THE CITY OF NEWPORT, RHODE ISLAND - AMERICA'S FIRST RESORT
DEPARTMENT OF UTILITIES

Julia A. Forgue, PE
Director

November 30, 2012

Mr. David Turin
U.S. Environmental Protection Agency
5 Post Office Square, Suite 100
Boston, MA 02109-3912

RE: Newport, RI Consent Decree No. 08-265S
Items # 63-68 – Collection System Capacity Assessment and System Master Plan

Dear Mr. Turin:

Enclosed for your review and approval in accordance with Item Nos. 63-68 of the referenced Consent Decree is the City's report on the Collection System Capacity Assessment and System Master Plan.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violation.

Please contact me if you have any questions regarding this submittal.

Very Truly Yours,

Julia A. Forgue
Director of Utilities

Cc: Jane Howington, City Manager
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Enclosure

Report

Collection System Capacity Assessment and System Master Plan

Prepared for

City of Newport

November 2012

CH2MHILL®
18 Tremont Street
Suite 700
Boston, MA 02108

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Acronyms and Abbreviations

ADF	average daily flow
AACE	Association for the Advancement of Cost Engineering
BL	Baseline scenario
BOD	biochemical oxygen demand
BSF	base sanitary flow
C1	Conveyance 1 scenario
CAFR	Comprehensive Annual Financial Report
CAP	Corrective Action Plan
CCTV	closed-circuit television
CD	Consent Decree
CEPT	chemically-enhanced primary treatment
CFD	computation fluid dynamic
CFU	colony forming units
CIP	Capital Improvement Project
City	City of Newport
CMOM	capacity, management, operations and maintenance
CPI	Consumer Price Index
CSCA	Collection System Capacity Assessment
CSO	combined sewer overflow
CWA	Clean Water Act
DWF	dry weather flow
E1	Elimination scenario
EC	Existing Conditions scenario
EPA	Environmental Protection Agency
FM	force main
FRC	fast response component
FY	fiscal year
GBT	gravity belt thickener
GIS	Geographic Information System
gpm	gallons per minute
H&H	hydrologic and hydraulic
HRC	high-rate clarification
HRT	high-rate treatment
I/I	infiltration and inflow
kw	kilowatts
LIDAR	Light Detection and Ranging
LTCP	Long Term Control Plan
M1	Master Mix 1 scenario
M2	Master Mix 2 scenario

M3	Master Mix 3 scenario
M4	Master Mix 4 scenario
MG	million gallons
MGD	million gallons per day
mg/L	milligrams per liter
MHI	median household income
mL	millileter
MPN	most probable number (bacteria count)
MU	MIKE URBAN
MWRA	Massachusetts Water Resources Authority
NASC	Narragansett Avenue Storage Conduit
NBC	Narragansett Bay Commission
NCDC	National Climatic Data Center
NEIWPCC	New England Interstate Water Pollution Control Commission
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCC	Northeast Regional Climate Center
NRCS	Natural Resources Conservation Service
O&M	operations and maintenance
PACP	Pipeline Assessment Certification Program
PS	pump station
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
R&R	repair and replace
RDII	rainfall-derived infiltration and inflow
RIDEM	Rhode Island Department of Environmental Management
RIDOH	Rhode Island Department of Health
RIPDES	Rhode Island Pollutant Discharge Elimination System
RTC	real-time control
S1	Storage 1 scenario
S2	Storage 2 scenario
S3	Storage 3 scenario
SEP	supplemental environmental project
SMP	System Master Plan
ft^2	square feet
SRC	slow response component
SS	settleable solids
SSES	sewer system evaluation survey
SSO	sanitary sewer overflow
SVI	sludge volume index
T1	Treatment 1 scenario
T2	Treatment 2 scenario
T3	Treatment 3 scenario
TKN	total kjeldahl nitrogen

TMDL	total maximum daily load
TSS	total suspended solids
UV	ultraviolet
US/DS	upstream and downstream
WACSOTF	Wellington Avenue Combined Sewer Overflow Treatment Facility
WPCP	Water Pollution Control Plant
WSCSOTF	Washington Street Combined Sewer Overflow Treatment Facility
WWF	wet weather flow

Executive Summary

This *Collection System Capacity Assessment and System Master Plan Report* documents engineering evaluations of the conveyance and treatment capacity for the City of Newport's (the City's) combined sewer system. Its content is aligned with the overall approach and the technical requirements described in the October 18, 2011 Consent Decree (CD) between Environment Rhode Island et al., the United States of America, the State of Rhode Island and the City of Newport (Civil Action No. 08-265S).

The primary objective of this report is to document characteristics of the collection system that may contribute to in-system sanitary sewer overflows (SSOs) and discharges from the City's two combined sewer overflow (CSO) treatment facilities, and to identify cost-effective remedial measures that may be implemented to eliminate them.

