infrastructure, and it is difficult to estimate long term impact of water conservation on wastewater concentrations.

The current wastewater characteristics for the City of Terrell were evaluated from 2007 through 2010. Design is based on the average concentrations plus one standard deviation. Over the 3 year period of data provided, the average influent conditions and standard deviation were:

- Influent ammonia: 23 $\pm$ 9.9 mgN/L

- Influent cBOD: 130 ± 30 mg/L
- Influent TSS: 160 ± 30 mg/L

These are relatively low average influent carbonaceous biochemical oxygen demand (cBOD) and TSS concentrations for a typical municipal wastewater (WEF Manual of Practice No. 8). The influent ammonia is near the typical wastewater concentration of 30 mgN/L. For future wastewater characteristics, it is recommended that the typical average concentrations for municipal wastewater are assumed. As new developments contribute more flow, dilution from I/I will become less of an impact and the concentration would increase. For planning purposes, the average assumed future influent conditions will be:

- Influent ammonia: 30 mgN/L
- Influent cBOD: 200 mg/L
- Influent TSS: 200 mg/L

Concentrations would be anticipated to rise to these levels over the next 10 to 15 years as increased new development becomes a significant portion of flow to the King's Creek WWTP.

2.4 ANTICIPATED TPDES PERMIT REQUIREMENTS

When first designed and permitted, the King's Creek WWTP was commissioned to remove cBOD at dry weather flows of 4.5 Million Gallons per Day (MGD). As regulatory requirements have increased and ammonia has been added to the discharge permit, the treatment capacity of the King's Creek WWTP may have fallen below 4.5 MGD because ammonia removal requires longer treatment times. The ammonia removal capability of the existing King's Creek WWTP is discussed in Section 4 and Appendix C.

During upcoming cycles of the Texas Pollutant Discharge Elimination System (TPDES) discharge permits, the two main areas of change are expected to be with respect to discharge phosphorus and ammonia concentrations. The Texas Commission on Environmental Quality (TCEQ) has recently released an update to the surface water standards that pertain to several reservoirs in the state, including the Cedar Creek Reservoir which ultimately receives the treated effluent discharged from the King's Creek WWTP. Based on the preliminary surface water quality criteria, municipal treatment facilities discharging to King's Creek can anticipate an effluent phosphorus discharge permit limit between 1 and 0.5 mgP/L. In addition, the seasonal $cBOD_5$ and ammonia in the current TPDES permit are anticipated to be rescinded. In a seasonal permit there are varying discharge limits in cold weather and warm weather. The current seasonal permit limits for the King's Creek WWTP are 3 and 5 mgN/L for ammonia and 7 and 10 mg/L $cBOD_5$, for warm and cold seasons respectively. A year round final effluent $cBOD_5$ discharge permit of 7 mg/L and an effluent ammonia discharge permit of 3 mgN/L are anticipated.

The full list of anticipated TPDES permit requirements for the upcoming permit cycles is shown in Table 2-2. The current TPDES discharge permit for the King's Creek WWTP has an expiration date of December 1, 2012. It can be anticipated that some or all of the permit changes shown in Table 2-2 will be included in the next discharge permit. Requirements to meet the anticipated TPDES permit discharge requirements in 2012 should be assumed and planned for in both near term and long term improvement projects. There are two significant differences in the anticipated TPDES permit than in the existing TPDES permit: a non-seasonal ammonia permit limit of 3 mgN/L and a phosphorus discharge limitation. These requirements significantly alter the required treatment processes for the King's Creek WWTP.

Until the TCEQ releases a draft permit for these parameters, the exact discharge values will not be known. Various regulatory program changes may result in different concentration values than shown in Table 2-2 for the discharge permit issued in December 2012. It is not anticipated that the flow rate will be modified in the next TPDES permit, with the current permitted flow of 4.5 MGD at dry weather flows. Existing permit values, if different than the anticipated values, are shown in red. It is also possible that additional contaminants not listed in the table (e.g. pharmaceuticals and personal care products (PPCPs), total nitrogen) could be included in TPDES discharge permits in the 20 year time horizon. These developments will need to continue to be monitored over the coming decades to assure that King's Creek WWTP has adequate treatment capacity to meet permit requirements.

Table 2-2 Anticipated TPDES permit requirements

Parameter	30-Day Average mg/L	30-Day Average lbs/day	7-Day Average mg/L	Daily Maximum mg/L
$CBOD_5$	7 ***(7/10)***	263	12 ***(12/15)***	22 ***(22/25)***
TSS	15	563	25	40
NH_3-N	3 ***(3/5)***	113	6 ***(6/7)***	10
Total Phosphorus	0.5 ***(N/A)***	19	1 ***(N/A)***	2 ***(N/A)***
Aluminum (total)	0.834	31	N/A	1.766
Copper (total)	Report	Report	N/A	Report
Silver (total)	0.0073	0.26	N/A	0.0155
Zinc (total)	0.241	9.0	N/A	0.509

*Anticipated to apply to next TPDES permit to be released in December 2012
**Note: if different, current permit values noted in red (warm weather/cold weather values)

In addition to the discharge permit requirements, TCEQ also regulates when facility expansions are required based on influent flow conditions. Treatment capacity expansion plan is required when the 12 month running average influent flow rate to a WWTP exceeds 75% of the permitted average influent flow rate for three consecutive months. The expansion must be under construction at the 90% level. These expansion requirements are important to consider when evaluating long term treatment alternatives.

3.0 COST METHODOLOGY

Costs developed for the evaluation of Alternative 1, 2, and 3 were from two categories: capital costs and annual costs. For both of these cost components, the total cost through 2040 was determined, allowing for the comparison of the total 30-year cost for each alternative. These values are reported in 2011 dollars.

3.1 CAPITAL COSTS

Capital costs were developed based on unit costs for piping, equipment, and other materials. For Alternatives 1 and 2, treatment costs were developed based on equipment sizing, budgetary equipment costs from manufacturers, and budgetary values for site development, demolition, and electrical and instrumentation were assumed. Contingency of 30% was added to all budgetary costs to account of unforeseen design and construction cost, such as poor soil conditions and unexpected underground utilities. Contractor costs, including mobilization (5%) and contractor overhead and profit (18%), were also included to reflect anticipated construction costs. All budgetary costs also included estimated engineering and surveying fees at 18% of the total estimated construction cost. These fees represent a budgetary estimate for surveying, geotechnical, preliminary design, final design, and construction phase services.

Capital costs for the regional system in Alternative 3 were estimated in a similar way to the treatment costs using pricing for pipelines and pump stations from previous North Texas infrastructure improvement projects. The total capital cost of each option in the regional analysis consisted of two components:

1. Capital Cost for City of Terrell Conveyance Infrastructure
2. NTMWD Regional Conveyance Capital Cost

The capital improvements were broken down into two phases: the improvements needed to serve 2025 flows and improvements needed to serve 2040 flows. Easement and right-of-way costs were calculated as $75 per linear foot for permanent easements and $25 per linear foot for temporary easements, assuming a 50 foot permanent and a 50 foot temporary easement. It was assumed that temporary easements would be needed for both the 2025 and 2040 improvements while the permanent easements acquired for the 2025 improvements would be sufficient for the 2040 improvements as well.

If a regional wastewater option is pursued and the King's Creek WWTP is not used in the future, a separate decommissioning study would need to be conducted. This study would provide options for decommissioning the King's Creek WWTP and opinion of costs for the varying levels of decommissioning, which were not included in this evaluation.

3.2 ANNUAL COSTS

Annual costs for treatment versus conveyance are based on relatively different factors, as compared to capital costs. Annual costs for Alternative 1 and 2 are based on treatment costs, which encompass electricity, solids disposal, labor, chemical costs, and miscellaneous costs associated with operation and maintenance. For Alternative 3, the annual costs consist of operation and maintenance costs associated with the interceptor system owned by the City of Terrell as well as fees paid to the NTMWD for collection and treatment of the wastewater.

3.2.1 Alternative 1 and 2 – Treatment Operation and Maintenance Costs

Operation and maintenance costs for wastewater treatment were developed using the operation cost estimation tool developed by the Water Environment Research Foundation (WERF Report No. 96-CTS-5). This tool was used with current operational data for the King's Creek WWTP. Using a 12-month average flow rate of 1.7 MGD, electricity cost of $0.0778 per kWh, and a historical average wages for treatment operations staff, the predicted total treatment cost for 2010 is $960,000. The 2010 treatment budget for the City of Terrell was reported as $1,065,000, which excludes pretreatment funding. This is a 10% difference between the predicted and actual cost. To account for this difference, a 10% contingency was added to all projected operation and maintenance costs. The resulting annual operations cost for the existing King's Creek WWTP is $1.72 per 1,000 gallons. The operation and maintenance cost projection calculations are shown in Appendix G. This projection tool will be used for calculation of all treatment operation and maintenance costs for Alternative 1 and Alternative 2. For cost projections in Alternative 1 and 2, and electricity rate of $0.10 per kWh will be used.

3.2.2 Alternative 3 – Regional Annual Costs

For Alternative 3, the annual costs consist of operation and maintenance costs associated with the interceptor system owned by the City of Terrell as well as fees paid to the NTMWD for collection and treatment of the wastewater.

The operation and maintenance (O&M) costs for the City of Terrell conveyance infrastructure was calculated using the following formula:

Annual O&M Cost = Operation Cost + Maintenance Cost

The operation cost consists of the energy cost based on projected kW-hr requirements for the King's Creek, Bachelor Creek and Brushy Creek Lift Stations. A 10 cents/kW-hr was assumed, and all costs are reported in 2011 dollars. Annual maintenance costs were calculated at 2% of the capital cost for each facility. The annual O&M costs are consistent with the costs used in the Freese and Nichols report titled *Wastewater System Study for Major Developments, September 2006.* Labor costs were included for the NTMWD regional conveyance annual costs. The labor cost was assumed to be $50,000 per year for the first phase of improvements until 2025 and $75,000 per year after 2025.

In addition to operation and maintenance of the City of Terrell regional conveyance infrastructure, a regional wastewater treatment fee would be paid to the NTMWD. The regional wastewater treatment fee covers the NTMWD capital improvement and O&M costs at their treatment plants. The same cost per 1000 gallons is charged to every regional treatment plant customer. The current fee that NTMWD charges is $0.96 per 1000 gallons of flow. For this study, it was assumed that the regional treatment fee would be $1.00 per 1000 gallons through 2040. The regional treatment fee could potentially increase depending on the result of the request by the City of Terrell to join the NTMWD regional wastewater treatment system as a member customer. If Terrell is added as a non-member customer, it is possible for non-member customers to be charged at a higher rate than member customers. The regional wastewater treatment costs for Alternative 3 were developed based on the dry weather flow projections for the City of Terrell and its surrounding areas. Since the dry weather flow is the same for each option, the regional treatment cost is the same for each option.

4.0 EXISTING FACILITIES

The existing King's Creek WWTP process flow diagram is shown in Figure 4-1. To meet current and future flow and treatment requirements, an assessment of the capabilities of the existing unit processes was required. Evaluation of the existing facilities at the King's Creek WWTP was completed through a Condition Assessment (Appendix B) and Process Evaluation (Appendix C). A summary of the Condition Assessment and Process Evaluation is included below, with the resulting overall assessment of the existing King's Creek WWTP. Evaluation of the existing facilities will be used to determine required improvements for Alternative 1 (improvements to King's Creek WWTP) to meet current and future flow rate and permit discharge requirements. The evaluation will also be used to determine the unit processes and equipment that could continue to be used in Alternative 2 (new WWTP).

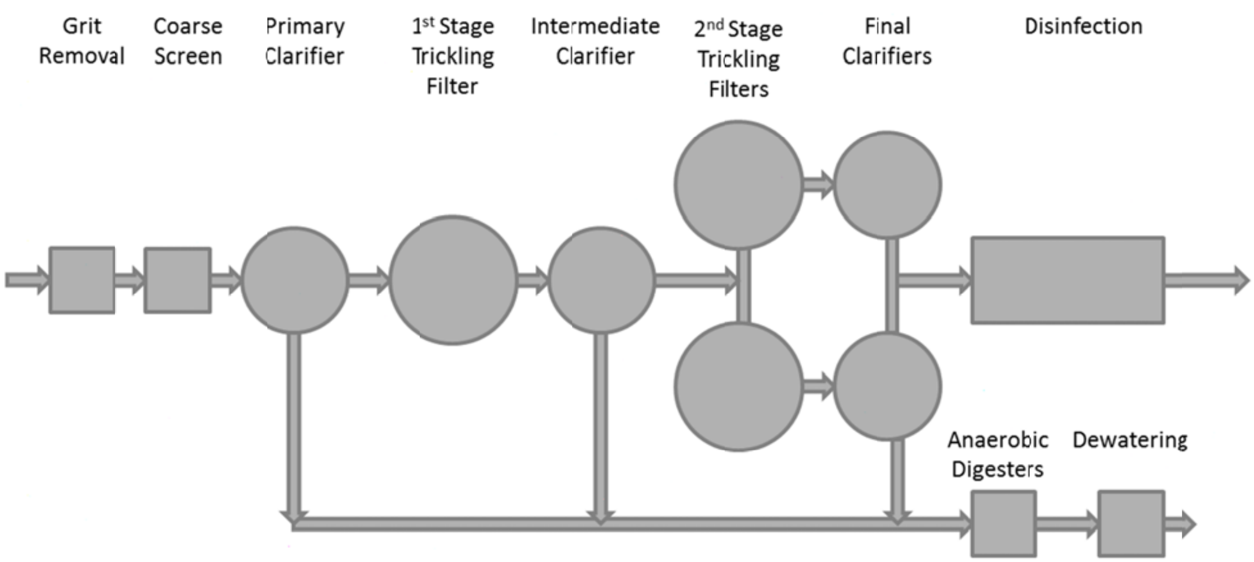

Figure 4-1 Existing King's Creek process flow diagram

4.1 CONDITION ASSESSMENT

To determine the current condition of the infrastructure at the King's Creek WWTP, and to allow projections of future conditions, a condition assessment of the King's Creek WWTP was conducted in May 2010. Condition assessment is a common tool in wastewater collection and treatment facilities. It can be a powerful tool for both prioritizing improvements and determining the long term reliability of unit processes. It is important to develop an unbiased rating system to allow quantitative comparison of the condition and criticality of each unit process. Once this quantitative rating system is developed, an objective comparison of the condition of different unit processes can be completed, and the required maintenance and equipment replacement projects can be made. The rating system involves scoring for condition and criticality, and developing an overall risk of failure associated with each unit process. The overall risk rating is the average of the condition assessment and criticality assessment.

The need for upgrades based on this risk assessment is broken down into the following categories:

- Greater than 75: Immediate repairs required; unit process has reached useful service life
- 50-75: High risk of failure and capacity impact; repair or replacement in near future
- 25-50: Fair mechanical condition, but little redundancy and/or obsolete equipment that would be difficult to replace
- 0-25: Good condition with minimal upgrades/improvements currently required

The combination of condition and criticality allows for a qualitative risk rating to be developed, which prioritizes needed improvements. Also, a higher risk rating correlates to a lower expected service life. The current prioritization of unit process improvements is shown in Table 4-1.

Table 4-1 Risk ratings for all unit processes

	Unit	Condition Rating	Criticality Rating	Risk Rating
Preliminary Treatment	Equalization Basin	30	4	17
	EQ Basin Blowers	18.75	6	22.4
	Bar Screen	12.5	18	15.25
	Influent Pump Station	34.75	8	21.4
	Grit Classifier	41.25	70	55.6
	Grit Basin	5.0	40	22.5
	Grit Blowers	47.5	5	26.25
Primary Treatment	Primary Clarifier	38.75	82	60.4
Secondary Treatment	Stage 1 Trickling Filter	25	84	54.5
	Intermediate Clarifier	32.5	70	51.25
	2nd Stage Pump Station	43.5	52	47.75
	2nd Stage Trickling Filters	23.75	72	47.9
	Final Clarifiers	27.5	64	45.75
Disinfection	Chlorine Contact Basin	33.75	58	45.9
	Chemical Storage Building	30	0	15
Solid Waste Management	Solids Building	28.75	52	40.4
	Anaerobic Digesters	14.5	8	11.25
	Sludge Holding Tank	13	50	31.5

These projected risk ratings are based on assumptions that overall condition will degrade linearly over time. When the risk rating for a unit process exceeds a score of 75, immediate repairs or upgrades would be required and the unit will be considered to reach its service life. Projected risk ratings for major units processes for the study period are shown in Table 4-2. In 2018, it is projected that eight of the 18 unit processes will have reached their service life. An additional six unit processes will be at high risk of failure, and likely require repairs and/or upgrades in the near term. Only the equalization basin, bar screen, chemical storage building, and anaerobic digesters are projected to be in good to fair condition in 2018.

Table 4-2 Projected risk ratings for the major unit processes

Unit Process	Risk Rating			
	2010	2020	2030	2040
Primary Clarifier	60.4	92.4	100	100
Grit Classifier	55.6	87.6	100	100
Stage 1 Trickling Filter	54.5	86.5	100	100
Intermediate Clarifier	51.25	83.25	100	100
2nd Stage Trickling Filters	47.9	79.9	100	100
2nd Stage Pump Station	47.75	79.75	100	100
Chlorine Contact Basin	45.9	77.9	100	100
Final Clarifiers	45.75	77.75	100	100
Solids Building	40.4	72.4	100	100
Sludge Holding Tank	31.5	63.5	100	100
Grit Blowers	26.25	58.25	100	100
Grit Basin	22.5	54.5	100	100
EQ Basin Blowers	22.4	54.4	100	100
Influent Pump Station	21.4	53.4	100	100
Equalization Basin	17	49	97	100
Bar Screen	15.25	47.25	95.25	100
Chemical Storage Building	15	47	95	100
Anaerobic Digesters	11.25	43.25	91.25	100

By the year 2020, eight of the 18 major unit processes will have reached their anticipated service life, with an addition six unit processes at high risk of failure. From a condition assessment standpoint, significant upgrades are likely required to maintain treatment capabilities at the King's Creek WWTP before 2020.

4.2 PROCESS EVALUATION

A process model was developed for the King's Creek WWTP to evaluate the treatment capacity of the facility. The model was developed in BioWin®, a propriety software package developed for advanced process modeling and simulation (www.envirosim.com). To accurately predict performance of the facility, calibration to field sampling data was used to assure that existing performance is matching the simulated performance. Validation of the model to historic data was also completed to further test the robustness of the model predictions. After matching the simulated results at current conditions with the observed field results, projections of future performance can be made.

Model simulations indicate that ammonia removal capacity would control the overall functional capacity of the King's Creek WWTP. Ammonia removal is typically the limiting parameter for facilities that are not required to remove nutrients. The simulated effluent ammonia concentration, based on the average loading conditions, is shown in Figure 4-2 for increasing flow rates. The cold weather treatment capacity of the existing unit processes at the King's Creek WWTP is 2.1 MGD. The warm weather treatment capacity is 2.4 MGD. If a year-round effluent ammonia permit of 3 mgN/L is issued, the cold weather treatment capacity to meet this effluent concentration is 1.9 MGD. Peak flow performance from a process performance analysis indicate that the peak flow of 9 MGD could be treated to permit levels in cold and warm weather; however, the current reported maximum flow from a hydraulic treatment standpoint is 6 MGD. Evaluation of the available storage volume indicates that at a peak inflow of 9 MGD, while treating 6 MGD through the WWTP, 7 hours of storage would be available.

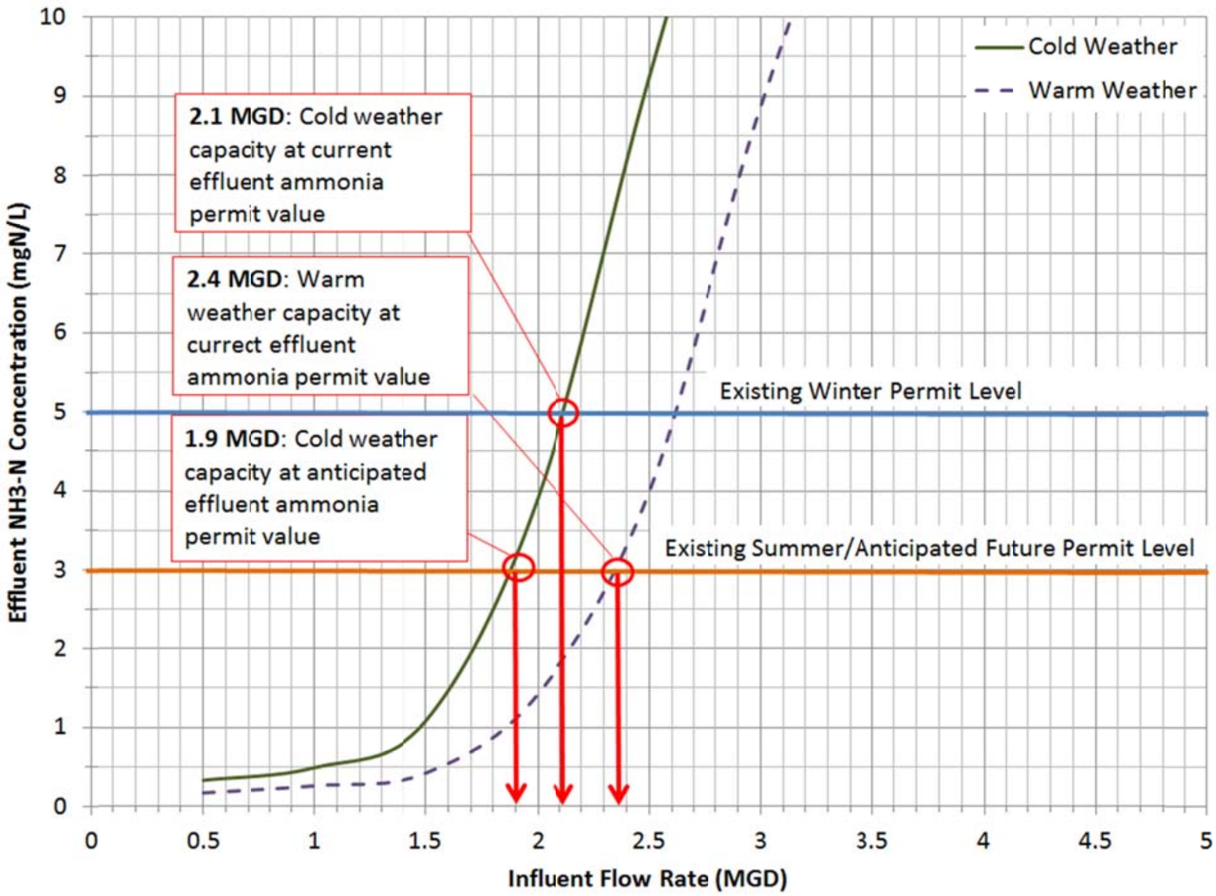

Figure 4-2 Simulated effluent ammonia concentration

A percent occurrence evaluation was also completed to determine the percent of time the King's Creek WWTP would be expected to exceed the cold and warm weather permitted effluent ammonia values. Based on this percent exceeding analysis, the probability of the effluent ammonia concentration exceeding the permitted 30-day average effluent ammonia concentration for both cold and warm weather conditions was determined, and is summarized in Table 4-3. Currently, the facility exceeds the permitted effluent ammonia 20% of the time in cold weather 15% of the time in warm weather conditions, at an average flow of 1.8 MGD. At a flow rate of 2 MGD, the King's Creek WWTP can be expected to exceed permitted effluent ammonia concentrations 33% of the time in cold weather, and 23% of the time in warm weather. At a flow rate of 3 MGD, the King's Creek WWTP can be expected to exceed permitted effluent ammonia concentrations 74% of the time in cold weather, and 65% of the time in warm weather.

Table 4-3 Probability of exceeding permitted effluent ammonia concentration

Flow Rate (MGD)	Percent of Days Exceeding Permit	
	Cold Weather	Warm Weather
1.8*	20%	15%
2	33%	23%
3	74%	65%
4	89%	86%
4.5	91%	94%

*based on past 3 years of operating data

Phosphorus is likely to be included in future TPDES permits for the King's Creek WWTP. To meet typical effluent phosphorus permit concentrations (0.5 to 1 mgP/L), enhanced biological phosphorus removal (EBPR) or chemical phosphorus removal is required. Trickling filters do not provide the environmental conditions necessary for the microbiology that performs EBPR (more detailed discussion included in Appendix C). Therefore, without conversion to an activated sludge system, the King's Creek WWTP would currently need to rely on chemical phosphorus removal to meet future permit levels.

4.3 EXISTING FACILITIES CONCLUSIONS

The existing King's Creek unit processes were evaluated for both condition and treatment capabilities. Based on mechanical condition, the primary clarifier, grit classifier, stage 1 trickling filter, and intermediate clarifier are in need of improvements. These improvement requirements are driven mainly by a lack of redundancy and age of equipment. In addition to the improvements identified through the condition assessment, several process improvements are needed to meet the future TPDES permit requirements discussed in Section 2.0. Currently, the King's Creek WWTP is projected to have a treatment capacity of 2.1 MGD with current infrastructure and a seasonal effluent ammonia permit. It is anticipated that the next discharge permit, which will be issued in December 2012, will include a year round effluent ammonia discharge concentration of 3 mgN/L and will likely include an effluent phosphorus discharge concentration of 1 to 0.5 mgP/L. The treatment capacity to meet and effluent ammonia discharge permit of 3 mgN/L is 1.9 MGD during cold weather conditions. To meet these effluent discharge requirements at the permitted flow of 4.5 MGD, improvements to the nitrification capabilities of the facility and addition of phosphorus removal processes will be required.

5.0 ALTERNATIVE 1: UPGRADE AND EXPAND KING'S CREEK WWTP

The first alternative evaluated for the King's Creek WWTP long term treatment needs was an update of the previous improvements identified in the *Wastewater System Evaluation Phase No. 1 – Prioritization of Improvements* (2004). The improvements identified in this previous report were updated to include the improvements identified during the condition assessment and process evaluation, and to include phosphorus removal infrastructure.

5.1 ALTERNATIVE 1 – IMPROVEMENTS

The facility improvements included in the original *Wastewater System Evaluation Phase No. 1 – Prioritization of Improvements* (2004) were developed before completion of a condition assessment and process evaluation at the King's Creek WWTP. The improvements identified in the previous report also did not consider improvements required to meet a phosphorus discharge limits. Several additional improvements were identified during the condition assessment and process evaluation that would be needed to meet current treatment needs and also would be required to meet the effluent phosphorus discharge requirement that is now anticipated in the 2012 TPDES permit that were not anticipated during the 2004 evaluation. The near term improvements are shown in Table 5-1.

Table 5-1 Alternative 1 near term improvements

Unit Process	Improvements
Improvements Identified in 2004 Report	
Equalization Basin	• Coarse screens to reduce solids accumulation • Conversion to jet aeration/mixing for more efficient aeration • Geotextile liner on slope surrounding basin for increased storage volume
Additional Primary Clarifier	• Addition of a second primary clarifier to increase BOD removal • Additional primary clarification capacity for chemical phosphorus removal
First Stage Trickling Filter	• Additional BOD and ammonia removal to meet 4.5 MGD treatment requirements
Additional Intermediate Clarifier	• Addition of a second intermediate clarifier to increase BOD removal • Additional intermediate clarification capacity for chemical phosphorus removal
Secondary Nitrification Unit Process	• Additional ammonia removal to meet more stringent effluent ammonia requirements
Improvements Identified during Condition Assessment and Process Evaluation (in addition to above improvements)	
Additional grit classifier	• Addresses redundancy concern from the condition assessment
New mechanisms for existing primary clarifier	• Replacement of aging infrastructure to assure treatment capacity
New mechanism for existing intermediate clarifier	• Replacement of aging infrastructure to assure treatment capacity
Chemical feed facilities	• Chemical feed (either alum or ferric) will be required to meet upcoming phosphorus discharge requirements • Feed locations in primary, intermediate, and secondary clarifiers
Tertiary disk filtration	• Disk filtration to reduce effluent TSS concentration • Filtration of any phosphorus containing particulate

Improvements to the first stage trickling filter, primary clarifier, and intermediate clarifier would improve $cBOD_5$ removal. Increasing $cBOD_5$ removal in these processes will result in lower $cBOD_5$ loading to the second stage trickling filter which will increase the nitrification capacity for these trickling filters.

The biologically aerated filter (BAF) process would provide the remaining nitrification capacity increase to meet the non-seasonal effluent ammonia discharge requirement of 3 mgN/L. BAFs are an emerging technology that relies on media to simultaneously support the growth of biomass and to retain filtered solids. Intermittent backwash is included to manage solids accumulation, and backwash water can either be recycled to the head of the WWTP or treated in a separate backwash storage facility. For the King's Creek WWTP, the backwash water would be returned to the head of the facility and solids would be removed in the clarifiers. An example of a BAF flow pattern is shown in Figure 5-1. For the King's Creek WWTP, a four cell BAF would be recommended, with each cell having dimensions of 18 ft by 24 ft, with a depth of 22 ft. The media depth would be 12 ft. The original proposal for a BIOFOR® system is included in Appendix D.

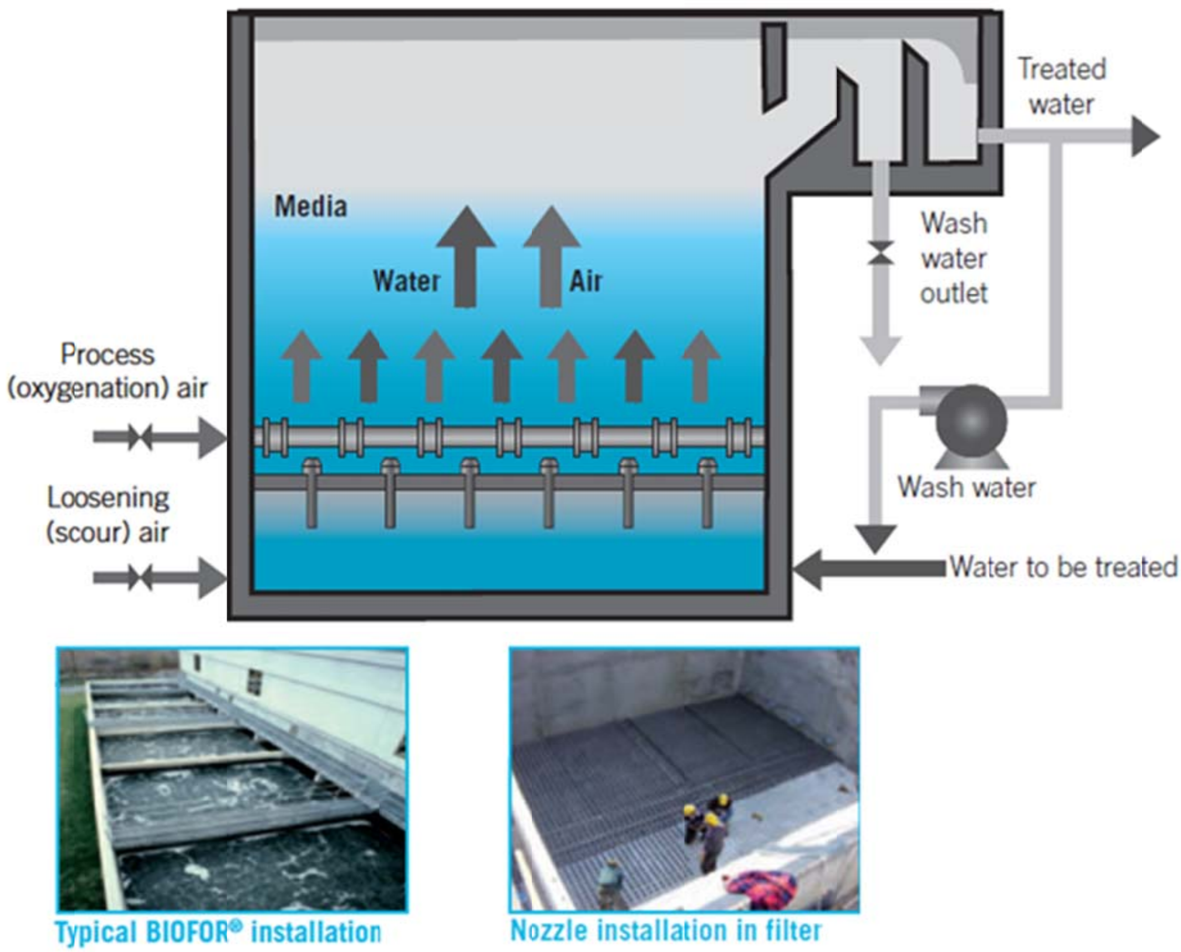

Figure 5-1 Example BAF flow diagram (BIOFOR®, Infilco-Degremont, Inc.)

The chemical feed facilities would allow the addition of alum or ferric to all three clarifier locations for chemical phosphorus precipitation. Chemical addition will be mainly for phosphorus removal, as the trickling filter and BAF processes do not select for the microbial ecology required for biological phosphorus removal. Chemical feed facilities would consist of a dual tank system with either a containment wall or double walled tank for containment. Chemical feed pumps are low flow pumps, and are typically diaphragm type metering pumps. These facilities would be located within the plant site in an area with easy access for chemical delivery.

Tertiary filters would remove chemical or biological particulate containing phosphorus from the effluent. The most common type of tertiary filtration is cloth media filtration. Cloth media filtration removes solids at the surface of the fabric by physical straining (Figure 5-2). The cloth is mounted on disks or frames, and water flows from the outside of the filter to the inside of the filter. Cloth media filters achieve similar filtration to granular media filters; however, the surface area per volume is greatly increased as the cloth filters can be arranged such that multiple sides are exposed to the water, whereas the granular media filters are flat and therefore have only one exposure surface. Cloth media filters also require less backwash water; perform better at elevated suspended solids concentrations; and can be installed in concrete, fiberglass, or steel tanks, limiting in-ground tankage and providing expansion flexibility. An example of a fixed disk cloth media filtration system with automatic backwash is shown in Figure 5-3. For the King's Creek WWTP, a pump station would be required to lift effluent flow to the tertiary filters during the intermediate improvements phase.

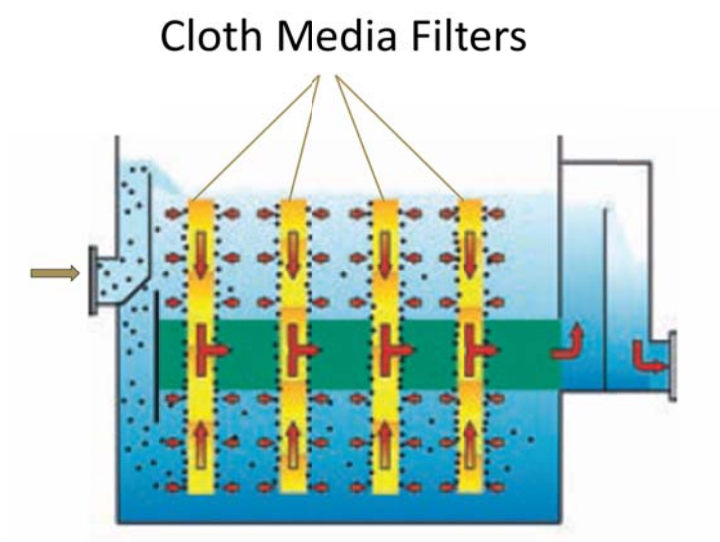

Figure 5-2 Flow pattern of cloth media filters

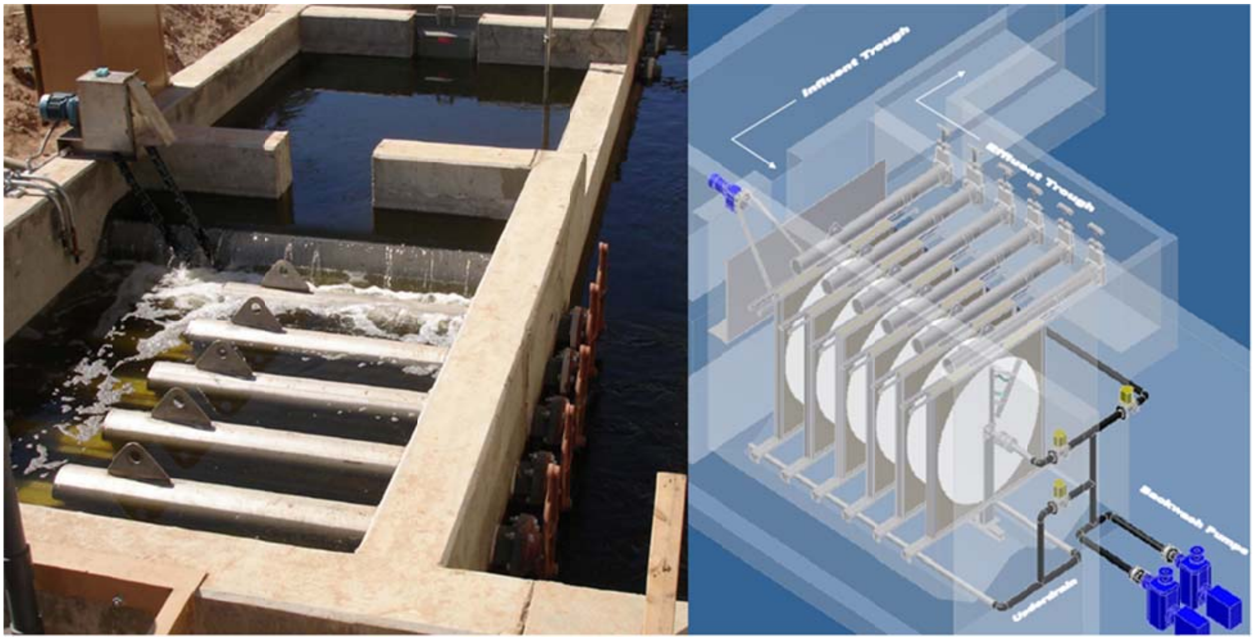

Figure 5-3 Example of a fixed disk cloth media filtration system

The improvements listed in Table 5-1 would significantly alter the process flow diagram for the King's Creek WWTP, as shown in Figure 5-4. Flow would need to be split between two primary clarifiers and two intermediate clarifiers. A portion of the effluent flow from the intermediate clarifier would need to be pumped to the new biologically aerated filter for treatment, and returned to combine with the effluent from the second stage trickling filters. The total effluent flow would then be filtered and disinfected. A total of 12 unit process types would be in operation under this configuration.

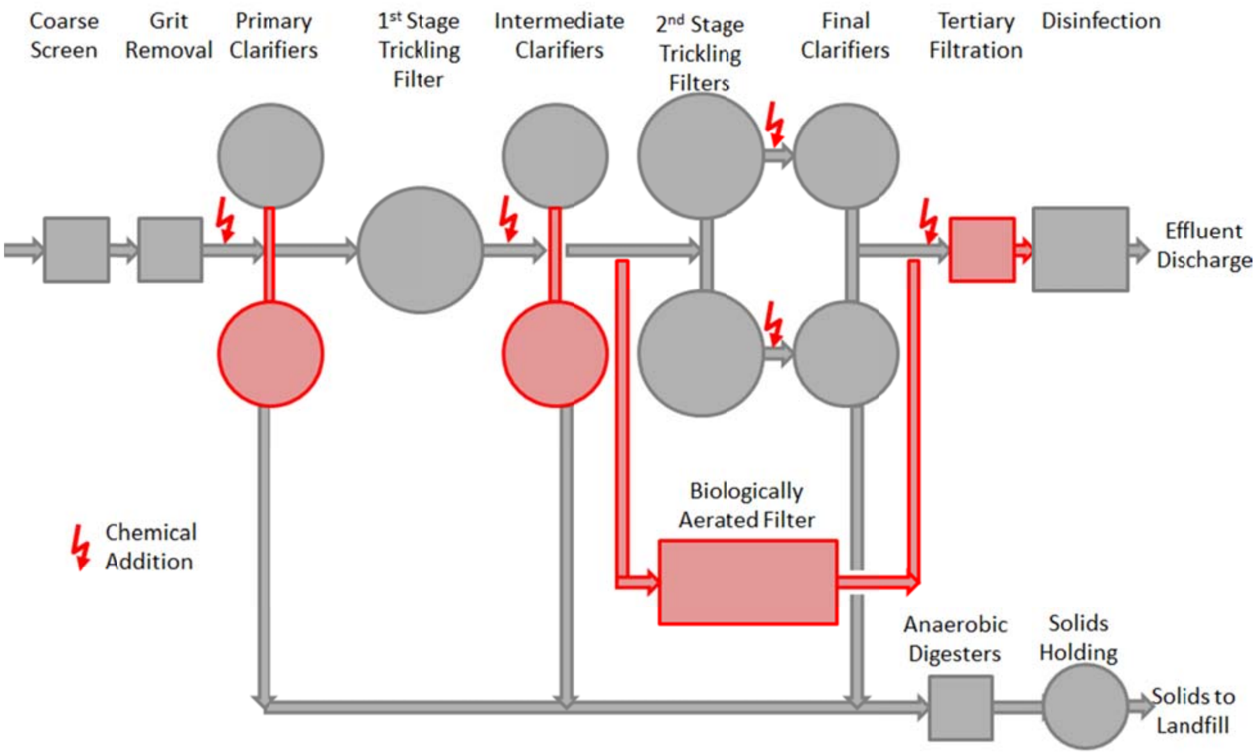

Figure 5-4 Process flow diagram for intermediate improvements for Alternative 1

The King's Creek WWTP site layout with the Alternative 1 improvements is shown in Figure 5-5. The new primary clarifier, intermediate clarifier, biologically aerated filter, and tertiary filters would fit in the existing site configuration, although future expansions would be difficult. The new facilities could be constructed with minimal interruption to the existing unit processes. The location of the chemical feed facilities would need to be included in an area with easy truck access. Improvements to the first stage trickling filter, existing primary clarifier, existing intermediate clarifier, grit classifier, and equalization basin would be recommended prior to construction of new unit processes to assure treatment capabilities of existing processes.

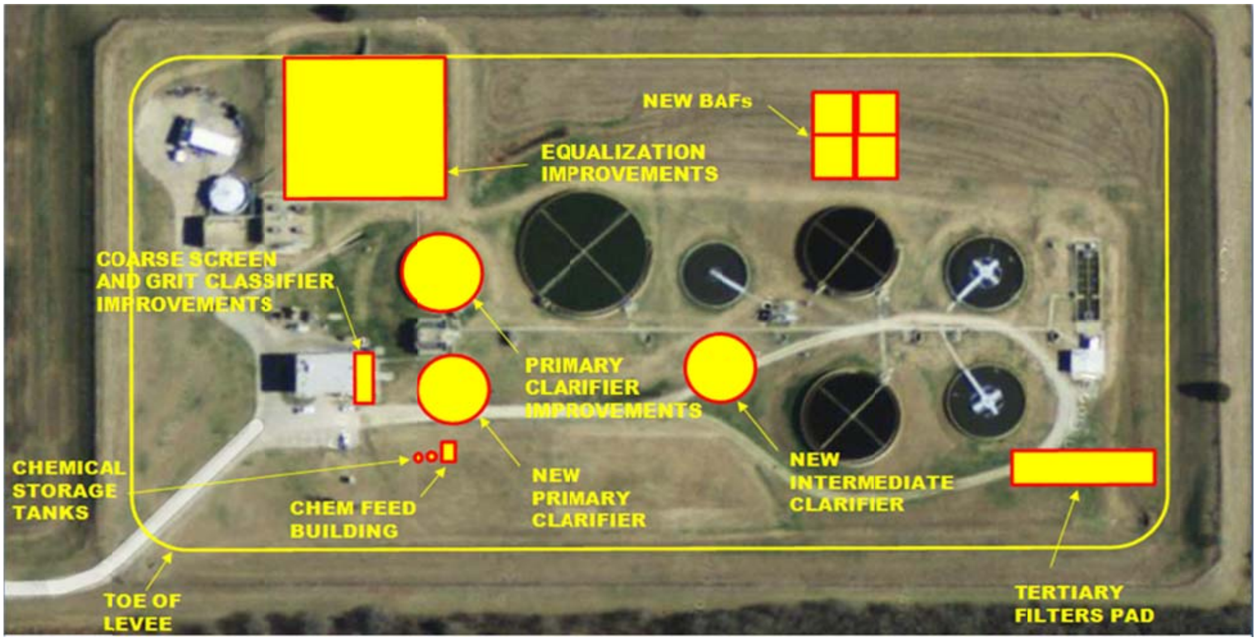

Figure 5-5 Alternative 1 site layout for intermediate improvements

The improvements shown in Table 5-1 would accomplish the treatment goals stated in Section 2.4 for 4.5 MGD of influent flow. These near term improvements will provide the redundancy and treatment capacity to meet the anticipated discharge permit values for 4.5 MGD of average day influent flow. However, it is likely that expansion beyond 4.5 MGD would require a new facility due to lack of available site area and future treatment needs. Future expansion of the facility would be difficult after the near term improvements shown in Figure 5-5 are completed, as the available footprint on the southwest side of the plant would be taken up by the new clarifiers in Alternative 1. In addition, continued use of chemical phosphorus removal rather than biological phosphorus removal is costly and would require increased solids handling facilities. As discussed in Section 4.2, the microbial ecology needed for biological phosphorus removal is not present at a significant fraction of the overall ecology in a trickling filter because the biomass is not exposed to alternating anaerobic and aerobic conditions. Activated sludge has a smaller footprint than trickling filters, which will be an important factor in future expansions, and allows for implementation of biological phosphorus removal. Long term improvements would need to center on new unit processes, and a move to an activated sludge facility would be recommended when the influent flow rates reached 90% of 4.5 MGD, the current permitted dry weather flow rate. When influent flow reached 90% of 4.5 MGD, a new 9 MGD activated sludge facility would be recommended at the King's Creek WWTP. The trickling filter and biologically aerated filter infrastructure would not be recommended to be used in conjunction with the activated sludge system because these unit processes are not designed to achieve biological nutrient removal. Achieving the anticipated phosphorus permit with long-term chemical precipitation would be costly and result in excess sludge production and alkalinity consumption. After construction of the 9 MGD activated sludge facility, an additional expansion of 4.5 MGD would be required prior to 2040.

5.2 ALTERNATIVE 1 – PROCESS PERFORMANCE

The process improvements included in Alternative 1 were incorporated into the BioWin model. This step was taken with Alternative 1 due to the unique nature of the existing unit processes and because several existing unit processes will continue to be used in Alternative 1. As shown in Figure 5-6, the process model developed for the existing process evaluation was modified by inclusion of chemical addition, a second primary clarifier, a second intermediate clarifier, and a series of BAFs. A chemical dosing rate of 2,000 lbs/day and treatment of 50% of the flow by the BAFs was required to achieve effluent concentrations of 1.5 mgN/L ammonia, 0.3 mgP/L total phosphorus, and 7 mg/L $cBOD_5$. This is consistent with the project TPDES permit limits shown in Table 2-2.

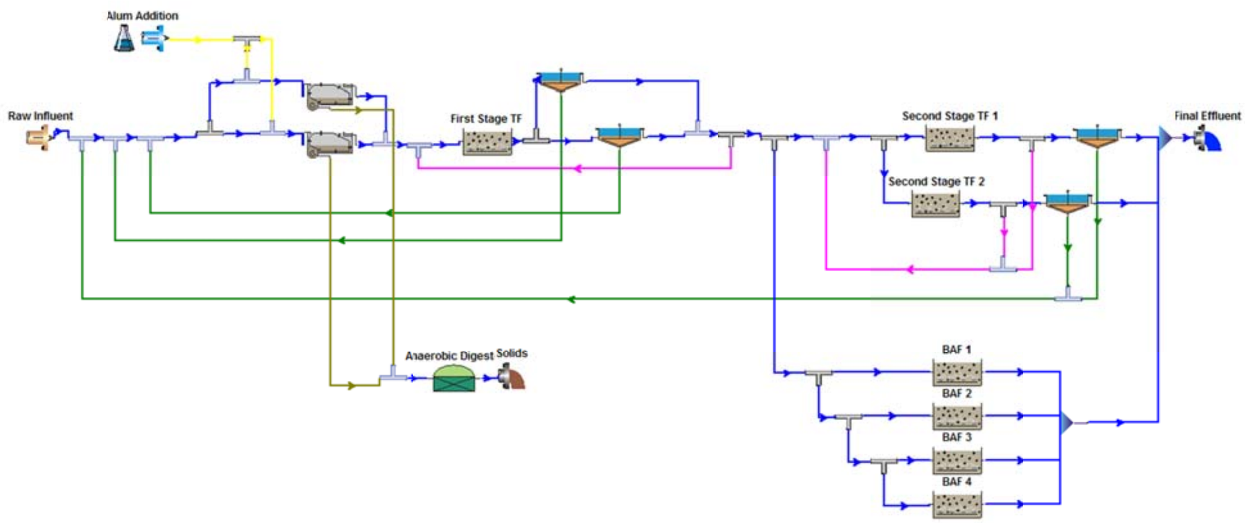

Figure 5-6 Process model for Alternative 1

5.3 ALTERNATIVE 1 – REQUIRED TREATMENT EXPANSIONS

The current treatment capacity of the King's Creek WWTP was found to be 2.1 MGD under existing effluent discharge permit conditions. With the anticipated effluent permit discharge requirements, the treatment capacity of King's Creek WWTP would decrease to 1.9 MGD. Near term improvements would bring the treatment capacity to the current permitted dry weather flow rate of 4.5 MGD. Future expansions would be required when influent flows reach 90% of the permitted flows, as stated in Section 2.4. After the treatment capacity is increased to 4.5 MGD, expansions over the next 30 years would be required in 2022 to 9 MGD and in 2035 to 13.5 MGD. The dry weather flow rates and treatment capacity expansions for 2010 through 2040 are shown in Figure 5-7. After the Alternative 1 near term improvements to increase the treatment capacity to 4.5 MGD, future expansions would shift the King's Creek WWTP to an activated sludge facility.

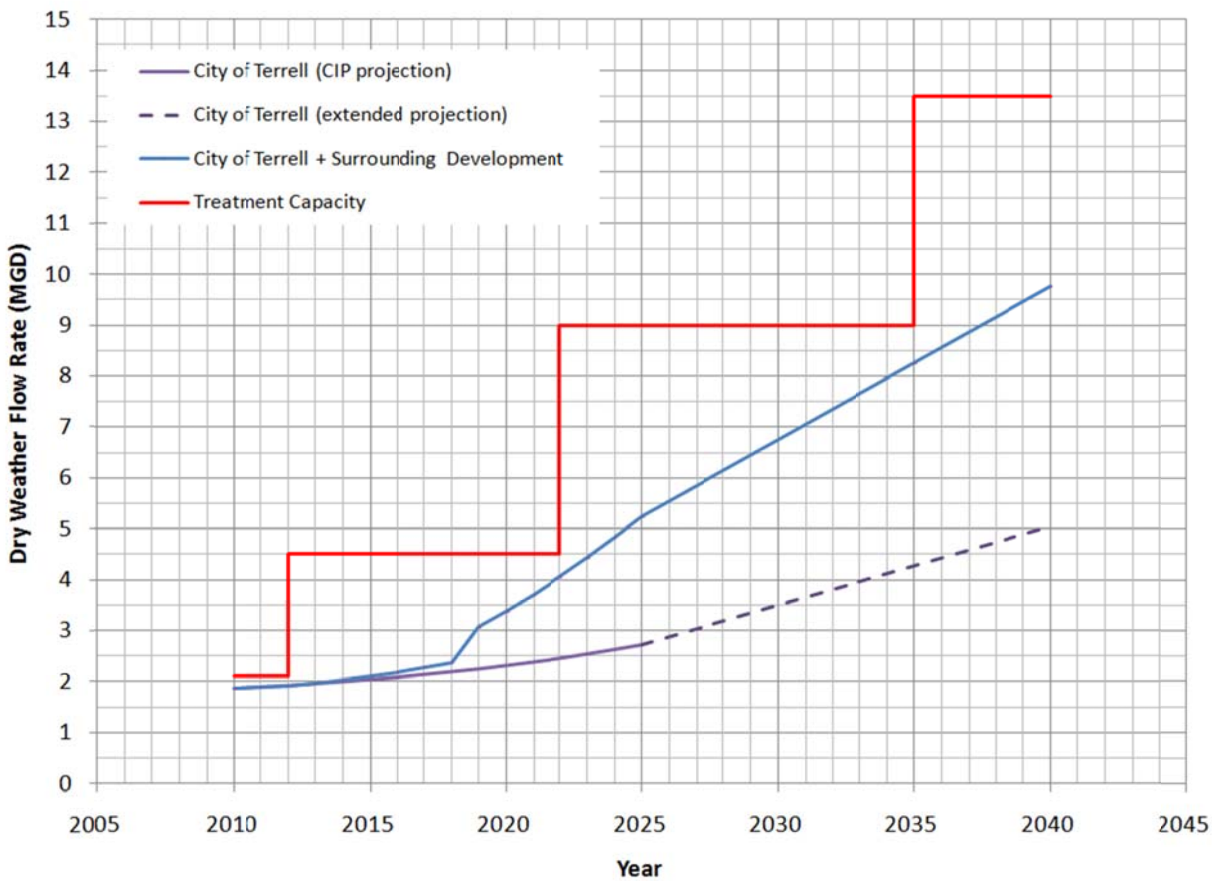

Figure 5-7 Dry weather flow and treatment expansions

Phasing of the treatment expansions for Alternative 1 is shown in Figure 5-8. Phase I would consist of the intermediate improvements shown in Table 5-1, which are based on the previous study and the condition and process assessments completed on the King's Creek WWTP. When flows reached 90% of 4.5 MGD, construction of Phase II would need to be in progress. This is projected to occur in 2022. Construction of Phase II would be difficult, as the space occupied by several existing unit processes would be needed for construction of aeration basins and final clarifiers. The difficulty presented as part of Phase II would add significant construction cost to the expansion. Phase III would then be completed with flow reached 90% of 9 MGD, which is projected to occur in 2035.

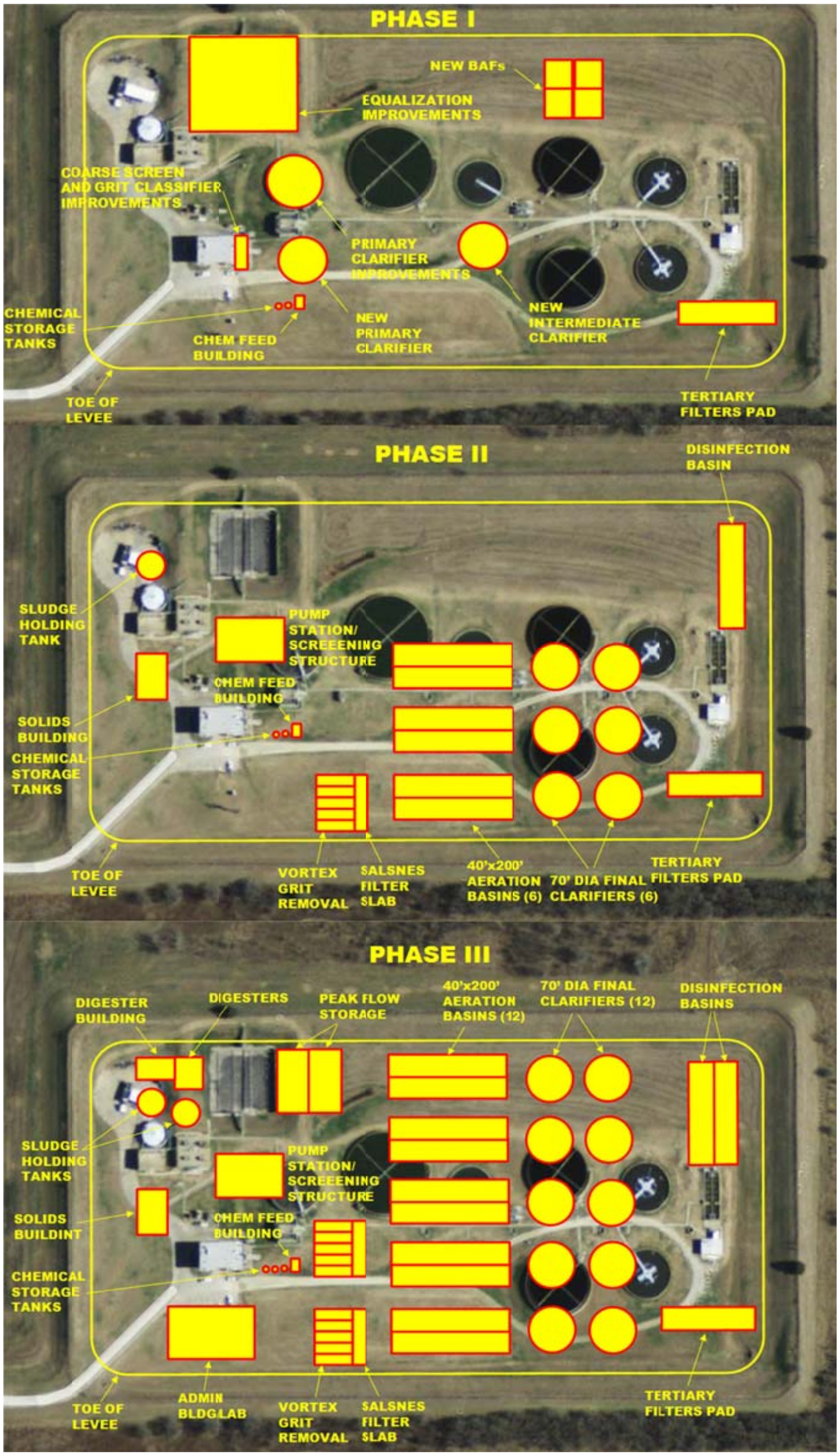

Figure 5-8 Phasing of expansions for Alternative 1

5.4 ALTERNATIVE 1 –BUDGETARY COSTS

Three facility expansions were identified as part of Alternative 1: near term improvements to existing facilities, construction of a new activated sludge facility when near term improvement capacity is reached, and expansion of the activated sludge facility. The opinion of probable construction costs (OPCCs) were developed for each of these improvements/expansions and are included in Appendix E. The budgetary construction cost and year of improvement for each phase are summarized in Table 5-2. The total budgetary construction cost for Alternative 1 for 2011 through 2040, in 2011 dollars, is $107.1 M. The treatment capacity and expansion costs for Alternative 1 are shown in Figure 5-9.

Table 5-2 Alternative 1 budgetary costs

Year	Improvement	Budgetary Cost (2011$)
2012	**Near Term Improvements**	**$16.3 M**
	Construction	$13.8 M
	Engineering and Surveying	$2.5 M
2022	**New 9 MGD Activated Sludge WWTP**	**$63.1 M**
	Construction	$53.5 M
	Engineering and Surveying	$9.6 M
2035	**Expansion 4.5 MGD Activated Sludge WWTP**	**$27.7 M**
	Construction	$23.5 M
	Engineering and Surveying	$4.2 M
TOTAL		**$107.1 M**

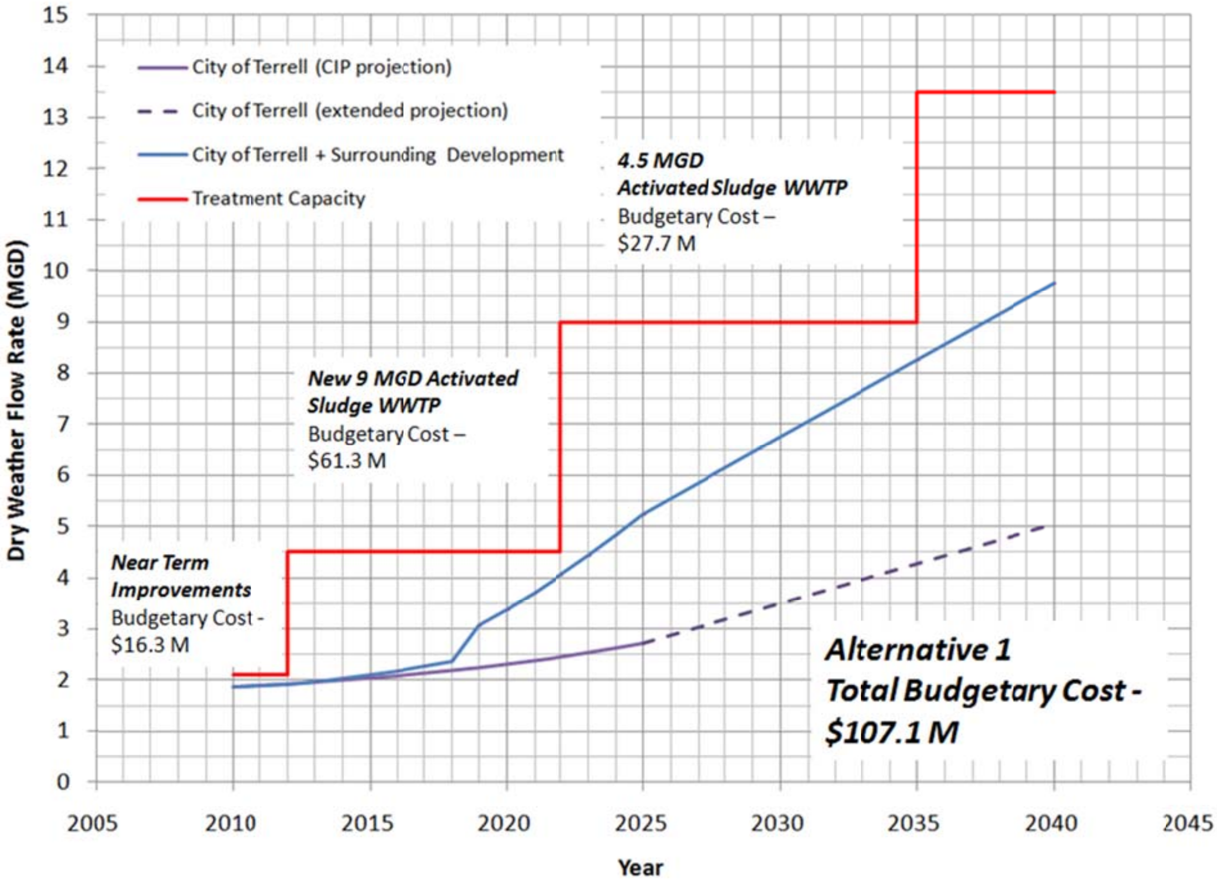

Figure 5-9 Projected treatment capacity and expansion capital costs for Alternative 1

5.5 ALTERNATIVE 1 –OPERATION AND MAINTENANCE

Operation and maintenance costs for Alternative 1 were developed based on the methodology described in Section 3. The cost projection calculation was modified to include the improvements shown in Table 5-1. From 2012 through 2022, the cost projection includes aeration for the biologically aerated filter, chemical costs for phosphorus removal, and increased solids disposal costs from increases solids associated with chemical removal. This total cost is $2.18 per 1,000 gallons of treated wastewater. Chemical costs will be significant additional costs for Alternative 1. The projected costs included $27,000 per MGD of influent flow per year for chemicals and an increase in solids hauling cost of $17,000 per MGD per year. These additional chemical costs calculations are shown in Appendix F. Starting in 2022, the operation and maintenance is based on a biological nutrient removal (BNR) activated sludge facility with minimal chemical addition. The BNR facility will use fewer chemicals and produce less waste solids, and the overall operation and maintenance cost would be $2.12 per 1,000 gallons of treated wastewater. The total operation and maintenance cost for Alternative 1 for the 30 year study period, expressed in 2011 dollars, is $126.0 M. This is the total amount of operations and maintenance required through 2040. Cost calculations are shown in Appendix G.

5.6 ALTERNATIVE 1 CONCLUSIONS

The total budgetary construction cost for Alternative 1 is $107.1 M. Alternative 1 would include $16.3M in improvements in the next five years, with an additional $63.1 M in the next ten years. The expansions would enable the King's Creek WWTP to achieve the treatment criteria discussed in Section 2.4 while meeting the projected flow rates shown in Section 2.1. Operation and maintenance costs would be $126.0 M for the thirty year study period. The resulting total 30 year cost for Alternative 1 would be $233.1 M.

6.0 ALTERNATIVE 2: CONSTRUCT NEW CITY OF TERRELL WWTP

The second alternative for the future wastewater management of the City of Terrell and surrounding areas was a new WWTP at the existing King's Creek WWTP site. Alternative 2 would consist of construction of a new activated sludge facility on the existing King's Creek WWTP site. The existing grit removal, coarse screen, solids processing, and disinfection would be maintained, with the improvements identified during the process evaluation and condition assessment. The existing clarifiers and trickling filters would be decommissioned and removed.

