City and County of San Francisco
2030 Sewer System Master Plan

TASK 600
TECHNICAL MEMORANDUM NO. 603
COLLECTION SYSTEM CONFIGURATIONS ANALYSIS AND IMPACT ON COMBINED SEWER DISCHARGE

FINAL DRAFT
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2700 YGNACIO VALLEY ROAD • SUITE 300 • WALNUT CREEK, CALIFORNIA 94598 • (925) 932-1710 • FAX (925) 930-0208

CITY AND COUNTY OF SAN FRANCISCO
2030 SEWER SYSTEM MASTER PLAN

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TABLE OF CONTENTS

LIST OF APPENDICES

APPENDIX A - TECHNICAL MEMORANDUM - COLLECTION SYSTEM ALTERNATIVES ANALYSIS

COLLECTION SYSTEM CONFIGURATIONS ANALYSIS AND IMPACT ON COMBINED SEWER DISCHARGE

1.0 PURPOSE OF COLLECTION SYSTEM CONFIGURATION ANALYSIS AND IMPACT ON CSD MEMO

The purpose of this memo is to present a summary of the sewer system performance under the scenarios developed by the SSMP project team during development of the SSMP in 2007. The memo describes the piping modifications that were necessary to accommodate the large-scale changes proposed for the wastewater treatment system as well as the benefit/impacts of each option.

Please note this technical memorandum (TM) is a result of analyses conducted in 2006 and 2007 that reflect the focus of the SSMP during that time. The analyses on the performance of the collection system continued after completion of this memo, but the document was not updated. Rather these updates are reflected in other memos included in the SSMP document. This document has been included because it was determined by the SFPUC and the consultants that it was important to capture the information at the time of development so the reviewers could see the progression of information and decisions made at the time of the TM development. Please also note that the word 'alternative' was used instead of 'configurations' for the TMs reflecting the existing wording at the time it was written. In the Summary Report, the term was updated to 'configuration' so as not to confuse the CEQA review process. The configurations mentioned herein may have changed or been eliminated and are not considered full CEQA alternatives.

The memo bases the analyses on results obtained through the application of the calibrated collection system model (Refer to TM 501, *Model Development, Validation and Baseline Report*, October 2007). As noted in TM 509 - *Combined Sewer Discharges*, the representation of SFPUC's collection system using the hydraulic model has been updated since completion of this report. A reader is encouraged to review TMs 501 and 509 in concert with this memo to provide a complete understanding of the conditions simulated during development of this document and how that baseline modeled condition has evolved and changed through subsequent reports and analysis.

In addition, PMA12 should be evaluated along with PMC 6 - Annotated Outline for One Less CSD Alternatives Analysis which can be found in TM509

Collection System Alternatives Analysis

Technical Memorandum

(Final Draft)

Prepared for

San Francisco Public Utilities Commission

October, 2007

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

1° Eff	Primary Effluent
2° Eff	Secondary Effluent
ALT	Alternative
BPS	Booster Pump Station
CHS	Channel Pump Station
CSD	Combined Sewer Discharge
DW	Dry Weather
FM	Force Main
GIS	Geographic Information System
HGL	Hydraulic Grade Line
LMT	Lake Merced Transport
mg	Million Gallons
mgd	Million Gallons per Day
NPF	North Point Wet Weather Treatment Facility
NPM	North Point Main
NPO	North Point Outfall
OSP	Oceanside Wastewater Treatment Plant
PS	Pump Station
RTC	Real-Time Control
SEBO	Southeast Bay Outfall
SEP	Southeast Wastewater Treatment Plant
SWOO	Southwest Ocean Outfall
T/S	Transport / Storage (Box)
UV	Ultraviolet
WPCP	Wastewater Pollution Control Plant
WSS	West Side Pump Station
WST	West Side Transport
WW	Wet Weather

I. EXECUTIVE SUMMARY

This document presents a summary of the collection system performance under the alternative scenarios developed by the Wastewater Master Plan project team, with a focus on the benefits/impacts of each of the alternatives to the collection system.

The alternatives that are discussed in this report represent the final piping modifications that were necessary to accommodate the large-scale changes proposed for the wastewater treatment system in San Francisco. There were several iterations of these alternatives prior to the final four. Where necessary, references to previous iterations of the alternatives are presented in the discussion.

Alternatives that were considered (and the major collection system changes from baseline) were as follows:

Alternative 1: Upgrade Existing System

- Increase the capacity of the North Point Wet Weather Treatment Facility (NPF) by an additional 90 mgd during wet weather to 240 mgd total and increase the flow from the Channel basin to the North Shore basin via the North Point Main (NPM).
- Increase the capacity of the Southeast Wastewater Treatment Plant (SEP) by an additional 150 mgd of primary treatment during wet weather to 400 mgd total.
- Increase the flow decanted from the Westside Transport/Storage box (T/S) to the Southwest Ocean Outfall (SWOO) by 125 mgd to a total of 235 mgd. Combined with the existing OSP flows, the maximum SWOO flow rate will be 300 mgd.

Alternative 2: Cayuga Diversion

All of the improvements in alternative 1 and:

- Reduce the flows reaching the SEP by diverting the Cayuga Basin (roughly 3,000 acres or 15% of the Bayside sewershed and 40% of the Islais Creek sewershed) to the Oceanside system for treatment at the Oceanside Wastewater Treatment Plant (OSP) with a 14-ft diameter tunnel.
- Addition of 30 mgd of secondary treatment to the NPF, making it an all-weather treatment facility.

Alternative 3: Southeast Plant, Wet Weather Only

All of the improvements in alternative 1 and:

- Move all secondary treatment capacities in the system to the Oceanside. A new Oceanside Treatment Plant (NOSP) with secondary capacity of 150 mgd will be built.
- A 150 mgd pump station would send influent flows through a force main from Islais Creek to the NOSP.
- Convert the SEP to a wet weather, primary only facility with capacity of 400 mgd.
- Combined with the existing OSP and the NOSP, SWOO flows will total 450 mgd.

Alternative 4: Relocate Southeast Plant

All of the improvements in alternative 1 and:

- Move the existing SEP to a new location. This alternative pertains only to the wastewater treatment system and will not significantly change the collection system hydraulics compared with alternative 1. As such, this alternative is examined synonymously with alternative 1 in this report.

The starting point for all the alternatives was the baseline model (refer to *Model Development, Calibration and Baseline Report, October 2007*) which represents the existing system updated with projects that were either constructed after the 2004-2005 calibration period or are nearing completion and will be a part of the system in the near future. To simulate the alternatives, the baseline configuration was modified to reflect the proposed changes included in a given alternative. Once the items were coded, the models were run and results of the alternative configuration were compared against the baseline to evaluate benefits and impacts.

In the baseline model, the North Point Wet Weather Facilities (NPF) is a wet weather only facility with primary capacity of 150 mgd. The Southeast Wastewater Treatment Plants (SEP) operates during both wet and dry weather, and has a secondary capacity of 150 mgd and a primary capacity of 100 mgd. The Oceanside Wastewater Treatment Plant operates during both dry and wet weather, and has a secondary capacity of 43 mgd, and a primary capacity of 22 mgd. Additionally, the West Side Pump Station (WSS) has a 110 mgd capacity to send decanted flows out the Southwest Ocean Outfall (SWOO) during wet weather.

Results of the model runs show that there is a benefit to collection system hydraulics and CSD[1] activation frequency with all of these alternatives compared with existing conditions. However, CSD activation frequency and discharge volume are not completely eliminated. After modeling to determine the impacts of each alternative, additional model runs were performed to determine additional level of effort needed to achieve "less than one activation on an annual basis" which would roughly equate to control of CSD to the typical year. In these runs, controls include additional treatment plant capacity along with additional storage and conveyance structures were added to each alternative to meet the less than one CSD per year on average goal.

The primary metrics used for alternative evaluation and comparison was the impact on CSD frequency and volume relative to baseline conditions. However, other benefits and impacts on overall system flexibility, reliability, flooding, and CSD reduction were also considered and are qualitatively.

The flexibility/reliability analysis assessed the ability of each alternative to treat flows at multiple locations and therefore maximize treatment according to specific storm characteristics. Flexibility/reliability also refers to the redundancy and/or ability to better respond to emergencies or unplanned outages. Flooding analysis considered large-scale and significant impacts on flooding as a result of each alternative. The impacts of CSD refers to the location of the CSD

[1] A CSD is defined in this analysis as a discharge that occurs at a location other than a treatment plant outfall (SEP, NPF, or SWOO).

and the recreational activities at that location.

Recommended Master Plan Alternative Configuration

While the alternatives evaluation task considered a variety of options, one combination of alternatives has been carried forward as the Recommended Master Plan Project (*PMA 47 – Recommended Master Plan Project*, Carollo, October 2007). Under the Recommended Plan, the dry weather operation of the collection system will mimic Alternative 1 while the wet weather operation will mimic Alternative 2.

Key project elements such as the expansion/conversion of the North Point Facility, expansion of the Oceanside Treatment Plant and SWOO, as well as the Cayuga diversion are all carried forward in different phases of the project.

II. INTRODUCTION

As part of the SFPUC Wastewater Master Plan Program, several alternatives are being developed for the SFPUC's wastewater treatment and collection system. As part of this effort, Metcalf & Eddy and its subconsultants, working in conjunction with SFDPW Hydraulics Section, developed a hydraulic model of the collection system to evaluate current system performance and the impact these alternatives have on improving CSD performance and localized flooding. The model development and validation as well as the evaluation of current system performance are both presented in the *Model Development, Validation, and Baseline Report* (October 2007). This *Collection System Alternatives Analysis* technical memorandum summarizes use of the model to analyze the hydraulic impacts of alternatives, particularly on the collection system.

The model used, InfoWorks CS, was developed and is maintained by Wallingford Software (United Kingdom). InfoWorks is a fully dynamic, hydrologic and hydraulic modeling program with sophisticated hydraulic routing algorithms that permit accurate simulation of backwater and overflow conditions. InfoWorks is capable of importing and managing changes to data from a GIS system, managing multiple scenarios, and supporting multiple users. It is an ideal software package for the San Francisco wastewater collection system, given its complexities and the City /consultant combined work efforts.

The City's collection system consists of approximately 900 miles of sewers, 21 pump stations, 9 major tunnels (of which 5 are active), 10 major transport and storage boxes and 3 treatment facilities (Figure 1). The collection system model currently includes all pipes 30" diameter and larger (216 of the 900 total miles of sewer), 15 of the 21 pump stations, the 5 active tunnels, all 10 major transport and storage boxes, and all 3 treatment facilities (Figure 2). The model was created using the City's existing GIS database, augmented with record drawings and visual inspections.

In addition to including the structures that make up the collection system, the model also includes a series of real-time control (RTC) rules intended to mimic the dynamic operation of the system – e.g. opening and closing of gates and the activation of pumps during wet weather events. Since the San Francisco wastewater system is essentially a manually operated system, meaning that operators make decisions on when to turn pumps on and off and activate control structures in the system based on judgment, the RTC represents the best summary of system operation possible. However, it may not capture some of the variation that can occur between operators on a daily basis. This is a limitation of the current model and should be considered when evaluating the results.

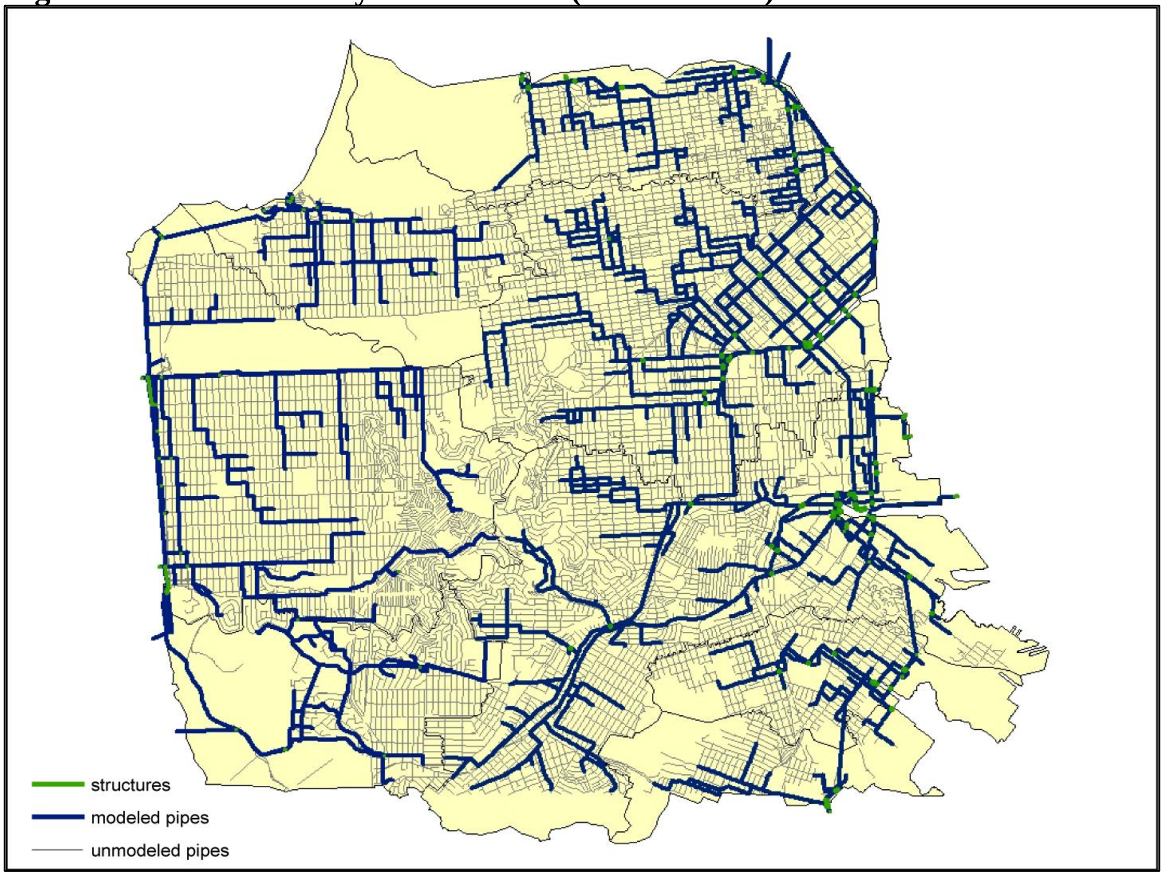
As part of future work, some of these RTC rules will be revisited and refined to better mimic the 'manual' operation of the system. Furthermore, future modeling work will expand the coverage of the model to include a greater number of smaller diameter pipes, thereby increasing the extent of the model and better defining upstream hydraulics.

Figure 1. Major Features of the San Francisco Wastewater System

Once constructed, the model was calibrated for both dry and wet weather conditions using a series of flow meters deployed across the system for a 5-month period in 2004. Following this initial calibration, the hydraulic model was then used to evaluate the system performance under the alternatives developed by the Wastewater Master Planning team. While these alternatives included a number of modifications to the entire wastewater system (including treatment) the primary focus of the hydraulic model was to evaluate the impact of the alternatives on CSD activation frequency and discharge volume as well as the impact to localized flooding.

This report presents results of the hydraulic modeling of the alternatives as of May 2007, which built upon previous analyses. This memorandum presents the results of three alternatives which have been run, processed, and analyzed in both a base format, and for a higher level of CSD control (no CSDs in a typical year). The fourth alternative is comparable from a collection system standpoint to the first alternative. As such, it was not modeled but will be analyzed synonymously with Alternative 1 in this technical memorandum. A summary of each of these four alternatives, in addition to the baseline model, is presented in this technical memorandum.

Figure 2. Extent of the Hydraulic Model (October 2006)



The evaluation of a higher level of CSD control refers to a configuration of each alternative in which there were no CSDs during the one year typical period. This roughly equates to a one year level of control for CSD activation frequency. A CSD is defined in this analysis as a discharge that occurs at a location other than a treatment plant outfall (SEP, NPF, or SWOO).

To attain this level of control, in addition to increasing the treatment capacities at the existing treatment facilities, additional storage and conveyance structures were added to the system such that the increased treatment could be accommodated at the same sites as existing treatment plants. The location and size of storage requirements determined in the analysis were based on actual available locations and volumes that could be placed in the system.

While the one CSD configuration presented in this report is one option for providing a high level of CSD control, it is not the only possible solution. As additional storage is added to the system, the treatment capacities required will likely decrease while still obtaining one CSD per year. The most cost-effective solution will likely be a combination of additional storage and treatment, but determining the optimal solution is beyond the scope of this analysis.

VIII. III. BASELINE SIMULATION

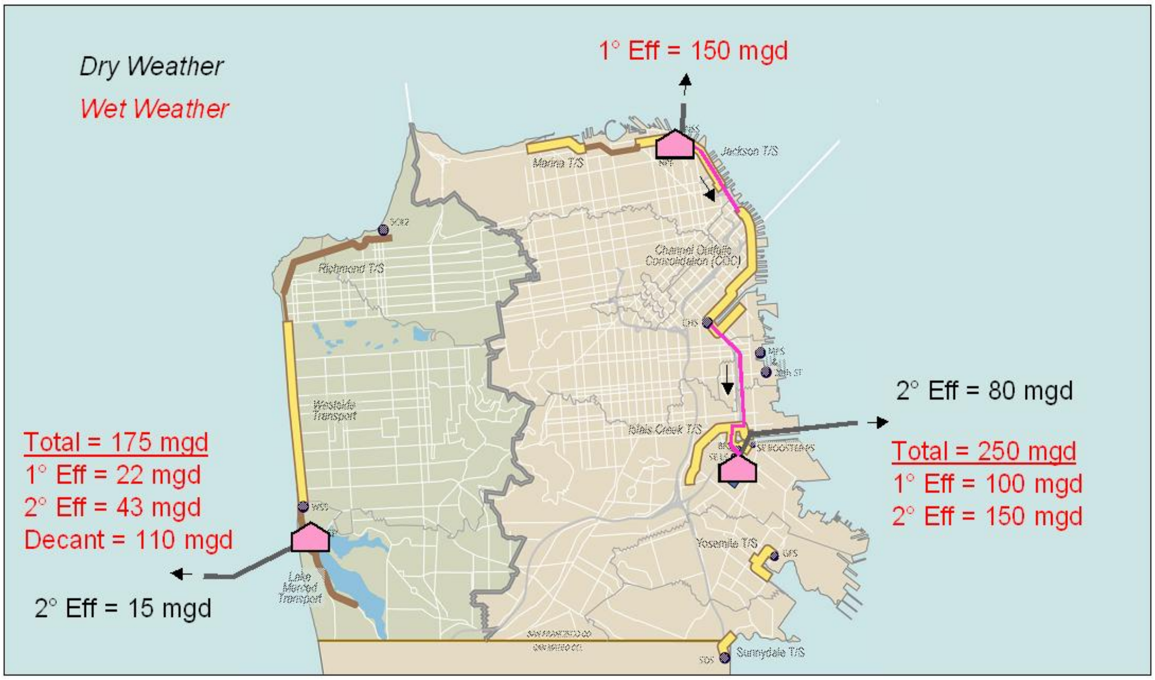
The baseline simulation is used to assess current system performance and the results provide a point of comparison to the other alternatives simulated in order to quantitatively assess the benefits of each alternative. The Baseline model represents the existing system updated with projects that were either constructed after the calibration period or are nearing completion and will be a part of the system in the near future. Once these projects were coded into the model, a typical one-year continuous simulation was run to produce an estimate of baseline annual system performance.

