December 2012

Tracy Wastewater Master Plan

Prepared for
City of Tracy, California

Prepared by
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Executive Summary

Introduction

The City of Tracy (City) is projecting residential and non-residential growth within its sphere of influence (SOI) that will require expansion of existing wastewater conveyance and treatment infrastructure. At the time of commencement of this Master Plan, the City's population of approximately 81,000 people generated an average dry weather flow (ADWF) of 7.6 million gallons per day (mgd). This flow is treated at the City's wastewater treatment plant (WWTP), which has an ADWF design capacity of 10.8 mgd. Future ADWF within the City's SOI is estimated at 21.1 mgd with the addition of currently proposed development projects. The purpose of this Wastewater Master Plan is to determine infrastructure requirements based on future wastewater flows and future regulations that would impact permitted discharge limits and biosolids disposal requirements. To accomplish this, wastewater generation rates were evaluated, and future wastewater flow and mass loadings were estimated for the entire Future Service Areas. In addition, current and forecasted regulations that impact discharge requirements were reviewed and summarized. Wastewater facilities were evaluated in terms of capacity from a hydraulic and process treatment perspective to outline modifications needed to convey and treat future wastewater conditions reliably.

Future Wastewater Flows and Loadings

Wastewater flows were projected using updated wastewater generation factors and the most current land use planning data available. New wastewater generation factors propose a reduction of the per capita flow rate from the City's current standard of 100 gallons per capita per day (gpcd) to 80 gpcd. This reduction is rational as the majority of new flows will be associated with new construction, which will include the latest water conserving appliances and fixtures. As a result, wastewater generation rates have been reduced from the City's current standards for most categories of land use, as shown in Table ES-1.

Assumptions used in developing future mass loadings within the Future Service Areas are shown in Table ES-2. The two loading parameters identified for this Tier I master planning effort include biochemical oxygen demand (BOD) and total suspended solids (TSS). Nutrient fractions are assumed to be consistent with domestic sewage at this stage of analysis.

Flows and loadings from residential units are based on equivalent dwelling units (EDU) (one EDU is the flow and load from one very-low- or low-density residential unit); flows and loadings from other land use categories are based on the number of equivalent dwelling units per acre of development. Gross acres have been assumed for the purposes of this master plan.

TABLE ES-1
Wastewater Flow and Loading Generation Factors
Tracy Wastewater Master Plan

Flow Parameter	Current Values	Tier I Master Plan Values
Per Capita Flow	100 gpcd	80 gpcd
Residential Flow – VLD	300 gpd/unit	264 gpd/unit
Residential Flow – LD	300 gpd/unit	264 gpd/unit
Residential Flow – MD	250 gpd/unit	216 gpd/unit
Residential Flow – HD	200 gpd/unit	176 gpd/unit
Industrial Flow	1,500 gal/ac-day	1,056 gal/ac-day
Office, Retail, and Commercial Flow	1,375 gal/ac-day	1,140 gal/ac-day

Notes:
gal = gallons
gal/ac- = gallon(s) per acre per day
gpcd = gallon(s) per capita per day
gpd = gallon(s) per day
HD = high density
LD = low density
MD = medium density
VLD = very low density

TABLE ES-2
Wastewater Loading Generation Factors
Tracy Wastewater Master Plan

Parameter	BOD Loading	TSS Loading
Per Capita Loading	0.18 lb/cap-day	0.21 lb/cap-day
Industrial Loading[a]	2.4 lb/acre	2.8 lb/acre
Office Loading[b]	1.2 lb/acre	1.4 lb/acre
Retail and Commercial Loading	3.3 lb/acre	3.8 lb/acre

[a]Based on 4 equivalent dwelling units (EDUs)/acre
[b]Based on 2 EDUs/acre

Note:
lb/cap-day = pounds per capita per day

The total wastewater flow and loading within the SOI will ultimately come from a combination of sources, which is divided into the following categories:

- Current flow to the WWTP from existing users
- The maximum allocated flow from Leprino Foods
- Flows generated for operational reasons (for example, dewatering systems at the WWTP)
- Flows from development projects with approved wastewater capacity, but not yet constructed
- Flows from undeveloped portions of constructed developments
- Flows generated from Future Service Areas

The wastewater flow generated from the Future Service Areas is estimated to have an ADWF of 21.1 mgd and a corresponding peak wet weather flow (PWWF) of 49.1 mgd. Future mass loading within the SOI is estimated to be approximately 46,445 pounds per day of BOD and 48,247 pounds per day of TSS.

Future Regulatory Impacts

Wastewater generated within the City limits is currently treated at the WWTP, located on Holly Drive, discharged to the Old River, and regulated by discharge requirements stated in Order No. R5-2011-0012. The WWTP's industrial pretreatment pond, industrial holding ponds, sludge drying beds, and biosolids storage area are regulated by separate waste discharge requirements as defined in order No. R5-2007-0038.

It is impossible to accurately predict the nature of future discharge requirements, but one can outline the driving factors that may lead to additional or more stringent regulations. First, it is well documented that the receiving waters of the Sacramento-San Joaquin Waterways are critical in terms of beneficial uses (that is, aquatic life, agriculture, habitat, recreation, and municipal and industrial water supply). Potentially, these waterways would be affected by future regional or statewide water management plans in terms of both flow and quality. The Bay-Delta Plan, which affects water quality regulation and flow requirements in the South Delta, is currently under revision by the State Water Resources Control Board (SWRCB). Under the proposed Bay-Delta Conservation Plan, the operations of the State Water Project and federal Central Valley Project and the physical configuration of the Delta may be altered. In recently passed state legislation, a new Delta Stewardship Council governance structure has been adopted, which may affect water quality regulation in the Delta. Each of these significant changes to the Delta environment and Delta regulatory context creates a layer of complexity for the City in assessing the future effect of its surface water discharge. For parameters such as salinity and temperature, which are of current concern in the Delta, quantifying the future impact to the system is difficult when the system itself is dynamic.

Future regulatory projections indicate that modifications to current wastewater treatment practices, and potentially source water control practices, are necessary. For example, an alternative disinfection system may be required to control disinfection byproducts. Advanced treatment technologies, such as membrane technology, may be required to address the certain future criteria such as salinity. However, source water control practices are likely the best means of targeting and reducing salinity and compounds of emerging concern. Thermal control of treated effluent may be required to minimize the impact on fisheries during ecologically critical periods. There are uncertainties regarding the City's ability to secure a National Pollutant Discharge Elimination System (NPDES) permit for surface water discharge for the future increased flows; for which wastewater recycling is a beneficial alternative.

For the purposes of treatment plant layouts for the planning period, it is recommended that all potential treatment requirements be included in the analysis to allow for sufficient land area for the ultimate treatment facilities. For costing the treatment plant requirements as part of any Specific Plan application, it is recommended that the then-current requirements be included in the financial plan assessment. NPDES permits must be renewed every 5 years, and additional costs will be incurred as new regulations are imposed.

With respect to discharging effluent (from one plant or multiple plants), it is recommended that the future Specific Plan studies assume that flows greater than 16 mgd (ADWF) will be land-applied or otherwise reused rather than directly discharged to a water body. This recommendation reflects the uncertainties of acquiring a permit to discharge more than 16 mgd (the current ADWF allowed in the City's existing permit) to the Old River. This assumption should be re-evaluated and tested with the Regional Water Quality Control Board (Water Board) when the total flow rate from the community approaches the 16-mgd limit.

Wastewater Infrastructure Requirements

This planning document evaluates the treatment infrastructure required for future growth and developments. As noted in more detail in Section 1, this study includes two wastewater treatment plant options: one option assumes that a second treatment facility will be constructed at the southern end of the existing City limits. The majority of all wastewater generated within the City would be directed toward the existing WWTP located on Holly Drive, with the proposed second treatment facility to process flow from one of the Future Service Areas (Tracy Hills). This second, and as yet unconstructed, treatment plant received conceptual approval from the City Council in December 2000.

The second wastewater treatment plant option assumes that all wastewater generated in the SOI area will be treated at a single plant located at the site of the existing treatment facility on Holly Drive.

This master plan has provided a review of anticipated changes in the regulatory environment, and recommendations for future treatment processes are included herein. The costs of those future requirements are not, however, included in the costs in this report. Based on discussions with the City, costs of future plant upgrades will be spread among existing and future users only after the discharge requirements for such improvements have been established by the Water Board (or other regulator). Until such future requirements are implemented, the connection fees that are to be established in the Finance Plan will only consider those costs necessary to meet the existing discharge requirements. All users (existing and future) will then share in the costs for such upgrades at that time.

The recommended long-term treatment strategy for the City's two-plant option is to plan for a new 2.0-mgd (ADWF) membrane bioreactor (MBR) Water Recycling Facility (WRF) for the Tracy Hills development, and to convert the existing treatment plant to a 19.06-mgd (ADWF) MBR facility. Both facilities would be capable of producing Title 22 effluent for unrestricted reuse. The WRF facility would be a self-sufficient facility including headworks, secondary treatment and filtration, disinfection, solids stabilization, solids dewatering, and land application. The main WWTP would be converted (over time) from an activated sludge treatment process with conventional filtration to an MBR process that reduces the need for additional aeration basins, secondary clarifiers, or filters; the conversion from activated sludge to MBR would not begin until after expansion to 16 mgd, and then only if the regulatory environment mandates this change. Costs for expansion beyond 16 mgd are anticipated to be slightly higher for the conversion to MBR, because of the investment in the more conventional activated sludge process that has already been incurred in the existing plant.

Based on the evaluation summarized in Section 4.5.3 of this report, it is recommended that the one-plant option be selected for implementation. The one-plant option is slightly less expensive than the two-plant option (particularly for operational costs), and it also offers benefits associated with a simplified operational plan. Additionally, the large initial capital investment required for the second treatment facility in the Tracy Hills development can be used for conveyance needs.

Wastewater conveyance requirements associated with the City's one-plant option include improvements in both the east and west catchment areas. Wastewater generated from Future Service Areas in the east catchment will require a new 14-inch force main to the WWTP, modifications to the MacArthur Pump Station to accommodate an additional 4.25 mgd, and new gravity pipelines. Conveyance improvements for the west catchment will require improvements to the Lammers and Corral Hollow sewer systems. The Lammers sewer system will require a new 30-inch force main (11,600 linear feet) and 14-inch force main (7,500 linear feet), a new 20.11-mgd pump station and 4.28-mgd pump station, and new gravity pipelines. Modifications to the Corral Hollow sewer system include expansion of the gravity system, expansion of the Hansen Pump Station to 11.15 mgd, and a new 24-inch-diameter force main (approximately 10,500 linear feet) conveying wastewater to the WWTP.

Capital Costs Estimates

Capital cost estimates were developed for modifications needed to expand the existing WWTP to 21.1 mgd (ADWF), plus sanitary sewer improvements needed to convey wastewater to the treatment plant. These cost estimates are considered to be Class 5 and were prepared in accordance with the guidelines of the Association for the Advancement of Cost Engineering International. Cost estimates shown in Table ES-3 have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate (estimates were current as of March 2012). The final costs of the project will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. Therefore, the final project costs will vary from the estimate presented herein. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

TABLE ES-3
Cost Estimates
Tracy Wastewater Master Plan

Facility	Total Capital Cost ($ Million)
East Catchment Conveyance Improvements	12.6
West Catchment Conveyance Improvements	49.2
Main WWTP Expansion Improvements	278.7

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Acronyms and Abbreviations

ADWF	average dry weather flow
BOD	biochemical oxygen demand
CC	construction cost
CEC	Compounds of Emerging Concern
City	City of Tracy
DBP	disinfection byproduct
DU	dwelling unit
EDC	endocrine disrupting compound
EDU	equivalent dwelling unit
EPA	U.S. Environmental Protection Agency
FAR	floor area ratios
FCRR	fecal coliform reactivation and regrowth
ft^2	square foot
gal	gallon(s)
gal/ac-day	gallon(s) per acre per day
GO	General Order
gpcd	gallon(s) per capita per day
gpd	gallon(s) per day
gpm/ft^2	gallon(s) per minute per square foot
GHG	greenhouse gas
HD	high density
hp	horsepower
ISP	Industrial Specific Plan
lb	pounds
lb/cap-day	pounds per capita per day
LD	low density
MBR	membrane bioreactor

MBBR	moving-bed bioreactor
MD	medium density
MG	million gallon
mgd	million gallon(s) per day
mg/L	milligrams per liter
NDMA	N-nitrosodimethylamine
NEI	Northeast Industrial
NPDES	National Pollutant Discharge Elimination System
PCB	polychlorinated biphenyl
PDWF	peak dry weather flow
PF	Peaking Factor
PWWF	peak wet weather flow
RO	reverse osmosis
SBR	sequencing batch reactor
SOI	sphere of influence
SSO	sanitary sewer overflow
SWRCB	State Water Resources Control Board
TDS	total dissolved solids
TSS	total suspended solids
UV	ultraviolet
WAS	waste activated solid
Water Board	Regional Water Quality Control Board
WERF	Water Environment Research Foundation
WRF	water recycling facility
WWTP	wastewater treatment plant
VLD	very low density

SECTION 1

Introduction

The City of Tracy (City) is projecting an increase in residential and industrial developments within its sphere of influence (SOI) requiring expansion of existing wastewater conveyance and treatment infrastructure. Currently, the City of approximately 81,000 people generates an average dry weather flow (ADWF) of 7.6 million gallons per day (mgd). Future ADWF within the SOI is estimated at 21.1 mgd with the addition of development projects that are presently proposed.

This Wastewater Master Plan derives future wastewater flow and mass loading conditions from available land use data and summarizes hydraulic and process infrastructure capacity requirements. At the direction of City staff, this document investigates two options regarding the number of treatment plants. A single-plant option includes expanding the existing wastewater treatment plant (WWTP) located near Holly Drive, whereas the two-plant option expands the existing treatment plant and includes a new, smaller treatment system that would only process wastewater from the Tracy Hills development project. The City is also interested in using reclaimed water for irrigation throughout the City and Future Service Areas to offset potable water demands. For the two-plant option, the proposed treatment strategy includes a 2.0-mgd Water Recycling Facility for the Tracy Hills development and expansion of the existing WWTP from 10.8 mgd to 19.1 mgd; both facilities would be capable of treating water to Title 22 (California Code of Regulations) unrestricted reuse standards.

This Wastewater Master Plan is organized in the following sections:

- Section 1: Introduction
- Section 2: Existing and Future Flows and Loadings
- Section 3: Existing and Future Regulatory Requirements
- Section 4: Wastewater Treatment Facilities
- Section 5: Wastewater Conveyance Facilities
- Section 6: Wastewater Infrastructure Capital Costs
- Section 7: Conclusion
- Section 8: References

SECTION 2

Existing and Future Flows and Loadings

2.1 Introduction

The primary objective of this section is to outline wastewater generation factors and present future wastewater flows and loadings to be used within the City of Tracy (City) and its Future Service Areas. Wastewater generation factors used in past planning exercises are not always applicable to forecasting wastewater infrastructure needs of the future. Population densities, land use, culture, regulatory drivers, construction practices, and topography all play a role in determining the quantity and composition of future wastewater flows. The more detailed understanding (spatially and temporally) of these factors, the less uncertainty there is in the resulting flows. The values generated herein as part of this Tier I Master Planning effort are to be used as the best available at this time. As with any engineering science, more accurate wastewater flow information can be derived as uncertainties are reduced.

Recent regulatory drivers regarding the control of wastewater collection systems have focused on the prevention of sanitary sewer overflows (SSO). The California Regional Water Quality Control Board (Water Board) has recently mandated a much more formal evaluation of collection systems in the state, and all sewer agencies with collection systems have been required to complete Sewer System Management Plans. The goal of the new requirements is to mandate appropriate maintenance of sewer collection systems (and to ensure that agencies have sized these systems appropriately) to alleviate SSOs. Additionally, the reporting of SSOs has been formalized. Future SSOs, which have historically been the subject of regulatory fines, are being targeted by these new regulations; while it is no more important from a health and safety standpoint to size collection system components appropriately, there is now an enhanced regulatory driver that mandates that some additional conservatism be included in calculations associated with anticipated flow rates in sanitary sewers. A single fine for an SSO can be very large (minimum mandatory fines can equal the cost "savings" determined by regulatory agencies for undersizing collection system components). Additionally, incremental oversizing of a pipeline is generally very inexpensive. With respect to wastewater treatment capital costs, hydraulic capacity is the least costly constituent cost; the solids and organic loads conveyed to a treatment plant are not impacted by low-flow water saving devices that are to be used in any new development. Further, unlike collection system components, a treatment plant is generally constructed in phases; if greater water savings are found to be occurring than initially projected, later phases of the treatment plant can accommodate for that change; because collection system components are constructed prior to any actual flow measurements, some oversizing may be impossible to overcome in a prudently designed system, as the consequences of undersizing are not acceptable.

The following terminology will be used throughout this report to describe variations in wastewater flow:

- ADWF: The average daily flow for the months of June, July, and August.
- Peak dry weather flow (PDWF): The PDWF as a result of the localized diurnal variations during the months of June, July, and August.
- Peak wet weather flow (PWWF): The peak hourly diurnal flow, which includes inflow and infiltration from storm events.
- Peak month flow: The maximum 30-day running average flow calculated from existing plant data.

2.2 Wastewater Flow

2.2.1 Existing Flow

Historical ADWFs, as monitored by the Tracy WWTP, are shown in Table 2-1. These flows are presented with the City's population for the given year.

TABLE 2-1
Historical Population and Average Dry Weather Flow
Tracy Wastewater Master Plan

Year	Population[a]	ADWF (mgd)[b]
2003	70,037	7.24
2004	74,656	7.33
2005	78,157	7.60
2006	80,063	7.51
2007	80,455	7.65
2008	81,143	7.69
2009	81,714	7.60

[a]Source: State of California Department of Finance, 2009

[b]Average dry weather influent flows, excluding Leprino Foods contribution, for the months of July, August, and September.

Note:

mgd = million gallon(s) per day

These data are presented for reference and are not specifically used in estimating wastewater flows for future needs. As observed in several Northern California communities, it is anticipated that dry weather wastewater flows will decrease per capita as more efficient appliances and fixtures are used in residential units. The non-residential land use areas within a given development may or may not follow this trend depending on the specific type of industry or commercial operation that establishes.

Existing flow rates by individual user category are difficult to discern, because only one industrial user (Leprino Foods) is assigned its own flow meter; all other users are combined, and that combined flow rate is measured at the treatment plant. Allocations based on water consumption have been made during the wet weather season to attempt to minimize the impacts of outside potable water use, but these efforts are not exact.

2.2.2 Future Flows

Future wastewater flows were projected based on the most current land use planning data available and wastewater generation factors. These generation factors have been updated from current City standards to reflect the changes in both water utilization and population density. Assumptions used to generate Tier I wastewater flows are shown in Table 2-2.

TABLE 2-2
Wastewater Flow Generation Factors
Tracy Wastewater Master Plan

Flow Parameter	Current Values	Tier I Master Plan Values
Per Capita Flow	100 gpcd	80 gpcd
Residential Flow – VLD	300 gpd/unit	264 gpd/unit
Residential Flow – LD	300 gpd/unit	264 gpd/unit
Residential Flow – MD	250 gpd/unit	216 gpd/unit
Residential Flow – HD	200 gpd/unit	176 gpd/unit
Industrial Flow	1,500 gal/gross acre/day	1,056 gal/gross acre/day
Office, Retail, and Commercial Flow	1,375 gal/gross acre/day	1,140 gal/gross acre/day

Notes:
gal = gallons
gpcd = gallon(s) per capita per day
gpd = gallon(s) per day
HD = high density
LD = low density
MD = medium density
VLD = very low density

Table 2-2 indicates a reduction in the per capita flow rate from the City's current standard. This is justified as future development will be new construction, which typically results in less infiltration because of better materials and construction methods, and because residential units will be outfitted with the latest in water conserving fixtures. Additionally, these wastewater generation factors are consistent with the indoor water consumption assumed for industrial, commercial, and office related land uses in the Water Master Plan for Tier I. Floor area ratios (FAR) used to establish wastewater flow generation factors for non-residential users were as follows:

- Commercial – assumed FAR of 0.3
- Office – assumed FAR of 0.45
- Industrial – assumed FAR of 0.5

Proposed residential wastewater generation factors are consistent with other communities. Residential land uses are divided into four categories: VLD, LD, MD, and HD.

These residential areas are defined in Table 2-3 in terms of residents per dwelling units (DU), which have increased from previous values used within the City.

TABLE 2-3
Residents per Dwelling Units
Tracy Wastewater Master Plan

Residential Category	Current Values (Residents/DU)	Tier I Master Plan Values (Residents/DU)
VLD	3.0	3.3
LD	3.0	3.3
MD	2.5	2.7
HD	2.0	2.2

2.2.2.1 Average Dry Weather Flow

The residential and non-residential generation factors shown in Table 2-2 are used to develop the ADWF on a daily basis. The ADWF is the foundation used to determine the peak flows that are used to size the required wastewater infrastructure.

Future wastewater flows were generated using best available land use data and the generation factors shown in Table 2-2. The total future wastewater flow within the City is divided into the following categories (flows for each category can be found in Table 2-7):

- Current flow to the existing WWTP
- The maximum allocated flow from Leprino Foods
- Operational discharge capacity reserve
- Development projects with “approved” wastewater capacity (includes City infill)
- Unused allocated capacity of constructed developments
- Future Service Areas

The current flow to the existing WWTP comprises both residential and non-residential wastewater flows from within the City limits. The portion of the flow generated from residential land use areas was estimated by multiplying the number of existing residential units by the DU generation factor for LD units (264 gpd per DU). The number of residential units used for this study was 24,790 units, as supplied by the City during a rate study conducted in 2006. This compares to the California Department of Finance 2009 estimate of 25,090 residential units, with a difference of 300 units. The current non-residential flows discharged to the WWTP include flows generated from Leprino Foods and other commercial users. City data from the 2006 rate study estimated this non-residential flow as 1.925 mgd.

Wastewater flows from the other components of the total wastewater flow are presented herein to illustrate the derivation of the total flow at buildout. The maximum allocated flow from Leprino Foods is currently 0.85 mgd as documented in an agreement with the City. City infill and vacant land projects are estimated at 0.47 mgd, which accounts for the undeveloped land within the City that currently is not generating any flow. Another component of the total flow includes the operational discharge capacity reserve, which provides an allowance for dewatering systems at the treatment plant that are used only intermittently. Future wastewater flows generated from development projects includes projects with some level of City-approved wastewater capacity but not yet constructed; and Future Service Areas, which include all other future development projects. It should be noted that a portion of the "approved" development projects have approved financing, while others do not.

With the exception of the current flows, both the development projects with "approved" wastewater capacity and the Future Service Areas consist of the large majority of future wastewater flows. Figure 2-1 (all figures are located at the end of their respective section) shows the locations of both of these development categories. Table 2-4 presents the "approved" projects and the resulting individual ADWFs based on the wastewater generation factors and available data describing land use, area, and density.

TABLE 2-4
Average Dry Weather Flow Generated from Development Projects with "Approved" Wastewater Capacity
Tracy Wastewater Master Plan

Specific Plan or General Plan Common Name	Residential ADWF	Industrial ADWF	Office ADWF	Retail ADWF	Total ADWF
Residential Specific Plan	---	0.014	0.011	0.006	0.031
ISP – North	---	0.032	---	---	0.032
ISP – South (LD)	0.154	0.144	0.033	---	0.331
I-205 Specific Plan	---	0.100	---	0.073	0.173
Plan "C" Residential Planning Area (LD)	0.030	---	---	0.011	0.041
NEI – Phase 1	---	0.097	---	---	0.097
NEI – Phase 2	---	0.031	---	---	0.031
NEI – Phase 3	---	0.366	---	---	0.366
South MacArthur (LD)	0.032	---	---	---	0.032
Downtown Specific Plan (LD)	0.032	---	0.003	0.003	0.039
Downtown Specific Plan (HD)	0.205	---	---	---	0.205
Infill Properties (LD)	0.319	0.079	0.013	0.055	0.465
Ellis Project (LD)	0.133	---	---	---	0.133
Ellis Project (MD)	0.368	---	---	---	0.368
Ellis Project (HD)	0.007	---	---	---	0.007
Ellis Project – Village Commercial	---	---	---	0.030	0.030
Ellis Project – Swim Center				0.020	0.020
Gateway – Phase 1	---	---	0.097	0.063	0.160
Standard Pacific	0.018	---	---	---	0.018
Total ADWF	**1.299**	**0.863**	**0.157**	**0.261**	**2.579**

Notes:

All flows are shown in mgd.

Inconsistencies in totals are due to rounding.

ISP = Industrial Specific Plan
NEI = Northeast Industrial

The total wastewater flow contribution from development projects with "approved" wastewater capacity is 2.579 mgd. Additional information associated with the development of the flows shown in Table 2-4 can be found in Appendix A.

Wastewater from the unused allocated capacity category accounts for developments that have been approved and partially constructed, but are not are not currently generating the entire anticipated flow. This future flow is specific to the NEI Plan and the ISP, which are both partially built out. City personnel have estimated that there are three equivalent dwelling units (EDU) per acre of future growth that must be reserved in these areas. Flows associated with the unused allocated capacity are shown in Table 2-5. Additional information associated with the development of the flows shown in Table 2-5 is presented in Appendix A.

TABLE 2-5
Average Dry Weather Flow Reserved for Unused Allocated Capacity
Tracy Wastewater Master Plan

Specific Plan Area Name	Acres	Unused Allocated Capacity[a] (gpd)
Constructed Areas in NEI		
Phase I	182	144,144
Phase II	220	174,240
Constructed Areas in ISP		
North	140	110,880
South	302	239,184
Total	**844**	**668,448**

[a]Based on three EDUs/acre in which each EDU generates 264 gpd.

ADWFs generated from Future Service Areas comprise 20 individual developments. The ADWF generated from each of these developments is shown in Table 2-6 in addition to the flow contribution by land use.

Total ADWF for Future Service Areas is 8.84 mgd. Future industrial areas within these developments generate the majority of the forecasted flow.

2.2.2.2 Peak Wet Weather Flow

PWWF is the most important criteria used for hydraulic considerations (for example, collection systems, pumping stations, and treatment processes dependent upon hydraulic loading). The objective of this portion of the study is to estimate maximum quantity of wastewater generated at buildout. The PWWF used in this planning effort is based PDWF, groundwater infiltration, and rainfall induced inflow/infiltration.