6.1 ALTERNATIVE 2 –IMPROVEMENTS

Alternative 2 would replace the majority of unit processes at the King's Creek WWTP. The primary clarifier, first stage trickling filter, intermediate clarifier, second stage trickling filters, and final clarifiers would all be decommissioned. They would be replaced with Salsnes Filters, aeration basins, and final clarifiers. Tertiary filtration would also be included to increase suspended solids removal and phosphorus removal, and would be the same as discussed for Alternative 1. Chemical feed facilities would also be included as a backup for biological nutrient removal (BNR). For budgetary planning purposes, new grit removal and fine screens were also included upstream of the Salsnes filters. Though these unit processes are not required, they are recommended for extended Salsnes filter belt life.

Salsnes Filters are an emerging technology that can replace primary clarifiers. The filters remove a similar amount of TSS and BOD as primary clarifiers via filtration through a coarse belt (see Figure 6-1 and Appendix H). Solids are removed from the belt and sent to solids processing facilities. The advantage of Salsnes Filters is their small footprint, low maintenance requirements, and high level of performance.

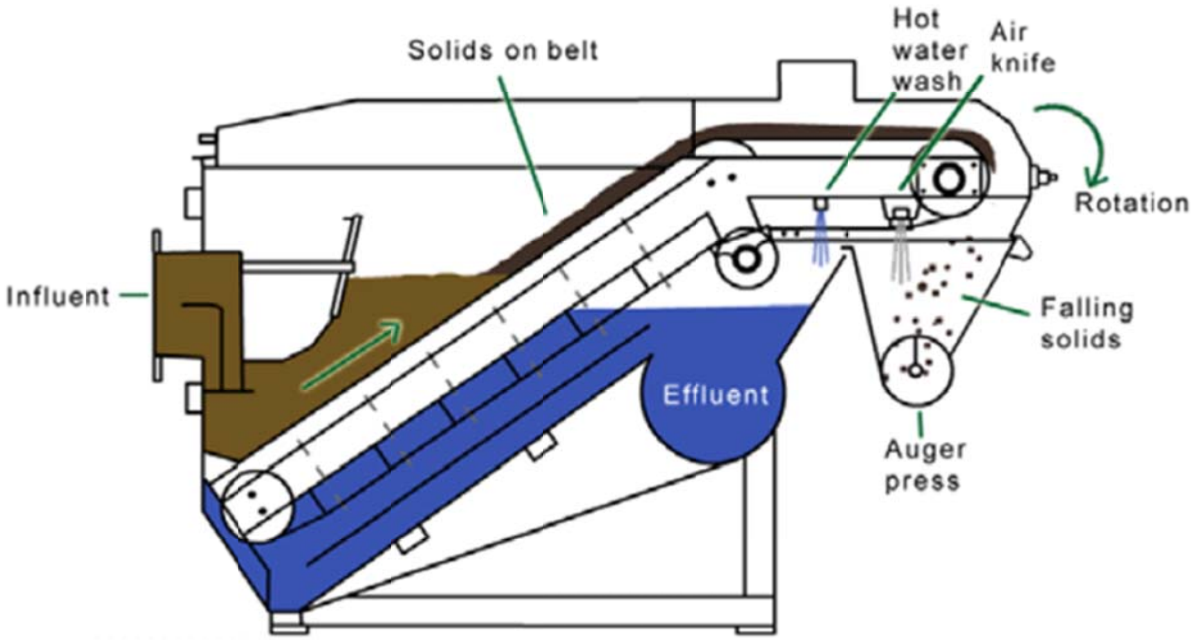

Figure 6-1 Salsnes Filter operation diagram

Preliminary sizing of the aeration basins and final clarifiers was completed using the guidelines presented in 30 TAC §217. Process calculations for this sizing are included in Appendix I. Sizing of these unit processes was based on a BNR operational strategy. The design would include fine bubble aeration for the aerated portions of the facility, and unaerated zones in the aeration basins would be mixed with submerged mixers. Operation as a BNR facility would significantly decrease the chemical addition required to meet the anticipated effluent phosphorus permit limit, reducing operation and maintenance costs. Implementation of a fine bubble aeration system would increase aeration efficiency and decrease energy consumption.

The modified King's Creek WWTP process flow diagram is shown in Figure 6-2. A total of 9 unit process types would be implemented, as opposed to 12 unit process types for Alternative 1. The solids processing facilities would provide adequate solids processing for the activated sludge facility.

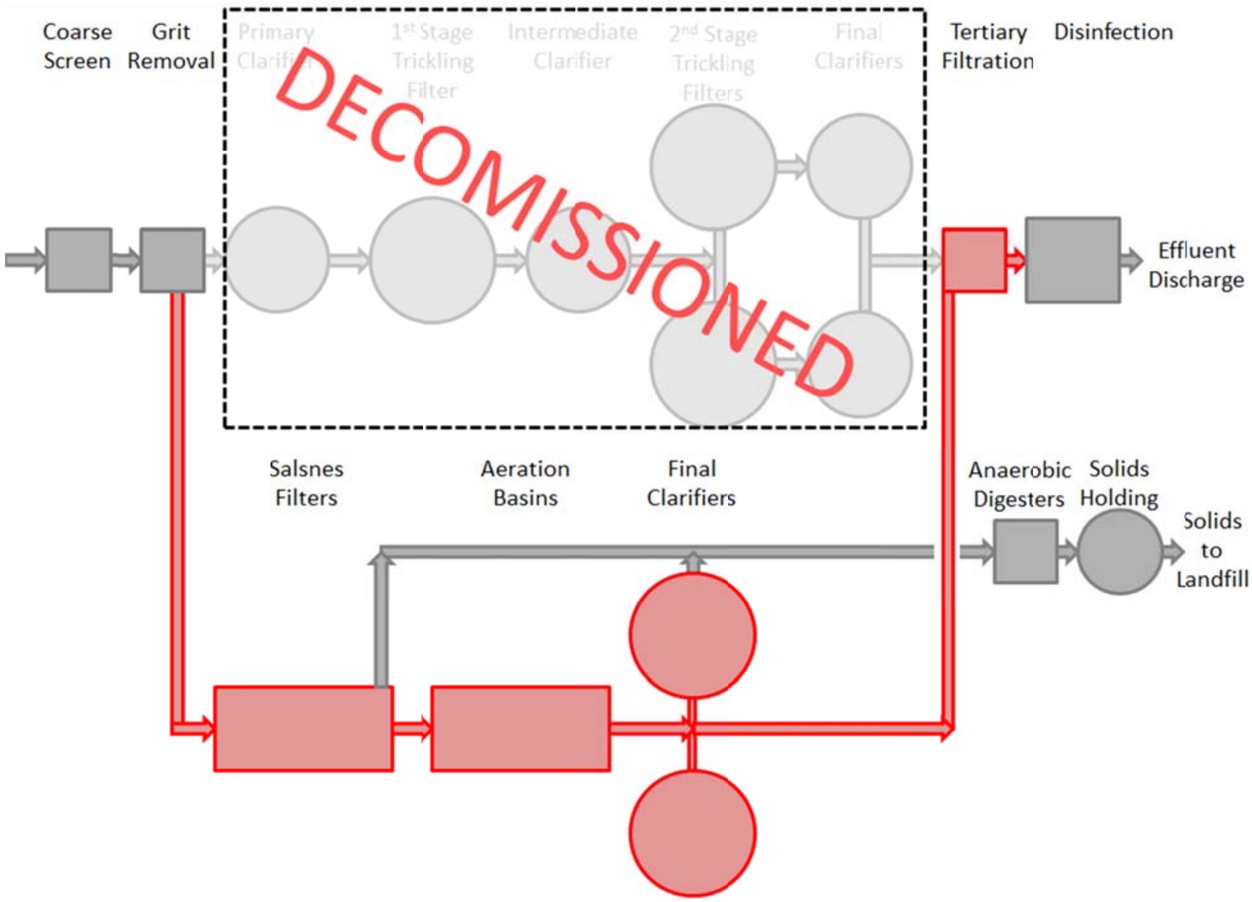

Figure 6-2 Process flow diagram for Alternative 2

The site layout for the new activated sludge WWTP at the King's Creek WWTP is shown in Figure 6-3. The Salsnes Filters and tertiary filters should be constructible without interfering with the operation of the existing facilities. The Salsnes Filters and tertiary filters would likely be constructed first to allow the King's Creek WWTP to meet the anticipated TPDES discharge permit concentrations while the remaining improvements are completed. The existing facilities would be decommissioned as required during construction. One of the second stage trickling filters would need to be decommissioned before construction of the final clarifiers. This construction could be completed in the summer to allow more favorable conditions. The chemical feed facilities would also need to be completed prior to this construction, which would allow for more BOD removal in the clarifiers to increase nitrification potential in the trickling filters during construction.

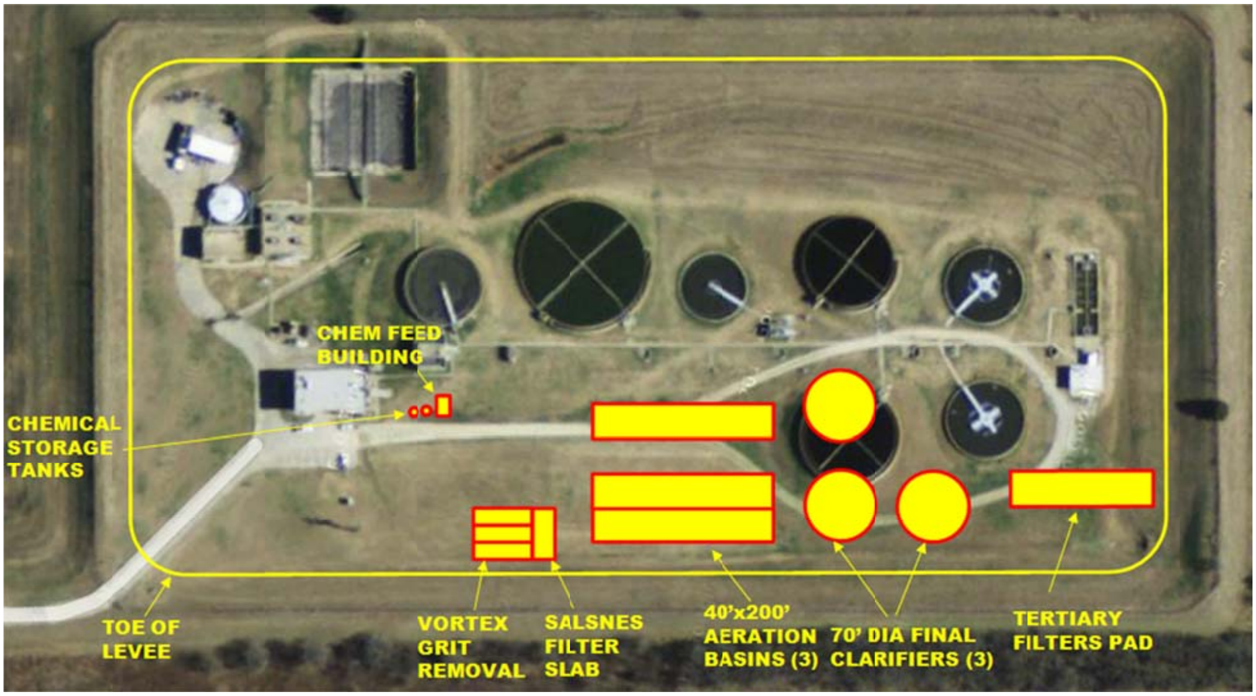

Figure 6-3 Site layout for a new activated sludge facility at the King's Creek WWTP

6.2 ALTERNATIVE 2 – PROCESS PERFORMANCE

The processes designed for Alternative 2 are new processes that will be designed to meet the anticipated TPDES permit requirements. For this reason, a process model was not completed for Alternative 2. The design follows best engineering practice for a BNR facility and should meet anticipated permit requirements.

6.3 ALTERNATIVE 2 – REQUIRED TREATMENT EXPANSIONS

The current treatment capacity of the King's Creek WWTP was found to be 2.1 MGD under existing effluent discharge permit conditions. With the anticipated effluent permit discharge requirements, the treatment capacity of King's Creek WWTP would decrease to 1.9 MGD. Future expansions would be required when influent flows reach 90% of the permitted flows, as stated in Section 2.4. After the treatment capacity is increased to 4.5 MGD, expansions over the next 30 years would be required in 2022 to 9 MGD and in 2035 to 13.5 MGD. The dry weather flow rates and treatment capacity expansions for 2010 through 2040 are shown in Figure 6-4. After the Alternative 2 construction of a 4.5 MGD activated sludge facility, future expansions follow the 4.5 MGD footprint used for initial construction.

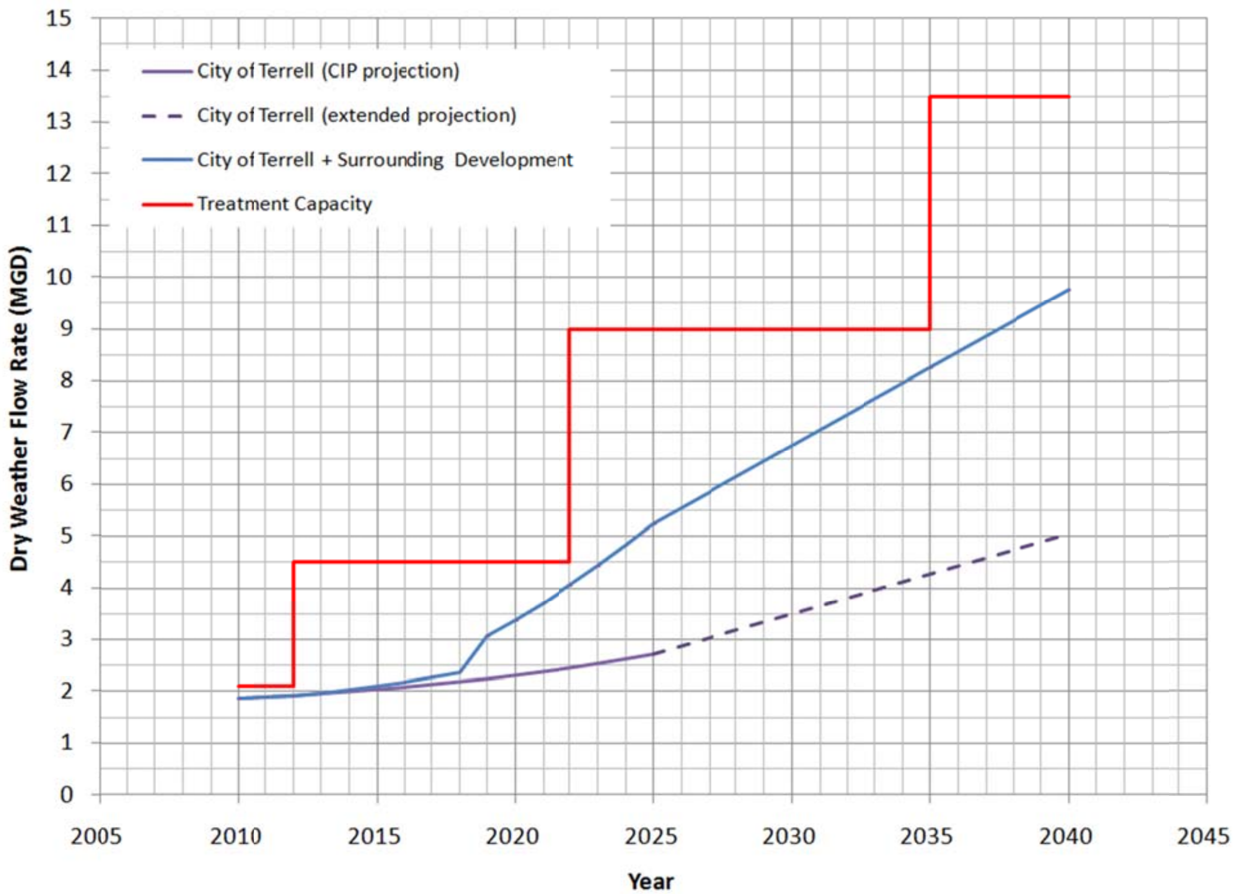

Figure 6-4 Treatment expansion phasing for Alternative 2

Phasing of the treatment expansions for Alternative 2 is shown in Figure 6-5. Phase I construction would consist of a new 4.5 MGD activated sludge facility on the existing King's Creek WWTP site. When flows reached 90% of 4.5 MGD, construction of Phase II would need to be in progress. This is projected to occur in 2022. Phase II would consist of a 4.5 MGD expansion of the King's Creek WWTP. It is anticipated that Phase II would require improvements to solids handling facility, a new pump station and screening structure, and new disinfection facilities. Phase III would then be completed when flow reached 90% of 9 MGD, which is projected to occur in 2035. Along with treatment capacity, Phase III would consist of expansion of the peak flow storage basin.

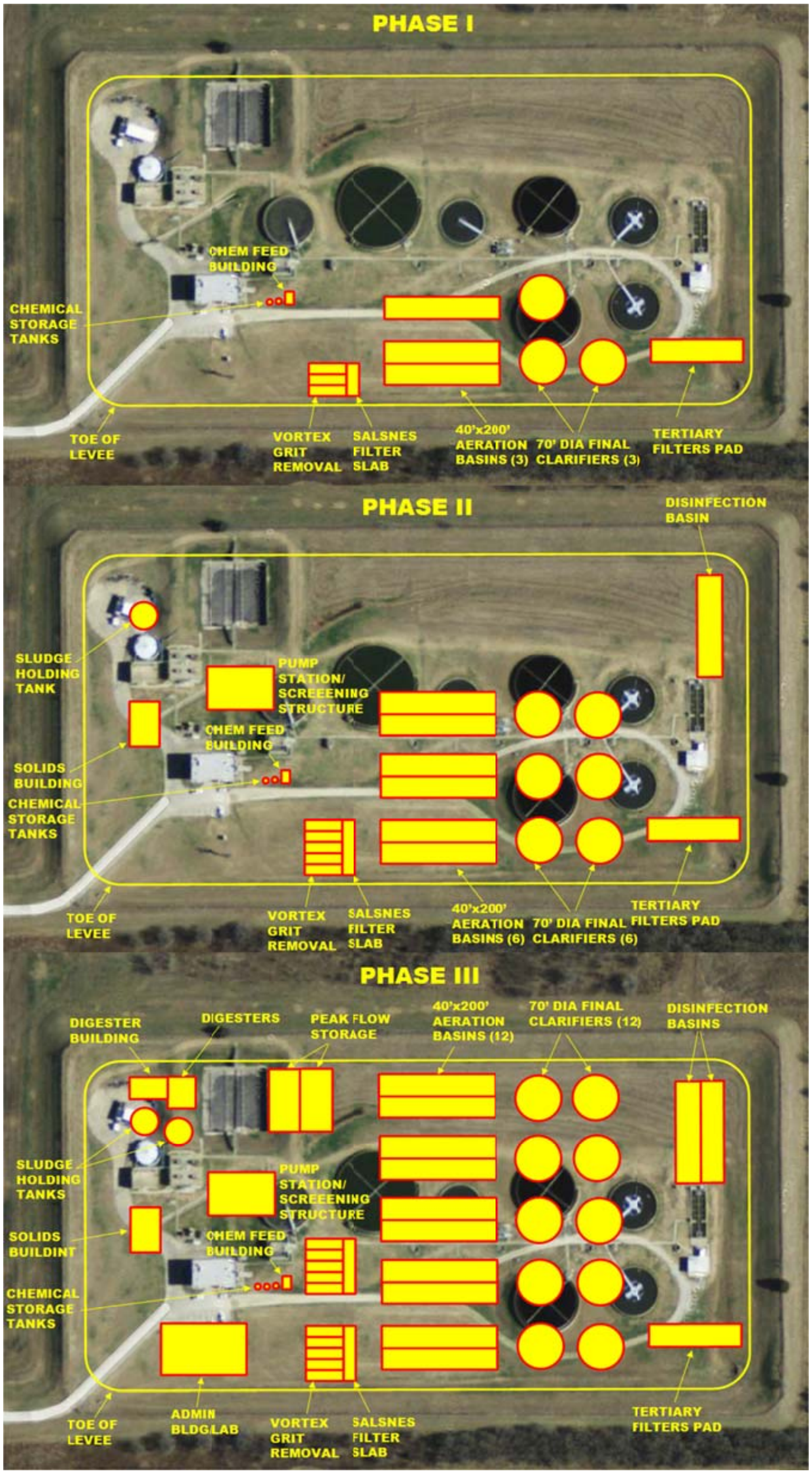

Figure 6-5 Treatment expansion phasing for Alternative 2

6.4 ALTERNATIVE 2 – BUDGETARY COSTS

Three facility expansions were identified as part of Alternative 2: construction of a 4.5 MGD activated sludge facility designed for BNR and two subsequent 4.5 MGD expansions. The OPCCs were developed for each of these improvements/expansions and are included in Appendix E. The budgetary cost and implementation year for each improvement are summarized in Table 6-1. The total budgetary construction cost for Alternative 2 for 2010 through 2040, in 2011 dollars, is $87.5 M. The treatment capacity and expansion costs for Alternative 2 are shown in Figure 6-6.

Table 6-1 Budgetary costs for Alternative 2

Year	Improvement	Budgetary Cost (2011$)
2012	**New Activated Sludge WWTP**	**$32.1 M**
	Construction	$27.2 M
	Engineering and Surveying	$4.9 M
2022	**Expansion 4.5 MGD Activated Sludge WWTP**	**$27.7 M**
	Construction	$23.5 M
	Engineering and Surveying	$4.2 M
2035	**Expansion 4.5 MGD Activated Sludge WWTP**	**$27.7 M**
	Construction	$23.5 M
	Engineering and Surveying	$4.2 M
TOTAL		**$87.5 M**

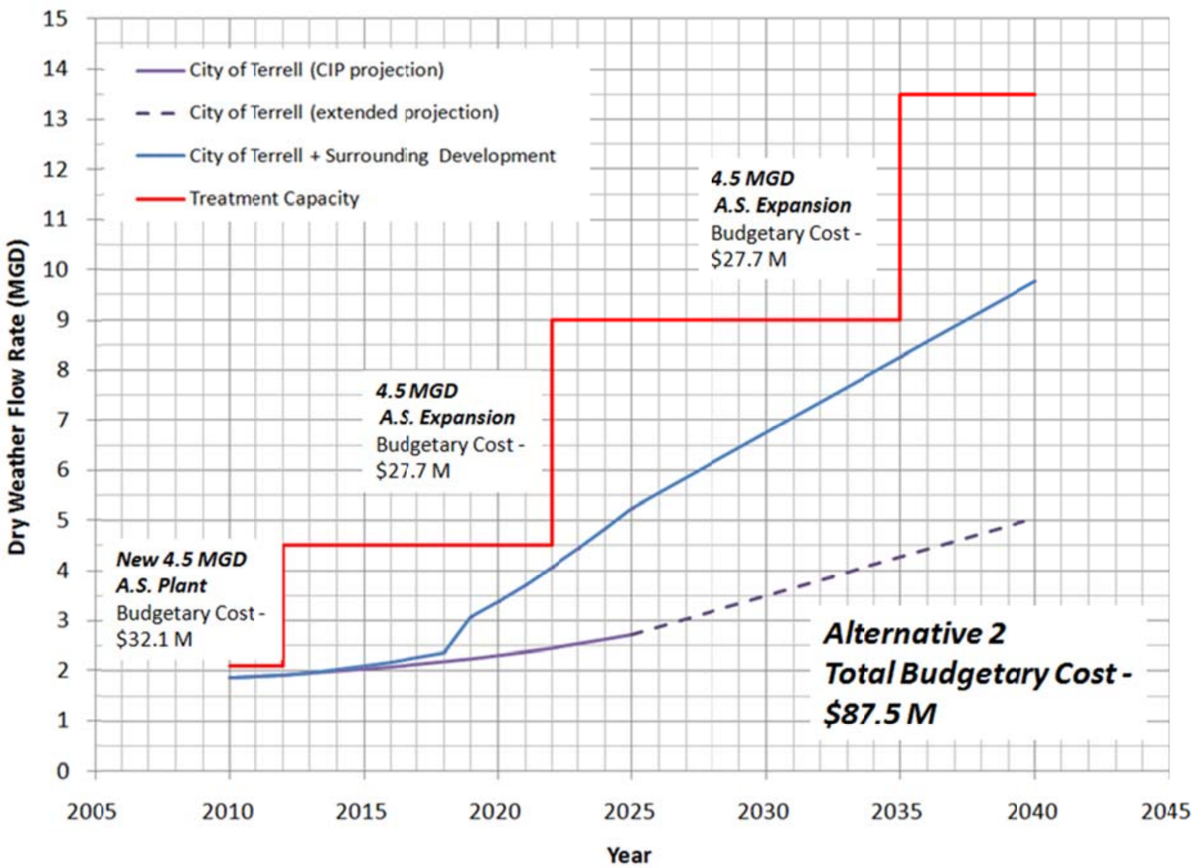

Figure 6-6 Treatment capacity and expansion capital costs for Alternative 2

6.5 ALTERNATIVE 2 –OPERATION AND MAINTENANCE

Operation and maintenance costs for Alternative 2 were developed based on the methodology described in Section 3. The cost projection calculation was modified to include 100% of the flow being treated by activated sludge. It was assumed that biological phosphorus removal would reduce effluent phosphorus to 1.5 mgP/L. Chemical precipitation was assumed to take the 1.5 mgP/L down to 0.5 mgP/L. The chemical costs for this portion of phosphorus removal were included in operation and maintenance costs for Alternative 2. Increases in solids hauling due to this small amount of chemical addition were assumed to be negligible. The projected costs are $4,000 per MGD of influent flow per year for chemicals. These additional chemical costs calculations are shown in Appendix F. The BNR facility for Alternative 2 will have the same overall operation and maintenance cost as the BNR facility in Alternative 1, which was found to be $2.12 per 1,000 gallons of treated wastewater. The total operation and maintenance cost for Alternative 2, expressed in 2011 dollars, is $125.6 M. This would be the cumulative operations costs for the WWTP through 2040. Cost calculations are shown in Appendix G.

6.6 ALTERNATIVE 2 – CONCLUSIONS

The total budgetary construction cost for Alternative 2 is $87.5 M. The expansions would enable the King's Creek WWTP to achieve the treatment criteria discussed in Section 2.4 while meeting the projected flow rates shown in Section 2.1. Operation and maintenance costs would be $125.6 M for the thirty year study period. The resulting total 30 year cost for Alternative 1 would be $213.1 M.

7.0 ALTERNATIVE 3: REGIONAL WASTEWATER SYSTEM

The third alternative analyzed in this study was evaluating the City of Terrell and its surrounding developments joining a regional wastewater system. For a regional wastewater system, participation would need to be requested to convey flows to the North Texas Municipal Water District (NTMWD) South Mesquite Regional Wastewater Treatment Plant (South Mesquite RWWTP). The City would have to request permission to join the system from the current NTMWD member entities. If participation in the regional system is approved, the City would be responsible for constructing and maintaining the infrastructure that would convey wastewater flow to the treatment plant. There are potential opportunities for the City to share in existing NTMWD interceptor systems to transfer flow to the WWTP in order to reduce overall capital and O&M costs. The two regional wastewater conveyance system options evaluated for Alternative 3 are the following:

- **Option 1: Connect to NTMWD's Forney Interceptor System (FIS)**
- **Option 2: Connect to NTMWD's Lower East Fork Interceptor System (LEFIS)**

Either regional option would involve the City of Terrell constructing a series of lift stations and force mains to convey the flows from the King's Creek WWTP to the respective interceptor system. Either option will also entail the City paying a monthly fee to NTWMD for the treatment of wastewater flows. The total cost of each option in the regional analysis consisted of five components:

1. Capital Cost for City of Terrell Conveyance Infrastructure
2. O&M Cost for City of Terrell Conveyance Infrastructure
3. Capital Cost for NTMWD Regional Conveyance Infrastructure
4. NTMWD Regional Conveyance O&M Cost
5. NTMWD Regional Treatment Cost

The sizing of conveyance infrastructure was based on the population and flow projections discussed in Section 2 of this report. The capital improvements were broken down into two phases: the improvements needed to serve 2025 flows and improvements needed to serve 2040 flows. The NTWMD treatment costs, NTMWD conveyance system O&M costs and City conveyance O&M costs were calculated on an annual basis through 2040. The improvements and associated costs needed for Alternative 3 are discussed in this section and are shown in Figure 7.1.

7.1 ALTERNATIVE 3 – DESIGN CRITERIA

The design criteria used in the sizing of the infrastructure in this evaluation is consistent with the criteria used in the Freese and Nichols report titled *Wastewater System Study for Major Developments, September 2006.*

Sewer Trunk Lines (Interceptors)

The design criteria for sewer trunk lines or interceptors is based on the TCEQ requirements that meet peak wet weather design flows with no overflows while maintaining a minimum of 2 feet/second cleaning velocity and a maximum of 8 feet/second velocity.

Lift Station Pumping Capacity

The design criteria for lift station pumping is to provide firm pumping capacity to meet 100% of the peak wet weather design flows. The firm pumping capacity is defined as the total available pumping capacity with the largest pump out of service.

Lift Station Wet Well Capacity

The design criteria for lift station wet wells are to provide adequate volumes to limit pump cycling to once every 10 minutes. Based on these criteria, the required operating volume for each pump can be calculated as:

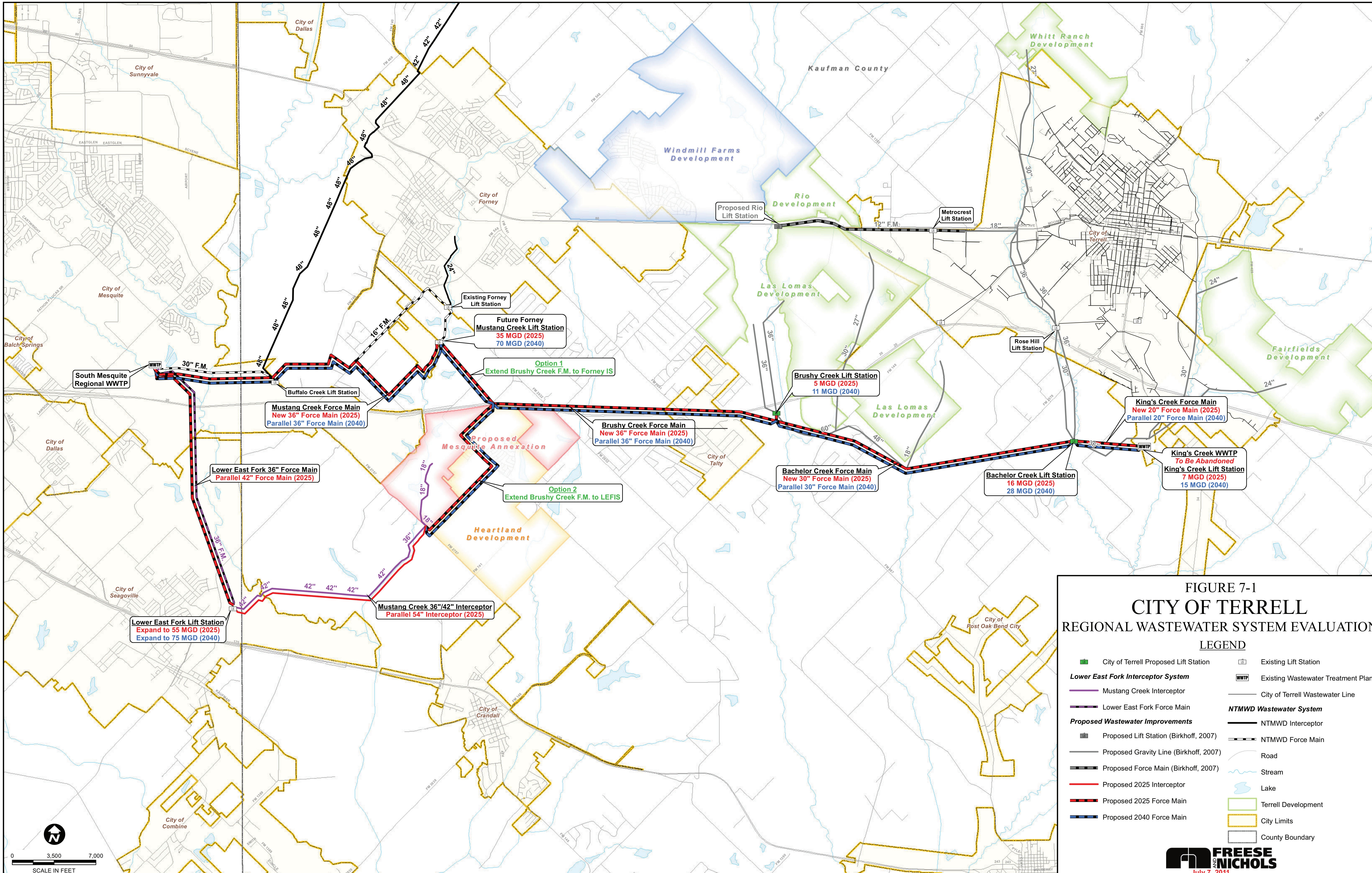

FIGURE 7-1
CITY OF TERRELL
REGIONAL WASTEWATER SYSTEM EVALUATION
LEGEND
City of Terrell Proposed Lift Station
Lower East Fork Interceptor System
Mustang Creek Interceptor
Lower East Fork Force Main
Proposed Wastewater Improvements
Proposed Lift Station (Birkhoff, 2007)
Proposed Gravity Line (Birkhoff, 2007)
Proposed Force Main (Birkhoff, 2007)
Proposed 2025 Interceptor
Proposed 2025 Force Main
Proposed 2040 Force Main
Existing Lift Station
Existing Wastewater Treatment Plant
City of Terrell Wastewater Line
NTMWD Wastewater System
NTMWD Interceptor
NTMWD Force Main
Road
Stream
Lake
Terrell Development
City Limits
County Boundary
FREESE AND NICHOLS
July 7, 2011
SCALE IN FEET
0
3,500
7,000
Kaufman County
Windmill Farms Development
Whitt Ranch Development
Rio Development
Las Lomas Development
Fairfields Development
Heartland Development
Proposed Mesquite Annexation
City of Dallas
City of Sunnyvale
City of Mesquite
City of Balch Springs
City of Forney
City of Terrell
City of Talty
City of Seagoville
City of Crandall
City of Combine
City of Post Oak Bend City
Proposed Rio Lift Station
Metrocrest Lift Station
Existing Forney Lift Station
Future Forney Mustang Creek Lift Station
35 MGD (2025)
70 MGD (2040)
Option 1
Extend Brushy Creek F.M. to Forney IS
Option 2
Extend Brushy Creek F.M. to LEFIS
South Mesquite Regional WWTP
Buffalo Creek Lift Station
Mustang Creek Force Main
New 36" Force Main (2025)
Parallel 36" Force Main (2040)
Brushy Creek Force Main
New 36" Force Main (2025)
Parallel 36" Force Main (2040)
Brushy Creek Lift Station
5 MGD (2025)
11 MGD (2040)
Rose Hill Lift Station
King's Creek Force Main
New 20" Force Main (2025)
Parallel 20" Force Main (2040)
King's Creek WWTP
To Be Abandoned
King's Creek Lift Station
7 MGD (2025)
15 MGD (2040)
Bachelor Creek Force Main
New 30" Force Main (2025)
Parallel 30" Force Main (2040)
Bachelor Creek Lift Station
16 MGD (2025)
28 MGD (2040)
Lower East Fork 36" Force Main
Parallel 42" Force Main (2025)
Lower East Fork Lift Station
Expand to 55 MGD (2025)
Expand to 75 MGD (2040)
Mustang Creek 36"/42" Interceptor
Parallel 54" Interceptor (2025)
30" F.M.
16" F.M.
12" F.M.
18" F.M.
36" F.M.
48"
42"
24"

$$V = \frac{t * Q}{4}$$

where,

t = Maximum pump cycling time (10 minutes)
Q = Lead pump discharge rate (gpm)
V = Required wet well volume between pump start and stop elevation

Force Mains

The design criteria recommended for force mains is to meet the required pumping capacity of the lift station at a velocity less than 8 feet per second and a maximum discharge pressure of 100 pounds per square inch (psi) and to allow a minimum of 2 feet per second scouring velocity during single pump operation.

7.2 ALTERNATIVE 3 - CITY OF TERRELL CONVEYANCE CAPITAL COSTS

This analysis studied two options for the regional wastewater system alternative. Option 1 consists of sending flow from King's Creek Wastewater Treatment Plant to the NTMWD Forney Interceptor System's proposed Mustang Creek Lift Station. Option 2 consists of sending flow from King's Creek WWTP to the NTMWD 36" Lower East Fork Interceptor System (LEFIS) Mustang Creek Interceptor. A map of the proposed conveyance system is shown on Figure 7.1.

In either option, wastewater will be pumped from a new King's Creek Lift Station to a new Bachelor Creek Lift Station. The King's Creek Lift Station will serve half of the existing Terrell city limits plus the Fairfields Development. The Bachelor Creek Lift Station will serve the King's Creek Lift Station flow as well as the other half of Terrell's city limits plus the Whitt Ranch and Rio Developments. The wastewater will then be pumped from the Bachelor Creek Lift Station all the way to the NTMWD system through the Bachelor Creek Force Main. A new Brushy Creek Lift Station will serve all of the flow from the Las Lomas development and pump it directly into this force main (after Brushy Creek entry point), which is referred to as the Brushy Creek Force Main. At a point west of Brushy Creek, the force main will either go north to

Forney's proposed Mustang Creek Lift Station (Option 1) or south to the LEFIS Mustang Creek Lift Station (Option 2).

The conveyance infrastructure will be sized for peak wet weather flows and be constructed in two phases, the first phase to serve 2025 flows and the second phase to serve 2040 flows. The peak flows that each lift station will serve are showing in Table 7.1.

Table 7-1 Peak Wet Weather Flows Served by Lift Stations

	Influent Flows (MGD)		
Year	King's Creek Lift Station	Bachelors Creek Lift Station	Brushy Creek Lift Station
2025	**6.97**	**15.68**	**4.59**
2040	**14.26**	**27.23**	**10.59**

The design criteria that each lift station will be sized to meet 100% of the peak wet weather design flows is used to determine the resulting lift station capacities. The proposed lift station approximate capacities are summarized on Table 7.2.

Table 7-2 Summary of Lift Station Capacity

	Lift Station Capacity (MGD)		
Year	King's Creek LS	Bachelor Creek LS	Brushy Creek LS
2025	**7**	**16**	**5**
2040	**15**	**28**	**11**
Size of Expansion for 2040	***8***	***12***	***6***

The resulting force main capacities are shown in Table 7.3. The force main segment from Brushy Creek to the NTMWD system will carry the flow from both the Brushy Creek Lift Station and the Bachelor Creek Lift Station.

Table 7-3 Summary of Force Main Capacity

	Force Main Capacity (MGD)		
Year	KC to Bachelor	Bachelor to Brushy	Brushy to NTMWD
2025	**7**	**16**	**21**
2040	**15**	**28**	**39**
Needed Capacity of Parallel FM for 2040 Flows	***8***	***12***	***18***

The only difference in capital conveyance infrastructure cost between Option 1 and Option 2 is that the force main from Brushy Creek to the NTMWD system is longer by approximately 8,000 feet for Option 2. The following improvements are required for both Option 1 and 2:

<u>2013-2025 Improvements</u>

- A new 7 MGD King's Creek Lift Station will pump through a 20" force main to a new 16 MGD Bachelor Creek Lift Station.
- The 16 MGD Bachelor Creek Lift Station will pump through a 30" force main to the Forney Mustang Creek Lift Station.
- A 5 MGD Brushy Creek Lift Station will be able to pump directly into this force main, which will be increased to 36" at this point, to Forney Mustang Creek Lift Station (approximately 8,000 feet longer for Option 2).

<u>2025-2040 Improvements</u>

- By 2040, the King's Creek Lift Station capacity will need to be expanded from 7 MGD to 15 MGD and the force main will need to be paralleled by an additional 20" line.
- The Bachelor Creek Lift Station capacity will need to be expanded from 16 MGD to 28 MGD, and the force main from Bachelor Creek to Brushy Creek will need to be paralleled by an additional 30" force main.
- The Brushy Creek Lift Station capacity will need to be expanded from 5 MGD to 11 MGD. The stretch of force main from Brushy Creek to Forney Mustang Creek will be paralleled by another 36" force main (approximately 8,000 feet longer for Option 2).

A summary of the conveyance capital cost for each regional option is shown in Table 7.4. A unit cost of $5.50/dia-inch was used for force mains and interceptors. This unit cost was consistent with the cost used in recent NTMWD regional wastewater studies. These costs include 30% contingency, 5% mobilization, 18% overhead and profit (OH&P), and 18% for engineering, surveying and geotechnical services. A detail cost estimate table for each project is provided in Appendix J.

Table 7-4 Summary of Conveyance Capital Cost for Each Regional Option

Year	Capital Improvement Project	Budgetary Cost (for City of Terrell)	
	King's Creek	**Option 1**	**Option 2**
2013-2025	King's Creek LS (7 MGD)	$ 4,751,565	$ 4,751,565
	King's Creek 20" FM	$ 1,931,680	$ 1,931,680
		$ 6,683,245	**$ 6,683,245**
	Bachelor Creek		
	Bachelor Creek LS (16 MGD)	$ 6,652,191	$ 6,652,191
	Bachelor Creek 30" FM (includes stretch from Bachelor Creek to Brushy Creek)	$ 10,857,086	$ 10,857,086
		$ 17,509,277	**$ 17,509,277**
	Brushy Creek		
	Brushy Creek LS (5 MGD)	$ 3,801,252	$ 3,801,252
	Brushy Creek 36" FM (includes stretch from Brushy Creek to NTMWD)	$ 14,313,535	$ 18,457,533
		$ 18,114,787	**$ 22,258,805**
2025-2040	**King's Creek**		
	King's Creek LS (8 MGD)	$ 5,226,722	$ 5,226,722
	King's Creek 20" FM	$ 1,462,930	$ 1,462,930
		$ 6,689,652	**$ 6,689,652**
	Bachelor Creek		
	Bachelor Creek LS (12 MGD)	$ 5,701,878	$ 5,701,878
	Bachelor Creek 30" FM	$ 8,888,336	$ 8,888,336
		$ 14,590,214	**$ 14,590,214**
	Brushy Creek		
	Brushy Creek LS (6 MGD)	$ 4,276,408	$ 4,276,408
	Brushy Creek 36" FM	$ 12,059,785	$ 15,551,303
		$ 16,336,193	**$ 19,827,711**
	Total	**$ 79,923,368**	**$ 87,558,904**

7.3 ALTERNATIVE 3 - CITY OF TERRELL CONVEYANCE O&M COSTS

The operation and maintenance (O&M) costs for the City of Terrell conveyance infrastructure was calculated as discussed in Section 3.0. The O&M annual costs start in 2014 which represents the first year that the lift stations could be in service. Table 7.5 shows a summary of the total 30 year O&M costs for each option. Appendix K shows tables with the O&M cost broken down by year for each facility.

Table 7-5 Total 30 Year O&M Costs for City of Terrell Conveyance System

	Total Project O&M Cost (2011$)
Option 1	**$14.9 M**
Option 2	**$15.2 M**

The total 30 year O&M cost for regional Option 2 will be slightly higher due to the force main in Option 2 being approximately 8,000 feet longer, therefore requiring a higher horsepower pump at the Brushy Creek and Bachelor Creek Lift Stations which will result in a higher power cost and higher maintenance cost.

7.4 ALTERNATIVE 3 – CAPITAL COST FOR NTMWD REGIONAL CONVEYANCE INFRASTRUCTURE

For the two regional options evaluated, there will be a need to join an existing regional interceptor system. For Option 1, it will mean partnering with the City of Forney in the Forney Interceptor System and cost sharing in the infrastructure that delivers flow to South Mesquite RWWTP. For Option 2, Terrell will join with the existing LEFIS partners, which are City of Mesquite, City of Seagoville and the Heartland Development. If the City of Terrell were to join either of these regional interceptor systems, the City would have to pay their flow based proportion of the capital and O&M cost of any proposed regional infrastructure.

<u>Option 1 – Connect to Forney Interceptor System</u>

The Forney Interceptor System (FIS), operated by NTMWD, serves wastewater flow from the City of Forney and conveys the flow to the South Mesquite Regional Wastewater Treatment

Plant. The FIS is in the planning stages at the time of this study of constructing a proposed Mustang Creek Lift Station and Force Main to handle all future flows for the City of Forney. If the City of Terrell chooses to become a partner in the FIS, then the proposed lift station would need to be designed to handle the peak flows from both entities. The populations for the City of Forney were obtained from the Freeman Millican, Inc study titled *Forney-Terrell Interceptor System Wastewater Planning Study, 2006*. The peak flows were determined using those populations and the peak flow calculation shown in Section 2. The projected peak wet weather flows and each City's percent flow contribution per planning period are shown in Table 7.6.

Table 7-6 Peak Wet Weather Flows for Option 1

	Peak Flows (MGD)			
Entity	**2025**	**% Flow Contribution**	**2040**	**% Flow Contribution**
City of Forney	13.9	40%	29.1	45%
City of Terrell	20.3	60%	37.8	55%
Total	**34.2**		**67.0**	

Using the flows shown in Table 7.6 and the design criteria of the lift station capacity meeting 100% of the peak flow, the proposed Mustang Creek Lift Station and Force Main will need to be sized at 35 MGD to serve 2025 flows and expanded to 70 MGD for 2040 flows. The resulting force main sizes are 36" for 2025 and a parallel 36" for 2040. The overall cost to the City of Terrell was determined by utilizing the percent flow contribution from the City of Terrell for each planning period. A detail cost estimate table for each project is provided in Appendix J. The summary of the regional conveyance cost for Option 1 is shown in Table 7.7. The total 30 year regional conveyance upgrade cost for the City of Terrell to send its flow to the Forney Interceptor System is $25.1 million.

Table 7-7 Regional Conveyance Upgrade Cost for Option 1

Year	Capital Improvement	Total Cost (Millions)	City of Terrell
2013-2025	35 MGD Lift Station	$10.5	$6.3
	36" Force Main	$11.3	$6.8
2025-2040	Add 35 MGD Lift Station	$10.5	$5.8
	Parallel 36" Force Main	$11.3	$6.2
	Total	**$43.6**	**$25.1**

Option 2 – Connect to Lower East Fork Interceptor System

The Lower East Fork Interceptor System (LEFIS), operated by NTMWD, currently has three customers: the City of Seagoville, the City of Mesquite and the Heartland Development. The City of Mesquite has a proposed annexation area in their extraterritorial jurisdiction (ETJ) that is served through the LEFIS. The LEFIS has the following existing infrastructure in service:

- **Lower East Fork Lift Station**
  - Pumping Capacity = 12 MGD
  - Wet Well Capacity = 35 MGD
- **Lower East Fork 36" Force Main**
  - Capacity = 35 MGD
- **Mustang Creek 36"/42" Interceptor**
  - Capacity = 21 MGD
  - Only Heartland and Mesquite ETJ utilize this interceptor

If the City of Terrell were to choose the option of sending their flow to the LEFIS, the Brushy Creek Force Main would flow to the Mustang Creek Interceptor and gravity to the Lower East Fork Lift Station which would then pump the flow to the South Mesquite Regional Wastewater Treatment Plant. Since the existing infrastructure is sized to meet the existing customer's future flows only, this study assumes that the City of Terrell would have to pay the full amount of the additional proposed improvements that will be necessary due to Terrell tying onto the LEFIS. Using the flows shown in Section 2 for the City of Terrell and the populations for each entity obtained from the Freeman Millican, Inc study titled *Forney-Terrell Interceptor System Wastewater Planning Study, 2006.*, as well as the design criteria of the lift station capacity meeting 100% of the peak flow, the following improvements would need to be made to the LEFIS to serve all of the City of Terrell future flow:

2013-2025 Improvements:

- Increase Lower East Fork Wet Well Capacity from 35 MGD to 55 MGD
- Increase Lower East Fork Lift Station Pump Capacity from 12 MGD to 55 MGD
- Parallel Lower East Fork Force Main with a new 36" force main
  - This new force main would serve 2040 flows
- Parallel Mustang Creek Interceptor with a 54" wastewater interceptor
  - This interceptor is sized to serve 2040 flows

2025-2040 Improvements:

- Increase Lower East Fork Wet Well Capacity from 55 MGD to 75 MGD
- Increase Lower East Fork Lift Station Pump Capacity from 55 MGD to 75 MGD

A detail cost estimate table for each project is provided in Appendix J. The summary of the regional conveyance cost for Option 2 is shown in Table 7.8. The total 30 year regional conveyance cost for the City of Terrell to send its flow to the Lower East Fork Interceptor System is $36.6 million.

Table 7-8 Regional Conveyance Cost for Option 2

Year	Capital Improvement	Total Cost for City of Terrell (Millions)
2013-2025	Expand Lift Station to 55 MGD	$7.6
	Parallel LEF 42" Force Main	$10.1
	54" Mustang Creek Interceptor	$11.3
2025-2040	Expand Lift Station to 75 MGD	$7.6
	Total	**$36.6**

7.5 ALTERNATIVE 3 – NTMWD REGIONAL CONVEYANCE O&M COSTS

The operation and maintenance (O&M) costs for NTMWD conveyance infrastructure was calculated as discussed in Section 3.0. The annual O&M costs start in 2013, which represents the first year that the lift stations could be in service. All of the entities would share the cost for O&M for the Lower East Fork Lift Station and Force Main. The populations for each entity were obtained from the Freeman Millican, Inc study titled *Forney-Terrell Interceptor System Wastewater Planning Study, 2006*. The peak flows were determined using those populations and the peak flow calculation shown in Section 2. The projected peak wet weather flows and each entity's percent flow contribution per planning period to the Lower East Fork Lift Station are shown in Table 7.9. Percent flow contribution to the Forney Interceptor System are shown in Table 7-6.

Table 7-9 Peak Wet Weather Flows for the Lower East Fork Interceptor System

	Peak Flows (MGD)			
Entity	**2025**	**% Flow Contribution**	**2040**	**% Flow Contribution**
City of Seagoville	10	19 %	10.6	14 %
Heartland Development	18	33 %	19.6	27 %
City of Mesquite ETJ	5.5	10 %	5.5	8 %
City of Terrell	20.3	38 %	37.8	51 %
Total	**53.8**		**73.5**	

Table 7.10 shows a summary of the total 30 year O&M costs for each option. Appendix L shows tables with the O&M cost broken down by year for each facility.

Table 7-10 Total 30 Year O&M Costs for NTMWD Conveyance System

	Total Project O&M Cost (2011$)
Option 1	**$5.8 M**
Option 2	**$6.5 M**

7.6 ALTERNATIVE 3 - NTMWD REGIONAL WASTEWATER TREATMENT COST

The final cost component of the regional alternative is the regional wastewater treatment fee for the North Texas Municipal Water District. Member entities are charged a set rate, and customer entities are charged an additional rate. The regional wastewater treatment costs for Alternative 3 were developed based on the dry weather flow projections for the City of Terrell and its surrounding areas, assuming that the City of Terrell is approved by the existing member entities to join the NTMWD system. Since the dry weather flow is the same for each option, the regional treatment cost is the same for each option. The total 30 year regional treatment cost is $61.3 million. A table showing the annual NTMWD regional treatment cost is shown in Appendix L.

7.7 ALTERNATIVE 3 - CONCLUSIONS

The costs related to Alternative 3 – Regional Wastewater System were associated with one of five categories: City of Terrell capital conveyance costs, City of Terrell operations and maintenance cost, capital regional conveyance and O&M costs, and NTMWD Regional Treatment fees. The total costs for each cost component and option are summarized in Table 7.11. The projected 30-year costs for Options 1 and 2 are $188.0 and $208.2 million, respectively.

Table 7-11 Total Cost of Regional System Alternative for Options 1 & 2

	2013-2025	
	Total Cost (2011$ Millions)	
	Option 1 - Forney	Option 2 - LEFIS
City of Terrell	$46.1	$50.3
Conveyance Capital Cost	$42.3	$46.5
Conveyance O&M Cost	$3.8	$3.8
Terrell Portion of NTMWD System Cost	$32.3	$48.1
Conveyance Capital Cost	$13.0	$29.0
O&M Cost	$2.0	$1.8
Regional Treatment Cost	$17.3	$17.3
2013 - 2025 TOTAL	$78.4	$98.4
	2025-2040	
	Total Cost (2011$ Millions)	
	Option 1 - Forney	**Option 2 - LEFIS**
City of Terrell	$48.7	$52.5
Conveyance Capital Cost	$37.6	$41.1
Conveyance O&M Cost	$11.1	$11.4
Terrell Portion of NTMWD System Cost	$60.9	$57.3
Conveyance Capital Cost	$12.0	$7.6
O&M Cost	$4.9	$5.7
Regional Treatment Cost	$44.0	$44.0
2026 - 2040 Total	$109.6	$109.8
	Total	
	Total Cost (2011$ Millions)	
	Option 1 - Forney	**Option 2 - LEFIS**
City of Terrell	$94.8	$102.8
Conveyance Capital Cost	$79.9	$87.6
Conveyance O&M Cost	$14.9	$15.2
Terrell Portion of NTMWD System Cost	$93.2	$105.4
Conveyance Capital Cost	$25.0	$36.6
O&M Cost	$6.9	$7.5
Regional Treatment Cost	$61.3	$61.3
Total Project Cost for Terrell	$188.0	$208.2

8.0 ALTERNATIVES COMPARISON

The total projected costs for three alternatives evaluated for the City of Terrell and the surrounding entities future wastewater needs are summarized in Table 8-1. Based on this cost comparison, regionalization with the NTMWD treatment system in Alternative 3 is the most cost effective alternative for the City of Terrell and the surrounding entities.

Table 8-1 Comparison of total costs for evaluated alternatives

	Budgetary 30-Year Costs (2011 $)			
	Alternative 1	Alternative 2	Alternative 3	
			Option 1	Option 2
Total Capital Cost	$107.1 M	$87.5 M	$103.9 M	$124.2 M
Total Annual Costs	$126.0 M	$125.6 M	$83.1 M	$84.0 M
Total Cost	**$233.1 M**	**$213.1 M**	**$187.0 M**	**$208.2 M**

Alternative 2 resulted in the lowest total capital investment for the study period (2011-2040). Alternative 3 resulted in a higher capital investment; however, the regional alternative options evaluated as part of Alternative 3 had the lowest total cost for the study period due to the decreased annual costs associated with the regional system.

The large annual cost difference between Alternative 1 and 2 and Alternative 3 is due to the relatively small size of the King's Creek WWTP (4.5 MGD) versus the larger NTMWD South Mesquite Regional Wastewater Treatment Plant (SMRWWTP) (>20 MGD). Larger facilities have much lower operation and maintenance costs due to increased efficiencies and decreased staffing per gallon. The NTMWD SMRWWTP currently is being expanded to a dry weather capacity of 33 MGD. This large difference in flow capacity as compared to the King's Creek WWTP results in significantly reduced operations costs. It should be noted that the overall economics of the alternatives is highly dependent on this fee from the NTMWD for treatment at the SMRWWTP, and if that rate were to increase by 10 to 20%, it would alter that total cost of Alternative 3 and bring the total cost of Alternatives 1, 2, and 3 very close to each other.

Regionalization of wastewater flows with the NTMWD will result in changes to the industrial pretreatment requirements for the City of Terrell, and a new technically based local limit (TBLL) will need to be developed.

9.0 MEETINGS

9.1 PUBLIC MEETINGS

During the study, three public meetings were held. The first public meeting was held on May 17th, 2010 and the scope and schedule of the study were presented. During this meeting, the design team asked all participating partners to update the population projections in the report and forward them to the City of Terrell. At the second public meeting held on August 5th, 2010, the scope, progress made, and schedule of the study was presented and discussed. Updated population projections were also presented. No public comments were received. The third public meeting was held on February 17th, 2011. The scope, recommendation, and the schedule of the study were presented and discussed. No public comments on the report were received.

9.2 MEETING WITH CITY OF TERRELL

FNI met with the City of Terrell on February 10th, 2011. The purpose of this meeting was to review comments on the draft report from the City. All comments were addressed before issuing the TWDB Draft submittal. FNI also presented the City with a PowerPoint outline to review for the third public meeting.

9.3 MEETING WITH NTMWD

FNI met with the NTMWD on February 14th, 2011. During this meeting additional comments were made on the report. Issues with the pre-treatment program and peaking factors were also discussed. Number discrepancies in the report were also discussed and the NTMWD agreed to send FNI the most recent data to update the report. All comments were addressed prior to issuing the TWDB Draft submittal. Agendas, meeting notes, presentation, and sign-in sheets from all meetings are included in Appendix M.

10.0 RECOMMENDATION AND IMPLEMENTATION PLAN

The recommended alternative for future wastewater needs for the City of Terrell and the surrounding entities is Alternative 3. The factors that contributed to this recommendation are:

- Lower cumulative annual cost for the evaluation period for Alternative 3.
- Continued savings of Alternative 3 beyond 2040.
- Comparable capital investment of Alternative 3 to Alternative 2.
- Due to the close total cost of Option 1 and Option 2 (less than 10% difference), there is not a strong economic driver for one option over the other.

The regional system will need to be a cooperative effort between the City of Terrell, its surrounding entities, and the NTMWD. The City will have to request permission to join one of the two NTMWD systems and receive approval from the NTMWD member entities before joining the system. If approval is granted to join the NTMWD system, the infrastructure for the regional system for the City of Terrell and its surrounding entities would be planned in two phases. The first phase would be constructed between 2013 and 2025 and would be designed for flows in 2025. The second phase would be constructed between 2025 and 2040 and would be designed for flows in 2040. The capital investment costs in 2013 and 2025 would consist of City of Terrell infrastructure and a capital fee for the NTMWD regional conveyance system. Budgetary capital costs for each of these phases for both Option 1 and Option 2 are shown in Table 10-1 and Table 10-2.

Table 10-1 Phasing of Alternative 3 - Option 1

	Implementation Year	Budgetary Cost (2011 $)
Option 1 – Phase I		
City of Terrell Infrastructure	2013-2025	$41.3 M
NTMWD Regional Infrastructure		$13.0 M
Total Capital Investment		$54.3 M
Option 1 – Phase II		
City of Terrell Infrastructure	2025-2040	$37.6 M
NTMWD Regional Infrastructure		$12.0 M
Total Capital Investment		$ 49.6 M
Total		**$103.9 M**

Table 10-2 Phasing of Alternative 3 - Option 2

	Implementation Year	Budgetary Cost (2011 $)
Option 2 – Phase I		
City of Terrell Infrastructure	2013-2025	$46.5 M
NTMWD Regional Infrastructure		$29.0 M
Total Capital Investment		$75.5 M
Option 2 – Phase II		
City of Terrell Infrastructure	2025-2040	$41.1 M
NTMWD Regional Infrastructure		$7.6 M
Total Capital Investment		$48.7 M
Total		**$124.2 M**

10.1 IMPLEMENTATION PLAN

Securing funding, designing the improvements, and completing construction for the improvements included in Alternative 3 will take two to three years to complete. It is anticipated that the regional system can be in operation by the end of 2013. However, due to the process limitations identified at the existing King's Creek WWTP and the anticipated changes to the TPDES permit anticipated in December 2012, several improvements are required at the King's Creek WWTP as the City transitions to a regional treatment system. The implementation plan of the regional system would consist of several phased improvements to the King's Creek WWTP, and the number of these phased improvements would be dependent on the implementation timeline of the regional system.

Interim improvements to the King's Creek WWTP that will be required as part of the implementation plan are:

- Phase I: addition of chemical facilities to provide for chemically enhanced primary treatment (CEPT), which will result in increased ammonia removal capabilities at the King's Creek WWTP and chemical phosphorus removal. These improvements would be needed by 2012, when a year-round effluent ammonia discharge limit of 3 mgN/L is anticipated to be included in the TPDES permit for King's Creek WWTP.
- Phase II: addition of tertiary filtration to meet the effluent phosphorus permit limit anticipated in the 2012 TPDES permit. Inclusion of phosphorus in the 2012 TPDES permit would include a 1 to 3 year implementation period, which is the reason for the implementation year for Phase II being 2014. While the chemical addition in Phase I would remove a significant amount of phosphorus, tertiary filtration would be required to assure meeting the discharge permit limits of 1 to 0.5 mgP/L of phosphorus. Tertiary filtration would provide relatively economical and quick improvements to help meet the new phosphorus permit.
- Phase III: implementation of Salsnes Filters for increased treatment capacity. Chemical improvements from Phase I would be sufficient to meet a year-round effluent ammonia discharge limit of 3 mgN/L through 2016; however, increased treatment capacity would be required after 2016 to continue meeting this discharge requirement. Based on current flow projections, this would provide capacity through 2020.

The implementation plan for the interim improvements is shown in Table 10-3, along with budgetary costs. The OPCC for these interim improvements is shown in Appendix E. The implementation year is the year that the interim improvement would be required to be completed by. It should be noted that if the regional system is in operation before 2014 as anticipated, the only improvement needed at the King's Creek WWTP would be Phase I. However, it was deemed prudent to develop an implementation strategy to assure that the treatment needs of the City of Terrell and the surrounding entities were met in the event that the regional system implementation timeline was extended. The cost of the interim improvements to the King's Creek WWTP would be in addition to the regional system costs shown in Table 8-1. Phasing of the improvements will help to minimize future investment to the King's Creek WWTP to the improvements needed to meet current permit and flow requirements.

Table 10-3 Phasing of Implementation Plan

Interim Improvements	Implementation Year	Budgetary Cost[2]	
		(2011 $)	(Actual Year $)[1]
Phase I - Chemical Feed Facilities	2012	$0.45 M	$0.47 M
Phase II - Tertiary Filters[3]	*2014*	*$2.0 M*	*$2.3 M*
Phase III - Salsnes Filters[3]	*2016*	*$2.6 M*	*$3.2 M*
Total		**$5.1 M**	**$6.0 M**

[1]Assumes 5% inflation per year
[2]Sunken cost
[3]Improvements shown in red are optional based on the implementation timeline of a regional system

The impact of the interim improvements on the performance of the King's Creek WWTP was evaluated using BioWin. Salsnes filters were modeled upstream of the existing primary clarifier. The existing primary clarifier would serve as a chemically enhanced primary treatment (CEPT) clarifier, with alum dosed at 25 mg/L to the influent flow. This dosing was assumed to achieve 75% removal of TSS and 50% removal of BOD, which are typical values for CEPT (WEF MOP 8). The generated BioWin model is shown in Figure 10-1, with simulated effluent ammonia concentrations under cold weather conditions shown in Figure 10-2. The same influent conditions and other parameters used in Section 4; the only modification was the addition of the Salsnes filters and the alum addition. The interim improvements would increase the functional capacity of the King's Creek WWTP to 2.9 MGD. This would be sufficient treatment capacity through 2019. This would give the City of Terrell sufficient time to secure funding and to determine if the growth in surrounding entities is more or less aggressive than current projections.