Table 1. Annual Average CSD Activation Frequency for the Baseline Simulation

	Bayside System						**Oceanside System**			
	North	Central			South					
Description	North Shore	Mission Creek	Islais Creek	Hunters Point	Yosemite	Sunnydale	Lake Merced	Vicente	Lincoln	Mile Rock
Overflow Count	3	10	11	1	0	0	6	7	7	7
Overflow Volume (Million Gallons)	16	353	865	0.4	0	0	13	58	80	54

The results of the baseline model simulations showed that on an annual basis, CSD activation frequency was consistent with reported activation frequency. Considering the specific CSD structures in the Bayside system, Islais Creek, Mariposa, and Mission Creek were shown to be the most active with all reporting an average of 10 or more overflows per year. Along the Oceanside system, activation frequency was highest at Lake Merced, Vicente, Lincoln, and Mile Rock, each reporting an annual average of 6 or 7 overflows per year. The results are consistent with the NPDES reporting filed by the city and by anecdotal evidence offered by operations staff.

Figure 3. Hydraulic Model Configuration for Baseline Simulation



IV. ALTERNATIVES

Once the baseline simulation was run and the CSD frequency results were verified, the model was used to evaluate the effectiveness of a series of alternatives intended to improve and enhance San Francisco's wastewater system.

The alternatives that are discussed in this report were not developed to solely address limitations with the collection system, but rather represent large-scale system-wide wastewater improvements to both the collection and treatment systems. This report presents the benefits/impacts of the alternatives to the collection system. The primary metric used for alternative evaluation was the impact on CSD frequency and volume. In addition, flexibility/reliability, flooding, and the impacts of CSDs are also considered and discussed qualitatively.

- **Flexibility/reliability** assessed each alternative's ability to treat flows at multiple locations which provides the opportunity for SFPUC to operate the system in response to localized rainstorm events that often occur during the fall and winter months. In addition, flexibility/reliability also refers to redundancy and/or ability to better respond to emergencies or unplanned outages.

- **Flooding** considered large-scale and significant impacts on flooding as a result of each alternative.

- **The impacts of CSDs** were evaluated qualitatively based on the predicted pollutant loading from the CSDs, the receiving water body (San Francisco Bay versus the Pacific Ocean) and the proximity of the CSD to recreational areas.

All four alternatives have several components in common including increasing primary treatment capacity at North Point Facility by 90 mgd to 240, increasing flows from the Channel drainage basin to North Point basin by diverting and/or pumping 90 mgd additional flows to the North Point Main, increasing the total capacity of SEP to 400 mgd and increasing the decant capacity in the Westside system from 110 mgd to 235 mgd.

The overall benefits and impacts of each alternative to the entire wastewater treatment system, such as the financial, economic, and opportunity costs associated with increasing treatment plant capacity are not presented in this report. That discussion can be found in the *San Francisco Wastewater Master Plan Executive Summary Report* (Loiacano, April 2007).

To evaluate the alternatives, a typical one-year continuous simulation was run. Unfortunately, the results from this simulation do not provide the same degree of detail as a 5-year typical period continuous simulation, as presented in the *Rainfall Analysis Technical Memorandum* (July 2006) however, the time it takes to run the 1-year simulation is much shorter than the time it takes to run the 5-year simulation. For initial evaluation of alternatives, the 1-year typical period is sufficient for comparing the alternatives.

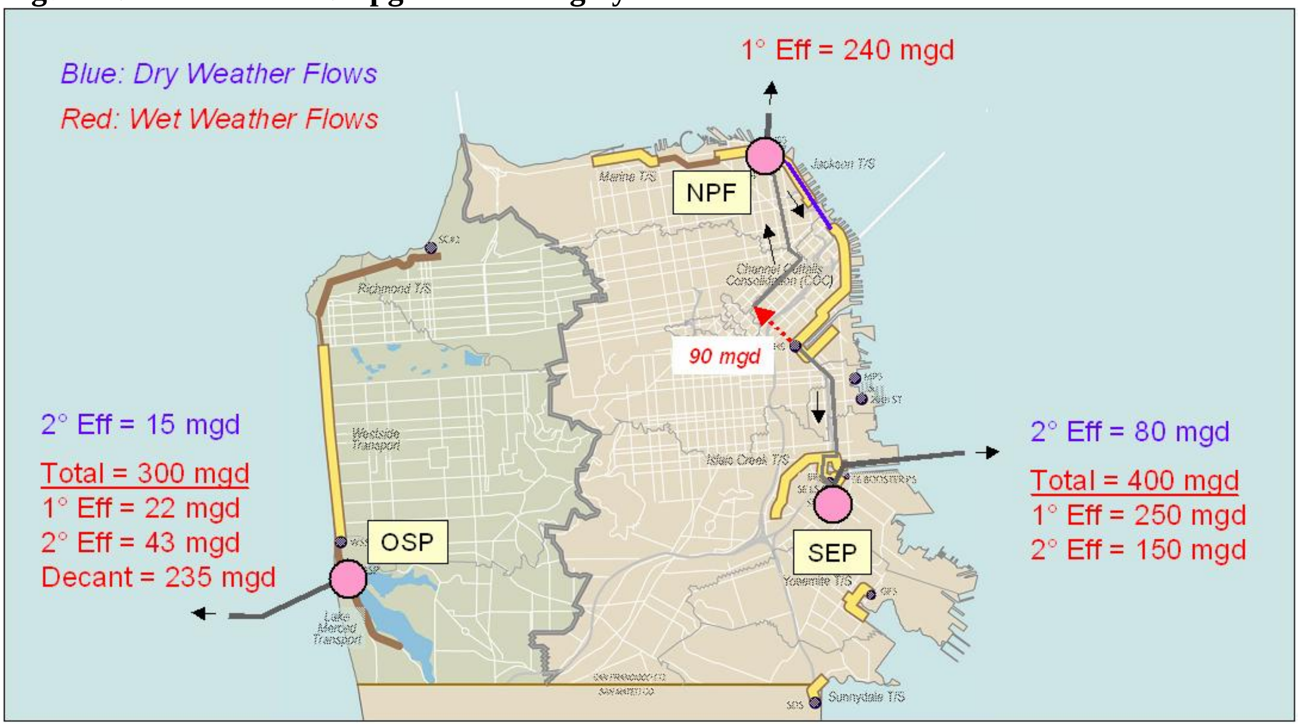
1. <u>Alternative 1 - Upgrade Existing System</u>

Model Description

Alternative 1 has the smallest number of system changes. The changes in this alternative are also included in the other alternatives.

- Increase primary treatment at North Point Facility to 240 mgd
- Pump/Divert 90 mgd from Channel basin to North Shore Basin
- Increase primary treatment at Southeast Plant to 250 mgd
- Increase decant at Westside Transport to 235 mgd (total SWOO flow to 300 mgd)

Figure 4. Alternative 1: Upgrade Existing System



InfoWorks Coding

Several changes were made to the baseline to simulate this alternative. These changes include:

- Increase NPF primary treatment by 90 mgd (to 240 mgd). An additional pumping station was placed off the 9 1/2' tunnel from Marina to North Point Facility. This facility is a 90 mgd "decant" pump station which has a baffle and weir to protect the pumps from larger solids and floating debris. The pump station is designed as a wet weather auxiliary pump station. When the North Shore Station wet weather pumps are overwhelmed the new pump station will then activate and increase pumping to primary treatment. Activation of the new wet weather (WW) pumps is approximately 6' above the activation of the primary wet weather pump station.

- Increase Channel pump station (CHS) to convey an additional 90 mgd from the Channel T/S box through the North Point Main (NPM). Pumping from Channel to NPF activates only when flows at the Southeast Plant (SEP) have reached secondary capacity and NPF is able to start operation. The existing Channel PS has additional space for two more pumps and it is proposed that pumps would be added to these spaces. After additional evaluation of the influent capacity of the Channel PS, if it is determined Channel Pump Station is not capable of producing an additional 90 mgd, an additional decant style pump station (as outlined for North Shore) of 45 mgd could be placed in the existing Channel T/S box. Note that subsequent modeling has shown that approx 45 mgd of this flow can be routed to the NPM by gravity, reducing the requirements for pumping from 90 to 45 mgd. This would require modifications to the junction structures at 5th, 6th, and 7th Streets and to the North Point Main to maximize wet weather flow in the North Point Main. For ease of comparison however, all alternatives were modeled with the additional 90 mgd capacity from Channel to the North Point Main.

- Modify the NPM to accept additional flow as follows:
  - Block NPM at 12th St. and Harrison St. to prevent pressurized flows from raising the hydraulic grade line at 14th St. and Harrison St. A raised hydraulic grade line would increase problems with flooding in the area during extreme storm events.
  - Re-route upper Channel tributary flows from NPM to the Division St. sewer via a new 96" sewer from the NPM at 13th St. to the Division St. sewer at 10th St.
  - Lower weirs at 14th, 15th, and 16th to allow moer flow from the NPM to the Division Street sewer.
  - Lower weirs at Commercial St., Jackson St., and Greenwich St. to help increase the capacity of the NPM.
  - Seal manholes downstream of the Commercial St. weirs, and on Howard St. between 5th and 7th Streets, to avoid flooding.
  - Additional modifications to the junction structures at 5th, 6th, and 7th Streets may help reduce the additional pumping from CHS.

  .

- Increase SEP primary capacity to 250 mgd, bringing the total SEP capacity to 400 mgd. Rankin St. PS was originally built with a total capacity of 180 mgd but currently only uses 120 mgd, thus this additional capacity was used in the model to pump additional flows to SEP. Since this additional capacity is only needed for extreme events, no additional backup capacity is proposed. Also, the SEP lift station which is older and needs improvement would need to be upgraded to allow 120 mgd of flow. These improvements to the Rankin PS and the SEP lift station, together with the 100 mgd flow from the Channel FM, would be sufficient to accommodate the increased wet weather treatment capacity at SEP.

- Increase SWOO discharge to 300 mgd – WSPS current sends 65 mgd to the OSP and

110 mgd from the west decant chamber of WST to SWOO. A new 125 mgd decant PS is proposed to pump the additional flows from the WST west chamber to SWOO. Since the WST west chamber is already decanted, these flows have large solids removed so no additional screening would be needed. Submersible pumps could be placed in the west chamber at Sloat Blvd. to produce this additional flow.

Treatment Rates

To accommodate the changes in the upstream system, adjustments were made in the model to wastewater treatment facility capacities. Table 2 below represents the treatment rates simulated in this alternative.

Table 2. Treatment Rates Specified in the Model for ALT 1

Facility	Secondary (mgd)	Primary (mgd)	Decant (mgd)	Total (mgd)
Oceanside	43	22	235	300
SEP	150	250	-	400
NPF	-	240	-	240
Channel	-	-	-	-
TOTAL	193	512	235	940

Results

The changes to the system were shown to have a benefit to some areas of the system in terms of overflow activation frequency (Table 3) and overflow volumes (Table 4).

Table 3. Combined Sewer Overflow Activation Frequency for ALT 1[2]

Description	Bayside System						Oceanside System			
	North	Central			South					
	North Shore	Mission Creek	Islais Creek	Hunters Point	Yosemite	Sunnydale	Lake Merced	Vicente	Lincoln	Mile Rock
Baseline Overflow Count (Annual)	3	10	11	1	0	0	6	7	7	7
ALT 1 Overflow Count (Annual)	1	6	8	0	0	0	2	2	1	7

Table 4. Combined Sewer Overflow Volume Changes for ALT 1

	Bayside System				Oceanside System			
	Hunters Point	Islais Creek	Mission Creek	North Shore	Lake Merced	Vicente	Lincoln	Total
ALT 1 Change in Overflow Volume from Baseline	-100%	-77%	-55%	-87%	-86%	-95%	-96%	-70%

The outcome of the simulation show several changes in system performance. A summary of the most notable changes is presented below:

- Compared with baseline, there is an estimated 70% reduction in total overflow volume on a system wide basis. This is mainly a result of the large increase in treatment at the wet weather facilities.

[2] Results from:
InfoWorks Database Path: R:\Alts_H_analysis\Final Analysis\InfoWorks.iwm
InfoWorks Network Name: >SFPUC>Alternative 1>Alternative H1 Final

- On the Bayside, the greatest benefit was observed at Mission Creek where expected annual activation frequency dropped from an annual average of 10 to 6 overflows per year and a 55% reduction in CSD volume.

- On the Oceanside, there was a significant reduction in both predicted CSD frequency and volume at the Ocean Beach locations (Lincoln, Vicente, and Lake Merced). Expected annual activation frequency dropped from 6 overflows to 2 at Lake Merced, and from 7 overflows to 1-2 overflows at Vicente and Lincoln. This resulted in an 86% to 96% reduction in volume.

- It is interesting to note that there was minimal change at the Mile Rock outfall. This can be attributed the 42-inch pipe and energy dissipater connecting the downstream end of the Richmond Tunnel that limits flow into the Westside T/S structure and forces storage in the Richmond Tunnel. It is recommended that this structure remain in the system so that this storage is not lost. Also, since the potential for recreational contact with overflows at Mile Rock is less likely than recreational contact with discharges at Lincoln and Vicente, it is preferable that discharges occur at Mile Rock instead of at Lincoln and Vicente.

Cost

Refer to Table 5 for an estimate of the costs of Alternative 1.

Table 5. Costs for Alternative 1

Major Component	Sub Elements	Cost ($ Millions)	
Increased Capacity of NPF	90 mgd additional pump station from NSF to NPF (Including electrical, instrumentation, controls, and station building expansion) This assumes the 30 mgd dry weather pumps remain off during wet weather.	$25.70	
	Increase force main capacity by 90 mgd from NSF to NPF (capacity originally at 150 to 240)	$1.50	
	Additional 90 mgd of primary treatment (Including site work and landscaping)	By Others	
	Additional 90 mgd pumping from NPF to outfalls	By Others	
	New 90 mgd force main (or replacing existing force main to outfalls) approximately 800 ft long.	By Others	
	New 240 mgd outfall (or upgrade outfalls originally at 150 to 240 mgd)	By Others	
	SUBTOTAL		**$27.20**
Increased Decant at SWOO	Additional 125 mgd pump station between WSS and JS3 (Including electrical, instrumentation, controls, and station expansion)	$38.20	
	New force main from WSS to JS3 is not needed (current capacity up to 245 according to "West side system re-evaluation," HCE Aug 2002)	---	
	Open risers of SWOO to increase SWOO capacity	$3.50	
	SUBTOTAL		**$41.70**
Additional Pumping Capacity of CHS	90 mgd additional pump station (Including electrical, instrumentation, controls, and station building expansion)	$25.70	
	48 in dia. (approx. 4045 ft long) force main	$3.60	
	10 # of MHs on force main	$0.10	
	SUBTOTAL		**$29.40**
Modifications to the North Point Main	96 in dia. (approx. 756 ft long) from NPM to the Division St. sewer	$1.20	
	Weir modifications @ Commercial and Jackson—lower by approximately 2-3 feet	$0.50	
	Seal approximately 6 existing MHs	$0.03	
	SUBTOTAL		**$1.73**
Cayuga Area Drainage Improvements	Auxiliary Alemany & Waterloo Sewers	$77.30	
	SUBTOTAL		**$77.30**
Modifications to SEP	SEP Headworks rebuilt to 120 MGD	By Others	
	RPS Upgraded from 120 to 180 MGD	By Others	
	Additional 150 mgd of primary treatment (Including site work and landscaping)	By Others	
	BPS increased capacity from 150 mgd to 400 mgd	By Others	
	New/improved force main from BPS to SEBO to handle 250 mgd (from 110), 4200 ft long, 60" dia	By Others	

	New /improved gravity main from SEP to BPS. New flow = 400 mgd from 150 mgd (1600 ft long). Currently a 72 inch pipe with gradient = .048%.	By Others	
	New 400 mgd Southeast Bay Outfall	By Others	
	SUBTOTAL		**$0.00**
ENR = 9837.4			
		TOTAL	$177.33
		San Francisco Bay Area Construction (15%)	$26.60
		Construction Total	$203.93
		Engineering Services (Design) (10%)	$20.39
		Engineering Services (Construction) (25%)	$50.98
		Contingency (40%)	$81.57
		PROJECT TOTAL	**$356.88**

Note: Certain costs (noted as "by others") were developed by others and are carried forward in the final alternatives cost estimate.

Summary

This section summarizes how the alternative performed with respect to the objectives described in Section II. In Section V the alternatives will be compared to each other.

1.1.1 Minimize CSD Frequency and Volume

The total CSD volume decreased by 70% with this alternative. The largest (by percentage) reductions were observed along the Oceanside system which can be attributed to the increase in discharge from SWOO. The CSD volume reduction along the Bayside system was also significant, with a 77% and 55% reduction in volume at Islais Creek and Mission Creek.

On the Bayside, the increase in the wet weather capacity of the NPF was shown to have a benefit to the CSD activation frequency and discharge volume from the North Shore and Mission Creek overflows. Results of the model show that the SEP and Channel Pump Stations are the likely bottlenecks and causes of the upstream CSDs. Benefits of additional treatment at SEP were not fully realized due to 103 mgd limit of the Channel Pump Station directing flows from Mission Creek to Islais Creek.

On the Oceanside, reduction in CSD frequency and volume at Ocean Beach (Lake Merced, Lincoln and Vicente overflows) was significant, averaging between 1-2 CSDs per year for the typical period. This is important because the beach area adjacent to these overflows is a prime recreation area and reducing CSD at these locations will reduce the potential for adverse human health impacts.