The engineering evaluations were completed in two steps as described in the CD. The first step provided an answer to the question of whether conveyance improvements, coupled with continued implementation of the City's public and private infiltration and inflow (I/I) reduction program and flow optimization at its Water Pollution Control Plant (WPCP), can be used to eliminate both SSOs and discharges from the CSO treatment facilities. The second step was to perform an evaluation of additional measures (including, but not limited to chemically-enhanced primary treatment (CEPT), in-line storage, WPCP upgrades and offline storage) that could be used to eliminate these discharges.

Introduction

The content of this *Collection System Capacity Assessment and System Master Plan Report* is aligned to CD Items 63, 65 and 66. The report describes the six topics outlined below.

1. **Introduction:** Objectives for the CSO Program to guide the engineering evaluations were shared with the CSO Stakeholder Workgroup throughout the planning process and at three City Council Briefing Workshops.
2. **Recent System Improvements and Their Effects on CSOs:** Recent progress by the City to rehabilitate or replace components of the system, and the effects of those improvements toward reducing CSOs. The required elements of this evaluation are described in Item 63d of the CD.
3. **Characterization of System Performance for a Typical Year:** Collection system response to local rainfall and a broad range of antecedent conditions. Evaluations related to this topic included use of the citywide hydraulic model to simulate the system's response to a continuous rainfall record for a "typical year." CD requirements are described in Item 63b of the CD.
4. **Characterization of System Capacity Limitations:** Identification of capacity limitations that may contribute to SSOs and/or CSOs and to identify where structural measures to eliminate them are required using the citywide hydraulic model. CD requirements are described in Items 63a, 63c, and 63e of the CD.
5. **Evaluation of Potential Solutions for CSO Elimination:** Combined effects of the proposed conveyance improvements and the continued implementation of the City's public and private I/I reduction program. This evaluation was used to identify if technically feasible and cost-effective levels of I/I reduction may result in the elimination of CSOs. CD requirements are described in Item 63f of the CD.

   Because it was found that elimination of discharges through only conveyance and inflow reduction was not affordable and that implementation of controls would not be feasible technically or within the schedule described in the CD, additional measures required to eliminate discharges from the CSO treatment facilities were evaluated. As described by the requirements in Item 65 of the CD, this evaluation included use of CEPT, in-line storage, WPCP upgrades and offline storage. This evaluation also included improved conveyance and pumping facilities.

6. **System Master Plan (SMP) Recommendations:** Lastly, based on the results and conclusions of the evaluations described above, the report contains recommendations for structural measures and operational adjustments required to mitigate in-system surcharges, capacity-related SSOs, and discharges from the CSO treatment facilities. The implementation schedule described in Item 66 of the CD is included in this section.

Recent System Improvements and their Effects on CSOs

The City has made a large investment in recent improvements to its combined sewer collection system. These include a variety of project types in both the Washington and Wellington CSO Sewershed. The driver for completing most of the larger projects has been rehabilitation or replacement of critical infrastructure that had reached the end of its useful life. Examples of this include the Long Wharf Force Main Emergency Repair, Thames Street Sanitary Sewer Interceptor Rehabilitation project, and the Railroad Interceptor and Wellington Avenue Sanitary Sewer Interceptor Rehabilitation projects. These investments were necessary to restore or to maintain reliable service and to prevent loss of service or environmental impacts that may occur when assets are “run to failure.” A smaller number of projects were designed specifically to reduce rainfall-derived inflows by removing catch basins from the collection system and reconnecting them to the City’s storm drainage system. A list of the collection system improvement projects completed within the last 10 years, their year of completion, construction costs and the primary effects on system performance is provided below in Table ES-1.

TABLE ES-1
Summary of Newport’s Recent Capital Improvement Projects for the Collection and Drainage Systems

Completion Date	City Project Number	Name	Project Type	Construction Cost	Effects on System Behavior
2003	Private	Newport Heights – Phase 1	Construction of new sanitary sewers	N/A	Redevelopment project
2007	Private	Newport Heights – Phase 2 & 3	Construction of new sanitary sewers	N/A	Redevelopment project
2008	Private	Newport Heights – Phase 4	Construction of new sanitary sewers	N/A	Redevelopment project
2008	08-001	Catch Basin Separation Project	Disconnect catch basins from sanitary system and reconnect to storm drainage system	$0.63M	Reduced inflow
2009	09-011	Wellington Service Area Manhole Rehabilitation Project	Manhole rehabilitation	$0.18M	Reduced inflow
2010	10-027	Area 6 Catch Basin Separation Project	Disconnect catch basins from sanitary system and reconnect to storm drainage system	$0.47M	Reduced inflow
2010	-	Long Wharf Force Main	Emergency repair of critical infrastructure	$11M	Maintained conveyance capacity