PDWF rates were computed using the following criteria:

- Industrial PDWF: ADWF Peaking Factor (PF) = 3.0
- Office PDWF: ADWF PF = 3.0

- Retail PDWF: ADWF PF = 2.5
- Commercial PDWF: ADWF PF = 3.0
- Residential PDWF: ADWF PF = $2.5\left(\frac{population}{1,000}\right)^{-0.11275}$

TABLE 2-6
Average Dry Weather Flow Generated from Future Service Areas
Tracy Wastewater Master Plan

Specific Plan or General Plan Common Name	Residential				Non-residential			ADWF Total
	VLD	LD	MD	HD	Industrial	Office	Retail	
Westside Residential								
UR 5 (Bright)	---	0.046	0.078	0.066	---	---	0.011	0.201
UR 7 (Bright)	---	0.046	0.093	---	---	---	---	0.139
UR 8 (Fahmy)	---	0.025	0.054	0.033	---	---	---	0.113
UR 9 (Keenan)	---	0.080	0.084	0.056	---	---	---	0.220
UR1 (Alvarez + others)	0.150	0.345	0.126	0.083	---	---	0.011	0.715
UR11 (South Linne)	---	---	---	---	0.127	---	---	0.127
Tracy Hills	0.022	0.420	0.710	0.093	0.476	---	0.276	1.997
Gateway (excluding Phase 1)	---	---	---	---	---	0.400	0.067	0.467
UR6 (Cordes Ranch)	---	---	---	---	1.486	0.171	0.061	1.719
UR4 (Bright Triangle)	---	---	---	0.132	---	0.057	0.108	0.297
UR3 (Catellus)	0.016	---	---	---	0.565	0.046	0.051	0.678
UR2 (Filios)	---	---	---	---	---	0.008	0.041	0.049
I-205 Expansion	---	---	---	---	---	---	0.196	0.196
West Side Industrial	---	---	---	---	0.512	---	---	0.512
East Side Industrial	---	---	---	---	0.389	---	---	0.389
Larch Clover	---	---	---	---	---	---	0.568	0.568
Chrisman Road	---	---	---	---	---	0.114	0.015	0.129
Rocha	---	0.078	---	0.076	---	---	---	0.154
Berg/Byron	---	---	0.097	---	---	---	0.005	0.102
Kagehiro	---	0.066	---	---	---	---	---	0.066
ADWF Total	**0.188**	**1.106**	**1.242**	**0.539**	**3.554**	**0.796**	**1.412**	***8.838***

Notes:
All flows are shown in mgd.
Inconsistencies in totals are due to rounding.

Residential peaking factors are based on Figure 4 of the *2008 City of Tracy Design Standards* (City of Tracy, 2008). The *population* variable pertains to the residential population within the catchment area of interest. Therefore, the Residential PDWF PF will vary between developments depending on the contributing residential population upstream. A larger population results in a smaller residential peaking factor, and vice versa. This is attributable to the fact that a larger population presents more socioeconomic variety and greater differences within residential units. The population of the City at buildout is used to estimate the residential portion of the PDWF.

Both groundwater infiltration and rainfall induced inflow were added to the PDWF to obtain the PWWF. Groundwater infiltration was incorporated as a percentage of the ADWF entering the system. The rate of infiltration depends on the groundwater elevation in relation to the elevation of typical gravity sewer systems. Areas located close to the City center were attributed with a groundwater infiltration rate that consists of 6 percent of the ADWF as the water table is typically higher than the conveyance system. Developments located at higher elevations (for example, Tracy Hills) were assigned a groundwater infiltration rate of 2 percent of the ADWF. Rainfall induced inflow to the sewage system was calculated using the current City standard of 400 gallons per acre per day (gal/ac-day).

With the exception of the current flows, both the development projects with "approved" capacity and the Future Service Areas consist of the large majority of future wastewater flows. Figure 2-1 shows the locations of both of these development categories. Table 2-4 presents the "approved" projects and the resulting individual ADWFs based on the wastewater generation factors and available data describing land use, area, and density.

The future wastewater flows generated within the City and its Future Service Areas are shown in Tables 2-7 and 2-8. Table 2-7 presents the contributors to the total ADWF, and Table 2-8 presents the contributors to the total PDWF and PWWF.

The total *committed flow* to the wastewater collection and treatment system is 12.2 mgd in terms of ADWF. This includes all flows shown in Table 2-7 with the exception of the Future Service Area projects. Total ADWF generated within the system, including the Future Service Area, is 21.1 mgd. The total PWWF of the future system is 49.1 mgd, resulting in a peak weather peaking factor of 2.33.

TABLE 2-7
Total Average Dry Weather Flow
Tracy Wastewater Master Plan

Residential Areas	Number of Units	Gross Area (acres)	WW Gen. Rate (gpd/DU)	ADWF (gpd)	Population
Future Residential (VLD)	713	502	264	188,232	2,353
Future Residential (LD)	4,190	1,126	264	1,106,160	13,827
Future Residential (MD)	5,752	831	216	1,242,432	15,530
Future Residential (HD)	3,062	170	176	538,956	6,736
"Approved"[a] Residential (LD)	2,720	625	264	718,080	8,976
"Approved"[a] Residential (MD)	1,705	189	216	368,280	4,604
"Approved"[a] Residential (HD)	1,207	64	176	212,432	2,655
Current Single Family[b]	21,982		264	5,803,248	72,541
Current Multi Family[b]	2,808		264	741,312	9,266
SUBTOTAL – Residential		***3,508***		***10,919,132***	***136,489***

TABLE 2-7
Total Average Dry Weather Flow
Tracy Wastewater Master Plan

Non-residential Areas	Area (acres)	WW Gen. Rate (gal/ac-day)	ADWF (gpd)	Dry Weather PF
Future Industrial	3,366	1,056	3,554,484	3.0
Future Office	698	1,140	795,720	3.0
Future Retail	1,238	1,140	1,411,608	2.5
"Approved"[a] Industrial	817	1,056	862,752	3.0
"Approved"[a] Office	138	1,140	157,320	3.0
"Approved"[a] Retail	229	1,140	260,635	2.5
Unused Allocated Capacity NEI[d]	402	792 (gpd/DU)	318,384	3.0
Unused Allocated Capacity ISP[d]	442	792 (gpd/DU)	350,064	3.0
Current Commercial			1,075,000	3.0
Current Leprino Foods[c]			850,000	3.0
Operational Discharge Capacity Reserve[e]			500,000	1.0
SUBTOTAL – Non-residential	***7,330***		***10,135,967***	
TOTAL AVERAGE DRY WEATHER FLOW			**21,055,099**	

[a]Development projects with approved wastewater capacity in which some projects have approved financing.

[b]City-provided data (based on EDU count).

[c]Maximum allocated flow as of February 2010.

[d]Based on three EDUs/acre of additional capacity that is reserved for future growth on partially developed sites.

[e]WWTP Capacity required by plant activities (for example, dewatering pumps).

Note:

Inconsistencies in totals are due to rounding.

TABLE 2-8
Total Peak Dry Weather and Wet Weather Flow
Tracy Wastewater Master Plan

PDWFs	
Residential	15,690,000
Industrial	17,810,000
Office	2,860,000
Retail	4,190,000
Commercial	3,230,000
Operational Discharge	500,000
Total PDWF	***44,280,000***
Groundwater Infiltration (% of ADWF)	525,800
Rainfall Induced Inflow (400 gal/ac-day)	4,340,000
Total PWWF	**49,145,800**
PWWF: ADWF	**2.33**

2.2.3 Existing Loadings

Historical average day mass loadings as monitored by the Tracy WWTP are shown in Table 2-9.

TABLE 2-9
Historical Average Day Mass Loadings
Tracy Wastewater Master Plan

Year	BOD (lb/day)	TSS (lb/day)
2003	13,691	12,664
2004	14,084	12,622
2005	14,006	12,628
2006	15,463	14,144
2007	17,819	15,152
2008	16,489	13,808
2009	16,878	14,554

Notes:
Average annual loadings, not including Leprino Foods contribution.
BOD = biochemical oxygen demand
lb = pounds
TSS = total suspended solids

2.3 Wastewater Loading

Forecasting wastewater flows generated within the City's Future Service Areas is vital for sizing collection systems and unit processes of the treatment system adequately; however, future mass loadings generated within the Future Service Areas are equally important in sizing the major unit processes within the WWTP. Wastewater mass loadings not only impact the design requirements of a treatment system, but also the costs associated with operations and maintenance of the plant (for example, energy and chemical usage). Other communities have experienced situations in which influent loadings increased at a much quicker rate than the influent flow, thereby hindering capacity (for example, aeration capacity, secondary treatment basin volume) of the treatment facility while the hydraulic loading was still below design conditions.

2.3.1 Future Loadings

As discussed previously, future wastewater flows are expected to decrease on a per capita basis, but this trend does not translate directly to per capita loadings. Overall wastewater loading rates are anticipated to remain relatively steady while wastewater flow rates decrease on a per capita basis. The two loading parameters identified for this Tier I master planning effort include BOD and TSS. Nutrient fractions are assumed to be consistent with domestic sewage at this stage of analysis. Assumptions used to generate future wastewater loadings are shown in Table 2-10.

TABLE 2-10
Wastewater Loading Generation Factors
Tracy Wastewater Master Plan

Parameter	BOD Loading	TSS Loading
Per Capita Loading	0.18 lb/cap-day	0.21 lb/cap-day
Industrial Loading[a]	2.4 lb/gross acre	2.8 lb/gross acre
Office Loading[b]	1.2 lb/gross acre	1.4 lb/gross acre
Retail and Commercial Loading	3.3 lb/gross acre	3.8 lb/gross acre

[a]Based on 4 EDUs/gross acre
[b]Based on 2 EDUs/gross acre
Note:
lb/cap-day = pounds per capita per day

Loading assumptions shown in Table 2-10 are consistent with planning efforts used in other communities, and assume that no "wet" industry (for example, an industry that uses process water that is discharged to the sewer system) will locate in the Tracy area. The Industrial loading shown in Table 2-10 is based on four EDUs per gross acre. Retail and Commercial land uses have wastewater loading generation factors that are consistent with previous loading evaluations within the City and, therefore, are based on the best available information at this time. It is emphasized that specific land use can greatly impact the composition of generated wastewater. Significant changes in the general or specific plans should note the change in loadings, if any.

Table 2-11 presents mass loading generated from each of the identified development projects with "approved" wastewater capacity and the resulting average loading.

TABLE 2-11
Average Mass Loadings Generated from Development Projects with "Approved" Wastewater Capacity
Tracy Wastewater Master Plan

Specific Plan or General Plan Common Name	Residential		Non-residential		Total Loading	
	BOD	TSS	BOD	TSS	BOD	TSS
Residential Specific Plan	---	---	60	69	60	69
ISP – North	---	---	72	84	72	84
ISP – South (LD)	347	405	361	421	708	826
I-205 Specific Plan	---	---	439	509	439	509
Plan "C" Residential Planning Area (LD)	67	78	33	38	100	116
NEI – Phase 1	---	---	221	258	221	258
NEI – Phase 2	---	---	70	81	69	81
NEI – Phase 3	---	---	833	972	833	972
South MacArthur (LD)	72	85	---	---	72	85
Downtown Specific Plan (LD)	71	83	14	16	85	99
Downtown Specific Plan (HD)	462	539	---	---	462	539
Infill Properties (LD)	717	836	352	408	1,069	1,244
Ellis Project (LD)	300	350	---	---	300	350
Ellis Project(MD)	829	967	---	---	829	967
Ellis Project (HD)	16	18	---	---	16	18
Ellis Project – Village Commercial	---	---	87	101	87	101
Ellis Project – Swim Center	---	---	57	65	57	65

TABLE 2-11
Average Mass Loadings Generated from Development Projects with "Approved" Wastewater Capacity
Tracy Wastewater Master Plan

Specific Plan or General Plan Common Name	Residential		Non-residential		Total Loading	
	BOD	TSS	BOD	TSS	BOD	TSS
Gateway – Phase 1	---	---	284	328	284	328
Standard Pacific	41	48	---	---	---	---
Total Loading	**2,922**	**3,410**	**2,881**	**3,349**	**5,803**	**6,759**

The total BOD and TSS loading from development projects with "approved" wastewater capacity are shown in Table 2-11 as 5,803 and 6,759 pounds per day, respectively. The non-residential land use areas account for approximately 50 percent of the estimated load. This is noted because loading in non-residential areas depends more on the specific business/ industry that becomes established. Therefore, there is more uncertainty associated with non-residential land use than with residential areas at this stage of planning.

Loadings generated from Future Service Areas are shown in Table 2-12.

TABLE 2-12
Average Mass Loadings Generated from Future Service Areas
Tracy Wastewater Master Plan

Specific Plan or General Plan Common Name	Residential		Non-residential		Total Loading	
	BOD	TSS	BOD	TSS	BOD	TSS
Westside Residential						
UR 5 (Bright)	427	498	33	38	460	536
UR 7 (Bright)	313	366	---	---	313	366
UR 8 (Fahmy)	254	296	---	---	254	296
UR 9 (Keenan)	495	578	---	---	495	578
UR1 (Alvarez + others)	1,584	1,848	33	38	1,617	1,886
UR11 (South Linne)	---	---	288	336	285	333
Tracy Hills	2,802	3,269	1,881	2,183	4,683	5,112
Gateway (excluding Phase 1)	---	---	616	716	612	710
UR6 (Cordes Ranch)	---	---	3,736	4,365	3,994	4,655
UR4 (Bright Triangle)	297	347	374	431	670	776
UR3 (Catellus)	36	42	1,481	1,725	1,503	1,751
UR2 (Filios)	---	---	127	147	127	146
I-205 Expansion	---	---	568	654	568	653
West Side Industrial	---	---	1,164	1,358	1,152	1,344
East Side Industrial	---	---	883	1,030	874	1,020
Larch Clover	---	---	1,643	1,892	1,643	1,890
Chrisman Road	---	---	163	189	162	188
Rocha	346	404	---	---	346	404
Berg/Byron	219	255	13	15	232	270
Kagehiro	149	173	---	---	149	173
Total	**6,921**	**8,074**	**13,002**	**15,107**	**19,923**	**23,181**

Table 2-12 shows that Future Service Areas are estimated to produce 19,923 pounds of BOD per day and 23,181 pounds of TSS per day based on current land use data. Similar to the "approved" projects, non-residential areas of these Future Service Areas generate the majority of the BOD and TSS. This is because the combined Future Service Area projects are approximately 45 percent industrial land use by area.

Future wastewater loadings generated within the City's SOI are shown in Table 2-13.

TABLE 2-13
Total Wastewater Loading
Tracy Wastewater Master Plan

	BOD (lb/day)	TSS (lb/day)
Current WWTP[a]	17,819	15,152
Leprino Foods[b]	1,400	1,400
Unused Allocated Capacity[c]	1,500	1,755
Development Projects with "Approved" Wastewater Capacity	5,803	6,759
Future Service Areas	19,923	23,181
Total Loading	**46,445**	**48,247**

[a]Baseline loadings based on 2007 influent data

[b]Leprino Foods contribution assuming 200 milligrams per liter (mg/L) of discharge

[c]Based on three EDUs/acre of capacity reserved for future growth

The total average BOD and TSS mass loading to the wastewater treatment system are 46,445 pounds per day and 48,247 pounds per day, respectively. Peaking factors associated with these loading rates are based on review of the historical loading data from the existing treatment plant. These peaking factors are as follows:

- Peak Month BOD = 1.2
- Peak Month TSS = 1.2
- Peak Day BOD Loading = 2.1
- Peak Day TSS Loading = 2.4

The flow and loading data presented here is used in determining conveyance system improvements and treatment system improvements for the City and its Future Service Areas.

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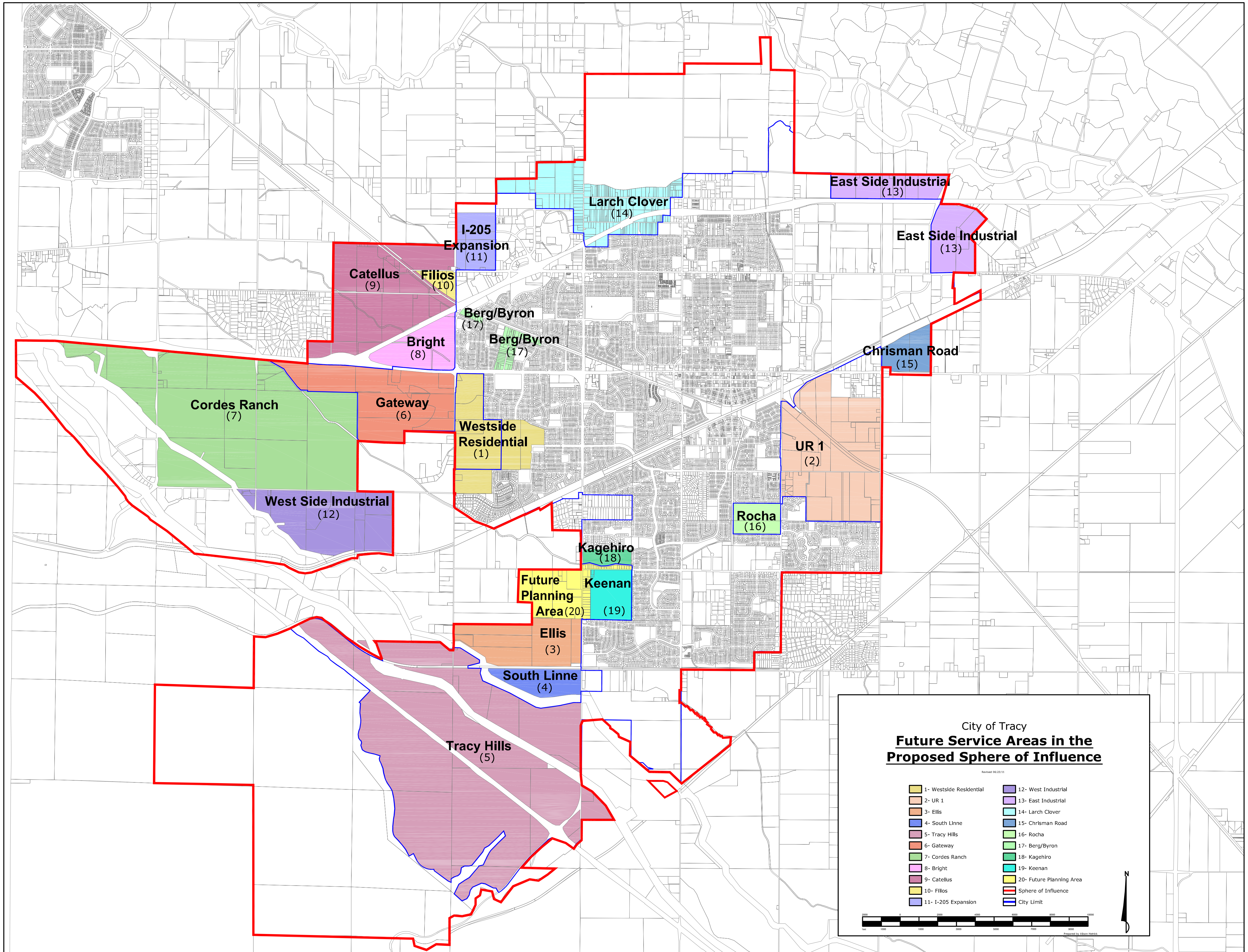

FIGURE 2-1
LOCATIONS OF PROPOSED SERVICE AREAS
CITY OF TRACY
WASTEWATER MASTER PLAN

CH2MHILL

WBG042211232811RDD_2-1

SECTION 3

Existing and Future Regulatory Requirements

3.1 Introduction

This section of the Wastewater Master Plan documents existing and possible future requirements for the City's effluent water quality and biosolids disposal for this time period. This section comprises the following discussion items:

- **Wastewater Regulatory Discussion:** National Pollutant Discharge Elimination System (NPDES) permit requirements, potential future regulations, improvements that might satisfy those future regulations, and requirements that are associated with increased surface water discharge above current NPDES-permitted levels.
- **Biosolids Regulatory Discussion:** Proposed or potential biosolids regulations and improvements that might satisfy those future requirements.
- **Conclusions and Recommendations:** Summary of recommendations for consideration.

3.2 Wastewater Regulatory Discussion

3.2.1 Summary of Existing Wastewater Regulations

The water quality regulations that aim to preserve water quality can be grouped into the following three levels:

1. U.S. Environmental Protection Agency (EPA) water quality rules and regulations administered under the Clean Water Act, including the California Toxics Rule.
2. California Environmental Protection Agency and State Water Resources Control Board (SWRCB) water quality policies, regulations, and statewide plans, including the Thermal Plan, Inland Surface Waters Plan, Bay-Delta Plan, and Bays and Estuaries Plan, administered under the California Water Code.
3. Water Board Basin Plan, NPDES permit, and Waste Discharge Requirements.

The main goal of these entities is to maintain water quality objectives to protect beneficial uses and to inhibit water quality degradation. Included in these regulations are the federal and California *Antidegradation Policies*, which establish a standard to protect high quality waters of the state. Further details of the regulations are included in Appendix B.

The NPDES permit for the Tracy WWTP was adopted in May 2007 with proposed amendments initiated in 2008 and 2010. Treated wastewater from the Tracy WWTP is discharged to Old River under Order No. R5-2007-0036 (NPDES No. CA0079154). Because, in the opinion of the Water Board, there is a potential impact to groundwater at the facility, the Tracy WWTP's industrial pretreatment ponds, industrial holding ponds, sludge drying beds, and biosolids storage areas of the facility are regulated by separate waste discharge requirements as defined in Order No. R5-2007-0038.

The 2007 adopted NPDES permit regulating the discharge of treated effluent to the Old River is scheduled for renewal in 2012. NPDES permits are to be renewed every 5 years, although they may be extended administratively beyond that period. Proposed amendments to the waste discharge permit in 2010 may modify the future renewal schedule.

It is impossible to accurately predict the nature of future discharge requirements, but one can outline the driving factors that may lead to additional or more stringent regulations. First, it is well documented that the receiving waters of the Sacramento-San Joaquin Waterways are critical in terms of beneficial uses (that is, aquatic life, agriculture, habitat, recreation, and municipal and industrial water supply). Potentially, these waterways would be affected by future regional or statewide water management plans in terms of both flow and quality. The Bay-Delta Plan, which affects water quality regulation and flow requirements in the South Delta, is currently under revision by the SWRCB. Under the proposed Bay-Delta Conservation Plan, the operations of the State Water Project and federal Central Valley Project and the physical configuration of the Delta may be altered. In recently passed state legislation, a new Delta Stewardship Council governance structure has been adopted, which may affect water quality regulation in the Delta. Each of these significant changes to the Delta environment and Delta regulatory context creates a layer of complexity for the City in assessing the future effect of its surface water discharge. For parameters such as salinity and temperature, which are of current concern in the Delta, quantifying the future impact to the system is difficult when the system itself is dynamic.

3.2.2 Summary of Potential Future Regulations

Discharge limits for new constituents, new treatment requirements, and protection against degradation of the environment are all anticipated to lead to further changes in future regulations as both state and federal regulators focus their efforts in these areas.

Since the Clean Water Act was passed in 1972, EPA has been tasked with the effort "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." To meet this goal, EPA is continuing to look for new points of concern as well as methods to test and treat water discharged into the environment. Currently, EPA is investigating regulation of emerging constituents such as endocrine disrupters or hormonally active agents, antibiotics, and pharmaceuticals and personal care products, as well as stricter requirements on currently regulated constituents such as nutrients.

As more is known regarding the fate and impact of various constituents in water and higher levels of treatment become cost effective, the assessment of the amount of acceptable and affordable risk associated with the constituents will drive the regulations. A major driver for regulatory changes will be public perception regarding the risks.

Another issue that drives regulations in California is water scarcity. As the state's population continues to grow and water sources are reduced, new uses for recycled water may become viable. However, without public acceptance, recycled water projects will not be implemented. Therefore, developing water reuse regulations that regulators, agencies, and the general public believe are acceptable is a vital component of water recycling, making water quality issues and advanced treatment ever more important. Water quality objectives, such as preventing environmental degradation, preventing potential public health problems, and meeting user requirements, must be satisfied to implement a successful water reuse program. As recycled water becomes an important water source in many regions, controlling salt and nitrates in the WWTP discharge becomes more important because it may control the water reuse activities.

Source control of various constituents is emerging as an issue for Title 22 and waste discharge permits in California. State regulators are examining the complete hydrodynamic system of a wastewater agency from source water to discharge. This includes investigating upstream source control, determining what is entering the system from users, and identifying the constituents present in the influent to the WWTP. This issue is linked to developing risk assessments for recycled water projects and the significant number of constituents that have recently been found downstream of wastewater plants around the U.S. Following is a brief discussion of the potential water quality limits that may need to be addressed in this planning period:

- **Compounds of Emerging Concern (CEC):** CECs include anthropogenic compounds such as pharmaceuticals, flame retardants, hormones, steroids, and personal care products. These contaminants have been detected at low levels in surface water leading to concerns that CECs may adversely impact aquatic habitat and human health. Regulations to remove CECs from influent wastewater and limit their discharge to the environment are still in the infancy phase as environmental monitoring and overall understanding of the compounds continues. Typical WWTPs are not specifically designed to remove CECs from the wastestream; treatment and operational processes are likely to be governed by the types of compounds and associated discharge limits if and when regulated.

- **Disinfection Byproducts:** Production of disinfection byproducts (DBP) is also of concern. One of the more common groups of DBPs includes trihalomethanes. These carcinogenic compounds are formed as a result of the chemical reactions between chlorine and the organic compounds in the wastewater. Another significant DBP is N-nitrosodimethylamine (NDMA), which has been the focus of several research efforts as it is a powerful carcinogen.

  NDMA is a candidate for future regulation because it has been associated with water disinfection treatment. NDMA is one of several nitrosamines, of which N-nitroso-diethylamine, N-nitroso-di-n-butylamine, N-nitroso-di-n-propylamine, N-nitroso-methylethylamine, and N-nitroso-pyrrolidine are also listed as part of the Unregulated Contaminants Requiring Monitoring list.

  Secondary wastewater effluent can contain between 10 to 1,000 nanograms per liter of NDMA. Even after advanced treatment such as microfiltration followed by reverse osmosis (RO) and/or ultraviolet (UV) disinfection, treated and chlorinated water can still contain between 20 to 100 nanograms per liter of NDMA (Sedlak et al, 2006).

  High NDMA concentrations can enter drinking water supplies through direct or indirect potable water reuse. Because of Title 22 requirements, many publically owned treatment works in California include NDMA in their monitoring programs. Title 22 requirements also include other nitrosamines such as N-nitroso-diethylamine and N-nitroso-pyrrolidine. Therefore, regulations pertaining to DBPs are anticipated to become more stringent as waterways downstream of the discharge point are used for municipal source water.

- **Salinity (electrical conductivity/total dissolved solids [TDS]):** More stringent salinity control is anticipated within the Sacramento-San Joaquin Delta Waterways. Whether salinity is controlled at the source prior to discharging to sewage collection systems, or at the treatment plant itself, state regulations will continue to restrict salinity discharge as measured by electrical conductivity. This issue is a prime focus of the ongoing revisions to the Bay-Delta Plan and also the Central Valley Salinity Alternatives for Long-term Sustainability management program that is being developed valleywide by the state and numerous stakeholders.

- **Methyl mercury Formation:** This will be of concern if the City implements a wetland treatment system for effluent polishing or thermal mitigation. It has been found that wetland systems foster the microbial activity associated with converting inorganic divalent mercury (Hg^{2+}) to the more toxic methyl mercury (MeHg). The rate of methyl mercury production within a wetland habitat depends on several factors, including the quantity of mercury within the influent waters and the surrounding site soil. A thorough study examining the specific site details should be conducted prior to implementing a natural wetland treatment option for the City.

- **Nutrients (nitrogen and phosphorous):** The need for stricter nutrient management requirements in the Delta will be evaluated in the future, given concern for the role of nutrients in the growth of nuisance algae and aquatic plants and the resulting impacts on the Delta ecosystem and drinking water supplies.