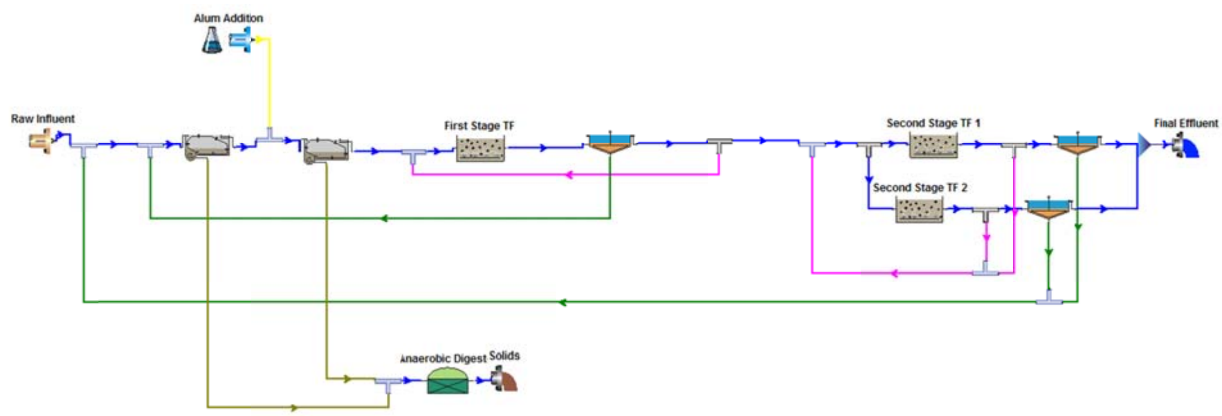

Figure 10-1 BioWin model of interim improvements

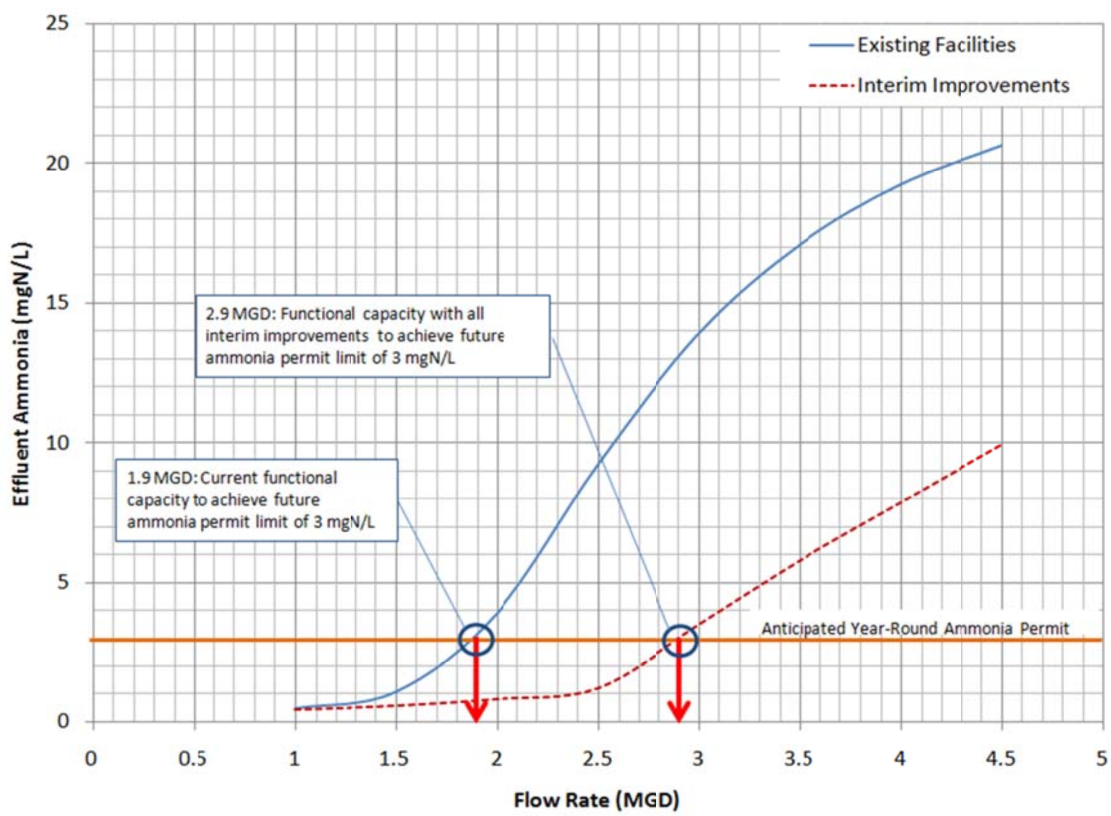

Figure 10-2 Impact of interim improvements on effluent ammonia (cold weather, 55°F)

It is important to note that alum addition can significantly depress pH due to alkalinity consumption. Simulated results indicated slight pH depression to 6.8. It will be important to conduct bench scale and pilot scale testing of chemical addition as part of the design for the interim improvements. Depending on testing results, it may be necessary to include a buffer addition system in addition to the alum dosing system. Potential buffer solutions include magnesium hydroxide, lime, and caustic.

10.2 FUNDING

Funding for improvements to the City of Terrell wastewater system can potentially come from several sources. Private financing is one option that can be pursued, but this typically entails higher financing costs. However, private financing on the open market can be completed on a shorter time line with fewer application requirements. Several state sponsored programs also exist, and a summary of the programs that the City of Terrell wastewater improvements would likely qualify for are shown below.

10.2.1 Clean Water State Revolving Fund

The Clean Water State Revolving Fund (SRF) provides loans at below market interest rates and principal forgiveness for planning, designing, and constructing wastewater infrastructure. These low rates are coupled with extended financing periods, and obtaining financing typically takes between one year and fifteen months. Eligible applicants are wastewater treatment agencies, including interstate agencies, cities, commissions, counties, districts, river authorities, or other public bodies created by or pursuant to state law that have authority to dispose of sewage, industrial waste, or other waste; authorized Indian tribal organizations; and private entities (nonpoint source or estuary management projects only). Nonprofit water supply corporations are not eligible. The program includes mainstream and disadvantaged community funds. Beginning with Fiscal Year 2011, not less than 20% of the funds available from the SRF capitalization grant funds will be used for projects that address green infrastructure, water or energy efficiency improvements, or other environmentally innovative projects. Loan term is up to 30 years.

10.2.2 Texas Water Development Fund

The Texas Water Development Fund provides loans for planning, designing, and constructing water supply, wastewater, and flood control projects. Applicants must be a political subdivision of the state or a nonprofit water supply corporation. The loan term is typically limited to 20-25 years, and the rate is based on market conditions. A preference for regional systems is part of the evaluation process for Texas Water Development Funds, and pursing Alternative 3 would increase the probability of receiving funding from this source.

10.2.3 State Participation Program

The State Participation Program enables the Texas Water Development Board (TWDB) to assume a temporary ownership interest in regional project when the local sponsors are unable to assume debt for the optimally sized facility. The TWDB may acquire ownership rights in water rights or co-ownership interest of the property and treatment facilities. The program is intended to allow optimization of regional projects through limited State participation where the benefits can be documented. The program is available to any subdivision of the state and water supply corporations. The loan term is up to 34 years. This funding is for projects where the existing population cannot support the debt required to implement the required infrastructure.

10.2.4 Title XVI Program

The Title XVI Program is administered by the U.S. Bureau of Reclamation. The purpose of the program is to provide grants for the planning, design, and construction of reclamation and reuse of municipal, industrial, domestic, and agricultural wastewater, and naturally occurring impaired ground and surface waters. Treatment of wastewater must be in excess of National Permit Discharge Elimination System (NPDES) requirements. Eligible projects include, but are not limited to, recycled water projects, aquifer storage and recovery, and desalination of brackish water or seawater. Eligible entities include state, regional, and local water agencies and authorities; entities with water management authority; and Indian tribal organizations.

10.2.5 Funding Plan

The funding program for implementation of wastewater system improvements for the City of Terrell and the surrounding entities will be highly dependent on the alternative pursued. It is critical that the City of Terrell request permission to join one of the NTMWD systems as soon as possible to determine if joining the regional system will be feasible. If approval to join the NTMWD system is obtained by the City of Terrell, pursing funds from the Texas Water Development Fund would likely be the most suitable funding source.

10.3 INNOVATION, SUSTAINABILITY, AND PROJECT VALUE

Innovative solutions that provide sustainable designs and significant project value are increasingly important goals in the field of wastewater management. Several components of the recommended regional wastewater system help the City of Terrell achieve these goals.

- Interim improvements associated with implementation plan achieve treatment requirements with minimal investment in King's Creek WWTP.
- Evaluation of two regional options helps to identify the more beneficial regional alternative for the City of Terrell and surrounding entities.
- Regionalization of flows will likely result in significant changes to the industrial pre-treatment standards for the City of Terrell, resulting in the potential for more industrial growth.

10.4 CONCLUSIONS

The next step for the regional wastewater system for the City of Terrell and the surrounding entities is to request participation in one of the NTMWD regional system. The City of Terrell should begin efforts to request participation within the first half of 2011 to ensure that a regional treatment option can be pursued. If permission to join one of the NTMWD regional systems is approved, the next steps is to begin planning and design of both the regional interceptor system and Phase I of the implementation plan. For implementation of Phase I interim improvements, the next steps would be:

- Preliminary design of the chemical feed facilities for chemically enhanced primary treatment (CEPT) improvements by late 2011
- Design and construction of chemical feed facilities prior to December 2012

For the regional treatment facilities, the next steps would be:

- Determine if the City will pursue Option 1 or Option 2 for Alternative 3 by mid-year 2011
- Securing project funding during 2011
- Preliminary design of alignment for the regional pipeline by late 2011
- Design and land acquisition for regional pipeline during 2012
- Full implementation of regional pipeline before the end of 2013

If participation in one of the NTMWD regional systems is not approved by the NTMWD member entities, the City of Terrell would need to continue treating its wastewater. If this scenario were to occur, Alternative 2 would be recommended. To ensure that the improvements needed for Alternative 2 are in place prior to 2014 when the changes to the TPDES permit are anticipated, securing funding and beginning preliminary design for a new WWTP would be recommended to being in 2011.

Appendix A:
Treatment Operation and Maintenance Methodology

PROJECT NAME: King's Creek WWTP
PROJECT NUMBER: TER 10191
DATE: January 2011
BY: LSD
CHECK: GB

The below O&M cost estimates were based on the method developed in WERF Report No. 96-CTS-5, and then calibrated to City of Terrel O&M Costs

O&M Cost Estimation Methodology

10.2 Wastewater Treatment and Biosolids Model

Several forms of the equation were considered. The preferred model takes the form:

$$OPCSTWET = e^{6.43} \times (MGD^{1.354}) \times (WBPLA^{-0.493}) \times \{[(ASOXY/100)+1]^{0.442}\} \times \{[(ASMEC/100)+1]^{0.404}\} \times (BIOPROD^{0.408}) \times (WBWAGE^{0.499}) \times (KWH^{0.342})$$

where:

OPCSTWET	= Total cost of wastewater and biosolids operations, excluding depreciation ($)
MGD	= Average daily flow (Mgal/day)
WBPLA	= Average daily flow per plant[1] (both wastewater and biosolids) operated (Mgal/day)
ASOXY	= % influent treated by activated sludge process using an oxygenation aeration device (pure oxygen)
ASMEC	= % influent treated by activated sludge process using mechanical aeration
BIOPROD	= The quantity of biosolids produced per unit of influent (dry ton/Mgal/day)
WBWAGE	= Annual average wage of a worker in wastewater and/or biosolids operations ($)
KWH	= Cost per kWh of electricity (cents)

[1] Biosolids treatment, even if conducted at the same site as wastewater treatment, is counted as an additional plant. Therefore, the minimum number of plants per utility is 2.

BIOPROD	= The quantity of biosolids produced per unit of influent (dry ton/Mgal/day)
WBWAGE	= Average wage of a worker in wastewater and biosolids operations ($)
KWH	= Cost per kWh of electricity (cents)

Variable	Value	Coefficient	Value^{coefficient}
Constant	2.718... (*e*)	6.43	620.2
MGD	35	1.354	123.2
WBPLA	17.5	−0.493	0.24
(ASOXY/100) + 1	1	0.442	1
(ASMEC/100)+1	1	0.404	1
BIOPROD	0.5	0.408	0.75
WBWAGE	24273	0.499	154.2
KWH	3.3	0.342	1.51
Predicted Value			**$3,200,000**

The predicted costs (per year) for the wastewater and biosolids operation for this hypothetical utility is $3.2 million. However, the utility's actual costs are approximately $3.4 million, which means that the utility is operating at about 6% above the predicted costs.

Methodology Calibration

		Trickling Filter
Flow Rate (MGD)		1.7
WBPLA		0.9
% Treated by P.O. AS		0
% Treated by Mechanical Aeration A.S.		0
Biosolids Production (dry tons/MGD/day)		0.0
Average Wage of Worker (including benefits)	$	81,000
Increased wage for BNR operation		0%
kWh Cost		7.708
Contingency		10%
Operations Cost	$	1,061,471
Chemical Cost for P Removal	$	-
Increased Solids Haulding from Chemical P removal	$	-
Total Projected Cost	$	-
Cost per 1,000	$	1.71
Actual Operating Cost 2010	$	1,065,000
Difference - predicted vs. observed		0.3%

Appendix B:
King's Creek WWTP Condition Assessment

Innovative approaches
Practical results
Outstanding service

Regional Wastewater Treatment Study

Condition Assessment

Prepared for:

City of Terrell

Prepared by:

FREESE AND NICHOLS, INC.
4055 International Plaza, Suite 200
Fort Worth, Texas 76109
817-735-7300

TER10191

Innovative approaches
Practical results
Outstanding service

Regional Wastewater Treatment Study

Condition Assessment

Prepared for:

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TER10191

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDIX

EXECUTIVE SUMMARY

A Regional Wastewater Treatment Study was commissioned by the Texas Water Development Board for the City of Terrell and its surrounding entities in Spring 2010. The first portion of this study is aimed at determining the condition and treatment capabilities of the existing King's Creek Wastewater Treatment Plant (WWTP), located in the City of Terrell. To determine the current condition of the infrastructure at the King's Creek WWTP, and to allow projections of future conditions, a condition assessment of the King's Creek WWTP was conducted on May 27, 2010. This chapter contains information on the overall condition, criticality, and risk of failure for each major unit process of the treatment system.

Condition assessments are a common tool in wastewater collection and treatment facilities. They can be a powerful tool for both prioritizing improvements and determining the long term viability of unit processes. It is important to develop an unbiased rating system to allow quantitative comparison of the condition and criticality of each unit process. Once this quantitative rating system is developed, an objective comparison of the condition of different unit processes can be completed, and the required maintenance and equipment life projects can be made. The rating system involves scoring for condition and criticality, and developing an overall risk of failure associated with each unit process. The overall risk rating is the average of the condition assessment and criticality assessment.

The need for upgrades based on this risk assessment is broken down into the following categories:

- Greater than 75: Immediate repairs required; unit process has reached useful service life
- 50-75: High risk of failure and capacity impact; repair or replacement in near future
- 25-50: Fair mechanical condition, but little redundancy and/or obsolete equipment that would be difficult to replace
- 0-25: Good condition with minimal upgrades/improvements currently required

The combination of condition and criticality allows for a qualitative risk rating to be developed, with prioritizes needed improvements. Also, a higher risk rating correlates to a lower expected service life. The current prioritization of unit process improvements is shown in Table ES-1.

Table ES-1 Risk ratings for all unit processes

	Unit	Condition Rating	Criticality Rating	Risk Rating
Preliminary Treatment	Equalization Basin	30	4	17
	EQ Basin Blowers	18.75	6	22.4
	Bar Screen	12.5	18	15.25
	Influent Pump Station	34.75	8	21.4
	Grit Classifier	41.25	70	55.6
	Grit Basin	5.0	40	22.5
	Grit Blowers	47.5	5	26.25
Primary Treatment	Primary Clarifier	38.75	82	60.4
Secondary Treatment	Stage 1 Trickling Filter	25	84	54.5
	Intermediate Clarifier	32.5	70	51.25
	2nd Stage Pump Station	43.5	52	47.75
	2nd Stage Trickling Filters	23.75	72	47.9
	Final Clarifiers	27.5	64	45.75
Disinfection	Chlorine Contact Basin	33.75	58	45.9
	Chemical Storage Building	30	0	15
Solid Waste Management	Solids Building	28.75	52	40.4
	Anaerobic Digesters	14.5	8	11.25
	Sludge Holding Tank	13	50	31.5

As equipment ages with time, a projection of the risk ratings for each unit process over the study period can be made. These projected risk ratings are based on assumptions that overall condition will degrade linearly over time. When the risk rating for a unit process exceeds a score of 75, immediate repairs or upgrades would be required and the unit will be considered to reach its service life. Projected risk ratings for major units processes for the study period are shown in Table ES-2. In 2018, it is projected that eight of the 18 unit processes will have reached their service life. An additional six unit processes will be at high risk of failure, and likely require repairs and/or upgrades in the near term. Only the equalization basin, bar screen, chemical storage building, and anaerobic digesters are projected to be in good to fair condition in 2018.

Table ES-2 Projected risk ratings for the major unit processes

Unit Process	Risk Rating			
	2010	2018	2030	2040
Primary Clarifier	60.4	92.4	100	100
Grit Classifier	55.6	87.6	100	100
Stage 1 Trickling Filter	54.5	86.5	100	100
Intermediate Clarifier	51.25	83.25	100	100
2nd Stage Trickling Filters	47.9	79.9	100	100
2nd Stage Pump Station	47.75	79.75	100	100
Chlorine Contact Basin	45.9	77.9	100	100
Final Clarifiers	45.75	77.75	100	100
Solids Building	40.4	72.4	100	100
Sludge Holding Tank	31.5	63.5	100	100
Grit Blowers	26.25	58.25	100	100
Grit Basin	22.5	54.5	100	100
EQ Basin Blowers	22.4	54.4	100	100
Influent Pump Station	21.4	53.4	100	100
Equalization Basin	17	49	97	100
Bar Screen	15.25	47.25	95.25	100
Chemical Storage Building	15	47	95	100
Anaerobic Digesters	11.25	43.25	91.25	100

By the year 2018, eight of the 18 major unit processes will have reached their anticipated service life, with an addition six unit processes at high risk of failure. From a condition assessment standpoint, significant upgrades are likely required to maintain treatment capabilities at the King's Creek WWTP before 2018. A process evaluation is currently being completed to determine if the existing unit processes will be capable of treating the permitted design flows to increasingly stringent TPDES effluent permit levels. The combination of the condition assessment and process evaluation will be used to determine the ability of the current facilities to operate through 2018. Projection of the future infrastructure needs for the City of Terrell and its surrounding entities to meet wastewater flow through 2040 will also be made.

1.0 INTRODUCTION

A Regional Wastewater Treatment Study was commissioned by the Texas Water Development Board for the City of Terrell and its surrounding entities in Spring 2010. The first portion of this study is aimed at determining the condition and treatment capabilities of the existing King's Creek Wastewater Treatment Plant (WWTP), located in the City of Terrell. To determine the current condition of the infrastructure at the King's Creek WWTP, and to allow projections of future conditions, a condition assessment of the King's Creek WWTP was conducted on May 27, 2010. This chapter contains information on the overall condition, criticality, and risk of failure for each major unit process of the treatment system.

1.1 RATING SYSTEM

Condition assessments are a common tool in wastewater collection and treatment facilities. They can be a powerful tool for both prioritizing improvements and determining the long term viability of unit processes. It is important to develop an unbiased rating system to allow quantitative comparison of the condition and criticality of each unit process. Once this quantitative rating system is developed, an objective comparison of the condition of different unit processes can be completed, and the required maintenance and equipment life projects can be made. The rating system involves scoring for condition and criticality, and developing an overall risk of failure associated with each unit process.

1.1.1 Condition

The condition rating assesses the physical and operational condition of equipment and infrastructure. The structural condition, operability of mechanical components (valves, gates, etc.), age and condition of major equipment, maintenance history, and electrical and instrumentation condition are the key components of the condition rating. The condition assessment form used is shown in Figure 1. A unit process with a condition rating of 100 would indicate that the overall condition is very poor and requires immediate attention. A condition rating of 0 would indicate new conditions with no needed maintenance or upgrades.

Inspection Date: ____________

Facility Information:

Unit Process: ____________ Last Rehabilitation: ____________

Component Group	Component Condition Rating	Weight Factor	Weighted Component Rating	Comments
Structure/materials		0.20	0.00	
Mechanical- Hatches, Valves, Vents, etc.		0.15	0.00	
Pumps, Motors, and Equipment		0.25	0.00	
Electrical & Instrumentation		0.15	0.00	
Maintenance History		0.25	0.00	
Overall Facility Rating	-	1.00	**0.00**	

Condition Rating	Description
0	New, perfect condition
25	Good condition, no improvements recommended to maintain function
50	Fair condition, improvements recommended to improve performance or
75	Poor condition, improvements recommended to maintain reliability
100	Eminent failure, rehabilitation or replacement required

1.1.2 Criticality

While the condition rating focuses solely on the operational condition of each unit process, the criticality of the unit process focuses on the performance impact of the unit processes (i.e. criticality to meeting TPDES permit), the process and capacity impacted by the unit process being out of service, and the replacement difficulty of the equipment associated with the unit process. The condition assessment form used is shown in Figure 2. Obsolete equipment that would create difficulties in meeting permitted effluent requirements that have no redundancy would score near 100. New equipment with readily available replacement parts that could be out of service for several days without severely impacting process performance and effluent quality would score near 0.

1.1.3 Risk Rating

The overall risk rating is the average of the condition assessment and criticality assessment. By averaging the two values, equal impact of condition and criticality for performance is determined for the overall risk rating. If specific items are identified as items of concern during the condition assessment, such as unsafe grating or electrical needs, these items can be specifically identified for near term improvements.

Inspection Date: ________________

Facility Information:

Unit Process: ________________ Last Rehabilitation: ________________

Component Group	Component Criticality Rating	Weight Factor	Weighted Component Rating	Comments
Redundancy		0.30	0.00	
Process and Capacity Impacted		0.30	0.00	
Replacement Difficulty		0.40	0.00	
Overall Facility Rating	-	**1.00**	**0.00**	

Firm Redundancy	
4 or more units	10
3 units	40
2 units	70
1 unit	100

Replacement Difficulty/Outage Duration	
Low	10
Moderate	40
Difficult/high	70
Very difficult/long term	100

Process and Capacity Impact	
Mild	10
Moderate	40
Severe	70
Inoperable/non-compliance	100

2.0 CONDITION ASSESSMENT

The condition assessment of the King's Creek WWTP was completed on May 27, 2010. A site walkthrough and discussions with the operations staff was the basis of the assessment. Each major unit process was assessed. A summary of each unit process is shown below, with the full score sheets included in Appendix A.

2.1 PRELIMINARY TREATMENT

The preliminary treatment processes at King's Creek WWTP consist of an equalization basin for peak flow control, a bar screen, an influent pump station, and an aerated grit removal system.

2.1.1 Equalization Basin

The equalization basin, shown below in Figure 3, was constructed as part of a plant improvement project in 1983 and has an estimated capacity of 0.66 MG. The basin is located in the northeastern corner of the plant and is in-line with the plant inflow. A 36" influent pipe enters on the eastern side and empties into a recessed channel that runs the length of the basin. A flow control gate is located at the western end of the channel, allowing the basin

Figure 3: Equalization Basin at Front End of the Plant

to be isolated from the plant during peak flow events. When the gate is lowered, the water elevation rises in the equalization basin and excess flow is stored until it can be properly processed by the plant. Course bubble diffusers are located along four main air lines, which run parallel to the influent channel, to provide aeration and maintain suspension of most solids.

The basin is in good condition overall with new electric valve operators and well maintained diffusers. Structural elements of the basin are in good shape, except for a small amount of settling visible near the steps on the western side. The basin is manually cleaned following peak flow conditions. Since the southern side is slightly lower in elevation than the main flow channel, settled solids tend to collect on this side. Because the basin is frequently dry, these solids tend to be very difficult to remove. According to plant operations, during peak flow events water often exceeds the basin capacity, causing the surrounding area to fill with water. Because this surrounding area is sloped to rise above the basin, maintenance of the grass sides is difficult due to the steep slopes. Removal of this grass and installation of a plastic liner around the basin could improve maintenance accessibility and reduce flooding damage.

Criticality of this unit is generally low due to its use only during peak events. Although the use of this basin is unlikely to be lost, no redundancy is provided for this unit and peak flow operation would be difficult without it on-line. Diffusers and air lines are easy to access and replace in the event of damage or failure. Table 1 contains numerical ratings for the condition and criticality of various aspects of the equalization basin.

Table 1: Condition and Criticality Rating for Equalization Basin

CONDITION	Structure & Materials	Mechanical	Pumps, Motors, & Equipment	Electrical & Instrumentation	Maintenance History	**Weighted Total**
	50	25	0.0	25	50	**30**
CRITICALITY	Redundancy	Process & Capacity Impact	Replacement Difficulty	**Weighted Total**	**RISK RATING: 17**	
	20	0.0	0.0	**4.0**		

2.1.2 Equalization Basin Blowers

Aeration for the equalization basin is provided by three blowers located in the southern room of the solids building. These blowers were rehabilitated in 2005 and are shown below in Figure 4. The building structure is composed of brick and some degradation is visible. Blower equipment is in good condition, but is extremely loud during operation. Chain valves are operational. Although the room provides ample space for the current equipment, no ventilation system is present in the building. A small box fan and two windows are the only sources of ventilation for this room. The master control center (MCC) was installed in 1995, and is at half its life expectancy.

Figure 4: Blower Units for Equalization Basin

The aeration system consists of three blowers, but only one is needed to operate the equalization basin, providing strong redundancy for the system. Ample space within the room provides adequate accessibility for maintenance and repair of the blower units. However, no crane is present and the equipment has multiple heavy components which are difficult to move without one. Numerical ratings for the various aspects of the equalization basin blowers are shown below in Table 2.

Table 2: Condition and Criticality Rating for Equalization Basin Blowers

CONDITION	Structure & Materials	Mechanical	Pumps, Motors, & Equipment	Electrical & Instrumentation	Maintenance History	**Weighted Total**
	25	25	25	25	0.0	**18.75**
CRITICALITY	Redundancy	Process & Capacity Impact	Replacement Difficulty	**Weighted Total**	**RISK RATING: 22.4**	
	0	0	30	**6**		

2.1.3 Bar Screen

Influent bar screens are located upstream of the influent pump station. The existing bar screen is a Vulcan, 3/4 inch bar screen with manual cleaning mechanism. The screen is 4 feet wide by 3.2 feet deep and is manually cleaned. A single motor and vertical rack system provides removal of screenings material (shown in Figure 5). The motor was last rehabilitated in May 2010. Once flow passes through the screen, it enters the wet well of the influent pump station. Screenings material is collected from the screen periodically throughout the day and emptied by wheelbarrow into a dumpster located below the supporting platform.

Figure 5: Motor and Lift Mechanism for Bar Screen Unit

The screen is supported by a steel frame positioned on top of a concrete deck. Both the steel and concrete are in good condition with no signs of significant corrosion. The wet well and metal gates are also in good condition, but all gates must be manually operated. The system is typically low maintenance, requiring maintenance only 3-4 times during its lifespan. A new gear was put on the electric motor during May 2010. The MCC was installed in 1995 and has reached half of its life expectancy.

The system consists of a bypass with only one screen, so little redundancy is provided, although the Vulcan units tend to be reliable. No compactors or conveyor belts are included in the system, requiring operators to manually remove and dispose collected trash. Most parts have adequate access and are easy to maintain. If the whole unit needs to be removed, a crane will be required. Numerical ratings for the various aspects of this bar screen system are shown below in Table 3.

Table 3: Condition and Criticality Rating for Bar Screen

CONDITION	Structure & Materials	Mechanical	Pumps, Motors, & Equipment	Electrical & Instrumentation	Maintenance History	**Weighted Total**
	25	25	0	25	0.0	**12.5**
CRITICALITY	Redundancy	Process & Capacity Impact	Replacement Difficulty	**Weighted Total**	**RISK RATING: 15.25**	
	70	0	20	**18.0**		

2.1.4 Influent Pump Station

The influent pump station is located adjacent to the administration building and consists of both a wet well and a dry pit separated by a partition wall. Pump motors are located on an upper deck above the dry well. Pumps are located in the dry well and pull water from the wet well into the discharge lines. Figure 6 below shows three of the four pumps located in the dry pit.

Figure 6: Pumps in Dry Well of Influent Pump Station

The system consists of four pumps, each rated for 3150 gpm and equipped with Fairbanks VFD. The VFDs are powered by MCC-1, which also powers the bar screen equipment. Air conditioning is limited for the VFDs, and no maintenance plan is in place for the VFDs. Two pumps were rehabilitated in 2009 and a third pump was rehabilitated earlier this year. Valves are old and replacement is recommended, but the electric operator is in good condition. A bubbler system is used for level sensing and seems to work well despite the old age of both compressors. Bridge cranes (1.5 ton) appear to be sturdy and in good condition. The ventilation system is operational and appears to provide adequate ventilation. No structural degradation was observed, but some corrosion was present on pumps and pipes in the dry well. Paint scraping and repainting is currently being completed. Some leaking was also observed near the pumps. A hatch opening from the upper deck into the dry well presents a walking hazard and should be upgraded. Better labeling of this area is recommended, and safety railing surrounding the hatch is suggested.

Although the system consists of four pumps, only one is needed for normal flows and two are required for the plant's peak capacity. Adequate redundancy for this system is provided by the extra pumps and by the equalization basin. Two bridge cranes (1.5 tons) are available for use with the pumps, but not with the motors. The city typically hires an outside company to perform any pump replacement that is required. Ratings for the condition and criticality of various aspects of the influent pump station can be found in Table 4.

Table 4: Condition and Criticality Rating for Influent Pump Station

CONDITION	Structure & Materials	Mechanical	Pumps, Motors, & Equipment	Electrical & Instrumentation	Maintenance History	**Weighted Total**
	30	50	25	50	30	**34.75**
CRITICALITY	Redundancy	Process & Capacity Impact	Replacement Difficulty	**Weighted Total**	**RISK RATING: 21.4**	
	0.0	0.0	40	**8.0**		

2.1.5 Grit Classifier

The grit classifier is located next to the eastern side of the bar screen platform and receives grit from the aerated grit basins via gravity flow. The grit is washed inside the classifier unit and then dried and separated with a large screw shaft. The cleaned grit is collected in a large bin located underneath the end of the screw shaft. A picture of the unit is shown below in Figure 7. The majority of grit removed is filter snails from the trickling filters. As much as a dumpster per day of grit can be collected.

Figure 7: Grit Classifier and Washer Unit

The concrete platform supporting the grit classifier appears to be in good condition. The shoes on the classifier are replaced regularly and the current pair is approximately six months old. The grit classifier was not in operation on June 3, 2010, but has been brought back online. The grit classifier is powered by MCC-1.

Only one unit is present and no redundant system is provided. This indicates that no grit washing will be available if the unit is inoperable. However, the plant can operate without this classifier for approximately six to seven weeks before there is a large accumulation of grit in the grit basin and serious problems occur. Maintenance for the unit is fairly easy, but the city has had to find a new parts supplier since the manufacturer went out of business and the system is obsolete. Numerical ratings for the various aspects of the grit classifier are shown below in Table 5.

Table 5: Condition and Criticality Rating for Grit Classifier

CONDITION	Structure & Materials	Mechanical	Pumps, Motors, & Equipment	Electrical & Instrumentation	Maintenance History	**Weighted Total**
	25	25	75	50	25	**41.25**
CRITICALITY	Redundancy	Process & Capacity Impact	Replacement Difficulty	**Weighted Total**	**RISK RATING: 55.6**	
	100	70	40	**70**		

2.1.6 Grit Basin

The aerated grit basin is located south of the administration building, next to the primary clarifier. A center wall runs through the middle of the basin and metal isolation gates on each end of the wall can be used to separate the basin into two chambers. Figure 8 below shows one of these two chambers. Wastewater is pumped from the influent pump station into the grit basin and settled grit is sent to the grit classifier via gravity flow. Outflow from the grit basin is normally sent to the primary clarifier, but can be diverted directly to the Stage 1 Trickling Filter if needed. Aeration for the basin is provided by blower units located underneath the basin.

Figure 8: Grit Removal Basin

The grit basin is in good condition overall, with a slight amount of corrosion visible in both chambers. Manual cleaning of the basin is performed occasionally. All four isolation gates appear to be in good condition and work well during operation. The isolation gates are manual slide gates with no operators. Effluent grit valves are also in good condition. The course bubble diffusers located at the bottom of the basin are made of stainless steel and were reported to be in good condition.

The aerated grit chamber consists of two chambers, but the plant can operate adequately with only one chamber. According to plant operations, the unit has not experienced complete failure; however, if failure were to occur, the primary clarifier, trickling filters and digesters could all be heavily impacted. Table 5 contains the numerical ratings for the various components of the grit basin.

Table 6: Condition and Criticality Rating for Grit Basin

CONDITION	Structure & Materials	Mechanical	Pumps, Motors, & Equipment	Electrical & Instrumentation	Maintenance History	**Weighted Total**
	25	0	0	0	0	**5**
CRITICALITY	Redundancy	Process & Capacity Impact	Replacement Difficulty	**Weighted Total**	**RISK RATING: 22.5**	
	70	40	10	**40**		

2.1.7 Grit Blowers

The blower system used to aerate the grit basin consists of three blower units located in a room underneath the grit basin. These blowers (shown in Figure 9) provide air to stainless steel course bubble diffusers located throughout the grit basin.

Figure 9: Blower Unit for Aeration of Grit Basins

The blower room appears to be structurally sound and shows only a few signs of corrosion. According to plant operation, these blowers have been problematic and two of the three blowers were out of commission on June 3, 2010—one due to upgrades and one due to electrical problems. The blower that was being upgraded was replaced on July 26, 2010, and two blowers are now available for operation. However, the blowers are fairly easy to replace and no problems have been reported with respect to blower valves. Power is supplied to the blowers from MCC-2, which is at 50% of its life expectancy.

Although three blowers are normally present, only one blower is needed for normal plant operations, providing a large amount of redundancy. The blower units are small and plenty of room is available for maintenance and repair work. Blowers are fairly easy to maintain and replace when needed. Numerical ratings for the condition and criticality of these blowers can be seen in Table 7 below.

Table 7: Condition and Criticality Rating for Grit Basin Blowers

CONDITION	Structure & Materials	Mechanical	Pumps, Motors, & Equipment	Electrical & Instrumentation	Maintenance History	**Weighted Total**
	25	0	75	75	50	**47.5**
CRITICALITY	Redundancy	Process & Capacity Impact	Replacement Difficulty	**Weighted Total**	**RISK RATING: 26.25**	
	0	0	25	**5**		

2.2 PRIMARY TREATMENT

Primary treatment at King's Creek Wastewater Treatment Plant is provided by one clarifier. The primary clarifier is located next to the eastern side of the grit basin. The clarifier, shown in Figure 10, was constructed as part of the original plant in 1970 and has a volume of 0.3 MG with a depth of seven feet. Flow is normally fed from the grit basin into the clarifier's center well via gravity. A scum baffle provides protection for the double-sided weir trough and a circulating scum rake is used to clear floating debris from the water surface. Effluent water from the primary clarifier flows by gravity to the Stage 1 Trickling Filter.

Figure 10: Primary Clarifier

The clarifier concrete structure is in good condition overall, but the metal bridge deck has a significant amount of corrosion and seems weak in some locations. The junction box valves and gates appear to be in good shape. Scum plug valves were replaced recently and the gear drive is less than two years old; both components are currently in good working condition. The clarifier's concentrator is also in solid condition. The surface skimmer recently broke and a makeshift skimmer is currently being used until the new part is received. Wire insulation is in poor condition, and power is supplied from MCC-2.

The primary clarifier is the only primary treatment component at the plant and has no back-up unit. When this clarifier is shut down, flow can be diverted directly into the Stage 1 Trickling Filter, but under these circumstances the trickling filter quickly becomes overloaded and clogs easily. Thus, the plant can operate for a few days without the primary clarifier, but significant problems are likely to occur if it is off-line for a longer period of time. Repair procedures are not difficult, but the equipment is obsolete, so parts are often hard to find and expensive to purchase. Numerical ratings for the various aspects of the primary clarifier are shown below in Table 8.

Table 8: Condition and Criticality Rating for Primary Clarifier

CONDITION	Structure & Materials	Mechanical	Pumps, Motors, & Equipment	Electrical & Instrumentation	Maintenance History	**Weighted Total**
	25	50	25	50	50	**38.75**
CRITICALITY	Redundancy	Process & Capacity Impact	Replacement Difficulty	**Weighted Total**	**RISK RATING: 60.4**	
	100	90	40	**82.0**		

2.3 SECONDARY TREATMENT

Secondary treatment at King's Creek WWTP is provided by trickling filters and clarifiers. Altogether, three trickling filters and three clarifiers comprise the secondary treatment processes at the WWTP.

2.3.1 Stage 1 Trickling Filter

The Stage 1 Trickling Filter was constructed in 1970 as part of the original plant. It has a volume of 0.8 MG and a total depth of six feet. The filter, shown in Figure 11, is the only trickling filter onsite that is filled with rock media. During normal operations, flow enters the trickling filter from the primary clarifier and is recirculated to the filter by the pumps at the second stage pump station. Flow is distributed by gravity through the distribution arms, and treatment occurs via a biofilm formed on the rock media. The Stage 1 Trickling Filter is mainly responsible for BOD oxidation.

Figure 11: Stage 1 Trickling Filter

Despite being an outdated technology, the trickling filter is in fair condition. The distribution base, arms and center column were rebuilt and installed less than two years ago (Figure 12). Control gates and underdrains are all in good operational condition. The Stage 1 Trickling filter is powered by MCC-3, located at the second stage pump station.

This trickling filter is the primary source of biological treatment at the plant and has no back-up unit present. The plant can operate for a maximum of one week without this unit, but permit limits will be hard to maintain in this situation. Failure of this unit will cause the BOD loading on the second stage trickling filters to increase, decreasing their capacity for nitrification. Diffuser ports are easy to clean and maintain, but other equipment is heavy and difficult to remove. In the event of necessary removal, a crane must be rented to complete the task. Table 9 below contains the numerical ratings for the various aspects of the Stage 1 Trickling Filter.

Figure 12: Distribution Arm and Rock Media of the Stage 1 Trickling Filter

Table 9: Condition and Criticality Rating for Stage 1 Trickling Filter

CONDITION	Structure & Materials	Mechanical	Pumps, Motors, & Equipment	Electrical & Instrumentation	Maintenance History	**Weighted Total**
	25	25	25	25	25	**25**
CRITICALITY	Redundancy	Process & Capacity Impact	Replacement Difficulty	**Weighted Total**	**RISK RATING: 54.5**	
	100	80	80	**84.0**		

2.3.2 Intermediate Clarifier

The intermediate clarifier is located south of the Stage 1 Trickling Filter and was constructed as part of the original plant in 1970. The clarifier, shown in Figure 13, is seven feet deep and has a volume of 0.23 MG. A double trough weir is located around the perimeter of the clarifier. During normal operations, water is gravity fed from the first stage trickling filter to this clarifier and outflow is sent to the second stage pump station.

Figure 13: Intermediate Clarifier

The intermediate clarifier is in good condition with no significant visible degradation of the concrete wall or metal deck. The last rehabilitation of the unit was performed sometime prior to 2007. The arm is operational and appears to be working well. Recently, masses of an unidentified growth have been accumulating around the outflow weir and have caused some cleaning problems. Figure 14 shows an example of this growth which was described as an "astroturf-like substance." The intermediate clarifier is powered by MCC-3, which is located on top of the second stage pump station.

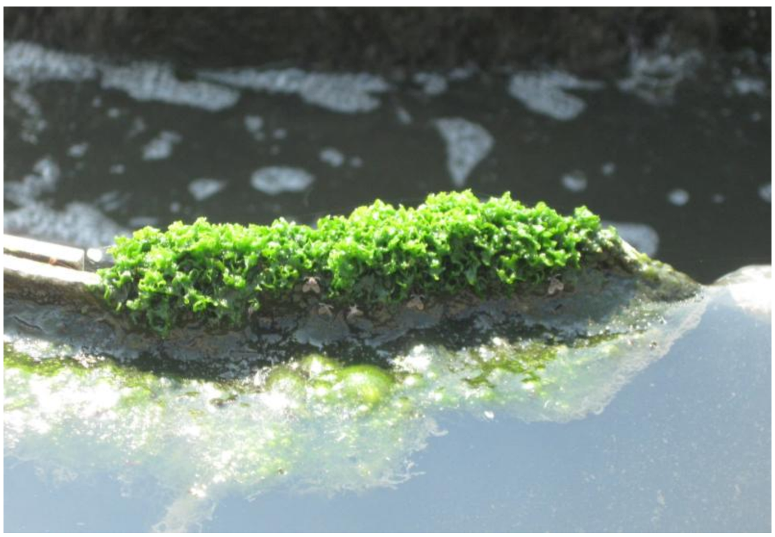


Figure 14: Unidentified Growth Present in Intermediate Clarifier

The system does not include any back-up clarifiers to provide redundancy for this treatment unit. However, in the event of failure, flow can be sent from the Stage 1 Trickling Filter directly to the Stage 2 Trickling Filter with few problems. Routine maintenance is easy to provide due to the clarifier's low impact on the rest of the treatment process. Parts are easy to replace, but can be expensive and hard to find due to the age of the equipment. Numerical ratings for the condition and criticality of this unit are displayed below in Table 10.

Table 10: Condition and Criticality Rating for Intermediate Clarifier

CONDITION	Structure & Materials	Mechanical	Pumps, Motors, & Equipment	Electrical & Instrumentation	Maintenance History	**Weighted Total**
	25	25	0.0	75	50	**32.5**
CRITICALITY	Redundancy	Process & Capacity Impact	Replacement Difficulty	**Weighted Total**	**RISK RATING: 51.25**	
	100	70	40	**70.0**		

2.3.3 Second Stage Pump Station

The Second Stage Pump Station was originally built in 1970 and is located between the intermediate clarifier and the Stage 2 Trickling Filters. This pump station provides recirculation of flow into the Stage 1 Trickling Filter for additional biological treatment, as well as lift for flow being sent to the Stage 2 Trickling Filters. Two of the pumps from this station are pictured in Figure 15. A rebuilt pump that was installed in July 2010 is shown in Figure 16.

Figure 15: Lift Pumps Located at the 2nd Stage Pump Station (unit on left side is being replaced)

Figure 16: Replacement Lift Pump for 2nd Stage Pump Station

Pumps are housed in a small brick structure that shows some signs of structural degradation. Floor grating above the wet well is unstable and needs to be replaced. One pump is currently being replaced and the remaining pumps are all in excellent condition. Control valve #2 is very difficult to turn, but other valves are in working condition. The compressor used for the level sensing bubbler system is in decent condition. Various maintenance tasks are performed at weekly, monthly, and quarterly intervals. The pumps in the second stage pump station are powered by MCC-3. Moisture accumulation was present in the MCC, and no lightening/surge protection was present. The ground bus was showing signs of corrosion, and hot buses will begin to show same corrosion if not tin plated. MCC needs to be megger tested to determine risk of premature failure.

The system consists of two recirculation pumps and three lift pumps. One recirculation pump is always redundant, but all three lift pumps are required for peak capacity. This provides good redundancy, but if one pump is lost, the plant flow would need to be pinched. Loss of either a lift pump or a recirculation pump would impact the plant process. Pumps are constant speed, which effects efficiency of the recirculation system. Heavy equipment is required for pump replacements which also impacts plant processes. Table 11 below contains the numerical ratings for the condition and criticality of this pump station.

Table 11: Condition and Criticality Rating for 2nd Stage Pump Station

CONDITION	Structure & Materials	Mechanical	Pumps, Motors, & Equipment	Electrical & Instrumentation	Maintenance History	Weighted Total
	50	65	25	75	25	**43.5**
CRITICALITY	Redundancy	Process & Capacity Impact	Replacement Difficulty	Weighted Total	RISK RATING: 47.75	
	60	40	80	**52.0**		

2.3.4 Stage 2 Trickling Filters

The Stage 2 Trickling Filters include two units located south of the Second Stage Pump Station. Unit #1 is located on the eastern side of the main plant road and was built as part of the original plant in 1970. Unit #2 was constructed during the 1994 improvement project and is on the western side of the plant road. Both filters are six feet deep and have a combined volume of 0.82 MG. These units contain Brentwood media, a plastic mesh that provides increased surface area for bacterial growth. Figure 17 shows a picture of this media in one of the units.

Figure 17: Distribution Arms and Brentwood Media of 2nd Stage Trickling Filter #2

Distribution arms on both units were rehabilitated in 2006 and are in good structural condition. Distributors are clean and well maintained, but regular cleaning is required. Ladders leading to the top of both units are old and extremely steep, creating a potential safety hazard. Grating in unit #2 and in the junction box (leading to final clarifiers) is very unstable and should be replaced. Effluent valves are in good condition, but the control valve for unit #2 is in poor condition and does not work properly. Manual slide gates are located in the junction box and in unit #2, and both seem to work well.

The system consists of two units which provides some redundancy. However, although the plant is hydraulically able to operate with just one unit functioning, the plant process would be highly impacted in this situation. One filter would not be capable of meeting nitrification requirements in cold weather conditions. Diffuser ports are easy to work on, but the remaining equipment is heavy and extremely hard to move. If removal is required, a crane must be rented. Condition and criticality ratings for these trickling filters are displayed below in Table 12.

Table 12: Condition and Criticality Rating for 2nd Stage Trickling Filters

CONDITION	Structure & Materials	Mechanical	Pumps, Motors, & Equipment	Electrical & Instrumentation	Maintenance History	**Weighted Total**
	50	50	0	0	25	**23.75**
CRITICALITY	Redundancy	Process & Capacity Impact	Replacement Difficulty	**Total**	**RISK RATING: 47.9**	
	70	70	80	**72.0**		

2.3.5 Final Clarifiers

Two final clarifiers are located on the southern end of the plant. Final Clarifier #1 was built in 1970 and is shown in Figure 18. This unit is located on the eastern side of the main plant road and is seven feet deep. Final Clarifier #2 (see Figure 19) was built in 1994 across the plant road from Final Clarifier #1 and has a depth of ten feet. Together, the units have a combined volume of 0.72 MG. These units provide final treatment of flow before it is sent through disinfection. Humus collected from these clarifiers is sent to the influent pump station via gravity flow.

Figure 18: Final Clarifier #1

Both units appear to be structurally sound, with a small amount of corrosion present on the metal bridges. No scrapper arm problems have been reported and the clarifiers appear to be working well. New gear boxes were installed in both units in 1995. Regular cleaning is provided throughout the year and, according to plant operations, keeps the units in working order despite fast build up of solids. Two blower units are connected to the clarifiers' centerwells to increase nitrification, but plant operations states that no difference is seen in the effluent whether or not the blowers are operating. The final clarifiers are powered by MCC-3, located on the top of the second stage pump station.

Figure 19: Final Clarifier #2

The presence of two clarifiers provides some redundancy for this process. Each unit can, and has been, taken off-line for maintenance, but not for an extended period of time. Replacement parts are expensive and difficult to find due to the age of the equipment, but installment procedures are not difficult. Table 13 contains the numerical ratings for various aspects of these final clarifiers.

Table 13: Condition and Criticality Rating for Final Clarifiers

CONDITION	Structure & Materials	Mechanical	Pumps, Motors, & Equipment	Electrical & Instrumentation	Maintenance History	Weighted Total
	25	0	25	75	25	**27.5**
CRITICALITY	Redundancy	Process & Capacity Impact	Replacement Difficulty	**Weighted Total**	**RISK RATING: 45.75**	
	70	70	40	**64.0**		

2.4 DISINFECTION

Disinfection at King's Creek WWTP takes place prior to effluent discharge and is accomplished by chlorination/dechlorination. The disinfection system consists of a chlorine contact basin and a chemical storage building, as well as various related equipment.

2.4.1 Chlorine Contact Basin

The chlorine contact basin is located on the southernmost edge of the plant site. The original basin was built in 1970, but the latest retrofit was performed in 2000 when the plant removed its UV disinfection and returned to chlorination. Figure 20 shows a picture of the contact basin, which is divided into two separate channels. Flows from the two final clarifiers are combined in an open-air junction box. Chlorine gas is added at the western end of the basin and sulfur dioxide is introduced at the eastern end of the basin prior to effluent discharge. Contact time in the basin is designed to be 20 minutes and vertical elevation drops at the outlet provide mixing of the sulfur dioxide.

Figure 20: Chlorine Contact Basin

Since the basin was retrofitted in 2000, structural elements of the basin appear to be in very good condition. The current plant water pump, which runs the belt press at the solids holding tank, is two years old and has to be replaced every two to five years according to plant operations. The gas master pump is a vacuum induction system and is in fair condition, but will require replacement in five years according to standard maintenance. The junction box that collects flow from the final clarifiers is in poor condition and does not contain any control gates. Control gates for the contact basin require two people for simultaneous opening or closing, which hinders the response speed for flow control. The transformer housing near the chlorine contact basin is showing signs of rust and corrosion.

The fact that the basin is divided into two separate channels provides the unit a fair degree of redundancy. Although the system is designed for a 20 minute retention time, testing should be performed to verify that operating conditions are producing the correct contact time. Failure of either sub-basin will impact the plant's capacity by 50%. Vacuum induction units are kept in stock at the plant due to the fact that they go out frequently and have no redundant system installed. The plant water pump has no back-up which could cause significant problems if failure occurs. Overall, most of the equipment is readily available and easy to replace. Condition and criticality ratings for the chlorine contact basin are displayed below in Table 14.

Table 14: Condition and Criticality Rating for Chlorine Contact Basin

CONDITION	Structure & Materials	Mechanical	Pumps, Motors, & Equipment	Electrical & Instrumentation	Maintenance History	**Weighted Total**
	0.0	75	50	25	25	**33.75**
CRITICALITY	Redundancy	Process & Capacity Impact	Replacement Difficulty	**Weighted Total**	**RISK RATING: 45.9**	
	70	70	10	**58**		

2.4.2 Chemical Storage Building

The chemical storage building houses the chlorine and sulfur dioxide storage cylinders and feed equipment. This building is located on the southern edge of the plant and is adjacent to the chlorine contact basin. This building provides storage for chemicals used in the contact basin and houses various safety equipment, including a large air scrubber that is connected to the chlorine gas storage room. The building was last updated in 2000 when chlorine disinfection was reinstated. A picture of this building can be seen below in Figure 21, with the scrubber and contact basin located on the left side of the picture.

Figure 21: Chemical Storage Building and Scrubber Unit for Disinfection Process

The building is a brick structure and appears to be in excellent condition. The scrubber is exercised monthly and has been updated within the past year. Chlorinators were installed in 2000 and have not required significant repair work since that time. Some of safety equipment that was observed is in very poor condition. The shower and eye wash stations located on the loading deck were both broken and inoperable. Each of these items should be repaired or replaced to provide adequate worker safety. Chemical analyzers also appeared to be nonoperational. Wallace and Tierman has been out multiple times to calibrate and but the analyzers still do not operate properly. Without analyzers working correctly, pacing chemicals is not possible and inefficient chemical dosing is likely.

The system has excellent redundancy, with 100% back-up present for the chlorinators and sulfanators. Automatic switch-overs are in place and process/capacity impact would be nominal if failure in one unit occurred. All equipment is fairly new, so little difficulty is expected with maintenance and repair. Table 15 contains the condition and criticality ratings for this storage building.

Table 15: Condition and Criticality Rating for Chemical Storage Building

CONDITION	Structure & Materials	Mechanical	Pumps, Motors, & Equipment	Electrical & Instrumentation	Maintenance History	**Weighted Total**
	0.0	0.0	75	75	0.0	**30**
CRITICALITY	Redundancy	Process & Capacity Impact	Replacement Difficulty	**Weighted Total**	**RISK RATING: 15**	
	0	0	0	**0**		

2.5 SOLIDS PROCESSING

Solids processing at the King's Creek WWTP treats solids collected from all trickling filters and clarifiers onsite. This system consists of a solid building that houses required pumps and heat exchangers, anaerobic digesters, and a sludge holding tank.

2.5.1 Solids Building

The solids building was constructed as part of the 1983 plant improvement project and is located at the northern end of the site, just east of the administration building. This building houses the sludge pumps (Figure 22) and heat exchanger (Figure 23) used in conjunction with

Figure 22: Sludge Pumps Located in the Solids Building

the anaerobic digester and sludge holding tank. Sludge from the clarifiers and trickling filters is pumped to the digesters, and heated sludge is recirculated through the sludge pumps and heat exchanger. Sludge from the digesters is then sent into the sludge holding tank, where it periodically cycles through a chopper pump located in the pump room. A separate room is included in the building for the equalization basin blowers.

Figure 23: Heat Exchanger for Digesters Located in Solids Building

The building itself is comprised primarily of brick and some degradation is visible, especially in the quality of the interior paint. The room has a poor ventilation system consisting of one wall-mounted fan unit and a single window. Pumps in the room appear to be in very good condition and many have been rebuilt or replaced recently. The Vaughn chopper pump was installed in 2007 and one Gorman Rupp recirculation pump was replaced in 2006. The heat exchanger has also recently been rebuilt. Most units have a lifespan of fifteen to twenty years and regular greasing of the equipment is required. Layout improvements are recommended due to the highly constricted space and difficulty in access for repair and maintenance procedures. The solids building also houses MCC-4, which was installed in 1995 and is at half of its life expectancy.

The system includes two progressive cavity pumps for flow from primary clarifiers to digesters, with 100% back-up. Two centrifugal pumps are present for flow between the digesters and heat exchanger, also with 100% back-up. Only one chopper pump is present for recirculation of solids in the holding tank, but no back-up is needed for this unit. The heat exchanger also has no redundancy provided which could cause serious problems for the solids management process in the event of a failure. Equipment repair and replacement is difficult to perform due to the highly restricted space. Numerical ratings for the condition and criticality of the solids building can be seen below in Table 16.

Table 16: Condition and Criticality Rating for Solids Building

CONDITION	Structure & Materials	Mechanical	Pumps, Motors, & Equipment	Electrical & Instrumentation	Maintenance History	**Weighted Total**
	25	50	0.0	25	50	**28.75**
CRITICALITY	Redundancy	Process & Capacity Impact	Replacement Difficulty	**Weighted Total**	**RISK RATING: 40.4**	
	50	50	60	**52.0**		

2.5.2 Anaerobic Digesters

The anaerobic digester facility consists of two digestion chambers and is located next to the solids building and sludge holding tank. This facility was also part of the 1983 improvement project. Sludge from the clarifiers and trickling filters is pumped through the solid building and heat exchanger into one of the two rectangular digestion chambers. Together, the two chambers have a volume of 0.27 MG. Two mixer units for each chamber are located on the top cover of the facility (see Figure 24).

Figure 24: Anaerobic Digester with Mixers Mounted on Top Cover

The unit was thoroughly cleaned and inspected in April 2010, and appears to be in excellent condition. However, some slight structural degradation was visible on the outer surface of the structure and some corrosion is present on the stairs. Many of the valves and mixers are fairly new, but one mixer and motor is scheduled to be updated in June 2010. The digesters are powered by MCC-4, located in the solids building. Mixer number 1 exhibited high vibration and mixer number 2 exhibited a low vibration.

The presence of two digestion chambers provides moderate redundancy. The plant is capable of running on only one chamber, but more dewatering would likely be necessary as a result. The mixer motors are easy to access and work on due to their locations above the top cover. However, any maintenance required on the interior of the digesters would be difficult to perform. Condition and criticality ratings for this digester facility are displayed below in Table 17.

Table 17: Condition and Criticality Rating for Anaerobic Digesters

CONDITION	Structure & Materials	Mechanical	Pumps, Motors, & Equipment	Electrical & Instrumentation	Maintenance History	Weighted Total
	35	0	0	50	0	**14.5**
CRITICALITY	Redundancy	Process & Capacity Impact	Replacement Difficulty	**Weighted Total**	**RISK RATING: 11.25**	
	20	0	20	**8**		

2.5.3 Sludge Holding Tank

The sludge holding tank is located on the eastern side of the solid building and was constructed as part of the 1994 plant improvement project. Sludge from the anaerobic digesters flow by gravity into this holding tank and stored until the contracted belt press is brought onsite for dewatering and disposal of the solids. Sludge is circulated from the bottom of the tank, through the chopper pump, and back into the top of the holding tank. The tank has a volume of 0.13 MG and is shown below in Figure 25.

Figure 25: Sludge Holding Tank

The holding tank was last rehabilitated during April 2010 in correspondence with the digester inspection. The holding tank appeared to be in good condition and the moving steel cover is in good operational condition. The chopper pump and flexible hosing for recirculation appear to be in excellent condition. The chopper pump is powered by MCC-4.

No other solids storage facility is present for use in case of failure of this unit. If the tank was inoperable, solids could be pulled directly from the digesters, but the procedure would be extremely difficult and would have a high impact on plant processes. Also, no dewatering would be available if this holding tank were to fail. According to plant operations, the tank occasionally fills up, indicating the possible need for increased storage capacity. Table 18 contains the numerical ratings for condition and criticality of this unit.

Table 18: Condition and Criticality Rating for Sludge Holding Tank

CONDITION	Structure & Materials	Mechanical	Pumps, Motors, & Equipment	Electrical & Instrumentation	Maintenance History	Weighted Total
	35	15	0	25	0	**13**
CRITICALITY	Redundancy	Process & Capacity Impact	Replacement Difficulty	**Weighted Total**	**RISK RATING: 31.5**	
	100	50	0	**50**		

2.6 ELECTRICAL AND INSTRUMENTATION

Electrical and instrumentation components for individual unit processes were noted in the condition assessment for each process. However, the condition of several electrical and instrumentation components impacts multiple unit processes, and could not be included with a single unit process. These components could have large scale impacts on operations and maintenance within the King's Creek WWTP.

Through the facility, electrical conductors should be tested to check for degradation of insulation, which can lead to short circuiting. The incoming electrical feed service was installed in 1995, and most of these conductors should be in good condition. However, a meggar test should be completed to show a more detailed analysis. Several of the area lamps need new lamps, and some fixtures with photocells have had operational problems with the photocells. These photocells should be repaired or replaced. The 125 kW generator is being exercised weekly, and no apparent problems were reported. Several unit processes, routed through MCC-1, are not tied into the SCADA system and should be upgraded in the future to allow better operations and control.

2.7 NON-PROCESS ITEMS

The main non-process items that were not included in the unit process assessment and the electrical and instrumentation assessment are the internal roadways and the maintenance building. Several of the internal roadways are crushed limestone or flexible pavement, which will not hold up well under heavy truck traffic. Upgrading the areas of heavy traffic to concrete pavement would increase the structural stability of the roadways. The entry road is also in poor condition, and upgrades should be considered. The maintenance/office building is in good condition, but many of the facilities are dated and are not ADA compliant.

3.0 CURRENT FACILITY RISK RATING

The overall condition of each unit process, and the risk rating associated with that condition, is summarized in Table 19. The need for upgrades based on this risk assessment is broken down into the following categories:

- Greater than 75: Immediate repairs required; indicates unit process has reached its expected life
- 50-75: High risk of failure and capacity impact; repair or replacement in near future
- 25-50: Fair mechanical condition, but little redundancy and/or obsolete equipment that would be difficult to replace
- 0-25: Good condition with minimal upgrades/improvements currently required

The combination of condition and criticality allows for a qualitative risk rating to be developed, which prioritizes needed improvements. The current prioritization of unit process improvements is shown in Table 19.

Table 19 Risk ratings for all unit processes

	Unit	Condition Rating	Criticality Rating	Risk Rating
Preliminary Treatment	Equalization Basin	30	4	17
	EQ Basin Blowers	18.75	6	22.4
	Bar Screen	12.5	18	15.25
	Influent Pump Station	34.75	8	21.4
	Grit Classifier	41.25	70	55.6
	Grit Basin	5.0	40	22.5
	Grit Blowers	47.5	5	26.25
Primary Treatment	Primary Clarifier	38.75	82	60.4
Secondary Treatment	Stage 1 Trickling Filter	25	84	54.5
	Intermediate Clarifier	32.5	70	51.25
	2nd Stage Pump Station	43.5	52	47.75
	2nd Stage Trickling Filters	23.75	72	47.9
	Final Clarifiers	27.5	64	45.75
Disinfection	Chlorine Contact Basin	33.75	58	45.9
	Chemical Storage Building	30	0	15
Solids Management	Solids Building	28.75	52	40.4
	Anaerobic Digesters	14.5	8	11.25
	Sludge Holding Tank	13	50	31.5

Table 20: Improvement Prioritization

Unit	Risk Rating
Primary Clarifier	60.4
Grit Classifier	55.6
Stage 1 Trickling Filter	54.5
Intermediate Clarifier	51.25
2nd Stage Trickling Filters	47.9
2nd Stage Pump Station	47.75
Chlorine Contact Basin	45.9
Final Clarifiers	45.75
Solids Building	40.4
Sludge Holding Tank	31.5
Grit Blowers	26.25
Grit Basin	22.5
EQ Basin Blowers	22.4
Influent Pump Station	21.4
Equalization Basin	17
Bar Screen	15.25
Chemical Storage Building	15
Anaerobic Digesters	11.25

Based on prioritization of the risk ratings, four unit processes currently have a high risk of failure due to a combination of condition and criticality. The primary clarifier, grit classifier, stage 1 trickling filter, and intermediate clarifier all have no redundancy, aging and/or obsolete equipment, and present a high risk to process operations to meet permitted effluent values in the TPDES permit.

Overall risk ratings take into account the condition of the entire unit process, but several specific items in need of repair were identified for each unit process. Although these items may not have a large overall impact on performance, many of them present safety hazards and operation limitations and would benefit from upgrades. Specific items of concern are shown in Table 21.

Table 21 Specific items of concerned identified for each unit process

Unit Process	Items of Concern
Bar Screen	•Compactor on conveyor needed for transport of screening materials
Influent Pump Station	•Replace ceiling hatch or provide safety railing to reduce safety hazard
Grit Classifier	•Stockpile shoes, as they are specially made by a local craftsman and are of limited supply
Grit Blowers	•Repair blower with electrical problems to assure firm capacity •Significant mud dauber nests are present in this MCC, and cleaning will be required to prevent operational issues in the future.
Intermediate Clarifier	•Addition of lightening/surge protection present on the MCC •Tin plate hot buses to prevent corrosion seen on ground bus •MCC needs to be megger tested to determine risk of premature failure
Second Stage Pump Station	•Floor grating is unstable and is a safety hazard; it should be replaced •Control valve 2 is difficult to operate and cannot be manually manipulated by one man; replacement or rehabilitation is recommended
2nd Stage Trickling Filters	•Ladders leading to the top of both units are old and extremely steep, creating a potential safety hazard and should be replaced •Grating in unit #2 and in the junction box (leading to final clarifiers) is very unstable and should be replaced. •Control valve for unit #2 is in poor condition and does not work properly; this should be replaced or rehabilitated
Chlorine Contact Basins	•Control gates for the contact basin require two people for simultaneous opening or closing, which hinders the response speed for flow control.
Chemical Storage Building	•The shower and eye wash stations located on the loading deck were both broken and inoperable. •Chemical analyzers are not working correctly, and pacing chemicals is not possible; upgrades or replacement are recommended to improve chemical use efficiency

4.0 EXPECTED SERVICE LIFE

As equipment ages with time, a projection of the risk ratings for each unit process over the study period can be made. These projected risk ratings are based on assumptions that overall condition will degrade linearly over time. When the risk rating for a unit process exceeds a score of 75, immediate repairs or upgrades would be required and the unit will be considered to reach its service life. Projected risk ratings for major units processes for the study period are shown in Table 22. The need for upgrades based on this risk assessment is broken down into the following categories:

- Greater than 75: Immediate repairs required; unit process has reached useful service life
- 50-75: High risk of failure and capacity impact; repair or replacement in near future
- 25-50: Fair mechanical condition, but little redundancy and/or obsolete equipment that would be difficult to replace
- 0-25: Good condition with minimal upgrades/improvements currently required

In 2018, it is projected that eight of the 18 unit processes will have reached their service life. An additional six unit processes will be at high risk of failure, and likely require repairs and/or upgrades in the near term. Only the equalization basin, bar screen, chemical storage building, and anaerobic digesters are projected to be in good to fair condition in 2018.

Table 22 Projected risk ratings for the major unit processes

Unit Process	Risk Rating			
	2010	2018	2030	2040
Primary Clarifier	60.4	92.4	100	100
Grit Classifier	55.6	87.6	100	100
Stage 1 Trickling Filter	54.5	86.5	100	100
Intermediate Clarifier	51.25	83.25	100	100
2nd Stage Trickling Filters	47.9	79.9	100	100
2nd Stage Pump Station	47.75	79.75	100	100
Chlorine Contact Basin	45.9	77.9	100	100
Final Clarifiers	45.75	77.75	100	100
Solids Building	40.4	72.4	100	100
Sludge Holding Tank	31.5	63.5	100	100
Grit Blowers	26.25	58.25	100	100
Grit Basin	22.5	54.5	100	100
EQ Basin Blowers	22.4	54.4	100	100
Influent Pump Station	21.4	53.4	100	100
Equalization Basin	17	49	97	100
Bar Screen	15.25	47.25	95.25	100
Chemical Storage Building	15	47	95	100
Anaerobic Digesters	11.25	43.25	91.25	100

5.0 CONCLUSIONS

The King's Creek WWTP is a well maintained facility that does a superb job in meeting the effluent quality requirements stipulated in the TPDES permit. However, the age of the equipment and the high level of obsolete equipment make the overall risk rating for the facility relatively high, and will escalate with time. Within in the next 8 years, the majority of the major unit processes will reach their service life or a point of high risk, making continued operation without significant upgrades challenging and potentially costly as the 2018 operational goal approaches.

Evaluation of the process condition of the King's Creek WWTP, and the ability of the existing unit processes to continue meeting the current and future TPDES permit, is being completed. This will give the process performance capabilities of the King's Creek WWTP, and the combination of the condition assessment and process assessment will be used to determine the ability of the current facilities to operate through 2018. Projection of the future infrastructure needs for the City of Terrell and its surrounding entities to meet wastewater flows through 2040 will also be made.