TABLE ES-1
Summary of Newport's Recent Capital Improvement Projects for the Collection and Drainage Systems

Completion Date	City Project Number	Name	Project Type	Construction Cost	Effects on System Behavior
2010	10-007	Railroad Interceptor	Rehabilitation of Aged Infrastructure	$0.56M	Maintained conveyance capacity
2011	10-013	High Priority Sewer Replacement	Replacement of poor condition sewer	$1.1M	Maintained conveyance capacity
2011	11-001	Wellington Avenue Sanitary Sewer Rehabilitation Project	Replacement of poor condition sewer located adjacent to harbor	$1.3M	Increased local conveyance capacity and reduced inflow/infiltration (I/I)
2011	11-011	Thames Street Sanitary Sewer Interceptor Rehabilitation Project	Rehabilitation of Aged Infrastructure and removal of obstructing utilities	$4.3M	Increased conveyance capacity from Wellington to Washington Service Areas
2011	11-018	Sherman Street Water, Sewer, and Drainage Improvements	Replacement of poor condition water, sewer, and storm drain infrastructure	$0.34M	Maintained conveyance capacity
2012	12-043	Sanitary Sewer System Manhole Rehabilitation Project	Replacement of vented manhole covers	$56K	Reduced inflow
Total				**$20 M**	

N/A – Not Applicable. Paid for by others.

The cumulative effect of recent projects has significantly changed the collection system's characteristics related to CSO discharges. Comparison of rainfall measured in Newport with flow data measured at the Wellington Avenue and Washington Street CSO Treatment Facilities (WACSOTF and WSCSOTF) indicates that these recent projects have changed the system's overflow characteristics. Over the period from January 2001 to October 2012, the measured values for CSOs at Wellington have decreased from 0.67 million gallons (MG) per inch of rain to 0.38 MG per inch of rain and most recently to 0.08 MG per inch of rain as shown in Figure ES-1. In contrast, the measured values for CSOs at WSCSOTF have increased from 0.72 to 0.86 MG per inch of rain as shown in Figure ES-2. These results are consistent with the nature of the improvements made in the Wellington Avenue CSO Sewershed that couple some reduction in rainfall-derived inflow with considerable conveyance improvements. In particular, by removing obstructing utilities, the Thames Street Sanitary Sewer Interceptor Rehabilitation project increased the system's ability to convey wet weather flows (WWFs) from the Wellington Avenue CSO Sewershed to the Long Wharf Pump Station and the WSCSOTF.