- **Title 22 Requirements:** The Central Valley Regional Water Quality Board has recently required Title 22 tertiary filtration standards of effluent ultimately discharging to surface waters to ensure that the discharger does not "produce undesirable or nuisance aquatic life; resulting in floating debris, oil, or scum; produce objectionable color, odor, taste, or turbidity." The Water Board has placed numeric requirements compliant with the California Department of Public Health on previous narrative requirements. One such example is the Sacramento Regional WWTP, which is required to produce Title 22 effluent by the year 2020.

Given the above regulatory changes and uncertainty, the wastewater facility master planning effort for the City must identify and evaluate future risks and provide flexibility and adaptability, where possible.

Following are anticipated future water quality CECs:

- Salts (for example, electrical conductivity and TDS)
- Temperature
- Total nitrogen
- Total phosphorus
- Total organic carbon
- DBPs

- Methyl mercury
- Endocrine disrupting compounds (EDC)
- Personal Care Products (PCP)
- Prions
- Musks and fragrances
- Plastics and plasticizers (some considered to be EDCs)
- Brominated flame retardants (some considered to be EDCs)
- Pharmaceuticals (referred to as PPCPs when combined with personal care products)

3.2.3 Potential Improvements

A number of means to alleviate the concerns related to liquid treatment and the following effluent water quality management concepts were identified:

- **CECs:** Source water control practices are likely the best means of targeting the CECs. Reducing contaminant levels reaching the facility would improve both the effluent and the biosolids quality. In addition to the source control of discharges to the sewers, controlling unauthorized discharges and urban runoff is needed.

  Longer solids retention time in an activated sludge facility like the City's could result in biodegradation of some of the organics. Some organics may be amenable to biodegradation if exposed to anaerobic/aerobic cycling. High mixed liquor concentration operation that could be achieved in a number of biological treatment processes (for example, membrane bioreactors [MBR]) can remove some of the organic material through adsorption on the mixed liquor solids. These solids can be captured with membrane technology (MBR or tertiary membranes), resulting in overall better removal efficiencies. Membrane technology could also allow a future transition to technologies such as RO that could remove the organic constituents. If stricter regulations are imposed on some of the organic constituents, advanced oxidation could also be considered to break down the organic compounds or remove these compounds in the case of RO.

- **Nutrients (nitrogen and phosphorous):** Biological nitrogen removal with nitrification/denitrification results in the removal of a significant amount of nitrogen from wastewater. Although nitrogen removal is already part of the Tracy WWTP process train, future regulations may further restrict discharge. Phosphorous removal is not currently emphasized in the Central Valley. However, the latest scientific studies have highlighted the dramatic increase in the prices of phosphorous for production of fertilizers during recent years. This is a result of the limited phosphorous sources available. Flexibility of existing and future bioreactor infrastructure to allow implementation of enhanced biological phosphorus removal may be required to meet long-term nutrient removal requirements for the City.

- **DBPs:** Controlling DBPs depends on the future management of the Delta waterways, which, in turn, can influence future regulations. Increased DBP control would most likely be required whether the City plans to engage in a water reuse system or continues to discharge to inland surface waters. More stringent trihalomethane and NDMA requirements may be enforced, because the entire water system (surface water and groundwater) is considered vital to the Delta and beyond. This combination would likely steer the City toward alternative disinfection methods such as chloramination, combined UV disinfection-chloramination or combined UV-ozone oxidation.

- **Salinity (electrical conductivity/TDS):** Potential salinity limits to the WWTP effluent discharge follow those established in the Basin Plan in regards to controlling salinity discharge receiving surface waters that are used for municipal supply and agricultural irrigation, among other uses. Removing dissolved solids from a waste stream is relatively complex, especially with RO technologies, as they generate a brine end-product that requires disposal management. Current trends indicate that salinity will be a driving factor that may direct public utilities toward certain buildout goals (that is, TDS reduction in domestic wastewater, wellhead treatment for groundwater supply, and/or identification of alternative source water resources). The City's effluent currently has TDS concentrations in the range of 650 milligrams per liter (mg/L), which (depending on soil properties) is generally acceptable for agricultural reuse on some crops, but too high for others. Likely sources of salinity in the City's wastewater include industrial discharges, use of self-regenerating water softeners in the community, and infiltration of poor quality groundwater into the collection system.
- **Temperature:** As outlined in the Thermal Plan, discharged effluent shall not adversely affect the receiving waters. Reducing effluent temperatures of treated wastewater is not an uncommon practice as there are a variety of approaches, including constructed wetlands, cooling towers, and heat pumps. Because of the dynamic nature of managing receiving waters, it is likely that effluent temperatures will become an increasing concern. Investigating the current mitigation technologies would be a proactive approach. The previously anticipated plan for cooling Tracy WWTP effluent prior to discharge was to employ constructed wetlands, where evaporation and shade from aquatic plants would decrease effluent temperature. Concerns associated with methyl mercury formation in wetland systems make the use of constructed wetlands a less likely option.
- **Application for Increased Surface Water Discharge:** As a master plan alternative, expanding the City's current discharge to Old River would require several planning studies to satisfy regulatory requirements. These studies include: (1) an antidegradation analysis to address the incremental water quality changes associated with increased discharge above the City's currently permitted 16-million-gallon-per-day (mgd) ADWF; (2) an environmental impact report to address California Environmental Quality Act (CEQA) requirements; and (3) thermal impact studies to either support a Thermal Plan exception or to establish treatment requirements for new cooling facilities. The Water Board will need these studies to allow them to grant an increase in permitted discharge capacity in the City's NPDES permit. Sophisticated water quality modeling tools must be employed to perform the necessary analyses. The above-mentioned dynamics of the physical Delta and future water project operations complicate, but do not prevent, performing these studies.

3.3 Biosolids Regulatory Discussion

Biosolids management is an integral part of any wastewater treatment facility, and includes solids stabilization and volume reduction steps rendering the waste solids into a biosolids product that could be either disposed or, preferably, beneficially used in a manner that does not cause any public health concerns. The regulatory criteria that form the basis of the biosolids product stability and management options are established by the 40 *Code of Federal Regulations* (CFR) Part 503 Rule. However, biosolids management is greatly driven by public perception, which can be influenced by subjective criteria such as odors at the WWTP or at land application sites.

3.3.1 Summary of Existing Regulations

EPA 503 Rule defines the "biosolids stability" and quality requirements to ensure that public health is protected. Existing biosolids regulations are being met by the Tracy WWTP. No additional improvements are planned to meet near-term requirements. Appendix B contains additional information on existing biosolids regulations.

Biosolids can be described as "Class A" or "Class B," in which Class A undergoes a higher degree of treatment and offers more options for disposal. The City currently disposes of Class A and B biosolids to land application. Methods to meet Class A and Class B biosolids disposal needs are discussed in Appendix B.

3.3.2 Summary of Upcoming Biosolids Regulatory Requirements

According to the California Integrated Waste Management Board, more than 50 percent of the biosolids produced in California are land-applied. Almost 30 percent are either composted or used as daily cover at landfills, and the remainder are disposed of in landfills, incinerated, or stored. Non-regulatory factors and growing public concern over the safety of biosolids have resulted in strict local ordinances banning or severely restricting biosolids use in several California counties (for example, Kern County and those lands within the Sacramento-San Joaquin watershed [such as the City area and beyond]), as described in the Delta Protection Act. The SWRCB completed a Program Environmental Impact Statement for the *General Order for Biosolids Land Application* in July 2004. Pertaining to the statewide Program Environmental Impact Statement and the General Order (GO) for biosolids land application, the SWRCB has declared biosolids land application to be the best, safest alternative for biosolids, given the boundaries set in the GO related to the acceptable maximum pathogen concentrations, application rates, application locations, acceptable ambient conditions at the time and location of the application, staging and proximity requirements, and monitoring requirements. Accumulation of polychlorinated biphenyls (PCB), metals, antibiotics, and recalcitrant pesticides in the biosolids are some of the concerns that the SWRCB aimed to address with this GO. Streamlining the application and permitting process is also one of the goals of the GO.

3.3.3 Summary of Potential Future Biosolids Regulations

The following are considered to be the key emerging issues related to the biosolids management and need to be addressed to ensure a sustainable biosolids management program:

- Fecal coliform reactivation and regrowth (FCRR)
- CECs
- Cake odor production potential
- Nutrients (phosphorus in particular)

In combination with public perception, the most important issue among those listed above is FCRR, because it deals with coliform reactivation even in biosolids that can meet Part 503 Rule stability requirements. The FCRR and cake odor production potential were observed in a Water Environment Research Foundation (WERF) project in parallel with a number of publicly owned treatment works observing FCRR in their biosolids product. With the FCRR, the biosolids product is still considered in compliance with EPA Part 503 if a process to significantly reduce pathogens is documented in the absence of any new regulatory requirements. However, it is likely that once FCRR is documented, the biosolids produced will need to be monitored in the field to verify that Class A product meets less than 1,000 maximum probable number of coliforms per gram; or Class B product meets less than 2 million maximum probable number per gram requirements. WERF has other ongoing projects evaluating FCRR and the underlying mechanisms. The existing body of knowledge indicates that FCRR and odor potential are interrelated, and biosolids handling practices influence both. In other words, once the waste solids are anaerobically digested consistent with best practices, the digested solids not only meet the 503 Rule requirements (minimum 38 percent volatile solids reduction and time-and-temperature requirements), but also have a low odor production level and acceptable coliform levels. The solids are then processed through high or low shear processes, or a combination, to dewater, transfer, and convey. Although the key mechanisms are still under investigation, when processes that impart high shear on the biosolids are used, the useful microorganisms seem to be inhibited allowing unfavorable populations to grow selectively, including coliforms.

It is possible that a heightened level of concern will develop, resulting in a reduction of land application of anaerobically digested biosolids (either with or without dewatering). This practice could be phased out in California over the next few decades if the scientific studies fail to provide answers to the concerns of the public and regulators. A number of solutions are provided in the completed and ongoing WERF studies that could be considered not only in biosolids handling processes selection, but also in overall planning for the City.

3.3.4 Potential Improvements

The following means to alleviate the concerns related to biosolids management were identified:

- **FCRR and Odor Generation Potential:** To control FCRR and manage odor generation in the biosolids product, effective (or perhaps enhanced) digestion of waste solids followed with processes such as belt filter presses and low-pressure conveyors could be implemented, instead of high-shear centrifuges, cake pumps, and long stretches of cake conveyance using screw conveyors. The Tracy WWTP currently uses drying beds for dewatering, which will convey even less shear than belt filter presses and low-pressure conveyors. One other means of FCRR control is low-level lime (or L3) or kiln dust addition, where a controlled dose of low level lime is added to the dewatered product without raising the cake pH to 10 or beyond, hence controlling lime-induced cake odors. It is also possible to maintain FCRR control if the treatment plant has the facilities for onsite biosolids product storage without chemical addition to achieve additional fecal coliform destruction.

- **Constituents of Emerging Concern:** The same constituents of emerging concern noted for NPDES permitting are also of concern in biosolids. Source control is by far the preferred method to control those constituents for biosolids management.

3.4 Conclusion and Recommendations

Multiple current wastewater and biosolids regulations affect the Tracy WWTP, which are addressed through existing treatment and mitigation practices. Future regulatory projections indicate that modifications to the current wastewater treatment practices are likely to be necessary in the future. Recommendations regarding a path forward are discussed in Section 4 of this Master Plan, and could include the following:

- Operational changes within the plant (for example, longer solids retention time) could result in biodegradation of some CECs. Specific regulatory goals are unknown as the industry is focusing on the investigative science.
- Tightening source control requirements throughout the sewage service area for CECs would prove beneficial. The California Water Code establishes need for pollution reduction measures, in the following section:

  > *13263.3(a) The Legislature finds and declares that pollution prevention should be the first step in a hierarchy for reducing pollution and managing wastes, and to achieve environmental stewardship for society. The Legislature also finds and declares that pollution prevention is necessary to achieve the federal goal of zero discharge of pollutants into navigable waters.*

- Potentially greater removal of nitrogen compounds, and possibly phosphorus removal, may be required in the future.
- An alternative disinfection system, such as combined UV-chloramination or UV-ozone oxidation, may be required to control DBPs.
- Planning for membrane technology, or similar advanced treatment options, to address salinity and otherwise mitigate future wastewater regulatory requirements. Alternatively, implementation of pollution prevention measures before addressing salinity reduction through new or improved treatment processes may prove to be more cost efficient.
- Determination and regulation (pretreatment or source control) of large salinity sources within the collection area. Self-regenerating water softeners, which discharge spent brine into the wastewater collection system, are a major source of salinity in many wastewater collection systems; additionally, self-regenerating water softeners can consume up to 300 gallons of water per week during the regeneration cycle when the brine solution is flushed through the system. Infiltration of poor quality groundwater into the sewer collection system is also a likely source of salinity; correction of sewer collection system defects, while costly, can have a significant impact on the reduction of salinity. Finally, source control approaches for industrial discharges with high levels of salinity can often lead to improvement.

- Planning for thermal control (cooling) of effluent to minimize the impact on fisheries during critical periods of time in the Old River. Mechanical cooling units (towers) are considered a better choice than the use of constructed wetlands given recent concerns associated with methyl mercury generation in wetland systems.
- There are costs and uncertainties regarding the City's ability to secure an NPDES permit for increased surface water discharge for flows greater that the currently permitted 16 mgd (ADWF). The alternative to direct discharge would involve the reuse of the wastewater effluent, either for urban irrigation, industrial use, or for agricultural irrigation.
- Considering potential biosolids regulatory requirements if, in the future, modifications are made to the current solids handling process. At this time, the most promising and least-cost alternative is to retain (and expand, if required) the drying bed operation for sludge dewatering and not change operations.

For the purposes of treatment plant layouts for the planning period, it is recommended that all potential treatment requirements be included in the analysis to allow for sufficient land area for the ultimate treatment facilities. For costing the treatment plant requirements as part of any Specific Plan application, it is recommended that the then-current requirements be included in the financial plan assessment. NPDES permits must be renewed every 5 years, and additional costs will be incurred as new regulations are imposed.

With respect to discharging effluent (from one plant or multiple plants), it is recommended that the future Specific Plan studies assume that flows greater than 16 mgd (ADWF) will be land-applied or otherwise reused rather than directly discharged to a water body. This recommendation reflects the uncertainties of acquiring a permit to discharge more than 16 mgd (the current ADWF allowed in the City's existing permit) to the Old River. This assumption should be re-evaluated and tested with the Water Board when the total flow rate from the community approaches the 16-mgd limit.

SECTION 4

Wastewater Treatment Facilities

4.1 Introduction

The City of Tracy's WWTP is located at the northern end of existing City limits, north of Interstate 205 and between MacArthur Drive and Holly Road. The WWTP has a permitted ADWF capacity of 16 mgd with a current influent design ADWF capacity of 10.8 mgd. This section of the Wastewater Master Plan presents the existing treatment infrastructure and recommended modifications to treat the future flows and loads that are discussed in Section 2.

This planning document evaluates the treatment infrastructure required for future growth and developments while maintaining compliance with current wastewater discharge requirements. This evaluation includes a conceptual-level analysis to determine whether a one-plant or two-plant approach should be implemented. The one-plant approach focuses all resources on expanding the existing treatment plant, and the two-plant approach consists of expanding the existing plant and constructing and operating a second treatment facility located at the southern end of the City's existing limits. For the two-plant option, a majority of the wastewater generated within the Future Service Areas would be directed toward the existing WWTP located on Holly Drive, with the proposed second treatment facility to process flow from one of the largest Future Service Areas (Tracy Hills). This second, and as yet unconstructed, treatment plant, received conceptual approval from the City Council in December 2000.

This master plan has provided a review of anticipated changes in the regulatory environment, and recommendations for future treatment processes are included herein. The costs of those future requirements are not, however, included in the costs in this report. It is proposed that the costs of future plant upgrades should be spread among existing and future users only after the discharge requirements for such improvements have been established by the Water Board or other regulator. Until such future requirements are implemented, the connection fees that are to be established in the Finance Plan will only consider those costs necessary to meet existing discharge requirements. All users (existing and future) will then share in the costs for such upgrades at that time.

4.2 Existing Facilities

The City's WWTP currently provides tertiary-level treatment for all flows received within the City's limits. Influent wastewater is primarily from domestic sources with the exception of industrial flows generated by Leprino Foods. Leprino Foods provides pretreatment to their industrial flows and sends it to the main plant for further treatment, entering at the primary clarifier. Treated and disinfected effluent is discharged to Old River via a 3.5-mile outfall pipeline and diffuser system. Stabilized biosolids are dried and hauled offsite for land application. There have been several modifications to the WWTP, with the most recent and extensive upgrades completed in 2007.

The existing headworks system includes three mechanical screens operating in a duty/duty/standby configuration with a PWWF flow capacity of 38.7 mgd. Screen openings are 6 millimeters (mm) and provide acceptable trash removal for the current treatment scheme. Three screenings washer compactors are installed to remove organics from the screened material, which are then compacted and discharged to a hopper for disposal to landfill. Primary treatment includes three sedimentation basins, one 90-foot-diameter circular clarifier, and two 72-foot by 32-foot rectangular clarifiers. Currently, only the circular clarifier is in service, with the rectangular basins on standby.

A new activated sludge system was brought online as part of the 2007 construction project to replace the trickling filter activated sludge system. The activated sludge system comprises three 1.5-million gallon (MG) aeration basins with anoxic selectors. Anoxic selectors comprise approximately 17 percent of the total basin volume and are equipped with mixers to keep solids in suspension. Fine-bubble diffusers are used to distribute the low-pressure air supply to the aerobic zones. Three mixed-liquor return pumps are installed for selector operation and not for enhanced nitrogen removal. Solids separation is provided by three 100-foot diameter secondary clarifiers with a 14-foot-sidewater depth.

Secondary effluent is filtered using conventional deep bed filters with anthracite media. The filtration system includes eight cells with a total filter area of 4,400 square foot (ft^2). This results in a hydraulic loading rate of 2.9 gallons per minute per square foot (gpm/ft^2) at 16 mgd and 4.9 gpm/ft^2 at 27 mgd, with the latter being the current equalized flow rate. A chemical feed and storage system allows the plant to dose alum and polymer upstream of the filters for enhanced performance.

The WWTP's disinfection system comprises chlorination and dechlorination processes. Tertiary effluent is dosed with chloramines and conveyed to chlorine contact basins for pathogen reduction. The current target chlorine concentration entering the chlorine contact basins is 10 mg/L. Chlorine and ammonia injection is achieved using an in-line chemical induction system (Water Champ) that allows mixing of the chemical solutions prior to injection to the tertiary effluent. Six chlorine contact basins have a total volume of 1.15 MG, each consisting of a baffled basin to provide plug flow conditions and to prevent short circuiting. Dechlorination is provided using sulfur dioxide to neutralize the chlorine from the plant effluent before discharging into Old River. Post-aeration is provided to achieve a final effluent dissolved oxygen concentration of 5 mg/L, as required by the NPDES permit.

Solids handling includes thickening, stabilization, and dewatering processes. Waste activated solids (WAS) are currently thickened using two dissolved air floatation thickeners. Thickened WAS is pumped to digestion via progressing cavity pumps. Thickened WAS and primary sludge are stabilized with two 75-foot anaerobic digesters. Digester gas is used to fuel boilers for digester heating with unused gas flared to the atmosphere. Digested solids are dewatered in drying beds with a total area of approximately 445,000 ft^2 (Figure 4-1).

4.3 Future Disposal Options

It is necessary to develop a disposal strategy for both liquid and solid streams, as the ultimate disposal location directly affects the planning for future treatment systems. For example, regulatory criteria for liquid discharge to surface water, such as the Old River, differ from using treated effluent for irrigation purposes. The differences between discharge criteria often leads to different treatment technologies, each developed to reliably achieve the specific treatment criteria. An unplanned or sudden change in disposal strategies may lead to treatment modifications without the proper funding mechanism in place. Subsections 4.3.1 and 4.3.2 discuss the disposal strategies for the City of Tracy.

4.3.1 Liquid Stream

In prior discussions with the Water Board it was determined that discharging more than the currently permitted 16 mgd (ADWF) of effluent to the Old River (from one or more treatment plants in the Tracy area) will be very difficult to achieve because of the lack of dilution credit. For the purposes of this Master Plan, it has, therefore, been assumed that flows in exceeding 16 mgd (ADWF) will be land-applied, and not discharge to surface water. Given the need to increase the potable water supply for the new growth areas, substituting recycled water for potable water on irrigated areas within the community is necessary and appropriate. Appendix C includes information associated with the use of recycled water for industrial, agricultural, and urban irrigation.

4.3.2 Solids Stream

Disposing of biosolids is often overshadowed by liquid stream disposal concerns, but biosolids disposal is a crucial part of WWTP planning that can greatly affect operational budgets if ignored. Some of the available biosolids disposal options include landfill disposal, land application, and incineration. For the purposes of this Master Plan, it is assumed that the City will continue to land-apply biosolids. This existing disposal plan is a sustainable practice in that properly treated biosolids serve as a soil amendment. It is proposed that the City strive to generate a Class A biosolids product, as the current regulations regarding land application may be modified, and because there have been cases of restrictions on Class B biosolids land application within California, Florida, and Texas. Available land for applying Class B biosolids may decrease in the future depending on public concerns.

4.4 Future Treatment Options

The approval of the Tracy Hills Specific Plan approximately 12 years ago resulted in the adoption of a plan to construct a second wastewater treatment facility, referred to in this document as the two-plant option. This second treatment facility would be a water recycling facility (WRF) similar to the one described in the Tracy Hills Specific Plan (2000), as modified by recommendations in this Master Plan. For the two-plant option, wastewater generated within the Tracy Hills development project would be treated to Title 22 standards for reuse applications within the development. All remaining wastewater flows generated within the SOI would be conveyed to the existing WWTP located on Holly Drive. The existing WWTP would be expanded to accommodate the increased flows from new development, with modifications to unit processes to incorporate reuse applications for irrigation demands within the SOI. For the one-plant option, the existing WWTP would be expanded to process 100 percent of the wastewater generated within the SOI. The treatment options at the Holly Drive location are the same for the one-plant and two-plant approaches.

4.4.1 Water Recycling Facility for Tracy Hills

For the two-plant option, a second wastewater treatment facility is proposed to treat all wastewater flows generated within the Tracy Hills development, with land application to dispose of treated effluent. The Tracy Hills subdivision is located at the south end of the City's SOI and bisected by Interstate 580. Raw sewage generated from the development will have municipal wastewater characteristics, as the majority of the flow will be from residential units. Average flow and loading criteria were calculated to reflect future land uses and are summarized in Table 4-1. An effluent capable of achieving Title 22 unrestricted reuse requirements was assumed in addition to a total nitrogen limit of 10 mg/L (as nitrogen).

The California Water Code provides the Water Board and the California Department of Public Health with authority to regulate water recycling to protect water quality. The Central Valley Water Board's Basin Plan identifies groundwater objectives that are equal to the maximum contaminant levels for chemical constituents and bacteria. Numeric objectives for nitrogen are 10 mg/L of nitrate as nitrogen or 45 mg/L of nitrate. The following provision is typically included in recycled water requirements to ensure groundwater quality objectives are achieved:

> *Application of recycled water to the reclamation areas shall be at reasonable rates considering the crop, soil, climate, and irrigation management system. The nutrient loading of the reclamation areas, including nutritive value of organic and chemical fertilizers and of the recycled water shall not exceed the crop demand.*

Recycled water users are typically required to ensure that groundwater contaminant levels do not increase to concentrations that would violate any groundwater quality objectives (for example, 10 mg/L nitrate as nitrogen). An increase in a constituent above groundwater background levels as the result of irrigation using recycled water would likely violate the state's antidegradation policy. Therefore, the wastewater treatment facilities proposed for the Tracy Hills area some 12 years ago would not meet the current regulatory requirements, and upgrades to the conceptual plan are required.

TABLE 4-1
Water Recycling Facility Design Criteria
Tracy Wastewater Master Plan

Description	Value
Average Dry Weather Flow	2.0 mgd
Maximum Month Flow[a]	3.0 mgd
PWWF	5.6 mgd
Average BOD Loading	4,680 lb/day
Design Maximum Month BOD Loading[b]	7,020 lb/day
Average TSS Loading	5,450 lb/day
Design Maximum Month TSS Loading[b]	8,100 lb/day

[a]Maximum month flow based on MMF: ADWF peaking factor of 1.5.

[b]Maximum month loading based on MML: average peaking factor of 1.5.

Several treatment options are available to effectively achieve Title 22 standard for reuse application. Conventional mechanical options include, but are not limited to, sequencing batch reactors (SBR), MBR, and moving-bed bioreactors (MBBR). Potential options for a natural treatment system approach include conventional lagoons, advanced-integrated type pond systems or similar, and treatment wetlands. Although a natural treatment system was investigated, it was determined that a conventional filtration system would be required after the natural treatment system to achieve turbidity standards associated with Title 22 requirements for unrestricted reuse.

4.4.1.1 Mechanical Treatment System

Several mechanical treatment systems are capable of providing reliable secondary treatment. Any mechanical system should include headworks components that would effectively remove rags, trash, and grit. These include mechanical screens, a screenings processing system, a grit removal system, and grit washing and classifying equipment.

Mechanized systems for secondary treatment include SBRs, MBRs, MBBRs, and conventional activated sludge treatment systems. SBRs, MBBRs, and conventional activated sludge systems all require filtration and disinfection processes to achieve reuse standards. MBR systems can forgo the additional filtration equipment as the membranes used for solids separation also provide high-quality filtered effluent. Of the four systems listed above, the conventional activated sludge system typically results in the largest overall footprint as it requires aeration basins and clarifiers for solids separation. In addition, the basins will be larger than those used in an MBBR or MBR system because the suspended solids concentration will typically be between 2,000 and 3,000 mg/L. In comparison, the biological activity in an MBBR system is attached to the media, and in an MBR system the suspended solids concentration is approximately 10,000 mg/L, both of which reduce the overall basin volume and, therefore, the overall footprint of the treatment system.

4.4.1.2 Natural Treatment System

The natural system deemed most appropriate after considering capital costs, acreage required, and operational and maintenance cost consists of an advanced integrated pond-type system followed by a free-water-surface treatment wetland. Between these two systems, pure oxygen injection would be included for winter months when low temperatures severely limit the nitrogen removal potential.

During summer months, when the temperatures increase, most of the nitrogen removal would occur in the advanced integrated pond system through nitrification/denitrification. Further polishing of nitrogen via denitrification would occur in the treatment wetland.

In the winter months, however, ammonia removal will be primarily via nitrification with little to no ammonia volatilization occurring. During this period, the treatment wetland component would provide nitrogen removal via denitrification, but would require full or near-full nitrification of the effluent within the wetland. A nitrifying wetland would be substantially larger than a denitrifying wetland.

A pure oxygen injection system would be recommended to overcome the oxygen transfer limitations within the wetland that slow nitrification rates. The oxygenation system would only be used during winter months when the advanced integrated pond system alone cannot achieve the nitrification or ammonia removal needs of the treatment wetland. A preliminary cost estimate is provided in Section 6 for comparison, and includes an oxygenation system sized to accommodate nitrification needs under winter conditions (daily average temperature of 15°C). In addition, the treatment wetland would be sized to achieve total inorganic nitrogen concentrations below 10 mg/L under typical winter conditions. Because of a strong temperature dependence on nitrogen removal, during the coldest periods of the year, the worst case scenario temperature conditions expected in the Tracy area require a 70 percent increase in wetland size compared to more average seasonal winter conditions to achieve inorganic nitrogen removal to below 10 mg/L. Therefore, it is assumed that additional equalization storage would be built into the advanced integrated pond system so that flows to the wetland can be decreased during the coldest periods of the year, thereby reducing the required wetland footprint and saving substantial cost.