1.1.2 Maximize Flexibility and Reliability

The overall system flexibility and reliability is improved with this alternative since the Channel Pump Station will now be able to pump either north or south. This will help alleviate some of impacts the SEP bottleneck generates. However, flows can only be sent north to the NPF during wet weather since the NPF only provides primary treatment. According to the current NPDES permit, secondary treatment will have to be maximized prior to discharging flow that has only received primary treatment. Should the Channel to SEP force main be damaged (most likely damage scenario is a moderate earthquake), this alternative would allow temporary primary treatment of flows from the Channel area at NPF until repairs can be made.

1.1.3 Reduce Flooding

The increase in flow to the North Point Main did require the sealing of several manholes on the North Point Main along Howard Street (between 5th and 7th Streets), and for several blocks downstream of the weir at Commercial Street, because the peak hydraulic gradeline (HGL) was shown to be close to the ground surface for several of the storms simulated. If these manholes were left unsealed, localized ponding could occur. Also, potential impacts to the adjacent Division Street sewer need to be evaluated further. Initial results suggest that impacts of routing more NPM flows into the Division St. system were somewhat offset by the additional pumping at CHS. There were some improvements to the Harrison and 14th St. area and upstream on 14th St. by the lowering of the wiers at 14th, 15th and 16th Streets, and the addition of the 96" connector. It is likely that future modeling will show that this connector can be reduced in size.

There were some improvements noted in the SOMA area due to the diversion of flows into the North Point Main along 5th to 7th Streets. However, in the lowest areas (most prone to flooding), the flooding improvements in a 5 year storm were moderate at best due to the very large overall size and capacity of the interconnected system. Additional work is being done to evaluate this area for flooding improvements.

While not specifically analyzed, this alternative will likely result in an improvement in flooding in areas hydraulically connected to the WST and/or Islais Creek box (e.g., Vicente, Lincoln, Toland) as these structures can be expected to have lower HGLs compared with baseline with the increased pumping for the additional decant and treatment.

Future Refinements

While the alternative showed significant benefit to parts of the collection system, there are opportunities for improvements and enhancements that could be considered as part of future work:

- Make additional changes to the NPM to further increase diversions from the Channel Basin to the North Shore Basin while minimizing the risk of flooding. This will possibly provide 45 mgd of additional gravity flows into the NPM, reducing Channel North Pumping requirements to 45 mgd.

- Consider options to be able to pump from Channel PS to NPM sooner and additional RTC logic to assure that both NPF and SEP are balanced and maximized with flows from Channel PS (i.e. if overflows are happening in Islais Creek but not in North Point area, consider slowing pumping to Islais Creek).

- Model a smaller connection from NPM to the Division St. sewer

2. <u>Alternative 2 -New NPF, Cayuga Diversion</u>

Model Description

The primary modification to the system in this alternative is to reduce the flows reaching the SEP by diverting the Cayuga Basin (roughly 3,000 acres or 15% of the Bayside sewer shed and 40% of the Islais Creek sewer shed) to the Oceanside system for treatment at the OSP. This was accomplished in the model by inserting a 14-ft diameter tunnel that starts near the confluence of the Cayuga and Alemany sewers and connects to the West Side Transport/Storage Box at Sloat Blvd. The alignment of the sewer generally follows Alemany Blvd., Ocean Ave. and Sloat Blvd. right-of-ways. The tunnel was modeled as an 11.5-ft diameter pipe and a 7-ft diameter pipe in these simulations to simulate two chambers in the tunnel. There is a variable flow device at the end of the tunnel limiting tunnel discharge to the WST system to 110 mgd to reduce the risk of flooding or increased CSDs during peak flows from the Cayuga drainage.

The 7-ft diameter pipe accounts for other possible flow options in future iterations of this alternative including the ability to pressurize dry weather flow from Bayside/Cayuga drainage to reduce pumping on the Westside. Also, additional conduits could potentially be laid in the tunnel structure. For example, additional interior conduits could carry solids to a regional handling facility and/or effluent from the SEP to be discharged out SWOO.

In previous versions of this alternative, the tunnel connected to the Lake Merced Transport and required a very large pumping/decant facility on the Lake Merced Transport at SWOO. In order to reduce the capital and operating costs, an alternative alignment is proposed that allows flows to better utilize the existing WST decant facilities and not require additional pumping facilities. Also, in this version of the alternative, flows to SWOO remain under 300 mgd to allow OSP flows to continue to gravity flow out SWOO.

A second major change in this alternative was the addition of 30 mgd of secondary treatment to the NPF. This was modeled by “breaking” the connection between the North Shore Pump Station and the Channel Pump Station during dry weather. Changes to the model RTC were made to allow pumping from CHS to NPF (via the NPM) to begin before primary treatment capacity is reached out at the SEP.

As in Alternative 1, the capacity of the NPF was increased by 90 mgd (to a total of 240 mgd) during wet weather. This flow comes from the area tributary to the Channel pump station (Figure 5). The capacity of SEP is increased to 400 mgd (150 mgd secondary and 250 mgd primary) and an additional 125 mgd decant capacity was added to the west side transport system.

InfoWorks Coding

Several changes were made to the baseline to simulate this alternative. This alternative uses Alternative 1 as its starting point. Additional changes include:

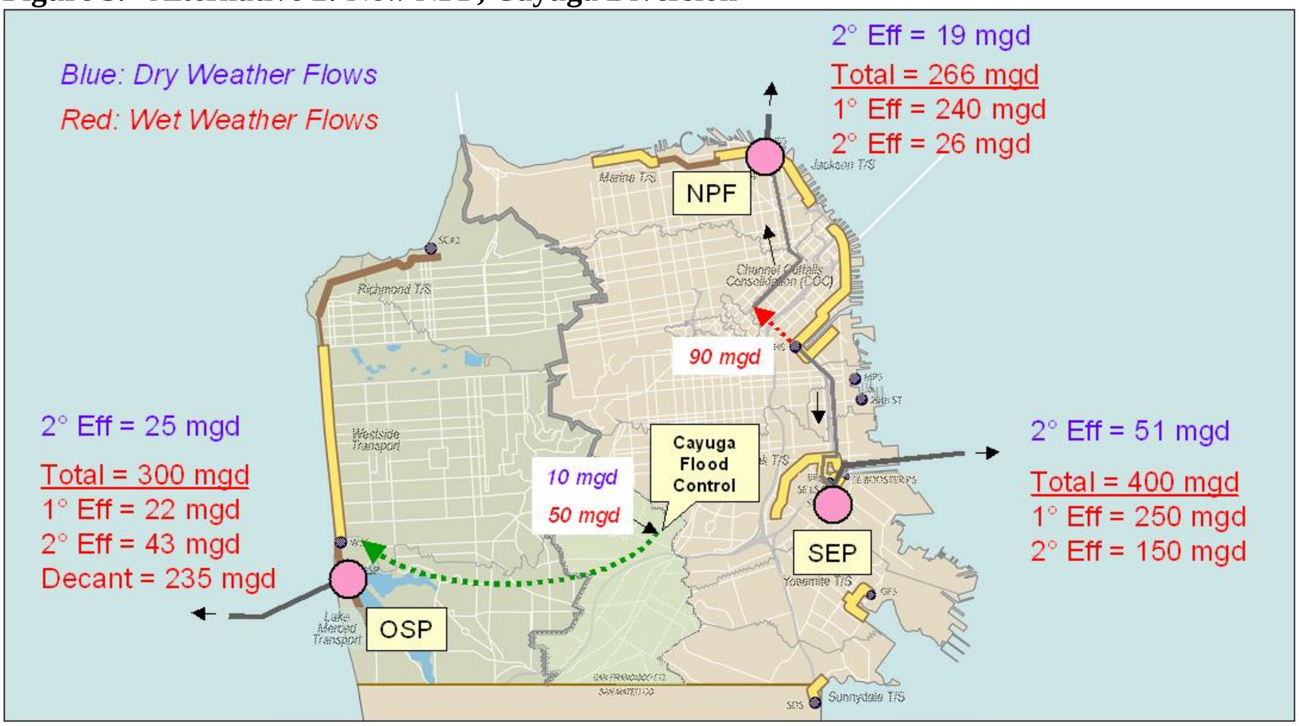
- Coding of a 14-ft diameter tunnel (11.5-ft and 7-ft diameter parallel pipes) from Cayuga/Alemany to the West Side Transport. Add variable flow device set to 115 mgd at the end of the tunnel.

- Some manholes were sealed along the Cayuga tunnel to reduce flooding.

- SWOO has a total discharge capacity of 300 mgd (65 mgd from OSP, 110 mgd decant from existing WST and 125 mgd from new decant PS).

- Change NPF to an all weather treatment facility. The North Shore dry weather pumps (previously pumping to Channel) are now 26 mgd all weather pumps, and represent secondary treatment. These pumps discharge out the North Point outfall. NPF primary capacity is upgraded to 240 mgd.

Figure 5. Alternative 2: New NPF, Cayuga Diversion



Treatment Rates

To accommodate the changes in the upstream system, adjustments were made in the model to wastewater treatment facility capacities. The table below represents the treatment rates simulated in this alternative.

Table 6. Treatment Rates Specified in the Model for ALT 2

Facility	Secondary (mgd)	Primary (mgd)	Decant (mgd)	Total (mgd)
Oceanside	43	22	235	300
SEP	150	250	-	400
NPF	26	240	-	266
Channel	-	-	-	0
TOTAL	219	512	235	966

Results

The changes to the system were shown to have a benefit to some areas of the system in terms of overflow activation frequency (Table 7).

Table 7. Combined Sewer Overflow Activation Frequency for ALT 2[3]

	Bayside System						Oceanside System			
	North	Central			South					
Description	North Shore	Mission Creek	Islais Creek	Hunters Point	Yosemite	Sunnydale	Lake Merced	Vicente	Lincoln	Mile Rock
Baseline Overflow Count (Annual)	3	10	10	1	0	0	6	7	7	7
ALT 2 Overflow Count (Annual)	0	6	0	0	0	0	6	7	6	7

In addition, the alternative was shown to have an impact on combined sewage overflow volumes. Table 8 shows the reduction in overflow volumes at major locations, in terms of percent reduction relative to baseline.

[3] Results from:
InfoWorks Database Path: R:\Alts_H_analysis\Final Analysis\InfoWorks.iwm
InfoWorks Network Name: >SFPUC>Alternative 2>Alternative H2 Final

Table 8. Combined Sewer Overflow Volume Changes for ALT 2

	Bayside System				Oceanside System			
	Hunters Point	Islais Creek	Mission Creek	North Shore	Lake Merced	Vicente	Lincoln	Total
ALT B2 Change in Overflow Volume from Baseline	-100%	-100%	-57%	-100%	-25%	-44%	-44%	-79%

The outcome of the simulation shows several changes in system performance. A summary of the most notable changes is presented below:

- Compared with baseline, there was an estimated 79% decrease in total system wide overflow volume.

- Compared with Alternative 1, there was a reduction in CSDs projected at North Shore. Overflows at this location were eliminated, thereby reducing CSD volume by 100% for the typical one year period.

- There was also a reduction in activation frequency at the Islais Creek overflows, from 10 to 0 activations. The corresponding reduction in overflow volume was 100%.

- The reduction in CSD volume for the Westside T/S structure ranged from 25% at Lake Merced to 44% at Vicente.

Cost

Refer to Table 9 for an estimate of the costs of Alternative 2.

Table 9. Costs for Alternative 2

Major Component	Sub Elements	Cost ($ Millions)	
Increased Capacity of NPF	90 mgd additional pump station from NSF to NPF (Including electrical, instrumentation, controls, and station building expansion) This assumes the 30 mgd dry weather pumps remain off during wet weather.	$25.70	
	Increase force main capacity by 90 mgd from NSF to NPF (capacity originally at 150 to 240)	$1.50	
	Additional 90 mgd of primary treatment (Including site work and landscaping)	By Others	
	Additional 90 mgd pumping from NPF to outfalls	By Others	
	New 90 mgd force main (or replacing existing force main to outfalls) approximately 800 ft long.	By Others	
	New 240 mgd outfall (or upgrade outfalls originally at 150 to 240 mgd)	By Others	
	SUBTOTAL		**$27.20**
Cayuga Tunnel	Tunneling of 14' OD (approx. 7700 ft long) in Soft Ground. Including contaminant soil removal, odor control facility and dewatering pumps	$33.30	
	Tunneling of 14' OD (approx. 15400 ft long) in Hard Rock. Including contaminant soil removal, odor control facility and dewatering pumps	$60.60	
	3 shaft (Including work & removal)		
	4 of MHs and drop shafts		
	1- diversion structures		
	SUBTOTAL		**$93.90**
Increased Decant at SWOO	Additional 125 mgd pump station between WSS and JS3 (Including electrical, instrumentation, controls, and station expansion)	$38.20	
	New force main from WSS to JS3 is not needed (current capacity up to 245 according to "West side system re-evaluation," HCE Aug 2002)	---	
	Open risers of SWOO to increase SWOO capacity	$3.50	
	SUBTOTAL		**$41.70**
Additional Pumping Capacity of CHS	90 mgd additional pump station (Including electrical, instrumentation, controls, and station building expansion)	$25.70	
	48 in dia. (approx. 4045 ft long) force main	$3.60	
	10 # of MHs on force main	$0.10	
	SUBTOTAL		**$29.40**
Modifications to the North Point Main	96 in dia. (approx. 756 ft long) from NPM to the Division St. sewer	$1.20	
	Weir modifications @ Commercial and Jackson—lower by approximately 2-3 feet	$0.50	
	Seal approximately 6 existing MHs	$0.03	
	SUBTOTAL		**$1.73**
Modifications to SEP	SEP Headworks rebuilt to 120 MGD		
	RPS Upgraded from 120 to 180 MGD		

	Additional 150 mgd of primary treatment (Including site work and landscaping)	By Others	
	BPS increased capacity from 150 mgd to 400 mgd	By Others	
	New/improved force main from BPS to SEBO to handle 250 mgd (from 110), 4200 ft long, 60" dia	By Others	
	New /improved gravity main from SEP to BPS. New flow = 400 mgd from 150 mgd (1600 ft long). Currently a 72 inch pipe with gradient = .048%.	By Others	
	New 400 mgd Southeast Bay Outfall	By Others	
	SUBTOTAL		**$0.00**

ENR = 9837.4

TOTAL	$193.93
San Francisco Bay Area Construction (15%)	$29.09
Construction Total	$223.02
Engineering Services (Design) (10%)	$22.30
Engineering Services (Construction) (25%)	$55.75
Contingency (40%)	$89.21
PROJECT TOTAL	**$390.28**

Note: Certain costs (noted as "by others") were developed by others and are carried forward in the final alternatives cost estimate.

Summary

This section summarizes how the alternative performed with respect to the objectives described in Section II. In Section V the alternatives will be compared to each other.

2.1.1 Minimize CSD Frequency and Volume

The total CSD volume decreased by 79% with this alternative.

On the Bayside, there is a moderate benefit to the CSD activation frequency into Islais and Mission Creeks and a significant decrease in CSD frequency at Islais Creek, Hunters Point and North Shore. As noted above, limitations on flow through the Channel force main to Islais Creek are the primary limitation on improved performance at Mission Creek. Compared to Alternative 1, the decrease in CSDs on the Oceanside was not as significant as Alternative 1. However, the decrease in flows city wide was considerable. There was a substantial increase in overall flows treated at the treatment plants also due to the increased storage in the system.

The Bayside impacts of CSDs are reduced with this alternative due to the reduction in CSDs into Mission and Islais Creeks. Excess flow that normally overflows to Mission Creek (and adjacent to recreational areas) is conveyed to the NPF where it receives primary treatment it would otherwise not receive and is discharged in an area with higher dilution rates. Excess flow that is normally discharged out the overflows in Islais Creek (and adjacent to recreational areas) is conveyed to the SEP where it receives primary or secondary treatment that it would otherwise not receive.

On the Oceanside, reduction in CSD frequency and volume at Ocean Beach (Lake Merced, Lincoln and Vicente overflows) was moderate.

This alternative moves sewershed area from the Bay to Oceanside, reducing the total flows to the SEP and the Bay during both wet and dry weather. This reduces the impact of both dry weather and wet weather discharges to the SF Bay which is considered a sensitive waterway.

2.1.2 Maximize Flexibility and Reliability

The overall flexibility and reliability of the system is improved with this alternative based on the ability to balance both dry and wet weather flows between the Bay and Oceanside, and between Islais Creek (SEP) and North Point. In this alternative, there are also more locations capable of providing secondary treatment, increasing the system's flexibility and reliability. The addition of dry weather treatment at North Point reduces reliance on the Channel Force Main and improves the flexibility of the system. Should the Channel FM be disabled in an earthquake or other mishap, flows from Channel could be routed for secondary treatment at North Point. Although secondary treatment capacity is below total daily flows from the combined North Point and Channel areas, it would provide the possibility of treating all dry weather flows if the transport storage boxes are used as temporary storage and it doesn't rain while work is done on repairing the Channel FM.

In addition, this alternative provides the ability to use part of the Cayuga tunnel to treat biosolids at the OSP instead of the SEP, where there would be less of a community impact.

The tunnel also has the benefit of providing both flood protection and sanitary flow conveyance. The design of the tunnel would allow most Cayuga flows to go to the Westside system but if the tunnel capacity is exceeded, the existing Alemany sewer would serve as a relief. Should OSP need to be shut down or flows diverted, there would be the possibility of using the "pipe within a pipe" to actually pump flows from the Westside system to SEP.

Flexibility for future improvements beyond the master plan period (30 years) is improved as the additional options for conveyance of either SEP treated flows to SWOO for Ocean discharge or Bayside dry weather flows to an expanded OSP are still both feasible options for future system improvements with this alternative.

2.1.3 Reduce Flooding

The Cayuga tunnel provides relief to the Alemany sewer which is a current bottleneck, thus avoiding the need for a costly improvement project. A particular design criteria was to develop a flow conveyance that improves overall system flexibility and reduces the need to provide additional flood relief projects to protect the Cayuga area.

The design of the tunnel with a variable flow device provides significant improvements to potential flooding at Cayuga with the additional storage, however there are still some potential flooding problems should an extreme storm event occur when the tunnel is full or nearly full. A possible design includes a variable flow device which allows a much higher discharge rate during extreme storm events. The device would allow CSDs during extreme storms but would meter flows to the Westside system during routine events to maximize storage and treatment. This control device also would allow additional balancing of the flows between Bayside and west side drainages by forcing storage in the tunnel if the west side system capacity is exceeded and allowing Cayuga flows to go eastward to SEP.