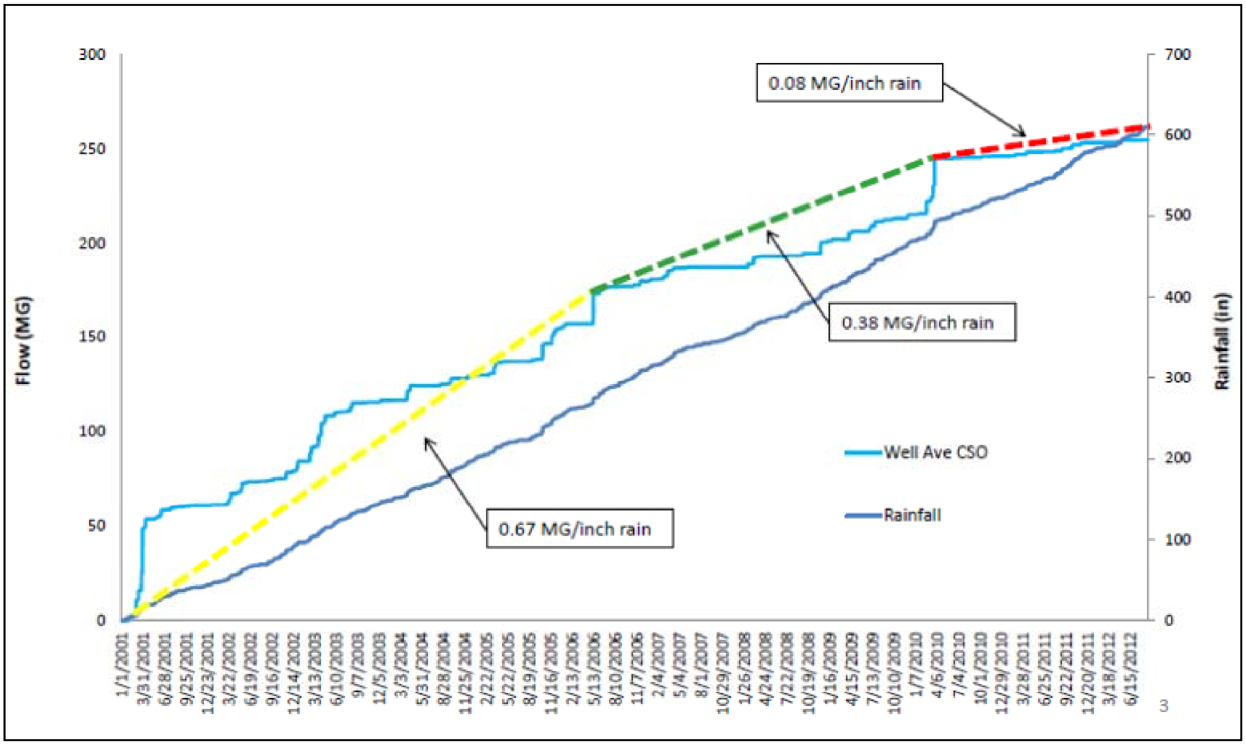


Figure ES-1. Historical Trends in Discharges from the WACSOTF

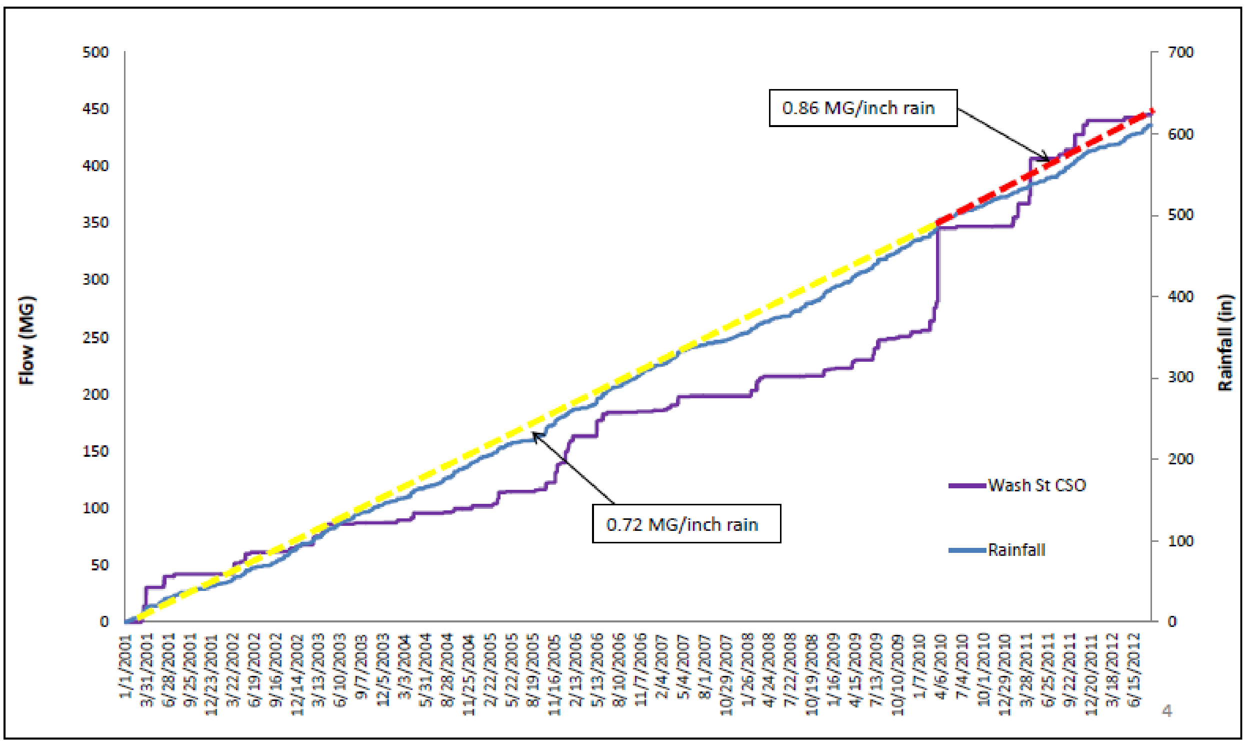


Figure ES-2. Historical Trends in Discharges from the WSCSOTF

Improvements made to the collection system through October of 2010 were described in the *Hydraulic Modeling Report* (CH2M HILL, 2011c). To address changes to the system implemented since that date, and to incorporate improvements to data available since model development and calibration, the Citywide hydraulic model was updated prior to performing the evaluations described in this report. Specific updates to the model included:

- The Thames Street Sanitary Sewer Interceptor Rehabilitation and the Wellington Avenue Sanitary Sewer Rehabilitation projects were incorporated into the model.
- Seventeen pump stations were added to the model to more accurately simulate their configuration and operating procedures. Nine existing pump stations in the model were updated to reflect current start/stop levels.
- Ninety-five links and 107 nodes were added – many of which were used to support the more detailed simulation of pump stations.
- Nodes with interpolated ground elevations were updated with 2011 United States Geological Survey (USGS) Statewide Provisional Light Detection and Ranging (LIDAR) data.
- The operating logic used to simulate the Long Wharf Pump Station, WSCSOTF dewatering pump, and Narragansett Avenue Storage Conduit (NASC) was reviewed and revised to reflect clarifications related to its actual operating protocols.
- A variety of data improvements for pipes and manholes were incorporated to account for improvements made to the Geographic Information System (GIS) and new data collected during field investigations.
- Revisions to the model data to simulate groundwater and tidal infiltration, particularly as related to seasonal variations seen in measured data collected during the monitoring period (April 2010 – April 2011).
- Adjustments to WWF hydrologic parameters to reflect changes as a result of system improvements.

Although the previous model was calibrated to one dry weather and two wet weather events and validated to one additional wet weather event in 2010, the 2012 hydraulic model was recalibrated to the April 13, 2011 event and verified with two additional wet weather events. The April 13, 2011 storm was a spring-time storm with a total rainfall of 2.63 inches and a peak intensity of 0.92 inches per hour. Comparisons of measured flows at the WACSOTF, the WSCSOTF, and the WPCP with flows predicted by the updated model for the April storm are presented below in Table ES-2.

TABLE ES-2
Metered and Modeled Volume and Peak Flow Results for the storm of April 13, 2011

Meter	Metered Volume (MG)	Modeled Volume (MG)	Percent Difference (%)	Metered Peak Flow (mgd)	Modeled Peak Flow (mgd)	Percent Difference (%)
WACSOTF	1.35	1.48	+9.71%	5.96	4.75	-20.30%
WSCSOTF	6.31	5.42	-14.09%	14.01	12.60	-10.08%
WPCP	47.62	42.32	-11.13%	21.51	22.47	+4.48%

Overall, it was demonstrated that the model simulates the system's current behavior with a level of accuracy which is suitable for the alternatives evaluations described in this report. Although the model replicates *typical* operation of the CSO treatment facilities, the NASC Gate and the public pump stations as described in the City's Operation and Maintenance Manual (Sevee & Maher Engineers, Inc., et al., 2009/2011), actual operations vary for each event. In particular, evaluations performed using the model indicate that operation of the NASC Gate and the Long Wharf Pump Station (throttling) have a significant impact on flows at the WACSOTF and WSCSOTF, respectively.

Characterization of System Performance for a Typical Year

To address varying antecedent and seasonal conditions, and to define a baseline for measuring improvements to system performance and water quality, the updated 2012 hydraulic model was used to simulate the system's performance for a typical year. This analysis included:

- Evaluation of historic precipitation records and selection of a typical year.
- Running a continuous simulation using the citywide hydraulic model to quantify the system's response.
- Evaluation of model results to characterize relationships between rainfall and CSO volumes.
- Evaluation of model results to quantify the effect of operating protocol on the WPCP's permit limits.

The evaluation of historic precipitation records concluded that a *modified* version of the data collected at T.F. Green Airport in 1996 best fits the objective of this study. The selection of this data set was made after review of data collected at Rose Island, TF Green Airport, and the Newport State Airport. The evaluation addressed gauge location, sampling interval, duration of records, total annual precipitation, ranges of storm sizes, and data completeness/quality issues. Evaluations completed previously for the City of Newport and Narragansett Bay Commission (NBC) projects were also considered.

Although the 44.61 inches of rain recorded at T.F. Green Airport in 1996 was found to best meet the average annual conditions, the records for that year do not include a storm with peak intensity larger than 1 inch per hour. To address this issue, the records were modified to include a storm recorded on June 11, 2001. This event had a total depth of rainfall of 2.02 inches and a peak intensity of 1.07 inch per hour.

In addition to the correlation relationships between precipitation and CSO volumes, results from the continuous simulation were used to quantify the system's performance relative to the WPCP's discharge permit limits. The results of this evaluation are based on the City's current infrastructure and operating protocols. These values provide a baseline for measuring the benefits of proposed control alternatives.

Key observations from this evaluation were the following:

- The simulation indicated that the collection system has sufficient capacity to convey up to a 1-inch rainfall event without discharges from the CSO treatment facilities.
- The simulation indicated that there would be 12 overflow events for the typical year at both the WSCSOTF and the WACSOTF.

Characterization of System Capacity Limitations

Identification of conveyance limitations contributing to SSOs and/or CSOs is a key component of the CD and this report. To address this and to support the identification of structural measures required to eliminate capacity related surcharging, SSOs and/or CSOs, engineering evaluations were performed using the 2012 hydraulic model. The scope of the investigations included:

- A review of historical records on SSOs, closed-circuit televised (CCTV) inspections and operations and maintenance (O&M) activities as well as input obtained from staff at the City of Newport Department of Utilities and the City's operator, United Water.
- Simulation of a broad range of design storms to identify each pipe segment and manhole operating under surcharged conditions during each event.
- A review of how permit limits, treatment capacities at the WPCP affect CSO discharges.