4.4.2 Main Treatment Plant

The ADWF capacity of the main WWTP located at Holly Drive would need to be nearly doubled from 10.8 mgd to 19.1 mgd for the two-plant option, or to 21.1 mgd for the one-plant option, based on the flow projections discussed in Section 2. The proposed expansion strategy is to produce Title 22 quality effluent to offset irrigation demand within the Future Service Areas regardless of the ultimate plant capacity. Treated effluent up to 16 mgd ADWF will continue to be discharged to the Old River during the winter months when irrigation demand is minimal (actual maximum flowrates to the Old River will exceed this ADWF value on some occasions due to peaking within the system, but this is allowed under the discharge permit). Flows that exceed the discharge or outfall piping limitations would be stored in ponds located to the north of the WWTP to attenuate discharge to the Old River. Solids generated from the WWTP would continue to be dewatered in drying beds and land-applied for final disposal. Design criteria for the one-plant and two-plant expansion of Tracy's WWTP are shown in Table 4-2.

TABLE 4-2
Holly Drive Wastewater Treatment Plant Expansion Design Criteria[a]
Tracy Wastewater Master Plan

Description	Two-plant Option	One-plant Option
Average Dry Weather Flow	19.1 mgd	21.1 mgd
Maximum Month Flow[a]	29.3 mgd	32.3 mgd
PWWF	48.8 mgd	49.1 mgd
Average BOD Loading	41,762 lb/day	46,445 lb/day
Design Maximum Month BOD Loading[b]	62,643 lb/day	69,667 lb/day
Average TSS Loading	42,796 lb/day	48,247 lb/day
Design Maximum Month TSS Loading[b]	64,194 lb/day	72,371 lb/day
ADWF Surface Water Discharge Limit	16 mgd	16 mgd
Final Effluent Quality Standard, Liquid	Title 22 Unrestricted Reuse	Title 22 Unrestricted Reuse
Solids Disposal Location	Land Application	Land Application
Solids Treatment Standard	Class A Biosolids	Class A Biosolids

[a]Maximum month flow based on MMF: ADWF peaking factor of 1.5.

[b]Maximum month loading based on MML: average peaking factor of 1.5.

Phasing of modifications to the WWTP needs to be thoroughly analyzed to accommodate phased growth within the Future Service Areas. In addition to the hydraulic loading to the plant, the overall mass loading entering the system must be analyzed in relation to growth. The per capita wastewater flow will decrease as water-conserving appliances and fixtures are incorporated, but the per capita mass loading is not expected to decrease. Therefore, phasing must be investigated in terms of both flow and mass loading.

Several technologies exist to expand the WWTP to an ADWF capacity of 19.1 mgd for the two-plant option, or 21.1 mgd for the one-plant option. The current plan to expand the plant to achieve a 16-mgd ADWF capacity includes adding a fourth aeration basin and a fourth secondary clarifier, and assumes an equalized flow to the existing conventional filtration system so that hydraulic filter loading will not exceed 5.0 gpm/ft^2 (the regulatory maximum rate for recycled water use). Available technologies to expand the secondary treatment capacity include, but are not limited to, MBR, MBBR, and integrated fixed-film activated sludge. All three are proven technologies for retrofitting an existing system and are applicable to the City of Tracy’s needs. However, both MBBR and integrated fixed-film activated sludge would require expanding the filtration system, and MBR would replace the existing filtration system in addition to providing secondary treatment. MBR technology has the added benefit of producing higher quality effluent, which will likely be necessary as discharge permit requirements become more stringent in the future.

4.5 Recommended Improvements

4.5.1 Water Reclamation Facility for Tracy Hills

An MBR process would be the recommended plant process for the WRF to serve the Tracy Hills development, should the two-plant approach be selected. MBR systems are a proven technology with a comparatively smaller footprint and are capable of providing high-quality effluent for water reclamation. In addition, MBR systems can be modular and constructed to complement the development growth. Although secondary clarifiers and filters are not required for an MBR facility, auxiliary facilities are required that may not be required for other treatment technologies (for example, permeate pumps and backwash systems). While natural treatment was investigated as a treatment option, it was determined that a conventional filtration system would be required after the natural treatment system to achieve turbidity standards associated with Title 22 requirements for unrestricted reuse. In addition, the natural treatment system investigated herein includes an auxiliary oxygen injection system to enhance nitrification during the colder winter months.

A headworks facility that includes both screening and grit removal is recommended for the WRF. An influent screening system that is more robust than a conventional screening system will be required to protect the membranes. The proposed system includes a dual screening system comprising both coarse screens with openings between 0.5 and 0.75 inch and fine screens with openings between 1 and 2 mm. The purpose of the coarse screens is to remove large debris that could damage or immediately blind the openings of the fine screens. Vortex grit removal would be located between the two screens with associated grit pump and classifying equipment.

The secondary treatment system would include bioreactors, membrane reactors, aeration system, and auxiliary equipment. A four-stage bioreactor is recommended to provide carbonaceous chemical oxygen demand removal and nitrification and denitrification required for effluent with a total nitrogen of 10 mg/L (as nitrogen). The number of reactor trains would depend on the modular design that would parallel the growth of the development. Similarly, the membrane cassettes would also be modular and could be added as growth occurs. Auxiliary systems include recycle pumps, permeate pumps, backwash pumps, and a chemical feed and storage facility for membrane cleaning.

UV disinfection is proposed at the WRF for master planning purposes. The appropriate disinfection technology should be thoroughly analyzed so that a reliable and cost-effective technology is implemented.

Solids handling processes for the WRF include aerobic digestion followed by sludge drying beds for dewatering before hauling to landfill for use as an alternative daily cover. Aerobic digestion provides stabilization for pathogen reduction, and is typically more cost-effective than an anaerobic process for treatment systems of this size. Sludge drying beds are recommended for the WRF because of the low rainfall typical in the Tracy area that makes drying beds cost-effective. The added operational and maintenance requirements associated with a mechanical dewatering system are not proposed at this time. In addition, the added shear that mechanical dewatering imposes on the digested sludge may increase odors. Advanced drying bed options are available, such as those that resemble a greenhouse, if odors or aesthetics are critical drivers of dewatering technologies. Finally, the cost of biosolids disposal can be greatly reduced with sludge drying beds, because drying beds can generate a product with a solids content in excess of 85 percent, as compared to the 20 to 25 percent solids content achieved from other mechanical dewatering technologies. This decreased water content not only results in lesser hauling costs, but increases the available options for disposal. The drying beds can serve as a "holding area" during winter months when land application would be inappropriate.

4.5.2 Main Treatment Plant

The ultimate expansion strategy of the main WWTP includes modifying and expanding the existing plant to an MBR facility capable of producing Title 22 effluent for unrestricted irrigation use. The projected PWWF for the WWTP is 46.1 mgd for the two-plant option and 49.1 for the one-plant option and would require several hydraulic modifications in addition to modifications required for increased treatment capacity. General unit process modifications are presented in this section.

The existing headworks facility would be modified for both screening and fat, oil and grease removal. An additional mechanical screen would be required for the future peak flows while maintaining one redundant unit. In addition, fine screens with openings no greater than 2 mm would be required. An alternative location for fine screening could be after primary clarification.

The secondary treatment system would be modified from a conventional activated sludge system to an MBR system in stages. The existing process train would be employed for ADWF up to 16 mgd, and those improvements would be retained for service for as long as they remain reliable. The proposed MBR improvements would be added to the system in subsequent expansion phases or at such time that either more restrictive discharge requirements mandate a change in treatment process or when the useful life of the existing process train has ended. During the period when two treatment trains are present (existing activated sludge and membranes), the effluent from each would be comingled prior to discharge; MBR effluent, which would be of better quality, could preferentially be diverted to either reuse or direct discharge, depending on the more stringent requirements for either use that are then in existence.

The existing digester complex would be expanded to provide additional stabilization volume to maintain current solids disposal practices. Because the regulatory and public perception regarding land application of biosolids is anticipated to result in changes for obtaining a Class A biosolids product, it is recommended that the City investigate other processes. For example, temperature-phased anaerobic digestion is a viable option for obtaining Class A biosolids.

The increased solids produced by future flows will require an increase in drying bed area for dewatering stabilized biosolids. To minimize the additional land required for dewatering, it is recommended that the City evaluate mechanical dewatering to augment the drying beds. This would also provide operational flexibility, as digested solids could be thickened to approximately 16 percent total solids and then applied to the drying beds to achieve an optimum dried product. During the winter months when rain is more prevalent, the mechanical dewatering system could be used with additional polymer to achieve a dewatered product above 20 percent total solids.

4.5.3 One-plant Versus Two-plant Option

An alternatives analysis was performed to evaluate the one-plant and two-plant options from an economic perspective. Capital and operational cost estimates were prepared from conceptual-level designs of the two options, which include cost estimates for wastewater treatment, wastewater conveyance systems, pump stations, and reclaimed water distribution systems. Infrastructure requirements that are identical for both options were not explored in details because this analysis focuses on the differentiators of the two options. For example, the wastewater collection system within Tracy Hills will be relatively similar if there is one plant or two plants; however, there will be additional wastewater conveyance costs associated with the one-plant option as the system will need to convey a greater flow from the southern portion of the Future Service Area, which translates to larger pipe and larger pumping systems. One advantage of the one-plant option that was addressed in the analysis was that the one-plant option did not require any expansion of the new outfall and diffuser that is currently planned. Because the proposed outfall and diffuser can serve either option, the larger flow rates for the one-plant option can be accommodated at no additional cost.

The basic reclaimed water distribution system is retained for both options, but the one-plant option will require additional piping and pumping to transfer recycled water from the Holly Drive plant location to the Tracy Hills community. Energy costs associated with these additional pumping needs are captured and included in the one-plant option. Comparative cost estimates for the one-plant and two-plant options are shown in Table 4-3.

TABLE 4-3
Comparative Cost Estimates for One-plant and Two-plant Option

Capital and Present-worth Cost Estimates	Two-plant Option ($)	One-plant Option ($)
Expansion of Main Plant to 19.1 mgd	239,700,000	--
Expansion of Main Plant to 21.1 mgd	--	278,700,000
Construction of 2.0-mgd WRF	57,000,000	--
Additional Wastewater Conveyance Requirements for One-plant Option	--	5,900,000
Additional Recycled Water Piping Requirements for One-plant Option	--	1,400,000
Additional Recycled Water Pump Station Requirements for One-plant Option	--	700,000
Present Worth of Incremental Recycled Water Pumping	--	1,800,000
Present Worth of Incremental WWTP Operations	18,400,000	---
Total Present Worth	**315,100,000**	**288,500,000**

The conceptual analysis summarized in Table 4-3 indicates that the cost of the two-plant option is slightly higher than the cost of the one-plant option. Further, the existing plant can be readily expanded in relatively small increments (with costs spread among a larger user group), but the Tracy Hills WRF would require a major capital infusion for the initial phase of construction (with costs spread among a smaller user group initially). It is, therefore, recommended that the City move forward with a one-plant option that would convey all wastewater generated within the SOI to the Holly Drive facility. It has been our experience that the O&M costs associated with operating two wastewater treatment plants is greater than the O&M costs required for one plant. Although this analysis did not investigate non-monetary factors, it can be assumed that additional traffic requirements for deliveries, odor potential at a second site, and overall management requirements would increase for multiple plants.

4.6 Implementation

Expanding the WWTP located at Holly Drive for the one-plant option would require a phased approach. A detailed investigation of the timing of the proposed development projects anticipated within the Future Service Areas is necessary to better understand the future demand wastewater treatment facilities. Modifying the existing WWTP to an MBR facility as recommended herein may best be accomplished by implementing a combined secondary treatment system consisting of conventional activated sludge and filtered system and an MBR process that would operate in parallel for a period of time, as discussed previously in this section.

4.7 Sustainability Concerns

4.7.1 General

Wastewater treatment and collection historically have been subjected to "engineering economics" types of evaluation, wherein the most "economical" alternatives (that meet overall treatment and disposal objectives) have been implemented. Those engineering evaluations typically evaluate only current (or reasonably projected future) costs. Many treatment plant owners are now considering, and implementing, project features that offer greater sustainability, with lesser emissions and energy use, and greater consideration of the environment. Some of the items that can be evaluated as part of the Tracy Wastewater Master Plan are as follows:

- Climate Change Adaption
- Wastewater Reclamation
- Greenhouse Gas Reduction Opportunities
- Biosolids Management

4.7.2 Climate Change Adaption

Projected effects of climate change could include increased extreme storm events, droughts that will lead to increased demand for recycled water as well as conservation (which will result in stronger wastewater), extreme temperatures potentially impacting treatment processes, and higher seawater elevations. Because the likely effects in a given location can be predicted, it is possible to proactively consider these future conditions.

For the City of Tracy, it has been determined that almost all of these factors can be postponed until the actual impacts are better understood. For instance, although extreme storm events have the potential for increasing infiltration and inflow that can find its way into the City's wastewater collection system, it is also the case that selected improvements to the collection system can be made at a later date that will protect the system from such infiltration and inflow. Although implementing such improvements now would not be cost-effective, it may be the case that future conditions may call for their implementation at a later date.

The use of recycled water is an option that does have merit, however, and it is discussed in greater detail below (and also in the main body of both the Water and the Wastewater Master Plans).

Temperature impacts are not anticipated to create an adverse condition with respect to the biological activity at the wastewater treatment plant, but increased effluent temperatures must be dealt with. As noted in Section 3.2.3 of the Wastewater Master Plan, effluent cooling may be required during certain portions of the year to reduce temperature increases in the receiving stream. The use of cooling units is recommended for this purpose.

4.7.3 Wastewater Reclamation

The reuse of treated wastewater is favored by the State of California's Basin Plan, and wastewater reuse must be evaluated for every new treatment plant (or plant expansion) in the state before a new discharge permit will be granted. Generally, the Water Board will issue a new permit for discharge to surface water if it can be shown that reuse is more expensive than direct discharge. It is almost always the case that reuse is more expensive than direct discharge, principally due to the need for additional conveyance requirements (and sometimes winter storage requirements) for reuse projects. However, the cost impacts change drastically when reuse can free up potable water that may be in short supply for a community. The ability to increase potable water availability, coupled with a desire on the part of many communities to implement "Green" policies, has led to considerably more reclamation projects recently. Further, reuse in Tracy has the potential to reduce the salt levels in the City's wastewater effluent, which is a potential discharge issue for the City. The salt levels can be reduced if potable water supplies with lower TDS levels (e.g., non-groundwater supplies) can be diverted from park and other landscape irrigation, and sent directly to homes and businesses that discharge to the treatment plant. This action will reduce the City's use of groundwater in the water distribution system, thereby lowering the influent TDS to the treatment plant. Importing water supplies with less salt, coupled with reduced use of groundwater for potable water supplies, will also allow for a reduction in the use of water softeners in the City's service area. Water softeners, particularly those that "backwash" into the wastewater conveyance system, are another source of salts at the wastewater treatment plant. Reducing the use of water softeners in the community is a goal that should be evaluated in more detail. At a minimum, the public should be educated on the issues associated with water softener use at such time that it is judged that the City's water supply can provide water that does not require softening.

As noted in both the Water and Wastewater Master Plans, reuse is recommended for the City of Tracy.

4.7.4 Greenhouse Gas Reduction Opportunities

Greenhouse gas (GHG) reduction can be achieved in treatment plants and collection systems though a number of potential actions. The use of energy-efficient motors and equipment can reduce the need for electrical demand, thereby reducing GHG production. This is generally cost-effective, but not always so. At treatment plants, the use of methane for energy production (by way of an engine-driven generator or other large piece of equipment such as a blower, or by other means) coupled with waste heat recovery for the plant's anaerobic digester(s), is used in a large number of treatment facilities. The carbon dioxide emissions from such equipment are much more benign than methane emissions from a GHG perspective, and there is a concurrent reduction in the need for energy production in other carbon-based power plants in the area, resulting in a double benefit (although methane is not generally exhausted to the atmosphere in any plant – when not used, the methane is typically burned in a flare, with no resultant energy capture; although the carbon dioxide emissions have a lesser impact than that for methane (by about a 20 to 1 ratio for the production of GHG), the lack of energy capture does not occur in this situation; the addition of engine, turbine, fuel cell technology, or other use for the methane gas utilization adds complexity to the plant operations, and is not always economical. Finally, planning for a single treatment plant will almost always result in lesser quantities of GHG emissions, because deliveries of supplies can be consolidated, fewer employees are required (resulting in fewer trips), and construction impacts can be reduced with economies of scale associated with the construction of larger unit processes. Additionally, economies of scale associated with plant operation favor a single plant (very much so in the size ranges contemplated for Tracy), and the reduced O&M costs passed on to the users of the system will result in a more sustainable operation.

With respect to methane gas utilization, the City is currently evaluating the potential for installing a third-party operation that could burn waste agricultural products near the existing treatment plant and produce electricity. The waste heat from this operation could also be captured in a cogeneration scheme, and it could be used for both digester heating and to evaporate a portion of the City's effluent stream (e.g., zero liquid discharge might be possible for some of the City's waste stream). This would allow for the capture of some of the salts (now in solid form due to the evaporation of the liquid phase of this effluent stream), thereby reducing the discharge of salts to the receiving waters. In the event of downtime in the cogeneration facility (for maintenance or other reasons), the City's existing digester gas heating system will be retained for use during such outages; alternatively, if digester gas is deemed inappropriate for use in the cogeneration system, the existing system for digester gas heating will be retained for full-time use.

The City will be evaluating this opportunity outside the Wastewater Master Plan, and adopt it if an agreement can be reached with the third-party vendor.

4.7.5 Recommended Improvements

The ultimate expansion strategy of the main WWTP includes modifying and expanding the existing plant to a 21.1-mgd ADWF MBR facility capable of producing Title 22 effluent for unrestricted irrigation use. The projected PWWF for the WWTP is 49.1 mgd and would require several hydraulic modifications in addition to modifications required for increased treatment capacity. General unit process modifications are presented in this section.

The existing headworks facility would be modified for both screening and fat, oil, and grease removal. An additional mechanical screen would be required for the future peak flows while maintaining one redundant unit. In addition, fine screens with openings no greater than 2 mm would be required. An alternative location for fine screening could be after primary clarification.

The secondary treatment system would be modified from a conventional activated sludge system to an MBR system in stages. The existing process train would be employed for ADWF up to 16 mgd, and those improvements would be retained for service for as long as they remain reliable. The proposed MBR improvements would be added to the system in subsequent expansion phases or at such time that either more restrictive discharge requirements mandate a change in treatment process or when the useful life of the existing process train has ended. During the period when two treatment trains are present (existing activated sludge and membranes), the effluent from each would be comingled prior to discharge; MBR effluent, which would be of better quality, could preferentially be diverted to either reuse or direct discharge, depending on the more stringent requirements for either use that are then in existence.

The existing digester complex would be expanded to provide additional stabilization volume to maintain current solids disposal practices. Because the regulatory and public perception regarding land application of biosolids is anticipated to result in changes for obtaining a Class A biosolids product, it is recommended that the City investigate other processes. For example, temperature-phased anaerobic digestion is a viable option for obtaining Class A biosolids.

The increased solids produced by future flows will require an increase in drying bed area for dewatering stabilized biosolids. To minimize the additional land required for dewatering, it is recommended that the City evaluate mechanical dewatering to augment the drying beds. This would also provide operational flexibility, as digested solids could be thickened to approximately 16 percent total solids and then applied to the drying beds to achieve an optimum dried product. During the winter months when rain is more prevalent, the mechanical dewatering system could be used with additional polymer to achieve a dewatered product greater than 20 percent total solids.

4.7.6 Biosolids Management

Wastewater treatment plants generate biosolids as part of their operation. Wastewater biosolids consist of stabilized organic material, plus some inorganic material, and can also include a large quantity of water. In Tracy, biosolids are currently dewatered in drying beds, and the water content of the dried solids is, therefore, very low (generally greater than 90 percent solids, as compared to some other dewatering operations that might result in a solids concentration of less than 20 percent); given the urbanization that has occurred in and around the plant site over the past 20-plus years, it is uncertain if solar drying (which requires more space and has a greater potential for odor release than mechanical dewatering processes) is feasible in the future. Solids disposal almost always involves the transport of the solid waste stream, and the less water that is hauled, the less energy (and total number of trips) are required. Further, solar drying on drying beds is less energy-intensive than other dewatering operations, and the use of chemicals to assist in the dewatering operation is eliminated or reduced substantially. The stabilization of the biosolids is generally accomplished by either aerobic (in the presence of oxygen) or anaerobic (in the absence of oxygen) means. Anaerobic treatment is currently used in Tracy. Aerobic systems require the input of large quantities of energy to supply the required oxygen; anaerobic systems require significantly less energy inputs (and they also produce methane as a by-product). The capital cost of anaerobic systems is higher than that for aerobic systems, but for treatment plants greater than about 5-mgd capacity, it is almost always the case that it is economical to employ anaerobic treatment, because the energy input to aerate the biosolids is not required for that operation; the use of satellite treatment plants (expected to be less than 5-mgd capacity) will add significant biosolids management costs that the community will need to fund.

Finally, some biosolids reuse plans can beneficially use the nitrogen and other organic constituents that are present in the solids stream. Some wastewater plants actively market their biosolids as a soil supplement; others dispose of their sludge in landfills (either as waste, or, if the solids content is high enough, as alternative daily cover for the landfill), and others use the sludge as a soil amendment for agricultural operations. Some years ago, the City of Tracy had a biosolids site permitted for the reuse of solids at a farming operation at the Old Jerusalem Airport; however, because of the adoption of the Delta Protection Act, this practice was eliminated. Currently, biosolids from the Tracy plant are beneficially used in Alameda County; although the transport distance to Alameda County is greater than that for the local site, this reuse opportunity still has merit from both economical and sustainability perspectives, and it is recommended that it be continued.

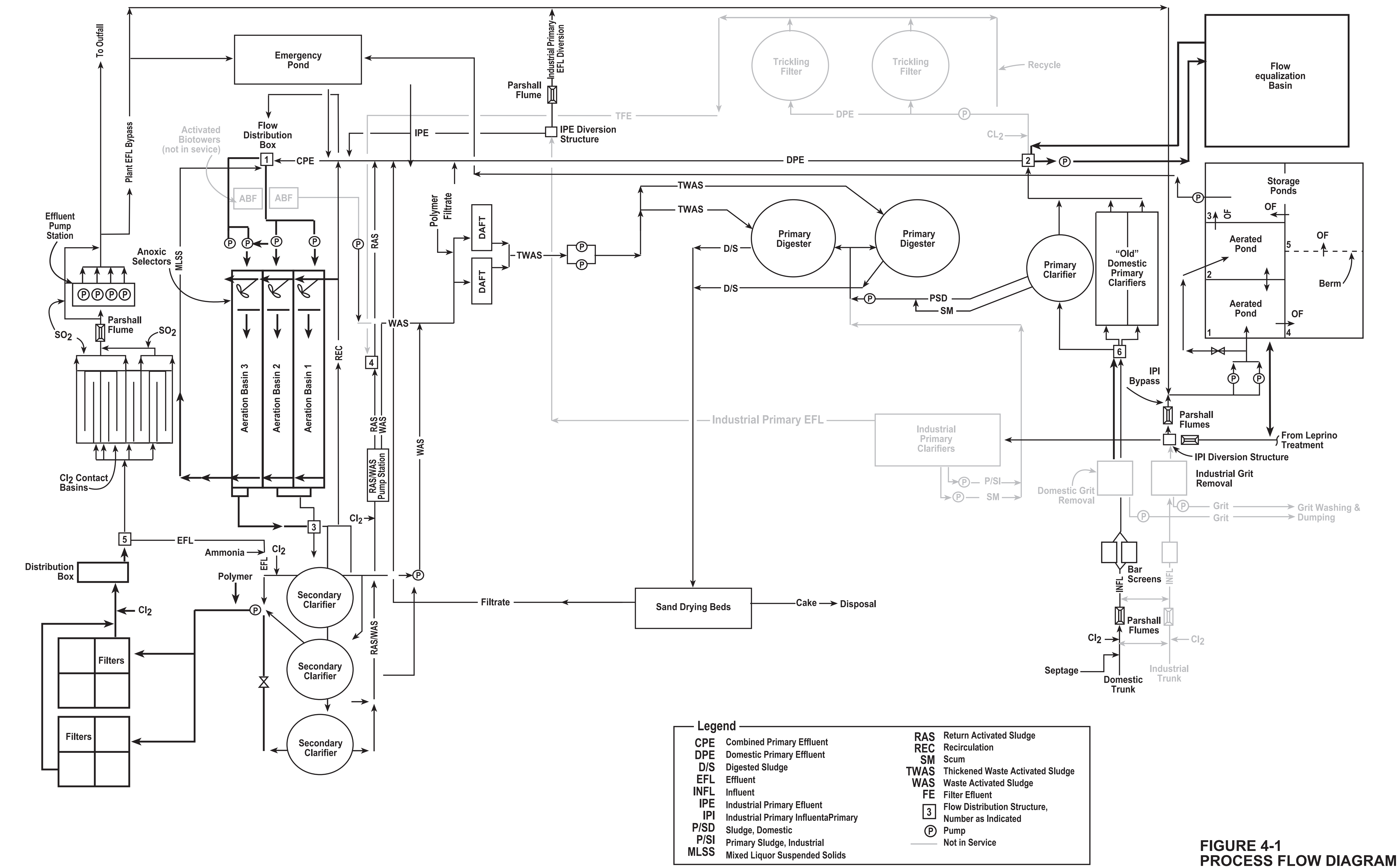

FIGURE 4-1
PROCESS FLOW DIAGRAM
TRACEY WASTEWATER TREATMENT PLANT

CH2MHILL.

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SECTION 5

Major Wastewater Conveyance Facilities

5.1 Introduction

This report describes the major wastewater conveyance facilities (18 inches in diameter or larger) that are anticipated at buildout to convey wastewater from the Future Service Areas to the Tracy Wastewater Treatment Plant (Tracy WWTP) located at 3900 Holly Drive.

A capital cost estimate is included as part of this effort. Although this evaluation was not intended to include pipes less than 18 inches in diameter, in some instances it was determined necessary to capture conveyance improvement costs below this threshold; the reason for this is to define required trunk sewer costs that might otherwise be considered offsite improvements.

For the purpose of this wastewater collection system evaluation, the Future Service Areas were subdivided into two main catchments. The catchments are spatially defined to the east and west of Tracy Boulevard.

The east catchment Future Service Areas include: Rocha, UR1 (Alvarez and others), Chrisman Road, and Eastside Industrial. The future improvements in the east catchment will serve 5,253 EDUs.

The west catchment Future Service Areas includes Tracy Hills, South Linne, UR10 (Ellis), UR9 (Keenan), Kagehiro, Westside Industrial, Cordes Ranch, Gateway (excluding Phase 1), UR5 (Bright), UR7 (Bright), UR8 (Fahmy), Berg/Byron, Catellus, Filios, I-205 Expansion, and Larch Clover. Conveyance facilities related to Gateway (Phase 1) are not considered herein and are assumed to be accounted for in the Hansen Sewer System as described in the *Tracy Gateway – Phase 1 Finance and Implementation Plan* (CH2M HILL, 2003).