The increase in flow to the North Point Main required the sealing of several manholes on the North Point Main along Howard Street (between 5th and 7th Streets), and for several blocks downstream of the weir at Commercial Street, because the peak hydraulic grade was shown to be close to ground surface for several of the storms simulated. If these manholes were left unsealed, localized ponding could occur. Also, potential impacts to the adjacent Division Street sewer should be carefully evaluated.

While not specifically analyzed, this alternative will likely result in an improvement in flooding in areas hydraulically connected to the WST and/or Channel box (e.g., Vicente, South of Market) as these structures can be expected to have lower HGLs compared with baseline.

Future Refinements

Although many issues were identified when diverting flow from Bayside to Oceanside, further improvements to this alternative could be developed. The following are some concepts under study:

- Attempt to alleviate existing upstream flooding and optimize Bayside and Oceanside facilities. This would be accomplished using the new tunnel to balance flows by controlling existing upstream flow where the two major trunk sewers meet before redirecting to from Bayside to Oceanside by movable weirs at the Cayuga entrance structure.
- Consider the cost/benefit trade-off of expanding the hard rock portion of the tunnel from 14' to 17' allowing increased storage.

3. <u>Alternative 3 – Southeast Plant Wet Weather Only</u>

Model Description

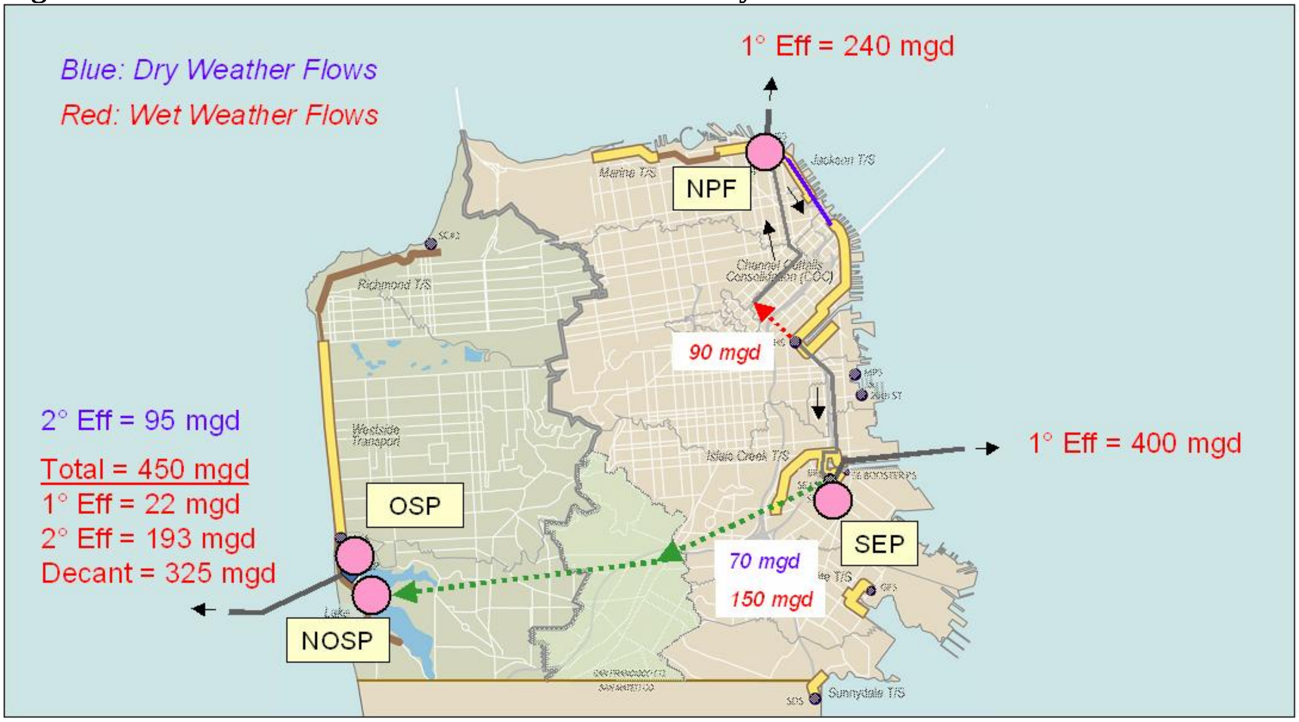
The major change associated with this alternative is to move all secondary treatment capacities in the system to the Oceanside. In order to accomplish this, a New Oceanside Treatment Plant (NOSP) will be constructed. Bayside flows will be pumped from the Southeast Plant area to the NOSP. The Southeast Plant will be converted to a wet-weather only facility.

A 150 mgd pump station and approx. 43,000 ft force main was added from the SEP to transport Bayside flows to Oceanside for treatment. The force main will reach an elevation of approximately 290 ft where it will gravity flow the remaining distance to the New Oceanside Plant. The 150 mgd pump station will remain in operation during both dry and wet weather so that the amount of Bayside flows receiving secondary treatment will not decrease from current conditions. During dry weather, the pump station acts as a booster pump station sending screened flows from the SEP pretreatment facility. Dry weather flows would be pumped to the SEP pretreatment facility from the SEP head works and Channel Pump stations. During wet weather, the 150 mgd pump station would pump flows directly from the Islais Creek Box after screening.

Another major change associated with this alternative is the removal of secondary treatment from SEP and the increase in SEP primary capacity to 400 mgd. As in Alternative 1, the capacity of the NPF was increased by 90 mgd during wet weather. Both SEP and NSF operate as wet weather only facilities in this alternative (Figure 6).

Another change associated with this alternative is an increase in the decant volume from the Westside T/S box to SWOO to 235 mgd. The total capacity of SWOO for this alternative is 450 mgd, which is the sum of the OSP secondary (43 mgd) and primary (22 mgd) treatment capacities, the capacity of NOSP (150 mgd secondary), and the decanted flows (235 mgd). Since SWOO flows exceed 300 mgd, plant effluent would also need to be pumped during heavier rains when the wet weather system would be operating at maximum capacity.

Figure 6. Alternative 3: Southeast Wet Weather Only



InfoWorks Coding

Several changes were made to the baseline to simulate this alternative. This alternative uses Alternative 1 as its starting point. Additional changes include:

- Move all secondary treatment capabilities to the Oceanside. In this alternative, NOSP secondary treatment capacity is 150 mgd.
- SEP no longer has secondary treatment capacity, and SEP primary capacity is increased to 400 mgd.
- NPF has no secondary treatment capacity, and NPF primary capacity is increased to 240 mgd
- Add a 150 mgd variable discharge pump and force main to pump from SEP to OSP to convey dry weather flows and some wet weather flows.

Treatment Rates

To accommodate the changes in the upstream system, adjustments were made in the model to wastewater treatment facility capacities. The table below represents the treatment rates simulated in this alternative.

Table 10. Treatment Rates Specified in the Model for ALT 3

Facility	Secondary (mgd)	Primary (mgd)	Decant (mgd)	Total (mgd)
Oceanside	193	22	235	450
SEP	-	400	-	400
NPF	0	240	-	240
Channel	-	-	-	0
TOTAL	193	662	235	1090

Results

The changes to the system were shown to have a benefit to some areas of the system in terms of overflow activation frequency (Table 11).

Table 11. Combined Sewer Overflow Activation Frequency for ALT 3[4]

Description	Bayside System						Oceanside System			
	North	Central			South					
	North Shore	Mission Creek	Islais Creek	Hunters Point	Yosemite	Sunnydale	Lake Merced	Vicente	Lincoln	Mile Rock
Baseline Overflow Count (Annual)	3	10	10	1	0	0	6	7	7	7
ALT 3 Overflow Count (Annual)	1	6	1	0	0	0	2	2	1	7

In addition, this alternative was shown to have an impact on combined sewage overflow and decant volumes. Table 12 shows the reduction in overflow volumes at major locations, in terms of percent reduction relative to baseline.

[4]Results from:
InfoWorks Database Path: R:\Alts_H_analysis\Final Analysis\InfoWorks.iwm
InfoWorks Network Name: >SFPUC>Alternative 3>Alternative H3 Final

Table 12. Combined Sewer Overflow Volume Changes for ALT 3

	Bayside System				Oceanside System			
	Hunters Point	Islais Creek	Mission Creek	North Shore	Lake Merced	Vicente	Lincoln	Total
ALT B3 Change in Overflow Volume from Baseline	-100%	-98%	-54%	-87%	-86%	-95%	-96%	-83%

The outcome of the simulation shows several changes in system performance. A summary of the most notable changes is presented below:

- Compared with baseline there was an estimated 83% decrease in total system wide overflow volume.
- Compared with baseline, there is a reduction in overflow activation at Islais Creek from 10 per year to 1 per year. The corresponding reduction in volume is 98%. Alternative 2 has a 100% decrease in overflow volume at Islais Creek compared with baseline.
- Due to the isolated nature of the pumping from Bayside to NOSP (flows from Bayside do not enter the Oceanside System but flow directly to NOSP), the Oceanside decrease in overflows for this alternative mimic the Oceanside decrease in overflows for Alternative 1.

Cost

Refer to Table 13 for an estimate of the costs of Alternative 3.

Table 13. Cost for Alternative 3

Major Component	Sub Elements	Cost ($ Millions)	
Increased Capacity of NPF	90 mgd additional pump station from NSF to NPF (Including electrical, instrumentation, controls, and station building expansion) This assumes the 30 mgd dry weather pumps remain off during wet weather.	$25.70	
	Increase force main capacity by 90 mgd from NSF to NPF (capacity originally at 150 to 240)	$1.50	
	Additional 90 mgd of primary treatment (Including site work and landscaping)	By Others	
	Additional 90 mgd pumping from NPF to outfalls	By Others	
	New 90 mgd force main (or replacing existing force main to outfalls) approximately 800 ft long.	By Others	
	New 240 mgd outfall (or upgrade outfalls originally at 150 to 240 mgd)	By Others	
	SUBTOTAL		**$27.20**
SEP-West to OSP FM	84" RCCP FM (approx. 43,000)	$59.00	
	Upgrade SEP Headworks to 120 MGD		
	New 150 MGD High pressure PS +decant sump on Cal Trans site	$58.70	
	SUBTOTAL		**$117.70**
Increased Decant at SWOO	Additional 125 mgd pump station between WSS and JS3 (Including electrical, instrumentation, controls, and station expansion)	$38.20	
	New force main from WSS to JS3 is not needed (current capacity up to 245 according to "West side system re-evaluation," HCE Aug 2002)	---	
	Open risers of SWOO to increase SWOO capacity	$3.50	
	New 150 MGD Booster pump station	$48.90	
	SUBTOTAL		**$41.70**
Additional Pumping Capacity of CHS	90 mgd additional pump station (Including electrical, instrumentation, controls, and station building expansion)	$25.70	
	48 in dia. (approx. 4045 ft long) force main	$3.60	
	10 # of MHs on force main	$0.10	
	SUBTOTAL		**$29.40**
Modifications to the North Point Main	96 in dia. (approx. 756 ft long) from NPM to the Division St. sewer	$1.20	
	Weir modifications @ Commercial and Jackson—lower by approximately 2-3 feet	$0.50	
	Seal approximately 6 existing MHs	$0.03	
	SUBTOTAL		**$1.73**
Cayuga Area Drainage Improvements	Auxiliary Alemany & Waterloo Sewers	$77.30	
	SUBTOTAL		**$77.30**
Modifications to SEP	SEP Headworks rebuilt to 120 MGD		
	RPS Upgraded from 120 to 180 MGD Additional 150 mgd of primary treatment (Including site work and landscaping)	By Others	
	BPS increased capacity from 150 mgd to 400 mgd	By Others	
	New/improved force main from BPS to SEBO to handle 250 mgd (from 110), 4200 ft long, 60" dia	By Others	
	New /improved gravity main from SEP to BPS. New flow = 400 mgd from 150 mgd (1600 ft long). Currently a 72 inch pipe with gradient = .048%.	By Others	
	New 400 mgd Southeast Bay Outfall	By Others	
	SUBTOTAL		**$0.00**
ENR = 9837.4			
		TOTAL	$295.03
		San Francisco Bay Area Construction (15%)	$44.25
		Construction Total	$339.28
		Engineering Services (Design) (10%)	$33.93
		Engineering Services (Construction) (25%)	$84.82
		Contingency (40%)	$135.71
		PROJECT TOTAL	**$593.75**

Note: Certain costs (noted as "by others") were developed by others and are carried forward in the final alternatives cost estimate.

Summary
This section summarizes how the alternative performed with respect to the objectives described in Section II. In Section V the alternatives will be compared to each other.

3.1.1 Minimize CSD Frequency and Volume

The total CSD volume decreased by 83% with this alternative.

On the Bayside, there is a significant reduction on CSD frequency at Hunters Point and into Islais Creek. There is also a moderate reduction into Mission Creek.

Additionally, impacts on the SF Bay are considerably improved by removing the dry weather discharge to the bay and instead sending it to the deep water ocean outfall where mixing and dilution would be considerably better.

On the Oceanside, reduction in CSD frequency and volume at Ocean Beach (Lake Merced, Lincoln and Vicente overflows) was significant, averaging between 1-2 CSDs per year for the typical period.

3.1.2 Maximize Flexibility and Reliability

The overall flexibility and reliability of the system is not improved with this alternative during dry weather as only OSP has the ability to treat to secondary capacity. During wet weather, the flexibility and reliability of the system is improved somewhat based on the ability to balance wet weather flows between either north or south from the Channel pump station.

The overall flexibility and reliability of the system is reduced since there is only one location in the system capable of providing secondary treatment. This condition also generates a potential odor concern because of the long detention times caused by pumping dry weather flows from the North Shore sewershed to Channel, from Channel to Southeast, from Southeast to a new force main, where they then flow by gravity to the OSP. Most likely, additional chemical injection locations would be necessary.

In addition, there is only one route for the flow to arrive at the secondary treatment facility: NP to Channel; Channel to Islais Creek; Islais Creek to NOSP. If a backup were to occur along this route, all upstream flows would not be able to receive secondary treatment. The system is currently at risk due to the reliance on the Channel FM which has been incapacitated after an earthquake and damage by construction, the system would now rely on 2 force mains. The portions of the force main in the soft bay mud and fill from the SEP plant/relay PS site to Alemany/101/280 intersection would be susceptible to the same kinds of risk during a seismic event as the current Channel force main.

3.1.3 Reduce Flooding

Under this configuration, this alternative would have similar performances as Alternative 1, except there would be some improvement in the low lying areas around Islais Creek (i.e., Toland) where the additional pumping from the Islais Creek basin would lower the local hydraulic grade line. Further examination of the effects of the lowered hydraulic grade line is necessary to clarify the flooding improvements. Compared with Alternative 2, this alternative would still require the additional expense of solving the Cayuga flooding problems via the easterly Alemany Auxiliary alignment.

Future Refinements

Ideas for future improvements and enhancements:

- Explore use of predictive controls to most efficiently distribute wet weather flows amongst the three plants.

- Previous iterations of this alternative included a Tunnel with the "pipe in a pipe" approach to convey Bayside flows to west side. These had reduced some of the disadvantages of the all FM proposal and the added advantages of the additional storage and flood protection.

- Add secondary treatment to NPF and/or at Channel to avoid potential odor issues.

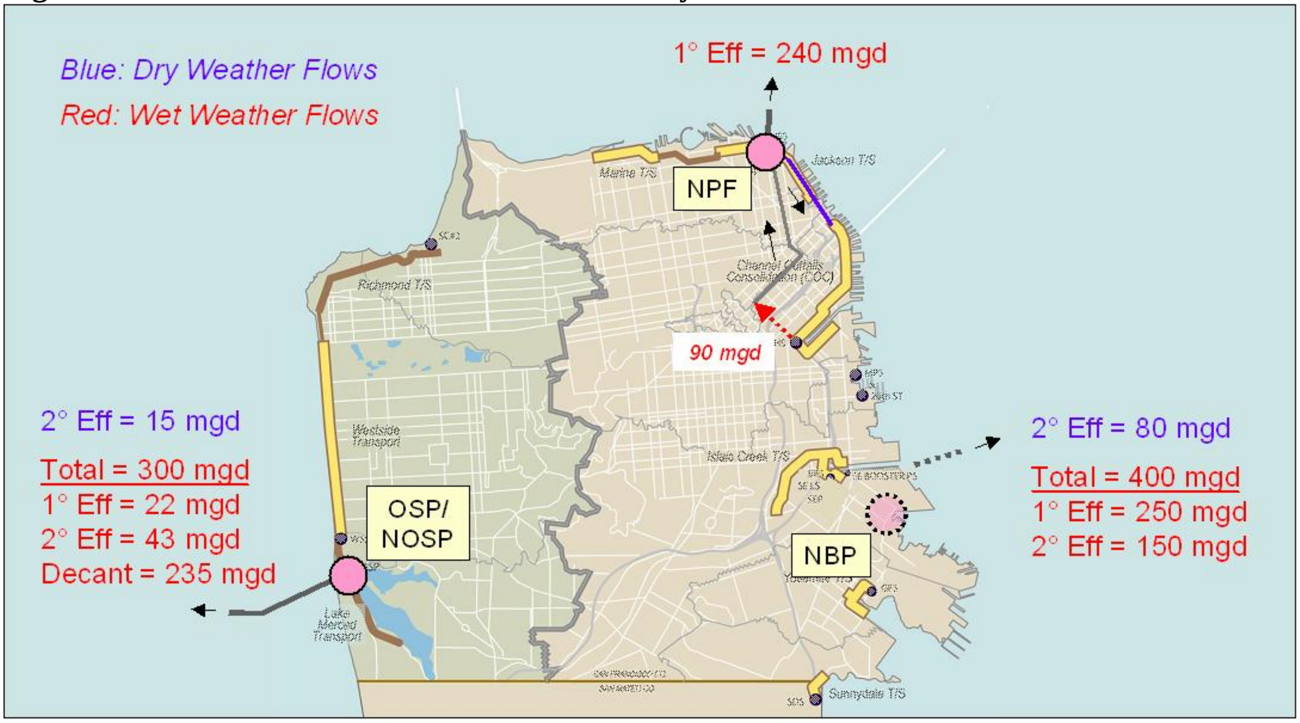
4. <u>Alternative 4 - Relocate Southeast Plant</u>

Model Description

No modeling was done for this alternative as treatment and CSD rates are expected to be the same as for Alternative 1.

Essentially, for the most recent configuration of this alternative, flows currently going to SEP pre-treatment from Channel FM, Rankin PS and SEP headworks would all be re-directed into either a very large FM (96-114") or into a tunnel and sent to the new plant site.