- Recommendations for addressing capacity limitations for both the collection system and the WPCP.

Historical records for SSOs, CCTV inspections, and O&M activities were reviewed to identify known locations of capacity limitations that may have contributed to the causes of SSOs or prevented flow to the WPCP that caused additional CSOs. Review of SSO records between 2003 and October of 2012 shows that 88 SSOs were documented by the City. Of those, approximately 55 percent are reported to be a result of pipe blockages, 20 percent were caused by wet weather, and the remaining 25 percent are miscellaneous collection system issues, including collapsed pipes or pump station failures. The SSOs related to blockages, pipe collapses, and pump station outages have generally already been addressed through corrective measures including repairs, replacements and/or changes to O&M procedures. The locations and frequency of SSOs occurring during wet weather were mapped and compared with the areas where the model predicted to have surcharging or capacity limitations.

The 2012 hydraulic model was used to simulate the system's performance for a broad range of design storms. The simulations were used document how the system performs during wet weather and then to identify structural measures that may be used to correct capacity limitations. Synthetic design storms ranging from a 3-month, 1-hour storm to a 10-year, 2-hour storm were developed from the *Technical Paper No. 40: Rainfall Frequency Atlas of the United States* (Hershfield, 1961). Two types of simulations were performed. First, design events were evaluated on an individual basis. After that, a continuous simulation including back-to-back design events was performed to quantify how the system may recover between events and how varying antecedent conditions affect performance. The location of surcharged pipe and manholes from these simulations were mapped to support the diagnosis of the causes of surcharging and potential solutions.

Results from the hydraulic evaluations and the review of historic data indicate that a large majority of Newport's collection system has sufficient capacity to convey weather flows during the broad range of storm events that were studied. However, the same analysis did identify five areas of the collection system with recurring SSOs and/or some characteristics of capacity limitations.

Historic SSO records, CCTV inspections, scheduled maintenance activities, and the hydraulic modeling results were used to identify areas where scheduled maintenance activities and/or system improvements are recommended. The location of each of these areas is shown in Figure ES-3. The recommendations are described below.

- **Long Wharf Pump Station:** It is recommended that the wet weather operation of the Long Wharf Pump Station be automated through SCADA and the existing programmable logic controller be used to limit maximum day flows to 19.7 million gallons per day (MGD) while also maximizing the volume to the plant during wet weather events.
- **Garfield Street and Homer Street/Butler Street and South Mayd Street:** It is recommended that the sewers in this area continue to be regularly cleaned through the City's scheduled maintenance program and that a structural solution be evaluated to mitigate sediment buildup, correct observed defects in pipe condition, and improve conveyance capacity.
- **J.T. Connell Highway near the Dyre Street Pump Station:** It is recommended that the pipe underneath J.T. Connell Hwy to the Dyre Street Pump Station continue to be regularly cleaned through the City's scheduled maintenance program; and that a structural solution be evaluated to mitigate sediment buildup, correct observed defects in pipe condition, and improve conveyance capacity.