The west catchment is served by the new Lammers Sewer System and improvements and upgrades to the Corral Hollow Sewer System. A total of 5,420 EDUs of new capacity will be provided by the future Corral Hollow improvements and upgrades, as described herein. The Lammers Sewer System will serve the remaining 25,128 EDUs.

5.2 Evaluation Criteria

The conceptual layout and sizing of conveyance facilities presented in this evaluation follow the guidelines and criteria prescribed in the *2008 City of Tracy Design Standards* (City of Tracy, 2008), but previously employed unit flow rates have been reduced to reflect national (and City of Tracy) trends associated with the use of water saving fixture units, as described in Section 2 of this report.

The conceptual pipe slope (new pipe) used in this evaluation was established by developing an original ground surface profile along the conceptual alignments and limiting the maximum bury depth to 15 feet above the pipe crown, where practical.

The original ground surface profile was developed from field survey data obtained in November 2011. The horizontal datum of the survey is the North American Datum of 1983 (2004.0 Epoch). The vertical datum of the survey is the North American Vertical Datum of 1988. The vertical accuracy of the survey data is 0.3 foot at the 95 percent confidence level. The field survey consisted of collecting ground surface elevations along the conceptual alignments at approximate 1,000-foot intervals and at apparent high and low points. The field survey included data collection at apparent existing structures that cross the conceptual alignments; however, in several cases, data were not obtainable because of accessibility and safety concerns, (for example, it was not possible to obtain crown and invert elevations for some water conveyance facilities or siphons under streets because of flowing water).

In the case of the improvements described herein to the Corral Hollow Sewer System, as-built drawings were used to define the pipe slope.

The required pipe diameter was calculated from available grade and City standards and increased to the next larger commercially available pipe diameter.

5.2.1 Future Service Areas Wastewater Design Flow Rate

The average dry-weather flow rates for the Future Service Areas are presented in Section 2, Existing and Future Flows and Loadings. The design flow rate used for conveyance sizing is presented in Appendix D.

For the purpose of this evaluation, nodes were established along the conceptual alignments to identify the point of wastewater contribution from Future Service Areas. The east and west catchment Future Service Area nodes are defined in Tables 5-1 and 5-2, respectively; and shown on Figure 5-1.

TABLE 5-1
East Catchment Future Service Areas – Wastewater Design Flow Rates
Tracy Wastewater Master Plan

Node	Future Service Area	Design Flow Rate @ Node (mgd)
1E	Rocha	0.40
2E	Node 1E and UR1 (Alvarez and Others)	2.07
3E	Node 2E and Chrisman Road	2.50
4E	Node 3E and Eastside Industrial[a]	3.10
5E and 5E.1	Node 4E and Eastside Industrial	4.25

[a]Includes wastewater generated from the portion of Eastside Industrial south of Interstate 205.

Note:

mgd = million gallons per day

TABLE 5-2
West Catchment Future Service Areas – Wastewater Design Flow Rates
Tracy Wastewater Master Plan

Node	Future Service Area Contributing to Node	Design Flow Rate @ Node (mgd)
1W	Tracy Hills and South Linne	5.92
2W	Node 1W and UR 10 (Ellis)	7.19
3W	Node 2W and Keenan	7.66[a]
4W	Node 3W and Kagehiro	7.83[b]
4W.1	Diversion to Corral Hollow Sewer System	3.55
4W.1	Diversion to Lammers Sewer System	4.28
4W.2	Begin Lammers Trunk Sewer	4.28
5W	Node 4W.2, Westside Industrial, and UR 8 (Fahmy)	6.38
6W	Cordes Ranch and Gateway (excluding Phase 1)	7.44
7W	Node 5W, Node 6W, UR 5 (Bright), and UR 7 (Bright)	14.50
8W	Node 7W, Bright, and Berg/Byron	15.44
9W	Node 8W, Catellus, and Filios	17.89
10W	Node 9W and I-205 Expansion	18.46
11W	Node 10W and Larch Clover	20.11

[a]Includes peak wet-weather flow (PWWF) from Infill (141 EDUs).

[b]Includes PWWF from Standard Pacific (69 EDUs).

5.2.2 Existing Wastewater Conveyance Facilities

The existing wastewater conveyance facilities pertinent to this evaluation are described below.

5.2.2.1 East Catchment

The existing MacArthur Sewer System, consisting of gravity sewer lines, force mains, and the MacArthur Pump Station, is at or near design capacity and, therefore, is not considered for the east catchment Future Service Areas absent upgrades to the MacArthur Sewer System. An assessment of the existing MacArthur Sewer System is included in the *Wastewater System Impact Fee Analysis for the NEI Phase 2 Area* (CH2M HILL, 2005).

The MacArthur Pump Station is designated as the downstream collection point for the east catchment Future Service Areas. Significant improvements to the MacArthur Pump Station will be required to accommodate flows exceeding the current buildout capacity.

5.2.2.2 West Catchment

The conveyance capacity of the Hansen Trunk Sewer and Pump Station has been fully allocated to other projects; therefore, no long-term conveyance capacity is available to the west catchment Future Service Areas absent upgrades to the Hansen Pump Station and force main. The interim conveyance capacity of the Hansen Trunk Sewer, as it relates to the west catchment Future Service Areas, will be assessed in future Tier 2 evaluations.

Similarly, portions of the Corral Hollow Sewer System, including the Larch Road Pump Station, are at or near design capacity; therefore, no conveyance capacity is available to the west catchment Future Service Areas absent upgrades to the Corral Hollow Sewer System.

The necessary upgrades to the abovementioned existing wastewater conveyance facilities to accommodate a portion of the wastewater transmitted to Node 4W.1 are considered herein. Specifically, the upgrades contemplated herein include upsizing the Corral Hollow Trunk Sewer between Node 4W.1 (near manhole 46, located at the intersection of Corral Hollow Road and Parkside Drive) and Interstate 205 (manhole 15). The Corral Hollow Trunk Sewer, downstream of the junction of Corral Hollow Road and Interstate 205 (manhole 15), is at or near design capacity under existing conditions and will not support additional flows. Furthermore, physical constraints (that is, existing infrastructure) prevent upgrades to this section of the system. For this reason, a relief sewer extending from manhole 15 to the Hansen Pump Station was constructed in the mid-2000s. The hydraulic capacity of the relief sewer is approximately 1.02 mgd, which is reserved for existing users of the Corral Hollow Sewer System.

5.2.3 Planning Area Topography

The east catchment topography generally slopes to the north-northeast. The catchment gradient north and south of 11th Street is approximately 0.3 percent and 0.6 percent, respectively.

The west catchment topography generally slopes to the northeast. The catchment gradient north and south of Byron Road is approximately 0.3 percent and 0.7 percent, respectively.

Vertical alignment constraints at the conceptual design stage are governed by topography and available grade, as well as existing infrastructure. The topography of the Future Service Areas is such that the minimum slope will be achievable along the majority of the conceptual alignments.

The west catchment Future Service Areas may require local pump stations to transmit wastewater to the new Lammers Trunk Sewer.

5.3 Major Wastewater Conveyance Facilities

5.3.1 East Catchment

Wastewater generated from the east catchment Future Service Areas will be conveyed to the Tracy WWTP via a new force main, upgrades to the MacArthur Pump Station, and new gravity sewer pipelines.

The conceptual horizontal and vertical alignments are shown on Figures 5-1 and 5-2, respectively, and summarized as follows:

- A new 14-inch-diameter force main to convey 4.25 mgd from the east catchment Future Service Areas to the Tracy WWTP. This section of pipe will extend from the Tracy WWTP to the east along the northern boundary of Interstate 205 to the MacArthur

Pump Station. Known major crossings include the Eastside Drainage Channel and the Southern Pacific Railroad (SPRR). For the purposes of estimating capital costs, it is assumed that open-cut trenching technologies would be implemented at the Eastside Drainage Channel, and trenchless technologies would be required to install the pipeline beneath the railroad.

- The MacArthur Pump Station will require significant improvements to accommodate an additional wastewater flow rate of 4.25 mgd. Preliminary calculations indicate that a 50-horsepower (hp) pump will be necessary to accommodate flows from the east catchment Future Service Areas. Expanding the existing wet well will also be necessary to control pump cycling to acceptable limits.
- A new gravity sewer line with a conveyance capacity of approximately 0.40 mgd (Node 1E) to 4.25 mgd (Node 5W.1) will be required to convey wastewater generated from the east catchment Future Service Areas to the MacArthur Pump Station. The proposed trunk sewer will extend from the MacArthur Pump Station to the east along the northern boundary of Interstate 205 to Paradise Avenue; south along Paradise Avenue; west along the northern boundary of Future Service Area Chrisman Road; south on Chrisman Road; bisect the northern end of UR 1 (Alvarez and others); and south on MacArthur Drive to its terminus near the northern boundary of Future Service Area Rocha. Trenchless technologies will be required to install the pipeline beneath Interstate 205 and the SPRR.

Table 5-3 presents the east catchment Future Service Area conveyance improvements.

TABLE 5-3
East Catchment Future Service Areas – Conveyance Improvements
Tracy Wastewater Master Plan

Pipeline Improvements (Node #E to Node #E)	Pipe Diameter (inches)	Pipe Length (linear feet)
1E to 2E (Gravity Main)	8	7,400
2E to 3E (Gravity Main)	18	7,500
3E to 4E (Gravity Main)	18	6,500
4E to 5E (Gravity Main)	21	5,000
5E to 5E.1 (Gravity Main)	27	4,900
5E.1 to Tracy WWTP (Force Main)	14	2,000

5.3.2 West Catchment

Wastewater generated from the west catchment Future Service Areas will be conveyed to the Tracy WWTP via new or upgraded force mains, pump stations, and gravity sewer pipelines. A portion of the west catchment Future Service Areas wastewater will be transmitted to the Corral Hollow Sewer System and the remainder to the proposed Lammers Sewer System. The Lammers Trunk Sewer will extend from the intersection of Naglee Road and Larch Road (location of proposed pump station, Node 11W), along Naglee Road and parallel to the Hansen Trunk Sewer, and south on Lammers Road to West Schulte Road.

5.3.2.1 Lammers Sewer System

The conceptual horizontal and vertical alignments are shown on Figures 5-1 and 5-3, respectively, and summarized as follows:

- A new 30-inch-diameter force main will be required to convey 20.11 mgd from the west catchment Future Service Areas (not including the wastewater diverted to the Corral Hollow Sewer System) to the Tracy WWTP. This section of pipe will extend from the Tracy WWTP to the west along Larch Road to its terminus at Naglee Road, where a new pump station will be located. Known major crossings include an irrigation/drainage canal located near Naglee Road. For the purposes of estimating capital costs, it is assumed that open-cut trenching technologies would be implemented at this crossing.
- A new 20.11-mgd pump station will be required to convey wastewater generated from the west catchment Future Service Areas to the Tracy WWTP. The new pump station will be located at the intersection of Naglee Road and Larch Road (Node 11W). Preliminary calculations indicate that a 330-hp pump will be necessary to accommodate flows from the west catchment Future Service Areas (not including the wastewater diverted to the Corral Hollow Sewer System).
- A new gravity sewer line, referred to as the Lammers Trunk Sewer, with a conveyance capacity of approximately 4.28 mgd (Node 4W.2) to 18.77 mgd (Node 10W, not including Future Service Area Larch Clover) will be required to convey wastewater generated from the west catchment Future Service Areas to the new pump station located at the intersection of Naglee Road and Larch Road (Node 11W). The proposed Lammers Trunk Sewer will extend from the new pump station (described above), along Naglee Road and parallel to the Hansen Trunk Sewer, south on Lammers Road to West Schulte Road. Known major crossings include the Hansen Trunk Sewer (two locations) and an irrigation canal and siphon located near Nodes 5W and 7W, respectively. For the purposes of estimating capital costs, it is assumed that open-cut trenching technologies would be implemented at the Hansen Trunk Sewer crossings, and trenchless technologies would be required to install the pipeline beneath the irrigation canal and siphon.
  - Future Service Area Larch Clover is located downstream of the gravity conveyance improvements (Lammers Trunk Sewer). It is assumed that Future Service Area Larch Clover will discharge directly to the new pump station located at the intersection of Naglee Road and Larch Road (Node 11W).
  - Conveyance improvements (that is, laterals) of less than 18 inches in diameter that will connect individual Future Service Area projects to the proposed Lammers Trunk Sewer are not included in this evaluation, unless there are no adjacent Future Service Areas that would otherwise be responsible for the installation of these laterals. In those limited cases, the smaller pipeline is included in this report in order that the associated costs might be captured.
- A new 14-inch-diameter force main will be required to convey 4.28 mgd from the new pump station (located at Node 4W.1) to the Lammers Trunk Sewer. This section of pipe will extend from the Lammers Trunk Sewer to the northeast along West Schulte Road to its terminus at Corral Hollow Road, where the new pump station will be located.

- A new 4.28-mgd pump station will be required to convey a portion of the wastewater generated upstream of Node 4W.1 to the Lammers Trunk Sewer. The new pump station will be located near the intersection of West Schulte Road and Corral Hollow Road (Node 4W.1). Preliminary calculations indicate that a 130-hp pump will be necessary.

Table 5-4 presents the west catchment Future Service Area conveyance improvements for the proposed Lammers Sewer System.

TABLE 5-4
West Catchment Future Service Areas – Lammers Sewer System Conveyance Improvements
Tracy Wastewater Master Plan

Pipeline Improvements (Node #W to Node #W)	Pipe Diameter (inches)	Pipe Length (linear feet)
4W.1 to 4W.2 (Force Main)	14	7,500
4W.2 to 5W	18	3,400
5W to 7W (Gravity Main)	21	5,800
6W to 7W (Gravity Lateral)	24	5,300
7W to 8W (Gravity Main)	30	3,400
8W to 9W (Gravity Main)	30	1,300
9W to 10W (Gravity Main)	36	2,100
10W to 11W (Gravity Main)	36	6,900
11W to Tracy WWTP (Force Main)	30	11,600

5.3.2.2 Corral Hollow Sewer System

A portion (3.55 mgd) of the wastewater transmitted to Node 4W.1 will be conveyed to the Tracy WWTP via the Corral Hollow Trunk Sewer and Hansen Pump Station and force main. The following describes the new conveyance facilities (that is, improvements) and the necessary upgrades to the Corral Hollow Trunk Sewer and Hansen Pump Station and force main to provide additional capacity.

The conceptual horizontal alignment is shown on Figure 5-1. The conceptual vertical alignment is shown on Figure 5-3 (Node 1W to 4W.1) and Figure 5-4 (Node 4W.1 to manhole 15).

Corral Hollow Trunk Sewer Improvements. A new gravity sewer line with a conveyance capacity of approximately 5.91 mgd (Node 1W) to 7.83 mgd (Node 4W.1) will be required to convey wastewater to the new pump station located near the intersection of West Schulte Road and Corral Hollow Road (Node 4W.1). This section of pipe will extend from Node 4W.1 to Future Service Area South Linne. The proposed improvements are sized to accommodate the PWWFs from Future Service Areas within the Corral Hollow Road sewer shed (including Standard Pacific and Infill properties).

As previously mentioned, a portion of PWWFs in excess of the Corral Hollow Trunk Sewer hydraulic capacity are diverted to the existing relief sewer extending from manhole 15 to the Hansen Pump Station. The existing relief sewer is a 12-inch-diameter pipe with a hydraulic capacity of approximately 1.02 mgd. The existing relief sewer will not accommodate the PWWF from the Future Service Areas; therefore, a second relief sewer (parallel to the existing relief sewer) will be necessary.

The proposed relief sewer consists of approximately 2,180 linear feet of 21-inch-diameter gravity sewer pipe and associated improvements (i.e., manholes). The proposed parallel relief sewer is sized to provide additional relief capacity of up to 3.55 mgd. The proposed parallel relief sewer is assumed to be constructed on the same grade as the existing relief sewer.

Table 5-5 presents the Corral Hollow Trunk Sewer conveyance improvements.

TABLE 5-5
West Catchment Future Service Areas – Corral Hollow Sewer System Conveyance Improvements
Tracy Wastewater Master Plan

Pipeline Improvements (Node #W to Node #W)	Pipe Diameter (inches)	Pipe Length (linear feet)
1W to 2W (Gravity Main)	18	2,100
2W to 3W (Gravity Main)	21	2,600
3W to 4W (Gravity Main)	21	2,600
4W to 4W.1 (Gravity Main)	24	3,900
Relief Sewer – Manhole 15 to Hansen Pump Station (Gravity Main)	21	2,180

Corral Hollow Trunk Sewer Upgrades. Sections of the existing Corral Hollow Trunk Sewer will be upgraded to provide new capacity to a total of 5,420 EDUs.

The PWWFs from existing users of the Corral Hollow Sewer System are currently accommodated by the existing system (that is, no surcharging). However, the introduction of additional flows to the system (i.e., 3.55 mgd) causes surcharging of the pipe between manhole 46 and manhole 15 (Figure 5-4). The upgrades presented in Table 5-6 are required to prevent surcharging the pipeline between manhole 46 and manhole 15.

TABLE 5-6
West Catchment Future Service Areas – Corral Hollow Sewer System Conveyance Upgrades
Tracy Wastewater Master Plan

Existing Pipe Diameter (inches)	Replacement Pipe Diameter (inches)	Pipe Length (linear feet)
18	21	6,900
21	27	3,240
24	30	1,490
30	36	690

As shown above, the proposed replacement pipe diameters are one to two diameter sizes larger than the pipe being replaced.

For the purposes of this master plan, it is assumed that these upgrades will be implemented using conventional open-cut construction. However, subsequent engineering evaluations should consider the possibility of implementing the required upgrades by use of pipe bursting technology. The benefits of pipe bursting generally include limiting construction disturbance, utility impacts, and right-of-way acquisition. Additionally, the existing Corral Hollow Trunk Sewer is constructed with vitrified clay pipe (VCP); VCP is well suited to pipe bursting for upgrades. All of the previously mentioned benefits would be significant factors that would favor pipe bursting over the construction of a parallel or replacement pipe. On the other hand, open-cut construction may be required if pipe bursting is found to be infeasible because of ground conditions, proximity of existing utilities and sensitive surface structures, or a variety of other factors. A final decision cannot be made until additional preliminary design is completed, which is outside the scope of this master planning activity. Costs for either option should be similar.

Hansen Pump Station and Force Main Upgrades. The Corral Hollow Sewer System currently conveys flows to the Larch Road Pump Station; however, during peak wet weather events, a portion is conveyed in the existing relief sewer to the Hansen Pump Station. The PWWFs generated from the Future Service Areas (including Standard Pacific and Infill properties) will require improvements to the Hansen Pump Station and force main to transmit additional flows to the Tracy WWTP.

The Hansen Pump Station is currently capable of pumping 3.9 mgd and is configured to allow expansion to 6.58 mgd, according to the *Capacity Analysis of the Hansen Sewer Collection System for Tracy Gateway* (Ruark, 2006). The City is proceeding with the design and construction of this expansion. The Hansen Pump Station buildout capacity (6.58 mgd) is consistent with the committed capacity of the Hansen Trunk Sewer. Furthermore, the existing force mains (12-inch-diameter and 14-inch-diameter) serving the Hansen Pump Station currently transmit flows to the Larch Road Pump Station. These force mains are capable of accommodating the Hansen Pump Station buildout capacity (6.58 mgd) (Ruark, 2006). The capacity of the expanded Hansen Pump Station and force main contemplated herein is 11.15 mgd, based on the following:

- Hansen Sewer System committed capacity is 6.58 mgd.
- Approximate PWWF transmitted from the Corral Hollow Sewer System to the Hansen Pump Station via the existing relief sewer is 1.02 mgd.
- PWWF associated with 5,420 EDUs from Future Service Areas is 3.55 mgd.

The original intent described in the Ruark report and that proposed herein is to disconnect the existing force mains (12-inch-diameter and 14-inch-diameter) from the Larch Road Pump Station and extend a single force main from the Hansen Pump Station to the Tracy WWTP. The proposed force main will extend from the WWTP to the west along Larch Road, south on Corral Hollow Road, to the Hansen Pump Station (approximately 10,500 feet). The flow velocity within the existing force mains (12-inch-diameter and 14-inch-diameter) exceeds criteria at the proposed buildout PWWF rate of 11.15 mgd. As a result, a new 24-inch-diameter force main will be necessary to limit flow velocities in the pipe to acceptable levels.

To expand the Hansen Pump Station capacity to 11.15 mgd, significant improvements to the mechanical and electrical components will be required. In addition, replacing and expanding the existing wet well will also be necessary to accommodate larger pumps and control pump cycling to acceptable limits. Preliminary calculations indicate that a 200-hp pump will be necessary to accommodate the PWWF rate of 11.15 mgd.