Figure 7. Alternative 4: Relocate SEP to New Bayside Site



The expected costs for this alternative are presented in Table 14.

Table 14. Cost for Alternative 4

Major Component	Sub Elements	Cost ($ Millions)	
Increased Capacity of NPF	90 mgd additional pump station from NSF to NPF (Including electrical, instrumentation, controls, and station building expansion) This assumes the 30 mgd dry weather pumps remain off during wet weather.	$25.70	
	Increase force main capacity by 90 mgd from NSF to NPF (capacity originally at 150 to 240)	$1.50	
	Additional 90 mgd of primary treatment (Including site work and landscaping)	By Others	
	Additional 90 mgd pumping from NPF to outfalls	By Others	
	New 90 mgd force main (or replacing existing force main to outfalls) approximately 800 ft long.	By Others	
	New 240 mgd outfall (or upgrade outfalls originally at 150 to 240 mgd)	By Others	
	SUBTOTAL		**$27.20**
Increased Decant at SWOO	Additional 125 mgd pump station between WSS and JS3 (Including electrical, instrumentation, controls, and station expansion)	$38.20	
	New force main from WSS to JS3 is not needed (current capacity up to 245 according to "West side system re-evaluation," HCE Aug 2002)	---	
	Open risers of SWOO to increase SWOO capacity	$3.50	
	SUBTOTAL		**$41.70**
Additional Pumping Capacity of CHS	90 mgd additional pump station (Including electrical, instrumentation, controls, and station building expansion)	$25.70	
	48 in dia. (approx. 4045 ft long) force main	$3.60	
	10 # of MHs on force main	$0.10	
	SUBTOTAL		**$29.40**
Modifications to the North Point Main	96" RCP (approx. 756') Sewer, diversion from NPM to the Division St. sewer	$1.20	
	Weir modifications @ Commercial and Jackson—lower by approximately 2-3 feet	$0.50	
	Seal approximately 6 existing MHs	$0.03	
	SUBTOTAL		**$1.73**
Cayuga Area Drainage Improvements	Auxiliary Alemany & Waterloo Sewers	$77.30	
	SUBTOTAL		**$77.30**
Modifications to SEP	SEP Headworks rebuilt to 120 MGD		
	RKS Upgraded from 120 to 180 MGD		
	400 MGD FM (approx 5800', 102")	$4.20	
	Additional 150 mgd of primary treatment (Including site work and landscaping)	By Others	
	BPS increased capacity from 150 mgd to 400 mgd	By Others	
	New/improved force main from BPS to SEBO to handle 250 mgd (from 110), 4200 ft long, 60" dia	By Others	
	New /improved gravity main from SEP to BPS. New flow = 400 mgd from 150 mgd (1600 ft long). Currently a 72 inch pipe with gradient = .048%.	By Others	
	New 400 mgd Southeast Bay Outfall	By Others	
	SUBTOTAL		**$4.20**
ENR = 9837.4			
		TOTAL	$181.53
		San Francisco Bay Area Construction (15%)	$27.23
		Construction Total	$208.76
		Engineering Services (Design) (10%)	$20.88
		Engineering Services (Construction) (25%)	$52.19
		Contingency (40%)	$83.50
		PROJECT TOTAL	**$365.32**

V. CSD REDUCTION

As a point of comparison, the effort and cost associated with reducing CSD activations to less than one per year at all discharge locations was investigated for each alternative. To attain this level of control, in addition to increasing the treatment capacities at the existing treatment facilities, additional storage and conveyance structures were added to the system. The location and size of the storage included in the analysis was determined from actual available locations and volumes that could be placed in the system. Similar configurations of storage and conveyance were added to all alternatives with a couple minor exceptions. Refer to Table 15 and Figure 8 for the locations and volumes of storage added to the model. This table details possible locations for additional storage, however it does not represent the only locations throughout the city where adding storage may be useful from a CSD reduction perspective. As different configurations of the storage were evaluated briefly, the proposed storage locations represent the locations believed to have the most benefit with the lowest cost and construction impacts.

For this analysis, no additional treatment facility locations were added. Instead, the capacity of existing facilities was increased. Due to flow constrictions in the system, it was necessary to add additional conveyance structures to decrease constrictions between overflow locations and the location of the treatment facilities. In particular, a 14-ft tunnel was added between Mission Creek and Islais Creek to alleviate the constriction caused by CHS and the 66-inch force main connecting Mission Creek to Islais Creek. The 42-inch pipe with energy dissipater connecting the Richmond Tunnel with the West Side Transport/Storage Box forces storage in the Richmond Tunnel but also acts as a flow constriction during heavy storms, causing the activation of the Mile Rock overflow. An additional 42-inch pipe was added parallel to the existing 42-inch pipe to alleviate this constriction, and the energy dissipater was also removed. Alternative configurations that can also be considered would include increasing conveyance on Fulton St to allow Old Richmond Tunnel and flows from Lake St area to get to the WST at Fulton/Great Highway area. The configuration that was modeled had a flow constriction in the Old Richmond Tunnel and was designed to use it as storage only. The size of the 72-inch pipe connecting the Lake Merced Transport to the West Side Box was increased to alleviate a flow constriction there.

This analysis presents one possible configuration for each alternative that can provide less than one CSD per year. The solution presented is not unique or necessarily the most cost-effective configuration, but is relevant to compare the effort required to obtain less than one average annual CSD per year. Different storage locations and volumes will result in different required additional treatment necessary. Further refinement of the analysis will likely provide a more efficient combination of treatment and storage than presented, however these give a good indicator of the scale of changes necessary to achieve less than one average annual CSD for each alternative.

Table 16 compares the additional treatment required to obtain one average annual CSD for the various alternatives.

Table 15. Storage Components of One CSD Option for All Alternatives

Location	Capacity (MG)
North Shore	
Marina Blvd between Avila St and Scott St	4
Total North Shore Additional Storage	**4**
Mission Creek	
Channel/Cesar-Chavez Tunnel	9
Total Mission Creek Additional Storage	**9**
Islais Creek	
DPW Yard at Cesar Chavez and Evans Ave	15
Total Islais Creek Additional Storage	**15**
Oceanside	
Additional Storage Below Great Highway	22
New Lake Street Tunnel, Old Richmond Tunnel Activated	**1.4**
Total Oceanside Additional Storage	**23.4**

Figure 8. Locations of Storage Components of One CSD Option for All Alternatives and Base Treatment Rates

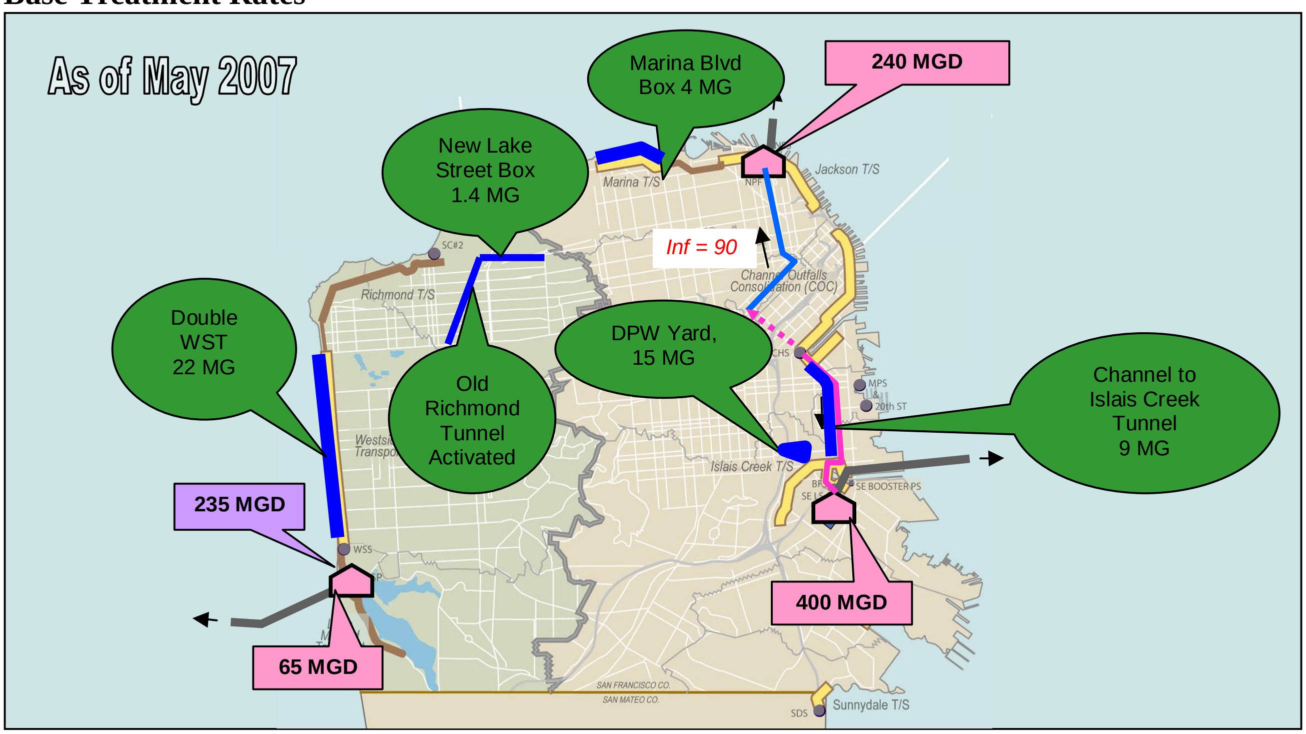


Table 16. Comparison of Treatment Requirements for One CSD Option of Alternatives

	Initial			Additional			Total		
	Alt 1	Alt 2	Alt 3	Alt 1	Alt 2	Alt 3	Alt 1	Alt 2	Alt 3
NPF	240	266	240	0	0	0	240	266	240
SEP	400	400	400	460	160	360	860	560	760
OSP	65	65	65				65	65	65
WST Decant	235	235	235	30	140	30	265	375	265
New OSP			150						150
Mariposa	10	10	10	25	25	25	35	35	35
SEP to WS			150						150

VII. COMPARISON OF ALTERNATIVES

In order to assist with evaluation of alternatives, a qualitative comparison between the findings of each simulation was developed.

Alternative 1 increases the primary treatment at the NPF to 240 mgd, the primary treatment at SEP to 250 mgd and the decant from the WST to 235 mgd (which with the maximum effluent from the OSP brings the total SWOO discharge to 300 mgd).

Alternative 2 includes the changes in Alternative 1, and adds a tunnel to divert flows from the Upper Islais Creek sewershed (aka "Cayuga") to the Oceanside to be treated at OSP. This diversion effectively moves approximately 3,000 acres (or 15%) of the existing Bayside sewer shed to the Oceanside sewershed. Secondary treatment (30 mgd) is added to the NPF and dry weather flow is treated within the North Shore sewershed, and is no longer pumped to the Southeast Plant.

Alternative 3 includes the changes to North Shore and the Channel Pump Station as in Alternative 1, and adds a New Oceanside Plant with a secondary capacity of 150 mgd. All dry weather flows from the Bayside sewershed are diverted to the Oceanside sewershed. The Southeast Plant is converted to a 400 mgd primary treatment plant.

Alternative 4 is similar to Alternative 1 as far as the collection system is concerned. The model results for Alternative 4 are expected to be the same as Alternative 1 with respect to CSD frequency and volume.

Tables 17-19 summarize the results of the collection system model analyses with respect to CSD activation frequency and discharge volume

Table 17. Comparison of Alternatives—Predicted CSD Frequency

Alternative	Overflow Count									
	Hunters Point	Islais Creek	Mission Creek	North Shore	Yosemite	Sunnydale	Lake Merced	Vicente	Lincoln	Mile Rock
Baseline	1	11	10	3	0	0	6	7	7	7
Alternative 1	0	8	6	1	0	0	2	2	1	7
Alternative 2	0	0	6	0	0	0	6	7	6	7
Alternative 3	0	1	6	1	0	0	2	2	1	7

Table 18. Comparison of Alternatives— Predicted CSD Volume

Alternative	Overflow Volume (Million Gallons)										
	Hunters Point	Islais Creek	Mission Creek	North Shore	Yosemite	Sunnydale	Lake Merced	Vicente	Lincoln	Mile Rock	**Total**
Baseline	0.4	865	353	16	0	0	13	58	80	54	**1456**
Alternative 1	0	202	160	2	0	0	2	3	3	51	**440**
Alternative 2	0	0	153	0	0	0	10	33	45	53	**311**
Alternative 3	0	20	162	2	0	0	2	3	3	51	**260**

Table 19. Comparison of Alternatives— Predicted CSD Reduction Compared with Baseline

Option	Change in Overflow Volume from Baseline (major locations only)															
	Hunters Point		Islais Creek		Mission Creek		North Shore		Lake Merced		Vicente		Lincoln		**Total**	
Baseline	0.4	--	865	--	353	--	16	--	13	--	58	--	80	--	1456	--
Alternative 1	0	100%	202	77%	160	55%	2	87%	2	86%	3	95%	3	96%	440	70%
Alternative 2	0	100%	0	100%	153	57%	0	100%	10	25%	33	44%	45	44%	311	79%
Alternative 3	0	100%	14	98%	162	54%	2	87%	2	86%	3	95%	3	96%	253	83%

Tables 20 and 21 present the total treatment volumes and treatment rates for each of the alternatives. The objective is to maximize the amount of secondary treatment while balancing the costs and the impacts of CSD to receiving waters.

Table 20. Overall Treatment Volumes (mg)

	Baseline	Alt 1 & 4	Alt 2	Alt 3
Bayside				
Nearshore Discharge	1,251	381	170	194
Southeast Plant/New Bayside Plant				
Secondary	26,499	26,128	17,895	
Primary	2,327	2,875	1,975	3,089
North Point Facility/Plant				
Secondary			5,177	
Primary	1,407	2,104	1,591	2,065
Westside				
Nearshore Discharge	205	59	140	59
Oceanside Plant				
Secondary	7,127	7,106	10,583	7,103
New Secondary Facility				26,142
Primary	586	566	773	564
Decant	1,261	1,449	2,377	1,466
Total Citywide				
Nearshore Discharge	1,456	440	311	253
Secondary (total)	33,626	33,234	33,655	33,245
Secondary (Dry Weather)	31,208	31,208	31,208	31,208
Secondary (Wet Weather)	2,419	2,026	2,447	2,038
Primary	4,320	5,545	4,338	5,718
Decant	1,261	1,449	2,377	1,466
Total Volume	40,662	40,667	40,681	40,682

Table 21. Design Treatment/Discharge Rates (mgd)

Treatment Volume in MG		Alternative		
Plant	Treatment	Alt 1	Alt 2	Alt 3
NPF	Secondary	-	26	-
	Primary	240	240	240
	Subtotal--NPO	240	266	240
SEP	Secondary	150	150	-
	Primary	250	250	400
	Subtotal--SEBO	400	400	400
OSP/ NOSP	Secondary	43	43	193
	Primary	22	22	22
	Decant	235	235	235
	Subtotal--SWOO	300	300	450

Table 22 compares the average annual pumping volume required for each alternative and baseline. For the alternatives, it is assumed that a new Southeast Bay Outfall and Southeast Booster Pump Station will be built with a capacities of 400 mgd. It is also assumed that effluent pump stations and outfalls will be included in the treatment plant analysis.

Table 22. Required Annual Pumping Volumes (mg)

TOTAL ANNUAL PUMPING VOLUMES in MG				
	Base	I 1	I 2	I 3
20th St	129	129	129	129
CHS North		1,078	944	1,047
CHS South	17,821	17,334	12,673	17,378
Geary Underpass	0	0	0	0
GPS	3,111	3,107	3,107	3,107
Mariposa (DW and WW)	872	872	872	872
NPS New WW		754	544	747
NS DW	6,080	4,805	5,191	4,813
NS WW	1,402	1,348	1,046	1,316
OS Decant	1,264	665	1,082	650
OS New Decant		789	1,296	806
OSP	7,711	7,667	11,352	7,668
Rankin	2,179	1,931	1,203	1,475
SE Lift Station	8,830	9,740	5,981	9,735
Seacliff #1	1	1	1	1
Seacliff #2	14	14	14	14
SEP to OSNP				26,145
Shotwell	1	0	0	0
Sunnydale	176	176	176	176
TOTAL	**49,591**	**50,412**	**45,612**	**76,079**

When compared with baseline, the total CSD volume for Alternatives 1 and 4 decreased by 68%, the CSD volume for Alternative 2 decreased by 79% and the CSD volume for Alternative 3 decreased by 82%.

The overall system flexibility and reliability is improved with Alternatives 1 and 4 due to the ability to pump either north or south from the Channel pump station. However, because the NPF is only primary treatment, this flexibility is somewhat constrained by the need to maximize secondary treatment at the SEP before pumping from Channel to NPF.

The overall flexibility and reliability of the system is greatly improved with Alternative 2. The addition of the Cayuga tunnel provides the system with the ability to balance both dry and wet weather flows between the Bayside and Oceanside. Additionally, the ability to pump either north or south from the Channel pump station coupled with the secondary capacities of both NPF and SEP on the Bayside makes Alternative 2 a flexible and reliable alternative.

Table 23. Comparison of Alternatives—Objectives

	Minimize CSD Frequency and Volume	Maximize Flexibility and Reliability	Reduce Flooding	Minimize CSD Impacts	TOTAL COST ($M)
Alt 1: Upgrade NPF, Increase Decant	○	◉	◉	○	○
Alt 2: New NPF, Cayuga Diversion	◉	●	●	◉	◉
Alt 3: Southeast Wet Weather Only	●	○	◉	●	●
Alt 4: Relocate Southeast Plant	○	◉	◉	○	●
KEY: ●=HIGH, ◉=MEDIUM, ○=LOW					

The overall flexibility and reliability of the system is not improved with Alternative 3 during dry weather as only OSP has the ability to treat to secondary capacity, and there is only one path for the Bayside flows to reach OSP. During wet weather, the flexibility and reliability of the system is somewhat improved based on the ability to pump either north or south from the Channel pump station.

While not specifically analyzed, Alternatives 1, 2, 3, and 4 will likely result in an improvement in flooding in areas hydraulically connected to the WST and/or Channel box (e.g., Vicente, South of Market) as these structures can be expected to have lower HGLs compared with baseline. The Cayuga tunnel in Alternative 2 provides relief to the Alemany sewer.