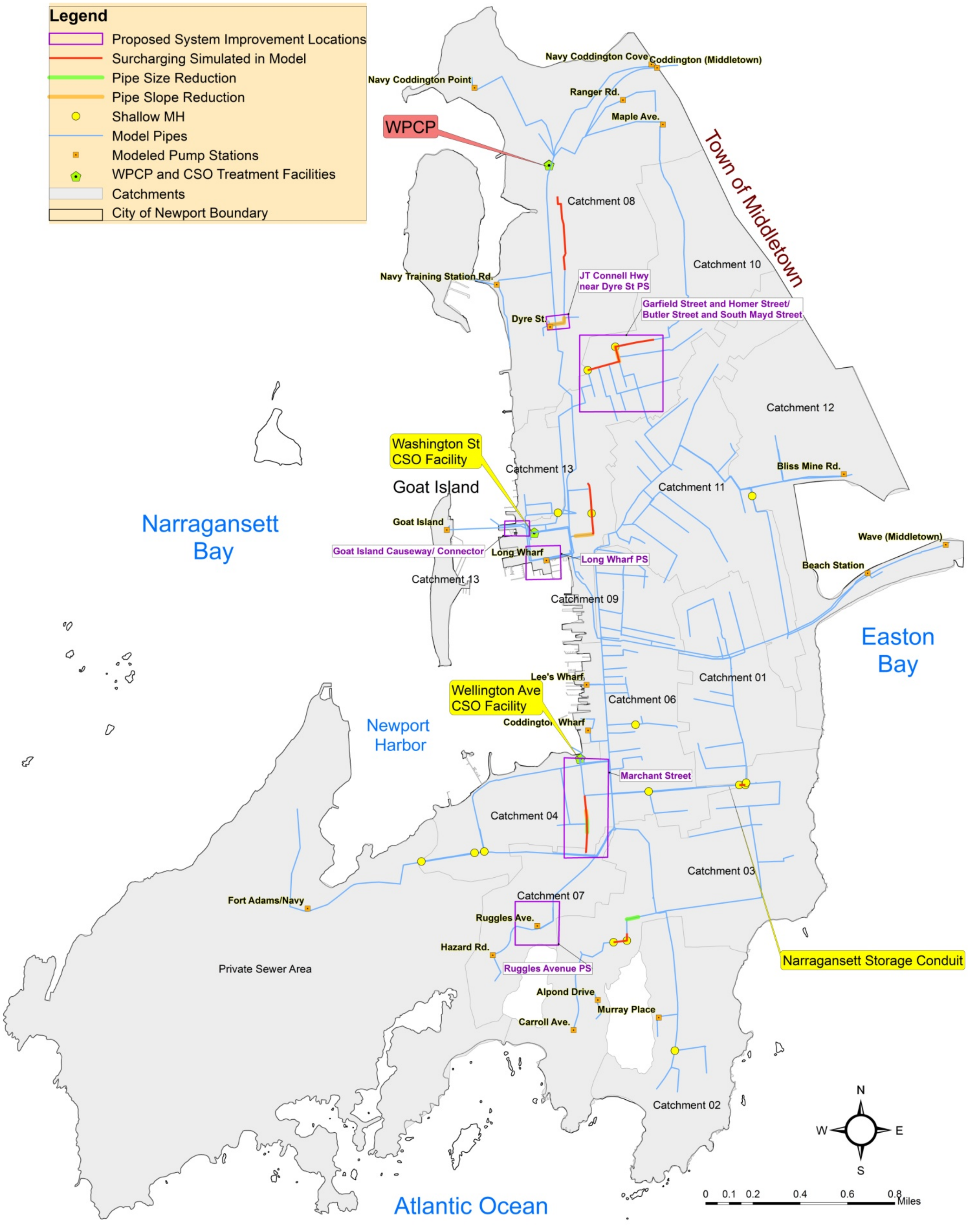


Figure ES-3. Map of Recommended System Improvement Locations

- **Marchant Street:** It is recommended that the pipes on Marchant Street between Atlantic Street and Wellington Avenue be cleaned on a semi-annual basis to prevent sediment accumulation in areas with sags and flat slopes. It also recommended that the segment from Narragansett Avenue to Wellington Avenue be evaluated for replacement to address the capacity limitation caused by the decrease in pipe size from 18 to 12 inches that starts at Narragansett Avenue.
- **Ruggles Avenue Pump Station:** It is recommended that a detailed engineering evaluation be completed on the Ruggles Avenue pumps and force main to determine the necessary capacities to convey the WWFs downstream and eliminate SSOs.
- **Goat Island Causeway/Connector:** It is recommended that the pipes in the area of the connection between Goat Island Causeway and Washington Street be evaluated for structural repairs to mitigate sediment buildup, correct observed defects in pipe condition, and improve conveyance capacity.

In general, the hydraulic evaluations concluded that the collection system, including the Long Wharf Pump Station, has the capacity to deliver much more flow to the WPCP during wet weather than is supported by its effective treatment limits and the limits defined in its discharge permit. During wet weather, flows from the Long Wharf Pump Station are throttled as a part of an operational strategy required to meet the WPCP's permit limits. This in-turn causes the volume of overflows at the WSCSOTF to be larger than might otherwise occur due to conveyance capacities.

To address the limitations at the WPCP, an engineering evaluation of its effective treatment capacities for each of its unit processes was performed. This evaluation concluded that improvements to the plant's headworks, disinfection, and solids processing units are needed to meet its existing design capacity. The recommended improvements for the WPCP are included in the project's baseline and are described below.