Appendix A
Condition Assessment Field Notes

Conditional Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Bar Screen   Last Rehabilitation: 5/28/2010

Component Group	Component Condition Rating	Weight Factor	Weighted Component Rating	Comments
Structure/materials	25	0.20	5.00	Wet well in good condition. Steel is in good shape. No significant concrete erosion
Mechanical- Hatches, Valves, Vents, etc.	25	0.15	3.75	Gates in good operation, but solely manual metal gates. Steel body is in good shape, no major failure points.
Pumps, Motors, and Equipment	0	0.25	0.00	Replacing motor. Manual Screen. No compactor.
Electrical & Instrumentation	25	0.15	3.75	MCC-1 installed in '95. Life expectancy is 50 years. Has reached half its life expectancy. Indication lights are out. Control panel needs minor maintenance.
Maintenance History	0	0.25	0.00	Low maintenance (3-4 times during operational life). New gear on electric motor.
Overall Facility Rating	-	1.00	**12.50**	

Condition Rating	Description
0	New, perfect condition
25	Good condition, no improvements recommended to maintain function
50	Fair condition, improvements recommended to improve performance or efficiency
75	Poor condition, improvements recommended to maintain reliability
100	Eminent failure, rehabilitation or replacement required

Conditional Assessment

Inspection Date: 5/27/2010

Facility Information:

* Pump Notes - 3150 gpm (each), Fairbanks VFD in VFD

Unit Process: Influent Pump Station

Last Rehabilitation: 2 pumps rehabilitated last year, 1 rehabilitated this year.

Component Group	Component Condition Rating	Weight Factor	Weighted Component Rating	Comments
Structure/materials	30	0.20	6.00	No structural degradation. Light H2S. Dry well has some degradation. Some Leaking.
Mechanical- Hatches, Valves, Vents, etc.	50	0.15	7.50	Cranes in solid condition. Hatch is a walking hazard. Ventilation system is operational. Valves are old but electric operator in good operation.
Pumps, Motors, and Equipment	25	0.25	6.25	4 Motors, regular maintenance. Only need one in operation on normal day. Old compressors for bubble system for level sensor, but works well.
Electrical & Instrumentation	50	0.15	7.50	VFD 1336, No A/C (limited). 1 VFD failure $4,000 component. VFD maintenance plan may help prevent future failures. VFDs powered from MCC-1. (Motors: have not been rewound, grease bearings, hard to get out)
Maintenance History	30	0.25	7.50	Regular motor maintenance. One in operation normally, two during storms. 1.5 ton crane. 3 of 4 are rebuilt (10-15 year rebuild cycles.)
Overall Facility Rating	-	1.00	**34.75**	

Condition Rating	Description
0	New, perfect condition
25	Good condition, no improvements recommended to maintain function
50	Fair condition, improvements recommended to improve performance or efficiency
75	Poor condition, improvements recommended to maintain reliability
100	Eminent failure, rehabilitation or replacement required

Conditional Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Grit Classifier   Last Rehabilitation: 6 months ago (new shoes)

Component Group	Component Condition Rating	Weight Factor	Weighted Component Rating	Comments
Structure/materials	25	0.20	5.00	Excellent. Large Cantilever
Mechanical- Hatches, Valves, Vents, etc.	25	0.15	3.75	New shoes, regular replacement
Pumps, Motors, and Equipment	25	0.25	6.25	Screw shaft
Electrical & Instrumentation	50	0.15	7.50	Powered from MCC-1. Stopped working Tuesday of this week, waiting for parts. Gas meter for R.S. room does not work.
Maintenance History	25	0.25	6.25	Low maintenance. Plant can run without classifier for 6 to 7 weeks. Snails.
Overall Facility Rating	-	1.00	**28.75**	

Condition Rating	Description
0	New, perfect condition
25	Good condition, no improvements recommended to maintain function
50	Fair condition, improvements recommended to improve performance or efficiency
75	Poor condition, improvements recommended to maintain reliability
100	Eminent failure, rehabilitation or replacement required

Conditional Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Grit Basin   Last Rehabilitation: N/A, cleaning is performed occasionally

Component Group	Component Condition Rating	Weight Factor	Weighted Component Rating	Comments
Structure/materials	25	0.20	5.00	Sound structural integrity. Some corrosion in chambers.
Mechanical- Hatches, Valves, Vents, etc.	0	0.15	0.00	Isolation gates in good condition. Diffusers are stainless steel, coarse bubble diffusers.
Pumps, Motors, and Equipment	0	0.25	0.00	No motors in basin
Electrical & Instrumentation	75	0.15	11.25	Compressor #2 not working. MCC #2 has mud dauber nests within. Really needs to be taked out of service and cleaned really well to prevent future problems. Indication lights out.
Maintenance History	0	0.25	0.00	No significant maintanence on basin; diffusers are regularly maintained
Overall Facility Rating	-	1.00	**16.25**	

Condition Rating	Description
0	New, perfect condition
25	Good condition, no improvements recommended to maintain function
50	Fair condition, improvements recommended to improve performance or efficiency
75	Poor condition, improvements recommended to maintain reliability
100	Eminent failure, rehabilitation or replacement required

Conditional Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Grit Blowers   Last Rehabilitation: Blower #3 is currently being rebuilt

Component Group	Component Condition Rating	Weight Factor	Weighted Component Rating	Comments
Structure/materials	25	0.20	5.00	Sound structural integrity. Some corrosion in chambers.
Mechanical- Hatches, Valves, Vents, etc.	0	0.15	0.00	No reported problems with blower valves
Pumps, Motors, and Equipment	75	0.25	18.75	2 of the 3 blowers out of commission. PD blowers. One is being upgraded. One has electrical issues.
Electrical & Instrumentation	75	0.15	11.25	MCC-2 needs to be taken out of service and serviced/cleaned of mud dauber nests. A nest built in the correct place could be detrimental to the equipment. MCC-2 is 15 years old. Life expectancy is 30 years. One blower has electrical problems
Maintenance History	50	0.25	12.50	Blowers have been problematic. Easy replacement. Can run on one basin.
Overall Facility Rating	-	1.00	**47.50**	

Condition Rating	Description
0	New, perfect condition
25	Good condition, no improvements recommended to maintain function
50	Fair condition, improvements recommended to improve performance or efficiency
75	Poor condition, improvements recommended to maintain reliability
100	Eminent failure, rehabilitation or replacement required

Conditional Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Primary Clarifier

Last Rehabilitation: Drive is 18 months old. Plug valves were recently replaced, and skimmers will be replaced next month.

Component Group	Component Condition Rating	Weight Factor	Weighted Component Rating	Comments
Structure/materials	25	0.20	5.00	Corrosion on Bridge
Mechanical- Hatches, Valves, Vents, etc.	50	0.15	7.50	Scum plug values replaced 4 years ago. Concentrator still in solid condition. Gravity to pumping near digesters. Scum trough. Junction box valves/gates in solid condition.
Pumps, Motors, and Equipment	25	0.25	6.25	Gear drives & Valves replaced 6 months ago
Electrical & Instrumentation	50	0.15	7.50	Wire insulation looking bad in disconnect. Power comes from MCC-2, which needs to be cleaned to prevent destructive failure when required to operate properly.
Maintenance History	50	0.25	12.50	Some maintenance.
Overall Facility Rating	-	1.00	**38.75**	

Condition Rating	Description
0	New, perfect condition
25	Good condition, no improvements recommended to maintain function
50	Fair condition, improvements recommended to improve performance or efficiency
75	Poor condition, improvements recommended to maintain reliability
100	Eminent failure, rehabilitation or replacement required

Conditional Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Stage 1 Trickling Filter   Last Rehabilitation: New distribution base, bearings, etc. installed 18 months ago.

Component Group	Component Condition Rating	Weight Factor	Weighted Component Rating	Comments
Structure/materials	25	0.20	5.00	Underdrains all working
Mechanical- Hatches, Valves, Vents, etc.	25	0.15	3.75	Distribution arm and center column rebuilt. Gates are in good operational condition.
Pumps, Motors, and Equipment	25	0.25	6.25	Distribution arm and center column rebuilt. No pumps/motors
Electrical & Instrumentation	75	0.15	11.25	MCC has slight moisture problems. MCC on top of structure without lightning/surge protection. Ground bus showing signs of corrosion. Hot buses will show the same corrosion if it is not tin plated. Premature failures are possible and MCC needs to be megger tested.
Maintenance History	25	0.25	6.25	Cleaning diffuser is relatively easy.
Overall Facility Rating	-	1.00	**32.50**	

Condition Rating	Description
0	New, perfect condition
25	Good condition, no improvements recommended to maintain function
50	Fair condition, improvements recommended to improve performance or efficiency
75	Poor condition, improvements recommended to maintain reliability
100	Eminent failure, rehabilitation or replacement required

Conditional Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Intermediate Clarifier Last Rehabilitation: At least 3 years since last rehabilitation

Component Group	Component Condition Rating	Weight Factor	Weighted Component Rating	Comments
Structure/materials	25	0.20	5.00	Bridge in good shape. No large concrete degradation.
Mechanical- Hatches, Valves, Vents, etc.	25	0.15	3.75	No mechanical equipment outside of arm. Good condition.
Pumps, Motors, and Equipment	0	0.25	0.00	Arm in good condition.
Electrical & Instrumentation	75	0.15	11.25	Powered from MCC-3. MCC-3 appears to have slight moisture problems. No lighting protection for MCC. Ground bus showing corrosion. Hot buses will show the same amount of corrosion. Possibility for premature failures. Recommend megger testing. Indication lights out.
Maintenance History	50	0.25	12.50	Cleaning problems. Regular maintenance.
Overall Facility Rating	-	1.00	**32.50**	

Condition Rating	Description
0	New, perfect condition
25	Good condition, no improvements recommended to maintain function
50	Fair condition, improvements recommended to improve performance or efficiency
75	Poor condition, improvements recommended to maintain reliability
100	Eminent failure, rehabilitation or replacement required

Conditional Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: 2nd Stage Pump Station   Last Rehabilitation: 1 pump is currently being replaced

Component Group	Component Condition Rating	Weight Factor	Weighted Component Rating	Comments
Structure/materials	50	0.20	10.00	Brick Structure. Grating needs to be replaced. Some structural degradation
Mechanical- Hatches, Valves, Vents, etc.	65	0.15	9.75	Working conditions. Compressor for bubbler system is in solid condition. Very difficult to turn control valve number 2.
Pumps, Motors, and Equipment	25	0.25	6.25	2 recirculation pumps. 4 lift station pumps (one replaced May 2010). Remaining pumps in excellent condition.
Electrical & Instrumentation	75	0.15	11.25	Same comments as Intermediate Clarifier.
Maintenance History	25	0.25	6.25	Monthly, weekly, quarterly maintenance
Overall Facility Rating	-	1.00	**43.50**	

Condition Rating	Description
0	New, perfect condition
25	Good condition, no improvements recommended to maintain function
50	Fair condition, improvements recommended to improve performance or efficiency
75	Poor condition, improvements recommended to maintain reliability
100	Eminent failure, rehabilitation or replacement required

Conditional Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: 2nd Stage Trickling Filters   Last Rehabilitation: 4 year ago (first time in a while)

Component Group	Component Condition Rating	Weight Factor	Weighted Component Rating	Comments
Structure/materials	50	0.20	10.00	Arms in good structural condition. Ladders steep & old. Grating in trickling filter no. 2 and junction box needs replacement.
Mechanical- Hatches, Valves, Vents, etc.	50	0.15	7.50	Control valve is well funtioning in filter no. 1 but not in no. 2. Distribution arms rebuilt. Effluent control valve in good condition. Brentwood media.
Pumps, Motors, and Equipment	0	0.25	0.00	Slide gates (manual) on no. 2 works well. Manual slide gates at junction box.
Electrical & Instrumentation		0.15	0.00	N/A
Maintenance History	25	0.25	6.25	Low maintenance & clean distributors. Regular Cleaning required.
Overall Facility Rating	-	1.00	**23.75**	

Condition Rating	Description
0	New, perfect condition
25	Good condition, no improvements recommended to maintain function
50	Fair condition, improvements recommended to improve performance or efficiency
75	Poor condition, improvements recommended to maintain reliability
100	Eminent failure, rehabilitation or replacement required

Conditional Assessment

Inspection Date: 5/27/2010

*** Blowers for nitrification in clarifiers, 4-5' below w.s.

Facility Information:

Unit Process: Final Clarifiers

Last Rehabilitation: New drives were installed in 1995

Component Group	Component Condition Rating	Weight Factor	Weighted Component Rating	Comments
Structure/materials		0.20	0.00	Some corrosion on bridges. Ladders not steep.
Mechanical- Hatches, Valves, Vents, etc.		0.15	0.00	No skimmers or arm problems.
Pumps, Motors, and Equipment		0.25	0.00	Humus return by gravity.
Electrical & Instrumentation	75	0.15	11.25	Same comment as Intermediate Clarifier.
Maintenance History		0.25	0.00	New gear boxes in 1995. Regular Cleaning.
Overall Facility Rating	-	1.00	**11.25**	

Condition Rating	Description
0	New, perfect condition
25	Good condition, no improvements recommended to maintain function
50	Fair condition, improvements recommended to improve performance or efficiency
75	Poor condition, improvements recommended to maintain reliability
100	Eminent failure, rehabilitation or replacement required

Conditional Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Chlorine Contact Basin   Last Rehabilitation: Converted back from UV in 2000

Component Group	Component Condition Rating	Weight Factor	Weighted Component Rating	Comments
Structure/materials	0	0.20	0.00	Retrofitted UV basin.
Mechanical- Hatches, Valves, Vents, etc.	75	0.15	11.25	Junction box with no gates that runs to the head of the plant. Two man job to open or close both gates.
Pumps, Motors, and Equipment	50	0.25	12.50	Gas master pumps going in, water champ currently. (vacuum induction). New back-up in supply. Plant water pump (single) two years old.
Electrical & Instrumentation	25	0.15	3.75	480V - 120/240V transformer housing is showing rust outside the enclosure.
Maintenance History	25	0.25	6.25	Pumps go out every 2-5 years. Gas master will be 5 years.
Overall Facility Rating	-	1.00	**33.75**	

Condition Rating	Description
0	New, perfect condition
25	Good condition, no improvements recommended to maintain function
50	Fair condition, improvements recommended to improve performance or efficiency
75	Poor condition, improvements recommended to maintain reliability
100	Eminent failure, rehabilitation or replacement required

Conditional Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Cl2 and SO2 Building   Last Rehabilitation: 2000 when UV was replaced

Component Group	Component Condition Rating	Weight Factor	Weighted Component Rating	Comments
Structure/materials	0	0.20	0.00	Brick Building
Mechanical- Hatches, Valves, Vents, etc.	0	0.15	0.00	No mechanical issues. Gas off-top of cylinders.
Pumps, Motors, and Equipment	75	0.25	18.75	Scrubber updated 9 months ago. Chlorinators installed in 2000; no work since. No shower or eye wash.
Electrical & Instrumentation	75	0.15	11.25	Analyzers don't appear to be operating correctly. Wallace and Tierman has been out muliple times to calibrate and but they still aren't working. Without analyers working correctly, pacing chemicals can not happen.
Maintenance History	0	0.25	0.00	Scrubber exercised every month.
Overall Facility Rating	-	1.00	**30.00**	

Condition Rating	Description
0	New, perfect condition
25	Good condition, no improvements recommended to maintain function
50	Fair condition, improvements recommended to improve performance or efficiency
75	Poor condition, improvements recommended to maintain reliability
100	Eminent failure, rehabilitation or replacement required

Conditional Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Solids Building   Last Rehabilitation: 12 months ago

Component Group	Component Condition Rating	Weight Factor	Weighted Component Rating	Comments
Structure/materials	25	0.20	5.00	Brick. Some degradation, poor painting.
Mechanical- Hatches, Valves, Vents, etc.	50	0.15	7.50	Poor ventilation. One plug valve operator.
Pumps, Motors, and Equipment	0	0.25	0.00	2 sludge pumps. For PS (1-3 yrs & 1-6 months). Vaughn Chopper pump (2007). Gorman Rupp recirculation pump (2006). Heat exchanger rebuilt.
Electrical & Instrumentation	25	0.15	3.75	Houses MCC-4. MCC-4 Components need to be cleaned to ensure proper operation. Indication lights are out. 15 year old, with life expectancy of 30 years.
Maintenance History	50	0.25	12.50	Regular greasing required. 15-20 year lives. Poor layout (constricted space).
Overall Facility Rating	-	1.00	**28.75**	

Condition Rating	Description
0	New, perfect condition
25	Good condition, no improvements recommended to maintain function
50	Fair condition, improvements recommended to improve performance or efficiency
75	Poor condition, improvements recommended to maintain reliability
100	Eminent failure, rehabilitation or replacement required

Conditional Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: EQ Basin Blowers   Last Rehabilitation: 5 years ago

Component Group	Component Condition Rating	Weight Factor	Weighted Component Rating	Comments
Structure/materials	25	0.20	5.00	Same as solids.
Mechanical- Hatches, Valves, Vents, etc.	25	0.15	3.75	Chain valves are operational. $10 box fan purchased for ventilation.
Pumps, Motors, and Equipment	25	0.25	6.25	One blower in operation at most. All in good shape back-up motor available.
Electrical & Instrumentation	25	0.15	3.75	MCC-4 installed in '95, appeared to be in good condition. Life expectancy on MCC is 30 years, so at about half of life expectancy. MCC indication lights are out.
Maintenance History	0	0.25	0.00	No Issues
Overall Facility Rating	-	1.00	**18.75**	

Condition Rating	Description
0	New, perfect condition
25	Good condition, no improvements recommended to maintain function
50	Fair condition, improvements recommended to improve performance or efficiency
75	Poor condition, improvements recommended to maintain reliability
100	Eminent failure, rehabilitation or replacement required

Conditional Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Digesters   Last Rehabilitation: Unit was cleaned and inspected 1 month ago

Component Group	Component Condition Rating	Weight Factor	Weighted Component Rating	Comments
Structure/materials	35	0.20	7.00	Some structural degradation. Corrosion on stairways
Mechanical- Hatches, Valves, Vents, etc.	0	0.15	0.00	New
Pumps, Motors, and Equipment	0	0.25	0.00	New (4-mixers). One mixer/motor needs updating (June 2010)
Electrical & Instrumentation	50	0.15	7.50	Mixer #1 high vibration @ motor - appears to have been recently worked on. Mixer # 2 low vibration @ motor. MCC-4 installed in '95 - appeared to be in good condition. Life expectancy is 30 years, so at half of life expectancy. MCC - Indication lights are out.
Maintenance History	0	0.25	0.00	New
Overall Facility Rating	-	1.00	**14.50**	

Condition Rating	Description
0	New, perfect condition
25	Good condition, no improvements recommended to maintain function
50	Fair condition, improvements recommended to improve performance or efficiency
75	Poor condition, improvements recommended to maintain reliability
100	Eminent failure, rehabilitation or replacement required

Conditional Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Sludge Tank   Last Rehabilitation: Unit was cleaned and inspected 1 month ago

Component Group	Component Condition Rating	Weight Factor	Weighted Component Rating	Comments
Structure/materials	35	0.20	7.00	Holding tank in good shape, steel moving cover working well.
Mechanical- Hatches, Valves, Vents, etc.	15	0.15	2.25	Flexible hosing for chopper pump and withdrawl
Pumps, Motors, and Equipment	0	0.25	0.00	Chopper pump for holding tank in good condition
Electrical & Instrumentation	25	0.15	3.75	One pump/motor installed 6 months ago. Two older ones. One pump/motor installed 18 months ago. Heat exchanger recently rebuilt - new tubes. MCC-4 Indication lights out.
Maintenance History	0	0.25	0.00	New
Overall Facility Rating	-	1.00	**13.00**	

Condition Rating	Description
0	New, perfect condition
25	Good condition, no improvements recommended to maintain function
50	Fair condition, improvements recommended to improve performance or efficiency
75	Poor condition, improvements recommended to maintain reliability
100	Eminent failure, rehabilitation or replacement required

Conditional Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Equalization Basin   Last Rehabilitation: 1995

Component Group	Component Condition Rating	Weight Factor	Weighted Component Rating	Comments
Structure/materials	50	0.20	10.00	Steps settling
Mechanical- Hatches, Valves, Vents, etc.	25	0.15	3.75	New electric operatior. Diffusers in good condition.
Pumps, Motors, and Equipment	0	0.25	0.00	
Electrical & Instrumentation	25	0.15	3.75	Valve actuator works.
Maintenance History	50	0.25	12.50	Manual Cleaning. Implementing chlorine return line. Plastic liner on grass surrounding basin possibly needed.
Overall Facility Rating	-	1.00	**30.00**	

Condition Rating	Description
0	New, perfect condition
25	Good condition, no improvements recommended to maintain function
50	Fair condition, improvements recommended to improve performance or efficiency
75	Poor condition, improvements recommended to maintain reliability
100	Eminent failure, rehabilitation or replacement required

Criticality Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Bar Screen   Last Rehabilitation: 5/28/2010

Component Group	Component Criticality Rating	Weight Factor	Weighted Component Rating	Comments
Redundancy	70	0.20	14.00	The system consists of a bypass with a manually cleaned screen. The gear box was rebuilt on 5/28/2010. No compactor or conveyer belt are present.
Process and Capacity Impact	0	0.60	0.00	Gate works well. Vulkan unit is reliable and in good condition.
Replacement Difficulty	20	0.20	4.00	Easy access to most parts. The use of a crane lift may be required to pull out the unit.
Overall Facility Rating	-	**1.00**	**18.00**	

Firm Redundancy	
4 or more units	10
3 units	40
2 units	70
1 unit	100

Replacement Difficulty/Outage Duration	
Low	10
Moderate	40
Difficult/high	70
Very difficult/long term	100

Process and Capacity Impact	
Mild	10
Moderate	40
Severe	70
Inoperable/non-compliance	100

Criticality Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Influent Pump Station

Last Rehabilitation: 2 pumps rehabilitated last year, 1 rehabilitated this year.

Component Group	Component Criticality Rating	Weight Factor	Weighted Component Rating	Comments
Redundancy	0	0.20	0.00	System consists of 4 pumps total, with 1 serving as a back-up. Each pump is rated for 3,150 gpm and has VFD capabilities. 2 pumps are required for the plant's peak capacity.
Process and Capacity Impact	0	0.60	0.00	Ventilation is good. A bubbler system is used for level sensing and control. Adequate redundancy is supplied for the system, both by extra pumps and the equalization basin.
Replacement Difficulty	40	0.20	8.00	City hires a company to do all work required for replacement. Bridge cranes--two, each for 1.5 tons--are available for use with the pumps, but not the motors.
Overall Facility Rating	**-**	**1.00**	**8.00**	

Firm Redundancy	
4 or more units	10
3 units	40
2 units	70
1 unit	100

Replacement Difficulty/Outage Duration	
Low	10
Moderate	40
Difficult/high	70
Very difficult/long term	100

Process and Capacity Impact	
Mild	10
Moderate	40
Severe	70
Inoperable/non-compliance	100

Criticality Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Grit Classifier   Last Rehabilitation: 6 months ago (new shoes)

Component Group	Component Criticality Rating	Weight Factor	Weighted Component Rating	Comments
Redundancy	100	0.20	20.00	Only 1 unit present. Grit is first collected in an aerated grit basin.
Process and Capacity Impact	50	0.60	30.00	No grit washing is available when the unit is down. The overflow/drain pipe is currently clogged and is not used. Instead, a flew hose is run on the ground to serve as the drain. For the process to be highly impacted, grit in the aerated grit basin would have to build up to a significantly high level.
Replacement Difficulty	70	0.20	14.00	The unit is easy to work on, but the manufacturer, *Linkbelt* , is out of business and the city has had to find a new outfitter for parts.
Overall Facility Rating	-	**1.00**	**64.00**	

Firm Redundancy	
4 or more units	10
3 units	40
2 units	70
1 unit	100

Replacement Difficulty/Outage Duration	
Low	10
Moderate	40
Difficult/high	70
Very difficult/long term	100

Process and Capacity Impact	
Mild	10
Moderate	40
Severe	70
Inoperable/non-compliance	100

Criticality Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Grit Blowers

Last Rehabilitation: Blower #3 is currently being rebuilt

Component Group	Component Criticality Rating	Weight Factor	Weighted Component Rating	Comments
Redundancy	0	0.20	0.00	The system consists of 3 blowers, but only 1 is needed to run the aerated grit basins, leaving 2 for back-up.
Process and Capacity Impact	0	0.60	0.00	Gravity is used to send grit to the classifier, eliminating the need for grit pumping.
Replacement Difficulty	25	0.20	5.00	Units are small, simple and easy to work on.
Overall Facility Rating	**-**	**1.00**	**5.00**	

Firm Redundancy	
4 or more units	10
3 units	40
2 units	70
1 unit	100

Replacement Difficulty/Outage Duration	
Low	10
Moderate	40
Difficult/high	70
Very difficult/long term	100

Process and Capacity Impact	
Mild	10
Moderate	40
Severe	70
Inoperable/non-compliance	100

Criticality Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Grit Basin

Last Rehabilitation: N/A, cleaning is performed occasionally

Component Group	Component Criticality Rating	Weight Factor	Weighted Component Rating	Comments
Redundancy	70	0.20	14.00	System consists of 2 basins, but the plant can fairly easily run on 1 basin. (Rating of 70 is too high.)
Process and Capacity Impact	40	0.60	24.00	No electrical vents are present. Passive vents are used for blower building. Unit failure has not occurred, but could impact the primary clarifier, trickling filters, and digesters.
Replacement Difficulty	10	0.20	2.00	The 2 control gates and effluent grit valves are in good shape. Coarse bubble diffusers are also in good condition.
Overall Facility Rating	-	**1.00**	**40.00**	

Firm Redundancy	
4 or more units	10
3 units	40
2 units	70
1 unit	100

Replacement Difficulty/Outage Duration	
Low	10
Moderate	40
Difficult/high	70
Very difficult/long term	100

Process and Capacity Impact	
Mild	10
Moderate	40
Severe	70
Inoperable/non-compliance	100

Criticality Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Primary Clarifier

Last Rehabilitation: Drive is 18 months old. Plug valves were recently replaced, and skimmers will be replaced next month.

Component Group	Component Criticality Rating	Weight Factor	Weighted Component Rating	Comments
Redundancy	100	0.20	20.00	System consists of 1 primary clarifier with a depth of 7 ft.
Process and Capacity Impact	90	0.60	54.00	When shut down, flow is bypassed directly to trickling filter and the trickling filter quickly becomes overloaded and clogs easily. The plant can opperate without this unit for a couple days, but failure will cause problems.
Replacement Difficulty	70	0.20	14.00	Equipment is obsolete and parts are expensive but are not difficult to replace.
Overall Facility Rating	-	**1.00**	**88.00**	

Firm Redundancy	
4 or more units	10
3 units	40
2 units	70
1 unit	100

Replacement Difficulty/Outage Duration	
Low	10
Moderate	40
Difficult/high	70
Very difficult/long term	100

Process and Capacity Impact	
Mild	10
Moderate	40
Severe	70
Inoperable/non-compliance	100

Criticality Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Stage 1 Trickling Filter   Last Rehabilitation: New distribution base, bearings, etc. installed 18 months ago.

Component Group	Component Criticality Rating	Weight Factor	Weighted Component Rating	Comments
Redundancy	100	0.20	20.00	Only one rock filter at plant.
Process and Capacity Impact	80	0.60	48.00	The plant can operate for a maximum of one week without this unit, but the permit will be impacted. If failure does occur, BOD loading on the second stage will be too high to properly regulate.
Replacement Difficulty	80	0.20	16.00	Equipment is heavy and difficult to remove. In the event of equipment movement, a crane must be rented. Diffuser ports are easy to work on.
Overall Facility Rating	-	**1.00**	**84.00**	

Firm Redundancy	
4 or more units	10
3 units	40
2 units	70
1 unit	100

Replacement Difficulty/Outage Duration	
Low	10
Moderate	40
Difficult/high	70
Very difficult/long term	100

Process and Capacity Impact	
Mild	10
Moderate	40
Severe	70
Inoperable/non-compliance	100

Criticality Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Intermediate Clarifier Last Rehabilitation: At least 3 years since last rehabilitation

Component Group	Component Criticality Rating	Weight Factor	Weighted Component Rating	Comments
Redundancy	100	0.20	20.00	System consists of one clarifier with a depth of 7 ft.
Process and Capacity Impact	60	0.60	36.00	No back-up unit is present. In event of failure, flow can go straight to Stage 2 trickling filter. Routine maintenace is easily provided due to the clarifier's low impact on the total plant process.
Replacement Difficulty	60	0.20	12.00	Equipment is obsolete and parts are expensive but are not difficult to replace.
Overall Facility Rating	-	**1.00**	**68.00**	

Firm Redundancy	
4 or more units	10
3 units	40
2 units	70
1 unit	100

Replacement Difficulty/Outage Duration	
Low	10
Moderate	40
Difficult/high	70
Very difficult/long term	100

Process and Capacity Impact	
Mild	10
Moderate	40
Severe	70
Inoperable/non-compliance	100

Criticality Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: 2nd Stage Pump Station   Last Rehabilitation: 1 pump is currently being replaced

Component Group	Component Criticality Rating	Weight Factor	Weighted Component Rating	Comments
Redundancy	60	0.20	12.00	System consists of 2 recirculation pumps and 3 lift pumps which send flow to the second stage trickling filters. 1 recirculation pump is alwas redundant. All 3 lift pumps are used during peak flow.
Process and Capacity Impact	60	0.60	36.00	Redundancy is decent, but if one pump is lost, the plant flow would have to be pinced. Process capacity would be impacted by losing either recirculation pumps or lift pumps.
Replacement Difficulty	80	0.20	16.00	Heavy equipment is needed for unit replacements, causing process impacts. Pumps are constant speed which impacts recirculation flows. A compressor is used for the bubbler system.
Overall Facility Rating	-	**1.00**	**64.00**	

Firm Redundancy	
4 or more units	10
3 units	40
2 units	70
1 unit	100

Replacement Difficulty/Outage Duration	
Low	10
Moderate	40
Difficult/high	70
Very difficult/long term	100

Process and Capacity Impact	
Mild	10
Moderate	40
Severe	70
Inoperable/non-compliance	100

Criticality Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: 2nd Stage Trickling Filters   Last Rehabilitation: 4 year ago (first time in a while)

Component Group	Component Criticality Rating	Weight Factor	Weighted Component Rating	Comments
Redundancy	70	0.20	14.00	System consists of 2 units, both with plastic media.
Process and Capacity Impact	70	0.60	42.00	The plant is able to operate hydraulically with only one unit, but the process would be greatly impacted. The splitter box from the trickling filters to the final clarifiers is missing proper grating and the outlets are stop logs.
Replacement Difficulty	80	0.20	16.00	Equipment is heavy and difficult to remove. In the event of equipment movement, a crane must be rented. Diffuser ports are easy to work on.
Overall Facility Rating	-	**1.00**	**72.00**	

Firm Redundancy	
4 or more units	10
3 units	40
2 units	70
1 unit	100

Replacement Difficulty/Outage Duration	
Low	10
Moderate	40
Difficult/high	70
Very difficult/long term	100

Process and Capacity Impact	
Mild	10
Moderate	40
Severe	70
Inoperable/non-compliance	100

Criticality Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Final Clarifiers   Last Rehabilitation: New drives were installed in 1995

Component Group	Component Criticality Rating	Weight Factor	Weighted Component Rating	Comments
Redundancy	70	0.20	14.00	System consists of 2 units. The unit installed in 1990 is 10 ft deep; the unit installed in 1970 is 7 ft deep.
Process and Capacity Impact	70	0.60	42.00	Units can be taken down for maintenance (and are), but not for an extended period of time. *2 blowers are present to aerate the centerwell, but do not seem to serve any particular purpose.
Replacement Difficulty	60	0.20	12.00	Equipment is obsolete and parts are expensive but are not difficult to replace.
Overall Facility Rating	-	**1.00**	**68.00**	

Firm Redundancy	
4 or more units	10
3 units	40
2 units	70
1 unit	100

Replacement Difficulty/Outage Duration	
Low	10
Moderate	40
Difficult/high	70
Very difficult/long term	100

Process and Capacity Impact	
Mild	10
Moderate	40
Severe	70
Inoperable/non-compliance	100

Criticality Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Chlorine Contact Basin   Last Rehabilitation: Converted back from UV in 2000

Component Group	Component Criticality Rating	Weight Factor	Weighted Component Rating	Comments
Redundancy	70	0.20	14.00	Junction box does not have control gates. System consists of 2 basins, each carry 50% of the flow. 20 minute capacity need to be checked.
Process and Capacity Impact	70	0.60	42.00	VIU's are always kept on the shelf because they have no redundancy and tend to go out often. Process impact of either basin failing would be 50%.
Replacement Difficulty	10	0.20	2.00	The plant water pump that runs the belt press has no back-up and failure would cause significant problems. Equipment is easy to replace.
Overall Facility Rating	-	**1.00**	**58.00**	

Firm Redundancy	
4 or more units	10
3 units	40
2 units	70
1 unit	100

Replacement Difficulty/Outage Duration	
Low	10
Moderate	40
Difficult/high	70
Very difficult/long term	100

Process and Capacity Impact	
Mild	10
Moderate	40
Severe	70
Inoperable/non-compliance	100

Criticality Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Cl2 and SO2 Building   Last Rehabilitation: 2000 when UV was replaced

Component Group	Component Criticality Rating	Weight Factor	Weighted Component Rating	Comments
Redundancy	0	0.20	0.00	100% back-up is present for chlorinators and sulfanators, with automatic switch-over in place. Safety shower and eyewash stations do not work.
Process and Capacity Impact	0	0.60	0.00	100% back-up.
Replacement Difficulty	0	0.20	0.00	All equipment is fairly new and is exercised frequently.
Overall Facility Rating	-	**1.00**	**0.00**	

Firm Redundancy	
4 or more units	10
3 units	40
2 units	70
1 unit	100

Replacement Difficulty/Outage Duration	
Low	10
Moderate	40
Difficult/high	70
Very difficult/long term	100

Process and Capacity Impact	
Mild	10
Moderate	40
Severe	70
Inoperable/non-compliance	100

Criticality Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Solids Building   Last Rehabilitation: 12 months ago

Component Group	Component Criticality Rating	Weight Factor	Weighted Component Rating	Comments
Redundancy	50	0.20	10.00	System includes 2 progressive cavity pumps for flow from primary clarifiers to digesters, with 100% back-up. 2 centrifugal pumps present for flow between the digesters and heat exchanger, also with 100% back-up. 1 chopper pump is present for recirculation of solids being held and no back-up is needed. ** 0 for sludge pumps and 100 for heat exchanger.
Process and Capacity Impact	50	0.60	30.00	System only contains one heat exchanger that has recently been rebuilt. There is no redundancy for this exchanger and huge problems would occur if it fails. If pumps go out, the process would be impacted, but redundancy is 100%. No ventilation is present in the building.
Replacement Difficulty	60	0.20	12.00	Tight spaces leave little room for replacement to occur. Equipment is heavy and requires a crane to move.
Overall Facility Rating	-	**1.00**	**52.00**	

Firm Redundancy	
4 or more units	10
3 units	40
2 units	70
1 unit	100

Replacement Difficulty/Outage Duration	
Low	10
Moderate	40
Difficult/high	70
Very difficult/long term	100

Process and Capacity Impact	
Mild	10
Moderate	40
Severe	70
Inoperable/non-compliance	100

Criticality Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: EQ Basin Blowers   Last Rehabilitation: 5 years ago

Component Group	Component Criticality Rating	Weight Factor	Weighted Component Rating	Comments
Redundancy	0	0.20	0.00	System consits of 3 blowers (positive displacement), but only one is needed. The room has no ventilation and equipment is extremely loud when in operation.
Process and Capacity Impact	0	0.60	0.00	No comments.
Replacement Difficulty	30	0.20	6.00	Adequated room for part maintenance. Part are heavy, and no crane is present.
Overall Facility Rating	-	**1.00**	**6.00**	

Firm Redundancy	
4 or more units	10
3 units	40
2 units	70
1 unit	100

Replacement Difficulty/Outage Duration	
Low	10
Moderate	40
Difficult/high	70
Very difficult/long term	100

Process and Capacity Impact	
Mild	10
Moderate	40
Severe	70
Inoperable/non-compliance	100

Criticality Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Digesters Last Rehabilitation: Unit was cleaned and inspected 1 month ago

Component Group	Component Criticality Rating	Weight Factor	Weighted Component Rating	Comments
Redundancy	20	0.20	4.00	System consists of 2 digesters and 4 mixers (2 for each digester). The process could be run with 1 unit, but more dewatering would likely be required.
Process and Capacity Impact	20	0.60	12.00	No comments.
Replacement Difficulty	20	0.20	4.00	Mixers are easy to work on from the top of the unit. Any work on the interior of the digesters would be very difficult.
Overall Facility Rating	-	**1.00**	**20.00**	

Firm Redundancy	
4 or more units	10
3 units	40
2 units	70
1 unit	100

Replacement Difficulty/Outage Duration	
Low	10
Moderate	40
Difficult/high	70
Very difficult/long term	100

Process and Capacity Impact	
Mild	10
Moderate	40
Severe	70
Inoperable/non-compliance	100

Criticality Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Equalization Basin   Last Rehabilitation: 1995

Component Group	Component Criticality Rating	Weight Factor	Weighted Component Rating	Comments
Redundancy	20	0.20	4.00	System is one basin in-line with the inflow to the plant. Not likely to loose this unit, but peak flow operation would be difficult without it.
Process and Capacity Impact	0	0.60	0.00	Impacts plant operation only during peak or excess flow events.
Replacement Difficulty	0	0.20	0.00	Diffusers are very easy to replace.
Overall Facility Rating	-	**1.00**	**4.00**	

Firm Redundancy	
4 or more units	10
3 units	40
2 units	70
1 unit	100

Replacement Difficulty/Outage Duration	
Low	10
Moderate	40
Difficult/high	70
Very difficult/long term	100

Process and Capacity Impact	
Mild	10
Moderate	40
Severe	70
Inoperable/non-compliance	100

Criticality Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Sludge Tank   Last Rehabilitation: 1 month ago

Component Group	Component Criticality Rating	Weight Factor	Weighted Component Rating	Comments
Redundancy	100	0.20	20.00	System only consists of one unit. Solids could be pulled directly from the digesters, but would be very difficult.
Process and Capacity Impact	100	0.60	60.00	No back-up is present. If unit went down, no dewatering would take place. Unit occasionally fills over the top.
Replacement Difficulty	0	0.20	0.00	Does not contain many parts needing replacement.
Overall Facility Rating	-	**1.00**	**80.00**	

Firm Redundancy	
4 or more units	10
3 units	40
2 units	70
1 unit	100

Replacement Difficulty/Outage Duration	
Low	10
Moderate	40
Difficult/high	70
Very difficult/long term	100

Process and Capacity Impact	
Mild	10
Moderate	40
Severe	70
Inoperable/non-compliance	100

Criticality Assessment

Inspection Date: 5/27/2010

Facility Information:

Unit Process: Non-Process

Facility*	Notes
Maintenance/Admin Building	
Roads	Entrance road is in poor condition.
Lights	
Power	
Levee	

*Complete evaluations of these facilities were not performed during the condition assessment, but their presence and general conditions were noted.

*Electrical conductors should be tested to check degradation of insulation.

*Incoming service was installed in '95. Most conductors should be in good condition but a megger testing would show a more detailed analysis.

*Few area lights need new lamps. Some fixtures with photocells have had problems with the photocells.

*125 kW generator being exercised weekly - No apparent known problems.

*Main plant switch board shall be monitored for mud dauber nests and cleaned of foreign debris to improve proper operation when required. Mud from nests in circuit breaker components will hamper operations causing destructive damage when required.

Appendix C:
King's Creek WWTP Treatment Evaluation

Innovative approaches
Practical results
Outstanding service

Regional Wastewater Treatment Study

Process Evaluation

Prepared for:

City of Terrell

Prepared by:

FREESE AND NICHOLS, INC.
4055 International Plaza, Suite 200
Fort Worth, Texas 76109
817-735-7300

TER10191

Innovative approaches
Practical results
Outstanding service

Regional Wastewater Treatment Study

DRAFT – Process Evaluation Interim Report

Prepared for:

City of Terrell

Prepared by:

FREESE AND NICHOLS, INC.
4055 International Plaza, Suite 200
Fort Worth, Texas 76109
817-735-7300

TER10191

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDIX

EXECUTIVE SUMMARY

As part of the Regional Wastewater Treatment Study commissioned by the Texas Water Development Board for the City of Terrell and the participating surrounding entities in Spring 2010, a process evaluation of the existing King's Creek Wastewater Treatment Plant (WWTP) was performed. The combination of the condition assessment presented in the first chapter of this study and evaluation of the process capabilities will give the City of Terrell and the other participating entities an estimate on the life expectancy of existing infrastructure and its performance capabilities at increasing flow rates.

A process model was developed for the King's Creek WWTP to evaluate the treatment capacity of the facility. The model was developed in BioWin, a propriety software package developed for advanced process modeling and simulation. To accurately predict performance of the facility, calibration to field sampling data was used to assure that existing performance is matching the simulated performance. Validation of the model to historic data was also completed to further test the robustness of the model predictions. After matching the simulated results at current conditions with the observed field results, projections of future performance can be made.

Model simulations indicated that ammonia removal capacity would control the overall functional capacity of the King's Creek WWTP. The simulated effluent ammonia concentration, based on the average loading conditions, is shown in Figure ES-1 for increasing flow rates. The cold weather treatment capacity of the existing unit processes at the King's Creek WWTP is 2.1 MGD. The warm weather treatment capacity is 2.4 MGD. Peak flow performance from a process performance analysis indicate that the peak flow of 9 MGD could be treated to permit levels in cold and warm weather; however, the current reported maximum flow from a hydraulic treatment standpoint is 6 MGD. Evaluation of the available storage volume indicates that at a peak inflow of 9 MGD, while treating 6 MGD through the WWTP, 7 hours of storage would be available.

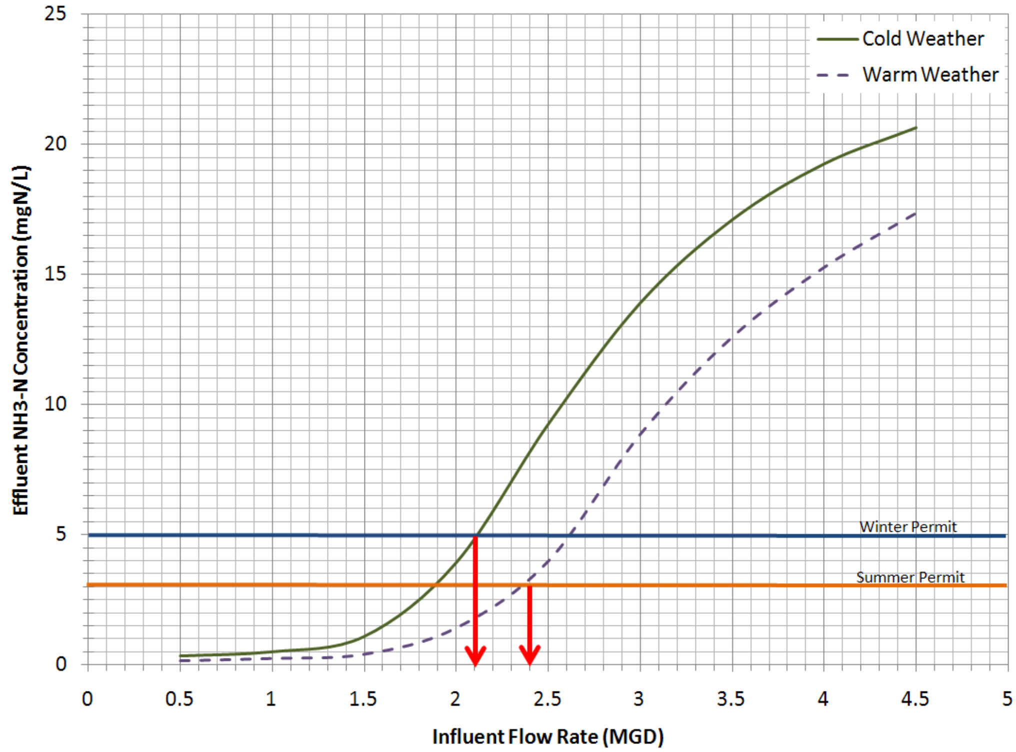


Figure ES-1 Simulated effluent ammonia concentration

A percent occurrence evaluation was also completed to determine the percent of time the King's Creek WWTP would be expected to exceed the cold and warm weather permitted effluent ammonia values. Based on this percent exceeding analysis, the probability of the effluent ammonia concentration exceeding the permitted 30-day average effluent ammonia concentration for both cold and warm weather conditions was determined, and is summarized in Table ES-1. Currently, the facility exceeds the permitted effluent ammonia 19% of the time in cold weather 11% of the time in warm weather conditions, at an average flow of 1.8 MGD. At a flow rate of 2 MGD, the King's Creek WWTP can be expected to exceed permitted effluent ammonia concentrations 33% of the time in cold weather, and 23% of the time in warm weather. At a flow rate of 3 MGD, the King's Creek WWTP can be expected to exceed permitted effluent ammonia concentrations 74% of the time in cold weather, and 65% of the time in warm weather.

Table ES-1 Probability of exceeding permitted effluent ammonia concentration

Flow Rate (MGD)	Percent of Days Exceeding Permit	
-	Cold Weather	Warm Weather
1.8*	20%	15%
2	33%	23%
3	74%	65%
4	89%	86%
4.5	91%	94%

*based on past 3 years of operating data

The next steps in the regional wastewater treatment study will be to compare the projected flow rates for the City of Terrell and its surrounding entities and determine when the treatment capacity will be reached. Evaluation of modifying the existing King's Creek WWTP, constructing a new WWTP for the City of Terrell, or constructing a regional WWTP will be completed to determine the path forward for wastewater treatment in the City of Terrell.

1.0 INTRODUCTION

A Regional Wastewater Treatment Study was commissioned by the Texas Water Development Board for the City of Terrell and the participating surrounding entities in Spring 2010. The first portion of this study assessed the mechanical, structural, and operational condition of the existing King's Creek Wastewater Treatment Plant (WWTP), located in the City of Terrell. In addition to the condition of the existing facility, the process performance capabilities of the WWTP need to be determined. This portion of the study looks to address the current process capabilities of the King's Creek WWTP, which will be used to determine the required modifications to meet future flows and treatment criteria. The combination of the condition assessment and process capabilities will give the City of Terrell and the other participating entities an estimate on the life expectancy of their infrastructure and their performance capabilities at increasing flow rates.

Evaluation of the process capabilities of the King's Creek WWTP was completed using BioWin computer software, a proprietary software package developed by Envirosim. BioWin is a fundamental model that dynamically simulates the complex microbial and chemical reactions occurring in a wastewater treatment facility. Calibration and validation of the model to existing conditions was completed, and then performance projections at increasing flows were evaluated.

The current process performance and projected process performance was compared to the existing Texas Pollutant Discharge Eliminate System (TPDES) permit for ammonia, carbonaceous biochemical oxygen demand (cBOD), and total suspended solids (TSS). Permitted effluent values are shown in Table 1. Simulated values will be compared to the permitted 30-day average effluent value, as this should represent the stable operation condition for the King's Creek WWTP. The 7-day average and daily maximum values are important parameters for peak flow and upset conditions, but the process performance should be designed to meet the 30-day average value. Throughout this report, the time period from May through September will be referred to as warm weather, and October through April will be referred to as cold weather.

Table 1 TPDES permitted effluent values

Parameter	30-Day Average		7-Day Average	Daily Maximum
	mg/l	lbs/day	mg/l	mg/l
$CBOD_5$				
May - September	7	263	12	22
October - April	10	375	15	25
TSS	15	563	25	40
NH_3-N				
May - September	3	113	6	10
October - April	5	188	7	10
Aluminum (Total)	0.834	31	N/A	1.766
Copper (Total)	Report	Report	N/A	Report
Silver (Total)	0.0073	0.26	N/A	0.0155

2.0 MODEL CALIBRATION

A process model was developed for the King's Creek WWTP to evaluate the treatment capacity of the facility. The model was developed in BioWin. To accurately predict performance of the facility, calibration to field sampling data was used to assure that existing performance is matching the simulated performance. Validation of the model to historic data was also completed to further test the robustness of the model predictions. After matching the simulated results at current conditions with the observed field results, projections of future performance was made.

2.1 MODEL DEVELOPMENT

The screen image of the developed BioWin model is shown in Figure 1, with the details of the model summarized in Appendix A. The model was developed based on record drawings, recycle pumping rates data, and the staff's operational strategies. Recycle flow rates were based on the secondary pump station pumps capabilities. Humus return was based on gravity flow from the final clarifiers. Primary clarifier performance (cBOD and TSS removal) was based on field performance testing.

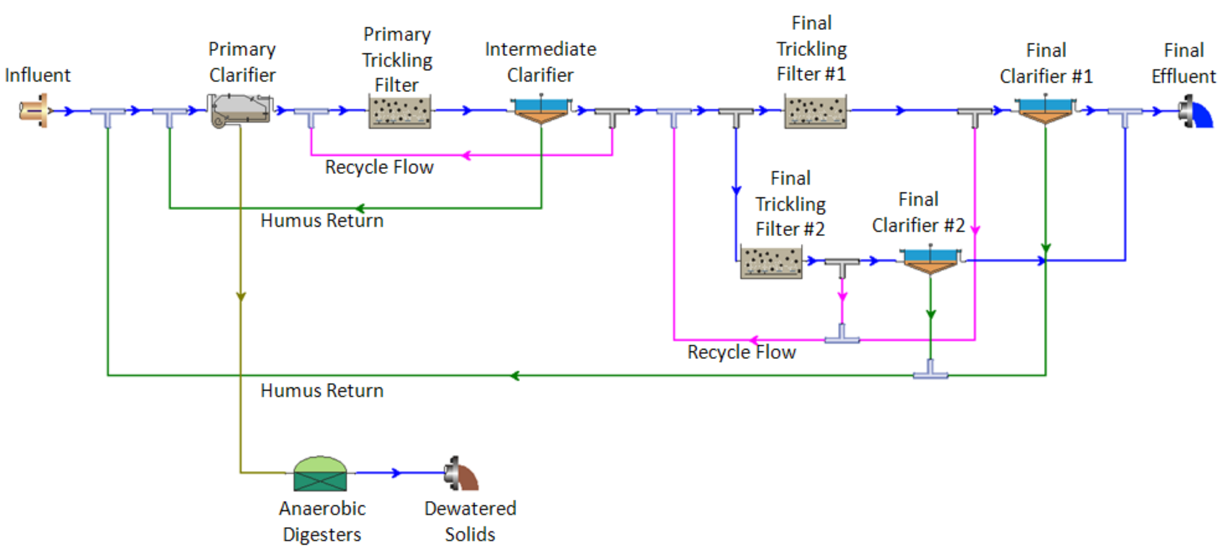


Figure 1 Screen image of BioWin process model

2.2 CALIBRATION – UNIT PROCESS TESTING

During May and June of 2010, three separate sampling events were completed where effluent samples were collected from the primary clarifier (PC), primary trickling filter (PTF), intermediate clarifier (IC), the final trickling filters (FTFs), the final clarifiers (FCs), and the final effluent. The raw influent was also sampled on the three sampling events. The average influent concentrations during these sampling events were 100 mg/L cBOD, 120 mg/L TSS, and 20 mgN/L ammonia. The average flow rate was 1.6 MGD. The average of the three sampling events was used to calibrate the process model.

Calibration of the model was made by adjusting the following parameters:

- Oxygen transfer rate to the trickling filters
- cBOD and TSS removal in the primary clarifier
- Surface area of the rock surface in the primary trickling filter

The surface area of the rock surface in the primary trickling filter was based on typical design standards for rock trickling filters (WEF Manual of Practice No. 8). The impact of the biofilm liquid diffusion layer thickness, recycle flow rates, and humus wasting rate was also examined, but the simulated results were not sensitive to these parameters. The remaining kinetic, stoichiometric, settling, biofilm, and influent parameters were set at the program default values. The calibrated ammonia and cBOD concentrations are shown in Figure 2 and Figure 3, respectively. The errors bars on the measured values indicate the standard deviation of the three separate field sampling results. All simulated values fall within the error of the individual sampling points.

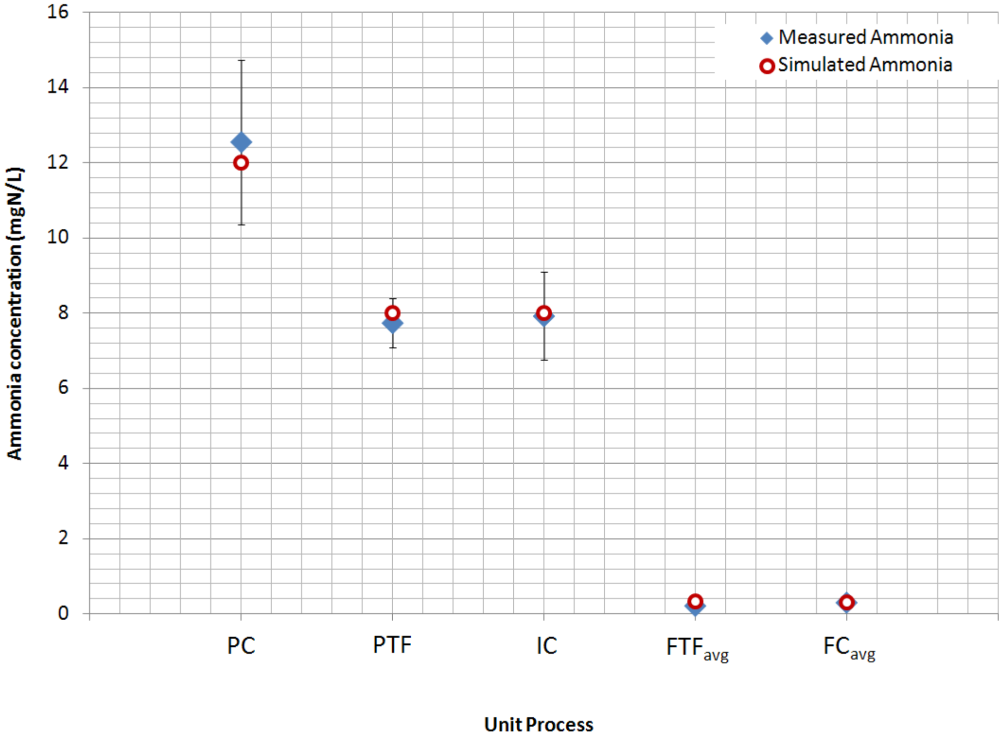


Figure 2 Calibrated ammonia concentrations

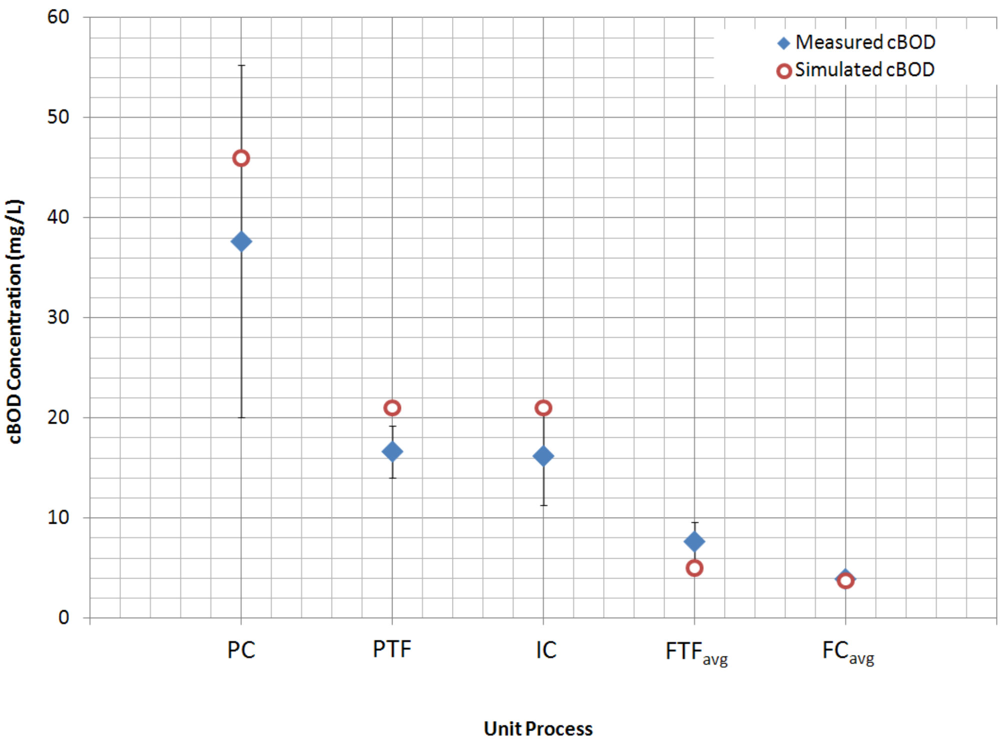


Figure 3 Calibrated cBOD concentrations

2.3 VALIDATION – HISTORIC DATA

After calibrating the process model to individual sampling events, it is important to validate the simulation results to historical performance data. Three years of data was provided by the King's Creek WWTP staff, which included influent and effluent data. The average influent flow rate is recorded daily, and the average flow rate has been 1.81 MGD over the past 3 years. Over the three year period, 43 influent samples were available and 242 effluent samples were available. Based on the 43 influent samples available, the average influent ammonia concentration was 23+/-9.9 mgN/L and the average influent $cBOD_5$ was 130+/-30mg/L. The effluent ammonia, cBOD, and TSS varied based on influent flow rate, concentrations, and temperature.

The error in the influent sampling is significant, and many of the influent sampling dates do not correspond to dates when effluent sampling was completed. To account for the error and the lack of correlation between influent and effluent sampling dates, validation was based on a percent occurrence analysis. The influent ammonia was the focus of the percent occurrence evaluation, as it had a large relative error (approximately 50%) and is the most sensitive constituent. The validation was based on simulating a range of influent ammonia concentrations, which were tied to the percent of time that the given influent concentration has historically occurred. The historic occurrence of influent ammonia concentrations is shown in Table 2. This data is read as a percent of time exceeding, i.e. if a given ammonia concentration corresponds to a 25% value, it would mean that 25% of the time this ammonia concentration is exceeded in the influent. For each influent concentration, a simulated effluent ammonia concentration is determined. The simulated effluent ammonia concentration for each influent ammonia condition was then tied to the same percent occurrence. In this way, the simulated effluent ammonia concentration percent occurrence was determined, and could be compared to the historical percent occurrence of effluent ammonia concentrations. During the percent occurrence evaluation, the influent flow rate and influent cBOD concentrations were held at 1.8 MGD and 130 mg/L, respectively, as the influent ammonia was varied. Wastewater temperature was simulated at the typical cold weather temperature of 13^{o}C (55^{o}F) and the typical warm weather temperature of 26°C (79°F). These temperatures were based on the historic data provided by the city of Terrell.

Table 2 Influent ammonia historic percent occurrence

Ammonia (mgN/L)	Percent Exceeding
0	100%
10	88%
15	77%
20	56%
25	35%
30	28%
35	9%
45	0%

The results of validation using this percent occurrence evaluation are shown in Figure 4 and Figure 5 for cold and warm weather conditions, respectively. Both cold weather and warm weather simulated results matched well with the measured results. Measured and simulated effluent ammonia concentrations were within 15% of each other for all simulated values, and typically within 5%. The least squares method was used to measure the error. The resulting sum of the squares was 0.06, well below the 1.0 threshold for being a good fit. An exact match should not be anticipated, as the influent flow rate and temperature for measured effluent ammonia concentration may be different from the 1.8 MGD flow rate and the 13°C or 26°C temperature used for simulation. Both cold weather and warm weather simulated results matched well with the measured results. Of important note is that over the last 3 years, cold weather effluent ammonia concentrations have exceeded the permitted 5 mgN/L 30-day average discharge concentration 20% of the cold weather months. During warm weather conditions, effluent ammonia concentrations have exceeded the permitted 3 mgN/L 30-day average discharge concentration 15% of the warm weather months.

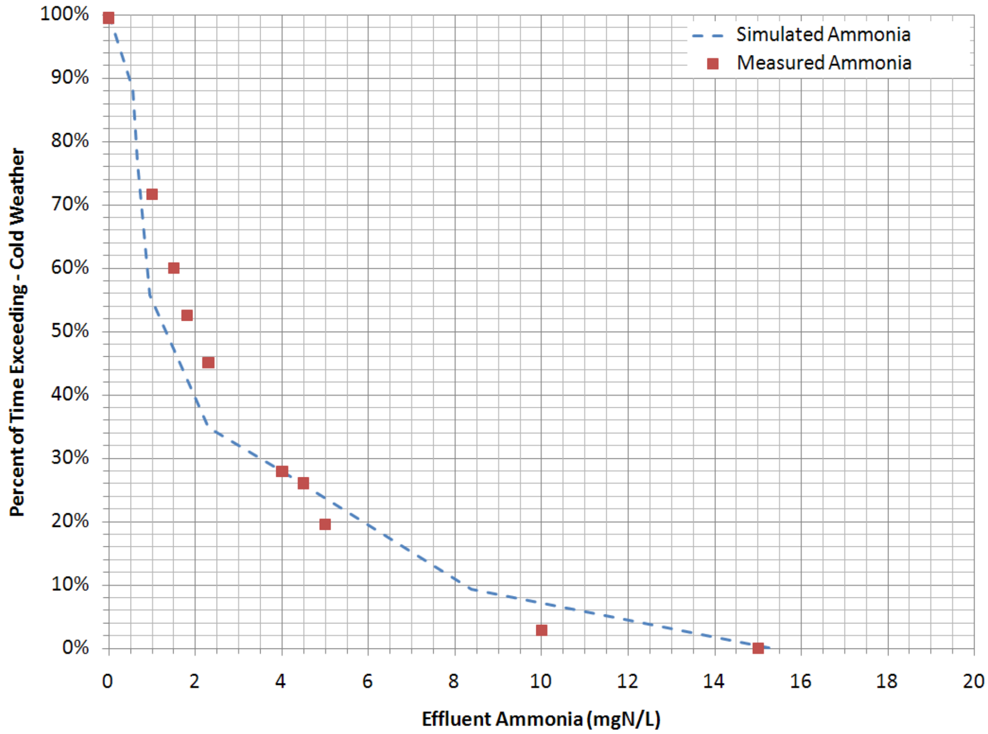


Figure 4 Cold weather percent occurrence validation

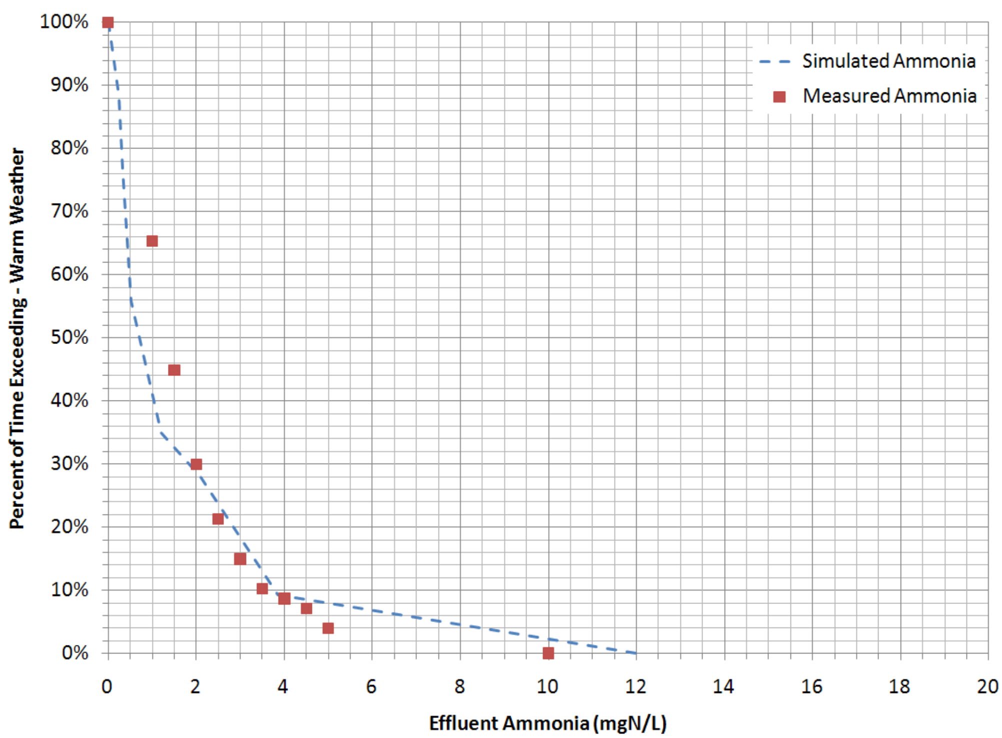


Figure 5 Warm weather percent occurrence validation

2.4 CALIBRATION AND VALIDATION CONCLUSIONS

Calibration and validation of the BioWin process model produced a simulation tool that accurately models the current process performance of the King's Creek WWTP. Field sampling to assess the performance of the individual unit processes was completed in May and June of 2010, and the BioWin model predicted the performance of each unit process at the given flow and concentration conditions within the anticipated level of error. The model simulated the final effluent ammonia concentration accurately for both cold and warm weather conditions, as compared to 3 years of historic data.