The impacts of CSDs on the Oceanside are reduced with Alternatives 1, 2, 3 and 4 due to the reduction of CSDs on Ocean Beach. On the Bayside, the impacts of CSDs are reduced with Alternatives 1, 2, 3, and 4 due to the reduction on CSDs on into Mission Creek. In addition, Alternative 2 moves sewer shed area from the Bay to Oceanside, reducing the total flows to the Bay in both wet and dry weather. In Alternative 3, all dry weather flows, including Bayside, are treated at NOSP which discharges out SWOO eliminating the flows from the Bay Outfall during dry weather.

Refer to the summary sections of each alternative discussion for a detailed discussion of the performance of each alternative.

Table 24 presents a comparison of the cost of the four alternatives.

Table 24. Comparison of Alternatives—Total Cost

	Alt 1	Alt 2	Alt 3	Alt 4
Total Cost (Millions)	$356.88	$390.28	$593.75	$365.32

VIII. FUTURE MODEL REFINEMENTS

In additional to the four primary alternatives and the preferred alternative, preliminary model analysis of several sub-alternatives has been completed during this phase of alternative analysis. At this time, detailed reporting on the specific results can not be included in this memorandum however various sub-alternatives can be subjectively discussed.

Sub-alternatives modeled include three separate alignments of the Cayuga tunnel, and various downstream configurations of each tunnel routing. For instance, the ability of each tunnel route to send decanted flows directly out SWOO was investigated; likewise each tunnel configuration was analyzed to determine if flows could gravity flow directly to OSP without being pumped on the Oceanside. Also analyzed were the effects of the Cayuga tunnel on the system without other system improvements. Alternative 3 was also analyzed with the addition of the Cayuga tunnel.

This modeling suggests that if looking at overall system impacts, the use of the Cayuga tunnel to improve flood protection, increase storage for treatment of wet weather flows and to be used as a conveyance of either limited Bayside diverted flows or all Bayside flows to OSP has an overall improved return on investment. For alternative 3, because the need to guarantee 150 mgd of Bayside wet weather flows receive secondary treatment to prevent backsliding, the force main options requires a very complex pump station. However with the tunnel, a substantial portion of Bayside wet weather flows would be diverted by gravity and consequently, the pump station could be smaller, maybe as low as 100 mgd. Modeling of this alternative was also done with complex RTC that maximized the storage and treatment on both west side and bay side and had even more substantial improvements in CSD performance. Additionally, some secondary treatment currently at SEP could conceivably be moved to OSP to allow more room at SEP and less pumping of flows from Bayside.

Additional Cayuga tunnel alignments have been proposed that would allow the tunnel to continue north from Cayuga to the western addition neighborhood allowing diversion of up to 35% of Bayside DW flows by gravity and also improving flood protection in the Division St. and some improvements in SOMA. Should treatment of 100% of Bayside at OSP flows be desired in the future, this also gives additional options for smaller force mains and use of existing pumping facilities at Channel and Rankin to pump into smaller FMs to the extended tunnel. These additional alignments will still need to be vetted for feasibility however.

Much analysis was also performed on the Channel North pump station and on gravity flows entering the North Point Main. Though not included in these alternatives, model results suggest that it is possible to divert an additional 45 mgd from SOMA into the NPM, reducing the Channel North Pumping requirement to 45 mgd.

APPENDIX B - PROJECT MEMORANDUM - ASSUMPTIONS FOR FOOTPRINT AND COST ESTIMATE OF ONE COMBINED SEWER DISCHARGE PER YEAR

DRAFT

PROJECT MEMORANDUM

Project Name:	SFPUC Sewer Master Plan	**Date:**	April 10, 2007
Client:	City and County of San Francisco	**Project Number:**	128680
Prepared By:	Fran Smith		
Reviewed By:	Denny Parker		
Subject:	Assumptions for Footprint and Cost Estimate of One Combined Sewer Discharge Per Year		
Distribution:	<Distribution>		

Introduction

This analysis is the first step in capturing components necessary to achieve one combined sewer discharge per year with all other flows receiving at least primary clarification. Other project elements (transport and storage) are to be determined by SF Public Works and Contract C consultants (M&E) and it is intended that this information is to be used as a component of their analysis.

The purpose of this memo is to present the costs and area requirements for treatment facilities to achieve this goal. The Actiflo® process has been chosen as the representative treatment technology because of its proven performance as a high rate clarification technology based on pilot studies conducted by the SFPUC. This analysis does not include a detailed site layout or process design and additional sites have not been identified for locating the additional treatment facilities. An initial cost estimate is included as well as an approximation of area needed for sufficient treatment capacity. The acreage and Actiflo® costs were determined by scaling from an existing project. Other costs were scaled from previous SFPUC Master Plan cost estimates.

Assumptions and Costs

San Francisco Public Works staff used modeling techniques to determine the additional flows that will need to be treated to achieve no more than one combined sewer discharge per year. These flows are listed in Table 1.

Table 1: Additional Flows to Each Treatment Plant[1]

Treatment Facility	Alternative 1 (mgd)	Alternative 2 (mgd)	Alternative 3 (mgd)	Alternative 4 (mgd)
SEP	570	210	170	570
NPF	30	0	30	30
OSP	0	0	0	0

[1]These flows are from an email from Greg Braswell, SFPWD to Denny Parker, BC, dated 3/18/07

For SEP, the assumption for each alternative was that there would be sufficient capacity to handle 250 mgd during wet weather and that to achieve the further reduction in CSDs, only the excess flow beyond this needed treatment by the Actiflo® process. The highest flows needing supplementary treatment were for Alternatives 1 and 4 (at 570 mgd). In the case of the NPF, the assumption was that the existing capacity was 240 mgd in each alternative, resulting in the maximum additional flow to be treated at NPF of 30 mgd. It can be assumed that the current primary clarifiers can provide adequate clarification and chemically enhanced primary clarification can be used to enhance the process by allowing a higher SOR during these peak events. Therefore, no significant additional costs were assumed for the NPF. No further treatment needs were identified for the OSP to achieve a goal of one combined sewer overflow per year, although other system improvements would be needed.

Neither the existing or upgraded SEP under any alternative can handle the increased flows in Table 1, so a separate facility will need to be built. This facility includes a lift station, headworks building with two stage screening (coarse screens followed by fine screens), Actiflo® units, effluent pump station, outfall and upgrades to the solids facilities for processing solids produced in Actiflo® process. It is assumed that the effluent pump station and outfall would be built as a common facility to handle all SEP flows, not just those generated to reduce the CSDs to achieve the targeted flows. The costs include new facilities and upsized facilities to accommodate the added flow. Upsized facilities are those that would have been built for each alternative, but would to be made larger to handle the additional wet weather flows and loads sent to the Actiflo® process. The breakdown of facilities included in the cost estimates is summarized Table 2.

Table 2: Elements Included in Cost Estimate

New Facilities	Upsized Facilities	Currently Not Included
• Influent Lift Pump Station • Headworks with coarse and fine bar screens • Actiflo® units • Sludge Storage	• Effluent Pump Station • Outfall • Solids Processing Facilities	• Increased collection system capacity (pipelines and storage) • Collection system and storage pump stations • Sludge pipe line • Land costs

To determine the sludge production it was necessary to include the production due to chemical additions as well as due to increased TSS reduction afforded by the Actiflo® process. These calculations are in Appendix A. The contribution from chemical addition was assumed to be 40 mg/L of TSS[1]. The increased load due to TSS in the treated flows was determined by using current data, provided by SFPUC, on water quality during overflow events and their pilot experience with the Actiflo® process. The total increased TSS load was then compared to the daily and monthly TSS loads that the SEP plant would otherwise receive, based on earlier SFPUC projections.. In this manner the percentage increase in facility capacity was determined. The extra storage needed was also calculated based on the additional solids loads generated by the Actiflo® process..

The costs associated with each alternative are shown in Table 3. The outfall and booster pump station costs are based on sizing the outfall for the combined flow of current SEP effluent and the effluent from the Actiflo® units. In order to prevent duplication, the costs of constructing an outfall for SEP flows that would prevail would further CSD reductions was subtracted in each alternative. The procedure for developing the outfall costs is in Appendix B. The cost for the

[1] Keller, J., Kobylinski, E., Hunter, G., Fitzpatrick, J. (2005) Actiflo: A Year's Worth of Operating Experience from the Largest SSO System in the US, WEFTEC 2005 Conference Proceedings; October 2005; pp 412.

Actiflo units is based on the cost of a similar facility, scaled up for the different flows. The remaining liquid processes, the headworks, screening and lift pumps, were scaled from the existing estimates. Appendix C includes the detailed cost estimate for all processes.

Table 3: Summary of Costs at SEP for all Alternatives

	Alternative 1 (dollars)	Alternative 2 (dollars)	Alternative 3 (dollars)	Alternative 4 (dollars)
Liquid treatment				
Headworks Building	69,985,261	26,917,408	21,533,926	69,985,261
Coarse Bar Screens	50,940,285	19,131,338	19,131,338	50,940,285
Mechanical Fine Bar Screens	121,028,880	46,581,835	37,275,954	121,028,880
Lift Pumps	36,081,997	13,008,130	10,444,367	36,081,997
Actiflo Units	370,286,543	149,142,303	116,707,186	370,286,543
Outfall & Booster PS	375,737,046	116,451,316	89,442,386	375,737,046
Liquid treatment sub-total	1,024,060,012	371,232,330	294,535,157	1,024,060,012
Solids treatment				
Mitigation	11,364,786	1,477,422	192,065	11,364,786
Civil/Site	348,428	45,296	5,888	348,428
Yard Piping	1,011,611	131,509	17,096	1,011,611
Unthickened Storage Tanks	3,309,149	2,250,221	1,530,150	3,309,149
Gravity Belt Co-thickening	8,233,284	5,598,633	3,807,071	8,233,284
Anaerobic Digesters	15,887,197	2,065,336	268,494	15,887,197
Past. Tanks & Heat Recovery	5,967,864	775,822	100,857	5,967,864
Digested Solids Storage	1,420,059	184,608	23,999	1,420,059
Digester Gas Management	5,688,784	739,542	96,140	5,688,784
Dewatering System	4,188,207	544,467	70,781	4,188,207
Odor Control & HVAC	5,057,947	657,533	85,479	5,057,947
Electrical/Instr	17,199,245	2,235,902	290,667	17,199,245
Storage	40,736,402	20,368,201	20,368,201	40,736,402
Solids treatment sub-total	120,412,962	37,074,492	26,856,889	120,412,962
Total	**1,144,472,973**	**408,306,821**	**321,392,046**	**1,144,472,973**

Appendix A

Sludge Production Using Actiflo to Prevent CSDs

Contributions from Chemical Additions and TSS

References include:

Keller, J., Ed Kobylinski, Gary L. Hunter, James D. Fitzpatrick, Actiflo: A Year's Worth of Operating Experience From the Largest SSO System in the US, WEFTEC 2005.

Bayside Wet Weather Overflow Monitoring Program Data Summary (Monitoring Data) - provided by SFPUC on 3/23/07

Flows and Definitions

$$MGD := 1000000 \frac{gal}{day}$$

$$MGal := 1000000gal$$

$$Q_{Alt1\_4} := 520MGD$$

$$Q_{Alt2} := 210MGD$$

$$Q_{Alt3} := 170MGD$$

Sludge Production from Chemical Addition

$$TSS_{Chem} := 40 \frac{mg}{L}$$

From Keller paper, pg. 412

Alternatives 1 and 4

$$Sludge_{FEAlt1\_4} := TSS_{Chem} \cdot Q_{Alt1\_4}$$

$$Sludge_{FEAlt1\_4} = 1.736 \times 10^5 \frac{lb}{day}$$

$$Totallbs_{Alt1\_4} := Sludge_{FEAlt1\_4} \cdot 2day$$

Assume 2 days of max flows

$$\boxed{Totallbs_{Alt1\_4} = 3.47 \times 10^5 lb}$$

Alternative 2

$Sludge_{FEAlt2} := TSS_{Chem} \cdot Q_{Alt2}$

$Sludge_{FEAlt2} = 7.01 \times 10^{4} \frac{lb}{day}$

$Totallbs_{Alt2} := Sludge_{FEAlt2} \cdot 2day$

Assume 2 days of max flows

$Totallbs_{Alt2} = 1.4 \times 10^{5}\ lb$

Alternative 3

$Sludge_{FEAlt3} := TSS_{Chem} \cdot Q_{Alt3}$

$Sludge_{FEAlt3} = 5.675 \times 10^{4} \frac{lb}{day}$

$Totallbs_{Alt3} := Sludge_{FEAlt3} \cdot 2day$

Assume 2 days of max flows

$Totallbs_{Alt3} = 1.13 \times 10^{5}\ lb$

Incremental Contributions from TSS

$AveIncreasedInfluentTSS := 91\frac{mg}{L}$

Ave value from Monitoring Data - 3/23/07

$AveEffluentTSS := 10\frac{mg}{L}$

Value approximated from SFPUC Actiflo pilot plant data - per email from Humphrey Ho 3/23/07

$TSSRemoved := AveIncreasedInfluentTSS - AveEffluentTSS$

$TSSRemoved = 81\frac{mg}{L}$

Alternatives 1 and 4

$IncrTSS_{Alt1\_4} := Q_{Alt1\_4} \cdot TSSRemoved$

$IncrTSS_{Alt1\_4} = 3.515 \times 10^{5}\frac{lb}{day}$

$TotTSSlb_{Alt1\_4} := IncrTSS_{Alt1\_4} \cdot 2day$

$\boxed{TotTSSlb_{Alt1\_4} = 7.03 \times 10^{5}\,lb}$

Alternative 2

$IncrTSS_{Alt2} := Q_{Alt2} \cdot TSSRemoved$

$IncrTSS_{Alt2} = 1.42 \times 10^{5}\frac{lb}{day}$

$TotTSSlb_{Alt2} := IncrTSS_{Alt2} \cdot 2day$

$\boxed{TotTSSlb_{Alt2} = 2.84 \times 10^{5}\,lb}$

Alternative 3

$IncrTSS_{Alt3} := Q_{Alt3} \cdot TSSRemoved$

$IncrTSS_{Alt3} = 1.149 \times 10^{5} \frac{lb}{day}$

$TotTSSlb_{Alt3} := IncrTSS_{Alt3} \cdot 2day$

$TotTSSlb_{Alt3} = 2.3 \times 10^{5} lb$

Needed increase in solids treatment

Alternatives 1 and 4

$PeakDay_1 := 773000 \frac{lb}{day}$

$PeakMonth_1 := 280000 \frac{lb}{day}$

Values from Master Plant Alternatives Flow and Loads matrix updated by Humphrey Ho on 3/6/07

$$TotalIncrSludge_{PeakDay1} := \frac{\frac{Totallbs_{Alt1\_4} + TotTSSlb_{Alt1\_4}}{2day}}{PeakDay_1}$$

$TotalIncrSludge_{PeakDay1} = 0.68$ *Use this percent upgrade for Thickening*

$$TotalIncrSludge_{PeakMonth1} := \frac{Totallbs_{Alt1\_4} + TotTSSlb_{Alt1\_4}}{PeakMonth_1 \cdot 30day}$$

$TotalIncrSludge_{PeakMonth1} = 0.13$ *Use this percent upgrade for Digestion and Dewatering*

Alternative 2

$PeakDay_2 := 467000 \frac{lb}{day}$

$PeakMonth_2 := 176000 \frac{lb}{day}$

$$TotalIncrSludge_{PeakDay2} := \frac{\frac{Totallbs_{Alt2} + TotTSSlb_{Alt2}}{2day}}{PeakDay_2}$$

$TotalIncrSludge_{PeakDay2} = 0.45$ *Use this percent upgrade for Thickening*

$$TotalIncrSludge_{PeakMonth2} := \frac{Totallbs_{Alt2} + TotTSSlb_{Alt2}}{PeakMonth_2 \cdot 30day}$$

$TotalIncrSludge_{PeakMonth2} = 0.08$ *Use this percent upgrade for Digestion and Dewatering*

Alternative 3 - (sludge will be treated at the OBC)

$$PeakDay_3 := 773000 \frac{lb}{day}$$

$$PeakMonth_3 := 289000 \frac{lb}{day}$$

$$TotalIncrSludge_{PeakDay3} := \frac{\frac{Totallbs_{Alt3}+TotTSSlb_{Alt3}}{2day}}{PeakDay_3}$$

$$TotalIncrSludge_{PeakDay3} = 0.22$$

Use this percent upgrade for Thickening

$$TotalIncrSludge_{PeakMonth3} := \frac{Totallbs_{Alt3} + TotTSSlb_{Alt3}}{PeakMonth_3 \cdot 30day}$$

$$TotalIncrSludge_{PeakMonth3} = 0.04$$

Use this percent upgrade for Digestion and Dewatering

Volume of Storage Needed

Assume storage is needed for a event that occurs at peak flow over 2 days.
Use a safety factor of 2 to allow for duration in case of back to back storms.

$SafetyFactor := 2$

$$Volume_{1\_4} := \frac{Totallbs_{Alt1\_4} + TotTSSlb_{Alt1\_4}}{0.05 \cdot 8.34 \frac{lb}{gal}} \cdot SafetyFactor$$

$Volume_{1\_4} = 5.04\,MGal$

This is approximately equivalent to two 2.5 MG digestors

$$Volume_{2} := \frac{Totallbs_{Alt2} + TotTSSlb_{Alt2}}{0.05 \cdot 8.34 \frac{lb}{gal}} \cdot SafetyFactor$$

$Volume_{2} = 2.03\,MGal$

One digester can be used for this storage.

$$Volume_{3} := \frac{Totallbs_{Alt3} + TotTSSlb_{Alt3}}{0.05 \cdot 8.34 \frac{lb}{gal}} \cdot SafetyFactor$$

$Volume_{3} = 1.65\,MGal$

One digester can be used for this storage.

Appendix B

Smith, Fran

From: Faisst, Bill
Sent: Tuesday, March 27, 2007 4:37 PM
To: Smith, Fran; Parker, Denny
Cc: Slezak, Lloyd
Subject: Bayside Discharges at Southeast--Additional Alternatives

Fran and Denny:

Based on Fran's email of March 19, 2007, I understand that we need sizes and costs for three additional alternative flows from the Southeast Water Pollution Control Plant. The additional flows are as follows:

- 420 mgd
- 460 mgd
- 820 mgd

Using the pipeline flow criterion of 8 feet per second (fps), I calculated the following diameters:

- For 420 mgd and 8 fps velocity, the calculated diameter is 10.18 ft. Therefore round down to 10 ft diameter with an actual velocity of 8.29 fps.
- For 460 mgd and 8 fps velocity, the calculated diameter is 10.65 ft. Therefore round up to 11 ft diameter with an actual velocity of 7.50 fps. Note that this rounding is conservative. During detailed design this value should be checked as it might be cost effective to use 10-ft diameter pipe but a detailed cost-effectiveness analysis is beyond the current scope.
- For 820 mgd and 8 fps velocity, the calculated diameter is 14.22 ft. Therefore round down to 14 ft diameter with an actual velocity of 8.26 fps.