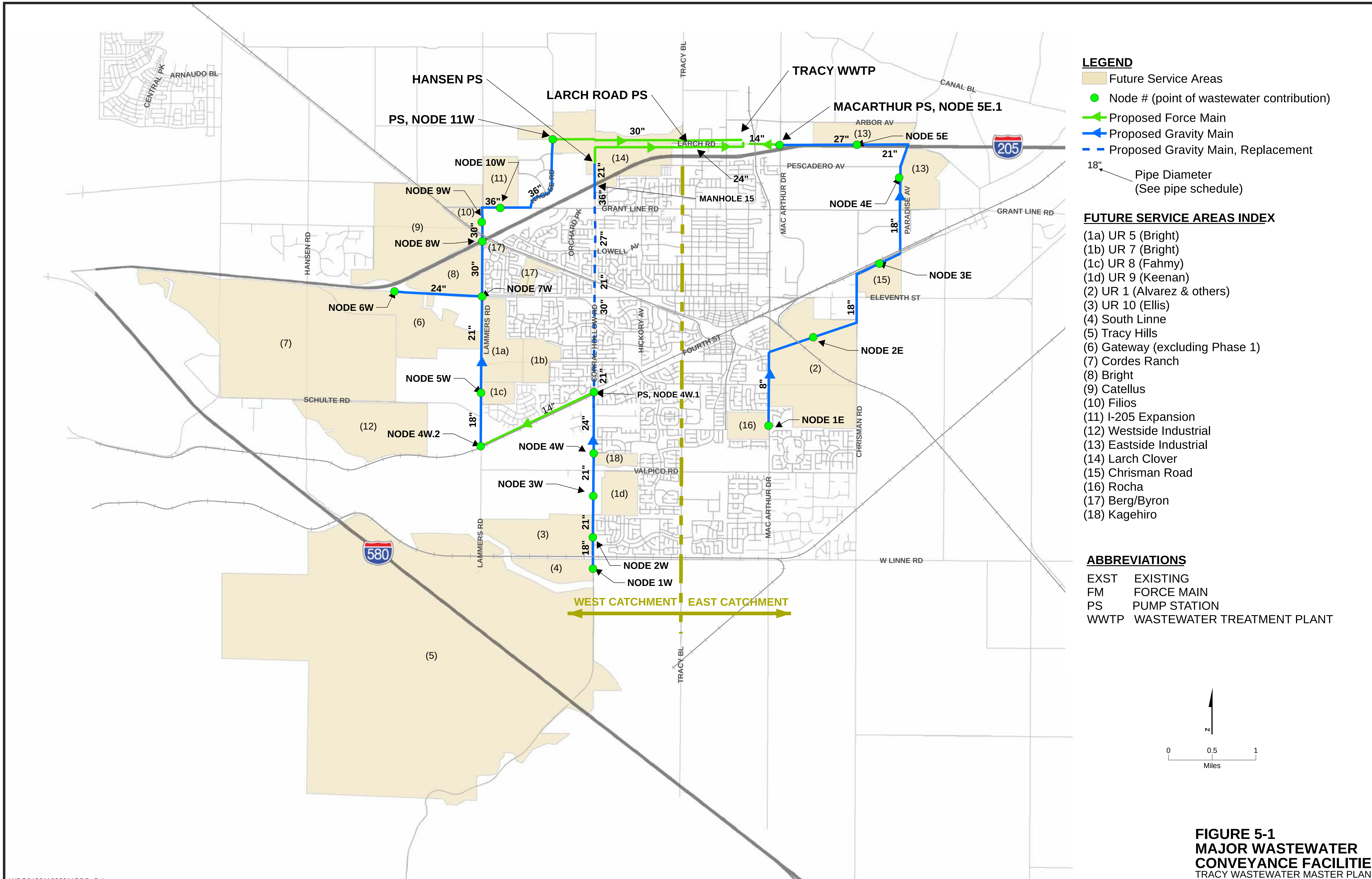

FIGURE 5-1
MAJOR WASTEWATER CONVEYANCE FACILITIES
TRACY WASTEWATER MASTER PLAN
CH2MHILL

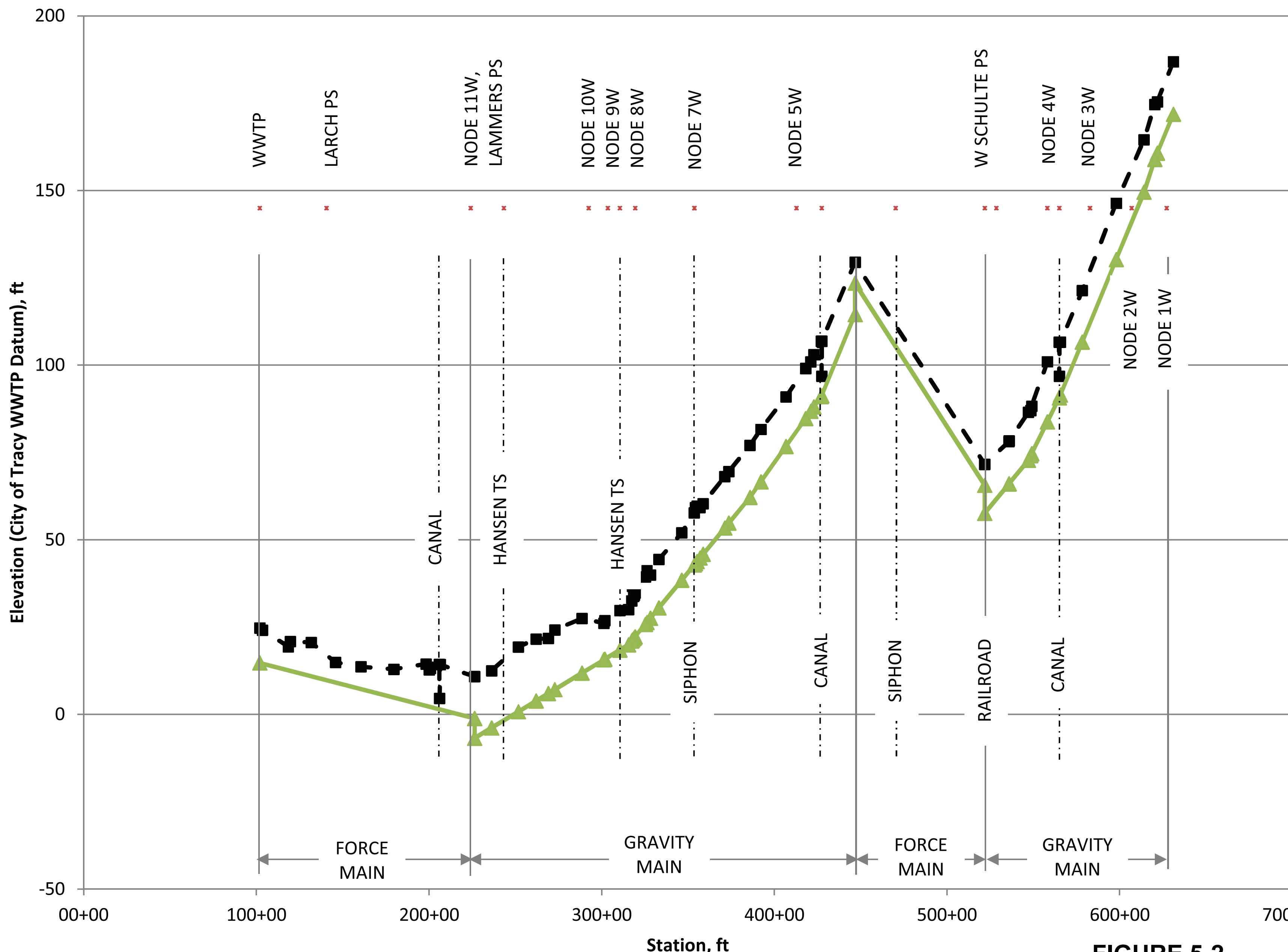

FIGURE 5-2
WEST CATCHMENT
VERTICAL ALIGNMENT
TRACY WASTEWATER MASTER PLAN

CH2MHILL®

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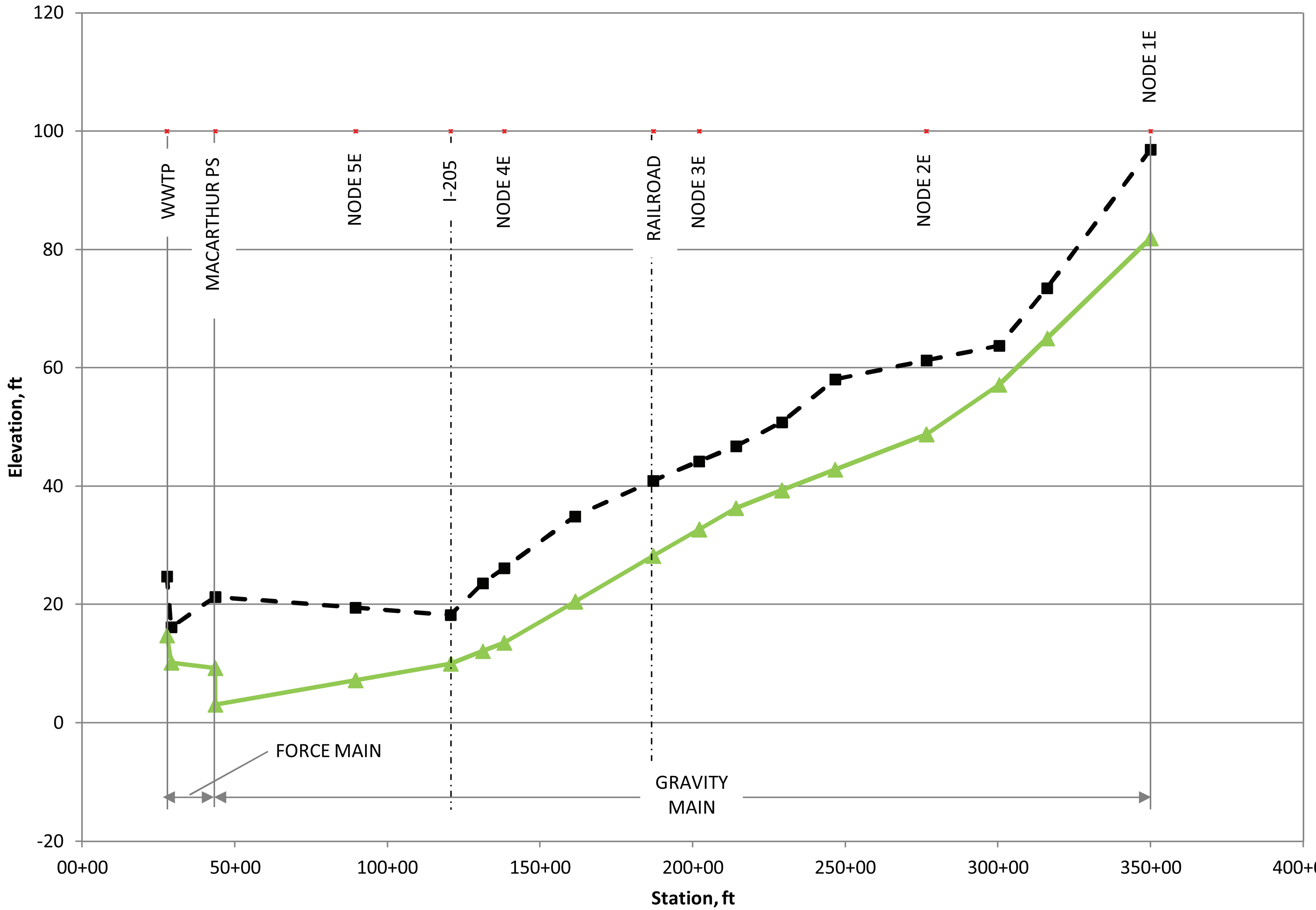

FIGURE 5-3
EAST CATCHMENT
VERTICAL ALIGNMENT
TRACY WASTEWATER MASTER PLAN
CH2MHILL®

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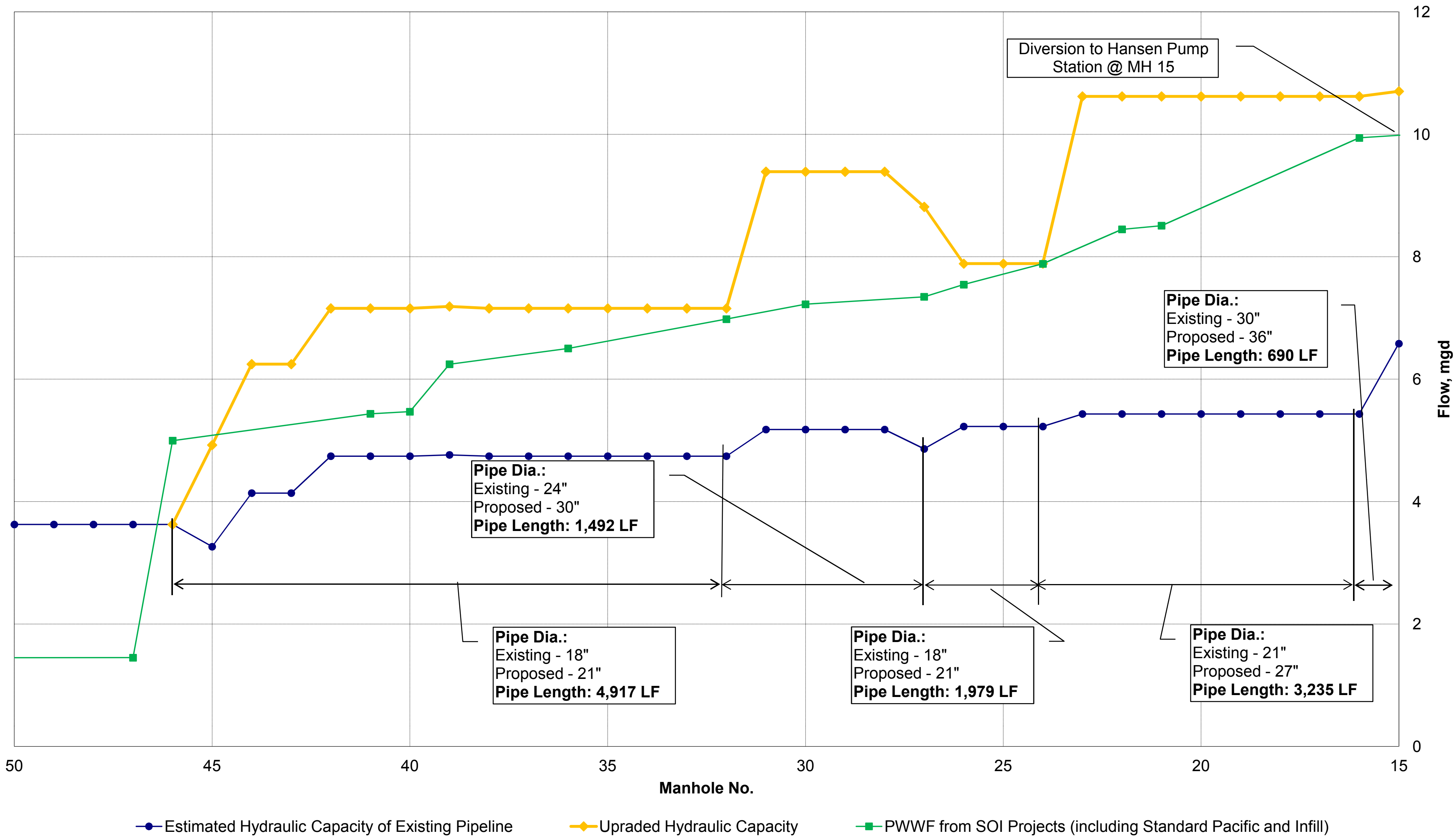

FIGURE 5-4
CORRAL HOLLOW SEWER UPGRADES
TRACY WASTEWATER MASTER PLAN
CH2MHILL

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SECTION 6

Wastewater Infrastructure Capital Cost Estimates

6.1 Wastewater Conveyance Facilities Capital Cost Estimates

Capital cost estimates were developed for the east and west catchment Future Service Areas. The cost estimates are based on March 2012 price levels. The cost estimates should be adjusted annually to account for inflation and then-current regulatory requirements. Cost information used in preparing the estimates included cost estimates for similar completed projects, vendor quotes, and cost-estimating database tools. The cost estimates are preliminary (that is, not based on completed engineering designs and site investigations).

6.1.1 Construction Cost

The construction cost (CC) includes directly related costs such as labor, material, and equipment.

6.1.2 Markups

As directed by the City of Tracy, the following add-on percentages were added to the CC to develop the total capital cost:

- Engineering Design: 10 percent of CC
- Construction Management: 10 percent of CC
- General Contingency: 15 percent of CC
- Program Administration: 5 percent of CC

6.1.3 Land Acquisition

Land acquisition is not anticipated for major wastewater conveyance facilities, because all proposed facilities are anticipated to be placed in future roadways.

6.1.4 Definition of Estimate Class

These cost estimates were prepared in accordance with the guidelines of the Association for the Advancement of Cost Engineering International. According to the definitions of Advancement of Cost Engineering International, the Class 5 Estimate is defined as follows:

> **Class 5 Estimate.** This estimate is prepared based on limited information, where little more than proposed plant type, its location, and the capacity are known, where preliminary engineering is from 0 percent to 2 percent complete. Strategic planning purposes include but are not limited to, market studies, assessment of viability, evaluation of alternate schemes, project screening, location and evaluation of resource needs and budgeting, and long-range capital planning. Examples of estimating methods used would

include cost/capacity curves and factors, scale-up factors, and parametric and modeling techniques. Typically, little time is expended in the development of this estimate. The expected accuracy ranges for this class of estimate are –20 percent to –50 percent for the low range side and +30 percent to +100 percent on the high range side.

The cost estimates shown, which do not include any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. Therefore, the final project costs will vary from the estimate presented herein. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

6.1.5 Total Capital Cost

The total capital cost for the east catchment Future Service Area projects major wastewater conveyance facilities is presented in Table 6-1. Table 6-2 summarizes total capital cost for the west catchment Future Service Area projects major wastewater conveyance facilities.

6.2 Wastewater Treatment Facilities Capital Cost Estimate

Table 6-3 shows the estimated costs to expand and upgrade the existing Tracy WWTP to 21.1 mgd under the one-plant option. Expansion would occur over five phases as dictated by growth-driven flow increases.

In the event that actual treatment plant loadings vary from those projected in this Master Plan (due to conservation or changes in land use densities, or other future change), the build out capacity of the plant can be adjusted to reflect those future changes. It is recommended that an evaluation of then-current flow and loading conditions be completed at each phase of future construction; if those future flows and loadings differ from those projected in this report, the necessary plant capacity should be adjusted to reflect the actual loading conditions encountered prior to construction of any phase of the treatment plant. While the required capital funding will be changed as a result of any such adjustments, the overall cost per equivalent dwelling unit is expected to remain almost identical to that estimated in this report if the changes are due to modifications in the number of EDUs, since the costs for construction are essentially proportional to the loading rate at this size of facility. If the changes are due to conservation, where each equivalent dwelling unit discharges a lesser flow or load, then the inflation-adjusted connection fees can be reduced at that future date. Updates to the Finance Plan for wastewater services are recommended as a complement to the updates to this Master Plan which will be done at each phase of construction.

TABLE 6-1
Major Wastewater Conveyance Facilities Capital Cost Estimate – East Catchment
Tracy Wastewater Master Plan

Node #E to #E	Diameter (inches)	Estimated Qty	Unit Price ($)	Total Amount ($)
1E to 2E	8	7,400 LF	131	967,180
Trenchless Crossing	8	100 LF	897	89,676
Manholes	#NA	17 EA	8,147	138,498
Miscellaneous Work	#NA	1 LS	102,142	102,142
Traffic Control	#NA	1 LS	42,727	42,727
2E to 3E	18	7,500 LF	213	1,598,625
Manholes	#NA	17 EA	8,147	138,498
Miscellaneous Work	#NA	1 LS	103,523	103,523
Traffic Control	#NA	1 LS	43,304	43,304
3E to 4E	18	6,500 LF	213	1,385,475
Trenchless Crossing	18	100 LF	1,267	126,713
Manholes	#NA	15 EA	8,147	122,204
Miscellaneous Work	#NA	1 LS	89,720	89,720
Traffic Control	#NA	1 LS	37,530	37,530
4E to 5E	21	5,000 LF	236	1,179,417
Trenchless Crossing	21	200 LF	1,052	210,435
Manholes	#NA	11 EA	8,147	89,616
Miscellaneous Work	#NA	1 LS	69,015	69,015
Traffic Control	#NA	1 LS	28,869	28,869
5E to 5E.1	27	4,900 LF	321	1,570,777
Manholes	#NA	10 EA	8,147	81,470
Miscellaneous Work	#NA	1 LS	67,635	67,635
Traffic Control	#NA	1 LS	28,292	28,292
5E.1 to WWTP	14	2,000 LF	171	342,533
Trenchless Crossing	14	100 LF	1,044	104,406
Open Cut Crossing	14	1 EA	20,125	20,125
Miscellaneous Work	#NA	1 LS	27,606	27,606
Traffic Control	#NA	1 LS	11,548	11,548
MacArthur PS Upgrades	#NA	1 LS	203,071	203,071
Construction Cost				**9,021,000**
General Contingency - 15%				1,354,000
Engineering Design - 10%				903,000
Construction Management - 10%				903,000
Program Administration - 5%				452,000
Total Markups				**3,612,000**
Total Capital Cost				**12,633,000**

Notes:

1. Ancillary costs such as excavation support systems, dewatering and surface restoration are included in the costs noted above.
2. The costs noted above are current as of the date indicated in Section 6 of this report. Adjustments for phasing and inflation will need to be considered for use of these costs in the future.

TABLE 6-2
Major Wastewater Conveyance Facilities Capital Cost Estimate – West Catchment
Tracy Wastewater Master Plan

Node #E to #E	Diameter (inches)	Estimated Qty	Unit Price ($)	Total Amount ($)
1W to 2W	18	2,100 LF	213	447,650
Manholes	#NA	5 EA	8,144	40,722
Miscellaneous Work	#NA	1 LS	31,626	31,626
Traffic Control	#NA	1 LS	23,321	23,321
2W to 3W	21	2,600 LF	234	607,880
Manholes	#NA	7 EA	8,144	57,011
Miscellaneous Work	#NA	1 LS	39,156	39,156
Traffic Control	#NA	1 LS	28,873	28,873
3W to 4W	21	2,600 LF	234	607,880
Trenchless Crossing	21	100 LF	1,276	127,604
Manholes	#NA	8 EA	8,144	65,155
Miscellaneous Work	#NA	1 LS	39,156	39,156
Traffic Control	#NA	1 LS	28,873	28,873
4W to 4W.1	24	3,900 LF	271	1,058,005
Manholes	#NA	10 EA	8,144	81,444
Miscellaneous Work	#NA	1 LS	58,734	58,734
Traffic Control	#NA	1 LS	43,310	43,310
4W.1 to MH 15	21	6,900 LF	236	1,626,733
(See description above)	30	1,490 LF	360	536,028
(See description above)	27	3,240 LF	321	1,038,582
(See description above)	36	690 LF	476	328,664
Manholes	#NA	27 EA	8,274	223,387
Miscellaneous Work	#NA	1 LS	229,733	229,733
Traffic Control	#NA	1 LS	170,032	170,032
Relief Sewer (MH 15 to Hansen PS)	21	2,180 LF	263	573,304
Manholes	#NA	10 EA	8,274	82,736
Miscellaneous Work	#NA	1 LS	40,651	40,651
Traffic Control	#NA	1 LS	30,087	30,087
Hansen Pump Station to WWTP	24	10,500 LF	296	3,108,613
Hansen Pump Station	#NA	1 LS	1,232,526	1,232,526
Miscellaneous Work	#NA	1 LS	433,006	433,006
Traffic Control	#NA	1 LS	193,192	193,192
4W.1 to 4W.2	14	7,500 LF	189	1,416,063
Trenchless Crossing	14	100 LF	1,046	104,623
Miscellaneous Work	#NA	1 LS	118,973	118,973
Traffic Control	#NA	1 LS	70,358	70,358
4W.2 to 5W	18	3,400 LF	214	726,297
Trenchless Crossing	18	100 LF	1,274	127,412
Manholes	#NA	7 EA	8,164	57,146
Miscellaneous Work	#NA	1 LS	53,934	53,934
Traffic Control	#NA	1 LS	31,896	31,896
5W to 7W	21	5,800 LF	234	1,359,037
Manholes	#NA	12 EA	8,164	97,965
Miscellaneous Work	#NA	1 LS	92,005	92,005

TABLE 6-2
Major Wastewater Conveyance Facilities Capital Cost Estimate – West Catchment
Tracy Wastewater Master Plan

Node #E to #E	Diameter (inches)	Estimated Qty	Unit Price ($)	Total Amount ($)
Traffic Control	#NA	1 LS	54,410	54,410
6W to 7W	24	5,300 LF	271	1,437,802
Manholes	#NA	11 EA	8,164	89,801
Miscellaneous Work	#NA	1 LS	84,074	84,074
Traffic Control	#NA	1 LS	49,720	49,720
7W to 8W	30	3,400 LF	456	1,549,323
Trenchless Crossing	30	100 LF	1,569	156,850
Manholes	#NA	7 EA	8,164	57,146
Miscellaneous Work	#NA	1 LS	53,934	53,934
Traffic Control	#NA	1 LS	31,896	31,896
8W to 9W	30	1,300 LF	456	592,388
Trenchless Crossing	30	200 LF	1,358	271,587
Manholes	#NA	3 EA	8,164	24,491
Miscellaneous Work	#NA	1 LS	20,622	20,622
Traffic Control	#NA	1 LS	12,195	12,195
9W to 10W	36	2,100 LF	606	1,272,215
Manholes	#NA	5 EA	8,164	40,819
Miscellaneous Work	#NA	1 LS	33,312	33,312
Traffic Control	#NA	1 LS	19,700	19,700
10W to 11W	36	6,900 LF	606	4,180,135
Manholes	#NA	15 EA	8,164	122,456
Miscellaneous Work	#NA	1 LS	109,455	109,455
Traffic Control	#NA	1 LS	64,729	64,729
11W to WWTP	30	11,600 LF	442	5,127,683
Trenchless Crossing	30	100 LF	1,655	165,486
Miscellaneous Work	#NA	1 LS	184,011	184,011
Traffic Control	#NA	1 LS	108,820	108,820
W. Schulte Rd Pump Station	#NA	1 LS	514,249	514,249
Lammers Pump Station	#NA	1 LS	1,217,868	1,217,868
Construction Cost				**35,137,000**
General Contingency - 15%				5,271,000
Engineering Design - 10%				3,514,000
Construction Management - 10%				3,514,000
Program Administration - 5%				1,757,000
Total Markups				**14,056,000**
Total Capital Cost				**49,193,000**

Notes:

1. Ancillary costs such as excavation support systems, dewatering and surface restoration are included in the costs noted above.

2. The costs noted above are current as of the date indicated in Section 6 of this report. Adjustments for phasing and inflation will need to be considered for use of these costs in the future.

TABLE 6-3
Cost Estimate to Expand and Upgrade the City of Tracy WWTP Capacity to 21.1 mgd
Tracy Wastewater Master Plan

Process Improvement	Estimated Cost ($ millions)	Phase 2 ($ millions)	Phase 3 ($ millions)	Phase 4 ($ millions)	Phase 5 ($ millions)
		12.0 mgd	**13.5 mgd**	**16.0 mgd**	**21.1 mgd**
Primary Treatment					
Upgrade electrical for pumps	5.1	2.47			2.66
Expand headworks, including screening and grit removal	7.5				7.50
Domestic clarifiers (two)	9.8		4.93		4.85
Advanced Secondary Treatment					
4th/5th aeration basin	10.4		5.55		4.83
Upgrade plant aeration system	13.3		2.47	5.55	5.33
Secondary clarifiers (two)	11.5		6.40		5.12
Expand PLCs and SCADA controls	3.7	1.23		1.23	1.22
Upgrade RAS/WAS pump station	2.4		1.23		1.22
Main electrical switchboard upgrade	2.3	1.23			1.09
Tertiary Treatment and Disinfection					
Three additional chlorine contact tanks	16.5	3.70		4.93	7.91
Upgrade filtration system	12.2		1.85	4.32	6.02
Solids Handling					
Upgrade DAFT to GBT	7.1	3.08		1.85	2.17
Pave drying beds	4.2	0.99	0.62	0.62	1.97
Digester cover and gas collection system upgrade	1.8	1.85			
Additional boiler for heating	3.3	0.62	1.23		1.48
Upgrade RAS/WAS system	4.5	1.23	1.48		1.78
New digester	11.5			5.55	5.96
New digester control building	5.1			3.08	1.97
Miscellaneous Plant Improvements					
Civil site work	3.6	0.86	0.49	0.62	1.58
Groundcover/landscaping	1.7	0.74	0.25	0.25	0.49
Emergency storage pond regrading	1.7	0.25		0.12	1.28
Expand admin building	2.4	1.23			1.20

TABLE 6-3
Cost Estimate to Expand and Upgrade the City of Tracy WWTP Capacity to 21.1 mgd
Tracy Wastewater Master Plan

Process Improvement	Estimated Cost ($ millions)	Phase 2 ($ millions)	Phase 3 ($ millions)	Phase 4 ($ millions)	Phase 5 ($ millions)
		12.0 mgd	**13.5 mgd**	**16.0 mgd**	**21.1 mgd**
Site security	1.1	0.37	0.12	0.25	0.39
Demo existing old facilities	0.8	0.25	0.25		0.30
Emergency power	4.7	0.62		1.85	2.19
Convert 53-acre pond to emergency storage with diesel pump option	0.7	0.74			
Distribution boxes/structures/yard piping	8.7	1.85	2.47	0.62	3.75
Effluent Pumping and Conveyance					
Post-aeration facility	5.7		3.70		2.00
Parallel line to Old River	14.0	14.00			
Effluent Pumping Plant	2.2	1.20			0.96
New junction structure and outfall within Old River	10.0	10.00			
Thermal Plan Compliance					
Temperature monitoring study and modeling	1.1	1.11			
Effluent cooling facilities	8.4		6.17	1.23	0.99
Estimated Construction Cost (March 2012)	**199.1**	**49.6**	**39.2**	**32.1**	**78.2**
General Contingency - 15%	29.9	7.4	5.9	4.8	11.7
Engineering Design - 10%	19.9	5.0	3.9	3.2	7.8
Construction Management - 10%	19.9	5.0	3.9	3.2	7.8
Program Administration - 5%	10.0	2.5	2.0	1.6	3.9
Total Estimated Program Cost (M$)	**278.7**	**69.5**	**54.9**	**44.9**	**109.5**

SECTION 7

References

Asano et al. 2006. Water *Reuse: Issues, Technologies, and Applications.* New York: McGraw Hill.

CH2M HILL. 2010. *City of Tracy Wastewater Master Plan/Corral Hollow Sewer Analysis*.

CH2M HILL. 2005. *Wastewater System Impact Fee Analysis for the NEI Phase 2 Area*.

City of Tracy. 2008. Engineering Design & Construction Standards. December.

Nolte Associates, Inc. 2000. *Tracy Hills Wastewater Collection System Master Plan*.

Ruark. 2006. *Capacity Analysis of the Hansen Sewer Collection System for Tracy Gateway*. December.

State of California Department of Finance. 2009. *E-5 Population and Housing Estimates for Cities, Counties and the State, 2001-2009, with 2000 Benchmark.* Sacramento, California. May.