3.0 EXISTING UNIT PROCESS EVALUATION

Process evaluation for the King's Creek WWTP consisted of three aspects:

- Process capabilities at increasing flow rates to meet TPDES monthly average discharge concentrations
- Percent occurrence analysis
- Peak storage available for existing peak storage basin

The process capabilities and solids production were evaluated using the calibrated and validated BioWin model. Peak storage volume was evaluated using peak flow rate conditions.

3.1 PROCESS PERFORMANCE EVALUATION

3.1.1 Average Influent Conditions

The first process evaluation completed was based on average influent conditions for cold and warm weather temperatures. Over the 3 year period of data provided, the average influent conditions were:

- Influent ammonia: 23 mgN/L
- Influent cBOD: 130 mg/L
- Influent TSS: 160 mg/L

These are relatively low influent cBOD and TSS concentrations. Typical wastewater has approximately 200 mg/L cBOD and TSS in the influent, but the influent concentrations are still within the normally expected range. The influent ammonia is near the typical wastewater concentration of 25 mgN/L. The influent Total Kjeldahl Nitrogen (TKN) was assumed to be 1.4 times the influent ammonia concentration, which is a standard ratio (WEF Manual of Practice No. 8). Using these average values, performance was simulated for flow rates ranging from 0.5 to 4.5 MGD, which is the currently permitted average annual day flow. Simulations were completed under cold weather (13^{o}C) and warm weather (26^{o}C) conditions.

The simulated effluent ammonia concentrations are shown in Figure 6. Based on simulations, the average effluent ammonia concentration would exceed the cold weather conditions permitted 30-day average effluent ammonia concentration of 5 mgN/L at an influent flow rate of 2.1 MGD. The warm weather permitted 30-day average effluent ammonia concentration of 3 mgN/L would be exceeded at 2.4 MGD.

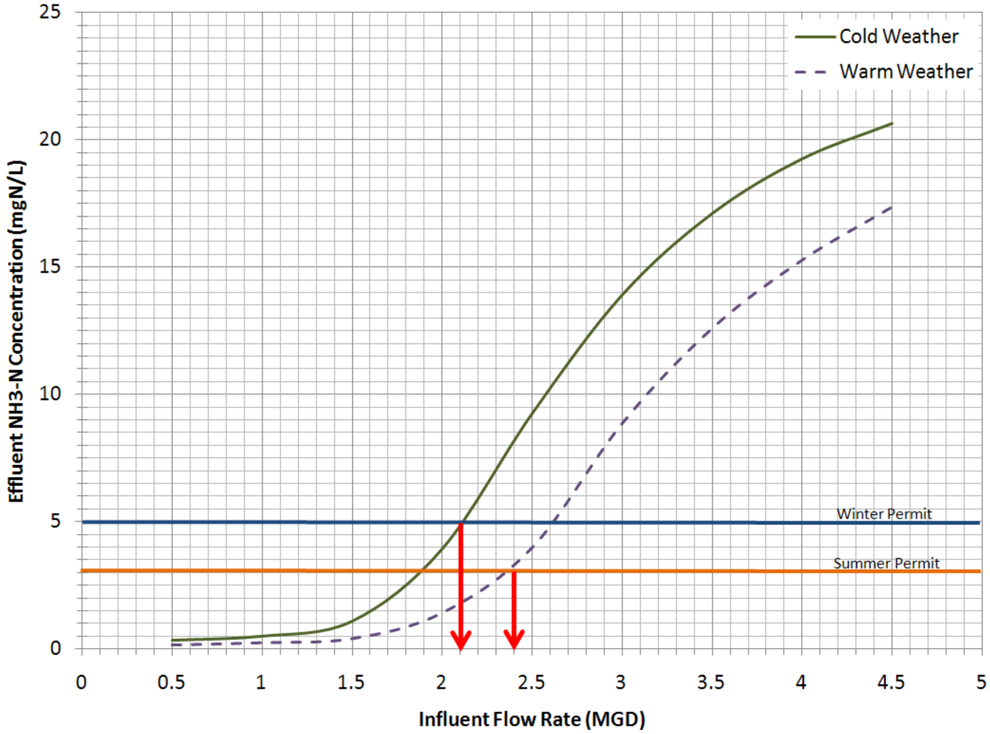


Figure 6 Simulated effluent ammonia concentration

The simulated effluent cBOD concentrations are shown in Figure 7. Based on simulations, the average effluent cBOD concentration would exceed the cold weather conditions permitted 30-day average effluent cBOD concentration of 10 mg/L at an influent flow rate of 4.4 MGD. The warm weather permitted 30-day average effluent ammonia concentration of 7 mgN/L would be exceeded at 3 MGD.

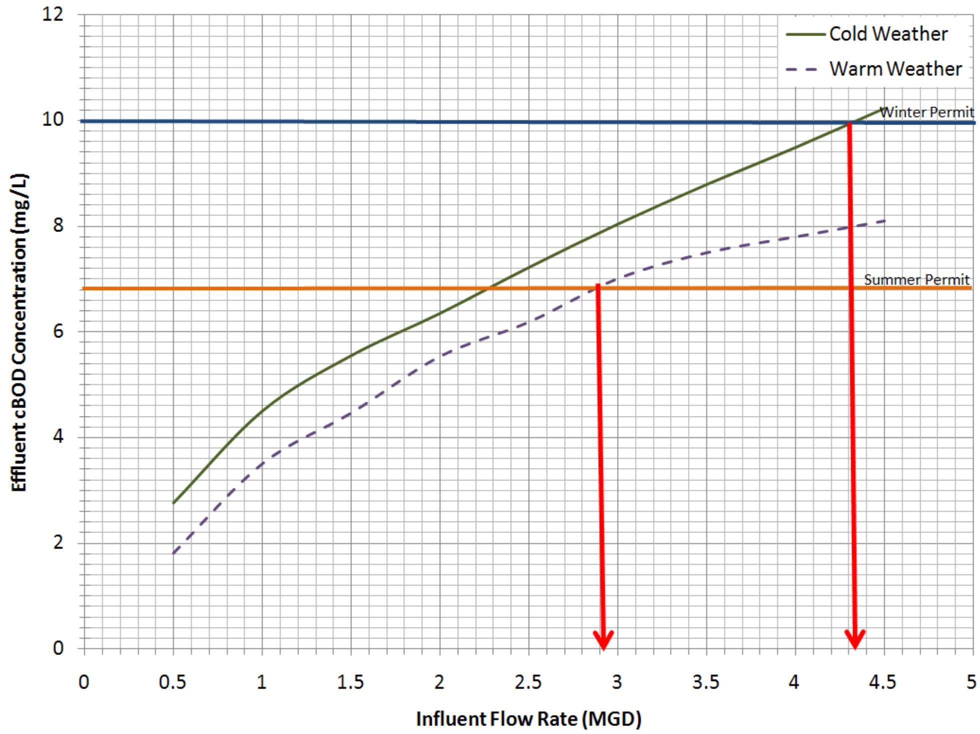


Figure 7 Simulated effluent cBOD concentration

The effluent TSS concentration is mainly a function of the complex hydraulics of the final clarifiers. Simulations results indicated that effluent TSS would remain below 10 mg/L at flow rates up to 4.5 MGD. However, this is highly dependent on the humus blanket thickness in the final clarifiers, solids accumulation in the final clarifier effluent troughs, and the final clarifier influent hydraulics. While it is likely that final clarifier capacity would be sufficient for the final trickling filters at an influent flow of 4.5 MGD, stress testing of the clarifiers would be needed to develop an absolute capacity.

3.1.2 Percent Occurrence Evaluation

A percent occurrence evaluation was completed for future performance, similar to the validation percent occurrence evaluation. The influent ammonia concentration occurrence for the provided influent data is shown in Table 2. Using this data, the effluent ammonia concentration was simulated for influent flow rates of 2, 3, 4, and 4.5 MGD for both cold and warm weather conditions. Influent cBOD and TSS were held at 130 and 160 mg/L, respectively. The simulated effluent ammonia concentrations for cold weather and warm weather are shown in Figure 8 and Figure 9. The data shown for 1.8 MGD in both figures represents the historic performance of King's Creek WWTP.

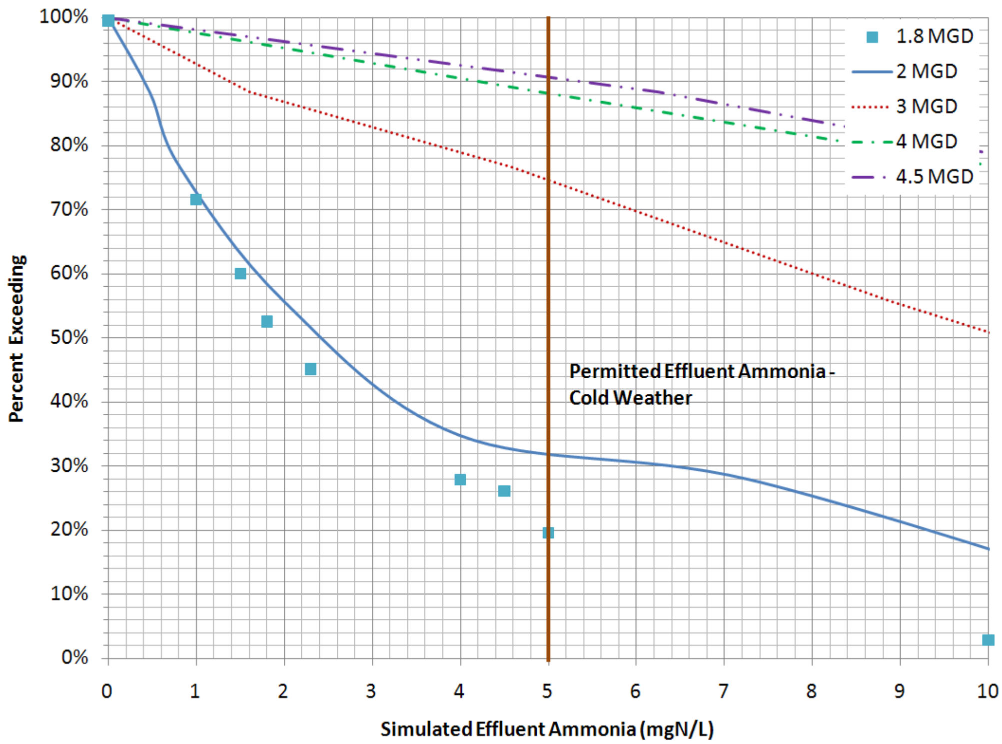


Figure 8 Cold weather - simulated percent of time exceeding current 30-day monthly average ammonia concentration

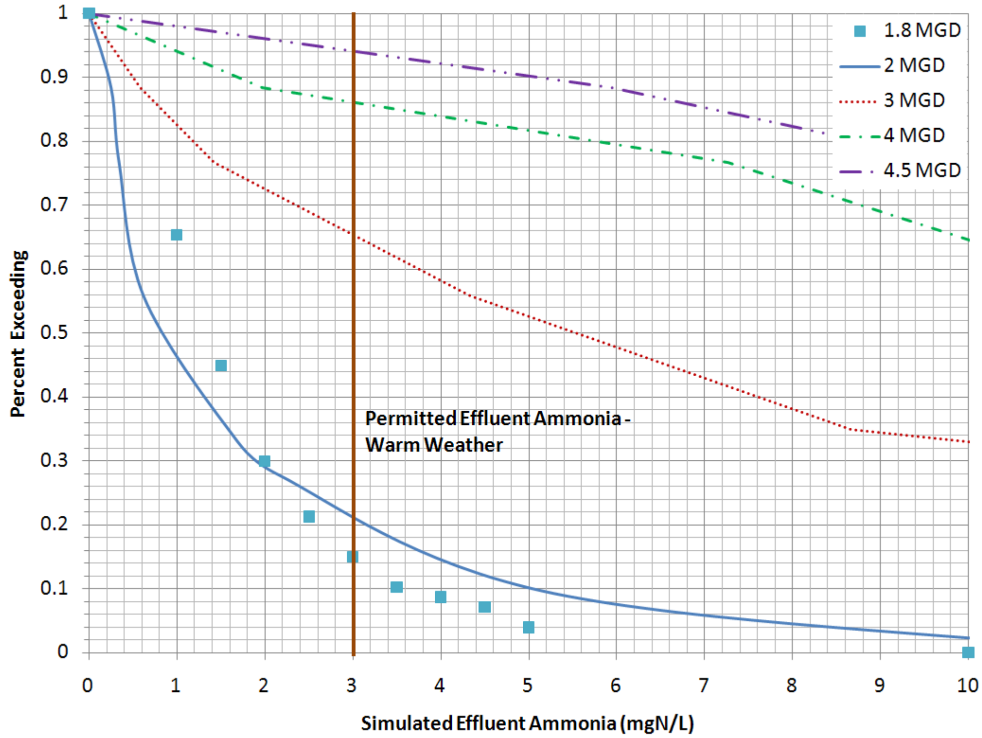


Figure 9 Warm weather - simulated percent of time exceeding current 30-day monthly average ammonia concentration

Based on this percent exceeding analysis, the probability of the effluent ammonia concentration exceeding the permitted 30-day average effluent ammonia concentration for both cold and warm weather conditions was determined, and is summarized in Table 3. At a flow rate of 2 MGD, the effluent would be expected to exceed the cold weather permit 33% of the time, and exceed the warm weather permit 23% of the time. At a flow rate of 3 MGD, the percent exceeding would increase to 74% of the time in the winter and 65% of time in the summer.

Table 3 Probability of exceeding permitted effluent ammonia concentration

Flow Rate (MGD)	Percent of Days Exceeding Permit	
-	Cold Weather	Warm Weather
1.8*	20%	15%
2	33%	23%
3	74%	65%
4	89%	86%
4.5	91%	94%

*based on historic performance data

3.1.3 Phosphorus Removal

Phosphorus is likely to be included in future TPDES permits for the King's Creek WWTP. Simulations were run with an influent phosphorus concentration of 6 mgP/L, which is a typical influent wastewater concentration. The simulation results are shown in Figure 10. Some phosphorus removal is anticipated in any biological process, as microbial biomass contains 2 to 3% phosphorus as a percent of its total mass. The more microbial activity that is occurring, the more biomass production occurs and the more phosphorus uptake occurs. This is why a dip in phosphorus removal occurs between 1.5 and 2 MGD. This flow rate represents the peak activity of both heterotrophs and nitrifiers, resulting in increased phosphorus uptake. As the nitrifier activity declines at approximately 2 MGD, only the heterophic biomass is taking up phosphorus. The rate of heterotrophic biomass production continues to increase as flows increase, which is why effluent phosphorus continues to decrease above 2 MGD. To meet typical effluent phosphorus permit concentrations (0.5 to 1 mgP/L), enhanced biological phosphorus removal (EBPR) or chemical phosphorus removal is required. Trickling filters do not provide the environmental oxidation-reduction potential (ORP) conditions to select for the needed microbial ecology to achieve EBPR. Therefore, without conversion to an activated sludge system, the King's Creek WWTP would currently need to rely on chemical phosphorus removal to meet future permit levels.

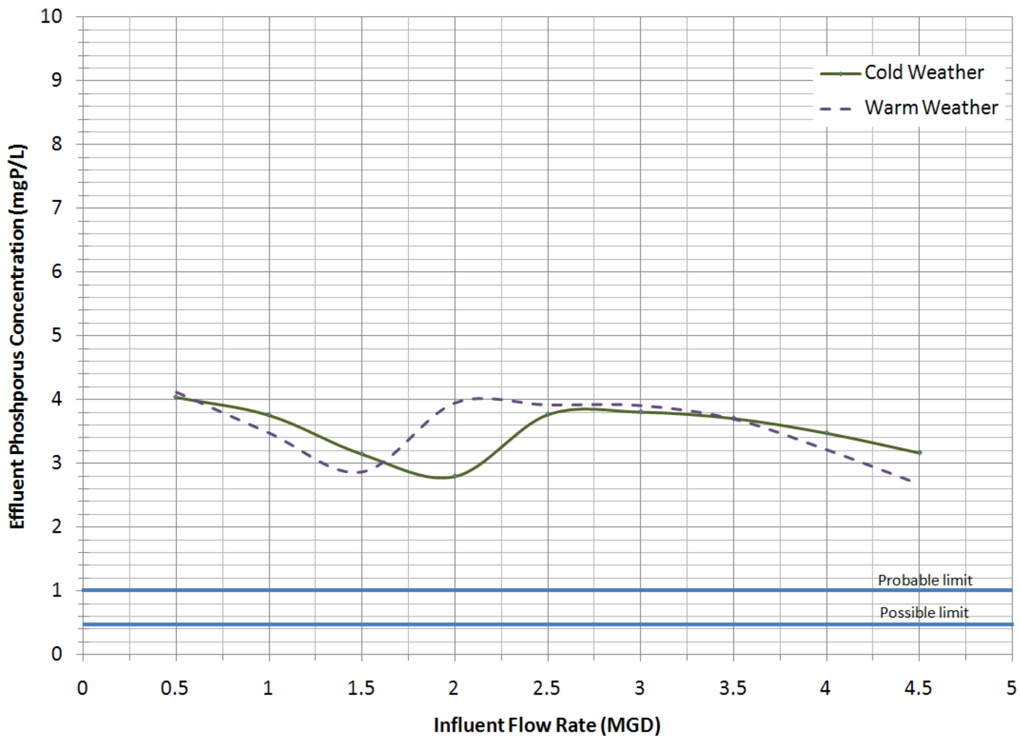


Figure 10 Simulated effluent phosphorus concentration

3.1.4 Nitrite Production

Nitrite is an intermediate product of nitrification, or the oxidation of ammonia. Ammonia is first nitrified to nitrite, and then nitrite is oxidized to nitrate. Nitrite can accumulate under low oxygen conditions or during insufficient reaction time. Nitrite accumulation does not directly impact the permitted performance of a facility, unless a total nitrogen permit is included. King's Creek WWTP is not likely to have a total nitrogen permit in the next two to three permit cycles. However, nitrite reacts with chlorine, and the presence of nitrite can significantly increase the required chlorine dosage to meet disinfection requirements. For every pound of nitrite, five pound of chlorine is consumed without having the desired disinfection impact. The simulated nitrite concentration is shown in Figure 11. Nitrite accumulation will be significant at flow rates between 1.75 and 3 MGD. As the average annual day flow increases to 2 MGD, increased nitrite accumulation is likely, resulting in increased chlorine demand. No current sampling of nitrite is available for cold weather, but sampling will be conducted in the winter of 2010/2011 to verify this nitrite production. Typical performance should not result in measureable nitrite in the effluent. Increased reaction time, increased oxygen supply, increased biomass inventory, or a combination of the three is the typically actions that can be taken to prevent nitrite accumulation. Oxygen supply and biomass inventory can be adjusted in activated sludge systems, but these parameters are very difficult to control in trickling filter systems.

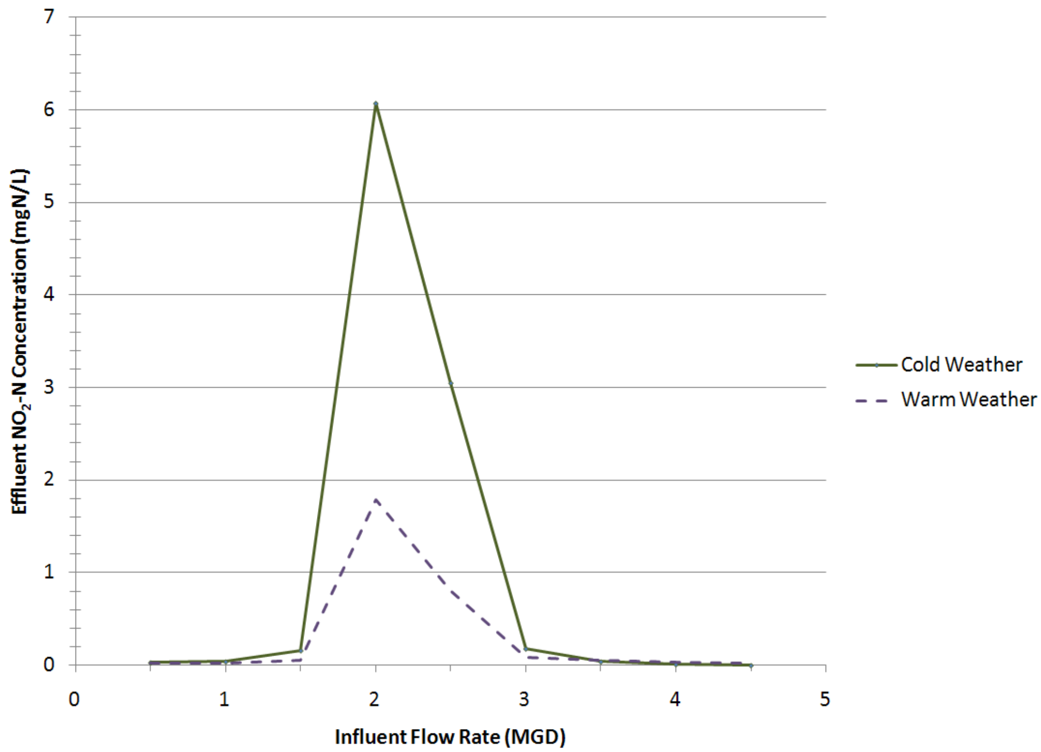


Figure 11 Simulated nitrite production

3.2 PEAK FLOW EVALUATION

3.2.1 Peak Flow Process Performance

During peak flow conditions, the process performance is typically not the limiting condition due to the significantly decreased influent cBOD and ammonia concentrations. Hydraulic functionality and solids washout are typically the limiting parameters. Simulating the peak flow process performance was completed using influent concentrations of 50 mg/L cBOD, 8 mgN/L ammonia, and 50 mg/L TSS, which are historic peak flow concentrations. The simulated effluent ammonia and cBOD concentrations during peak flow conditions are shown in Figure 12 and Figure 13, respectively. Based on these results, the King's Creek WWTP should be capable of meeting permitted effluent concentrations during peak flows up to 10 MGD. However, the plant has been reported to have a hydraulic capacity of 6 MGD.

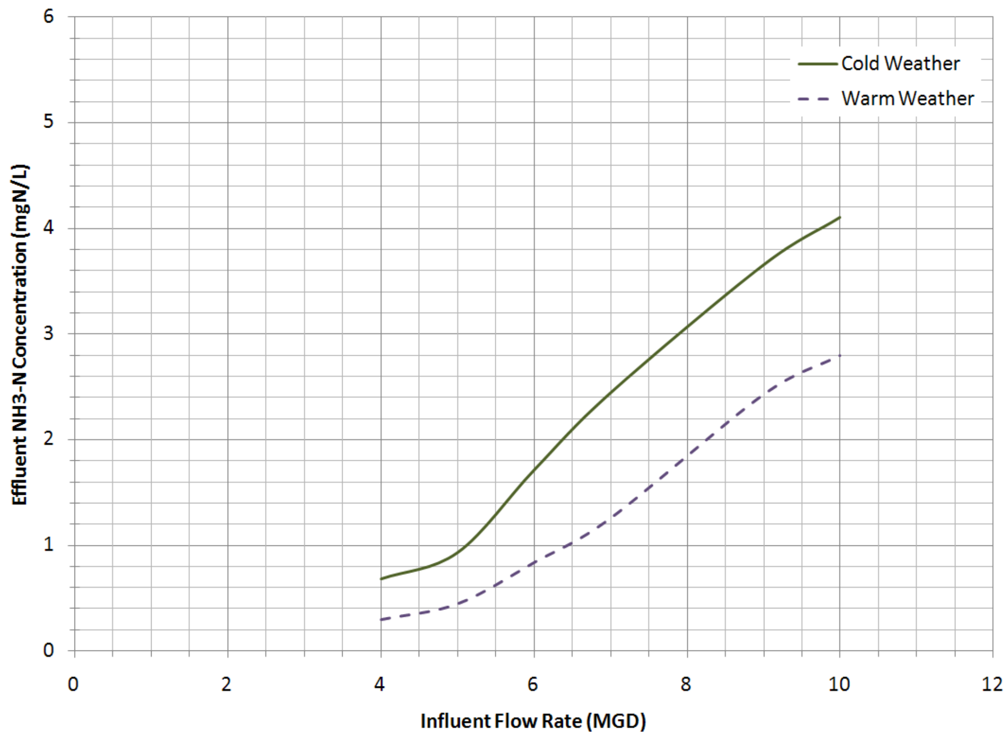


Figure 12 Simulated peak flow response of effluent ammonia concentration

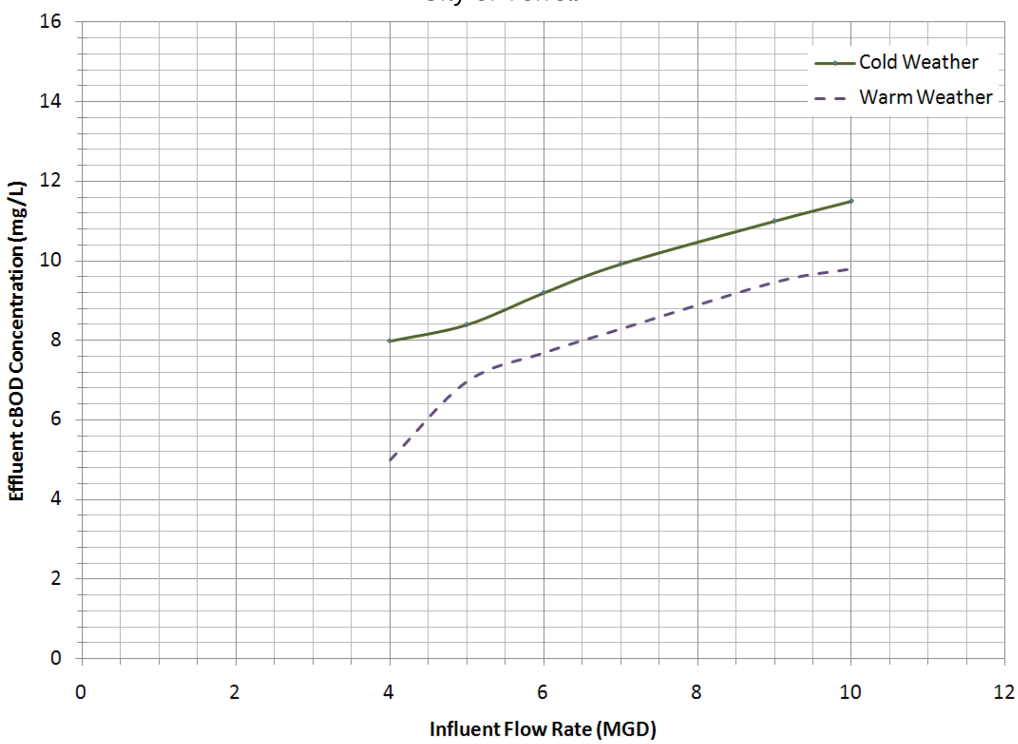


Figure 13 Simulated peak flow response of effluent cBOD concentration

3.2.2 Peak Flow Storage

The peak flow equalization basin can be used to equalize the influent flow to the King's Creek WWTP. For the storage analysis, it was assumed that the maximum flow that would be treated by the facility would be 6 MGD. The flow above this value would need to be stored. Using storage volume calculated from the King's Creek WWTP record drawings, the time to fill the equalization basin was calculated for four fill heights: 0.5 feet of freeboard for the concrete basin, and 1, 5, and 10 feet above the concrete basin on the sloped grass area. Storage times are shown in Figure 14. At the current rated peak flow rate of 9 MGD, approximately 7 hours of storage would exist at a 0.5 foot freeboard elevation. Calculations are shown in Appendix B.

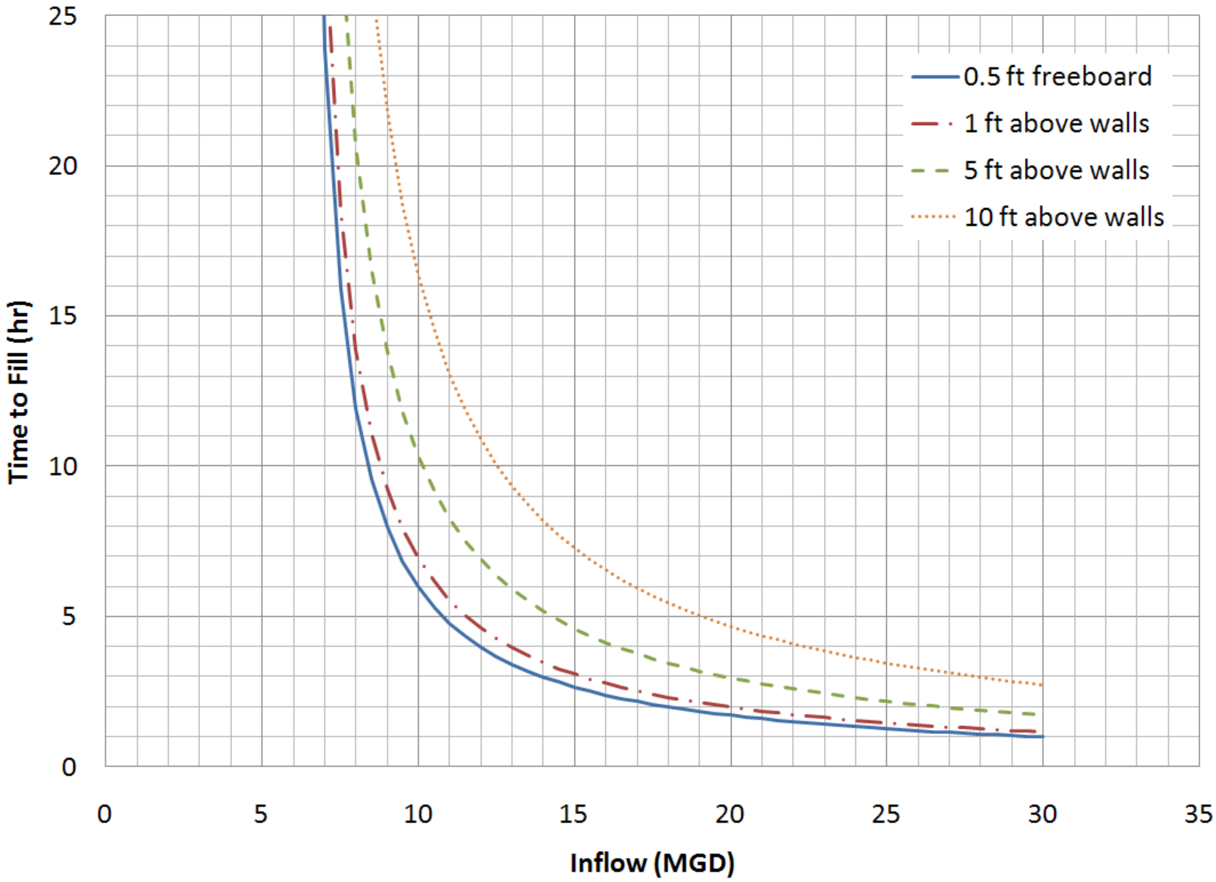


Figure 14 Storage time for the equalization basin with varying fill heights

4.0 CONCLUSIONS

The process performance evaluation was completed using BioWin modeling software. Calibration of the model to performance testing data and validation to historic performance data was completed to match simulated performance data to the current performance of the King's Creek WWTP. After calibration and validation, projected performance at increasing flow rates was simulated.

Based on the average loading conditions, the cold weather treatment capacity of the existing unit processes at the King's Creek WWTP is 2.1 MGD. The warm weather treatment capacity is 2.4 MGD. Peak flow performance from a process performance analysis indicated that the permitted peak flow of 9 MGD could be treated to permit levels in cold and warm weather; however, the current reported maximum flow from a hydraulic treatment standpoint is 6 MGD. Evaluation of the available storage volume indicates that 7 hours of storage would be available at a peak flow of 9 MGD, while treating 6 MGD in the WWTP.

A percent occurrence evaluation was completed to determine the percent of time the King's Creek WWTP would be expected to exceed the cold and warm weather permitted effluent ammonia values. Currently, the facility exceeds the permitted effluent ammonia 20% of the time in cold weather 15% of the time in warm weather conditions, at an average flow of 1.8 MGD. At a flow rate of 2 MGD, the King's Creek WWTP can be expected to exceed permitted effluent ammonia concentrations 33% of the time in cold weather, and 23% of the time in warm weather. At a flow rate of 3 MGD, the King's Creek WWTP can be expected to exceed permitted effluent ammonia concentrations 74% of the time in cold weather, and 65% of the time in warm weather.

The next steps in the regional wastewater treatment study will be to compare the projected flow rates for the City of Terrell and its surrounding entities to the King's Creek Performance capacity and determine when the treatment capacity will be reached. Evaluation of modifying the existing King's Creek WWTP, constructing a new WWTP for the City of Terrell, or joining a regional WWTP will be completed to determine the path forward for wastewater treatment in the City of Terrell and surrounding entities.

Appendix A

BioWin Model

A.1 UNIT PROCESS VOLUMES AND AREAS

Unit process volumes and areas were provided by the City of Terrell, and are shown in Figure A.1.

Figure A.1 Unit process information provided by the City of Terrell

	Design Conditions: Average	Maximum Month	Peak Flow
WASTEWATER CHARACTERISTICS			
Flow, mgd	2.80	4.50	9.00
BOD5, mg/L	140	120	
1000 lb/d	3.3	4.5	
TSS, mg/L	140	120	
1000 lb/d	3.3	4.5	
TKN, mg/L	25	20	
1000 lb/d	0.6	0.8	
Temperature Range, C	13	to	28
EQUALIZATION BASIN			
Number 1			
Size 112*112*7.06 SWD			
Volume = 0.66 mg			
Detention, hrs	5.7	3.5	1.8
BAR SCREENS			
One mechanically cleaned 4.0 feet wide * 3.2 feet deep, 3/4 " openings			
One mechanically cleaned			
RAW SEWAGE PUMPS			
FOUR @ 4.5 mgd			
AERATED GRIT BASIN			
Number 2			
Size 12*24*13 SWD			
Volume = 0.06 mg Area =	576 sq ft		
Detention, min	29	18	9
Overflow Rate, gpd/sq ft	4861	7813	15625
PRIMARY CLARIFIER			
Number 1			
Size 85 Diam * 7 SWD			
Volume = 0.30 mg Area =	5675 sq ft		
Detention, hr	2.5	1.6	0.8
Overflow Rate, gpd/sq ft	493	793	1586
Effluent Quality			
Flow, mgd	2.8	4.5	9.0
BOD5, mg/L	91	82	
1000 lb/d	2.1	3.1	
TSS, mg/L	63	58	
1000 lb/d	1.5	2.2	
TKN, mg/L	22	18	
1000 lb/d	0.5	0.7	
PRIMARY CLARIFIER			
Sludge Quality			
Flow, 1000 gpd	5.4	7.0	
BOD5, 1000 lb/d	1.1	1.4	
TSS, 1000 lb/d	1.8	2.3	
TKN, 1000 lb/d	0.1	0.1	

	Design Conditions: Average	Maximum Month	Peak Flow
FIRST STAGE TRICKLING FILTER			
Number 1 Size	140 ft diam * 7 ft deep		
Area = 15394 sq ft Volume =	107757 cu ft		
Wetting Rate	0.13	0.20	0.41
BOD Loading, lb/1000 cu ft	20	28	
K	0.16	0.18	0.21
Effluent Quality, BOD5, mg/L	28	28	
INTERMEDIATE CLARIFIER			
Number 1 Size	75 Diam * 7 SWD		
Volume = 0.23 mg Area =	4418 sq ft		
Detention, hr	2.0	1.2	0.6
Overflow Rate, gpd/sq ft	634	1019	2037
SECOND STAGE TRICKLING FILTERS			
Number 2 Size	100 ft diam * 6 ft deep		
Area = 15708 sq ft Volume =	109956 cu ft		
Wetting Rate	0.12	0.20	0.40
BOD Loading, lb/1000 cu ft	6	10	
K	0.20	0.20	0.20
Effluent Quality, BOD5, mg/L	6	9	
FINAL CLARIFIERS			
Number 1 Size	85 Diam * 7 SWD		
1 Size	85 Diam *10 SWD		
Volume = 0.36 mg Area =	11349 sq ft		
Detention, hr	3.1	1.9	1.0
Overflow Rate, gpd/sq ft	247	397	793
UV DISINFECTION			
Number of channels= 2			
Number of banks per chan= 3			
Retention time, @ 9.0 MGD= 7.74 SEC			
ANAEROBIC DIGESTER			
Number 2 Size	24*48*15.5 SWD		
Volume = 0.27 mg			
Primary Sludge Q, 1000 gpd	5.4	7.0	
Primary Sludge, BOD 1000 ppd	1.1	1.4	
Primary Sludge, TSS 1000 ppd	1.8	2.3	
Humus, Q 1000 gpd	5.3	7.4	
Humus, BOD 1000 ppd	0.2	0.2	
Humus, TSS 1000 ppd	0.9	1.2	
Total Q, 1000 gpd	10.7	14.4	
Total BOD, 1000 ppd	1.3	1.7	
Total TSS, 1000 ppd	2.7	3.6	
Detention, days	24.9	18.6	
TSS out, 1000 lb/month	44.0	61.8	
SLUDGE HOLDING TANK/GAS HOLDER			
Number 1 Size	42 Diam*13 SWD		
Volume= 0.13 mg			
Gas Vol= 5281 cf			

A.2 TRICKLING FILTER INFORMATION

The trickling filter media surface area and air supply rates were critical to accurately modeling the King's Creek WWTP. Surface area for the rock media in the primary trickling filter was estimated from the WEF Manual of Practice No. 8 standard values. The plastic media surface area for the final trickling filters was taken from the shop drawings of the Brentwood media installed in the last plant modifications project. The air supply rate was calibrated to the performance testing data to match cBOD and ammonia removal observed at the facility. The values for these parameters are summarized in Table A.2.

Table A.2 Values for trickling filter parameters used in the BioWin model

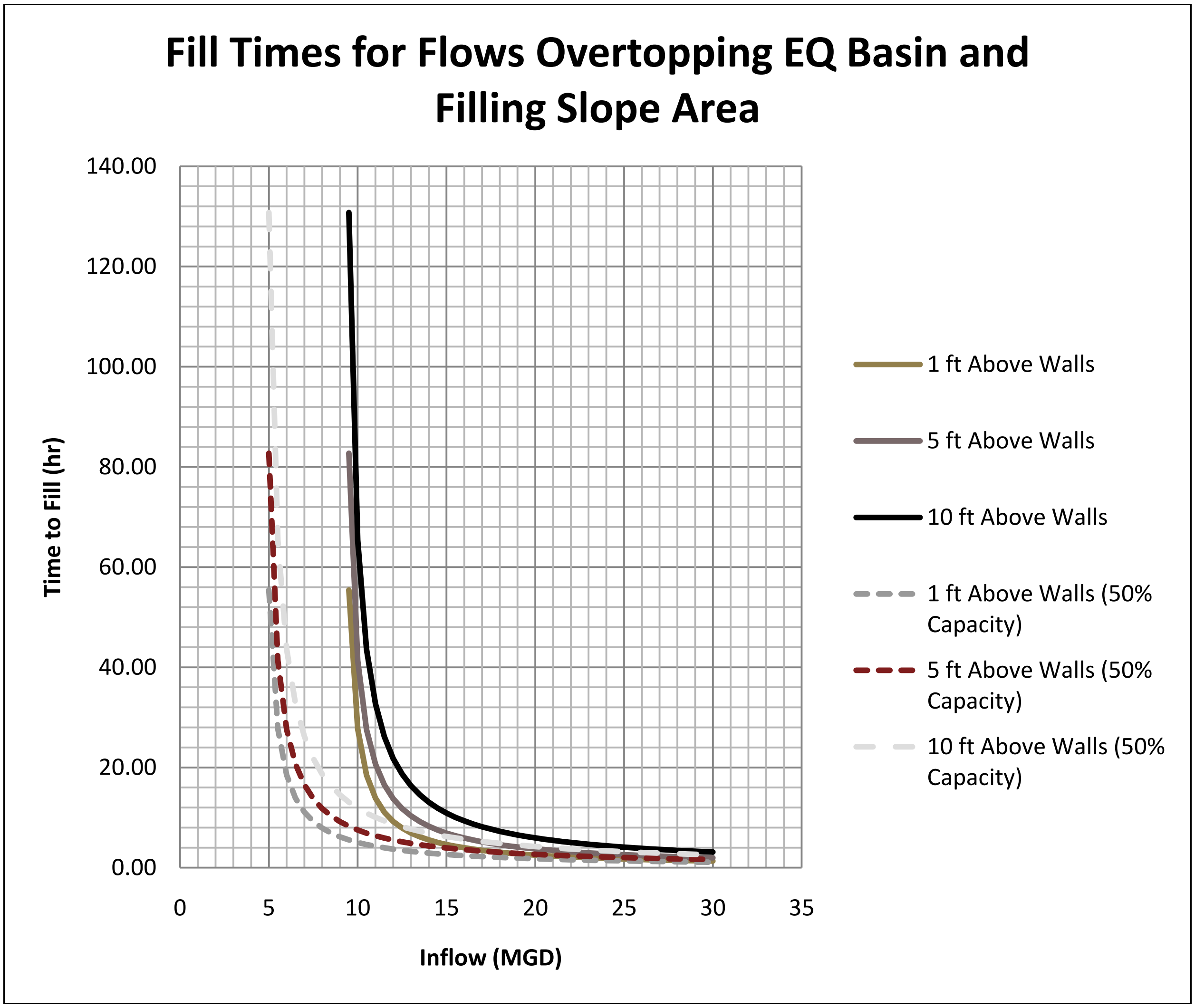
Parameter	Value
Rock media specific surface area	19 ft^2/ft^3
Rock media specific volume	0.5 ft^3/ft^3
Rock media fill fraction	100%
Primary trickling filter air supply rate	650 ft^3/min
Plastic specific surface area	48 ft^2/ft^3
Plastic media specific volume	0.05 ft^3/ft^3
Plastic media fill fraction	100%
Final trickling filter air supply rate	650 ft^3/min

A.3 REMAINING PARAMETERS

The recirculation pump flow rates were developed from the pump curves. Flow rates were approximately the same as the influent flow rates. The model was did not have a high sensitivity to the recirculation flow rate during the calibration process. All influent fractionation was left at default values, as well as microbial kinetics and stoichiometry. The primary solids wasting rate was set at 0.16 MGD for 20 minutes out of every hour, which is the current wasting pattern. Humus wasting rates were set at 0.05 MGD, which is based on gravity flow to the primary clarifier.

Appendix B

Peak Storage Calculations


Fill Times for Flows Overtopping EQ Basin and Filling Slope Area
Time to Fill (hr)
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
0
5
10
15
20
25
30
35
Inflow (MGD)
1 ft Above Walls
5 ft Above Walls
10 ft Above Walls
1 ft Above Walls (50% Capacity)
5 ft Above Walls (50% Capacity)
10 ft Above Walls (50% Capacity)

Appendix D:
Biofor Information

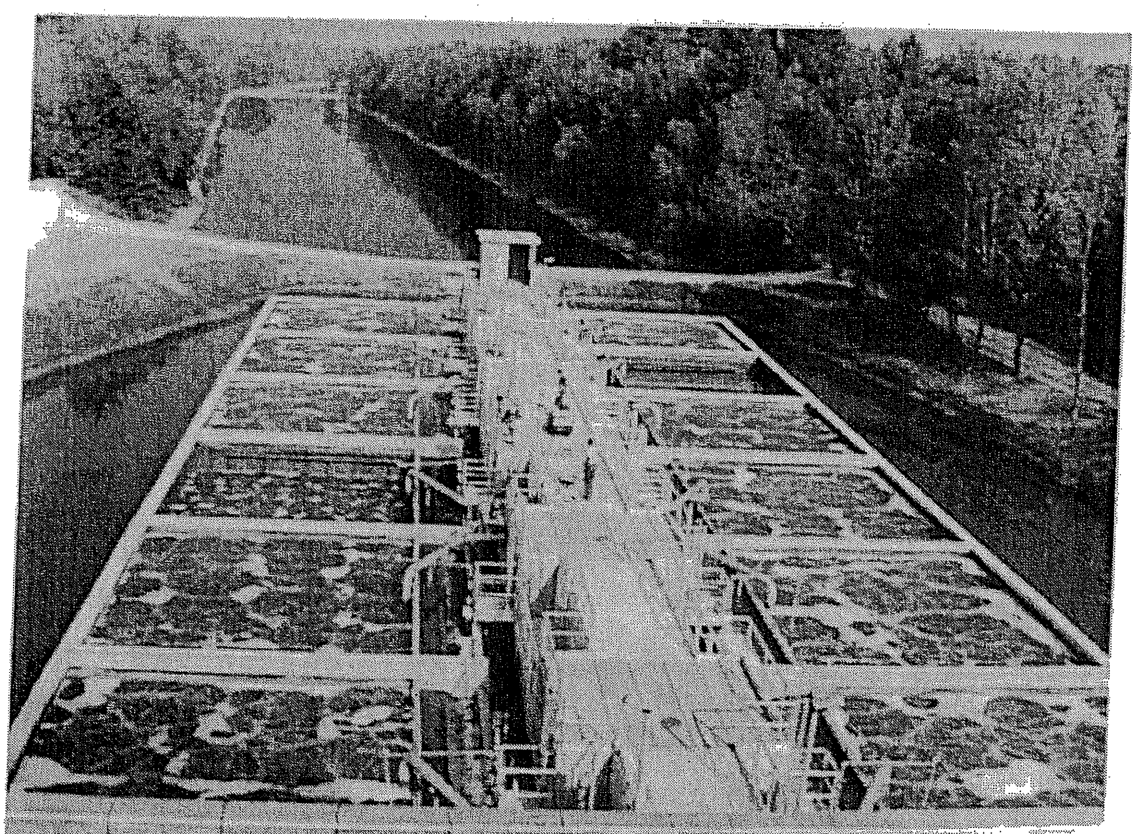
ONDEO Degrémont

Proposal No: Preliminary

June 25, 2002

TERRELL WWTP

BIOFOR™-"N" SUBMERGED BIOLOGICAL AERATED FILTER NITRIFICATION SYSTEM



BUDGET PROPOSAL PREPARED FOR:
FREESE & NICHOLS, INC

TABLE OF CONTENTS

APPENDIX

1. BIOFOR™- GENERAL DESCRIPTION

The BIOFOR is a biological, submerged filter containing a fixed, dense granular bed with influent wastewater flowing in the upward direction. The BIOFOR Process is applied individually or in separate stages for carbonaceous BOD_5 reduction (BIOFOR-"C"), nitrification (BIOFOR-"N"), and denitrification (BIOFOR-"Pre-DN", BIOFOR-"Post-DN"). In aerated systems ("C" and "N"), process air is introduced at the bottom of the media bed and flows co-currently with the influent wastewater.

The BIOFOR is based on the following basic principles:

- a single layer of granular BIOLITE media for biomass attachment and retention of suspended solids.
- a discrete process air distribution system (for aerated systems only)
- upflow, co-current distribution of air and water
- backwash sequence automated and optimized per application requirements

BIOLITE™ Media

BIOLITE media is an expanded clay material with a high specific surface area, low density, and good resistance to attrition. The porosity of the material ensures biomass attachment. Different particle sizes ranging from 1mm to 5mm are available depending on the application.

OXAZUR® Air Diffusers

OXAZUR air diffusers, present in all aerated BIOFOR units, are aerating devices with elastic rubber membranes enclosed in a polypropylene casing. The diffusers are installed on a series of process air distribution pipes located at the bottom of the media bed, directly above the plenum. The combination of diffused air and media retention produces a highly efficient aeration system with fine bubble diffusion characteristics. In order to assure homogeneous distribution over long-term operation, a pressurized cleaning water system is provided and operated approximately once per month to flush the diffusers.

Upflow Distribution of Air and Water

Distribution of process air and influent wastewater is upward through the BIOLITE media. This co-current, upward flow ensures an even distribution of water and air. It enables the media to retain solids and biomass throughout the entire bed depth and prevents short-circuiting and gas entrapment. In anoxic, denitrifying systems, nitrogen gas bubbles are continuously and effectively released from the media to atmosphere. The media operates in slight expansion, thereby ensuring full use of the available media volume and allowing high hydraulic loading rates.

MONOFLOR® Underdrain

Concrete BIOFOR installations have the distribution nozzles located in the poured-in-place filter floor. To ensure an accurate, grout-free installation, the MONOFLOR underdrain is used. This underdrain is simple to install, leak-proof, and has been widely used on filter systems for many years.

Backwash Sequence

Backwash sequences for biological aerated filters must comply with several requirements:

- The entire filter bed must be cleaned of any retained solids and excess biomass
- Sufficient biomass must remain in the reactor following a backwash
- Air and water flows must not cause filter media to be lost
- Water and energy consumption must be minimized
- The backwash sequence must be initiated and carried out automatically.

The standard BIOFOR backwash sequence has been developed specifically to meet the requirements listed above. The backwash sequence may be optimized during start-up and can be modified based on operating experience.

The sequence may be initiated manually, on operating time, or upon reaching a pre-set terminal headloss. The main steps of the sequence are :

- quick drain to backflush the influent distribution nozzles
- air scour
- a series of simultaneous air/water washes
- water rinse

The water used for backwashing is typically BIOFOR effluent which is stored in a separate clean water tank. Backwash wastewater is normally stored in a separate holding tank and pumped over time back to the head of the treatment plant.

2. DESIGN CONDITIONS

The Submerged Biological Filter BIOFOR™-"N" described herein is a wastewater treatment system designed for the removal of ammonia-nitrogen.

The single-stage biofilter system will be furnished and installed as described herein and shown on the accompanying plans. The system will have a maximum monthly average flow capacity of **5.8 MGD** and a peak flow capacity of **5.8 MGD,** and is based on treating municipal wastewater secondary effluent with the following characteristics:

Influent	mg/l	Given	Assumed
Biological Oxygen Demand (BOD_{5t})	15.0	X	
Total Suspended Solids (TSS)	25.0	X	
Total Kjeldahl Nitrogen(TKN)	28.0		X
Ammonia Nitrogen (NH_3-N)	25		X
Minimum Water Temperature Winter	12.0		X

The single-stage BIOFOR™-"N" system described herein is designed to achieve the following monthly average effluent quality:

Effluent Requirements	mg/l
Biological Oxygen Demand (BOD_{5t})	10
Total Suspended Solids (TSS)	10
Ammonia Nitrogen (NH_3-N)	2

3. BIOLOGICAL REACTORS

Infilco Degremont, Inc. will provide 4 upflow, biological, submerged fixed-film aerobic reactors as shown on the plans; with BIOLITE® media for biomass support. Each reactor with an effective filter surface area of 426.92 sq.ft.

Each reactor will consist of concrete tank with monolithic underdrain (MONOFLOR®), bottom influent and air/water backwash distribution system, process air distribution system, granular expanded clay media, influent channel, effluent and backwash waste channels with stilling baffle Process air blowers, air distribution system cleaning pump, air scour blowers, backwash pumps, controls and instrumentation and all associated valves and skid piping will be furnished by IDI. One flat, static screen fabricated of 316 stainless steel with 2.5 mm perforations will be provided for each pair of reactors.

The media will be periodically washed by a sequence of air scour, combination air scour/backwash water, and water only rinse steps. Water used to backwash the biofilter will be pumped from a separate storage tank supplied by others. The air scour blower capacity is based on a maximum air scour rate of 4.8 scfm/sq.ft. of filter media. The backwash pump will be sized for a maximum backwash water rate of 12.2 gpm/sq.ft. of filter media.

4. SCOPE OF SUPPLY

Complete Scope of IDI Supply:

4.1. Biofilter Modules

4 -BIOFOR™ Reactors, 426.92 ft² effective filtration area, 18.17' x 23.50' approximate inside dimensions, with internals and required wall pieces. Each reactor will include of the following:

- Equipment for MONOFLOR® underdrain including forms, polyethylene nozzles and accessories.
- 1 - Tranquilizer (stilling baffle) consisting of staggered vertical aluminum slats extending across the width of the reactor. Installation of the tranquilizer baffle is by others.
- Process air distribution system in 316 stainless steel with OXAZUR air diffusers*

* The air distribution laterals, headers and downcomers are shipped to site loose for field assembly by the Contractor. Couplings, supplied by IDI are used for process air connections. The OXAZUR® air diffusers are shop installed on the laterals.

4.2. Media

22,730 ft³ BIOLITE-"L" media, 2.7mm, to 12.10ft. depth in the BIOFOR reactor (includes 10% extra). BIOLITE will be shipped to the jobsite.

1,793 ft³ Gravel, to 12" depth, in each BIOFOR unit (includes 5% extra). Gravel will be shipped to the jobsite.

4.3. Centrifugal Pumps

2 - Backwash supply pumps, horizontal centrifugal type rated for 3492 gpm at 60 ' TDH (2 x 100 % duty).

1 - Air distribution system cleaning pump, horizontal centrifugal type rated for 1309 gpm at 120 ' TDH.

Pumps will be skidded on a structural steel base with required piping, valves, flange fittings and accessories fully assembled.

4.4. Blowers and Appurtenances

4 - Process air blowers, rotary lobe type, rated for 425 scfm at 11.5 psig

2 - Air scour blowers, rotary lobe type, rated for 1952 scfm at 10.5 psig (2 x 100 % duty).

Each blower provided with:

- Motor
- V-belt drive
- Inlet filter/silencer and outlet silencer
- check valve
- manual valve for outlet isolation
- relief valve
- flexible connections
- discharge pressure gauge
- acoustic enclosure, to meet 85 dBA free field noise requirements.

Blowers shipped to site skidded on separate structural steel bases, assembled with piping, silencers, valves and fittings.

An automatic by-pass flow control valve is included with each air scour blower.

4.5. Compressed Air for Automatic Valves

1 - Compressed Air System, comprising:

- 1 - dual-head reciprocating type compressor rated for 7.5 scfm at 100 psig
- 1 - standby head
- 1 - 80 gallon carbon steel receiver
- Air dryer
- Required relief, exit, and blowdown valves
- pressure gauges

System shipped to site pre-piped and skidded on a structural steel base.

Pneumatic tubing, valves, and appurtenances for air feed to automatic valves is by others.

4.6. Automatic and Manual Valves

Lot automatic valves including:

4 -14" diameter influent open/close
1 -18" diameter backwash water inlet flow control
4 -18" diameter backwash water inlet open/close
4 -10" diameter backwash air inlet open/close
4 -3" diameter air cushion vent open/close
4 -20" diameter backwash waste open/close
4 -8" diameter quick drain open/close

All automatic valves are butterfly type equipped with double-acting pneumatic cylinder actuators. Solenoids are mounted directly on actuators. Positioners are pneumatic. Valves include open and close limit switches.

Lot - Manual Valves including

4 - 4" diameter drain gate valves with flanged ends

Lot - process air header isolation butterfly valves with flanged ends

4.7. *Strainers*

1 - Backwash inlet strainer in-line Y type, 18" diameter, 2 mm stainless steel mesh, carbon steel body with flanged ends.

1 - Air distributor cleaning header strainer, in-line Y type, 6" diameter, 2 mm stainless steel mesh, carbon steel body with flanged ends.

4.8. *Miscellaneous Equipment*

Lot - bolts, gaskets, etc., associated with equipment within IDI's Scope.

4.9. *Controls and Instrumentation*

1 -PLC/PC control system, mounted in a free-standing NEMA 12 enclosure.

Lot -Field instruments including:

- 4 - level transmitters, ultrasonic-type
- 4 - pressure transmitters (cell pressure)
- 4 - pressure transmitters (plenum pressure)
- 1 - inlet flow meter/transmitter, 14" diameter, magnetic type
- 1 - backwash flow meter/transmitter, 8" diameter, magnetic type
- 1 - air scour flow meter/transmitter, pitot tube-type for 10" line
- 4 - process air flow meter/transmitters, pitot-tube type for 6" line
- 2 - differential pressure gauges across strainers
- 2 - pH/temperature sensors/transmitters, in inlet and outlet channels
- Lot - pressure gauges, local indication only

4.10. Field Service

15 - days total service time by a qualified, factory-trained service engineer to inspect the BIOFOR equipment installation, provide start-up assistance and training of operations personnel.

5. BUDGET PRICING

The budget price for the equipment and services described above is:

$1,500,000 F.O.B. shipping point, freight allowed to jobsite.

ONDEO Degrémont
2924 Emerywood Parkway, PO Box 71390, Richmond, VA 23255-1390, Telephone: (800) 446-1150, Fax: (804)756-7788

June 25, 2002

Muncipal Wastewater Systems - Preliminary Design Sheet

Project Name:	Terrell WWTP			
Project Location:	Terrell, TX			
Prepared for:	Freese & Nichols, Inc	**Influent Wastewater Characteristics (mg/L):**		
			BOD_t	15
Inquiry Number:			TSS	25
Application:	Nitrification		TKN	28
			$N\text{-}NH_4$	25
Design Average Flow (MGD):	5.8	**Effluent Wastewater Requirements (mg/L)**		
Design Peak Flow (MGD):	5.8			
Design Peak Hydraulic Flow (MGD):	5.8		BOD_t	<10
Minimum Winter Temp. (°C)	12.0		TSS	<10
			$N\text{-}NH_4$	<2

Biofor Filter Cells

No. of filters	4	426.92 ft^2
Unit Filter dimensions:		
Width (ft)	18.17	
Length (ft)	23.50	
Height (ft)	22	
Media Height (ft)	12.10	

Ancillary Equipment

	No. of Units	Capacity (scfm)	Discharge Pressure (psig)	(ft WC)	Duty (%)
Process Air Blower(s) Nitrification	4	425	11.5		100
Backwash Pump(s)	2	3492		60	100
Air Scour Blower(s)	2	1952	10.5		100
Cleaning Pump(s)	1	1309		120	100

Budgetary Price: $1,500,000.00

Prepared by: *Christopher W. Tabor, P.E.*
Senior Project Engineer
EXT: 7692

Biofor (R)

HARTWELL ENVIRONMENTAL CORPORATION

2200 S. Smith Barry Road
Suite 214
Arlington, TX 76013
817.459.0400
817.459.0415 Fax
E-Mail:henvdal@flash.net

Fax Coversheet

Date:	May 28, 2002
To:	Trooper Smith
Company:	Freese and Nichols, Inc.
From:	Trish Bullock
Subject:	**Literature Requested on Biofor**

Total # of Pages (including cover): 9

Memo:

Regarding your request through Bob Russell attached is the ONDEO Degremont Biorfor brochure.

Please call if you have any questions.

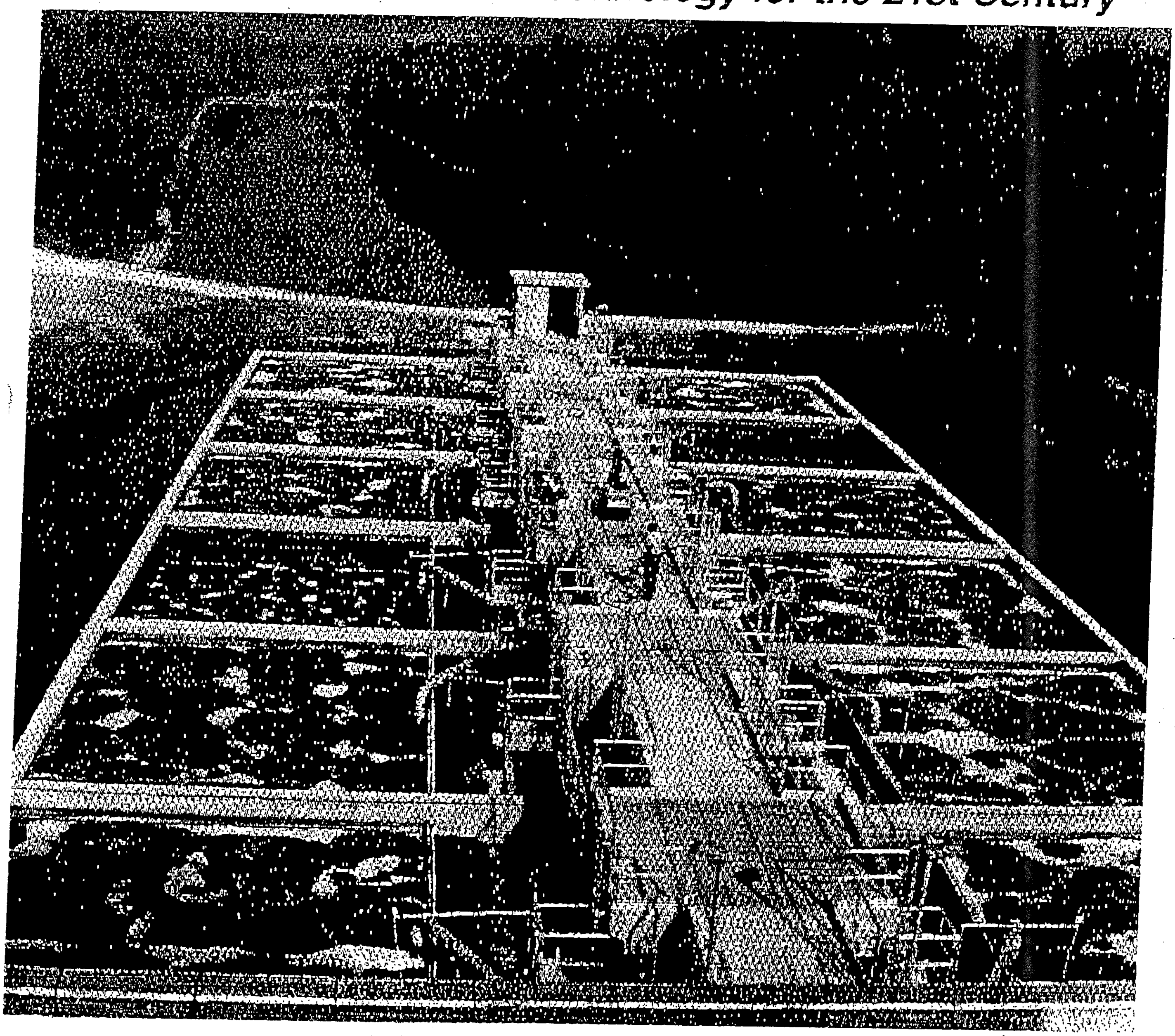
Regards,
Trish

DB-965

Biofor™

Biological Aerated Filtration

Wastewater Treatment Technology for the 21st Century



Infilco Degremont Inc

September 1997
Supersedes September 1994

Biofor™
Biological Filtration Oxygenated Reactor

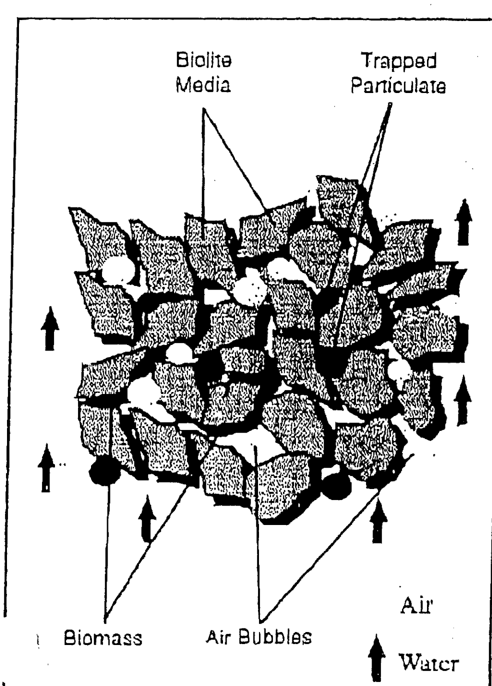
The Biofor Process is the most advanced system available for carbonaceous BOD_5 reduction, nitrification, and denitrification.

Conceived in the 1970's by Degremont, S.A. of Paris, France, the biological aerated filter (BAF) has many features particularly well-suited to the needs of today's and tomorrow's wastewater treatment professionals.

Treatment of municipal wastewater generally employs activated sludge processes. Though well-proven and reliable, these processes require large surface areas and react slowly to high load variations.

In order to obtain compact plants and to assure greater treatment reliability, submerged, aerated fixed film reactors were developed. The technology of biofiltration applied first to aerobic carbonaceous BOD_5 removal and then to nitrification and denitrification.