The average water depth for each diffuser is about 50 feet. The offshore pipeline length upstream of the diffuser would be the same as those shown in Table 3, 2500 feet for an alignment north of Islais Channel and 1,900 ft south of Islais Channel. The corresponding diffuser lengths are as follows:

- For a flow of 420 mgd, the length is 8,700 ft. Total offshore system length of 11,200 ft north of Islais Channel. Total system length of 10,600 ft south of Islais Channel.
- For a flow of 460 mgd, the length is 8,900 ft. Total offshore system length of 11,400 ft north of Islais Channel. Total system length of 10,800 ft south of Islais Channel.
- For a flow of 820 mgd, the length is 15,800 ft. Total offshore system length of 18,300 ft north of Islais Channel. Total system length of 17,700 ft south of Islais Channel.

Using unit costs for the offshore construction developed from the technical memo (system lengths from Table 3 and costs from Table 5, I arrive at the following unit costs:

- For a flow of 420 mgd, the unit cost is $6,200/ ft.
- For a flow of 460 mgd, the unit cost is $6,700/ft.
- For a flow of 820 mgd, the unit cost is $8,100/ft.

Offshore Section

The total offshore cost for each flow rate is:

North of Islais Channel
- For a flow of 420 mgd, the total cost is $69 million.
- For a flow of 460 mgd, the total cost is $76 million.

- For a flow of 820 mgd, the total cost is $148 million. Note that this cost assumes a uniform diameter for the diffuser for its full length. Given the huge cost and long length, we could use 10-ft diameter pipe for the 7,900 ft furthest offshore, reducing the cost by (7,900) x ($8,100-$6,200) = $15 million.

South of Islais Channel

- For a flow of 420 mgd, the total cost is $66 million
- For a flow of 460 mgd, the total cost is $72 million
- For a flow of 820 mgd, the total cost is $143 million

Onshore Section

For the onshore facilities I scaled costs using a 7/10ths power rule applied to peak flow capacity to arrive at the following:

North of Islais Channel

- For a flow of 420 mgd, the total cost is $135 million.
- For a flow of 460 mgd, the total cost is $143 million
- For a flow of 820 mgd, the total cost is $215 million

South of Islais Channel

- For a flow of 420 mgd, the total cost is $131 million
- For a flow of 460 mgd, the total cost is $140 million
- For a flow of 820 mgd, the total cost is $210 million

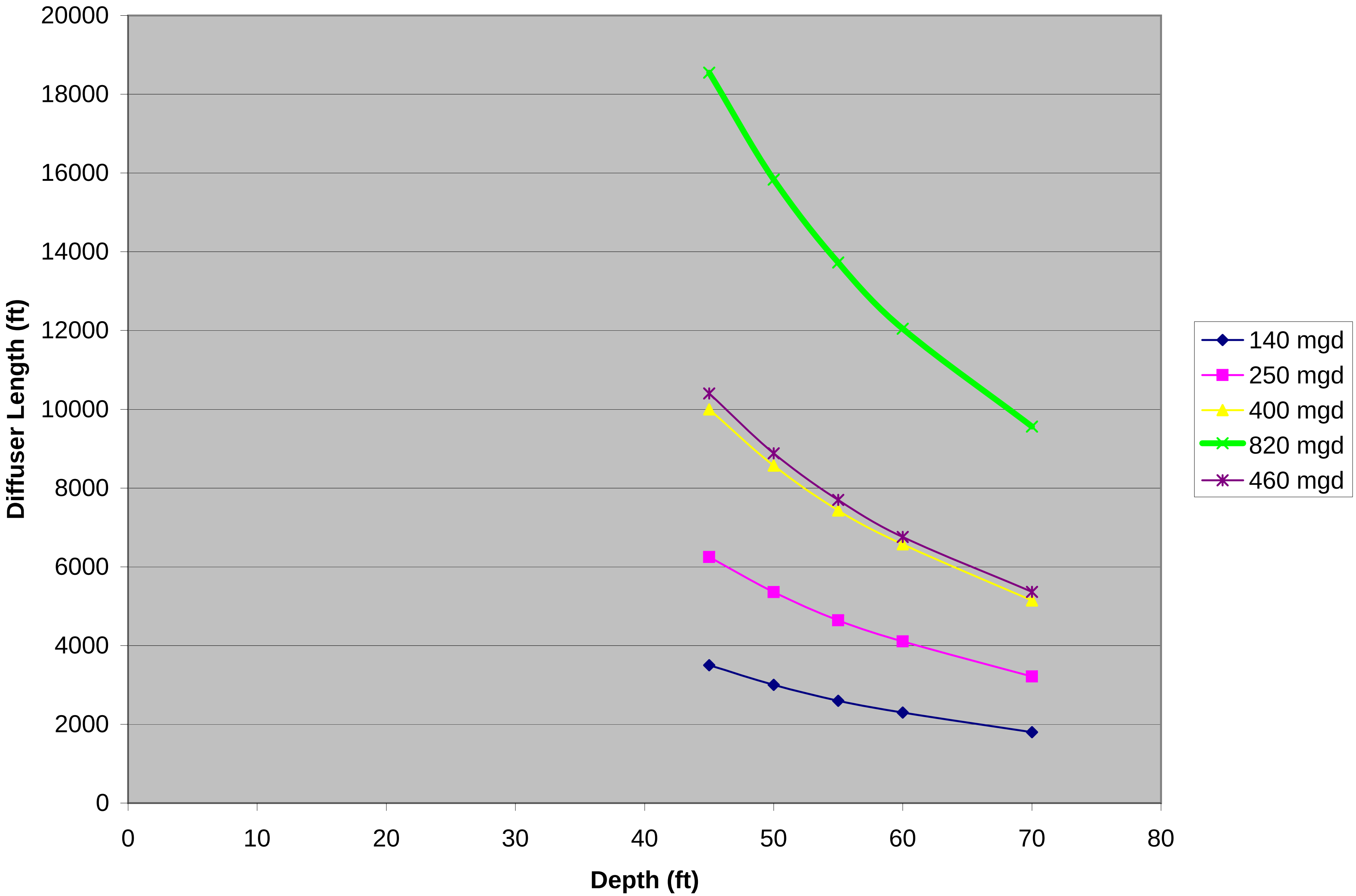
Note that the costs presented above **do not** include any of the costs that Butch Matthews has added to my previous estimates--Contractor's overhead and profit, etc. Also more fine tuning of the diffusers could save a bit on costs as noted above but at this stage that's probably premature.

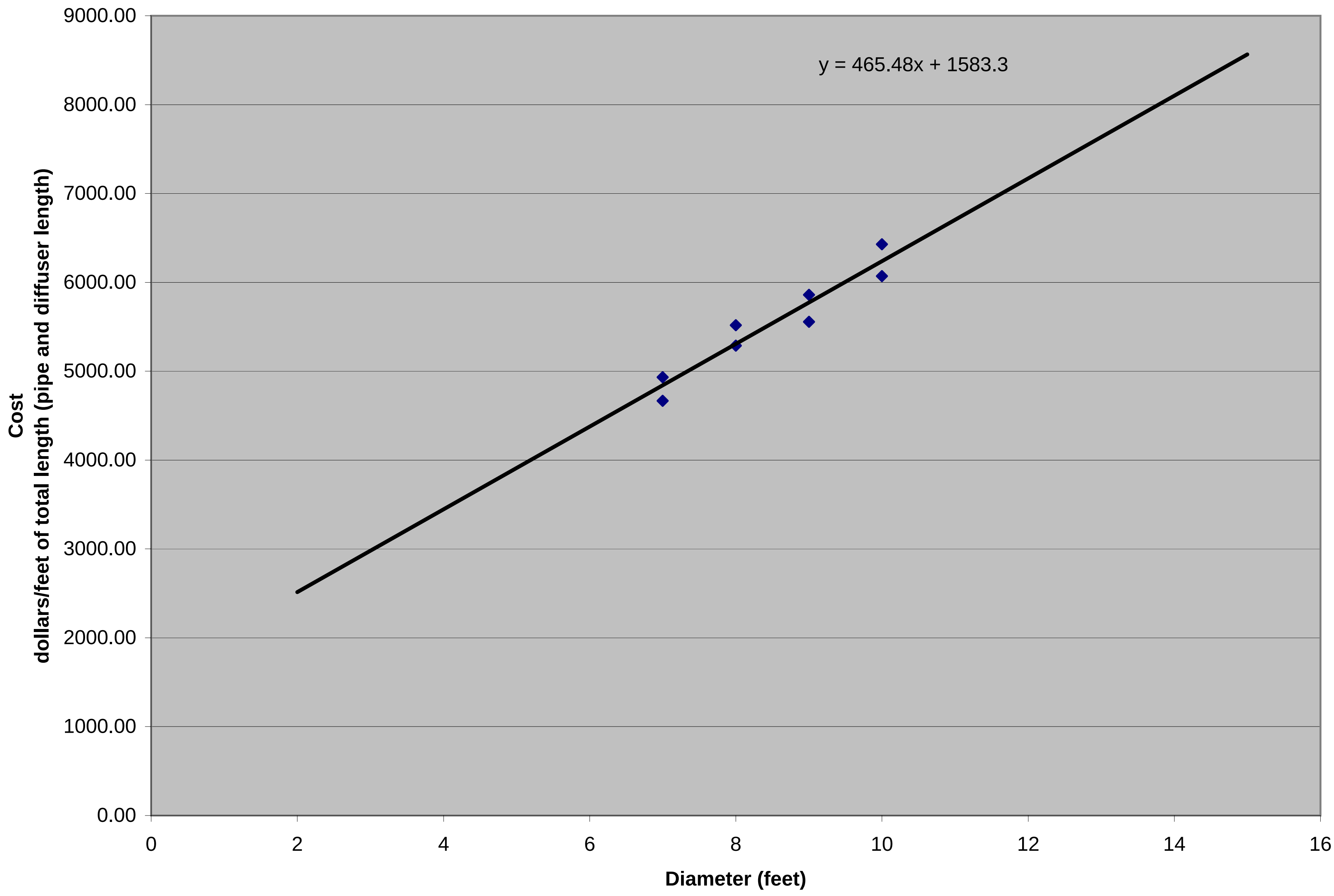
Please call or email with any questions or comments.

Bill

P.S. Fran--For our internal files, let's attach copies of the curves that you worked up for me to a hard copy of this email.

Bill Faisst
bfaisst@brwncald.com
925-210-2384 (direct)
925-997-6992 (mobile)
925-937-9026 (fax)


Diffuser Length (ft)
Depth (ft)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
0
10
20
30
40
50
60
70
80
140 mgd
250 mgd
400 mgd
820 mgd
460 mgd



y = 465.48x + 1583.3
9000.00
8000.00
7000.00
6000.00
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
0
2
4
6
8
10
12
14
16
Cost
dollars/feet of total length (pipe and diffuser length)
Diameter (feet)

Appendix C

Lift Pumps Alternatives 1 and 4

Pump #	14	
Raw total	12,007,967	
30.00%	3,602,390	Labor
70.00%	8,405,577	Material
	75,000	Equipment
25.00%	6,022,733	Electrical/Instrumenation (Subcontractor)
	18,105,700	Net Costs
18%	648,430	Labor Mark-up
15%	1,260,836	Material Mark-up
5%	301,137	Subcontractor Mark-up
15%	11,250	Equipment Mark-up
8.75%	735,488	Sales tax (material)
8.75%	6,563	Sales tax (equipment)
4.00%	336,223	Material Shipping & Handling
1.00%	36,024	Worker's Travel/Subsistence
	21,441,651	Subtotal
12%	2,572,998	Contractor General Conditions
	24,014,649	Subtotal
2%	480,293	Start-up, training, O&M
	24,494,942	Subtotal
30%	7,348,483	Design and Construction Contingency
	31,843,424	Subtotal
8%	509,318	Escalation to Year end 2007 Labor
	32,352,742	Subtotal
8%	1,275,792	Escalation to Year end 2007 materials
	33,628,535	Subtotal
8%	762,363	Escal. To Year end 2007 Subs, equip
	34,390,898	Subtotal
2.85%	980,141	Bldg Risk, Liability Auto Ins
	35,371,039	Subtotal
1%	353,710	Performance Bond
	35,724,749	Subtotal
1%	357,247	Payment Bond
	36,081,997	Subtotal
	36,081,997	Total Estimate

Lift Pumps Alternative 2

Pump #	5	
Raw total	4,288,560	
30.00%	1,286,568	Labor
70.00%	3,001,992	Material
	75,000	Equipment
25.00%	2,163,030	Electrical/Instrumenation (Subcontractor)
	6,526,589	Net Costs
18%	231,582	Labor Mark-up
15%	450,299	Material Mark-up
5%	108,151	Subcontractor Mark-up
15%	11,250	Equipment Mark-up
8.75%	262,674	Sales tax (material)
8.75%	6,563	Sales tax (equipment)
4.00%	120,080	Material Shipping & Handling
1.00%	12,866	Worker's Travel/Subsistence
	7,730,054	Subtotal
12%	927,606	Contractor General Conditions
	8,657,660	Subtotal
2%	173,153	Start-up, training, O&M
	8,830,813	Subtotal
30%	2,649,244	Design and Construction Contingency
	11,480,058	Subtotal
8%	181,899	Escalation to Year end 2007 Labor
	11,661,957	Subtotal
8%	455,640	Escalation to Year end 2007 materials
	12,117,597	Subtotal
8%	280,865	Escal. To Year end 2007 Subs, equip
	12,398,462	Subtotal
2.85%	353,356	Bldg Risk, Liability Auto Ins
	12,751,818	Subtotal
1%	127,518	Performance Bond
	12,879,336	Subtotal
1%	128,793	Payment Bond
	13,008,130	Subtotal
	13,008,130	Total Estimate

Lift Pumps Alternative 3

Pump #	4	
Raw total	3,430,848	
30.00%	1,029,254	Labor
70.00%	2,401,593	Material
	75,000	Equipment
25.00%	1,734,174	Electrical/Instrumenation (Subcontractor)
	5,240,021	Net Costs
18%	185,266	Labor Mark-up
15%	360,239	Material Mark-up
5%	86,709	Subcontractor Mark-up
15%	11,250	Equipment Mark-up
8.75%	210,139	Sales tax (material)
8.75%	6,563	Sales tax (equipment)
4.00%	96,064	Material Shipping & Handling
1.00%	10,293	Worker's Travel/Subsistence
	6,206,543	Subtotal
12%	744,785	Contractor General Conditions
	6,951,328	Subtotal
2%	139,027	Start-up, training, O&M
	7,090,355	Subtotal
30%	2,127,106	Design and Construction Contingency
	9,217,461	Subtotal
8%	145,519	Escalation to Year end 2007 Labor
	9,362,981	Subtotal
8%	364,512	Escalation to Year end 2007 materials
	9,727,493	Subtotal
8%	227,365	Escal. To Year end 2007 Subs, equip
	9,954,858	Subtotal
2.85%	283,713	Bldg Risk, Liability Auto Ins
	10,238,572	Subtotal
1%	102,386	Performance Bond
	10,340,957	Subtotal
1%	103,410	Payment Bond
	10,444,367	Subtotal
	10,444,367	Total Estimate

Headworks - Alternatives 1 and 4

Raw total	19,697,018	
41.9261%	8,258,198	Labor
29.2493%	5,761,246	Material
23.3573%	4,600,700	Subcontractor
5.4672%	1,076,875	Equipment
		Other
	19,697,018	Net Costs
18%	1,486,476	Labor Mark-up
15%	864,187	Material Mark-up
5%	230,035	Subcontractor Mark-up
15%	161,531	Equipment Mark-up
8.75%	504,109	Sales tax (material)
8.75%	94,227	Sales tax (equipment)
4.00%	230,450	Material Shipping & Handling
1.00%	82,582	Worker's Travel/Subsistence
	43,047,633	Subtotal
12%	5,165,716	Contractor General Conditions
	48,213,348	Subtotal
2%	964,267	Start-up, training, O&M
	49,177,615	Subtotal
30%	14,753,285	Design and Construction Contingency
	63,930,900	Subtotal
8%	1,167,572	Escalation to Year end 2007 Labor
	65,098,472	Subtotal
8%	874,438	Escalation to Year end 2007 materials
	65,972,910	Subtotal
8%	732,267	Escal. To Year end 2007 Subs, equip
	66,705,177	Subtotal
2.85%	1,901,098	Bldg Risk, Liability Auto Ins
	68,606,275	Subtotal
1%	686,063	Performance Bond
	69,292,337	Subtotal
1%	692,923	Payment Bond
	69,985,261	Subtotal
	69,985,261	Total Estimate

Headworks - Alternative 2

Raw total	7,575,776	
16.1254%	3,176,230	Labor
11.2497%	2,215,864	Material
8.9836%	1,769,500	Subcontractor
2.1028%	414,183	Equipment
		Other
	7,575,776	Net Costs
18%	571,721	Labor Mark-up
15%	332,380	Material Mark-up
5%	88,475	Subcontractor Mark-up
15%	62,127	Equipment Mark-up
8.75%	193,888	Sales tax (material)
8.75%	36,241	Sales tax (equipment)
4.00%	88,635	Material Shipping & Handling
1.00%	31,762	Worker's Travel/Subsistence
	16,556,782	Subtotal
12%	1,986,814	Contractor General Conditions
	18,543,596	Subtotal
2%	370,872	Start-up, training, O&M
	18,914,467	Subtotal
30%	5,674,340	Design and Construction Contingency
	24,588,808	Subtotal
8%	449,066	Escalation to Year end 2007 Labor
	25,037,874	Subtotal
8%	336,322	Escalation to Year end 2007 materials
	25,374,196	Subtotal
8%	281,641	Escal. To Year end 2007 Subs, equip
	25,655,837	Subtotal
2.85%	731,191	Bldg Risk, Liability Auto Ins
	26,387,029	Subtotal
1%	263,870	Performance Bond
	26,650,899	Subtotal
1%	266,509	Payment Bond
	26,917,408	Subtotal
	26,917,408	Total Estimate