Appendix A
Flow and Loading Detail Information

TABLE A-1

Flow and Loading Detail for Development Projects with Approved Wastewater Capacity

	Residential				Industrial				Office				Retail				Total ADWF (gpd)		
Specific Plan or General Plan Common Name	**Units Remaining**	**ADWF (gpd)**	**BOD (lbs/day)**	**TSS (lbs/day)**	**Acres Remaining**	**ADWF (gpd)**	**BOD (lbs/day)**	**TSS (lbs/day)**	**Acres Remaining**	**ADWF (gpd)**	**BOD (lbs/day)**	**TSS (lbs/day)**	**Acres remaining**	**ADWF (gpd)**	**BOD (lbs/day)**	**TSS (lbs/day)**	**Total ADWF (gpd)**	**Total BOD (lbs/day)**	**Total TSS (lbs/day)**
Residential Specific Plan					13	13,728	31	36	10	11,400	12	14	5	5,700	17	19	30,828	60	69
Industrial Specific Plan – North					30	31,680	72	84									31,680	72	84
Industrial Specific Plan – South (Low Density)	584	154,176	347	405	136	143,616	326	381	29	33,060	35	41					330,852	708	826
I-205 Specific Plan					95	100,320	228	266					64	72,960	211	243	173,280	439	509
Plan "C" Residential Planning Area (Low Density)	113	29,832	67	78									10	11,400	33	38	41,232	100	116
Northeast Industrial – Phase 1					92	97,152	221	258									97,152	221	258
Northeast Industrial – Phase 2					29	30,624	70	81									30,624	70	81
Northeast Industrial – Phase 3					347	366,432	833	972									366,432	833	972
South MacArthur (Low Density)	122	32,208	72	85													32,208	72	85
Downtown Specific Plan (Low Density)	120	31,680	71	83					3	3,420	4	4	3	3,420	10	11	38,520	85	99
Downtown Specific Plan (High Density)	1,167	205,392	462	539													205,392	462	539
In-fill Properties (Low Density)	1,207	318,648	717	836	75	79,200	180	210	11	12,540	13	15	48	54,720	158	182	465,108	1,069	1,244
Ellis Project (Low Density)	505	133,320	300	350													133,320	300	350
Ellis Project (Medium Density)	1705	368,280	829	967													368,280	829	967
Ellis Project (High Density)	40	7,040	16	18													7,040	16	18
Ellis Project – Village Commercial													26	30,199	87	101	30,199	87	101
Ellis Project – Swim Center													17	19,536	57	65	19,536	57	65
Gateway – Phase 1									85	96,900	102	119	55	62,700	182	209	159,600	284	328
Standard Pacific	69	18,216	41	48													18,216	41	48
Total	**5,632**	**1,298,792**	**2,922**	**3,409**	**817**	**862,752**	**1,961**	**2,288**	**138**	**157,320**	**166**	**193**	**229**	**260,635**	**754**	**869**	**2,579,499**	**5,803**	**6,759**

TABLE A-2

Flow and Loading Detail for Future Service Areas (Residential)

Specific Plan or General Plan Common Name	Very Low Density (1.5 DU per acre)					Low Density (4.35 DU per acre)					Medium Density (9 DU per acre)					High Density (18.75 DU per acre)				
	No. of Units	Area (acres)	ADWF (gpd)	BOD (lbs/day)	TSS (lbs/day)	No. of Units	Area (acres)	ADWF (gpd)	BOD (lbs/day)	TSS (lbs/day)	No. of Units	Area (acres)	ADWF (gpd)	BOD (lbs/day)	TSS (lbs/day)	No. of Units	Area (acres)	ADWF (gpd)	BOD (lbs/day)	TSS (lbs/day)
Westside Residential (URs 5, 7, 8, 9)																				
UR5 (Bright)						174	40	45,936	103	121	360	40	77,760	175	204	375	20	66,000	149	173
UR7 (Bright)						174	40	45,936	103	121	432	48	93,312	210	245					
UR8 (Fahmy)						96	22	25,265	57	66	252	28	54,432	122	143	188	10	33,000	74	87
UR 9 (Keenan)						305	70	80,388	181	211	387	43	83,592	188	219	319	17	56,100	126	147
UR1 (Alvarez + others)	570	380	150,480	339	395	1,305	300	344,520	775	904	585	65	126,360	284	332	469	25	82,500	186	217
UR11 (South Linne)																				
Tracy Hills	83	82	21,912	49	58	1,591	539	420,024	945	1,103	3,286	557	709,776	1,597	1,863	531	35	93,456	210	245
Gateway (excluding Phase 1)																				
UR6 (Cordes Ranch)																				
UR4 (Bright Triangle)																750	40	132,000	297	347
UR3 (Catellus)	60	40	15,840	36	42															
UR2 (Filios)																				
I-205 Expansion																				
West Side Industrial																				
East Side Industrial																				
Larch Clover																				
Chrisman Road																				
Rocha						296	68	78,091	176	205						431	23	75,900	171	199
Berg/Byron											450	50	97,200	219	255					
Kagehiro						250	47	66,000	149	173										
Total	**713**	**502**	**188,232**	**424**	**494**	**4,190**	**1,126**	**1,106,160**	**2,489**	**2,904**	**5,752**	**831**	**1,242,432**	**2,795**	**3,261**	**3,062**	**170**	**538,956**	**1,213**	**1,415**

TABLE A-3
Flow and Loading Detail for Future Service Areas (Non-residential)

Specific Plan or General Plan Common Name	Industrial Areas				Office Areas				Retail Areas				Total (Residential + Non-residential) SOI Contribution		
	Area (acres)	ADWF (gpd)	BOD (lbs/day)	TSS (lbs/day)	Area (acres)	ADWF (gpd)	BOD (lbs/day)	TSS (lbs/day)	Area (acres)	ADWF (gpd)	BOD (lbs/day)	TSS (lbs/day)	Total ADWF (gpd)	Total BOD (lbs/day)	Total TSS (lbs/day)
Westside Residential (URs 5, 7, 8, 9)															
UR5 (Bright)									10	11,400	33	38	201,096	460	536
UR7 (Bright)													139,248	313	366
UR8 (Fahmy)													112,697	254	296
UR9 (Keenan)													220,080	495	578
UR1 (Alvarez + others)									10	11,400	33	38	715,260	1,617	1,886
UR11 (South Linne)	120	126,720	288	336									126,720	288	336
Tracy Hills	451	475,821	1,081	1,262					242	276,282	800	921	1,997,272	4,683	5,451
Gateway (excluding Phase 1)					351	400,140	421	491	59	67,260	195	224	467,400	616	716
UR6 (Cordes Ranch)	1,407	1,486,214	3,378	3,941	150	171,000	180	210	54	61,446	178	205	1,718,660	3,736	4,356
UR4 (Bright Triangle)					50	57,000	60	70	95	108,300	314	361	297,300	671	778
UR3 (Catellus)	535	564,960	1,284	1,498	40	45,600	48	56	45	51,300	149	171	677,700	1,516	1,767
UR2 (Filios)					7	7,980	8	10	36	41,040	119	137	49,020	127	147
I-205 Expansion									172	196,080	568	654	196,080	568	654
West Side Industrial	485	512,160	1,164	1,358									512,160	1,164	1,358
East Side Industrial	368	388,608	883	1,030									388,608	883	1,030
Larch Clover									498	567,720	1,643	1,892	567,720	1,643	1,892
Chrisman Road					100	114,000	120	140	13	14,820	43	49	128,820	163	189
Rocha													153,991	346	404
Berg/Byron									4	4,560	13	15	101,760	232	270
Kagehiro													66,000	149	173
Total	**3,366**	**3,554,484**	**8,078**	**9,425**	**698**	**795,720**	**838**	**977**	**1,238**	**1,411,608**	**4,086**	**4,705**	**8,837,592**	**19,923**	**23,181**

Appendix B
Summary of Existing Wastewater Regulations

APPENDIX B

Summary of Existing Wastewater Regulations

California Toxics Rule and State Implementation Plan

The U.S. Environmental Protection Agency (EPA) promulgated the California Toxics Rule (CTR) in May 2000. The CTR, which is outlined in 40 Code of Federal Regulations (CFR) Section 131.38, establishes numeric criteria for priority toxic pollutants in California. The CTR and National Toxics Rule (NTR) criteria and water quality objectives for priority pollutants in state-adopted water quality control plans, together with designated beneficial uses in those plans, serve as priority pollutant standards for the state. Concurrently with CTR adoption, the State Water Resources Control Board (SWRCB) adopted a Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (State Implementation Plan [SIP]). The SIP establishes procedures for selecting priority pollutants requiring water quality-based effluent limitations (SIP Section 1.3) and for calculating the limits (SIP Section 1.4). Water quality monitoring and high-quality laboratory data with the reporting limits required in the SIP are required for all priority pollutants.

An overview of the major constituents of concern and descriptions of the sources and problems associated with these constituents are provided in Table B-1 (tables are located at the end of this appendix). Table B-2 lists the priority pollutants that are generally monitored in large publicly owned treatment works effluent. In addition to the original priority pollutants of EPA, this list contains chemical constituents that have been included on a draft Candidate Contaminant List (CCL). The draft CCL was published in the *Federal Register* Volume 69, Number 64, issued on April 2, 2004, and contains 42 chemical and 9 microbiological contaminant candidates (see constituents in Footnote "b" of Table B-2). The aim of the CCL is to draw attention to specific contaminants that need to be monitored in water resources and drinking water to determine their effect on public health and safety.

Thermal Plan

Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California, commonly known as the *Thermal Plan,* sets limits on the discharge of elevated temperature wastes into coastal, estuarine, and interstate waters of California. The plan distinguishes between "cold" and "warm" interstate waters. Permits issued in California for a particular discharger may be less stringent than those required by applicable standards and limitations, if the discharger demonstrates to the satisfaction of the permitting authority that such effluent limitations are more stringent than necessary to ensure the protection and propagation of a balanced indigenous community of shellfish, fish, and wildlife in and on the body of water into which the discharge is made.

Total Residual Chlorine and Chlorine-produced Oxidants Policy of California

The SWRCB is proposing to adopt EPA-recommended total residual chlorine (TRC) and chlorine-produced oxidants (CPO) criteria to protect aquatic life in fresh water and saltwater (Table B-3) (CalEPA, 2006).

Chlorine in fresh water is found as free chlorine or combined chlorine. Both are toxic to aquatic organisms; thus, TRC refers to the sum of free chlorine and combined chlorine in fresh water. Saltwater contains bromide, and the addition of chlorine will also produce hypobromous acid (HOBr), hypobromous ion (OBr-), and bromamines. CPO refers to the sum of these oxidative products in saltwater. The formation of these oxidants directly depends on the amount of chlorine available to react in saltwater. Both TRC and CPO refer to the sum of free and combined chlorine and bromine in water measured using analytical methods for determining total residual chlorine. These criteria would only be applicable to inland surface waters, enclosed bays, and estuaries classified as fresh water, saltwater, or estuarine.

The proposed policy requires continuous monitoring at all facilities except where the Water Board has determined that such monitoring does not appropriately characterize the discharge. The SWRCB defines continuous monitoring as one or more data points every minute. It was recommended that these criteria be applied at the end of pipe when dilution is not allowed for a specific constituent. This policy does not incorporate dilution into effluent limits for TRC and CPO because of the acute toxicity of chlorine to aquatic organisms.

Water Reuse Regulations

The policies that encourage water reuse in California serve as guidelines developed in response to water scarcity and population growth facing California. Water reuse has emerged as an important method to enable California to continue to grow while meeting local, state, and federal demands regarding water supply planning. Because of the importance of recycled water as a supply source, the state has instituted a number of policies to encourage the use of recycled water as a means to conserve fresh waters. One of these policies is the *Reasonable Use Doctrine*, which prohibits the waste of water and encourages the use of recycled water where possible for greenbelt irrigation.

Public health regulations address the use of recycled water in California. Title 22 of the California Health and Safety Code of Regulations establishes the criteria for water quality standards and treatment reliability related to use of recycled water. These criteria were developed and are regulated by the California Department of Public Health to ensure that the public health is protected.

Summary of Existing Biosolids Regulations

EPA 503 Rule defines the "biosolids stability" and quality requirements to ensure that public health is protected. In general, the volatile solids content of the biosolids must be reduced by a minimum of 38 percent. If it is not possible to achieve a 38 percent reduction through digestion processes, the following options are available to TWWTP:

- **Additional Digestion of Anaerobically Digested Biosolids:** When the 38 percent volatile solids reduction requirement in (b)(1) cannot be met for anaerobically digested biosolids, vector attraction reduction can be demonstrated by digesting a portion of the previously digested biosolids anaerobically in the laboratory in a bench-scale unit for 40 additional days at a temperature between 30 and 37 degrees Celsius. If the volatile solids in the biosolids are reduced by less the 17 percent from the beginning to the end of the period, vector attraction reduction is achieved.
- **Addition of Alkaline Material:** The pH of biosolids must be raised to 12 or higher by alkali addition and, without the addition of more alkali, shall remain at 12 or higher for 2 hours and then 11.5 or higher for an additional 22 hours.

"Class A Biosolids" Pathogen Requirements state that the density of the fecal coliforms must be less than 1,000 MPN per gram total solids (dry weight basis) or the density of the *Salmonella* must be less than 3 MPN per 4 grams of total solids (dry weight basis).

Alternatives to achieve these pathogen requirements include the following:

- Thermally treated biosolids
- Biosolids treated using high-pH, high temperature process
- Biosolids treated by other processes: Once shown to be present prior to treatment, the density of enteric virus in the biosolids must be less than 1 plaque-forming unit per 4 grams, and helminth ova must be less than 0.25 grams after treatment
- Biosolids treated by an unknown process: The biosolids must be analyzed for *Salmonella* or fecal coliforms, enteric viruses, and helminth ova at the time biosolids are used or disposed
- Biosolids treated in a Process to Further Reduce Pathogens (PFRP): They are treated by any process determined to be equivalent to a PFRP by the permitting authority; the EPA's Pathogen Equivalency Committee (PEC) is available as a resource to provide recommendations on equivalency determinations

Alternatives for meeting "Class B Biosolids" pathogen requirements include the following:

- Monitoring for indicator organisms (fecal coliform): Geometric mean of seven samples shall be less than 2 million per gram
- Processes to significantly reduce pathogens

"Exceptional Quality" biosolids have lower metals concentration requirements than either Class A or Class B biosolids and have the same pathogen levels as Class A biosolids.

In addition to the pathogen reduction requirements, the biosolids must meet the quality requirements appropriate to the local soil characteristics as well as the groundwater quality (nutrients, sodium, potassium, organic contaminants, metals) for land application.

Appendix C
Evaluation of Irrigated Agriculture

Evaluation of Irrigated Agriculture as a Reuse Option for City of Tracy Recycled Water

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Jim Jordahl/CH2M HILL

DATE: April 14, 2010 (updated October 31, 2012)

PROJECT NUMBER: 179201.MP.01

Introduction

When appropriately treated, recycled water from wastewater treatment processes can contribute to the overall water supply for the City of Tracy and surrounding areas for urban, agricultural, and industrial uses. The purpose of this technical memorandum is to quantify reuse needs and evaluate opportunities associated with irrigated agriculture reuse in proximity to the City of Tracy.

General Economic Considerations

Many studies associated with wastewater disposal options in the Central Valley of California indicate that agricultural reuse is generally more costly than direct discharge to a stream or river system. This is usually because of the increased infrastructure required for a reuse system. The treatment requirement for surface water discharges is similar to that for discharges to land. However, the costs associated with constructing the surface water outfalls are usually less than the costs of installing water supply piping necessary for agricultural reuse, because the reuse areas for irrigation may have wide geographic distribution, but surface water discharges typically occur at a single point. Additionally, storage ponds are often required to accommodate excess water that is produced during the rainy season when stormwater intrusion occurs into the sewer collection system, and the greater volume of recycled water produced generally coincides with periods of lower water demand by plants. Reuse, however, is environmentally beneficial, because it reduces overall loadings to surface waters (in the case of Tracy, the discharge point is the Old River) and can offset the use of potable water supplies on irrigated lands, thereby allowing an "exchange" of reclaimed water for potable water. The Water Master Plan evaluated "urban" reuse potential and needs; the "urban" reuse need is determined for lands within the City of Tracy General Plan boundary. This technical memorandum evaluates agricultural reuse opportunities for areas outside the General Plan boundary area.

Estimated Minimum Reuse Requirement

The California Regional Water Quality Control Board, Central Valley Region (Water Board) established permit limits for effluent average daily discharge flow (referred to in this technical memorandum as average day dry weather flow, or ADWF), which represents the daily average flow when stormwater runoff is not occurring (Order No. R5-2007-0036). Compliance with the ADWF effluent limit is determined annually based on the average daily flow over 3 consecutive dry weather months (e.g., June, July, and August). During the remainder of the year, permitted Old River discharge volumes are allowed to be increased to accommodate stormwater inflows to the City's sanitary sewer collection system, and total discharges are greater than those permitted for ADWF compliance months. The ADWF effluent limit is 16 million gallons per day (mgd), and the recycled water production (i.e., total plant effluent, ADWF) is estimated to be 21.1 mgd at General Plan buildout. As noted in the Regulatory Requirements and Needs section of the Wastewater Master Plan, the ability to discharge more than 16 mgd (during ADWF compliance months) into the Old River is uncertain, and it has, therefore, been assumed that this existing discharge limit cannot be increased. Consequently, for 3 consecutive dry weather months, reuse opportunities need to be identified for a minimum of 5.1 mgd of recycled water (or 21.1 mgd – 16 mgd). As noted in the Water Master Plan, those minimum reuse needs during dry weather months are expected to be met entirely through urban reuse, such as for irrigation of parks, playgrounds, and landscaping (see Table C-1 and Figure C-1).

TABLE C-1
Average Dry Weather Recycled Water Production and Reuse at Buildout
Evaluation of Irrigated Agriculture as a Reuse Option for City of Tracy Recycled Water

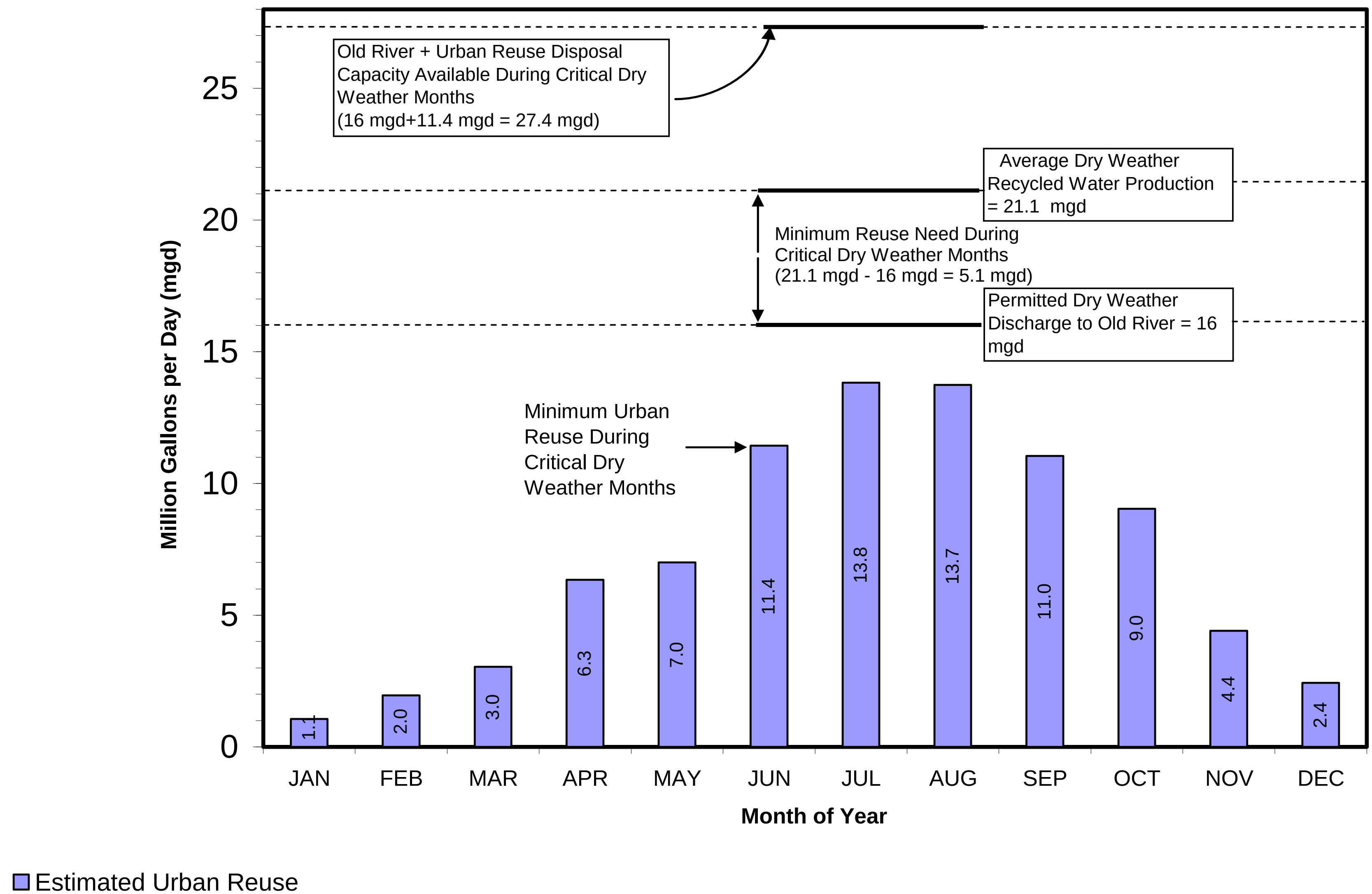
Month	Total Recycled Water Production (mgd)	Maximum Allowable Discharge to Old River (mgd)	Minimum Dry[a] Weather Reuse Need (mgd)	Estimated Dry Weather Urban Reuse Planned (mgd)	Additional Dry Weather Reuse Need (mgd)[b]
June[c]	21.1	16	5.1	11.4	0
July	21.1	16	5.1	13.8	0
August	21.1	16	5.1	13.7	0

[a]Minimum dry weather reuse requirement = recycled water production minus maximum allowable discharge to Old River.

[b]None required because urban reuse flows exceed minimum dry weather reuse need.

[c]Note that the City's NPDES permit states that compliance is based on 3 consecutive dry months, but does not specify which months. June through August is used in this table as an example.

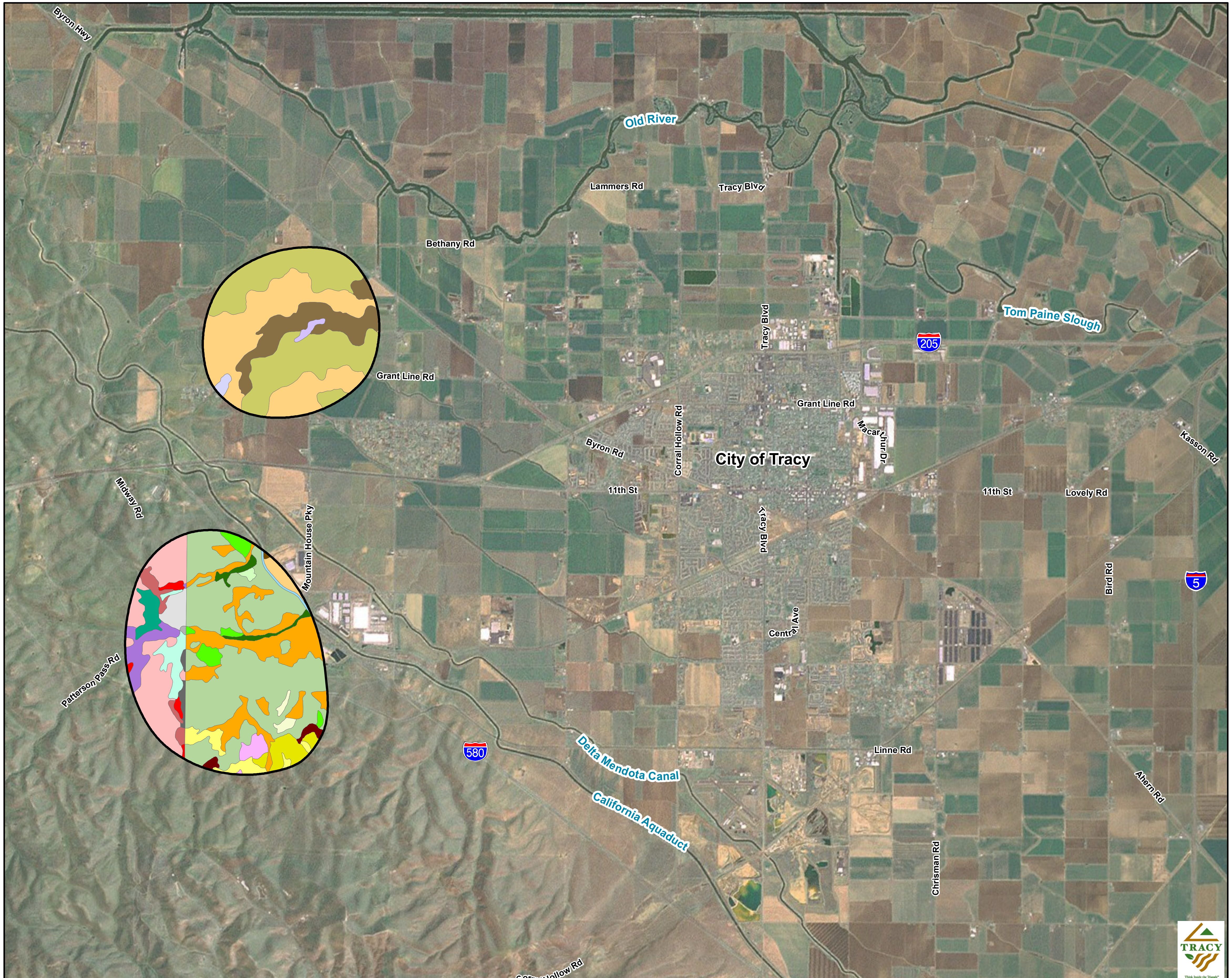
Even though minimum reuse requirements can be solely met with the urban reuse projects identified in the *Water Master Plan* (2012, West Yost), increasing the amount of reuse to nearby agricultural or industrial users has potential merit, if funding sources can be identified. Figure C-2 shows agricultural areas within which interest in receiving recycled water has been stated; these areas are close to the proposed Brookfield Pumped Storage Project, which is currently in the planning phase. Contact has not been made with all potential interested users to the south and west of the City of Tracy Sphere of Influence, because the minimum reuse need can be met through recycled water irrigation on urban areas.



SOURCE: URBAN REUSE FLOW RATE TAKEN FROM WEST YOST ASSOCIATES, 2010

FIGURE C-1
TOTAL WASTEWATER GENERATED COMPARED TO ESTIMATED URBAN REUSE
WASTEWATER MASTER PLAN
CITY OF TRACY

CH2MHILL



LEGEND

POTENTIAL AGRICULTURAL REUSE AREAS

San Joaquin Soils

- Alo-Vaquero complex, 8 to 30 percent slopes
- Calla clay loam, 2 to 8 percent slopes
- Calla-Carbona complex, 30 to 50 percent slopes
- Calla-Carbona complex, 8 to 30 percent slopes
- Calla-Pleito complex, 8 to 30 percent slopes
- Capay clay, 0 to 2 percent slopes
- Capay clay, 2 to 5 percent slopes
- Carbona clay loam, 2 to 8 percent slopes
- Carbona complex, 15 to 50 percent slopes
- Stomar clay loam, 0 to 2 percent slopes
- Stomar clay loam, wet, 0 to 2 percent slopes
- Vaquero-Carbona complex, 8 to 30 percent slopes
- Vernalis clay loam, 0 to 2 percent slopes
- Water
- Wisflat-Arburua-San Timoteo complex, 30 to 50 percent slopes
- Wisflat-Arburua-San Timoteo complex, 50 to 75 percent slopes
- Zacharias clay loam, 0 to 2 percent slopes

Alameda Soils

- Clear Lake clay, drained, 3 to 7 percent slopes
- Diablo clay, 15 to 30 percent slopes
- Diablo clay, 30 to 45 percent slopes, eroded
- Diablo clay, 7 to 15 percent slopes
- Linne clay loam, 15 to 30 percent slopes
- Linne clay loam, 3 to 15 percent slopes
- Linne clay loam, 30 to 45 percent slopes, eroded
- Rincon clay loam, 0 to 3 percent slopes
- Sycamore silt loam

N

0 1 2
Miles

FIGURE C-2
CITY OF TRACY WASTEWATER MASTER PLAN
POTENTIAL AGRICULTURAL REUSE AREAS AND ASSOCIATED SOIL UNITS

\\ZION\SACGIS\PROJ\179201_TRACYGIS\MAPFILES\WATERMP\FIG2_AGRICULTURAL_SOILS.MXD JBONE MCLAY1 3/31/2010

CH2MHILL

To minimize the financial impact on existing and future City of Tracy ratepayers, developing additional agricultural or industrial demand would depend on the willingness of potential users to construct the necessary infrastructure for water deliveries. In the event that industrial uses of recycled water are implemented in the future (e.g., the Brookfield Pumped Storage Project, or other industrial uses), it may be possible to incrementally oversize the recycled water supply pipeline to that industrial user at minimal additional cost, thereby enhancing the potential for beneficial reuse of treated effluent. Without such a nearby industrial user (or a significant shift in the economics associated with the use of agricultural water), it is assumed that potential agricultural water users will not be able to justify the costs associated with reuse.

To approximate potential agricultural recycled water needs, Table C-2 provides monthly water use estimates for a 100-acre irrigated pasture. The water budget assumes pasture (rotated grazing) with a grass rooting depth of 24 inches, and clay loam soils with an available water content of 4 inches. Leaching requirement and irrigation efficiency would depend on effluent water quality and salinity threshold of pasture, as well as other site-specific conditions; however, for purposes of this evaluation, the values provided in Table C-2 are assumed to be reasonable estimates. Results suggest that average annual recycled water use per 100 acres of irrigated pasture in the Tracy area would be approximately 0.5 mgd.