Biofor "C" system at Châteauguay, Quebec, Canada



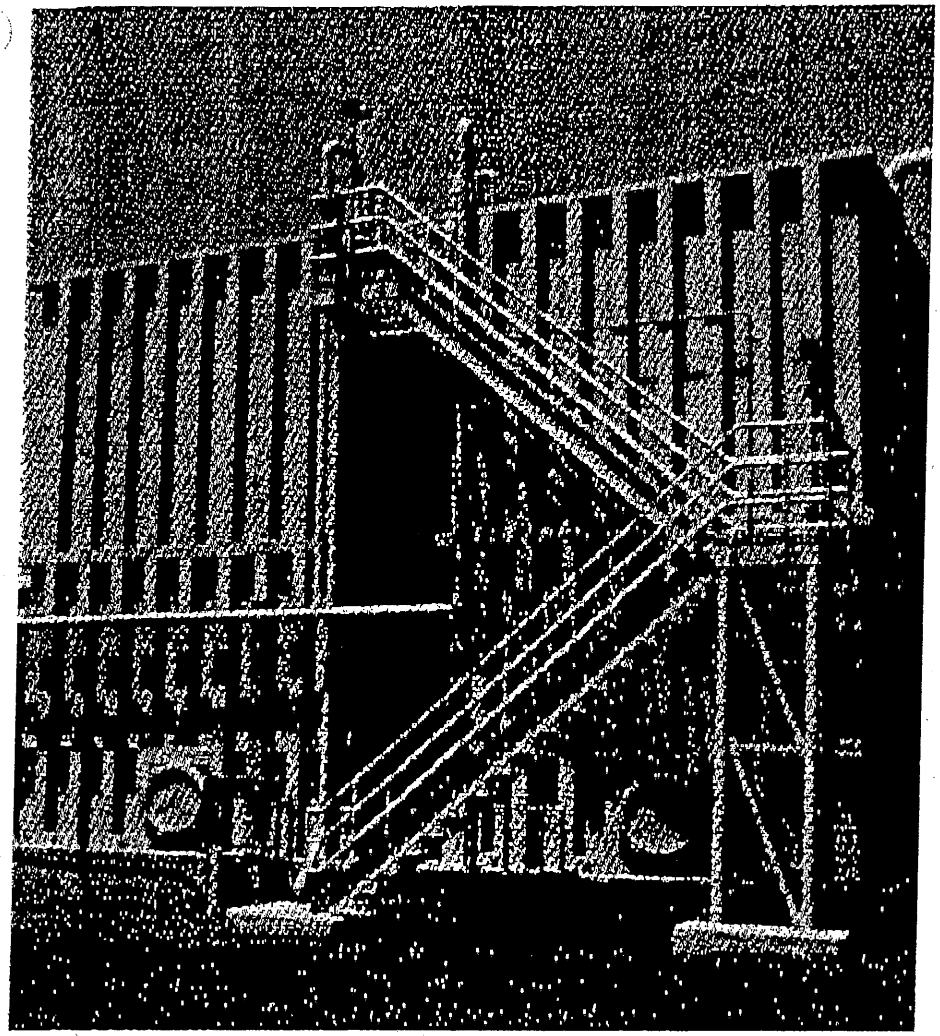
Co-current Air and Water Flow

These submerged, aerated fixed film reactors are extremely efficient. The media supports a strong, thin biomass which is maintained in a healthy condition by the introduction of air in the form of fine bubbles, 1-2 mm. Not only do these bubbles remain in contact with the water for a long period because of the depth, over 16 feet, but they also have to take a tortuous route through the media. Co-current flows, air and water traveling in the same direction, aid in distributing the air throughout the media and eliminate gases from binding the filter bed.

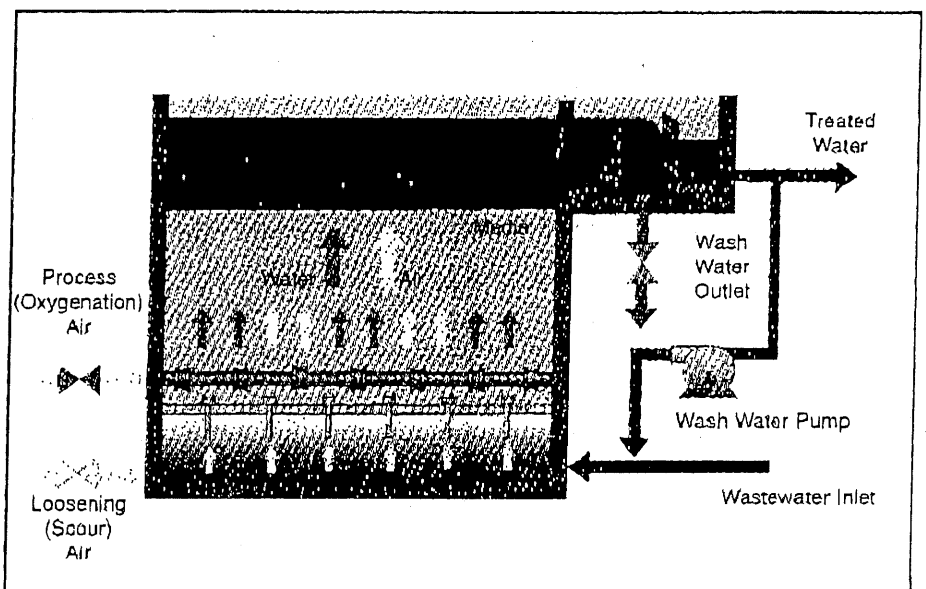
The media not only provides a surface for the biomass but also effectively captures suspended solids. This combination treatment, biological treatment of soluble organics and nutrients, plus solids removal, eliminates the need for a final clarification stage and all the costs and operational difficulties associated with final clarifiers.

The process is based on four principles:

1. Single-layer carrier material-Biolite™
2. Specific aeration system-Oxazur™
3. Upflow distribution of air & water
4. Unique washing sequences



Biofor "N" System at West Basin M.W.D., CA - Steel Package Design



Biofor Cell in Backwash Mode

Biolite™ Media

Biolite, a unique expanded clay material, has a high specific surface area (400 - 500 ft²/ft³), low density, and good resistance to attrition. Its porosity assures optimum biomass fixation. Different sizes and shapes are available (1 - 4 mm, crushed or nodular). Media depths are typically in the range of 10 - 13 ft., with the shallower depths and coarser sizes generally being used for denitrification.

Microscopic view of biomass growing on and in Biolite media

Oxazur™ Diffusers

The aeration diffusers are arranged above the distribution plenum in the bottom of the filter support media. These well-proven, non-clogging, flexible membrane diffusers create 1-2 mm fine bubbles which are evenly distributed at the bottom of the media, providing excellent oxygen transfer efficiency.

Upflow Distribution of Air & Water

The co-current upflow distribution of air and water enables homogeneous suspended solids retention and biomass growth throughout the media without short circuiting or entrapment of gas bubbles. Since there is always treated water above the media, odors are eliminated during filtration.

Backwashing Sequence

Unique washing sequences maintain the biomass at its optimum activity while ensuring that the retained solids are effectively and efficiently removed from the media.

Typical Biofor Arrangement

Biofor systems are always arranged with multiple modules and are often mirror imaged about a central service gallery. Having multiple modules serves two purposes: it allows for one or more cells to be taken off duty for backwashing, and it allows the number of duty modules to be controlled in relation to the incoming flow. The benefits are consistent high performance and energy savings.

IDI Distribution Nozzles

The distribution nozzles are located in the filter floor and perform multiple tasks:

- Distribution of influent wastewater
- Distribution of the backwash water
- Distribution of the air for scouring

The Biofor distribution nozzle is based on proven technology and was specifically developed for wastewater upflow filters using a combined air/water backwash sequence. It provides effective, uniform distribution, is resistant to clogging and, being fabricated of polypropylene, is both unbreakable and impervious to corrosion. A unique feature of the nozzles is its self-flushing characteristic. The nozzle is specially designed such that any solids trapped in the openings are effectively flushed out during the rapid drain step of each backwash sequence.

The IDI Oxazur™ Air Diffusers

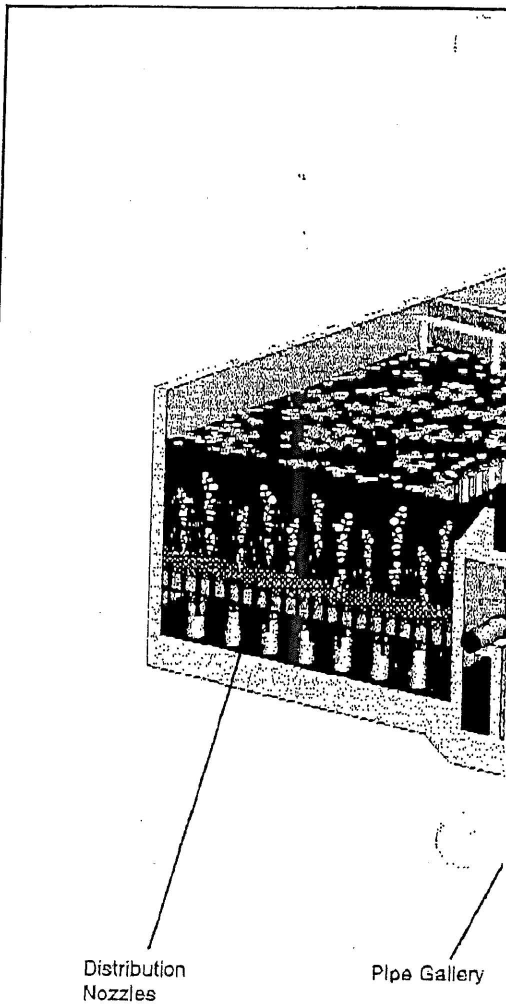
An essential requirement of the Biofor process is the efficient and effective introduction of air; to this end, we use our patented Oxazur process air diffusers.

These diffusers utilize a flexible membrane which is non-clogging and produces a high density of fine bubbles. Mounted on a distribution system located above the filter floor in the gravel layer supporting the Biolite media, these air diffusers provide for excellent oxygen transfer while maintaining the biomass in optimum condition. They are resistant to both corrosion and temperature fluctuations.

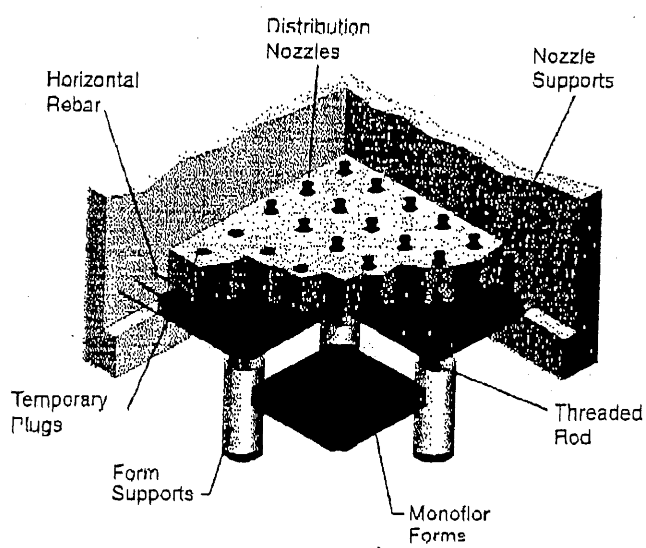
The IDI Monoflor™ Underdrain

Concrete Biofor installations have the distribution nozzles located in the poured-in-place filter floor. To ensure an accurate, grout-free installation, the IDI Monoflor underdrain is used. This underdrain is simple to install, leak proof, and has been widely used on filter systems for many years. Biofor applications have a special nozzle density to ensure even distribution.

The key component of the Monoflor system is a molded polystyrene form. When concrete is poured into the form, it becomes a permanent part of the filter underdrain. Each form includes nozzle adapters into which the nozzles are threaded after the concrete is installed. Disposable plugs are included to prevent concrete from entering the nozzle adapters. Once the concrete is cured the plugs are easily removed, permitting installation of the distribution nozzles.



Typical concrete Biofor arrangement illustrates t

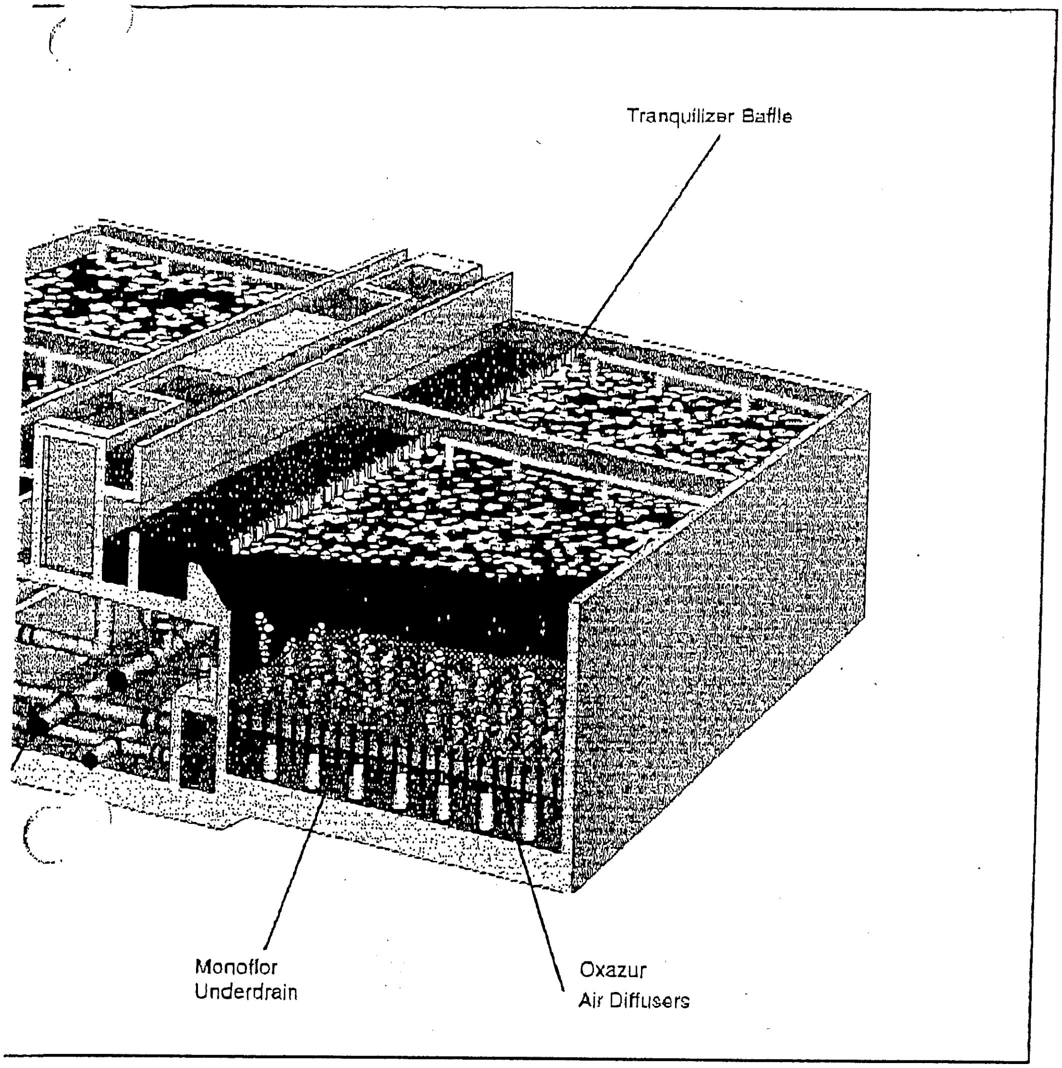


Monoflor Underdrain

The IDI Tranquilizer Baffle

To ensure that any filter media entrained by air bubbles during a backwash is retained in the filter bed, each Biofor is equipped with a patented tranquilizer baffle.

This baffle arrangement is located between the filter cell and the



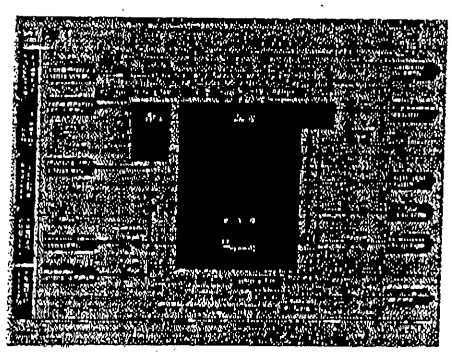
ltration mode on the right and the backwash mode on the left.

The tranquilizer baffle in each unit prevents media carry over.

discharge weir and channel. Here it provides a separation of the air bubbles from the tranquil, non-aerated zone. As a result of this feature, media carry over is virtually eliminated.

Biofor Controls and Instrumentation

All Biofor systems are fully automatic and very simple to operate. Control and monitoring is provided by Programmable Logic Controllers (PLCs) or Microprocessors (PCs). In either case, the system can interact with the treatment plant's main control and/or monitoring system with communications customized by our systems integrator. In the case of a PLC-based system, a panel-



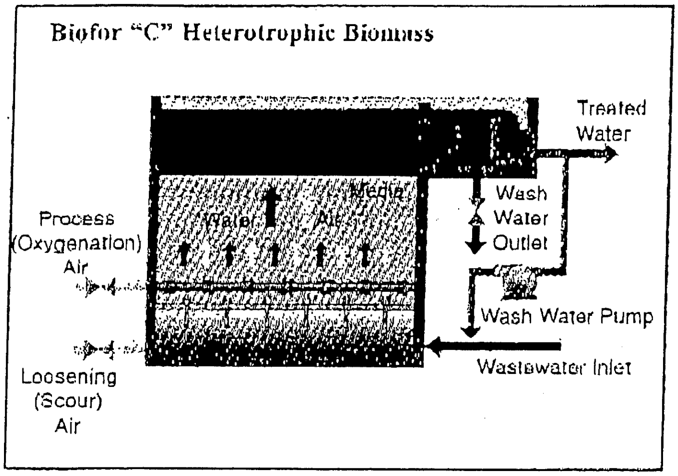
PLC/PC controls provide a fully automatic system for simple operation

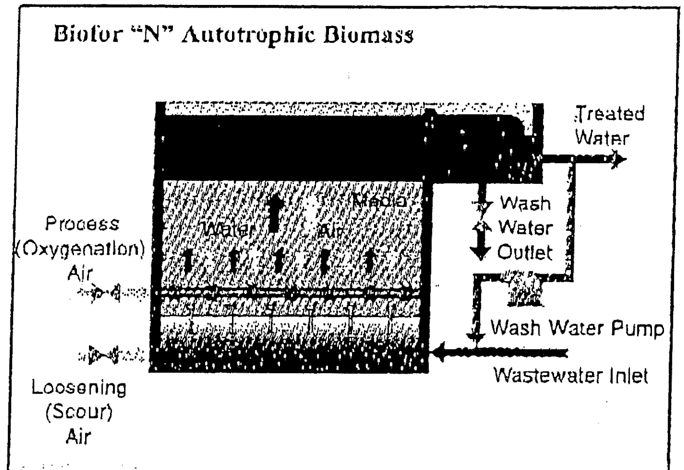
mounted screen with customized graphic display is provided. With a PC based system, an industrial quality computer with monitor is mounted in the control panel and is programmed for that particular installation with graphic screens designed using state of the art software.

Operated in automatic mode the Biofor backwashing sequences are activated on headloss or a time cycle, and include a normal wash or an energetic cycle when appropriate. By monitoring the plant flow, via a signal from a measuring device, the Biofor cells can be placed in or out of service. This ability to flow pace the duty cells serves two functions: first, it allows the cells to work at their optimum flow rate and, second, it saves energy by activating only the minimum number of cells necessary to treat the flow. The biomass in the non-duty cells is maintained in a healthy condition by automatic, periodic aeration. Monitoring can be tailored to a plant operator's individual requirements. It includes, at a minimum, the following parameters:

- Cell Level
- Differential Pressure
- Terminal Headloss
- pH
- Air and Water Flows
- Backwash Cycles
- Nitrates (for Biofor "DN")

)iofor Arrangements





Biofor "C" - Carbonaceous BOD_5 & TSS Reduction

For carbonaceous BOD_5 reduction, the Biofor module is typically set up with 13 ft. of media and a flow rate as high as 8.5 gpm/ft². Air scour, backwash flow, and process air requirements are calculated for specific BOD_5 and TSS loadings.

Wastewater is introduced into the Biofor plenum following screening, grit removal and primary clarification. Since a Biofor system eliminates the need for final clarifiers, the effluent flows directly to the disinfection step

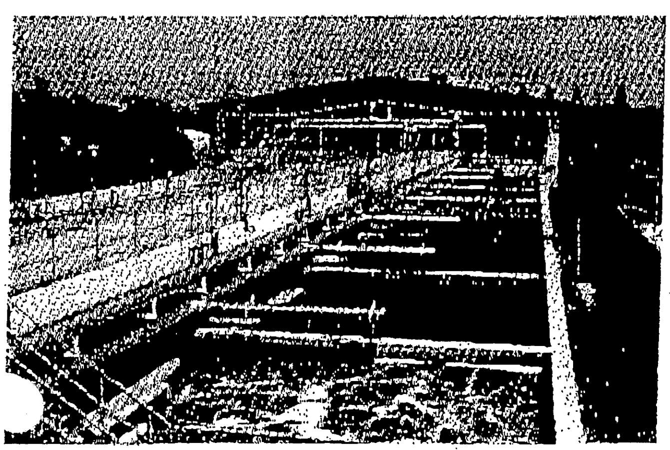
With its excellent oxygen transfer efficiency and hydraulic loading rates as high as of 8.5 gpm/ft², the Biofor "C" is the most efficient secondary treatment system available today.

Biofor "N" - Nitrification & TSS Reduction

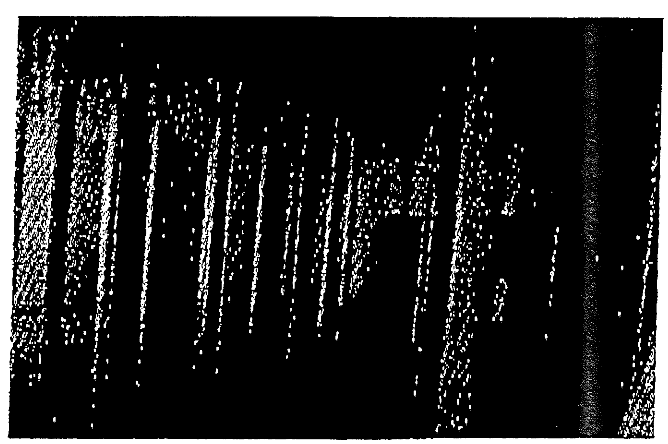
The setup for nitrification is the same as that shown for Biofor "C" with similar media depths. In this case, however, the water is received from the Biofor carbonaceous reduction step or from a conventional secondary treatment process. The high efficiency of the up-flow biofilter allows it to maximize autotrophic bacterial activity under optimal running conditions.

Just like the Biofor "C" version, Biofor "N" performs best at high rates, typically being operated close to the maximum loading rate of 8.5 gpm/ft².

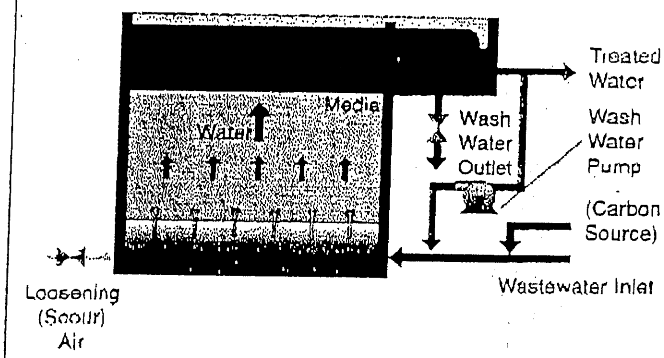
Nitrification mechanisms in wastewater treatment are well known, specifically in activated sludge processes. In those cases, sludge age and hydraulic retention time are key points for correct and reliable nitrification. For Biofor "N", sludge age and retention time are no longer applicable because the biomass is attached as a thin film on the Biolite media. The excellent diffusion inherent in the Biofor design guarantees full nitrification with hydraulic retention in the media as low as two minutes.



Biofor "C & N" system at Poole, Dorset, UK



Inlet plenum for a typical Steel Biofor unit



Biofor "DN" - Denitrification

The Biofor "DN" can be located prior to or following the nitrification stage (Pre-"DN" or Post-"DN").

As pre-"DN", no additional carbon source is required since sufficient easily biodegradable organic carbon is available in the influent. Post-"DN" is used to meet very stringent effluent nitrate standards and, in this case, an external carbon source is required. Biofor "DN" units are usually significantly smaller than the "C" or "N" versions because rates as high as 16.5 gpm/ft² are employed. Media depths of 10 feet, and coarser, nodular Biolite are used.

Typical Biofor Loading Rates

Biofor Type	"C"	"C+N"	"N"	"DN"
Hydraulic Loading				
Vmin., gpm/ft2	1.5	1.5	1.5	4.00
Vmax., gpm/ft2	8.5	8.5	8.5	16.5
Pollution Loading				
BOD_5, lbs/d/kcf	375	185	*	**
TSS, lbs/d/kcf	315	185	*	**
COD, lbs/d/kcf	935		*	**

* Nitrification capacity depends on temperature, BOD_5 loading, media, air flow rate, and BOD_5 biodegradability.

** Typical carbon/nitrate ratios required.

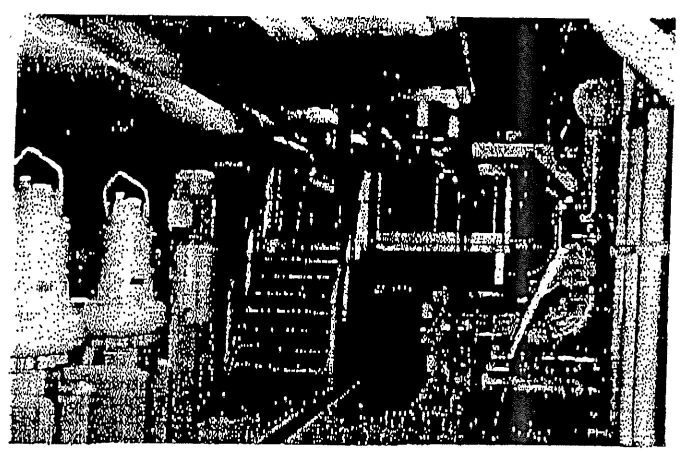
Biofor "C+N" is an arrangement used when less stringent effluent ammonia levels are permitted.

Conclusion

More than one hundred (100) operating systems worldwide have established Biofor biological aerated filtration as the technology for the 21st century. See how the flexibility of the Biofor system leads to these significant benefits for your installation:

- Very Compact Layout
- Rapid Start Up
- Elimination of Final Clarifiers
- Effective with High Load Variations
- Effective at Low Temperatures.
- Simple Operation
- Free of Nuisance Odors
- Waste Solids with Excellent Settling Characteristics
- Energy Efficient

Biofor Pre-DN pilot testing in France.



A typical Biofor service gallery

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Appendix E:
Treatment Improvements Opinion of Probable Construction Costs

PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST

KING'S CREEK WASTEWATER PLANT
ALTERNATIVE 1 - 4.5 MGD MODIFCATIONS TO EXISTING FACILITIES

ACCOUNT NO.	ESTIMATOR	CHECKED BY	DATE
TER10191	LSD	GB	August 17, 2010

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	EQUALIZATION BASIN				$ 737,000
	JET MIXING/AERATION SYSTEM	1	LS	$ 329,000	$ 329,000
	CF100 BAND SCREENS	2	EA	$ 98,000	$ 196,000
	MACERACER - SCREENING EQUIP.	2	EA	$ 80,000	$ 160,000
	GEOTEXTILE LINER	1	LS	$ 45,000	$ 45,000
	FLAP VALVE	1	EA	$ 7,400	$ 7,000
2	GRIT CLASSIFIER				$ 108,900
*	GRIT WASHING AND COMPACTOR	3	EA	$ 54,450	$ 108,900
2	1ST-STAGE TRICKLING FILTER				$ 687,000
	REMOVAL OF EXISTING ROCK MEDIA	1	LS	$ 120,000	$ 120,000
	REPLACEMENT WITH NEW PLASTIC MEDIA	1	LS	$ 477,000	$ 477,000
	CONVERSION OF UNIT TO 100-FOOT DIAMETER	1	LS	$ 90,000	$ 90,000
3	PRIMARY CLARIFIER				$ 460,000
*	NEW MECHANSIM FOR EXISTING CLARIFIER	1	LS	$ 227,000	$ 227,000
	ADDITIONAL PRIMARY CLARIFIER	1	LS	$ 178,000	$ 178,000
	WEIRS AND BAFFLES	1	LS	$ 18,000	$ 18,000
	EXCAVATION	1	LS	$ 30,000	$ 30,000
	BACKFILL	1	LS	$ 7,400	$ 7,000
4	INTERMEDIATE CLARIFIER				$ 460,000
*	NEW MECHANSIM FOR EXISTING CLARIFIER	1	LS	$ 227,000	$ 227,000
	ADDITIONAL INTERMEDIATE CLARIFIER	1	LS	$ 178,000	$ 178,000
	WEIRS AND BAFFLES	1	LS	$ 18,000	$ 18,000
	EXCAVATION	1	LS	$ 30,000	$ 30,000
	BACKFILL	1	LS	$ 7,400	$ 7,000
5	SECONDARY NITRIFICATION				$ 3,077,000
	BIOFOR	1	LS	$ 2,664,000	$ 2,664,000
	CONCRETE	435	CY	$ 600	$ 261,000
	PUMP STATION REPLACEMENTS	4	EA	$ 38,000	$ 152,000
6	DISK FILTERS				$ 968,000
*	CONCRETE	100	CY	$ 600.00	$ 60,000.00
*	DISK FILTERS	2	EA	$ 350,000.00	$ 700,000.00
*	ASPIRATING MIXERS	3	EA	$ 36,000.00	$ 108,000.00
*	PIPING AND VALVES	1	LS	$ 100,000.00	$ 100,000.00
9	**CHEMICAL FEED FACILITIES**				$137,000.00
	PRE-FEBRICATED 9,000 GALLON FIBERGLASS TANK	1	EA	$ 35,000.00	$35,000.00
	DIAPHRAGM CHEMICAL METERING PUMPS	2	EA	$ 15,000.00	$30,000.00
	CONCRETE CONTAINMENT	45	CY	$ 600.00	$27,000.00
	VALVES AND PIPING	1	LS	$ 45,000.00	$45,000.00
7	ELECTRICAL AND INSTRUMENTATION				$ 1,946,000
	ELECTRICAL, INSTRUMENTATION & CONTROL	$ 5,558,000	%	20	$ 1,112,000
	MISCELLANEOUS MECHANICAL	$ 5,558,000	%	15	$ 834,000
PRELIMINARY COST					**$8,580,900.00**
	CONTINGENCY			**30%**	$2,574,270.00
	SUBTOTAL:				$11,155,170.00
	MOBILIZATION			**5%**	$557,758.50
	SUBTOTAL:				$11,712,928.50
	OH&P			**18%**	$2,108,327.13
	SUBTOTAL:				$13,821,255.63
CONSTRUCTION TOTAL (2011$)					**$13,820,000.00**
ENGINEERING AND SURVEYING				**18%**	**$2,487,600.00**
TOTAL BUDGETARY COST (2011$)					**$16,307,600.00**

Freese and Nichols

PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST

KING'S CREEK WASTEWATER PLANT
9.0 MGD BNR ACTIVATED SLUDGE PLANT

ACCOUNT NO.	ESTIMATOR	CHECKED BY	DATE
TER10191	LSD	GB	December 9, 2010

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	**SITE WORK**				$5,922,000.00
	Cost for Demolition, Tree Removal, Trenching for Pipes, Backfilling, Compacting, Grubbing, Grading, Fencing, and Land-Scaping	1	LS	$5,922,000.00	$5,922,000.00
2	**INFLUENT PUMP STATION**				$717,000.00
	Concrete	450	CY	$ 600.00	$270,000.00
	Submersible Pumps and VFDs	4	EA	$ 67,000.00	$268,000.00
	Cost For Isolation Valves and Fittings	1	LS	$ 136,000.00	$136,000.00
	Piping	1	LS	$ 43,000.00	$43,000.00
3	**HEADWORKS**				$1,846,000.00
	Concrete	300	CY	$ 600.00	$180,000.00
	Fine Screens, Washer Unit and Compactor	4	LS	$ 170,000.00	$680,000.00
	Grit Removal Units	4	LS	$ 122,000.00	$488,000.00
	Grit Washing and Compactor	4	EA	$ 97,000.00	$388,000.00
	Valves and Piping	1	LS	$ 110,000.00	$110,000.00
4	**PRIMARY CLARIFIERS**				$2,148,000.00
	Concrete	2,100	CY	$ 600.00	$1,260,000.00
	Chain and Flight Mechanism, Skimmer Mechanism	5	EA	$ 152,000.00	$760,000.00
	Valves and Piping	1	LS	$ 128,000.00	$128,000.00
5	**AERATION BASINS**				$2,846,040.00
	Concrete	3,078	CY	$ 600.00	$1,847,040.00
	Diffusers	24,000	SF	$ 20.00	$480,000.00
	Valves and Piping	1	LS	$ 147,000.00	$147,000.00
	BNR Equipment	1	LS	$ 372,000.00	$372,000.00
6	**BLOWER BUILDING**				$1,625,000.00
	Concrete	120	CY	$ 600.00	$72,000.00
	Blowers, VFDs and Explosion Proof Jackets	4	EA	$ 364,000.00	$1,456,000.00
	Valves and Piping	1	LS	$ 97,000.00	$97,000.00
7	**SIDE STREAM EQUALIZATION STORAGE**				$444,000.00
	Concrete	45	CY	$ 600.00	$27,000.00
	Concrete Tank	1	LS	$ 390,000.00	$390,000.00
	Valves and Piping	1	LS	$ 27,000.00	$27,000.00
8	**SALSNES FILTERS**				$1,612,000.00
	Concrete	150	CY	$ 600.00	$90,000.00
	Salsnes Filters	1	LS	$ 1,396,000.00	$1,396,000.00
	Valves and Piping	1	LS	$ 126,000.00	$126,000.00
9	**CHEMICAL FEED FACILITIES**				$294,000.00
	Pre-Fabricated 9,000 Gallon Fiberglass Tank	2	EA	$ 45,000.00	$90,000.00
	Diaphragm chemical metering pump	4	EA	$ 15,000.00	$60,000.00
	Concrete Containment	90	CY	$ 600.00	$54,000.00
	Valves and Piping	1	LS	$ 90,000.00	$90,000.00
9	**DISK FILTERS**				$1,812,000.00
	Concrete	200	CY	$ 600.00	$120,000.00
	Disk Filters	4	EA	$ 350,000.00	$1,400,000.00
	Re-lift pumps	3	EA	$ 60,000.00	$180,000.00
	Valves and Piping	1	LS	$ 112,000.00	$112,000.00

ACCOUNT NO.	ESTIMATOR	CHECKED BY	DATE
TER10191	LSD	GB	December 9, 2010

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
10	**ULTRA VIOLET RADIATION DISINFECTION SYSTEM**				$903,000.00
	Concrete	300	CY	$ 600.00	$180,000.00
	UV Disinfection Equipment	1	LS	$ 223,000.00	$669,000.00
	Valves and Piping	1	LS	$ 54,000.00	$54,000.00
11	**RAS/WAS Pump Station**				$606,000.00
	Concrete	250	CY	$ 600.00	$150,000.00
	Submersible Pumps and VFDs	1	LS	$ 61,000.00	$305,000.00
	Cost For Isolation Valves and Fittings	1	LS	$ 115,000.00	$115,000.00
	Valves and Piping	1	LS	$ 36,000.00	$36,000.00
12	**WAS HOLDING TANK**				$517,000.00
	Pre-Fabricated Fiberglass Tank	1	LS	$ 390,000.00	$390,000.00
	Sludge Pumps,Motors and VFDs	1	LS	$ 32,000.00	$96,000.00
	Valves and Piping	1	LS	$ 31,000.00	$31,000.00
13	**GRAVITY BELT THICKENERS**				$1,314,000.00
	Concrete	400	CY	$ 600.00	$240,000.00
	Gravity Belt Thickeners	4	EA	$ 218,000.00	$872,000.00
	Polymer Feed and Equipment	1	LS	$ 31,000.00	$124,000.00
	Valves and Piping	1	LS	$ 78,000.00	$78,000.00
14	**SLUDGE BLENDING TANK**				$717,000.00
	Pre-Fabricated Fiberglass Tank	1	LS	$ 390,000.00	$390,000.00
	Sludge Pumps,Motors and Mixers	1	LS	$ 37,000.00	$148,000.00
	Cost For Isolation Valves and Fittings	1	LS	$ 136,000.00	$136,000.00
	Valves and Piping	1	LS	$ 43,000.00	$43,000.00
15	**BELT PRESS BUILDING**				$1,314,000.00
	Concrete	400	CY	$ 600.00	$240,000.00
	Belt Press	4	EA	$ 218,000.00	$872,000.00
	Polymer Feed and Equipment	1	LS	$ 31,000.00	$124,000.00
	Valves and Piping	1	LS	$ 78,000.00	$78,000.00
16	**ADMINISTRATION BUILDING**				$570,000.00
	Concrete	700	CY	$ 600.00	$420,000.00
	Miscellaneous Architectural Cost	1	LS	$ 150,000.00	$150,000.00
17	**MISCELLANEOUS STRUCTURES/EQUIPMENT**				$2,760,000.00
	Miscellaneous Mechanical, Structural, HVAC, Odor Control,	1	LS	$ 2,760,000.00	$2,760,000.00
18	**ELECTRICAL AND INSTRUMENTATION**				$5,534,608.00
	Electrical, Instrumentation, and Control	20.00%		$27,673,040	$5,534,608.00
TOTAL COST (2011$)					**$33,207,648.00**
	CONTINGENCY			**30%**	$9,962,294.40
	SUBTOTAL:				$43,169,942.40
	MOBILIZATION			**5%**	$2,158,497.12
	SUBTOTAL:				$45,328,439.52
	OH&P			**18%**	$8,159,119.11
	SUBTOTAL:				$53,487,558.63
PROJECT TOTAL (2011 $)					**$53,490,000.00**
UNIT COST PER GALLON					**$5.94**
ENGINEERING AND SURVEYING				**18%**	**$9,628,200.00**
TOTAL BUDGETARY COST (2011 $)					**$63,118,200.00**

PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST

Freese and Nichols

KING'S CREEK WASTEWATER PLANT
4.5 MGD BNR ACTIVATED SLUDGE PLANT

ACCOUNT NO.	ESTIMATOR	CHECKED BY	DATE
TER10191	LSD	GB	December 9, 2010

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	**SITE WORK**				$2,520,000.00
	Cost for Demolition, Tree Removal, Trenching for Pipes, Backfilling, Compacting, Grubbing, Grading, Fencing, and Land-Scaping	1	LS	$2,520,000.00	$2,520,000.00
2	**INFLUENT PUMP STATION**				$429,000.00
	Concrete	225	CY	$ 600.00	$135,000.00
	Submersible Pumps and VFDs	3	EA	$ 69,000.00	$207,000.00
	Cost For Isolation Valves and Fittings	1	LS	$ 64,000.00	$64,000.00
	Piping	1	LS	$ 23,000.00	$23,000.00
3	**HEADWORKS**				$1,373,000.00
	Concrete	175	CY	$ 600.00	$105,000.00
	Fine Screens, Washer Unit and Compactor	3	LS	$ 175,000.00	$525,000.00
	Grit Removal Units	3	LS	$ 125,000.00	$375,000.00
	Grit Washing and Compactor	3	EA	$ 100,000.00	$300,000.00
	Valves and Piping	1	LS	$ 68,000.00	$68,000.00
4	**SALSNES FILTERS**				$990,000.00
	Concrete	75	CY	$ 600.00	$45,000.00
	Salsnes Filters	3	LS	$ 294,000.00	$882,000.00
	Valves and Piping	1	LS	$ 63,000.00	$63,000.00
5	**AERATION BASINS**				$1,484,417.20
	Concrete	1,620	CY	$ 600.00	$971,917.20
	Diffusers	12,075	SF	$ 20.00	$241,500.00
	Valves and Piping	1	LS	$ 77,000.00	$77,000.00
	BNR Equipment	1	LS	$ 194,000.00	$194,000.00
6	**BLOWER BUILDING**				$1,220,000.00
	Concrete	60	CY	$ 600.00	$36,000.00
	Blowers, VFDs and Explosion Proof Jackets	3	EA	$ 375,000.00	$1,125,000.00
	Valves and Piping	1	LS	$ 59,000.00	$59,000.00
7	**SIDE STREAM EQUALIZATION STORAGE**				$419,000.00
	Concrete	25	CY	$ 600.00	$15,000.00
	Concrete Tank	1	LS	$ 390,000.00	$390,000.00
	Valves and Piping	1	LS	$ 14,000.00	$14,000.00
9	**CHEMICAL FEED FACILITIES**				$137,000.00
	Pre-Fabricated 4,500 Gallon Fiberglass Tank	1	EA	$ 35,000.00	$35,000.00
	Diaphragm chemical metering pump	2	EA	$ 15,000.00	$30,000.00
	Concrete	45	CY	$ 600.00	$27,000.00
	Valves and Piping	1	LS	$ 45,000.00	$45,000.00
10	**DISK FILTERS**				$913,500.00
	Concrete	113	CY	$ 600.00	$67,500.00
	Disk Filters	2	EA	$ 350,000.00	$700,000.00
	Re-lift pumps	3	EA	$ 30,000.00	$90,000.00
	Valves and Piping	1	LS	$ 56,000.00	$56,000.00
11	**ULTRA VIOLET RADIATION DISINFECTION SYSTEM**				$588,000.00
	Concrete	150	CY	$ 600.00	$90,000.00
	UV Disinfection Equipment	2	EA	$ 232,000.00	$464,000.00
	Valves and Piping	1	LS	$ 34,000.00	$34,000.00

ACCOUNT NO.	ESTIMATOR	CHECKED BY	DATE
TER10191	LSD	GB	December 9, 2010

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
12	**RAS/WAS Pump Station**				$434,000.00
	Concrete	150	CY	$ 600.00	$90,000.00
	Submersible Pumps and VFDs	4	EA	$ 67,000.00	$268,000.00
	Cost For Isolation Valves and Fittings	1	LS	$ 54,000.00	$54,000.00
	Valves and Piping	1	LS	$ 22,000.00	$22,000.00
13	**WAS HOLDING TANK**				$182,000.00
	Pre-Fabricated Fiberglass Tank	1	EA	$ 95,000.00	$95,000.00
	Sludge Pumps,Motors and VFDs	3	EA	$ 26,000.00	$78,000.00
	Valves and Piping	1	LS	$ 9,000.00	$9,000.00
14	**GRAVITY BELT THICKENERS**				$645,000.00
	Concrete	250	CY	$ 600.00	$150,000.00
	Gravity Belt Thickeners	2	EA	$ 199,000.00	$398,000.00
	Polymer Feed and Equipment	2	EA	$ 26,000.00	$52,000.00
	Valves and Piping	1	LS	$ 45,000.00	$45,000.00
15	**SLUDGE BLENDING TANK**				$365,000.00
	Pre-Fabricated Fiberglass Tank	2	EA	$ 95,000.00	$190,000.00
	Sludge Pumps,Motors and Mixers	2	EA	$ 48,000.00	$96,000.00
	Cost For Isolation Valves and Fittings	1	LS	$ 58,000.00	$58,000.00
	Valves and Piping	1	LS	$ 21,000.00	$21,000.00
16	**BELT PRESS BUILDING**				$621,500.00
	Concrete	213	CY	$ 600.00	$127,500.00
	Belt Press	2	EA	$ 199,000.00	$398,000.00
	Polymer Feed and Equipment	2	EA	$ 26,000.00	$52,000.00
	Valves and Piping	1	LS	$ 44,000.00	$44,000.00
17	**ADMINISTRATION BUILDING**				$260,000.00
	Concrete	350	CY	$ 600.00	$210,000.00
	Miscellaneous Architectural Cost	1	LS	$ 50,000.00	$50,000.00
18	**MISCELLANEOUS STRUCTURES/EQUIPMENT**				$1,490,000.00
	Miscellaneous Mechanical, Structural, HVAC, Odor Control, Roadwork	1	LS	$ 1,490,000.00	$1,490,000.00
19	**ELECTRICAL AND INSTRUMENTATION**				$2,814,283.44
	Electrical, Instrumentation, and Control	20.00%		$14,071,417	$2,814,283.44
TOTAL COST (2011$)					**$16,885,700.64**
	CONTINGENCY			**30%**	$5,065,710.19
	SUBTOTAL:				$21,951,410.83
	MOBILIZATION			**5%**	$1,097,570.54
	SUBTOTAL:				$23,048,981.37
	OH&P			**18%**	$4,148,816.65
	SUBTOTAL:				$27,197,798.02
PROJECT TOTAL (2011 $)					**$27,200,000.00**
UNIT COST PER GALLON					**$6.04**
ENGINEERING AND SURVEYING				**18%**	**$4,896,000.00**
TOTAL BUDGETARY COST (2011 $)					**$32,096,000.00**

PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST

Freese and Nichols

KING'S CREEK WASTEWATER PLANT
4.5 MGD BNR ACTIVATED SLUDGE PLANT
EXPANSION

ACCOUNT NO.	ESTIMATOR	CHECKED BY	DATE
TER10191	LSD	GB	December 9, 2010

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	**SITE WORK**				$1,260,000.00
	Cost for Demolition, Tree Removal, Trenching for Pipes, Backfilling, Compacting, Grubbing, Grading, Fencing, and Land-Scaping	1	LS	$1,260,000.00	$1,260,000.00
2	**INFLUENT PUMP STATION**				$429,000.00
	Concrete	225	CY	$ 600.00	$135,000.00
	Submersible Pumps and VFDs	3	EA	$ 69,000.00	$207,000.00
	Cost For Isolation Valves and Fittings	1	LS	$ 64,000.00	$64,000.00
	Piping	1	LS	$ 23,000.00	$23,000.00
3	**HEADWORKS**				$1,373,000.00
	Concrete	175	CY	$ 600.00	$105,000.00
	Fine Screens, Washer Unit and Compactor	3	LS	$ 175,000.00	$525,000.00
	Grit Removal Units	3	LS	$ 125,000.00	$375,000.00
	Grit Washing and Compactor	3	EA	$ 100,000.00	$300,000.00
	Valves and Piping	1	LS	$ 68,000.00	$68,000.00
4	**SALSNES FILTERS**				$807,000.00
	Concrete	75	CY	$ 600.00	$45,000.00
	Salsnes Filters	3	LS	$ 233,000.00	$699,000.00
	Valves and Piping	1	LS	$ 63,000.00	$63,000.00
5	**AERATION BASINS**				$1,484,417.20
	Concrete	1,620	CY	$ 600.00	$971,917.20
	Diffusers	12,075	SF	$ 20.00	$241,500.00
	Valves and Piping	1	LS	$ 77,000.00	$77,000.00
	BNR Equipment	1	LS	$ 194,000.00	$194,000.00
6	**BLOWER BUILDING**				$1,220,000.00
	Concrete	60	CY	$ 600.00	$36,000.00
	Blowers, VFDs and Explosion Proof Jackets	3	EA	$ 375,000.00	$1,125,000.00
	Valves and Piping	1	LS	$ 59,000.00	$59,000.00
7	**SIDE STREAM EQUALIZATION STORAGE**				$419,000.00
	Concrete	25	CY	$ 600.00	$15,000.00
	Concrete Tank	1	LS	$ 390,000.00	$390,000.00
	Valves and Piping	1	LS	$ 14,000.00	$14,000.00
8	**CHEMICAL FEED FACILITIES**				$147,000.00
	Pre-Fabricated 9,000 Gallon Fiberglass Tank	1	EA	$ 45,000.00	$45,000.00
	Diaphragm chemical metering pump	2	EA	$ 15,000.00	$30,000.00
	Concrete	45	CY	$ 600.00	$27,000.00
	Valves and Piping	1	LS	$ 45,000.00	$45,000.00
9	**DISK FILTERS**				$913,500.00
	Concrete	113	CY	$ 600.00	$67,500.00
	Disk Filters	2	EA	$ 350,000.00	$700,000.00
	Re-lift pumps	3	EA	$ 30,000.00	$90,000.00
	Valves and Piping	1	LS	$ 56,000.00	$56,000.00
10	**ULTRA VIOLET RADIATION DISINFECTION SYSTEM**				$588,000.00
	Concrete	150	CY	$ 600.00	$90,000.00
	UV Disinfection Equipment	2	EA	$ 232,000.00	$464,000.00
	Valves and Piping	1	LS	$ 34,000.00	$34,000.00

ACCOUNT NO.	ESTIMATOR	CHECKED BY	DATE
TER10191	LSD	GB	December 9, 2010

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
11	**RAS/WAS Pump Station**				$434,000.00
	Concrete	150	CY	$ 600.00	$90,000.00
	Submersible Pumps and VFDs	4	EA	$ 67,000.00	$268,000.00
	Cost For Isolation Valves and Fittings	1	LS	$ 54,000.00	$54,000.00
	Valves and Piping	1	LS	$ 22,000.00	$22,000.00
12	**WAS HOLDING TANK**				$182,000.00
	Pre-Fabricated Fiberglass Tank	1	EA	$ 95,000.00	$95,000.00
	Sludge Pumps,Motors and VFDs	3	EA	$ 26,000.00	$78,000.00
	Valves and Piping	1	LS	$ 9,000.00	$9,000.00
13	**GRAVITY BELT THICKENERS**				$645,000.00
	Concrete	250	CY	$ 600.00	$150,000.00
	Gravity Belt Thickeners	2	EA	$ 199,000.00	$398,000.00
	Polymer Feed and Equipment	2	EA	$ 26,000.00	$52,000.00
	Valves and Piping	1	LS	$ 45,000.00	$45,000.00
14	**SLUDGE BLENDING TANK**				$365,000.00
	Pre-Fabricated Fiberglass Tank	2	EA	$ 95,000.00	$190,000.00
	Sludge Pumps,Motors and Mixers	2	EA	$ 48,000.00	$96,000.00
	Cost For Isolation Valves and Fittings	1	LS	$ 58,000.00	$58,000.00
	Valves and Piping	1	LS	$ 21,000.00	$21,000.00
15	**BELT PRESS BUILDING**				$621,500.00
	Concrete	213	CY	$ 600.00	$127,500.00
	Belt Press	2	EA	$ 199,000.00	$398,000.00
	Polymer Feed and Equipment	2	EA	$ 26,000.00	$52,000.00
	Valves and Piping	1	LS	$ 44,000.00	$44,000.00
16	**ADMINISTRATION BUILDING**				$260,000.00
	Concrete	350	CY	$ 600.00	$210,000.00
	Miscellaneous Architectural Cost	1	LS	$ 50,000.00	$50,000.00
17	**MISCELLANEOUS STRUCTURES/EQUIPMENT**				$990,000.00
	Miscellaneous Mechanical, Structural, HVAC, Odor Control, Roadwork	1	LS	$ 990,000.00	$990,000.00
18	**ELECTRICAL AND INSTRUMENTATION**				$2,427,683.44
	Electrical, Instrumentation, and Control	20.00%		$12,138,417	$2,427,683.44
TOTAL COST (2011$)					**$14,566,100.64**
	CONTINGENCY			**30%**	$4,369,830.19
	SUBTOTAL:				$18,935,930.83
	MOBILIZATION			**5%**	$946,796.54
	SUBTOTAL:				$19,882,727.37
	OH&P			**18%**	$3,578,890.93
	SUBTOTAL:				$23,461,618.30
PROJECT TOTAL (2011 $)					**$23,460,000.00**
UNIT COST PER GALLON					**$5.21**
ENGINEERING AND SURVEYING				**18%**	**$4,222,800.00**
TOTAL BUDGETARY COST (2011 $)					**$27,682,800.00**

Freese and Nichols

PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST

KING'S CREEK WASTEWATER PLANT
INTERIM IMPLEMENTATION IMPROVEMENTS

ACCOUNT NO.	ESTIMATOR	CHECKED BY	DATE
TER10191	LSD	GB	December 8, 2010

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	**SITE WORK**				$14,000.00
	Cost for Demolition, Tree Removal, Trenching for Pipes, Backfilling, Compacting, Grubbing, Grading, Fencing, and Land-Scaping	1	LS	$14,000.00	$14,000.00
2	**CHEMICAL FEED FACILITIES**				$176,000.00
	Pre-Fabricated, 5,000 Gallon, Double Wall Fiberglass Tank	2	EA	$ 33,000.00	$66,000.00
	Diaphragm chemical metering pump skid	1	LS	$ 36,000.00	$36,000.00
	Concrete	45	CY	$ 600.00	$27,000.00
	Canopy	1	LS	$ 24,000.00	$24,000.00
	Valves and Piping	1	LS	$ 23,000.00	$23,000.00
3	**ELECTRICAL AND INSTRUMENTATION**				$44,000.00
	Electrical, Instrumentation, and Control	25%		$176,000	$44,000.00

TOTAL COST			**$234,000.00**
	CONTINGENCY	**30%**	$70,200.00
	SUBTOTAL:		$304,200.00
	MOBILIZATION	**5%**	$15,210.00
	SUBTOTAL:		$319,410.00
	OH&P	**18%**	$57,493.80
	SUBTOTAL:		$376,903.80
PROJECT TOTAL (2011$)			**$380,000.00**
UNIT COST PER GALLON			**$0.08**
ENGINEERING AND SURVEYING		**18%**	**$68,400.00**
TOTAL BUDGETARY COST (2011$)			**$448,400.00**

Freese and Nichols

PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST

KING'S CREEK WASTEWATER PLANT
INTERIM IMPLEMENTATION IMPROVEMENTS

ACCOUNT NO.	ESTIMATOR	CHECKED BY	DATE
TER10191	LSD	GB	December 8, 2010

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	**SITE WORK**				$79,000.00
	Cost for Demolition, Tree Removal, Trenching for Pipes, Backfilling, Compacting, Grubbing, Grading, Fencing, and Land-Scaping	1	LS	$79,000.00	$79,000.00
2	**DISK FILTERS**				$1,044,500.00
	Concrete	113	CY	$ 600.00	$67,500.00
	Disk Filters	2	EA	$ 420,000.00	$840,000.00
	Re-lift pumps	3	EA	$ 27,000.00	$81,000.00
	Valves and Piping	1	LS	$ 56,000.00	$56,000.00
3	**ELECTRICAL AND INSTRUMENTATION**				$261,125.00
	Electrical, Instrumentation, and Control	25%		$1,044,500	$261,125.00
TOTAL COST					**$1,384,625.00**
	CONTINGENCY			**30%**	$415,387.50
	SUBTOTAL:				$1,800,012.50
	MOBILIZATION			**5%**	$90,000.63
	SUBTOTAL:				$1,890,013.13
	OH&P			**18%**	$340,202.36
	SUBTOTAL:				$2,230,215.49
PROJECT TOTAL (2011$)					**$2,230,000.00**
UNIT COST PER GALLON					**$0.50**
ENGINEERING AND SURVEYING				**18%**	**$401,400.00**
TOTAL BUDGETARY COST (2011$)					**$2,631,400.00**

Freese and Nichols

PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST

KING'S CREEK WASTEWATER PLANT
INTERIM IMPLEMENTATION IMPROVEMENTS

ACCOUNT NO.	ESTIMATOR	CHECKED BY	DATE
TER10191	LSD	GB	December 8, 2010

ITEM	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
1	**SITE WORK**				$61,000.00
	Cost for Demolition, Tree Removal, Trenching for Pipes, Backfilling, Compacting, Grubbing, Grading, Fencing, and Land-Scaping	1	LS	$61,000.00	$61,000.00
2	**SALSNES FILTERS**				$802,000.00
	Concrete	75	CY	$ 600.00	$45,000.00
	Access Platform	1	LS	$ 20,000.00	$20,000.00
	Salsnes Filters	3	LS	$ 233,000.00	$699,000.00
	Valves and Piping	1	LS	$ 38,000.00	$38,000.00
3	**ELECTRICAL AND INSTRUMENTATION**				$200,500.00
	Electrical, Instrumentation, and Control	25%		$802,000	$200,500.00
TOTAL COST					**$1,063,500.00**
	CONTINGENCY			**30%**	$319,050.00
	SUBTOTAL:				$1,382,550.00
	MOBILIZATION			**5%**	$69,127.50
	SUBTOTAL:				$1,451,677.50
	OH&P			**18%**	$261,301.95
	SUBTOTAL:				$1,712,979.45
PROJECT TOTAL (2011$)					**$1,710,000.00**
UNIT COST PER GALLON					**$0.38**
ENGINEERING AND SURVEYING				**18%**	**$307,800.00**
TOTAL BUDGETARY COST (2011$)					**$2,017,800.00**

Appendix F:
Chemical Phosphorus Removal Calculations

Chemical Phosphorus Removal

FREESE AND NICHOLS

Innovative approaches
Practical results
Outstanding service

PROJECT NAME: King's Creek WWTP
PROJECT NUMBER: TER 10191

DATE: Aug-10
BY: LSD
CHECK:

FULL CHEMICAL P REMOVAL

Influent Phosphorus		8	mg/L
Effluent Phosphorus		0.5	mg/L
AADF		4.5	MGD
Phosphorus to be removed		281	lbs/day
		127,677	g/day
		4,123	moles/day

Aluminum sulfate solution

Assumed aluminum molar ratio		1.03	M:P (Source: WEF MOP 29)
Aluminum required		4,246	moles/day
		114,650	g/day
Alum required		1,261,146	g/day
		2,784	**lbs/day**
Percent solution		49%	
Specific gravity		1.34	
Volume required		**513.6**	**gal/day**
Number of totes		**2.0**	
Volume per container		**500.0**	**gallons**
Days of Storage		**1.9**	**days**
Flow Period		30	min/cycle
Cycles per day per basin		5.0	
Total feed time		450	min/day
Pump flow rate		**68.5**	**gph**

Chemical Cost

Alum	$	0.12	per pound
	$	334.08	per day
	$	**121,938.61**	**per year**

Sludge Production

Existing production		2,400,000	gal/year
Increase from chemical feed		35	%
Future solids production		3240000.0	gal/year
Cost per gallon		0.085	
Current Cost	$	204,000	
Future Cost	$	275,400	
Difference	**$**	**71,400**	
Total Cost Increase	**$**	**193,338.61**	**per year**

PARTIAL CHEMICAL P REMOVAL; RELY ON BIO P

Influent Phosphorus		1.5	mg/L
Effluent Phosphorus		0.5	mg/L
AADF		4.5	MGD
Phosphorus to be removed		38	lbs/day
		17,024	g/day
		550	moles/day

Aluminum sulfate solution

Assumed aluminum molar ratio		1.03	M:P (Source: WEF MOP 29)
Aluminum required		566	moles/day
		15,287	g/day
Alum required		168,153	g/day
		371	**lbs/day**
Percent solution		49%	
Specific gravity		1.34	
Volume required		**68.5**	**gal/day**
Number of totes		**2.0**	
Volume per container		**500.0**	**gallons**
Days of Storage		**14.6**	**days**
Flow Period		30	min/cycle
Cycles per day per basin		5.0	
Total feed time		450	min/day
Pump flow rate		**9.1**	**gph**

Chemical Cost

Alum	**$**	**0.12**	**per pound**
	$	**44.54**	**per day**
	$	**16,258.48**	**per year**

Appendix G:
Treatment Operation and Maintenance Costs

Operation and Maintenance Cost - Comparison

FREESE AND NICHOLS

Innovative approaches
Practical results
Outstanding service

PROJECT NAME: King's Creek WWTP
PROJECT NUMBER: TER 10191

DATE: January 2011
BY: LSD
CHECK: GB

	Cost per 1,000 gallons (2011$)
Alternative 1	
Before 2022	$ 2.18
After 2022	$ 2.12
Alternative 2	$ 2.12

Year	Projected Flow Rate (MGD)	Yearly O&M (2011 $) Alternative 1	Alternative 2
2013	1.96	$ 1,554,614	$ 1,512,445
2014	2.03	$ 1,612,568	$ 1,568,827
2015	2.11	$ 1,673,356	$ 1,627,966
2016	2.18	$ 1,735,880	$ 1,688,794
2017	2.28	$ 1,808,917	$ 1,759,850
2018	2.37	$ 1,884,879	$ 1,833,751
2019	3.08	$ 2,445,681	$ 2,379,341
2020	3.38	$ 2,689,015	$ 2,616,075
2021	3.71	$ 2,947,157	$ 2,867,215
2022	4.06	$ 3,139,699	$ 3,139,699
2023	4.44	$ 3,436,549	$ 3,436,549
2024	4.84	$ 3,741,849	$ 3,741,849
2025	5.24	$ 4,050,349	$ 4,050,349
2026	5.76	$ 4,450,537	$ 4,450,537
2027	6.27	$ 4,850,726	$ 4,850,726
2028	6.70	$ 5,178,080	$ 5,178,080
2029	7.01	$ 5,424,595	$ 5,424,595
2030	7.33	$ 5,664,708	$ 5,664,708
2031	7.59	$ 5,872,273	$ 5,872,273
2032	7.86	$ 6,079,837	$ 6,079,837
2033	8.13	$ 6,287,401	$ 6,287,401
2034	8.40	$ 6,494,965	$ 6,494,965
2035	8.67	$ 6,702,530	$ 6,702,530
2036	8.94	$ 6,910,094	$ 6,910,094
2037	9.20	$ 7,117,658	$ 7,117,658
2038	9.44	$ 7,303,879	$ 7,303,879
2039	9.61	$ 7,431,406	$ 7,431,406
2040	9.78	$ 7,559,110	$ 7,559,110
Total		**$ 126,048,312**	**$ 125,550,509**

Appendix H:
Salsnes Filters Information

BLUE WATER TECHNOLOGIES INC

Blue Water Technologies, Inc.

September 2, 2010

Leon Downing, Ph.D., P.E.
Freese and Nichols, Inc.
4055 International Plaza, Suite 200
Fort Worth, Texas 76109-4895

Subject: Primary Filtration
City of Terrell, Texas – King's Creek WWTP
Proposal # 100249-001

Dear Dr. Downing:

Blue Water Technologies, Inc. (Blue Water) appreciates the opportunity to provide our proposal to you for the project referenced above. Blue Water is the exclusive United States distributor of the Salsnes filtration technology, developed in 1992 by Salsnes Filter AS, Norway. The Salsnes Filter is a fully automated mechanical wastewater treatment system for primary treatment in municipal or industrial applications.

The Salsnes Filter has a flexible range of removal efficiencies, depending upon the customer's requirements. The Salsnes system offers filter ranges from 50 microns to 850 microns. By simply changing the screen mesh size, the system may be used for effective pre-treatment to replace conventional primary treatment or to separate secondary sludge from biological or chemical plants. The Salsnes Filters are compact, completely covered systems with a small footprint and are easy to maintain. The filters provide removal efficiencies of more than 50% for Total Suspended Solids (TSS) and more than 20% removal of Biochemical Oxygen Demand (BOD_5) from typical municipal wastewater. An integrated dewatering option can provide solids concentrations of 25-40% in the dewatered sludge cake.

Blue Water offers a broad platform of water treatment technology products, from primary wastewater treatment to advanced effluent polishing steps to environmental remediation processes. Our team strives to meet customers' needs cost-effectively, considering both capital expense and ongoing operations and maintenance costs. Additionally, we keep an eye on the future by looking for sustainability in our technologies, including environmentally-friendly materials and energy conservation.

1.0 Equipment Features and Benefits:

- Patented air cleaning system allows for self-cleaning operation.

- When compared with sedimentation as primary sewage treatment, the Salsnes Filter typically requires less than 50% of the capital investment and less than 10% of the footprint.

- Models are available as stand alone, in-channel, or with integrated chemical flocculation chambers.

- Compact, operator friendly design results in very low maintenance costs – typically less than one (1) hour or routine maintenance per week.

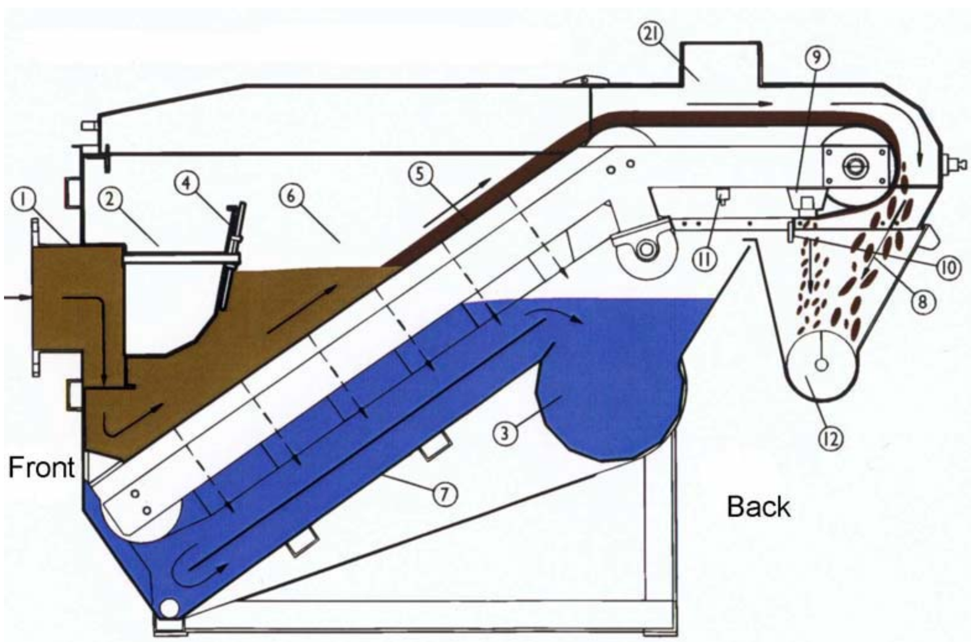
- Odor problems are mitigated.