Headworks - Alternative 3

Raw total	6,060,621	
12.9003%	2,540,984	Labor
8.9998%	1,772,691	Material
7.1869%	1,415,600	Subcontractor
1.6822%	331,346	Equipment
		Other
	6,060,621	Net Costs
18%	457,377	Labor Mark-up
15%	265,904	Material Mark-up
5%	70,780	Subcontractor Mark-up
15%	49,702	Equipment Mark-up
8.75%	155,110	Sales tax (material)
8.75%	28,993	Sales tax (equipment)
4.00%	70,908	Material Shipping & Handling
1.00%	25,410	Worker's Travel/Subsistence
	13,245,425	Subtotal
12%	1,589,451	Contractor General Conditions
	14,834,876	Subtotal
2%	296,698	Start-up, training, O&M
	15,131,574	Subtotal
30%	4,539,472	Design and Construction Contingency
	19,671,046	Subtotal
8%	359,253	Escalation to Year end 2007 Labor
	20,030,299	Subtotal
8%	269,058	Escalation to Year end 2007 materials
	20,299,357	Subtotal
8%	225,313	Escal. To Year end 2007 Subs, equip
	20,524,670	Subtotal
2.85%	584,953	Bldg Risk, Liability Auto Ins
	21,109,623	Subtotal
1%	211,096	Performance Bond
	21,320,719	Subtotal
1%	213,207	Payment Bond
	21,533,926	Subtotal
	21,533,926	Total Estimate

Coarse screens - Alternatives 1 and 4

Screen #	8	
Raw total	21,600,000	
40.0000%	8,640,000	Labor
60.0000%	12,960,000	Material
15.0000%	3,240,000	Subcontractor
	100,000	Equipment
		Other
	24,840,000	Net Costs
18%	1,555,200	Labor Mark-up
15%	1,944,000	Material Mark-up
5%	162,000	Subcontractor Mark-up
15%	15,000	Equipment Mark-up
8.75%	1,134,000	Sales tax (material)
8.75%	8,750	Sales tax (equipment)
4.00%	518,400	Material Shipping & Handling
1.00%	86,400	Worker's Travel/Subsistence
	30,263,750	Subtotal
12%	3,631,650	Contractor General Conditions
	33,895,400	Subtotal
2%	677,908	Start-up, training, O&M
	34,573,308	Subtotal
30%	10,371,992	Design and Construction Contingency
	44,945,300	Subtotal
8%	1,221,553	Escalation to Year end 2007 Labor
	46,166,853	Subtotal
8%	1,967,059	Escalation to Year end 2007 materials
	48,133,912	Subtotal
8%	418,893	Escal. To Year end 2007 Subs, equip
	48,552,805	Subtotal
2.85%	1,383,755	Bldg Risk, Liability Auto Ins
	49,936,560	Subtotal
1%	499,366	Performance Bond
	50,435,926	Subtotal
1%	504,359	Payment Bond
	50,940,285	Subtotal
	50,940,285	Total Estimate

Coarse screens - Alternatives 2 and 3

Screen #	3	
Raw total	8,100,000	
40.0000%	3,240,000	Labor
60.0000%	4,860,000	Material
15.0000%	1,215,000	Subcontractor
	100,000	Equipment
		Other
	9,315,000	Net Costs
18%	583,200	Labor Mark-up
15%	729,000	Material Mark-up
5%	60,750	Subcontractor Mark-up
15%	15,000	Equipment Mark-up
8.75%	425,250	Sales tax (material)
8.75%	8,750	Sales tax (equipment)
4.00%	194,400	Material Shipping & Handling
1.00%	32,400	Worker's Travel/Subsistence
	11,363,750	Subtotal
12%	1,363,650	Contractor General Conditions
	12,727,400	Subtotal
2%	254,548	Start-up, training, O&M
	12,981,948	Subtotal
30%	3,894,584	Design and Construction Contingency
	16,876,532	Subtotal
8%	454,233	Escalation to Year end 2007 Labor
	17,330,765	Subtotal
8%	737,647	Escalation to Year end 2007 materials
	18,068,412	Subtotal
8%	166,274	Escal. To Year end 2007 Subs, equip
	18,234,687	Subtotal
2.85%	519,689	Bldg Risk, Liability Auto Ins
	18,754,375	Subtotal
1%	187,544	Performance Bond
	18,941,919	Subtotal
1%	189,419	Payment Bond
	19,131,338	Subtotal
	19,131,338	Total Estimate

Fine screens - Alternatives 1 and 4

Screen #	13	
Raw total	51,350,000	
40.0000%	20,540,000	Labor
60.0000%	30,810,000	Material
15.0000%	7,702,500	Subcontractor
	100,000	Equipment
		Other
	59,052,500	Net Costs
18%	3,697,200	Labor Mark-up
15%	4,621,500	Material Mark-up
5%	385,125	Subcontractor Mark-up
15%	15,000	Equipment Mark-up
8.75%	2,695,875	Sales tax (material)
8.75%	8,750	Sales tax (equipment)
4.00%	1,232,400	Material Shipping & Handling
1.00%	205,400	Worker's Travel/Subsistence
	71,913,750	Subtotal
12%	8,629,650	Contractor General Conditions
	80,543,400	Subtotal
2%	1,610,868	Start-up, training, O&M
	82,154,268	Subtotal
30%	24,646,280	Design and Construction Contingency
	106,800,548	Subtotal
8%	2,904,016	Escalation to Year end 2007 Labor
	109,704,564	Subtotal
8%	4,676,319	Escalation to Year end 2007 materials
	114,380,883	Subtotal
8%	975,590	Escal. To Year end 2007 Subs, equip
	115,356,473	Subtotal
2.85%	3,287,659	Bldg Risk, Liability Auto Ins
	118,644,133	Subtotal
1%	1,186,441	Performance Bond
	119,830,574	Subtotal
1%	1,198,306	Payment Bond
	121,028,880	Subtotal
	121,028,880	Total Estimate

Fine screens - Alternative 2

Screen #	5	
Raw total	19,750,000	
40.0000%	7,900,000	Labor
60.0000%	11,850,000	Material
15.0000%	2,962,500	Subcontractor
	100,000	Equipment
		Other
	22,712,500	Net Costs
18%	1,422,000	Labor Mark-up
15%	1,777,500	Material Mark-up
5%	148,125	Subcontractor Mark-up
15%	15,000	Equipment Mark-up
8.75%	1,036,875	Sales tax (material)
8.75%	8,750	Sales tax (equipment)
4.00%	474,000	Material Shipping & Handling
1.00%	79,000	Worker's Travel/Subsistence
	27,673,750	Subtotal
12%	3,320,850	Contractor General Conditions
	30,994,600	Subtotal
2%	619,892	Start-up, training, O&M
	31,614,492	Subtotal
30%	9,484,348	Design and Construction Contingency
	41,098,840	Subtotal
8%	1,116,929	Escalation to Year end 2007 Labor
	42,215,769	Subtotal
8%	1,798,584	Escalation to Year end 2007 materials
	44,014,353	Subtotal
8%	384,275	Escal. To Year end 2007 Subs, equip
	44,398,628	Subtotal
2.85%	1,265,361	Bldg Risk, Liability Auto Ins
	45,663,989	Subtotal
1%	456,640	Performance Bond
	46,120,629	Subtotal
1%	461,206	Payment Bond
	46,581,835	Subtotal
	46,581,835	Total Estimate

Fine screens - Alternative 3

Screen #	4	
Raw total	15,800,000	
40.0000%	6,320,000	Labor
60.0000%	9,480,000	Material
15.0000%	2,370,000	Subcontractor
	100,000	Equipment
		Other
	18,170,000	Net Costs
18%	1,137,600	Labor Mark-up
15%	1,422,000	Material Mark-up
5%	118,500	Subcontractor Mark-up
15%	15,000	Equipment Mark-up
8.75%	829,500	Sales tax (material)
8.75%	8,750	Sales tax (equipment)
4.00%	379,200	Material Shipping & Handling
1.00%	63,200	Worker's Travel/Subsistence
	22,143,750	Subtotal
12%	2,657,250	Contractor General Conditions
	24,801,000	Subtotal
2%	496,020	Start-up, training, O&M
	25,297,020	Subtotal
30%	7,589,106	Design and Construction Contingency
	32,886,126	Subtotal
8%	893,543	Escalation to Year end 2007 Labor
	33,779,669	Subtotal
8%	1,438,867	Escalation to Year end 2007 materials
	35,218,537	Subtotal
8%	310,360	Escal. To Year end 2007 Subs, equip
	35,528,897	Subtotal
2.85%	1,012,574	Bldg Risk, Liability Auto Ins
	36,541,471	Subtotal
1%	365,415	Performance Bond
	36,906,885	Subtotal
1%	369,069	Payment Bond
	37,275,954	Subtotal
	37,275,954	Total Estimate

Actiflo - Alternatives 1 and 4

Mat. total	109,800,000	
	35,000,000	Labor
	109,800,000	Material
	75,000	Equipment
25.00%	36,218,750	Electrical/Instrumenation (Subcontractor)
	181,093,750	Net Costs
18%	6,300,000	Labor Mark-up
15%	16,470,000	Material Mark-up
5%	1,810,938	Subcontractor Mark-up
15%	11,250	Equipment Mark-up
8.75%	9,607,500	Sales tax (material)
8.75%	6,563	Sales tax (equipment)
4.00%	4,392,000	Material Shipping & Handling
1.00%	350,000	Worker's Travel/Subsistence
	220,042,000	Subtotal
12%	26,405,040	Contractor General Conditions
	246,447,040	Subtotal
2%	4,928,941	Start-up, training, O&M
	251,375,981	Subtotal
30%	75,412,794	Design and Construction Contingency
	326,788,775	Subtotal
8%	4,948,420	Escalation to Year end 2007 Labor
	331,737,195	Subtotal
8%	16,665,363	Escalation to Year end 2007 materials
	348,402,558	Subtotal
8%	4,529,319	Escal. To Year end 2007 Subs, equip
	352,931,877	Subtotal
2.85%	10,058,558	Bldg Risk, Liability Auto Ins
	362,990,436	Subtotal
1%	3,629,904	Performance Bond
	366,620,340	Subtotal
1%	3,666,203	Payment Bond
	370,286,543	Subtotal
	370,286,543	Total Estimate

Actiflo - Alternative 2

Mat. total	40,500,000	
	18,000,000	Labor
	40,500,000	Material
	75,000	Equipment
25.00%	14,643,750	Electrical/Instrumenation (Subcontractor)
	73,218,750	Net Costs
18%	3,240,000	Labor Mark-up
15%	6,075,000	Material Mark-up
5%	732,188	Subcontractor Mark-up
15%	11,250	Equipment Mark-up
8.75%	3,543,750	Sales tax (material)
8.75%	6,563	Sales tax (equipment)
4.00%	1,620,000	Material Shipping & Handling
1.00%	180,000	Worker's Travel/Subsistence
	88,627,500	Subtotal
12%	10,635,300	Contractor General Conditions
	99,262,800	Subtotal
2%	1,985,256	Start-up, training, O&M
	101,248,056	Subtotal
30%	30,374,417	Design and Construction Contingency
	131,622,473	Subtotal
8%	2,544,902	Escalation to Year end 2007 Labor
	134,167,374	Subtotal
8%	6,147,060	Escalation to Year end 2007 materials
	140,314,435	Subtotal
8%	1,837,836	Escal. To Year end 2007 Subs, equip
	142,152,271	Subtotal
2.85%	4,051,340	Bldg Risk, Liability Auto Ins
	146,203,610	Subtotal
1%	1,462,036	Performance Bond
	147,665,646	Subtotal
1%	1,476,656	Payment Bond
	149,142,303	Subtotal
	149,142,303	Total Estimate

Actiflo - Alternative 3

Mat. total	32,700,000	
	13,000,000	Labor
	32,700,000	Material
	75,000	Equipment
25.00%	11,443,750	Electrical/Instrumenation (Subcontractor)
	57,218,750	Net Costs
18%	2,340,000	Labor Mark-up
15%	4,905,000	Material Mark-up
5%	572,188	Subcontractor Mark-up
15%	11,250	Equipment Mark-up
8.75%	2,861,250	Sales tax (material)
8.75%	6,563	Sales tax (equipment)
4.00%	1,308,000	Material Shipping & Handling
1.00%	130,000	Worker's Travel/Subsistence
	69,353,000	Subtotal
12%	8,322,360	Contractor General Conditions
	77,675,360	Subtotal
2%	1,553,507	Start-up, training, O&M
	79,228,867	Subtotal
30%	23,768,660	Design and Construction Contingency
	102,997,527	Subtotal
8%	1,837,985	Escalation to Year end 2007 Labor
	104,835,512	Subtotal
8%	4,963,182	Escalation to Year end 2007 materials
	109,798,694	Subtotal
8%	1,438,636	Escal. To Year end 2007 Subs, equip
	111,237,330	Subtotal
2.85%	3,170,264	Bldg Risk, Liability Auto Ins
	114,407,593	Subtotal
1%	1,144,076	Performance Bond
	115,551,669	Subtotal
1%	1,155,517	Payment Bond
	116,707,186	Subtotal
	116,707,186	Total Estimate

14 ft Outfall - Alternatives 1 and 4 (820 mgd)

Raw total	363,000,000	
		Labor
		Material
	363,000,000	Subcontractor
		Equipment
		Other
		Net Costs
18%		Labor Mark-up
15%		Material Mark-up
7%	25,410,000	Subcontractor Mark-up
15%		Equipment Mark-up
8.75%		Sales tax (material)
8.75%		Sales tax (equipment)
4.00%		Material Shipping & Handling
1.00%		Worker's Travel/Subsistence
	388,410,000	Subtotal
12%	46,609,200	Contractor General Conditions
	435,019,200	Subtotal
2%	8,700,384	Start-up, training, O&M
	443,719,584	Subtotal
30%	133,115,875	Design and Construction Contingency
	576,835,459	Subtotal
8%		Escalation to Year end 2007 Labor
	576,835,459	Subtotal
8%		Escalation to Year end 2007 materials
	576,835,459	Subtotal
8%	46,146,837	Escal. To Year end 2007 Subs, equip
	622,982,296	Subtotal
2.85%	17,754,995	Bldg Risk, Liability Auto Ins
	640,737,291	Subtotal
1%	6,407,373	Performance Bond
	647,144,664	Subtotal
1%	6,471,447	Payment Bond
	653,616,111	Subtotal
	653,616,111	Total Estimate

11 ft Outfall - Alternative 2 (4600 mgd)

Raw total	219,000,000	
		Labor
		Material
	219,000,000	Subcontractor
		Equipment
		Other
		Net Costs
18%		Labor Mark-up
15%		Material Mark-up
7%	15,330,000	Subcontractor Mark-up
15%		Equipment Mark-up
8.75%		Sales tax (material)
8.75%		Sales tax (equipment)
4.00%		Material Shipping & Handling
1.00%		Worker's Travel/Subsistence
	234,330,000	Subtotal
12%	28,119,600	Contractor General Conditions
	262,449,600	Subtotal
2%	5,248,992	Start-up, training, O&M
	267,698,592	Subtotal
30%	80,309,578	Design and Construction Contingency
	348,008,170	Subtotal
8%		Escalation to Year end 2007 Labor
	348,008,170	Subtotal
8%		Escalation to Year end 2007 materials
	348,008,170	Subtotal
8%	27,840,654	Escal. To Year end 2007 Subs, equip
	375,848,823	Subtotal
2.85%	10,711,691	Bldg Risk, Liability Auto Ins
	386,560,515	Subtotal
1%	3,865,605	Performance Bond
	390,426,120	Subtotal
1%	3,904,261	Payment Bond
	394,330,381	Subtotal
	394,330,381	Total Estimate

10 ft Outfall - Alternatives 3 (420 mgd)

Raw total	204,000,000	
		Labor
		Material
	204,000,000	Subcontractor
		Equipment
		Other
		Net Costs
18%		Labor Mark-up
15%		Material Mark-up
7%	14,280,000	Subcontractor Mark-up
15%		Equipment Mark-up
8.75%		Sales tax (material)
8.75%		Sales tax (equipment)
4.00%		Material Shipping & Handling
1.00%		Worker's Travel/Subsistence
	218,280,000	Subtotal
12%	26,193,600	Contractor General Conditions
	244,473,600	Subtotal
2%	4,889,472	Start-up, training, O&M
	249,363,072	Subtotal
30%	74,808,922	Design and Construction Contingency
	324,171,994	Subtotal
8%		Escalation to Year end 2007 Labor
	324,171,994	Subtotal
8%		Escalation to Year end 2007 materials
	324,171,994	Subtotal
8%	25,933,759	Escal. To Year end 2007 Subs, equip
	350,105,753	Subtotal
2.85%	9,978,014	Bldg Risk, Liability Auto Ins
	360,083,767	Subtotal
1%	3,600,838	Performance Bond
	363,684,605	Subtotal
1%	3,636,846	Payment Bond
	367,321,451	Subtotal
	367,321,451	Total Estimate

Increase in costs at biosolids facility

	Current	Alts 1&4	Alt 2	Alt 3
Mitigation	87,421,428	11,364,786	1,477,422	192,065
Civil/Site	2,680,216	348,428	45,296	5,888
Yard Piping	7,781,622	1,011,611	131,509	17,096
Unthickened Storage Tanks	4,866,395	3,309,149	2,250,221	1,530,150
Gravity Belt Co-thickening	12,107,771	8,233,284	5,598,633	3,807,071
Thickened Solids Storage	5,486,692	Value calculated from digester cost (below)		
Anaerobic Digesters	122,209,205	15,887,197	2,065,336	268,494
Past. Tanks & Heat Recovery	45,906,647	5,967,864	775,822	100,857
Digested Solids Storage	10,923,534	1,420,059	184,608	23,999
Digester Gas Management	43,759,874	5,688,784	739,542	96,140
Dewatering System	32,216,980	4,188,207	544,467	70,781
Trucked Grease Receiving	2,287,384	n/a	n/a	n/a
Sludge/Scum/Grease Handling	8,453,519	n/a	n/a	n/a
Chemical Systems	6,781,490	n/a	n/a	n/a
Odor Control & HVAC	38,907,281	5,057,947	657,533	85,479
Electrical/Instr	132,301,882	17,199,245	2,235,902	290,667
Advanced Biosolids Processing	33,492,838	n/a	n/a	n/a

% for items in yellow		13%	8%	4%
% for items in blue		68%	45%	22%

Difference in cost		Alts 1&4	Alt 2	Alt 3
Incremental Subtotal		79,676,560	16,706,291	6,488,688
Storage		40,736,402	20,368,201	20,368,201
Totals		120,412,962	37,074,492	26,856,889