TABLE C-2
Monthly Water Budget for 100 Acres of Irrigated Pasture in Tracy Area
Evaluation of Irrigated Agriculture as a Reuse Option for City of Tracy Recycled Water

Crop	Irrigated Area (acres)	Leaching Fraction	Irrigation Efficiency (Sprinkler)	Annual Irrigation Demand Acre-Feet	Annual Irrigation Demand Average (mgd)
Pasture (Rotated Grazing)	100	15%	85%	549	0.5

Month	ET_o (in)	P (in)	ET_c Pasture (in)	GIWR w/ LF (in)	GIWR w/LF (AF)	GIWR w/LF (MG)
Jan	1.19	1.79	0.48	0.00	0	0
Feb	1.94	1.37	0.78	0.00	0	0
Mar	3.93	0.87	2.56	2.77	23	8
Apr	5.30	0.68	3.98	4.86	41	13
May	7.68	0.27	6.53	8.81	73	24
Jun	8.83	0.02	9.27	12.83	107	35
Jul	9.06	0.00	9.52	13.17	110	36
Aug	8.02	0.00	8.42	11.65	97	32
Sep	6.03	0.12	5.13	7.08	59	19
Oct	4.07	0.50	3.05	3.80	32	10
Nov	2.08	0.89	1.14	0.86	7	2
Dec	1.56	2.25	0.62	0.00	0	0
Totals	**59.68**	**8.77**	**55.96**	**65.83**	**549**	**179**

Notes:

AF = acre-feet
ET_c = crop evapotranspiration (ET_o x K_c pasture)
ET_o = reference evapotranspiration, from CIMIS #167, Tracy, California
GIWR w/ LF = gross irrigation water requirements with leaching fraction (ET_c-Effective Precipitation)/[(irrigation efficiency)*(1-LF)]
LF = leaching fraction
MG = million gallons
P = average precipitation measured at CIMIS #167, Tracy, California

Agricultural Reuse

This section explores agricultural reuse opportunities and describes potential issues to be considered when evaluating the agricultural reuse option. Potential agricultural reuse locations may include those shown on Figure C-2, as well as other areas that may be identified in the future. Crops in the areas depicted on Figure C-2 consist predominantly of dryland pasture, but irrigated crops can include alfalfa for hay, cannery tomatoes, and beans (Bureau of Reclamation, 2005). Factors to consider when evaluating the feasibility of using recycled water for crop irrigation are described below.

Regulatory Requirements

Title 22 of the California Code of Regulations (CCR) establishes the criteria for water quality standards and treatment reliability related to using recycled water. Title 22 includes four levels of treatment, which are set according to the associated use of the recycled water. They are identified and defined as follows (CCR Title 22, Division 4, Chapter 3, Article 3, Section 60301):

- Nondisinfected secondary treatment
- Disinfected secondary-23 recycled water:

  "Disinfected secondary-23 recycled water" means recycled water that has been oxidized and disinfected so that the median concentration of total coliform bacteria in the disinfected effluent does not exceed a most probable number (MPN) of 23 per 100 milliliters

- Disinfected secondary-2.2 recycled water:

  "Disinfected secondary-2.2 recycled water" means recycled water that has been oxidized and disinfected so that the median concentration of total coliform bacteria in the disinfected effluent does not exceed an MPN of 2.2 per 100 milliliters

- Disinfected tertiary recycled water:

  "Disinfected tertiary recycled water" means a filtered and subsequently disinfected wastewater that meets the following criteria:

  – The filtered wastewater has been disinfected by either of the following:

    - A chlorine disinfection process following filtration that provides a CT (the product of total chlorine residual and modal contact time measured at the same point) value of not less than 450 milligram-minutes per liter at all times with a modal contact time of at least 90 minutes, based on peak dry weather design flow.
    - A disinfection process that, when combined with the filtration process, has been demonstrated to inactivate and/or remove 99.999 percent of the plaque-forming units of F-specific bacteriophage MS2, or polio virus in the wastewater. A virus that is at least as resistant to disinfection as polio virus may be used for purposes of the demonstration.

- The median concentration of total coliform bacteria measured in the disinfected effluent does not exceed an MPN of 2.2 per 100 milliliters utilizing the bacteriological results of the last 7 days for which analyses have been completed and the number of total coliform bacteria does not exceed an MPN of 23 per 100 milliliters in more than one sample in any 30-day period. No sample shall exceed an MPN of 240 total coliform bacteria per 100 milliliters.

The City of Tracy Wastewater Treatment Plant employs tertiary treatment, and essentially produces the highest quality of recycled water described in Title 22 (even though the plant is not currently permitted to produce recycled water). The CCR, Title 22, Division 4, Chapter 3, Article 3, Section 60304 provides the following allowable uses of tertiary-treated wastewater for irrigation:

> "Recycled water used for the surface irrigation of the following shall be a disinfected tertiary recycled water, except that for filtration pursuant to Section 60301.320(a) coagulation need not be used as part of the treatment process provided that the filter effluent turbidity does not exceed 2 NTU, the turbidity of the influent to the filters is continuously measured, the influent turbidity does not exceed 5 NTU for more than 15 minutes and never exceeds 10 NTU, and that there is the capability to automatically activate chemical addition or divert the wastewater should the filter influent turbidity exceed 5 NTU for more than 15 minutes:
>
> - Food crops, including all edible root crops, where the recycled water comes into contact with the edible portion of the crop
> - Parks and playgrounds
> - School yards
> - Residential landscaping
> - Unrestricted access golf courses
> - Any other irrigation use not specified in this section and not prohibited by other sections of the California Code of Regulations"

These criteria would be met by the City of Tracy's treated wastewater and, therefore, recycled water would be suitable for irrigation of food and nonfood crops, as well as the proposed urban landscape irrigation uses.

Irrigation Water Quality

Constituent concentrations in recycled water produced by the City of Tracy are shown in Table C-3.

Salinity

High dissolved salt content in soil can make it difficult for sensitive plants to take up water and can damage plants on a cellular level. The monthly average total dissolved solids (TDS) content of City of Tracy recycled water is about 854 milligrams per liter (mg/L) (Table C-3). In general, this salinity level may result in slight to moderate use restrictions for sensitive crops, although specific crop species would need to be evaluated. Applying a leaching fraction would likely be sufficient to ensure that plants are not adversely affected by salts.

TABLE C-3
Average Concentration of Constituents of Agronomic Interest in City of Tracy Recycled
Evaluation of Irrigated Agriculture as a Reuse Option for City of Tracy Recycled Water

Constituent	Average Concentration	Unit
TDS	854	mg/L
Electrical conductivity	1,390	μS/cm
TSS	ND	mg/L
Total alkalinity as $CaCO_3$	158	mg/L
Potassium	24.6	mg/L
Sodium	186	mg/L
Calcium	51.0	mg/L
Magnesium	25.4	mg/L
Chloride	229	mg/L
Total Kjeldahl Nitrogen	1.21	mg/L
Nitrate-N	6.54	mg/L
Nitrite-N	ND	mg/L
NH_3-N	0.19	mg/L
Sulfate	151	mg/L
Orthophosphate	3.48	mg/L

Notes:

Data represent the average of monthly sampling for the period July 2008 through February 2009.

μS/cm = microSiemens per centimeter
ND = no data
TSS = total suspended solids

Sodium and Chloride Toxicity

Sodium and chloride concentrations in the City of Tracy's recycled water (186 and 229 mg/L, respectively) may be high enough to cause specific ion toxicity, and levels may present slight to moderate use restrictions. Specific plant species would need to be evaluated, because there is a substantial amount of variation in plant sensitivity to sodium and chloride, and effects may occur through either foliar exposure (sprinkler irrigation) or exposure to these elements in the soil, depending on the plant species.

Infiltration Hazard

High sodium content in fine-textured soils can cause destruction of soil structure, dispersion, and reduced ability for water to infiltrate the soil. The sodium hazard is more severe when sodium is the dominant ion in solution (i.e., calcium and magnesium levels are low) and electrical conductivity is low. The sodium hazard is evaluated by calculating the sodium adsorption ratio (SAR), which is defined in irrigation water in the following equation:

$$SAR = \frac{[Na]}{\sqrt{\frac{([Ca]+[Mg])}{2}}} \quad (1)$$

The relative soil infiltration hazard due to sodium is shown on Figure C-3, which is based on concurrent evaluation of irrigation water SAR and salinity. A slight infiltration hazard could result with irrigation using City of Tracy recycled water. However, this risk could be controlled if problems arise by periodic application of gypsum to increase soil calcium levels, improve soil structure, and support leaching of sodium through the root zone.

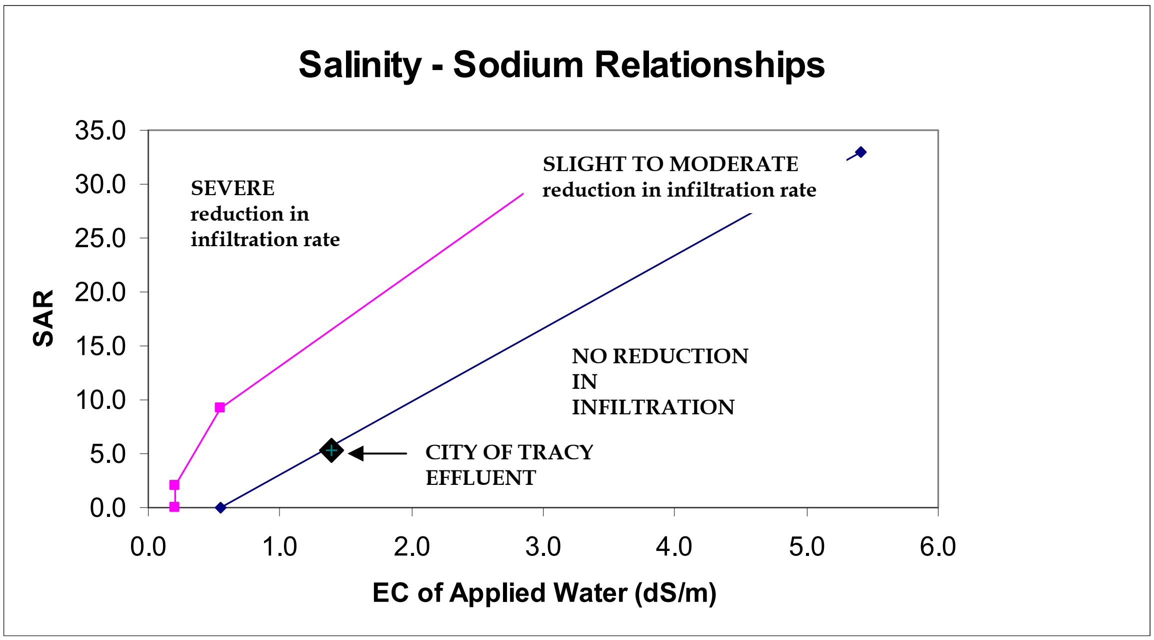


FIGURE C-3
Estimated Infiltration Hazard Associated with City of Tracy Recycled Water

Leaching Requirement

The leaching requirement is the amount of irrigation water that must be applied above and beyond the amount required by the crop to prevent salts from accumulating within the root zone. Salts contained in the irrigation water are left behind in the root zone as water is evaporated on the soil surface and taken up into vegetation for plant transpiration. The leaching fraction helps to move this salt beyond the root zone to avoid salinity-induced problems with vegetation growth. The leaching fraction applied depends on the salinity of the water being used for irrigation and the tolerance of the vegetation to salinity. Leaching fraction calculations for potential reuse areas should be evaluated prior to irrigation with recycled water.

The following equation is used to calculate the necessary leaching fraction (Ayers and Wescott, 1985):

$$LF = EC_w / (5 \times EC_e) - EC_w \quad (2)$$

Where:

LF = Leaching fraction needed to control salts within the soil salinity tolerance (EC_e) of irrigated vegetation

EC_w = Salinity (deciSiemens per meter [dS/m]) of the irrigation water

EC_e = Average soil salinity (dS/m) tolerated by the crop

As an example, using the estimated average EC_w of 1.39 dS/m (Table C-3) and the EC_e value for alfalfa of 2.0 (Table C-4), the necessary LF would be about 16 percent. This is essentially the same value as that assumed in Table C-2.

Soil Properties

Soil types that are commonly found in the Tracy area, and their characteristics that could affect their suitability for irrigation with recycled water, are described in Table C-4. These soils are found in the areas where agricultural reuse could potentially occur in the future (Figure C-2).

TABLE C-4
Typical Soils in the Tracy Vicinity
Evaluation of Irrigated Agriculture as a Reuse Option for City of Tracy Recycled Water

Map Unit Symbol	Map Unit Description	Soil Properties
118	Capay clay, 0 to 2 percent slopes	• Saturated hydraulic conductivity: 0.06 to 0.20 inch/hour • Depth to water table: More than 80 inches • Available water capacity: 0.15 inch per inch • Land capability classification (irrigated): 2s • Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm) • Maximum sodium adsorption ratio: 10.0 • Typical profile: 0 to 20 inches: clay 20 to 60 inches: clay
252	Stomar clay loam, 0 to 2 percent slopes	• Saturated hydraulic conductivity: 0.06 to 0.20 inch/hour • Depth to water table: More than 80 inches • Available water capacity: 0.17 inch per inch • Land capability classification (irrigated): 2s • Maximum salinity: Nonsaline (0.0 to 2.0 mhos/cm) • Typical profile: 0 to 17 inches: clay loam 17 to 47 inches: clay 47 to 60 inches: clay loam
114	Calla-Carbona complex, 8 to 30 percent slopes	• Saturated hydraulic conductivity: 0.20 to 0.57 inch/hour • Depth to water table: More than 80 inches • Available water capacity: 0.17 inch per inch • Land capability classification (irrigated): 4e • Maximum salinity: Nonsaline (0.0 to 2.0 mhos/cm) • Maximum calcium carbonate content: 25 percent • Typical profile: 0 to 18 inches: clay loam 18 to 30 inches: clay loam 30 to 60 inches: clay loam

TABLE C-4
Typical Soils in the Tracy Vicinity
Evaluation of Irrigated Agriculture as a Reuse Option for City of Tracy Recycled Water

Map Unit Symbol	Map Unit Description	Soil Properties
123	Carbona clay loam, 2 to 8 percent slopes	• Saturated hydraulic conductivity: 0.06 to 0.20 inch/hour • Depth to water table: More than 80 inches • Available water capacity: 0.16 inch per inch • Land capability classification (irrigated): 2e • Maximum salinity: Nonsaline to very slightly saline (0.0 to 4.0 mmhos/cm) • Typical profile: 0 to 6 inches: clay loam 6 to 25 inches: clay loam 25 to 36 inches: clay loam 36 to 62 inches: clay loam
LaC	Linne clay loam, 3 to 15 percent slopes	• Saturated hydraulic conductivity: 0.00 inch/hour (in bedrock) • Depth to weathered bedrock: 20 to 40 inches • Available water capacity: 0.18 inch per inch • Land capability classification (irrigated): 3e • Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm) • Maximum calcium carbonate content: 10 percent • Typical profile: 0 to 36 inches: clay loam 36 to 40 inches: weathered bedrock (sandstone and shale)

Notes:

Map unit information was obtained from online soil survey information for San Joaquin and Alameda Counties (Soil Survey Staff, 2010).

mhos/cm = mhos per centimeter
mmhos/cm = millimhos per centimeter

Characteristics that limit suitability for irrigation on these soils include high clay content (Map Units 118 and 252) and low hydraulic conductivity, shallow depth to bedrock (Map Unit LaC), and steep slopes (Map Units 114 and LaC). None of the soils contain high salinity; however, Capay clays (Map Unit 118) have a maximum SAR of 10 (Table C-4), which is near levels where degradation of soil structure and reduced water infiltration rates can occur in some soils.

Land capability class (LCC) ratings for soils are 2s, 2e, 3e and 4e. LCC 2 soils have moderate limitations that reduce the choice of crop or require moderate conservation practices; Class 3 soils have severe limitations, and Class 4 soils have very severe limitations that restrict the choice of crop or require very careful management, or both. Subclass "e" is made up of soils for which the susceptibility to erosion or past erosion damage is the dominant problem or hazard affecting their use. Subclass "s" is made up of soils that have soil limitations within the rooting zone, such as shallowness of the rooting zone, stones, low moisture-holding capacity, low fertility that is difficult to correct, and salinity or sodium content (Soil Survey Staff, 2010). All dominant soils have some degree of use limitation related to soil characteristics.

Crops

Recycled water typically contains salinity and other constituents at levels that may be harmful to sensitive plants. Without adequate leaching of salts below the crop root zone, salinity present in recycled water could build up to harmful levels in soil. Table C-5 lists crops grown in the vicinity and their salinity thresholds (i.e., the salinity level in a soil saturated past extract [EC_e], above which there would be a reduction in crop yield). Selecting crops with low sensitivity to salinity may be advisable if salinity in irrigation water or soils is excessive, and ability to apply a leaching fraction is restricted.

TABLE C-5
Crop Salt Tolerance Coefficients for Important Crops in the Vicinity of City of Tracy
Evaluation of Irrigated Agriculture as a Reuse Option for City of Tracy Recycled Water

Crop	Tolerance Based On	Threshold EC_e (dS/m)
Alfalfa	Shoot dry weight	2.0
Almond	Shoot growth	1.5
Apricot	Shoot growth	1.6
Asparagus	Spear yield	4.1
Barley	Grain yield/shoot dry weight	8.0/6.0
Bean	Seed yield	1.0
Corn	Ear fresh weight/shoot dry weight	1.7/1.8
Cucumber	Fruit yield	2.5
Grape	Shoot growth	1.5
Muskmelon	Fruit yield	1.0
Oat	Grain yield, straw dry weight	--
Safflower	Seed yield	--
Squash	Fruit yield (zucchini)	4.9
Sugar beet	Storage root	7.0
Tomato	Fruit yield	2.5
Walnut	Foliar injury	--
Watermelon	Fruit yield	--
Wheat	Grain yield	6.0

Source: Maas and Grattan, 1999 as cited in Hoffman, 2010 for crops in South Delta.

Conclusions

Urban reuse of recycled water within the General Plan area is expected to utilize 100 percent of the minimum volume necessary to comply with flow limitations identified in the wastewater treatment plant discharge permit. However, additional effluent that would normally be discharged to the Old River during summer months would be available for beneficial reuse, should potential users fund installation of the infrastructure necessary for water deliveries. Use of recycled water of suitable quality conserves potable water for domestic uses and furthers the State's water conservation goals. Where recycled water would be used to irrigate crops, the user should consider regulatory requirements in addition to potential constraints related to water quality, soil properties, and crop sensitivities.

References

Ayers, R.S., and D.W. Wescott. 1985. Water Quality for Agriculture. FAO Irrigation and Drainage Paper No. 29. Rome, Italy.

Hoffman, G.J. 2010. Salt Tolerance of Crops in the Southern Sacramento-San Joaquin Delta. Final Report.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. http://websoilsurvey.nrcs.usda.gov. Accessed March 19, 2010.

Bureau of Reclamation Delta Mendota Canal Unit Environmental Assessment and Finding of No Significant Impact (FONSI). February 2005. http://www.usbr.gov/mp/cvpia/3404c/env_docs/final_ea_fonsi/dmc/index.html. Accessed on March 19, 2010.

Appendix D
Collection System Design Calculations

Project:	City of Tracy, Major Wastewater Conveyance Facilities, East Catchment
Project No.	179201.MP.01
By:	Brad Memeo
Date:	30-Jul-12

Manning's Equation

$$Q = \left(\frac{1.49}{n}\right) A * R_H^{2/3} * S^{1/2}$$

where:

Q	Design flow, cfs
n	Manning Roughness Coefficient
A	Cross-sectional flow area, ft^2
R_H	Hydraulic radius (A / P_w), ft
S	slope, ft/ft

Flow Calculations Using Manning's Equation

n = 0.013 *VCP, manning's n value in accordance with City design standards*

Flow depth to pipe dia ratio (d/D) = 0.80 ft/ft

θ_{rad} = 4.43

θ_{deg} = 254

East Catchment Pipe Sizing Calculations

Actual Pipe Diameter	Nominal Pipe Diameter	Pre-Design Slope	Flow Depth (d/D)	θ_{rad}	θ_{deg}	Flow Area	P_w	R_H	PWWF	Vel	Node	SOI Index
(inches)	(inches)	(ft/ft)	(ft/ft)	(radians)	(degrees)	(ft^2)	(ft)	(ft)	(gpd)	(ft/sec)	-	-
7.7	8	0.004	0.8	4.4	253.7	0.3	1.4	0.2	403,220	2.3	1E	16
15.7	18	0.002	0.8	4.4	253.7	1.2	2.9	0.4	2,070,340	3.0	2E	Node 1E, 2
15.6	18	0.003	0.8	4.4	253.7	1.1	2.9	0.4	2,502,320	3.7	3E	Node 2E, 15
18.3	21	0.002	0.8	4.4	253.7	1.6	3.4	0.5	3,103,670	3.4	4E	Node 3E, 13 (South)
24.5	27	0.001	0.8	4.4	253.7	2.8	4.5	0.6	4,247,590	2.5	5E	Node 4E, 13 (North)

Project:	City of Tracy, Major Wastewater Conveyance Facilities, West Catchment
Project No.	179201.MP.01
By:	Brad Memeo
Date:	30-Jul-12

Manning's Equation

$$Q = \left(\frac{1.49}{n}\right) A * R_H^{2/3} * S^{1/2}$$

where:

Q	Design flow, cfs
n	Manning Roughness Coefficient
A	Cross-sectional flow area, ft^2
R_H	Hydraulic radius (A / P_w), ft
S	slope, ft/ft

Flow Calculations Using Manning's Equation

n = 0.013 *VCP, manning's n value in accordance with City design standards*

Flow depth to pipe dia ratio (d/D) = 0.80 ft/ft

θ_{rad} = 4.43

θ_{deg} = 254

West Catchment Pipe Sizing Calculations

Actual Pipe Diameter	Nominal Pipe Diameter	Pre-Design Slope	Flow Depth (d/D)	θ_{rad}	θ_{deg}	Flow Area	P_w	R_H	PWWF	Vel	Node	SOI Index
(inches)	(inches)	(ft/ft)	(ft/ft)	(radians)	(degrees)	(ft^2)	(ft)	(ft)	(gpd)	(ft/sec)	-	-
16.7	18	0.012	0.8	4.4	253.7	1.3	3.1	0.4	5,914,720	7.4	1W	5 & 4
17.9	21	0.012	0.8	4.4	253.7	1.5	3.3	0.5	7,188,590	8.2	2W	Node 1W, 3
18.4	21	0.012	0.8	4.4	253.7	1.6	3.4	0.5	7,654,430	8.2	3W	Node 2W, 1d
21.1	24	0.006	0.8	4.4	253.7	2.1	3.9	0.5	7,827,320	6.4	4W	Node 3W, 18, Std. Pac., & Infill
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4,277,320	N/A	4W.1	Node 4W
16.8	18	0.006	0.8	4.4	253.7	1.3	3.1	0.4	4,277,320	5.2	4W.2	Node 4W.1
19.5	21	0.006	0.8	4.4	253.7	1.8	3.6	0.5	6,379,240	5.8	5W	Node 4W.2, 12 & 1c
22.3	24	0.004	0.8	4.4	253.7	2.3	4.1	0.6	7,441,030	5.2	6W	7 & 6
27.5	30	0.005	0.8	4.4	253.7	3.5	5.1	0.7	14,504,910	6.7	7W	Node 5W & 6W, 1a & 1b
28.1	30	0.005	0.8	4.4	253.7	3.7	5.2	0.7	15,436,290	6.7	8W	Node 7W, 8 & 17
35.3	36	0.002	0.8	4.4	253.7	5.8	6.5	0.9	17,888,160	4.8	9W	Node 8W, 9 & 10
35.7	36	0.002	0.8	4.4	253.7	6.0	6.6	0.9	18,458,920	4.8	10W	Node 9W, 11

Note: SOI Project (14) Larch Clover is not considered in the pipe sizing evaluation. It is assumed this development will discharge directly to the proposed pump station on Naglee Rd.

Project:	City of Tracy, Major Wastewater Conveyance Facilities
Project Number:	179201.MP.01
By:	Brad Memeo
Date:	30-Jul-12

Hazen-Williams Formula

$$Q = 1.318 \cdot C \cdot R^{0.63} \cdot S^{0.54} \cdot A$$

where:

Q	Flow rate, cfs
A	Cross-sectional flow area, ft^2
C	Roughness Coefficient
R	Hydraulic radius (A / P_w), ft
S	Energy loss per foot of pipe

West Schulte Road PS & FM

Design flow rate, gpd	4,277,320	*Node 4W.1*
Roughness Coefficient	130	*Assume cement-lined cast iron or ductile iron*
Pipe Length, ft	7,500	Approximate (survey point # 1060 and 1097)

Q	ID, D	A	P_w	R	S	V	H_L	H_S	TDH
cfs	in	(ft^2)	(ft)	(ft)	(ft/ft)	(fps)	(ft)	(ft)	(ft)
6.6	14.0	1.1	3.7	0.3	0.0090	6.2	74.2	60.0	134.2

HP	Pressure psi	Pump Efficiency
130	58.1	0.8

Lammers PS & FM

Design flow rate, gpd	20,111,490	*Node 11W*
Roughness Coefficient	130	*Assume cement-lined cast iron or ductile iron*
Pipe Length, ft	11,600	Approximate (survey point # 1038 and 1051)

Q	ID, D	A	P_w	R	S	V	H_L	H_S	TDH
cfs	in	(ft^2)	(ft)	(ft)	(ft/ft)	(fps)	(ft)	(ft)	(ft)
31.1	30.0	4.9	7.9	0.6	0.0039	6.3	49.3	25.0	74.3

HP	Pressure psi	Pump Efficiency
330	32.1	0.8

Hansen Pump Station

Design flow rate, gpd	11,150,000	*Assume 6.58 mgd from Hansen Sewer, 3.55 mgd from southern future SOI projects, and 1.02 mgd from exsting users of Corral Hollow Sewer*
Roughness Coefficient	130	*Assume cement-lined cast iron or ductile iron*
Pipe Length, ft	10,500	Hansen PS to WWTP

Q	ID, D	A	P_w	R	S	V	H_L	H_S	TDH
cfs	in	(ft^2)	(ft)	(ft)	(ft/ft)	(fps)	(ft)	(ft)	(ft)
17.3	24.0	3.1	6.3	0.5	0.0038	5.5	44.3	35.0	79.3

HP	Pressure psi	Pump Efficiency
200	34.3	0.8

MacArthur Pump Station

Design flow rate, gpd	4,247,590	*Node 5E.1*
Roughness Coefficient	130	*Assume cement-lined cast iron or ductile iron*
Pipe Length, ft	2,000	Approximate (survey point # 1054 and 1051)

Q	ID, D	A	P_w	R	S	V	H_L	H_S	TDH
cfs	in	(ft^2)	(ft)	(ft)	(ft/ft)	(fps)	(ft)	(ft)	(ft)
6.6	14.0	1.1	3.7	0.3	0.0089	6.1	19.5	30.0	49.5

HP	Pressure psi	Pump Efficiency
50	21.4	0.8