- The Salsnes Filters are thoroughly proven and documented.

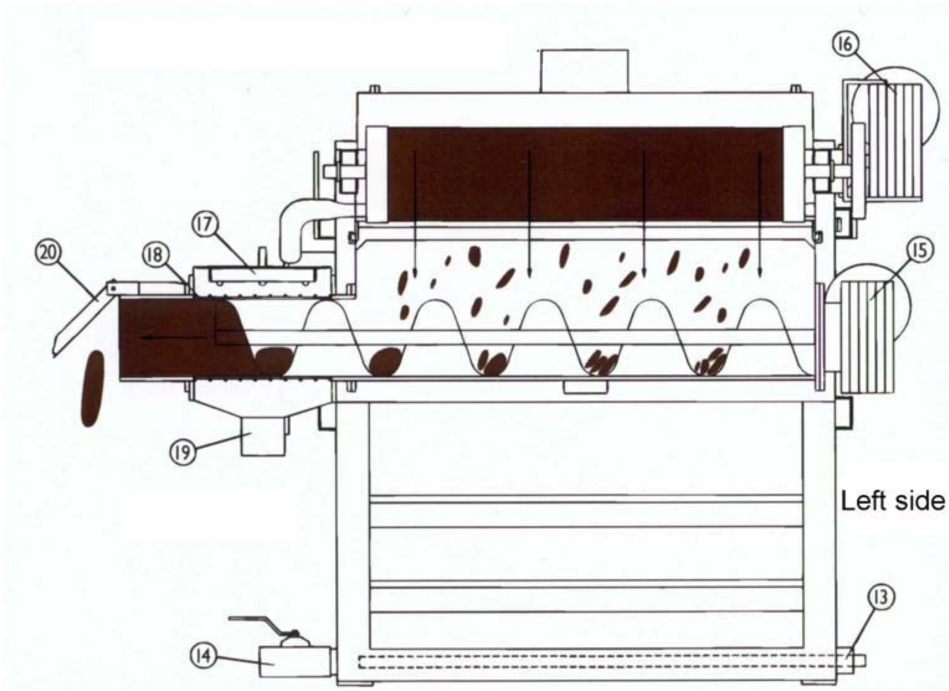
1.1 **System Design**:

The Salsnes Filter is a fully automated mechanical wastewater treatment system for primary treatment in municipal or industrial applications. The SF series includes integrated dewatering for the filtered sludge. The system is prepared for odor mitigation with its enclosed design and connection pipe for ventilation and odor control systems.

As wastewater enters the inlet pipe, it is intercepted by an inclined moving mesh screen. The solids are removed by the mesh screen and liquid that passed through the filter is collected behind the wire cloth and discharged into the outlet pipe. Solids deposited on the mesh screen are transported upward and collected in the sludge compartment. The system uses high pressure air for removal of the sludge resulting in a dry cake. Collected sludge is dewatered to approximately 25-35% dry solids in the optional integrated screw press and press cylinder. The mesh screen is washed twice a day with hot water to remove oil and grease. A side view of the Salsnes Filter is depicted in Figure 1.



Cut from the right side



Cut from behind

Figure 1. **The Salsnes Filter fine mesh sieve**.

Key:

1 Inlet	9 Air cleaning device	16 Gear/motor for wire cloth
2 Overflow	10 Rubber scraper	17 Hot water nozzles for cleaning press cylinder
3 Outlet	11 Hot water nozzles	
4 Level indicator	12 Screw	18 Optional Press cylinder
5 Wire cloth	13 Cold water pipe for settled waste removal	19 Optional Reject from press cylinder
6 Wastewater		
7 Filtered water	14 Drain valve for settled waste	20 Optional Spring-loaded lid
8 Sludge compartment	15 Gear/motor for screw press	21 Ventilation

2.0 Basis of Design:

Influent TSS	160 mg/L
Influent BOD	150 mg/L
Average design flow	4.5 MGD
Peak design flow	9.0 MGD

3.0 Proposed Treatment System:

Blue Water is pleased to offer three (3) Salsnes Model SF-6000 primary filters with associated ancillary equipment to treat the above referenced waste stream.

TSS separation efficiency	40-70%
Particulate BOD separation efficiency	20-30%

Filter Cake	20 - 35% solids (if applicable)
Filter mesh size	350 micron (anticipated size)
Size (L x W x H)	102" x 107" x 65" (each filter)
Weight including water	3,792 lbs (each filter)

The proposed Salsnes Filter system will be complete and will include the following:

(3) Salsnes SF-6000 Filters
(3) Air blowers
(1) Water heater
(1) Electrical control panel (NEMA 4)
(3) Extra filter belts, 350 micron

4.0 Equipment Price and Included Field Engineering:

Blue Water's budgetary price of components and service for this project is ....**$698,000.**

Equipment is F.O.B. factory. The price does not include any import, sales, use, excise or similar taxes, fees, permits, etc. This proposal is valid for a period of sixty (60) days unless extended in writing by Blue Water.

Terms: 25% (net 30 days) with purchase order
25% (net 30 days) with approval of drawings and submittals
45% (net 30 days) with delivery of the equipment to the jobsite
5% (net 30 days) payable upon startup not to exceed 45 days from delivery

The price includes an allowance for factory trained **Manufacturer's Services** as noted below:

- Up to Twelve (12) - Eight (8) hour days in up to Three (3) trips for installation oversight, start-up, and training.

Additional time, if requested by the Owner, shall be invoiced at the rate of $1,200 per day plus travel and living expenses.

5.0 Estimated Submittal and Shipping Dates:

Blue Water is prepared to ship equipment in approximately eighteen (18) to twenty-two (22) weeks from the receipt of approved drawings, submittals, and a signed release to fabrication. Submittals shall be issued to the engineer within four (4) to six (6) weeks from the date of countersigned purchase order. While drawings are issued for approval, they are intended for informational purposes only. The drawings will remain Blue Water's property and may not be used by others for fabrication.

6.0 Warranty:

Equipment will be warranted against manufacturer's defects in accordance with Blue Water's standard warranty for twelve (12) months from start-up or fourteen (14) months from date of shipment, whichever comes first, when operated at stated conditions and according to the instructions in Blue Water's operations and maintenance manual.

7.0 Work by "Others":

The following items are not included in this **Scope of Supply**, but will be required for these systems:

- Preparation of structural engineering drawings for all concrete work.
- Concrete material and its placement.
- Site preparation, unloading, placement and installation of equipment. Installation of all Blue Water supplied equipment.
- Ancillary tankage (chemical feed tanks, flow equalization tanks, etc.).
- Buildings and building utilities and HVAC.
- Supply and connection of electrical service to Blue Water supplied control panel. Supply, installation, and connection of interconnecting circuits between Blue Water supplied panels and auxiliary panels and/or instrumentation.
- Supply and installation of required drain piping, influent piping, effluent piping, overflow piping, all associated valves, required pipe support, and appurtenances to and from the connection point on Blue Water supplied equipment.
- Supply and installation of interconnecting vent, drain, and airlines and their associated valves and appurtenances.
- Supply and installation of insulation and heat tracing of any piping or tubing (if required).
- Chemicals required for operation (if required).

Thank you for your consideration on this project. If you have questions or need additional formation, please feel free to contact our manufacturer's representative Bob Russell of Hartwell Environmental Corporation at (817) 446-9500 or myself at (208) 209-0391.

Sincerely,

Tony Moraska
Regional Sales Manager

Blue Water Technologies, Inc.
10450 N. Airport Drive
Hayden, Idaho 83835
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Appendix I:
Activated Sludge Sizing

Facility:	City of Terrell - New WWTP	**Project:**	
Notes:	Regional Wastewater Treatment Study	**Date:**	7/25/2010
	TCEQ Section 217 design criteria	**By:**	LSD
Scenario:	New Facility	**QC:**	GB

1. WASTEWATER AND PLANT CHARACTERIZATION

Flow rates

Annual average			**4.5**	MGD =	3,125	gpm
Peak month	Factor =	**1.5**	6.8	MGD =	4,688	gpm
Peak 2-hour	Factor =	**2**	9.0	MGD =	6,250	gpm
Min. Month	Factor =	**0.5**	2.3	MGD =	1,563	gpm

Raw Wastewater Concentrations

		Avg.	2-hr Peak	Peak Month	Min. Month
BOD (total)	mg/L	**130**	**120**	**250**	**200**
BOD (soluble)	mg/L	**78**	**80**	**200**	**120**
TSS	mg/L	**150**	**200**	**250**	**200**
VSS	mg/L	**120**	**60**	**150**	**140**
TKN	mg/L	**32**	**30**	**45**	**35**
NH3-N	mg/L	**25**	**20**	**30**	**20**
TP	mg/L	**8**	**8**	**10**	**8**

Effluent Requirements

BOD	mg/L	**7**
TSS	mg/L	**15**
NH3-N	mg/L	**3**
TP	mg/L	**1**
DO	mg/L	**6**

Select Treatment Processes from the list

Preliminary Treatment	**Coarse Screening**
Primary Treatment	**Conventional**
Biological Treatment	**Conv. Act. Sldg w/ Nitrification, @ Min. Temp 13-15 C**
Solids Treatment	**Aerobic Digestion + Dewatering**

2. ACTIVATED SLUDGE BASIN

Enter data in grey cells

Description:
Conv. Act. Sldg w/ Nitrification, @ Min. Temp 13-15 C

A. TCEQ Design Criteria (Chapter 217, Subchapter F)

Aeration Basin Max. Organic Loading = 25 lb BOD/1000 ft^3-d
Aeration basin min. depth = 10 ft
Number of basins (for flow > 0.4 MGD) = 2

BOD Removal Credit for Preliminary and Primary Treatment (Optional) = **30%**

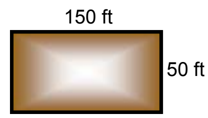
		Avg	2-hr Peak	Peak Month	Min
BOD concentration to aeration basin =	mg/L	91	84	175	140

Design BOD Loading Rate = **25** lb BOD/1000 ft^3-d
(If you want to use a loading rate different than the TCEQ design criteria)

Total peak BOD loading (based on peak month flow) = 9,852 lb/d
Total aeration volume required = 394,080 ft^3

B. Aeration Basins Sizing

Conventional Rectangular Basin Configuration

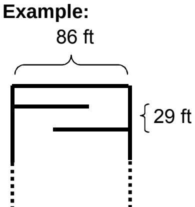


Required number of aeration basins = **3**
Assume side water depth of basins = **18** ft
Volume of each basin = 131,360 ft^3
Surface area of each basin = 7,298 ft^2
Assume Length to Width Ratio = **3.0** to 1 (Typical 3 or 4 to 1)
Required Width of each basin = **50** ft
Required Length of each basin = **150** ft

Notes: Multipass configuration is more amenable to step feed, future IFAS retrofitting, and for anoxic and/or anaerobic zones for biological nutrient removal

Square Basin Multipass Configuration

Example:



Required number of aeration basins = **3**
Assume side water depth of basins = **18** ft
Number of passes = **3**
Volume of each basin = 131,360 ft^3
Surface area of basins = 7,298 ft^2

Assume square aeration basins w/ multiple passes
Required length and width of basins = **86** ft
Width of each pass = 29.0 ft

C. Aeration Equipment Sizing

Aeration Requirements		Avg	2-hr Peak	Peak Month	Min
BOD Loading =	lb/d	3,416	6,306	9,852	2,628
Oxygen Requirement =	SCF/lb BOD	3,200	3,200	3,200	3,200
Minimum Required Air Flow rate =	scfm	**8,000**	**15,000**	**22,000**	**6,000**

Notes: The aeration system should be designed so that the maximum design air requirements can be met with the largest single blower out of service.

For detailed aeration requirement calculations, refer to **Activated Sludge Aeration Calculation Spredsheet/Tool** on Water/Wastewater Treatment TEP website.

3. SECONDARY CLARIFICATION UNITS

Enter data in grey cells

Description:
Conv. Act. Sldg w/ Nitrification, @ Min. Temp 13-15 C

A. TCEQ Design Criteria (Chapter 317.4 (d))

Max. surface loading rate @ design flow =	700	gal/ft^2-d
Max. surface loading rate @ peak flow =	1,400	gal/ft^2-d
Min. side water depth =	10	ft
Min. detention time @ design flow =	2.6	hr
Min. detention time @ peak flow =	1.3	hr
Max. weir loading rate =	30,000	gal/ft-d
Solids loading rate @ peak flow rate =	50	lb TSS/ft^2-d

TCEQ Design Criteria (Chapter 217, Subchapter F)

Max. surface loading rate @ peak flow =	1200	gal/ft^2-d
Min. detention time @ peak flow =	1.8	hr
Min. side water depth =	10	ft

B. Clarifier Sizing

Diameter =	**65**	ft	
Depth =	**16**	ft	
Surface area =	3,317	ft^2	
Volume =	53,066	ft^3	
Design capacity of clarifier =	2.32	MGD	
Peak capacity of clarifier =	3.98	MGD	
Max. weir loading rate =	19,500	gal/ft-d	**OK!**
Min detention time @ design flow =	4.12	hr	**OK!**
Min detention time @ peak flow =	2.40	hr	**OK!**

Number of clarifiers required =	**3**

4. SLUDGE PUMPING UNITS

Enter data in grey cells

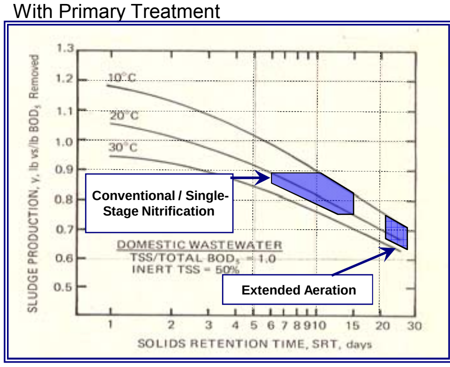
Description:
Conv. Act. Sldg w/ Nitrification, @ Min. Temp 13-15 C

A. WAS Pump Sizing

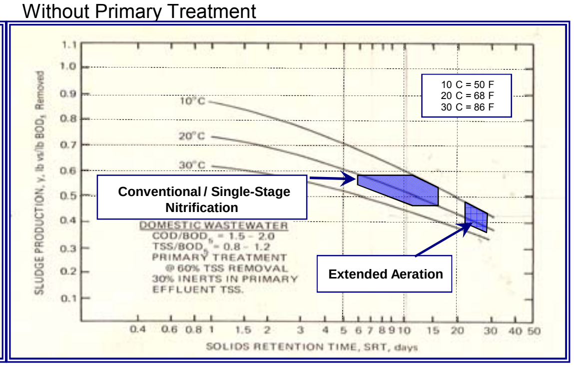
(If there is a RAS/WAS pump station with separate RAS and WAS pumps)

Select Solids Yield from the Chart below:

With Primary Treatment



Without Primary Treatment



Net secondary sludge production = **0.5** lb VS/BOD removed

Notes: Typical minimum Solids Retention Time (SRT) maintained in WWTPs is 8 days. Secondary solids production is typically estimated at SRT of 8 days and at 15C temperature.

		Avg	2-hr Peak	Peak Month	Min
Select Mixed Liquor VS/TS Ratio =		0.75	0.6	0.8	0.8
Select solids concentration in WAS =	mg/L	8,000	6,000	10,000	8,000

		Avg	2-hr Peak	Peak Month	Min
Secondary solids produced =	lb TS/d	3,077	7,068	8,550	2,264
	lb TS/hr	128	295	356	94
Wet secondary sludge produced =	gal/d	46,125	141,250	102,516	33,926
	GPM	32	98	71	24

B. RAS Pump Sizing

Approach #1

Maximum secondary clarifier underflow rate per clarifier= 400 gal/d.ft^2
Maximum secondary clarifier underflow per clarifier= 1,326,650 gal/d
1,000 GPM

Notes: A conservative design would be a single dedicated RAS pump for each clarifier with one stanby pump for every pair of clarifiers. For example, a triplex RAS pump station for a plant with two final clarifiers

Total number of clarifiers = 3
Number of RAS pumps = 4
Flow rate of each RAS pump = 1,000 GPM
Total Max. RAS Flow Rate = 4,000 GPM

OR

Approach #2

		Avg	2-hr Peak	Peak Month	Min
Assume MLSS in the aeration basins =	mg/L	3,000	1,500	3,500	2,500
Solids concentration in RAS =	mg/L	**8,000**	**6,000**	**10,000**	**8,000**
Required recycle ratio =		0.6	0.34	0.54	0.46
Total RAS Flow Rate =	MGD	2.7	3.06	3.645	1.035
	GPM	1,875	2,125	2,531	719

C. Primary Sludge Pump Sizing

Select % TSS removed in Primary Clarifier = **65%** (Typical 60%-65%)
Select % solids in primary sludge = **2.0%** (Typical 1.5% - 2%)

		Avg	2-hr Peak	Peak Month	Min
Dry Primary solids produced =	lb/d	3,659	9,758	9,148	2,439
	lb/hr	152	407	381	102
(Typical ≈ 1,000 lb/MG)	lb/MG	813	1,084	1,355	1,084
Wet primary sludge produced =	gal/d	22,000	58,500	54,900	14,700
	GPM	15	41	38	10

Appendix J:
Cost Estimate Tables for Conveyance CIP Projects

Table X
City of Terrell
Regional Wastewater System Analysis
Opinions Of Probable Project Cost
Option 1 - 2025

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
1	New 7 MGD King's Creek Lift Station; 20" Force Main to Bachelor Creek Lift Station	Lift Station - New 7 MGD	1	LS	$2,500,000	$2,500,000
		20" Force Main	6,250	LF	$110	$687,500
					Subtotal	$3,187,500
					Contingency @ 30%	$956,250
					Subtotal	$4,143,750
					Mobilization @ 5%	$207,188
					Subtotal	$4,350,938
					OH&P @ 18%	$783,169
					Total Construction Cost	$5,134,106
					Engineering, Surveying & Geotech @ 18%	$924,139
					Easement/ROW cost	$625,000
					Total Project Cost	$6,683,245
2	New 16 MGD Bachelor Creek Lift Station; 30" Force Main to Brushy Creek tie-in	Lift Station - New 16 MGD	1	LS	$3,500,000	$3,500,000
		30" Force Main	26,250	LF	$165	$4,331,250
					Subtotal	$7,831,250
					Contingency @ 30%	$2,349,375
					Subtotal	$10,180,625
					Mobilization @ 5%	$509,031
					Subtotal	$10,689,656
					OH&P @ 18%	$1,924,138
					Total Construction Cost	$12,613,794
					Engineering, Surveying & Geotech @ 18%	$2,270,483
					Easement/ROW cost	$2,625,000
					Total Project Cost	$17,509,277
3	New 5 MGD Brushy Creek Lift Station and 36" Brushy Creek Force Main; FM conveys flow from Brushy and Bachelor Creek Lift Stations	Lift Station - New 5 MGD	1	LS	$2,000,000	$2,000,000
		36" Force Main	30,050	LF	$198	$5,949,900
					Subtotal	$7,949,900
					Contingency @ 30%	$2,384,970
					Subtotal	$10,334,870
					Mobilization @ 5%	$516,744
					Subtotal	$10,851,614
					OH&P @ 18%	$1,953,290
					Total Construction Cost	$12,804,904
					Engineering, Surveying & Geotech @ 18%	$2,304,883
					Easement/ROW cost	$3,005,000
					Total Project Cost	$18,114,787

City of Terrell
Regional Wastewater System Analysis Costs- Option One (2025) **$42,307,309**

Table X
City of Terrell
Regional Wastewater System Analysis
Opinions Of Probable Project Cost
Option 1 - 2040

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
1	King's Creek Lift Station expansion from 7 MGD to 15 MGD by adding a parallel 8 MGD Lift Station; 20" Parallel Force Main to Bachelor Creek Lift Station	Lift Station - New 8 MGD	1	LS	$2,750,000	$2,750,000
		20" Force Main	6,250	LF	$110	$687,500
					Subtotal	$3,437,500
					Contingency @ 30%	$1,031,250
					Subtotal	$4,468,750
					Mobilization @ 5%	$223,438
					Subtotal	$4,692,188
					OH&P @ 18%	$844,594
					Total Construction Cost	$5,536,781
					Engineering, Surveying & Geotech @ 18%	$996,621
					Easement/ROW cost	$156,250
					Total Project Cost	$6,689,652
2	Bachelor Creek Lift Station expansion from 16 MGD to 28 MGD by adding a parallel 12 MGD Lift Station; 30" Parallel Force Main to Brushy Creek tie-in	Lift Station - New 12 MGD	1	LS	$3,000,000	$3,000,000
		30" Force Main	26,250	LF	$165	$4,331,250
					Subtotal	$7,331,250
					Contingency @ 30%	$2,199,375
					Subtotal	$9,530,625
					Mobilization @ 5%	$476,531
					Subtotal	$10,007,156
					OH&P @ 18%	$1,801,288
					Total Construction Cost	$11,808,444
					Engineering, Surveying & Geotech @ 18%	$2,125,520
					Easement/ROW cost	$656,250
					Total Project Cost	$14,590,214
3	Brushy Creek Lift Station expansion from 5 MGD to 11 MGD by adding a parallel 6 MGD Lift Station; 36" Parallel Force Main to Mustang Creek Lift Station	Lift Station - New 6 MGD	1	LS	$2,250,000	$2,250,000
		36" Force Main	30,050	LF	$198	$5,949,900
					Subtotal	$8,199,900
					Contingency @ 30%	$2,459,970
					Subtotal	$10,659,870
					Mobilization @ 5%	$532,994
					Subtotal	$11,192,864
					OH&P @ 18%	$2,014,715
					Total Construction Cost	$13,207,579
					Engineering, Surveying & Geotech @ 18%	$2,377,364
					Easement/ROW cost	$751,250
					Total Project Cost	$16,336,193

City of Terrell
Regional Wastewater System Analysis Costs- Option One (2040) **$37,616,059**

Table X
City of Terrell
Regional Wastewater System Analysis
Opinions Of Probable Project Cost
Option 2 - 2025

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
1	New 7 MGD King's Creek Lift Station; 20" Force Main to Bachelor Creek Lift Station	Lift Station - New 7 MGD	1	LS	$2,500,000	$2,500,000
		20" Force Main	6,250	LF	$110	$687,500
					Subtotal	$3,187,500
					Contingency @ 30%	$956,250
					Subtotal	$4,143,750
					Mobilization @ 5%	$207,188
					Subtotal	$4,350,938
					OH&P @ 18%	$783,169
					Total Construction Cost	$5,134,106
					Engineering, Surveying & Geotech @ 18%	$924,139
					Easement/ROW cost	$625,000
					Total Project Cost	$6,683,245
2	New 16 MGD Bachelor Creek Lift Station; 30" Force Main to Brushy Creek tie-in	Lift Station - New 16 MGD	1	LS	$3,500,000	$3,500,000
		30" Force Main	26,250	LF	$165	$4,331,250
					Subtotal	$7,831,250
					Contingency @ 30%	$2,349,375
					Subtotal	$10,180,625
					Mobilization @ 5%	$509,031
					Subtotal	$10,689,656
					OH&P @ 18%	$1,924,138
					Total Construction Cost	$12,613,794
					Engineering, Surveying & Geotech @ 18%	$2,270,483
					Easement/ROW cost	$2,625,000
					Total Project Cost	$17,509,277
3	New 5 MGD Brushy Creek Lift Station and 36" Brushy Creek Force Main; FM conveys flow from Brushy and Bachelor Creek Lift Stations	Lift Station - New 5 MGD	1	LS	$2,000,000	$2,000,000
		36" Force Main	38,750	LF	$198	$7,672,500
					Subtotal	$9,672,500
					Contingency @ 30%	$2,901,750
					Subtotal	$12,574,250
					Mobilization @ 5%	$628,713
					Subtotal	$13,202,963
					OH&P @ 18%	$2,376,533
					Total Construction Cost	$15,579,496
					Engineering, Surveying & Geotech @ 18%	$2,804,309
					Easement/ROW cost	$3,875,000
					Total Project Cost	$22,258,805

City of Terrell
Regional Wastewater System Analysis Costs- Option Two (2025) **$46,451,328**

Table X
City of Terrell
Regional Wastewater System Analysis
Opinions Of Probable Project Cost
Option 2 - 2040

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
1	King's Creek Lift Station expansion from 7 MGD to 15 MGD by adding a parallel 8 MGD Lift Station; 20" Parallel Force Main to Bachelor Creek Lift Station	Lift Station - New 8 MGD	1	LS	$2,750,000	$2,750,000
		20" Force Main	6,250	LF	$110	$687,500
					Subtotal	$3,437,500
					Contingency @ 30%	$1,031,250
					Subtotal	$4,468,750
					Mobilization @ 5%	$223,438
					Subtotal	$4,692,188
					OH&P @ 18%	$844,594
					Total Construction Cost	$5,536,781
					Engineering, Surveying & Geotech @ 18%	$996,621
					Easement/ROW cost	$156,250
					Total Project Cost	$6,689,652
2	Bachelor Creek Lift Station expansion from 16 MGD to 28 MGD by adding a parallel 12 MGD Lift Station; 30" Parallel Force Main to Brushy Creek tie-in	Lift Station - New 12 MGD	1	LS	$3,000,000	$3,000,000
		30" Force Main	26,250	LF	$165	$4,331,250
					Subtotal	$7,331,250
					Contingency @ 30%	$2,199,375
					Subtotal	$9,530,625
					Mobilization @ 5%	$476,531
					Subtotal	$10,007,156
					OH&P @ 18%	$1,801,288
					Total Construction Cost	$11,808,444
					Engineering, Surveying & Geotech @ 18%	$2,125,520
					Easement/ROW cost	$656,250
					Total Project Cost	$14,590,214
3	Brushy Creek Lift Station expansion from 5 MGD to 11 MGD by adding a parallel 6 MGD Lift Station; 36" Parallel Force Main to Mustang Creek Interceptor	Lift Station - New 6 MGD	1	LS	$2,250,000	$2,250,000
		36" Force Main	38,750	LF	$198	$7,672,500
					Subtotal	$9,922,500
					Contingency @ 30%	$2,976,750
					Subtotal	$12,899,250
					Mobilization @ 5%	$644,963
					Subtotal	$13,544,213
					OH&P @ 18%	$2,437,958
					Total Construction Cost	$15,982,171
					Engineering, Surveying & Geotech @ 18%	$2,876,791
					Easement/ROW cost	$968,750
					Total Project Cost	$19,827,711

City of Terrell
Regional Wastewater System Analysis Costs- Option Two (2040) **$41,107,578**

Table X
City of Terrell
Regional Wastewater System Analysis Option 1
Capital Improvements to the Forney Interceptor System
Opinions Of Probable Project Cost

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
1 **2025**	New 35 MGD Mustang Creek Lift Station and 36" Force Main to South Mesquite Regional WWTP	Lift Station - New 35 MGD	1	LS	$5,500,000	$5,500,000
		36" Force Main	30,000	LF	$198	$5,940,000
					Subtotal	$11,440,000
					Contingency @ 30%	$3,432,000
					Subtotal	$14,872,000
					Mobilization @ 5%	$743,600
					Subtotal	$15,615,600
					OH&P @ 18%	$2,810,808
					Total Construction Cost	$18,426,408
					Engineering, Surveying & Geotech @ 18%	$3,316,753
					Total Project Cost	$21,743,161
2 **2040**	Expand Mustang Creek Lift Station from 35 MGD to 70 MGD by adding a parallel 35 MGD lift station; Construct a 36" parallel Force Main to South Mesquite Regional WWTP	Lift Station - New 35 MGD	1	LS	$5,500,000	$5,500,000
		36" Force Main	30,000	LF	$198	$5,940,000
					Subtotal	$11,440,000
					Contingency @ 30%	$3,432,000
					Subtotal	$14,872,000
					Mobilization @ 5%	$743,600
					Subtotal	$15,615,600
					OH&P @ 18%	$2,810,808
					Total Construction Cost	$18,426,408
					Engineering, Surveying & Geotech @ 18%	$3,316,753
					Total Project Cost	$21,743,161

City of Terrell
Upgrades to NTMWD Forney Interceptor System Costs- Option One **$43,486,323**

Table X
City of Terrell
Regional Wastewater System Analysis Option 2
Capital Improvements to the Lower East Fork Interceptor System
Opinions Of Probable Project Cost

Project Number	Project Description	Construction Items	Quantity	Units	Unit Price	Costs
1 **2025**	Expand LEF Lift Station from 35 MGD to 55 MGD by adding a parallel 20 MGD Lift Station; parallel the Lower East Fork Force Main with a 42" to serve 2040 flows	Lift Station - New 20 MGD	1	LS	$4,000,000	$4,000,000
		42" Force Main	23,000	LF	$231	$5,313,000
					Subtotal	$9,313,000
					Contingency @ 30%	$2,793,900
					Subtotal	$12,106,900
					Mobilization @ 5%	$605,345
					Subtotal	$12,712,245
					OH&P @ 18%	$2,288,204
					Total Construction Cost	$15,000,449
					Engineering, Surveying & Geotech @ 18%	$2,700,081
					Total Project Cost	$17,700,530
2 **2025**	Parallel Mustang Creek Interceptor with a new 54" Interceptor to serve Mesquite and Terrell Flows	54" Sanitary Sewer	20,000	LF	$297	$5,940,000
					Subtotal	$5,940,000
					Contingency @ 30%	$1,782,000
					Subtotal	$7,722,000
					Mobilization @ 5%	$386,100
					Subtotal	$8,108,100
					OH&P @ 18%	$1,459,458
					Total Construction Cost	$9,567,558
					Engineering, Surveying & Geotech @ 18%	$1,722,160
					Total Project Cost	$11,289,718
3 **2040**	Expand Lower East Fork Lift Station from 55 MGD to 75 MGD by adding a parallel 20 MGD Lift Station	Lift Station - New 20 MGD	1	LS	$4,000,000	$4,000,000
					Subtotal	$4,000,000
					Contingency @ 30%	$1,200,000
					Subtotal	$5,200,000
					Mobilization @ 5%	$260,000
					Subtotal	$5,460,000
					OH&P @ 18%	$982,800
					Total Construction Cost	$6,442,800
					Engineering, Surveying & Geotech @ 18%	$1,159,704
					Total Project Cost	$7,602,504

City of Terrell
Upgrades to NTMWD Regional Wastewater System Costs- Option Two **$36,592,752**

Appendix K:
Annual Conveyance O&M Cost Tables

King's Creek Lift Station O&M Cost								
Year	Average Daily Flow (MGD)	Total Dynamic Head (ft)	Power (HP)	Power (kW)	Annual Power Consumption (kWh)	Annual Power Cost ($)	Annual Maintenance Cost ($)	Total Annual O&M Cost
2011	-	-	-	-	-	-	-	-
2012	-	-	-	-	-	-	-	-
2013	0.96	25.46	5.7	4.3	37,266	3,727	95,031	98,758
2014	0.98	25.48	5.8	4.3	38,036	3,804	95,031	98,835
2015	1.00	25.50	5.9	4.4	38,824	3,882	95,031	98,914
2016	1.02	25.52	6.1	4.5	39,630	3,963	95,031	98,994
2017	1.04	25.54	6.2	4.6	40,454	4,045	95,031	99,077
2018	1.06	25.56	6.4	4.7	41,506	4,151	95,031	99,182
2019	1.09	25.59	6.5	4.9	42,586	4,259	95,031	99,290
2020	1.12	25.62	6.7	5.0	43,698	4,370	95,031	99,401
2021	1.19	25.69	7.1	5.3	46,489	4,649	95,031	99,680
2022	1.27	25.79	7.7	5.7	50,061	5,006	95,031	100,037
2023	1.38	25.91	8.3	6.2	54,441	5,444	95,031	100,475
2024	1.51	26.08	9.2	6.8	59,923	5,992	95,031	101,024
2025	1.65	26.28	10.2	7.6	66,323	6,632	95,031	101,664
2026	1.80	25.43	10.7	8.0	69,965	6,997	199,566	206,562
2027	1.96	25.50	11.7	8.7	76,207	7,621	199,566	207,186
2028	2.11	25.58	12.6	9.4	82,500	8,250	199,566	207,816
2029	2.27	25.66	13.6	10.1	88,847	8,885	199,566	208,450
2030	2.42	25.75	14.6	10.9	95,252	9,525	199,566	209,091
2031	2.58	25.84	15.6	11.6	101,719	10,172	199,566	209,738
2032	2.71	25.93	16.4	12.3	107,361	10,736	199,566	210,302
2033	2.85	26.01	17.3	12.9	113,053	11,305	199,566	210,871
2034	2.98	26.11	18.2	13.6	118,798	11,880	199,566	211,446
2035	3.12	26.20	19.1	14.2	124,598	12,460	199,566	212,026
2036	3.25	26.30	20.0	14.9	130,456	13,046	199,566	212,611
2037	3.38	26.40	20.9	15.6	136,372	13,637	199,566	213,203
2038	3.52	26.51	21.8	16.2	142,350	14,235	199,566	213,801
2039	3.62	26.59	22.5	16.8	147,144	14,714	199,566	214,280
2040	3.66	26.62	22.7	17.0	148,532	14,853	199,566	214,419
					TOTAL	**228,239**	**4,228,893**	**4,457,132**

O&M Cost won't start on LS until 2013 once they are in service

King's Creek Lift Station O&M Cost								
Year	Average Daily Flow (MGD)	Total Dynamic Head (ft)	Power (HP)	Power (kW)	Annual Power Consumption (kWh)	Annual Power Cost ($)	Annual Maintenance Cost ($)	Total Annual O&M Cost
2011	-	-	-	-	-	-	-	-
2012	-	-	-	-	-	-	-	-
2013	0.96	25.46	5.7	4.3	37,266	3,727	95,031	98,758
2014	0.98	25.48	5.8	4.3	38,036	3,804	95,031	98,835
2015	1.00	25.50	5.9	4.4	38,824	3,882	95,031	98,914
2016	1.02	25.52	6.1	4.5	39,630	3,963	95,031	98,994
2017	1.04	25.54	6.2	4.6	40,454	4,045	95,031	99,077
2018	1.06	25.56	6.4	4.7	41,506	4,151	95,031	99,182
2019	1.09	25.59	6.5	4.9	42,586	4,259	95,031	99,290
2020	1.12	25.62	6.7	5.0	43,698	4,370	95,031	99,401
2021	1.19	25.69	7.1	5.3	46,489	4,649	95,031	99,680
2022	1.27	25.79	7.7	5.7	50,061	5,006	95,031	100,037
2023	1.38	25.91	8.3	6.2	54,441	5,444	95,031	100,475
2024	1.51	26.08	9.2	6.8	59,923	5,992	95,031	101,024
2025	1.65	26.28	10.2	7.6	66,323	6,632	95,031	101,664
2026	1.80	25.43	10.7	8.0	69,965	6,997	199,566	206,562
2027	1.96	25.50	11.7	8.7	76,207	7,621	199,566	207,186
2028	2.11	25.58	12.6	9.4	82,500	8,250	199,566	207,816
2029	2.27	25.66	13.6	10.1	88,847	8,885	199,566	208,450
2030	2.42	25.75	14.6	10.9	95,252	9,525	199,566	209,091
2031	2.58	25.84	15.6	11.6	101,719	10,172	199,566	209,738
2032	2.71	25.93	16.4	12.3	107,361	10,736	199,566	210,302
2033	2.85	26.01	17.3	12.9	113,053	11,305	199,566	210,871
2034	2.98	26.11	18.2	13.6	118,798	11,880	199,566	211,446
2035	3.12	26.20	19.1	14.2	124,598	12,460	199,566	212,026
2036	3.25	26.30	20.0	14.9	130,456	13,046	199,566	212,611
2037	3.38	26.40	20.9	15.6	136,372	13,637	199,566	213,203
2038	3.52	26.51	21.8	16.2	142,350	14,235	199,566	213,801
2039	3.62	26.59	22.5	16.8	147,144	14,714	199,566	214,280
2040	3.66	26.62	22.7	17.0	148,532	14,853	199,566	214,419
					TOTAL	**228,239**	**4,228,893**	**4,457,132**

O&M Cost won't start on LS until 2013 once they are in service

Bachelor Creek Lift Station O&M Cost								
Year	Average Daily Flow (MGD)	Total Dynamic Head (ft)	Power (HP)	Power (kW)	Annual Power Consumption (kWh)	Annual Power Cost ($)	Annual Maintenance Cost ($)	Total Annual O&M Cost
2011	-	-	-	-	-	-	-	-
2012	-	-	-	-	-	-	-	-
2013	1.96	29.86	13.6	10.2	89,156	8,916	133,044	141,959
2014	2.03	30.21	14.3	10.7	93,539	9,354	133,044	142,398
2015	2.11	30.58	15.0	11.2	98,254	9,825	133,044	142,869
2016	2.18	30.97	15.8	11.8	103,234	10,323	133,044	143,367
2017	2.28	31.44	16.7	12.5	109,226	10,923	133,044	143,966
2018	2.37	31.95	17.7	13.2	115,662	11,566	133,044	144,610
2019	2.47	34.52	19.9	14.9	130,308	13,031	133,044	146,075
2020	2.68	36.23	22.7	16.9	147,963	14,796	133,044	147,840
2021	2.90	38.20	25.9	19.3	168,927	16,893	133,044	149,937
2022	3.15	40.54	29.8	22.2	194,658	19,466	133,044	152,510
2023	3.43	43.33	34.7	25.9	226,936	22,694	133,044	155,737
2024	3.74	46.48	40.6	30.3	265,330	26,533	133,044	159,577
2025	4.05	49.90	47.3	35.2	308,673	30,867	133,044	163,911
2026	4.47	80.8	84.4	62.9	551,140	55,114	247,081	302,195
2027	4.88	86.1	98.1	73.2	641,035	64,103	247,081	311,185
2028	5.20	90.5	110.0	82.0	718,400	71,840	247,081	318,921
2029	5.42	93.9	118.8	88.6	776,116	77,612	247,081	324,693
2030	5.62	97.3	127.8	95.3	835,014	83,501	247,081	330,583
2031	5.79	100.3	135.6	101.1	885,696	88,570	247,081	335,651
2032	5.95	103.3	143.7	107.2	938,650	93,865	247,081	340,946
2033	6.12	106.4	152.2	113.5	993,938	99,394	247,081	346,475
2034	6.28	109.7	161.0	120.0	1,051,619	105,162	247,081	352,243
2035	6.45	113.0	170.2	126.9	1,111,756	111,176	247,081	358,257
2036	6.61	116.4	179.8	134.1	1,174,406	117,441	247,081	364,522
2037	6.78	119.8	189.8	141.5	1,239,632	123,963	247,081	371,045
2038	6.91	123.0	198.7	148.1	1,297,677	129,768	247,081	376,849
2039	6.98	124.9	203.6	151.8	1,330,117	133,012	247,081	380,093
2040	7.04	126.9	208.7	155.6	1,363,292	136,329	247,081	383,411
					TOTAL	**1,696,035**	**5,435,790**	**7,131,826**

O&M Cost won't start on LS until 2013 once they are in service

Bachelor Creek Lift Station O&M Cost								
Year	Average Daily Flow (MGD)	Total Dynamic Head (ft)	Power (HP)	Power (kW)	Annual Power Consumption (kWh)	Annual Power Cost ($)	Annual Maintenance Cost ($)	Total Annual O&M Cost
2011	-	-	-	-	-	-	-	-
2012	-	-	-	-	-	-	-	-
2013	1.96	30.59	14.0	10.4	91,320	9,132	133,044	142,176
2014	2.03	30.98	14.7	11.0	95,940	9,594	133,044	142,638
2015	2.11	31.41	15.4	11.5	100,922	10,092	133,044	143,136
2016	2.18	31.86	16.3	12.1	106,196	10,620	133,044	143,663
2017	2.28	32.40	17.2	12.8	112,557	11,256	133,044	144,300
2018	2.37	32.99	18.3	13.6	119,408	11,941	133,044	144,985
2019	2.47	36.19	20.9	15.6	136,633	13,663	133,044	146,707
2020	2.68	38.22	23.9	17.8	156,119	15,612	133,044	148,656
2021	2.90	40.57	27.5	20.5	179,389	17,939	133,044	150,983
2022	3.15	43.34	31.9	23.8	208,096	20,810	133,044	153,853
2023	3.43	46.64	37.4	27.9	244,259	24,426	133,044	157,470
2024	3.74	50.35	44.0	32.8	287,431	28,743	133,044	161,787
2025	4.05	54.39	51.5	38.4	336,402	33,640	133,044	166,684
2026	4.47	93.5	97.5	72.7	637,094	63,709	247,081	310,791
2027	4.88	99.6	113.6	84.7	741,821	74,182	247,081	321,263
2028	5.20	104.8	127.4	95.0	832,169	83,217	247,081	330,298
2029	5.42	108.9	137.8	102.7	899,841	89,984	247,081	337,065
2030	5.62	112.9	148.3	110.6	968,978	96,898	247,081	343,979
2031	5.79	116.4	157.5	117.4	1,028,660	102,866	247,081	349,947
2032	5.95	120.1	167.0	124.6	1,091,063	109,106	247,081	356,188
2033	6.12	123.8	177.0	132.0	1,156,259	115,626	247,081	362,707
2034	6.28	127.7	187.4	139.8	1,224,322	122,432	247,081	369,514
2035	6.45	131.6	198.3	147.9	1,295,324	129,532	247,081	376,614
2036	6.61	135.7	209.6	156.3	1,369,338	136,934	247,081	384,015
2037	6.78	139.8	221.4	165.1	1,446,437	144,644	247,081	391,725
2038	6.91	143.6	232.0	173.0	1,515,242	151,524	247,081	398,606
2039	6.98	146.0	237.9	177.4	1,554,238	155,424	247,081	402,505
2040	7.04	148.4	244.0	182.0	1,594,133	159,413	247,081	406,495
					TOTAL	**1,952,959**	**5,435,790**	**7,388,749**

O&M Cost won't start on LS until 2013 once they are in service

Brushy Creek Lift Station O&M Cost								
Year	Average Daily Flow (MGD)	Total Dynamic Head (ft)	Power (HP)	Power (kW)	Annual Power Consumption (kWh)	Annual Power Cost ($)	Annual Maintenance Cost ($)	Total Annual O&M Cost
2011	-	-	-	-	-	-	-	-
2012	-	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-	-
2014	-	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-	-
2018	-	-	-	-	-	-	-	-
2019	0.60	26.0	3.7	2.7	23,965	2,396	76,025	78,422
2020	0.71	27.2	4.5	3.3	29,320	2,932	76,025	78,957
2021	0.81	28.5	5.4	4.0	35,254	3,525	76,025	79,550
2022	0.91	30.0	6.4	4.8	41,928	4,193	76,025	80,218
2023	1.01	31.9	7.5	5.6	49,287	4,929	76,025	80,954
2024	1.10	33.9	8.7	6.5	56,894	5,689	76,025	81,714
2025	1.19	36.1	10.0	7.5	65,344	6,534	76,025	82,559
2026	1.29	55.3	16.7	12.4	108,808	10,881	161,553	172,434
2027	1.39	58.6	19.1	14.2	124,614	12,461	161,553	174,015
2028	1.50	61.5	21.5	16.0	140,502	14,050	161,553	175,603
2029	1.60	63.8	23.9	17.8	155,818	15,582	161,553	177,135
2030	1.70	66.1	26.3	19.6	171,932	17,193	161,553	178,746
2031	1.81	68.2	28.8	21.5	188,101	18,810	161,553	180,363
2032	1.91	70.4	31.4	23.4	205,112	20,511	161,553	182,064
2033	2.01	72.6	34.1	25.5	222,994	22,299	161,553	183,853
2034	2.12	74.8	37.0	27.6	241,776	24,178	161,553	185,731
2035	2.22	77.2	40.0	29.8	261,486	26,149	161,553	187,702
2036	2.32	79.5	43.2	32.2	282,154	28,215	161,553	189,769
2037	2.43	82.0	46.5	34.7	303,808	30,381	161,553	191,934
2038	2.53	84.2	49.8	37.2	325,466	32,547	161,553	194,100
2039	2.63	85.8	52.8	39.4	345,096	34,510	161,553	196,063
2040	2.74	87.4	55.9	41.7	365,330	36,533	161,553	198,086
					TOTAL	**374,499**	**2,955,473**	**3,329,972**

O&M Cost won't start on LS until 2013 once they are in service

Brushy Creek Lift Station O&M Cost								
Year	Average Daily Flow (MGD)	Total Dynamic Head (ft)	Power (HP)	Power (kW)	Annual Power Consumption (kWh)	Annual Power Cost ($)	Annual Maintenance Cost ($)	Total Annual O&M Cost
2011	-	-	-	-	-	-	-	-
2012	-	-	-	-	-	-	-	-
2013	-	-	-	-	-	-	-	-
2014	-	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-	-
2018	-	-	-	-	-	-	-	-
2019	0.60	27.7	3.9	2.9	25,509	2,551	76,025	78,576
2020	0.71	29.2	4.8	3.6	31,476	3,148	76,025	79,173
2021	0.81	30.9	5.8	4.4	38,182	3,818	76,025	79,843
2022	0.91	32.8	7.0	5.2	45,833	4,583	76,025	80,608
2023	1.01	35.2	8.3	6.2	54,401	5,440	76,025	81,465
2024	1.10	37.8	9.7	7.2	63,390	6,339	76,025	82,364
2025	1.19	40.6	11.2	8.4	73,456	7,346	76,025	83,371
2026	1.29	65.1	19.6	14.6	128,127	12,813	161,553	174,366
2027	1.39	69.4	22.6	16.8	147,443	14,744	161,553	176,297
2028	1.50	73.1	25.5	19.0	166,863	16,686	161,553	178,240
2029	1.60	76.0	28.4	21.2	185,552	18,555	161,553	180,108
2030	1.70	79.0	31.4	23.4	205,258	20,526	161,553	182,079
2031	1.81	81.6	34.4	25.7	225,036	22,504	161,553	184,057
2032	1.91	84.3	37.6	28.1	245,888	24,589	161,553	186,142
2033	2.01	87.2	41.0	30.6	267,851	26,785	161,553	188,338
2034	2.12	90.0	44.5	33.2	290,962	29,096	161,553	190,649
2035	2.22	93.0	48.3	36.0	315,258	31,526	161,553	193,079
2036	2.32	96.1	52.2	38.9	340,776	34,078	161,553	195,631
2037	2.43	99.2	56.3	42.0	367,552	36,755	161,553	198,308
2038	2.53	102.1	60.4	45.0	394,334	39,433	161,553	200,987
2039	2.63	104.1	64.1	47.8	418,527	41,853	161,553	203,406
2040	2.74	106.1	67.9	50.6	443,489	44,349	161,553	205,902
					TOTAL	**447,516**	**2,955,473**	**3,402,990**

O&M Cost won't start on LS until 2013 once they are in service

Lower East Fork Lift Station O&M Cost- without Windmill Farms										
Year	Average Daily Flow (MGD)	Total Dynamic Head (ft)	Power (HP)	Power (kW)	Annual Power Consumption (kWh)	Annual Power Cost ($)	Annual Maintenance Cost ($)	Annual Labor Cost ($)	Total Annual O&M Cost ($)	Terrell Annual O&M Cost ($)
2014	7.46	80.02	139.6	104.1	911,702	91,170	168,000	50,000	309,170	84,032
2015	8.14	81.78	155.6	116.1	1,016,630	101,663	168,000	50,000	319,663	82,634
2016	8.56	82.92	165.8	123.7	1,083,273	108,327	168,000	50,000	326,327	83,270
2017	9.01	82.95	174.6	130.2	1,140,512	114,051	168,000	50,000	332,051	83,890
2018	9.45	83.02	183.3	136.7	1,197,630	119,763	276,000	50,000	445,763	111,841
2019	10.51	83.32	204.5	152.5	1,336,042	133,604	276,000	50,000	459,604	134,607
2020	11.00	83.52	214.7	160.1	1,402,295	140,230	276,000	50,000	466,230	143,391
2021	11.53	83.79	225.8	168.4	1,475,133	147,513	276,000	50,000	473,513	152,213
2022	12.10	84.11	237.8	177.3	1,553,086	155,309	276,000	50,000	481,309	161,548
2023	12.69	84.51	250.6	186.9	1,637,028	163,703	276,000	50,000	489,703	171,489
2024	13.29	84.97	264.0	196.8	1,724,352	172,435	276,000	50,000	498,435	181,409
2025	13.90	85.49	277.7	207.1	1,814,275	181,428	276,000	50,000	507,428	191,155
2026	14.63	86.17	294.6	219.7	1,924,528	192,453	384,000	75,000	651,453	256,252
2027	15.36	86.93	311.9	232.6	2,037,693	203,769	384,000	75,000	662,769	270,729
2028	15.79	87.42	322.6	240.5	2,107,115	210,712	384,000	75,000	669,712	283,996
2029	16.09	87.78	330.1	246.2	2,156,549	215,655	384,000	75,000	674,655	294,044
2030	16.44	88.20	338.8	252.7	2,213,230	221,323	384,000	75,000	680,323	303,156
2031	16.72	88.55	345.9	257.9	2,259,530	225,953	384,000	75,000	684,953	311,152
2032	16.99	88.92	353.1	263.3	2,306,397	230,640	384,000	75,000	689,640	319,061
2033	17.27	89.29	360.3	268.7	2,353,845	235,384	384,000	75,000	694,384	326,888
2034	17.55	89.67	367.7	274.2	2,401,884	240,188	384,000	75,000	699,188	334,641
2035	17.83	90.06	375.1	279.7	2,450,526	245,053	384,000	75,000	704,053	342,327
2036	18.10	90.46	382.7	285.4	2,499,785	249,978	384,000	75,000	708,978	349,952
2037	18.38	90.88	390.3	291.1	2,549,670	254,967	384,000	75,000	713,967	357,522
2038	18.63	91.26	397.3	296.2	2,595,139	259,514	384,000	75,000	718,514	364,262
2039	18.80	91.53	402.2	299.9	2,627,102	262,710	384,000	75,000	721,710	368,828
2040	18.98	91.80	407.1	303.6	2,659,366	265,937	384,000	75,000	724,937	373,387
					TOTAL	**5,143,432**	**8,640,000**	**1,725,000**	**15,508,432**	**6,437,674**

O&M Cost won't start on LS until 2013 once they are in service

Forney Lift Station O&M Cost- without Windmill Farms										
Year	Average Daily Flow (MGD)	Total Dynamic Head (ft)	Power (HP)	Power (kW)	Annual Power Consumption (kWh)	Annual Power Cost ($)	Annual Maintenance Cost ($)	Annual Labor Cost ($)	Total Annual O&M Cost ($)	Terrell Annual O&M Cost ($)
2014	3.87	8.80	7.9	5.9	51,895	5,189	168,000	50,000	223,189	117,146
2015	4.05	9.14	8.6	6.4	56,487	5,649	168,000	50,000	223,649	116,270
2016	4.24	9.50	9.4	7.0	61,419	6,142	168,000	50,000	224,142	115,561
2017	4.44	9.92	10.3	7.7	67,277	6,728	168,000	50,000	224,728	115,086
2018	4.66	10.37	11.3	8.4	73,737	7,374	168,000	50,000	225,374	114,715
2019	5.49	12.28	15.7	11.7	102,875	10,288	168,000	50,000	228,288	127,974
2020	5.92	13.38	18.5	13.8	120,847	12,085	168,000	50,000	230,085	131,499
2021	6.41	14.71	22.0	16.4	143,921	14,392	168,000	50,000	232,392	134,427
2022	6.96	16.32	26.5	19.8	173,384	17,338	168,000	50,000	235,338	137,262
2023	7.58	18.25	32.3	24.1	211,056	21,106	168,000	50,000	239,106	140,234
2024	8.20	20.36	39.0	29.1	254,917	25,492	168,000	50,000	243,492	143,610
2025	8.84	22.62	46.7	34.8	305,089	30,509	168,000	50,000	248,509	147,320
2026	9.60	22.81	51.2	38.2	334,310	33,431	336,000	75,000	444,431	266,395
2027	10.37	23.30	56.5	42.1	368,797	36,880	336,000	75,000	447,880	270,976
2028	11.04	23.96	61.8	46.1	403,775	40,377	336,000	75,000	451,377	273,776
2029	11.62	24.69	67.1	50.0	438,128	43,813	336,000	75,000	454,813	274,471
2030	12.20	25.56	72.9	54.3	475,907	47,591	336,000	75,000	458,591	275,360
2031	12.73	26.48	78.8	58.8	514,654	51,465	336,000	75,000	462,465	275,796
2032	13.27	27.52	85.3	63.6	557,293	55,729	336,000	75,000	466,729	276,570
2033	13.80	28.67	92.4	68.9	603,896	60,390	336,000	75,000	471,390	277,709
2034	14.34	29.95	100.4	74.9	655,830	65,583	336,000	75,000	476,583	279,048
2035	14.88	31.32	108.9	81.2	711,329	71,133	336,000	75,000	482,133	280,884
2036	15.41	32.80	118.1	88.1	771,594	77,159	336,000	75,000	488,159	283,063
2037	15.94	34.39	128.1	95.5	836,856	83,686	336,000	75,000	494,686	285,587
2038	16.45	35.99	138.3	103.1	903,565	90,356	336,000	75,000	501,356	287,887
2039	16.88	37.42	147.6	110.1	964,094	96,409	336,000	75,000	507,409	288,907
2040	17.31	38.92	157.4	117.4	1,028,314	102,831	336,000	75,000	513,831	290,204
					TOTAL	**1,119,125**	**7,056,000**	**1,725,000**	**9,900,125**	**5,727,736**

O&M Cost won't start on LS until 2013 once they are in service

Appendix L:
Annual NTWMD Regional Treatment Cost Tables

	Annual NTMWD Regional Wastewater Treatment Cost ($ Millions)					
Year	Fairfield	Whitt Ranch	Las Lomas	Rio	Terrell	Total ***
2010	-	-	-	-	0.68	0.68
2011	-	-	-	-	0.69	0.69
2012	-	-	-	-	0.70	0.70
2013	-	-	-	-	0.71	0.71
2014	-	0.80	-	-	0.74	1.54
2015	-	0.93	-	-	0.77	1.70
2016	-	1.02	-	-	0.80	1.81
2017	-	1.11	-	-	0.83	1.94
2018	-	1.20	-	-	0.87	2.07
2019	-	1.30	0.50	-	1.12	2.92
2020	0.93	1.33	0.52	0.93	1.23	4.94
2021	0.93	1.40	0.52	0.99	1.35	5.20
2022	0.94	1.48	0.52	1.06	1.48	5.47
2023	0.94	1.55	0.52	1.14	1.62	5.78
2024	0.94	1.63	0.52	1.23	1.77	6.08
2025	0.95	1.70	0.52	1.31	1.91	6.39
2026	0.95	1.77	0.52	1.40	2.10	6.74
2027	0.95	1.85	0.52	1.49	2.29	7.10
2028	0.96	1.85	0.52	1.59	2.44	7.35
2029	0.95	1.85	0.52	1.68	2.56	7.56
2030	0.96	1.85	0.52	1.78	2.67	7.78
2031	0.97	1.85	0.52	1.88	2.77	7.98
2032	0.97	1.85	0.52	1.97	2.87	8.18
2033	0.97	1.85	0.52	2.07	2.97	8.37
2034	0.98	1.85	0.52	2.17	3.07	8.58
2035	0.98	1.85	0.52	2.27	3.16	8.77
2036	0.98	1.85	0.52	2.36	3.26	8.97
2037	0.99	1.85	0.52	2.46	3.36	9.17
2038	0.99	1.85	0.52	2.56	3.45	9.36
2039	0.99	1.85	0.52	2.65	3.51	9.52
2040	1.00	1.85	0.52	2.75	3.57	9.68
Sum	**20.20**	**43.06**	**11.39**	**37.74**	**61.33**	**173.72**

Appendix M:
Meeting Minutes

NOTICE OF PUBLIC MEETING

Notice is hereby given that the City of Terrell and Las Lomas Municipal Utility District No. 4 of Kaufman County will hold a public meeting to discuss the status of the Regional Water Facilities Plan. The City of Terrell is seeking input and comments and will consider such input and comments for incorporation in the final report. The scope for the work for the Regional Water Facilities Plan will be presented to the public on May 17, 2010.

The public meeting regarding the scope of work will be held on Monday, May 17, 2010 at 10:00 a.m. at Council Chambers, Terrell City Hall, located at 201 East Nash Street, Terrell, Texas 75160.

Public comments are encouraged and will be solicited at this meeting. Written and oral comments regarding the scope of work will be accepted at the public meeting. Anyone unable to attend the meeting may submit comments in writing to City of Terrell, Attention: Sonny Groessel at P.O. Box 310, Terrell, TX 75160-0310. Written comments must be received by the City of Terrell by 10:00 a.m. on Monday, May 17, 2010.

For additional information, please contact Sonny Groessel, telephone number (972) 551-6609.

Published
Terrell Tribune
Thursday, May 13th, 2010

NOTICE OF PUBLIC MEETING

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Mission: *Innovative approaches ... practical results ... outstanding service*
Vision: *Be the firm of choice for clients and employees*

PURPOSE
The overall objective of the meeting should be clear and noted on the agenda.

AGENDA
The agenda should include what is to be covered, who is responsible and how long each item will require.

CODE OF CONDUCT
Meeting participants should respect each other by honoring the Code of Conduct.

EXPECTATIONS
The expectations of the participants should be discussed, noted and reviewed for closure.

ROLES
The roles of leader, scribe, minute taker, time keeper and facilitator should be clarified at the beginning of the meeting.

City of Terrell
Water and Wastewater Regional Studies – Public Meeting No. 1
May 17, 2010
Cit of Terrell City Hall – Council Chambers
10:00 to 11:00 am

AGENDA

Topic	Who	Time
1. Wastewater Study Scope	GB	10:00 AM
2. Wastewater Flow Projections	GB	10:10 AM
3. TCEQ Discharge Permit Requirements	GB	10:20 AM
4. Wastewater Study Schedule	GB	10:25 AM
5. Water Study Scope	RAI	10:30 AM
6. Water Study Schedule	RAI	10:40 AM
7. Questions/Discussions	All	10:45 AM

CLOSE/ADJOURN **11:00 AM**

CODE OF CONDUCT
1. Publish an agenda and maintain minutes.
2. Challenge ideas and processes, not people.
3. Share responsibility and ownership.
4. Maintain an open, honest environment.
5. Question and participate.
6. Listen constructively.
7. Begin and end on time unless participants agree to an extension.
8. Come prepared and with action items completed.
9. Base decisions on factual data.
10. Keep confidences.

Terrell Regional Water and Wastewater Studies

Public Meeting No. 1

Monday, May 17, 2010

Wastewater Study Scope

1. Condition Assessment
   - What equipment needs replacement?
   - When does equipment need to be replaced?
2. Process Modeling
   - How much flow can we process at different effluent limits?
3. Improvement Recommendations
   - Based on modeling, assessment, and future wastewater flow projections
   - What improvements are needed to continue to meet TCEQ permit requirements?

Wastewater Flow Projections

	Average Annual Day Flow Projections (MGD)					
Year	Fairfield	Whitt Ranch	Las Lomas	RIO	Terrell	Total
2010	0	0	0	0	1.86	1.86
2015	0	0.07	0.38	0.16	2.03	2.64
2020	0.35	0.29	1.71	0.4	2.3	5.04
2025	0.86	0.58	3.43	0.64	2.71	8.22

TCEQ Permit Requirements

	Current 30-day Average mg/L	Current 7-day Average mg/L	Current Daily Maximum mg/L	Draft 30-day Average mg/L	Draft 7-day Average mg/L	Draft Daily Maximum mg/L
$cBOD_5$						
May-Sept.	7	12	22	7	12	22
Oct.-April	10	15	25	10	15	25
TSS	15	25	40	15	25	40
NH_3-N						
May-Sept.	3	6	10	3	6	10
Oct.-April	5	7	10	5	7	10
Aluminum (Total)	0.834	N/A	1.766	0.834	N/A	1.766
Copper (Total)	Report	N/A	Report	Report	N/A	Report
Silver (Total)	0.0073	N/A	0.0155	0.0073	N/A	0.0155
Zinc (Total)	0.241	N/A	0.509	0.241	N/A	0.509
DO (Minimum)						
May-Sept.	6	N/A	N/A	6	N/A	N/A
Oct.-April	4	N/A	N/A	4	N/A	N/A
Fecal Coliform, Colonies/100 ml	-	-	-	-	-	-
E. coli, Colonies/100 ml	-	-	-	**126**		**394**

- No major changes in draft permit
- Draft permit would expire in December, 2012
- Phosphorus will most likely be included in next TCEQ permit

Wastewater Schedule

- Major Milestones
  1. Public Meeting No. 1 – May 17, 2010
  2. Condition Assessment Report – June 14, 2010
  3. Improvement Recommendations – Aug. 4, 2010
  4. Public Meeting No. 2 – Aug. 5, 2010
  5. Draft Improvements Report – Sept. 23, 2010
  6. Texas Water Development Board Review – Nov. 7, 2010
  7. Develop Final Report – Nov. 21, 2010
  8. Public Meeting No. 3 – Nov. 22, 2010

Water Study Scope

1. Water Supply – New Terrell City Lake
   - Determine available supply from the lake
   - Determine who might use the water
   - Estimate costs and recommend facilities required to make use of the available supply
2. Dam Safety Regulations
   - Inspect the dam to assess its condition
   - Estimate the Probable Maximum Flood (PMF) for the dam
   - Recommend improvements to the dam
   - Develop a breach analysis and emergency action plan for the dam

Water Study Schedule

- Major Milestones
  1. Public Meeting No. 1 – May 17, 2010
  2. Condition Assessment Site Visit – May 21, 2010
  3. Facility Recommendations – Jul. 25, 2010
  4. Public Meeting No. 2 – Aug. 5, 2010
  5. Draft Water Supply Study Report – Sept. 27, 2010
  6. Emergency Action Plan – Oct. 29, 2010
  7. TWDB Review of Report – Nov. 8, 2010
  8. Develop Final Report – Nov. 21, 2010
  9. Public Meeting No. 3 – Nov. 22, 2010

7

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PROJECT: City of Terrell Water and Wastewater Studies
NAME OF MEETING: Public Meeting Number 1
RECORDED BY: Rachel Ickert
DATE: May 17, 2010
LOCATION: City of Terrell
ATTENDEES:

Name	Company
Angela Kennedy	Texas Water Development Board
Steve Rogers	City of Terrell
Sonny Groessel	City of Terrell
Dick Boyd	City of Terrell
John Rickman	City of Terrell
Torry Edward	City of Terrell
John Rounsavall	City of Terrell
Brian Dench	Pate Engineers
Bob Wright	Pate Engineers
Robert McCarthy	North Texas Municipal Water District
Yanbo Li	North Texas Municipal Water District
Scott Norris	Land Advisors LTD
Todd Watson	Hunt Realty
Adam Conway	Petitt Barraza
Ron Perkins	North Kaufman WSC
Ryan Estes	Rose Hill SUD
Michael Shook	City of Forney
Frank Nuchereno	Anthony Properties
David Hinds	Markout WSC, Van Tone Flavorings
Vickie Armstrong	Rose Hill SUD
Shirley Blakely	College Mound WSC
Gennady Boksiner	Freese and Nichols
Rachel Ickert	Freese and Nichols

The following reflects our understanding of the items discussed during the subject meeting. If you do not notify us within five working days, we will assume that you are in agreement with our understanding.

ITEM	DESCRIPTION
1	Introductions • Steve Rogers welcomed everyone and facilitated introductions. The sign in sheets for the meeting are attached.

ITEM	DESCRIPTION
2	Presentation • Gennady Boksiner presented the scope and schedule for the wastewater study. • Rachel Ickert presented the scope and schedule for the water study.
3	Questions/Discussion • Frank Nuchereno (Anthony Properties) asked if the wastewater study would be a continuation of previous studies, or if we are starting from scratch. Steve Rogers indicated that the permit allows two more years, and flows into the wastewater treatment plant have decreased significantly. The plant is currently treating an average of 1.5 MGD and is permitted for 4.5 MGD. For these reasons, Terrell may be able to use the existing plant longer and buy some time in making improvements. This study is going to look at what is needed to continue using the existing plant, or if it makes more sense to build a new WW treatment plant or build a lift station to send wastewater to NTMWD. This study will not look at specific locations for a new plant or improvements to the collection system. • Las Lomas MUD No. 4 and all other potential customers need to revise their flow projections to better reflect current conditions. It is anticipated that everyone will have lower projections that what was shown in the last wastewater study. **Steve Rogers and FNI requested that updated projections be provided within 30 days in order to be considered in the study.** • David Hinds with Van Tone Flavorings asked if the same trickling filter technology will be used when assessing keeping the existing plant. Gennady Boksiner indicated that trickling filter technology is outdated and has limited options for improvements. However, certain process improvements to the existing plant are possible, and will be studied, to prolong existing plant's life. • It was asked if there is room at this existing plant to retrofit while keeping the plant in use. Terrell believes there is enough room. • Scott Norris with Land Advisors LTD asked if this study will be looking at future treatment requirements and trying to stay one step ahead of the TCEQ regulations, or if Terrell is just trying to meet current permit requirements. Steve Rogers indicated that right now, Terrell is trying to meet the permit, which presents a significant challenge. Gennady Boksiner pointed out that the most logical anticipated TCEQ requirements, such as phosphorus, will be considered.
4	End Public Meeting
5	TWDB/Terrell/FNI Discussion Following the Public Meeting • The timing of the public meetings needs to be adjusted. The 2nd Public Meeting should occur sometime in the middle of the study. The 3rd Public Meeting needs to be after the draft report is prepared but before TWDB reviews the draft report. **FNI will adjust the schedules and send to Terrell and TWDB for review.** • For both the water study and the wastewater study, the scope in the contract between Terrell and FNI should be revised to better follow the contract between Terrell and the TWDB. Angela Kennedy indicated that we need to add a list of deliverables, requirements for meetings and meeting documentation, specific scenarios to be studied, etc. **Angela has already looked at rewording the scope and will send Rachel Ickert what she has drafted to this point. Rachel, Gennady, and Angela will work together to**

ITEM	DESCRIPTION
	develop a revised scope. • **Terrell and FNI will develop a list of potential users of the Terrell raw water supply and will provide the list to Angela.** This list will be included in the scope. **Terrell will discuss internally and then contact Rachel to discuss further.** • **Per TWDB requirements, FNI will send Terrell monthly progress reports with billings.** Terrell will need separate reports for the water and wastewater studies.

ACTION ITEMS			
WHAT	**WHO**	**WHEN**	**STATUS**
1. Provide revised wastewater flow projections to Terrell and FNI.	All Participating Entities	June 17, 2010	
2. Revise project schedules.	GB/RAI	May 27, 2010	
3. Send suggested scope revisions to FNI.	Angela Kennedy	May 27, 2010	
4. Develop list of potential customers for Terrell water supply and discuss with Rachel Ickert.	Sonny Groessel/ Steve Rogers	May 24, 2010	
5. Prepare separate progress reports for the water and wastewater studies.	GB/RAI	On-going	

Terrell Regional Wastewater Plan

Public Meeting No. 1
May 17, 2010

Name	Company	Address	Phone	E-mail	Signature
Angela Kennedy	TWDB	Austin TX	512-463-1437	angela.kennedy@twdb.state.tx.us	[signature]
Brian Dench	Pate Engineers	8150 Brookriver Dr. Suite S-700	214 357 2981	bdench@pateeng.com	[signature]
Bob Wright	Pate Engineers	Dallas, Texas 75247	"	bwright@pateeng.com	[signature]
Robert McCarthy	NTMWD	505 E Brown Wylie TX 75098	972-442-5405	RMCCARTHY@NTMWD.COM	[signature]
Yanbo Li	"	"	"	yli@ntmwd.com	[signature]
Scott Norris	Land Advisors LTD	4265 Kellway Cir Addison TX 75001	972 239-0703	SNORRIS@[illegible]	[signature]
Todd Watson	Hunt Realty	1900 N Akard Dallas	214 978 8761		[signature]
Adam Conway	Petitt Barraza	300 Municipal Dr. Richardson 75080 TX	214 2219955	aconway@petittbarraza.com	[signature]
Roy Perkins	North Kaufman WSC	P.O. Box 870 Kaufman TX	972-962-7644	ROY_NKWSC@YAHOO.COM	[signature]
Ryan Estes	Rose Hill SUD	P.O. Box 190 Kaufman, 75142	972 932 3077	ryan@rhsud.com	[signature]
MICHAEL Shook	City of Forney	P.O. BOX 826 Forney TX 75126	972-564-7300	MSHOOK@cityofforney.org	[signature]
Frank Nicher	Anthony	6 1277 [illegible] Road Dallas 75247	214 [illegible]	frank@anthony[illegible]	[signature]
Gennady Boksiner	FNI	1701 N.Market St, Dallas	214-217-2224	gb@freese.com	[signature]
Torry Edwards	City of Terrell		972-551-6604		[signature]
DAVID HINDS	VTCF	200 METRO DR	214-244-1944	david_hinds@airmail.net	[signature]

Terrell Regional Water Plan

Public Meeting No. 1
May 17, 2010

Name	Company	Address	Phone	E-mail	Signature
Brian Dench	Pate Engineers	8150 Brookriver Dr, Dallas, TX 75247	214 357 2981	bdench@pateeng.com	[illegible]
Bob Wright	" "	" "	214 357 2981	bwrigh@pateeng.com	[illegible]
Angela Kennedy	TWDD	Austin TX	512-463-1437	angela.kennedy@twdb.state.tx.us	[illegible]
Robert McCarthy	NTMWD	505 E Brown Wylie TX 75098	972-442-5405	RMCCARTHY@NTMWD.COM	[illegible]
Yanbo Li	"	"	"	YLi@ntmwd.com	[illegible]
Scott Norris	Land Advisors	4265 Cyclone Dr. Addison TX 75001	972-239-0707	[illegible]	[illegible]
Rachel Ickert	Freese + Nichols	4055 International Plaza, Suite 200	817-735-7286	rai@freese.com	[illegible]
Dick L. Boyd	City of Terrell	P.O. Box 310, Terrell	972-551-6635	dboyd@cityofterrell.org	[illegible]
Todd Waters	Hunt Realty	1900 N Akard Dallas	214 978 8761		[illegible]
Vickie Armstrong	Rose Hill SUD	PO Box 190 Kaufman	972 932 3077	RHWSC@AOL.Com	[illegible]
Shirley Blakely	College Mound WSC	12731 FM 429 Terrell	972-563-1355	SBlakely.cmwsc@Airmail.net	[illegible]

NOTICE OF PUBLIC MEETING

Notice is hereby given that the City of Terrell and Las Lomas Municipal Utility District No. 4 of Kaufman County will hold a public meeting to discuss the status of the Regional Water Facilities Plan. The City of Terrell is seeking input and comments and will consider such input and comments for incorporation in the final report. The scope for the work and an update on any findings for the Regional Water Facilities Plan will be presented to the public on August 5, 2010.

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Public comments are encouraged and will be solicited at this meeting. Written and oral comments regarding the Regional Water Facilities Plan will be accepted at the public meeting. Anyone unable to attend the meeting may submit comments in writing to City of Terrell, Attention: Sonny Groessel at P.O. Box 310, Terrell, TX 75160-0310. Written comments must be received by the City of Terrell by 10:00 a.m. on Thursday, August 5, 2010.

For additional information, please contact Sonny Groessel, telephone number (972) 551-6609.

Published
Terrell Tribune
Thursday, July 29th, 2010
Sunday August 1st, 2010

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ROLES
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City of Terrell
Water and Wastewater Regional Studies – Public Meeting No. 2
August 5, 2010
Cit of Terrell City Hall – Council Chambers
10:00 to 11:00 am

AGENDA

Topic	Who	Time
1. Wastewater Study Scope	GB	10:00 AM
2. Condition Assessment Summary	GB	10:05 AM
3. Process Evaluation Summary	GB	10:10 AM
4. Planning Development (Next Steps)	GB	10:15 AM
5. Wastewater Study Schedule	GB	10:20 AM
6. Water Study Scope	RAI	10:25 AM
7. Available Raw Water Supply	RAI	10:30 AM
8. Water Supply Alternatives	RAI	10:35 AM
9. Water Study Schedule	RAI	10:40 AM
10. Questions/Discussions	All	10:45 AM

CLOSE/ADJOURN **11:00 AM**

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4. Maintain an open, honest environment.
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6. Listen constructively.
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9. Base decisions on factual data.
10. Keep confidences.

Terrell Regional Water and Wastewater Studies

Public Meeting No. 2

Thursday, August 5, 2010

Wastewater Study Scope

1. Condition Assessment
   – What is the current mechanical condition of the King's Creek WWTP?
2. Process Modeling
   – What is the process capacity for the King's Creek WWTP?
3. Wastewater Treatment Planning Development
   – Consensus on population projections to be used
   – Projected flow impact alternatives evaluation

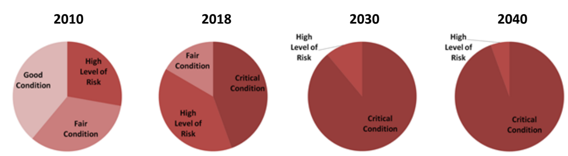
Condition Assessment

- Conducted on May 27 and June 3 of 2010
- Standardized evaluation of unit processes for risk of failure
- Used to determine functional life of existing facilities
- Four categories
  – Good Condition: No immediate repairs required
  – Fair Condition: Repairs likely in next 5-10 years
  – High Level of Risk: Near term repairs required
  – Critical Condition: Immediate repairs required



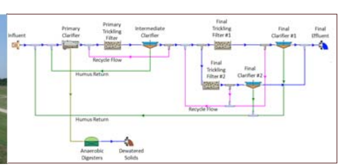
Condition Assessment

- 8 of 18 unit processes will be in critical condition in 2018
- 16 of 18 unit processes will be in critical condition in 2030
- Significant mechanical upgrades required before 2018 to maintain treatment capabilities



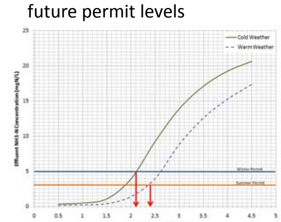
Process Evaluation

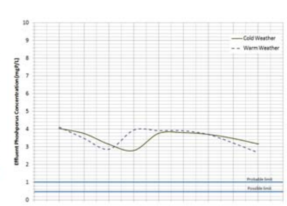
- Computer model developed to simulate King's Creek WWTP
- Calibrated to process performance sampling of individual unit processes
- Validated with 3 years of historic performance data
- Performance projections made for increasing flows

Process Evaluation

- Calibrated, validated model used to simulate performance
- Existing critical parameter: ammonia (NH_3-N) removal
- Future critical parameters: ammonia and phosphorus removal
- Capacity for ammonia removal: 2.1 MGD (Cold Weather)
- Capacity for phosphorus removal: current processes do not meet future permit levels





Wastewater Treatment Planning Development

- Next step: develop treatment alternatives
- Reconciled population and flow projections
  - Provide agreed upon flows to be treated
  - Impact treatment expansion timeline
- Three sources of population information
  1. Population projections for City of Terrell and surrounding developments – City of Terrell CIP November 2009 (FNI – 2009).
  2. FNI projected populations for NTMWD for water demand – DRAFT 2010 NTMWD CIP (FNI – 2010).
  3. Texas Water Development Board (TWDB) projected populations for North Texas Municipal Water District (NTMWD) proposed populations for water demand – DRAFT 2010 NTMWD CIP (TWDB – 2010).

7

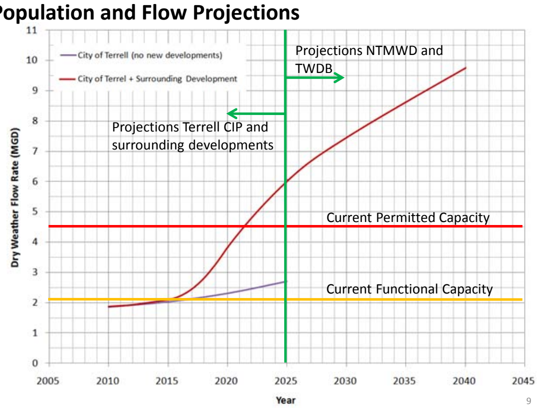
Population and Flow Projections

	Population					
	City of Terrell	Fairfield	Whitt Ranch	Las Lomas	RIO	Total
2010	16,185	0	0	0	0	16,185
2015	17,694	0	612	0	0	18,306
2020	20,018	300	2,487	6,183	81	33,219
2025	23,546	3,900	5,019	15,183	1,090	52,788
2030	-	-	-	-	-	65,000
2040	-	-	-	-	-	85,000

- Populations through 2025 provided July 2010
- 2040 Total Population from North Texas Municipal Water District water supply projections, based on Texas Water Development Board projections

8

Population and Flow Projections



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Wastewater Treatment Planning Development

- Two critical components of alternatives analysis
  1. Facility upgrades to treat current permitted flow capacity
  2. Timeline for expansion beyond current permitted flow capacity
- Alternative being evaluated
  1. Upgrade existing King's Creek WWTP unit processes to meet flows and permit requirements through 2040
  2. Construct a new WWTP on the existing King's Creek WWTP site
  3. Construction of infrastructure to convey all flows to a NTMWD regional wastewater treatment facility

10

Wastewater Schedule

- Major Milestones
  - Mid October, 2010 – Draft Improvements Report
  - October 21, 2010 – Public Meeting No. 3
  - Mid November, 2010 – Texas Water Development Board Review
  - Mid January, 2011 – Develop Final Report

11

Water Study Scope

Completed Scope Items
- Determined available supply from the lake
- Identified potential alternative uses of the lake
- Completed dam site inspection

12

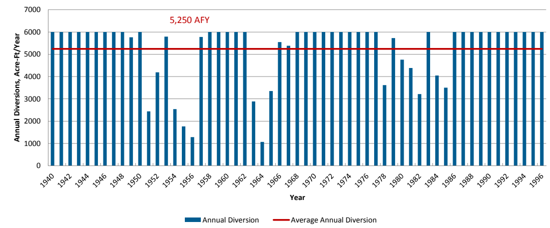
Water Study Scope

Remaining Scope Items

- Estimate costs and recommend facilities required to make use of the available supply
- Complete Dam Condition Assessment
- Review Water Conservation and Drought Contingency Plans
- Prepare report

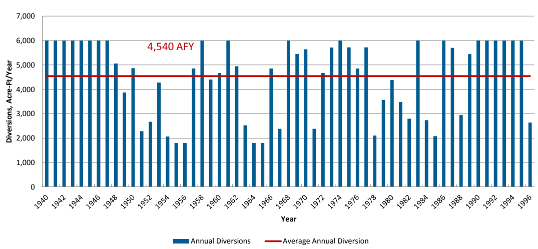
Available Supply From Lake

- Analysis completed using the TCEQ Trinity WAM
- Firm Yield = 2,300 ac-ft/yr for 2060 conditions
- Water Availability Analysis
  - Target diversion of 6,000 ac-ft/yr – in 12% of the months, the actual diversion is less than the target diversion. Average annual diversion = 5,250 acre-feet



Available Supply From Lake

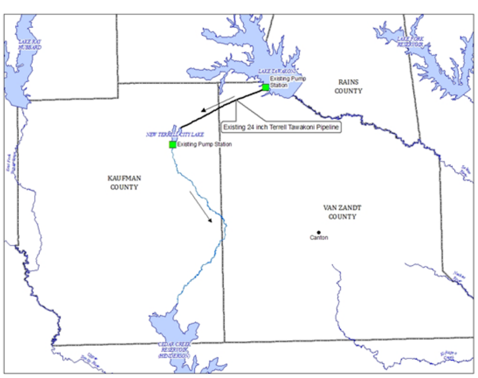
- Water Availability Analysis
  - Target diversion of 6,000 ac-ft/yr when reservoir storage is > 50% and target diversion of 1,800 ac-ft/yr when reservoir storage is < 50%
    - Results in no shortages
    - Average annual diversion = 4,540 ac-ft



Possible Alternatives

- Dallas Water Utilities (DWU) - Interested in taking water through New Terrell City Lake to Cedar Creek Reservoir.
- North Texas Municipal Water District (NTMWD) - Interested in delivering water from New Terrell City Lake to their Tawakoni WTP
- Sabine River Authority (SRA) - Interested in taking New Terrell City Lake water back to Lake Tawakoni or supplying customers closer to Terrell
- City of Canton – Interested in delivering water from New Terrell City Lake to their WTP

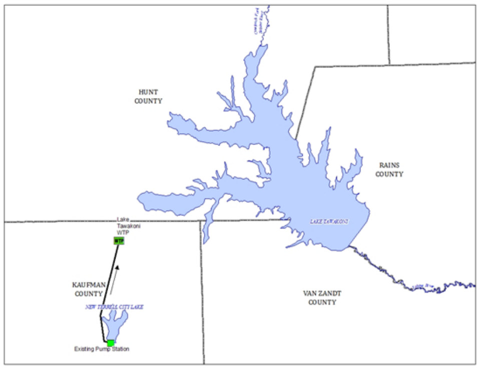
Possible Alternatives - DWU



Possible Alternatives

- Dallas Water Utilities (DWU)
  - Interested in taking water through New Terrell City Lake to Cedar Creek Reservoir. Study will determine:
    - Amount of water that can be transported through the existing Terrell Tawakoni pipeline.
      - Existing 24" Tawakoni pipeline capacity = 12.5 mgd
    - Capacity of outlet works at Terrell City Lake.
      - Approximately 20 to 58 MGD (depending on lake level)
    - If an additional pipeline can be constructed in the existing 30-ft easement from Tawakoni to New Terrell City Lake.
    - Identify where DWU's Lake Fork pipeline crosses the Terrell Tawakoni pipeline.

Possible Alternatives - NTMWD



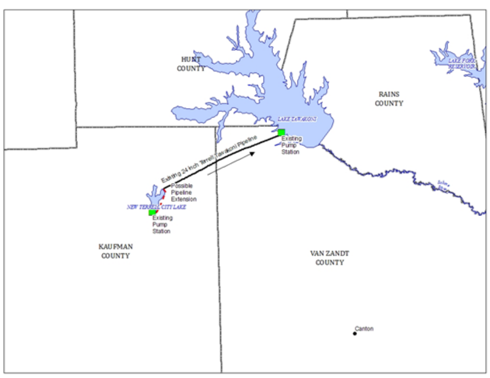
19

Possible Alternatives

- North Texas Municipal Water District (NTMWD)
  - Interested in delivering water from New Terrell City Lake to their Tawakoni WTP. Study will determine:
    - Pipe size required
    - If existing Terrell lake pumps can be used
    - Pipe size needed to utilize Terrell water as an emergency back-up supply for NTMWD Tawakoni WTP

20

Possible Alternatives - SRA



21

Possible Alternatives

- Sabine River Authority
  - Interested in taking New Terrell City Lake water back to Lake Tawakoni. Study will determine:
    - Capacity of existing pipeline in reverse
    - Additional water transmission facilities required
    - If Terrell pumps can be used
  - Interested in supplying customers closer to Terrell. Study will determine:
    - Which customers could be supplied and their demands
    - The required facilities

22

Possible Alternatives (SRA)

- Capacity of existing pipeline in reverse
  - 12,000 ac-ft/yr (11 mgd)
  - Based on pipe diameter, pipe pressure classes, and ground profile
  - Pipeline will need to be extended approximately 3 miles to New Terrell City Lake Dam, and an outlet structure will need to be added at Lake Tawakoni.

23

Possible Alternatives (SRA)

- Existing and potential customers near Terrell
  - Customers with WTPs
    - Cash SUD
    - MacBee SUD
  - Customers with no WTPs
    - Ables Springs WSC
    - Elmo WSC
    - Poetry WSC
    - College Mound WSC
    - North Kaufman WSC

24

Possible Alternatives (SRA)

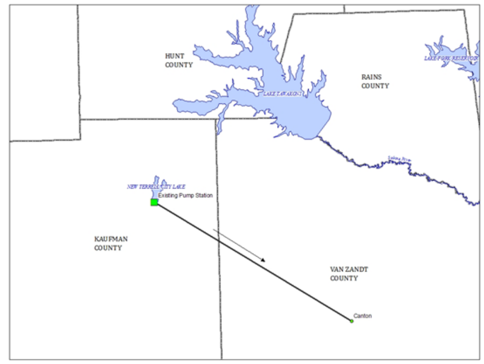
– Demands of SRA Customers near Terrell

	Demands* (ac-ft/yr)					
SRA Customers	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Ables Springs WSC	1,120	1,120	1,120	1,120	1,120	1,120
NTMWD (formerly Terrell)	10,081	10,081	10,081	10,081	10,081	10,081
Cash SUD	5,803	5,803	5,803	5,803	5,803	5,803
MacBee SUD	2,240	2,240	2,240	2,240	2,240	2,240
Subtotal Existing Customers	19,244	19,244	19,244	19,244	19,244	19,244
Potential Future Customers	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Elmo WSC	4,484	4,484	4,484	4,484	4,484	4,484
Poetry WSC	2,242	2,242	2,242	2,242	2,242	2,242
College Mound WSC	5,605	5,605	5,605	5,605	5,605	5,605
North Kaufman WSC	1,233	1,233	1,233	1,233	1,233	1,233
Subtotal Potential Customers	13,564	13,564	13,564	13,564	13,564	13,564
Total	**32,808**	**32,808**	**32,808**	**32,808**	**32,808**	**32,808**

* Based on 2011 Region C Water Plan

25

Possible Alternatives - Canton



26

Possible Alternatives

- <u>City of Canton</u>
  - Interested in delivering New Terrell City Lake water to their WTP. Study will determine:
    - Pipe size needed to deliver water from New Terrell City Lake to Canton's WTP
    - If Terrell pumps can be used

27

Water Schedule

– Major Milestones
- Late August – Complete determination of costs and recommendations
- Mid September – Complete review of Water Conservation and Drought Contingency Plans
- Early October – Complete dam condition assessment
- Mid October – Develop Draft Report
- October 21st – Hold Public Meeting Number 3
- Mid November – Develop Final Report
- Mid January – Submit Final Report with the incorporation of TWDB comments

28

MEETING MINUTES

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PROJECT: City of Terrell Water and Wastewater Studies
NAME OF MEETING: Public Meeting Number 2
RECORDED BY: Keeley Kirksey
DATE: August 5, 2010
LOCATION: City of Terrell
ATTENDEES:

Name	Company
Steve Rogers	City of Terrell
Sonny Groessel	City of Terrell
Dick Boyd	City of Terrell
John Rickman	City of Terrell
Mike Sims	City of Terrell
Gary Burton	Gary Burton Engineering, Inc. (Representing the City of Canton)
Michael Dowdey	Dowdey, Anderson
Mark Edgren	Hillwood
Michael Shook	City of Forney
Linda Stewart	High Point WSC
Vickie Armstrong	Rose Hill SUD
Shirley Blakely	College Mound WSC
Gennady Boksiner	Freese and Nichols
Rachel Ickert	Freese and Nichols
Keeley Kirksey	Freese and Nichols

The following reflects our understanding of the items discussed during the subject meeting. If you do not notify us within five working days, we will assume that you are in agreement with our understanding.

ITEM	DESCRIPTION
1	Introductions • Steve Rogers welcomed everyone and facilitated introductions. The sign in sheets for the meeting are attached.
2	Presentation • Gennady Boksiner presented the scope, progress made, and the schedule for the wastewater study. • Rachel Ickert presented the scope, progress made, and schedule for the water study.
3	Questions/Discussion • Gary Burton (Canton's Engineer) inquired about the drainage area of New Terrell City Lake and the volume of New Terrell City Lake based on the most recent volumetric survey. Rachel Ickert will provide this information to Gary.

ITEM	DESCRIPTION
	• Gary Burton also asked if there was a site for a regional North Texas MWD WWTP. Gennady Boksiner informed him that a pump station and pipeline would be built to convey flows to NTMWD's existing WWTP. • Vickie Armstrong (Rose Hill SUD) asked what Planning Region Canton is located in. Rachel informed her it is in Region D. Rachel Ickert went on to say that the Canton and SRA alternatives would require IBTs. • Gary Burton asked how the presented population projections match up with the Texas Water Development Board Projections. Gennady Boksiner informed him that the actual population numbers used were scaled back to reflect the more recent growth trends and the economy. • Rachel Ickert explained that the firm yield of New Terrell City Lake is based on the TCEQ WAM and matches the firm yield presented in the 2011 Region C Water Plan. Upon Terrell's review and approval, Rachel will send Gary Burton a memorandum on the yield analysis. • Mike Shook (City of Forney) asked why the SRA demands presented do not change over time. Rachel Ickert explained that the demands shown are demands on SRA (not total demands for each customer), and the amounts shown are the contract amounts. • Gary Burton asked if the cost of the raw water will be determined in this study. Steve Rogers (City of Terrell) replied that the raw water cost will be determined in this study and will likely be presented at the next public meeting. Gary mentioned that Canton is interested in the water, but cannot win a bidding war. Rachel Ickert mentioned that the DWU option may be possible without DWU purchasing the raw water from Terrell Lake. • Gary Burton asked about the existing 24" pipeline from Lake Tawakoni to New Terrell City Lake. Rachel informed him that it was included in the presentation because it may be used for some of the possible alternative uses of New Terrell City Lake, but a condition assessment will likely need to be performed at some point.
4	End Public Meeting
5	Terrell/FNI Discussion Following the Public Meeting • Steve asked that cost estimates and summaries for each alternative be prepared and sent to the potential customers for their review and comment and that meetings be held with the potential customers as needed. • Steve asked that a meeting between FNI and Terrell be held to discuss the options for water and wastewater studies separately.

ACTION ITEMS			
WHAT	WHO	WHEN	STATUS
1. Provide drainage area, volume of New Terrell City Lake based on most recent volumetric survey, and memo on New Terrell City Lake yield to Gary Burton.	RAI		
2. Schedule a meeting with Terrell and FNI.	RAI		

Terrell Regional Water Plan

Public Meeting No. 2
August 5, 2010

Name	Company	Address	Phone	E-mail	Signature
SONNY GROESSEL	City of TERRELL	PO Box 310 TERRELL TX 75160	9725516609	sgroessel@cityofterrell.org	[signature]
Dick L. Boyd	City of Terrell	PO Box 310 Terrell Tx 75160	972 551-6635	dboyd@cityofterrel.org	[signature]
Steve Rogers	City of Terrell	P.O. Box 310 Terrell, TX 75160	972-551-6607	srogers@cityofterrell.org	[signature]
Gennady Boksiner	Freese & Nichols	1701 N. Market St, Suite 500, Dallas TX	214-217-2224	gb@freese.com	[signature]
Keeley Kirksey	" "	~~20~~ 4055 International Plaza, Suite 200 FW TX	817-735-7476	kek@freese.com	[signature]
Gary Burton	City of Canton	14531 SH 155 S. Tyler 75703	903-561-6984	gburton@gbei-tx.com	[signature]
Rachel Tckert	Freese & Nichols	4055 International Plaza, Suit 200	817-735-7286	rai@freese.com	[signature]
Shirley Blakely	College Mound	12731 FM 429	9725631355	SBlakely.CMWS@Airmail.Net	[signature]
Vickie Armstrong	Rose Hill SUD	PO Box 190 Kaufman TX 75142	9729323077	RHWSC@AOL.COM	[signature]
LINDA STEWART	HIGH POINT	16986 VALLEY VIEW RD	972-564-3801	HIGHPOINTWSC@AOL.COM	[signature]
MIKE SHOOK	CITY of FORNEY	P.O. BOX 826, Forney 75126	972-564-3148	MSHOOK@cityofforney.org	[signature]
Mike Sims	City of Terrell				
MARK EDGREN	HILLWOOD	5430 LBJ STE 800 DALLAS 75240	972 201 · 2956	mark.edgren@hillwood.com	[signature]

Terrell Regional Wastewater Plan

Public Meeting No. 2
August 5, 2010

Name	Company	Address	Phone	E-mail	Signature
Sonny Groessel	City of Terrell	PO Box 310 Terrell TX 75160	972-551-6609	sgroessel@cityofterrell.org	[signature]
Dick L. Boyd	City of Terrell	P.O. Box 310 Terrell TX 75160	972-551-6635	dboyd@cityofterrell.org	[signature]
Steve Rogers	City of Terrell	P.O. Box 310 Terrell, TX 75160	972-551-6607	srogers@cityofterrell.org	[signature]
Gennady Boksiner	Freese & Nichols	1701 N. Market St, Suite 500, Dallas TX	214-217-2224	gb@freese.com	[signature]
Gary Burton	City of Canton	14531 SH 155 S. Tyler, TX	903-561-6984	gburton@gbeitx.com	[signature]
Rachel Ickert	FNI	4055 International Plaza, Suite	817-735-7286	rai@freese.com	[signature]
Keeley Kirksey	FNI	Fort Worth, TX 76109 200	817-735-7476	kek@freese.com	
Michael Dowdey	Dowdey, Anderson	5225 Village Creek Dr. Ste 200 Plano 75093	972-931-0694	mdowdey@daa-civil.com	[signature]
Mike Sims	City of Terrell				
John Rickman	City of Terrell	P.O. Box 310, Terrell, Tx 75160	972-551-6630	jrickman@cityofterrell.org	[signature]

NOTICE OF PUBLIC MEETING

Notice is hereby given that the City of Terrell and Las Lomas Municipal Utility District No. 4 of Kaufman County will hold a public meeting to discuss the status of the Regional Water Facilities Plan. The City of Terrell is seeking input and comments and will consider such input and comments for incorporation in the final report. An update on any findings for the Regional Water Facilities Plan will be presented to the public on February 17, 2011.

The public meeting regarding the Regional Water Facilities Plan will be held on Thursday, February 17, 2011 at 11:00 a.m. at Council Chambers, Terrell City Hall, located at 201 East Nash Street, Terrell, Texas 75160.

Public comments are encouraged and will be solicited at this meeting. Written and oral comments regarding the Regional Water Facilities Plan will be accepted at the public meeting. Anyone unable to attend the meeting may submit comments in writing to City of Terrell, Attention: Sonny Groessel at P.O. Box 310, Terrell, TX 75160-0310. Written comments must be received by the City of Terrell by 10:00 a.m. on Thursday, February 17, 2011.

For additional information, please contact Sonny Groessel, telephone number (972) 551-6600, ext. 297.

Published
Terrell Tribune
Thursday, February 10th, 2011
Sunday February 13th, 2010

NOTE
Facilities Draft Plan is posted on the City web site at:
http://www.cityofterrell.org/pdf/Regional-Water-Facilities-Plan-Report_Alternatives-2-3-2011.pdf

NOTICE OF PUBLIC MEETING

Notice is hereby given that the City of Terrell, Las Lomas Municipal Utility District No. 4 of Kaufman County, Fairfields Municipal Utility District, and Kaufman County Water Control and Improvement District No. 1 will hold a public meeting to discuss the status of the Regional Wastewater Facilities Plan. The City of Terrell is seeking input and comments and will consider such input and comments for incorporation in the final report. An update on any findings for the Regional Wastewater Facilities Plan will be presented to the public on February 17, 2011.

The public meeting regarding the Regional Wastewater Facilities Plan will be held on Thursday, February 17, 2011 at 11:00 a.m. at Council Chambers, Terrell City Hall, located at 201 East Nash Street, Terrell, Texas 75160.

Public comments are encouraged and will be solicited at this meeting. Written and oral comments regarding the Regional Wastewater Facilities Plan will be accepted at the public meeting. Anyone unable to attend the meeting may submit comments in writing to City of Terrell, Attention: Sonny Groessel at P.O. Box 310, Terrell, TX 75160-0310. Written comments must be received by the City of Terrell by 10:00 a.m. on Thursday, February 17, 2011.

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Published
Terrell Tribune
Thursday, February 10th, 2011
Sunday February 13th, 2010

NOTE
Facilities Draft Plan is posted on the City web site at:
http://www.cityofterrell.org/pdf/Regional-Wastewater-Facilities-Plan_CLIENT%20DRAFT_Feb2011.pdf

Terrell Regional Water and Wastewater Studies

(TWDB Contract No. 1004831081 and No. 1004831082)

Public Meeting No. 3

Thursday, February 17, 2011

1

Water Study

- Determined available supply from the lake
- Performed needs assessment for water suppliers near lake
- Identified potential alternative uses of the lake and associated costs
- Reviewed Region C and Region D Water Plans for potential changes needed

2

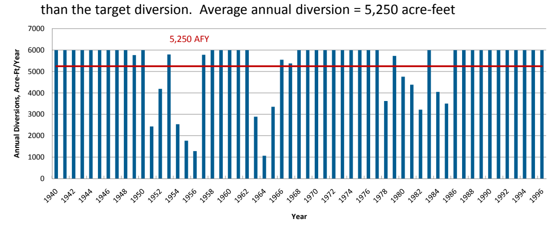
Water Study, Continued

- Completed dam site inspection
- Developed dam improvement alternatives and associated costs
- Reviewed water conservation and drought contingency plans for Terrell and potential customers

3

Available Supply From Lake

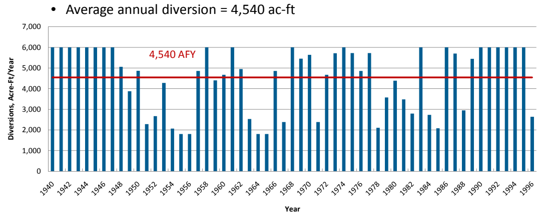
- Analysis completed using the TCEQ Trinity Water Availability Model (WAM)
- Firm Yield = 2,300 ac-ft/yr for 2060 conditions
- Water Availability Analysis
  - Target diversion of 6,000 ac-ft/yr – in 16% of the months, the actual diversion is less than the target diversion. Average annual diversion = 5,250 acre-feet



4

Available Supply From Lake

- Water Availability Analysis
  - Target diversion of 6,000 ac-ft/yr when reservoir storage is > 50% and target diversion of 1,800 ac-ft/yr when reservoir storage is < 50%
    - Results in no shortages
    - Average annual diversion = 4,540 ac-ft



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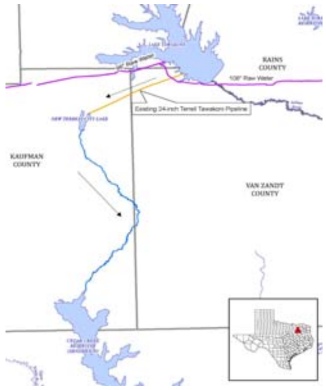
Potential Alternatives

- Dallas Water Utilities (DWU) – Transmit water through New Terrell City Lake to Cedar Creek Reservoir.
- North Texas Municipal Water District (NTMWD) - Transmit water from New Terrell City Lake to NTMWD Tawakoni WTP
- Sabine River Authority (SRA) – Transmit New Terrell City Lake water to Lake Tawakoni
- City of Canton – Transmit water from New Terrell City Lake to Canton's WTP

6

Potential Alternatives - DWU



7

Potential Alternatives

- Dallas Water Utilities (DWU)
  - Interested in taking water through New Terrell City Lake to Cedar Creek Reservoir
  - Pass-through without purchase of New Terrell City Lake water (Option 1)
    - Transport 75 mgd (peak) from Lake Tawakoni to New Terrell City Lake (based on outlet capacity at Terrell Lake).
    - Replace the existing 24-inch pipeline from Lake Tawakoni with a 66-inch pipeline.
    - New 4,100 HP intake pump station at Lake Tawakoni.

8

Potential Alternatives

- Dallas Water Utilities (DWU)
  - Pass-through with purchase of New Terrell City Lake water (Option 2)
    - Transport 67.3 mgd from Lake Tawakoni and purchase 4.7 mgd from Lake Terrell
    - Replace the existing 24-inch pipeline from Lake Tawakoni with a 66-inch pipeline.
    - New 3,700 HP intake pump station at Lake Tawakoni.

9

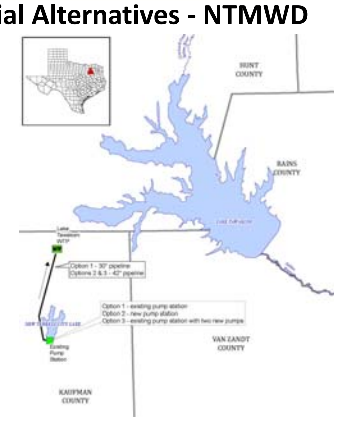
DWU - Costs

Alternative	Supply (peak, mgd)	Cost of New Construction	Cost of Existing Facilities	Unit Costs (per 1,000 gallons)	
				Pre-Amortization	Post-Amortization
Option 1	72	$51,809,100	$2,292,593	$0.37*	$0.11*
Option 2	72	$50,995,200	$2,292,593	$0.37	$0.14

*Unit costs are based on an average annual supply of 50 mgd from Lake Tawakoni

10

Potential Alternatives - NTMWD



11

Potential Alternatives

- North Texas Municipal Water District (NTMWD)
  - Interested in delivering water from New Terrell City Lake to their Tawakoni WTP as a primary or backup supply.
    - Primary supply (Option 1)
      - 8-mile long, 30-inch pipeline is required to transport 13 mgd
      - Existing Terrell pumps can be used
    - Backup supply (Options 2 & 3)
      - 8-mile long, 42-inch pipeline is required to transport 30 mgd
      - New 1,500 HP pump station and a new intake at Lake Terrell required (Option 2) or
      - Existing intake structure and several existing pumps with 2 new pumps can be used (Option 3)

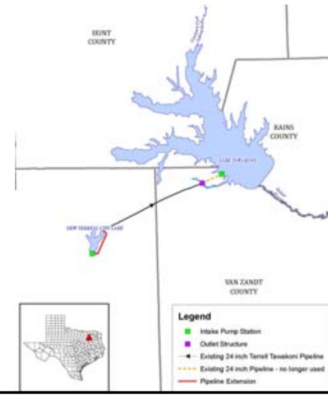
12

NTMWD - Costs

Alternative	Supply (peak, mgd)	Cost of New Construction	Cost of Existing Facilities	Unit Costs (per 1,000 gallons)		Unit Costs (per 1,000 gallons)	
				Average Annual Yield		Firm Yield	
				Pre-Amortization	Post-Amortization	Pre-Amortization	Post-Amortization
Option 1	12.96	$9,001,000	$1,150,000	$1.09	$0.66	$1.78	$0.84
Option 2	30	$20,056,000	$0	$1.54	$0.69	$2.78	$0.92
Option 3	30	$13,397,000	$1,150,000	$1.31	$0.70	$2.26	$0.91

13

Potential Alternatives - SRA



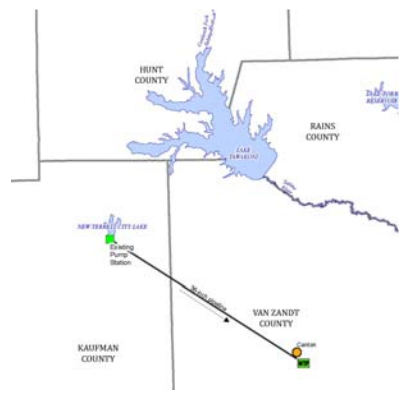
14

Potential Alternatives

- <u>Sabine River Authority</u>
  - Transmit New Terrell City Lake water to Lake Tawakoni.
    - Existing 24-inch pipeline to be extended approximately 3 miles to New Terrell City Lake.
    - New outlet structure needed at Lake Tawakoni.
  - Based on the overall estimated cost, SRA is not interested in pursuing the Terrell supply any further.

15

Potential Alternatives - Canton



16

Potential Alternatives

- <u>City of Canton</u>
  - Interested in delivering New Terrell City Lake water to their WTP.
    - 25-mile long, 36-inch pipeline required to transport 13 mgd (peak) to Canton's WTP.
    - Interbasin transfer permit is required.
    - Existing Terrell pumps can be used.

Alternative	Supply (peak, mgd)	Cost of New Construction	Cost of Existing Facilities	Unit Costs (per 1,000 gallons)		Unit Costs (per 1,000 gallons)	
				Average Annual Yield		Firm Yield	
				Pre-Amortization	Post-Amortization	Pre-Amortization	Post-Amortization
New Terrell City Lake to Canton's WTP	12.96	$35,745,000	$1,150,000	$2.33	$0.77	$4.52	$1.09

17

Regional Water Plans

- The New Terrell City Lake water supply is not included as a recommended or alternative water management strategy for any of the potential users.
- If Canton, DWU, or NTMWD pursue the New Terrell City Lake supply, the *2011 Region C Water Plan* and/or the *North East Texas Regional Water Plan* (Region D) may need to be amended for the projects to be eligible for state funding.

18

Dam Site Assessment

- A separate study was performed by NRCS to assess the dam's hydraulic capacity against NRCS requirements.
- The NRCS study found that the dam does not meet current NRCS hydraulic capacity requirements.
- Four alternatives were developed to rehabilitate the dam to meet NRCS requirements.
- Terrell can potentially partner with the NRCS for funding for the dam rehabilitation.

19

Water Schedule

- Major Milestones
  - February 28th – Comments on draft report are due to FNI
  - March 24th – FNI submit Report to TWDB with the incorporation of public comments
  - April – Present report to Terrell City Council
  - May – Finalize Report with TWDB Comments

20

Terrell Regional Wastewater Study

Thursday, February 17, 2011

21

Wastewater Study Scope

- Condition Assessment
  - What equipment needs replacement?
  - When does equipment need to be replaced?
- Process Modeling
  - How much flow can we process at different effluent limits?
- Improvement Recommendations
  - Based on modeling, assessment, and future wastewater flow projections
  - What improvements are needed to continue to meet TCEQ permit requirements?

22

Population Projection

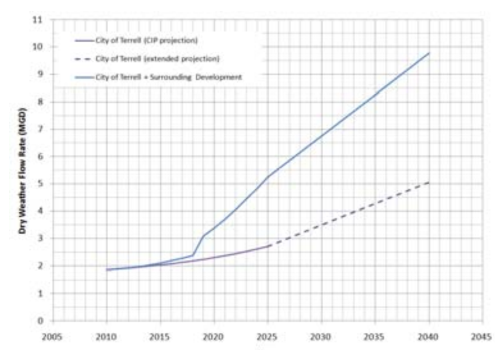
	Population					
Year	Fairfield[1]	Whitt Ranch[1]	Las Lomas[1]	RIO[2]	Terrell[3]	**Total**
2010	-	-	-	-	16,185	**16,185**
2015	-	612	-	-	17,694	**18,306**
2020	300	2,487	6,150	462	20,018	**29,417**
2025	3,900	5,019	10,308	2,772	23,546	**45,545**
2040	Not Available	Not Available	Not Available	Not Available	Not Available	**85,000[4]**

Notes:

1. As provided by participating partners in August 2010
2. As provided by Rio, updated by City of Terrell
3. As provided in City of Terrell CIP 2009
4. From Region C long term planning

23

Flow Projection – Average Day Flow



24

Permit Evaluation

- Permit changes are anticipated in upcoming TPDES discharge permit (2012)

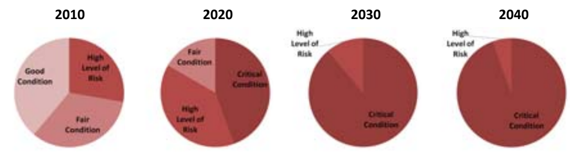
Parameter	30-Day Average		7-Day Average	Daily Maximum
	mg/L	lbs/day	mg/L	mg/L
$CBOD_5$	7 (7/10)	263	12 (12/15)	22 (22/25)
TSS	15	563	25	40
NH_3-N	3 (3/5)	113	6 (6/7)	10
Total Phosphorus	0.5 (N/A)	19	1 (N/A)	2 (N/A)
Aluminum (total)	0.834	31	N/A	1.766
Copper (total)	Report	Report	N/A	Report
Silver (total)	0.0073	0.26	N/A	0.0155
Zinc (total)	0.241	9.0	N/A	0.509

Note: current permit values noted in red (warm weather/cold weather values)

25

Condition Assessment

- 8 of 18 unit processes will be in critical condition in 2018
- 16 of 18 unit processes will be in critical condition in 2030
- Significant mechanical upgrades required before 2018 to maintain treatment capabilities



26

Process Evaluation

- Computer model developed to simulate King's Creek WWTP
- Calibrated and validated to process performance sampling of individual unit processes
- Performance projections made for increasing flows
- Existing critical parameter: ammonia (NH_3-N) removal
- Future critical parameters: ammonia and phosphorus removal

- **Functional capacity for _current_ permit: 2.1 MGD**
- **Functional capacity for _future_ permit: 1.9 MGD**

27

Alternatives Evaluation

- **Alternative 1:** Upgrade and expand the existing King's Creek WWTP
- **Alternative 2:** Construct new City of Terrell WWTP on existing site
- **Alternative 3:** Request Service from North Texas Municipal Water District (NTMWD)
  - **Option 1:** Connect to NTMWD's Forney Interceptor System (FIS)
  - **Option 2:** Connect to NTMWD's Lower East Fork Interceptor System (LEFIS)

28

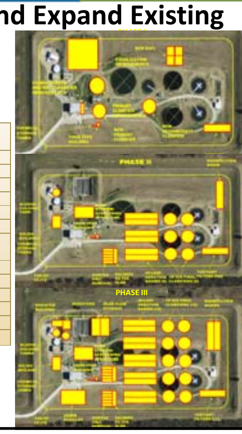
Alternative 1 – Upgrade and Expand Existing King's Creek WWTP

- Phase I: Near Term Improvements to the existing facilities
  - Based on 2004 improvements and current condition assessment
- Phase II: Replace existing facilities with new 9.0 MGD activated sludge facilities
  - Most efficient use of site to meet future permits
  - Treat flows through 2035
- Phase III: Expansion of activated sludge facilities
  - Treat flows past 2040
- Annual cost based on operation of treatment facilities

29

Alternative 1 – Upgrade and Expand Existing King's Creek WWTP

Year	Improvement	Budgetary Cost (2011$)
2012	**Near Term Improvements**	**$16.3 M**
	Construction	$13.8 M
	Engineering and Surveying	$2.5 M
2022	**New 9 MGD Activated Sludge WWTP**	**$63.1 M**
	Construction	$53.5 M
	Engineering and Surveying	$9.6 M
2035	**Expansion 4.5 MGD Activated Sludge WWTP**	**$27.7 M**
	Construction	$23.5 M
	Engineering and Surveying	$4.2 M
TOTAL CAPITAL COSTS		**$107.1 M**
TOTAL ANNUAL COSTS (2014-2040)		**$126.0 M**
TOTAL COST		**$233.1 M**



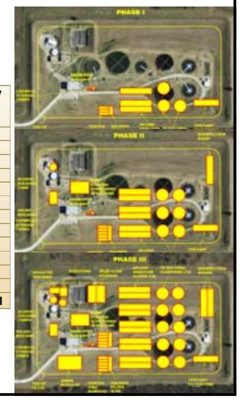
Alternative 2 – New City of Terrell WWTP

- New WWTP would be an activated sludge facility
- Provides most efficient treatment option for future permit requirements
- Replaces aging infrastructure
- Three phases, each adding 4.5 MGD of treatment capacity
  - Phase I treats flows through 2023
  - Phase II treats flows through 2035
  - Phase III treats flows past 2040
- Annual cost based on operation of treatment facilities

31

Alternative 2 – New City of Terrell WWTP

Year	Improvement	Budgetary Cost (2011$)
2012	**New Activated Sludge WWTP**	**$32.1 M**
	Construction	$27.2 M
	Engineering and Surveying	$4.9 M
2022	**Expansion 4.5 MGD Activated Sludge WWTP**	**$27.7 M**
	Construction	$23.5 M
	Engineering and Surveying	$4.2 M
2035	**Expansion 4.5 MGD Activated Sludge WWTP**	**$27.7 M**
	Construction	$23.5 M
	Engineering and Surveying	$4.2 M
TOTAL CAPITAL COSTS		**$87.5 M**
TOTAL ANNUAL COSTS (2014-2040)		**$125.6 M**
TOTAL COST		**$213.1 M**

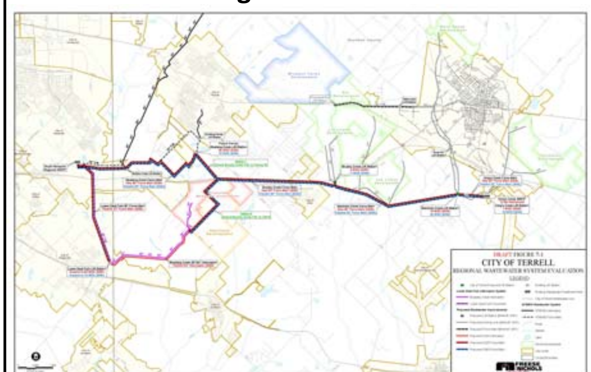


Alternative 3 – Regional Treatment

- Regional wastewater treatment system
- Request to become a partner with the North Texas Municipal Water District (NTMWD) regional system
- Two options
  - Option 1: Connect to NTMWD's Forney Interceptor System (FIS)
  - Option 2: Connect to NTMWD's Lower East Fork Interceptor System (LEFIS)
- Annual costs based on:
  - City of Terrell conveyance costs
  - Regional conveyance operation and maintenance costs
  - Regional treatment costs

33

Alternative 3 – Regional Treatment



34

Alternative 3 – Regional Treatment

	Total	
	Total Cost (2011$ Millions)	
	Option 1 - Forney	Option 2 - LEFIS
City of Terrell	**$94.8**	**$102.8**
Conveyance Capital Cost	$79.9	$87.6
Conveyance O&M Cost	$14.9	$15.2
Terrell Portion of NTMWD System Cost	**$93.2**	**$105.4**
Conveyance Capital Cost	$25.0	$36.6
O&M Cost	$6.9	$7.5
Regional Treatment Cost	$61.3	$61.3
TOTAL CAPITAL COST	**$104.9 M**	**$124.2 M**
TOTAL ANNUAL COST (2014-2040)	**$83.1 M**	**$84.0 M**
TOTAL COST FOR TERRELL	**$188.0**	**$208.2**

35

Alternatives Comparison

	Budgetary Costs (2011 $) (Through 2030)			
	Alternative 1 Upgrade and Replace Existing King's Creek WWTP	**Alternative 2** New City of Terrell WWTP	**Alternative 3** Regional Treatment	
			Option 1	**Option 2**
Total Capital Cost	$107.1 M	$87.5 M	$104.9 M	$124.2 M
Total Annual Costs	$126.0 M	$125.6 M	$83.1 M	$84.0 M
Total Cost	**$233.1 M**	**$213.1 M**	**$188.0 M**	**$208.2 M**

- Alternative 1, 2, and 3 have similar capital costs
- Alternative 3 have the lowest annual costs

36

Recommendation

- Recommend pursuing a regional treatment alternative
  - Lower cumulative annual cost for the evaluation period for Alternative 3
  - Continued savings of Alternative 3 beyond 2040
  - Due to the close total cost of Option 1 and Option 2 (less than 10% difference), there is not a strong economic driver for one option over the other. The decision for which option to pursue will need to be discussed soon
  - Begin formal process/discussions with NTMWD to request becoming a member

37

Implementation

- Treatment needs exist before 2013
  - Interim improvements to meet near term treatment needs
  - Phased approach to minimize investment in King's Creek WWTP
  - Total cost will depend on implementation of timeline of Alternative 3

		Budgetary Cost	
Interim Improvements	**Implementation Year**	**(2011 $)**	**(Actual Year $)***
Phase I - Chemical Feed Facilities	2012	$0.45 M	$0.47 M
Phase II - Tertiary Filters	2014	$2.0 M	$2.3 M
Phase III - Salsnes Filters	2016	$2.6 M	$3.2 M
Total		**$5.1 M**	**$6.0 M**

*Assumes 5% inflation per year

38

Wastewater Schedule

- **February 28, 2011** – Comments due to City/FNI
- **March 24, 2011** – Report submitted to TWDB with the incorporation of public comments
- **April 2011** – Present report findings to Terrell City Council
- **May 2011** – Finalize report with TWDB Comments
- **Mid 2011** – Alternative 3 option decision needed by City
- **Early 2014** – Alternative 3 improvements in place

39

MEETING MINUTES FREESE AND NICHOLS Innovative approaches Practical results Outstanding service
4055 International Plaza, Suite 200 • Fort Worth, Texas 76109 • 817-735-7300 • fax 817-735-7491 www.freese.com

PROJECT: City of Terrell Water and Wastewater Studies
NAME OF MEETING: Public Meeting Number 3
RECORDED BY: Keeley Kirksey
DATE: February 17, 2011
LOCATION: City of Terrell
ATTENDEES: See attached sign-in sheet

The following reflects our understanding of the items discussed during the subject meeting. If you do not notify us within five working days, we will assume that you are in agreement with our understanding.

ITEM	DESCRIPTION
1	Introductions • Steve Rogers welcomed everyone and facilitated introductions. He also explained the purpose of the studies.
2	Presentation • Rachel Ickert presented the scope, water availability, potential alternatives, and schedule for the water study. • Gennady Boksiner presented the scope, recommendations, and the schedule for the wastewater study.
3	Questions/Discussion • Ray Longoria (Freese and Nichols) commented that the interim improvement costs to King's Creek WWTP (slide 38) do not include costs for maintenance of existing mechanical issues as the plant ages. It only considerers improving the plant to meet new permit regulations. • A question was posed as to whether the annual costs for Alternative 3 (slide 33) include operation and maintenance (O&M) costs. Steve Rogers and Gennady Boksiner explained that the annual costs for that alternative include City of Terrell conveyance costs, regional conveyance and O&M costs, and regional treatment costs. • Steve Rogers announced that all comments on either of the draft reports can be sent to him and he will forward them on to Freese and Nichols. The due date for comments is February 28, 2011. • Matt Holzappel (City of Mesquite) asked if Alternative 3 had been discussed with NTMWD regarding the capacity of the South Mesquite WWTP (where Terrell's wastewater would be sent) and land constraints associated with expanding the plant. He asked if NTMWD would be able to expand the plant to sufficiently treat Terrell's wastewater in addition to the flows already treated at the South Mesquite WWTP. Gennady Boksiner (Freese and Nichols) replied that NTMWD has seen the report and the projected flow amounts from Terrell. The draft Wastewater Study Report assumes all of Terrell's flow will be sent to the South Mesquite WWTP, but realistically Terrell's wastewater may be sent to multiple plants as new WWTPs are built in the vicinity and this fact will be acknowledged in the report.

ITEM	DESCRIPTION
	• Steve Rogers (City of Terrell), Gennady Boksiner (Freese and Nichols), and Torry Edwards (City of Terrell) all wanted to make it clear that no agreements have been made with NTMWD or any of its customers regarding regional treatment for the City of Terrell. The Wastewater Study is only pointing out feasible options at this point. • Torry Edwards (City of Terrell) asked the entities present to consider a regional approach to future planning and to seriously consider the information presented at the meeting.
4	End Public Meeting

Terrell Regional Water and Wastewater Studies

Public Meeting No. 3
February 17, 2011

Name	Company	Address	Phone	E-mail
SONNY GROESSEL	CITY OF TERRELL	PO BOX 310 TERRELL TX 75161	972 551 6600 [illegible]	sgroessel@cityofterrell.org
Gennady Boksiner	Freese & Nichols	1701 N. Market St. Suite 500, Dallas TX	(214) 217-2224	gb@freese.com
John Ho	Huitt-Zollars	1717 McKinney Ave, Dallas 75202	214-871-3311	jho@huitt-zollars.com
JASON STOVALL	Sabine River Authority	PO BOX 310 Point TX 75472	903-598-2216	jstovall@sratx.org
Randy Traylor	"	"	"	rtraylor@sratx.org
Angela Kennedy	TWDB		512-463-1437	angela.kennedy@twdb.state.tx.us
John Rickman	City of Terrell	P.O. Box 310, Terrell	972-551-6630	jrickman@cityofterrell.org
Dick L. Boyd	City of Terrell	P.O. Box 310 Terrell	972-551-6635	dboyd@cityofterrell.org
RAY LONGORIA	FREESE & NICHOLS	1701 N. MARKET ST. SUITE 500 DALLAS	214/217-2252	rrl@freese.com
Roy PERKINS	NORTH KAUFMAN WSC	P.O. Box 870 KAUFMAN TX 75142	972/932/9614	
Richard Dormier	Freeman-Millican	12225 Greenville Ave Dallas	214 503 0555	richard@fmi-dallas.com
MIKE Hook	City of Forney	P.O. BOX 826 Forney TX 75126	972-564-7300	mhook@cityofforney.org
RL Lemke	Prime Income	1800 Valley View #300 Dallas 75234	214 912 7360	RL.Lemke@PrimeAsset.com
Keeley Kirksey	FNI	4055 International Plaza Ste 200	817 735 7476	kek@freese.com
DENIS QUALLS	DALLAS	1500 MARILLA ST 4AS DALLAS TX 75201	214 670-3843	DENIS.QUALLS@DALLASCITYHALL.COM
Yanbo Li	NTMWD	505 E Brown St. Wylie TX 75098	972-442-5405	yli@ntmwd.com
Richie Armstrong	Rose Hill SUD	PO Box 190 Kaufman TX 75142	972 932 3027	RHWSC@AOL.COM
Don Thurman	City of Terrell	P.O. Box 310 Terrell		
Mickey Butler	NTMWD	505 E BROWN WYLIE	972-442-5405	MBUTLER@NTMWD.COM
Marty Paris	Kimley-Horn	12700 Park Central Dallas, TX 75251	972-776-1732	marty.paris@kimley-horn.com
Frank [illegible]	[illegible]		214 683 9450	frank@[illegible]

Terrell Regional Water and Wastewater Studies

Public Meeting No. 3
February 17, 2011

Name	Company	Address	Phone	E-mail
Jerry L. Edwards	City of Terrell	201 E. Nash	972-551-6604	TEdwards@cityofterrell.org
Scott Shipp	Hunt Realty	1900 N. Akard Dallas, TX	214-978-8584	sshipp@huntrealty.com
Mike Sims	City of Terrell			
Matt Holzapfel	City of Mesquite		972.216.6353	mholzapf@cityofmesquite.com
Steve Rogers	City of Terrell	201 E. Nash St	972-551-6600	srogers@cityofterrell.org
Jack Jones	City of Terrell	✓	972.524.5793	jack0423@swbell.net

MEETING MINUTES

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PROJECT: NTMWD Terrell Wastewater Treatment Study
NAME OF MEETING: Draft Report Review
RECORDED BY: Gennady Boksiner/Scott Cole
DATE: February 14, 2011
LOCATION: NTMWD Engineering Conference Room
ATTENDEES: FNI: David Jackson (DRJ), Brian Coltharp (BCC), Scott Cole (SAC), Gennady Boksiner (GB), Richard Weatherly (RAW)
NTMWD: Mickey Butler (MB), Brooke Noack (BN), Jerry Allen (JA), Bruce Cole (BC), Yanbo Li (YL), Joe Stankiewicz (JS), Ken Wesson (KW)

The following reflects our understanding of the items discussed during the subject meeting. If you do not notify us within five working days, we will assume that you are in agreement with our understanding.

ITEM	DESCRIPTION
1.01	• JS Asked how the populations were developed and GB replied that they used the developers populations and Terrell's CIP number through 2025 and Region C at 2040. • JS noted that in order to allow Terrell to become a customer and send flow to the South Mesquite WWTP, NTMWD has to show to the Board that addition of Terrell will be a benefit to existing customers. • JS noted that additionally, the City of Terrell will have to become a member of the pre-treatment program and sign the appropriate contract. • JA stated that NTMWD doesn't have enforcement authority over industries and are trying to work a more direct enforcement strategy with all cities. In the new contracts, cities will give the NTMWD the authority to enforce pretreatment regulations directly to industries. • JA stated that the projected cost of joining the pre-treatment program is projected to be approximately the same or slightly more as Terrell is currently paying. • JA noted that NTMWD would have to reevaluate the pre-treatment limits of the South Mesquite WWTP for all contributing customers if Terrell were to become a customer. • JS stated that Page ES-5 needs revision. Bullets 4 and 5 need to be reworded to not make a negative impact on NTMWD and its existing customers. • JA stated that in one month, a more up-to-date pre-treatment limits for the South Mesquite WWTP will be available and then Terrell's numbers could be added to determine projected limits. • JA stated that NTMWD would be modifying the method to allocate pretreatment cost to cities to better distribute the cost equitably and to deter noncompliance of industries. • JS suggested that due to previous issues with Terrell's pre-treatment program, the report should properly address the impact of the potential additional loading on the plant. For example, one impact on the existing members could be a decrease in the current established pre-treatment loading requirements. Additionally, an increase in the overall loading from industrial sources could impact the current planned residential flow to the plant. • JMS suggested that the current contracts should be reviewed relative to the stated peaking factors. Should Terrell's current peaking factor exceed that in the current contract, the report

ITEM	DESCRIPTION
	should indicate that Terrell should consider a program for I/I reduction to achieve a peaking factor within the limits stated in the District's current contracts. • JA stated that NTMWD is also concerned the flows and loadings presented are not consistent with those provided for the Local Limits Development submitted. • ***FNI is to obtain most recent flows from Terrell and timing of the collection system improvements.*** • JA stated that Table 2.2, Terrell's numbers are off. ***NTMWD will provide the correct numbers.*** Also, NTMWD's numbers should be deleted since they will have to be determined by the study. • ***On page 7, the numbers in the report and NTMWD's WW influent characteristics are significantly different. FNI to find the discrepancy from data forwarded by NTMWD.*** • JS stated that the South Mesquite WWTP's expandable capacity is limited. It is possible that Terrell's WW will have to be diverted to a different plant in the future and the economic impact of this is unknown. A disclaimer should be added to the report. • On Page 12, the assumed price is $1.00/1,000 gallons; a qualification that this price will be adjusted must be added. • JS Stated that payment schedule table or "Funding" section should be added to this report that will explain when the money will be needed. • JS noted that NTMWD's annual collection cost does not include the cost for chemicals, if NTMWD deems it necessary, and that the qualifying statement should be added to the report. • FNI needs to add the language "Upon approval by NTMWD and existing member cities, the regional option is recommended…" • The time associated with the approval process is not currently considered in the schedule. • Page ES-4 the phrase "anticipated…by the end of 2013" needs to be rephrased to sound more like the GTUA study. • JS noted that NTMWD and the member cities have to approve the recommendation to accept Terrell before any other actions can be taken. Additionally, Forney (Option 1) or Seagoville/Mesquite (Option 2) have to sign a transmission agreement. • In the Request Service for Option 3, the wording needs to reflect that NTMWD has not accepted Terrell's joining the system. • At the end of the meeting, JS discussed the recommendation further with BCC and DRJ. DRJ indicated that consideration should be given to revising the recommendation, i.e. not making a direct recommendation for Terrell to join the District's Regional WW System. Instead, recommendation should be made that Terrell request service from NTMWD. FNI should review the overall recommendation being developed with the District before revising the Draft report.

PATH FORWARD AND ACTION ITEMS		
WHAT	**WHO**	**WHEN**
FNI is to obtain most recent flows from Terrell improvements.	GB/FNI	February 15, 2011

NTMWD to provide the most recent pre-treatment limits for the City of Terrell	JA/NTMWD	February 28, 2011
On page 7, the numbers in the report and NTMWD's WW influent characteristics are significantly different. FNI to find the discrepancy from data forwarded by NTMWD.	GB/FNI	February 28, 2011

MEETING MINUTES

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PROJECT: City of Terrell Regional Wastewater Treatment Study
NAME OF MEETING: Draft Report Review
RECORDED BY: Gennady Boksiner/Scott Cole
DATE: February 10, 2011
LOCATION: City of Terrell Office
ATTENDEES: FNI: Scott Cole (SAC), Brian Coltharpv(BCC), Gennady Boksiner (GB), Ray Longoria (RRL), Richard Weatherly (RAW)
City of Terrell: Mike Sims (MS), Steve Rogers (SR), John Rickman (JR), Sonny Groesel (SG)

The following reflects our understanding of the items discussed during the subject meeting. If you do not notify us within five working days, we will assume that you are in agreement with our understanding.

ITEM	DESCRIPTION
1.01	Review City Comments on Draft Report • SR stated that he has distributed DRAFT Reports to participating partners for review prior to Public Meeting No. 3 via City's website. • SR stated that he requested comments by February 28, 2011. • SR, SG, JR and MS went over City's comments on the report and provided City's marked up copy of the DRAFT report for comments incorporation by FNI.
1.02	Review Public Meeting No. 3 Outline • Copies of the PowerPoint presentation needed as handouts at the public meeting. • Need to make report formats and covers more consistent between water and wastewater studies. • Need to include the TWDB logo or no logos at all. • Include 3 logos on cover and no logos in the body of the report. • ***Steve Rogers will review the outline for the presentation and forward comments to GB.***
1.03	Next Steps/ Path Forward • ***City to provide comments on PowerPoint presentation outline by tomorrow morning***. • Meet with NTMWD on Monday. • ***FNI to send Draft PowerPoint.*** • DRAFT Report comments due on February 28, 2011. • April presentation to Council.

PATH FORWARD AND ACTION ITEMS		
WHAT	**WHO**	**WHEN**
Steve Rogers will review the outline for the presentation and forward comments to GB.	Steve Rogers	February 11, 2011
FNI to send Draft PowerPoint.	GB	February 14, 2011