- **Headworks**: The pretreatment offered by the existing headworks is not adequate to protect downstream process equipment. Proper pretreatment with grit removal and screening of the incoming wastewater is important to ensure the reliable operation and performance of downstream unit processes. At a minimum, renovation of the headworks requires a better grit removal system or replacement with a new system, and replacement of the existing coarse screens with two new fine screens (e.g., ¼-inch spacing).
- **Disinfection**: The existing plant disinfects only with liquid sodium hypochlorite. Additional disinfection capacity is required to improve performance and reliability in meeting effluent limits. Additional studies (e.g., computation fluid dynamic (CFD) study) are recommended to optimize the chlorine contact tanks performance under wet weather conditions. If studies find that chlorine disinfection cannot achieve sufficient removals, additional tank volume, higher chlorine dosage and ultraviolet (UV) disinfection for a portion of the dry weather flow (DWF) can be considered. For this report, additional tank volume calculated by using a 30-minute contact time at peak flows is used to estimate the cost, as required by Technical Report No. 16: *Guides for the Design of Wastewater Treatment Works* (NEIWPCC, 2011) and Ten States Standard's *Recommended Standards for Wastewater Facilities* (GLUMRB, 2004).
- **Solids Processing Capacity:** Currently, one small gravity belt thickener (GBT) operates nearly continuously to process the primary and secondary solids generated at the WPCP. Significantly higher solid processing throughput capacity is required to reduce the hours of operation to a more manageable schedule. At a minimum, two 2-meter GBTs or two centrifuges are required to provide for system redundancy and reliability.

Evaluation of Potential Solutions for CSO Elimination

To support the evaluation of potential solutions, input was solicited from the CSO Stakeholders Workgroup through a series of 12 meetings. The purpose of the first five meetings was to provide background information to the stakeholders to enable them to provide informed input and feedback to the CSO Program. During meeting 6, the stakeholder discussed four priority criteria categories that affect the selection of CSO control options:

- Regulatory Compliance
- Water Quality
- Social/Community Impacts
- Rates & Affordability

The priorities identified by the stakeholders were:

1. Compliance with Clean Water Act (CWA) requirements
2. Keeping rates under/at affordability limits
3. Meeting water quality standards in Newport Harbor
4. (tie) Compliance with implementation schedule in the CD
   (tie) Supporting designated uses in Newport Harbor

These criteria were used to evaluate which control technologies best met the priorities of the CSO Stakeholder Workgroup.

An engineering evaluation of potential solutions for CSO elimination was completed. The scope of work for this evaluation followed a two-step process as described in Items 63 and 65 of the CD. The first step provided an answer to the question of whether conveyance improvements, coupled with continued implementation of the City's public and private I/I reduction program and flow optimization at the WPCP can be used to eliminate both SSOs and discharges from the CSO treatment facilities. Because this step did not achieve elimination of overflows in a technically and economically feasible manner, an evaluation of additional control measures was performed as a second step. The second step included evaluations of additional measures, including but not limited to CEPT, in-line storage, WPCP upgrades and offline storage that could be used to eliminate these discharges.

Projects already in the City's Capital Improvement Project (CIP) and other projects required to maintain system operation were considered as a baseline for the evaluation of all alternatives. The baseline included improvements to both the collection system and WPCP identified through the capacity assessment. A summary of the baseline projects is shown below in Table ES-3.

The potential benefits for the candidate improvements were evaluated using the 2012 hydraulic model in several steps. First, screening evaluations were performed to quantify the effects of each candidate as standalone projects. The screening evaluations were performed for a 2-year, 6-hour storm. Second, combinations of those improvements found to be most effective were evaluated using the model to identify how the system would perform for storms ranging from a 2-year to a 10-year recurrence interval.

TABLE ES-3
Baseline Scenario Projects and Costs

Project Code	Name/Brief Description	Total Capital Cost	Change in Annual O&M Cost	Equivalent Annual Cost
City of Newport CIP Projects FY2013-2017				
	Bridge Street Tide Gates	$ 85,000	$ -	$ 3,000
	Almy Pond - TMDL	$ 170,000	$ -	$ 9,000
	Sanitary Sewer Improvements	$ 11,000,000	$ -	$ 299,000
II-1	Catch Basin Disconnections	$ 2,000,000	$ (8,000)	$ (0)
	Beach PS Improvements	$ 305,000	$ -	$ 11,000
	Audit - UW Service Agreement	$ 100,000	$ -	$ 5,000
	CSO Program Management	$ 1,000,000	$ -	$ 51,000
WPCP-1.1	Headworks and Disinfection Improvements	$ 2,250,000	$ -	$ 89,000
WPCP-1.1	WPCP Improvements	$ 1,500,000	$ -	$ 54,000
	Subtotal	$ 18,410,000	$ (8,000)	$ 521,000
Recommended Projects				
WPCP-1.1	WPCP Improvements (Headworks, Disinfection and Solids Handling)	$ 9,985,000	$ -	$ 395,000
	Wellington Pump Station Improvements	$ 2,886,000	$ -	$ 104,000
	Ruggles Pump Station Improvements	$ 206,000	$ -	$ 7,000
	Subtotal:	$ 13,077,000	$ -	$ 507,000
	Scenario Totals:	$ 31,487,000	$ (8,000)	$ 1,029,000

Overall, the results from the preliminary hydraulic screening evaluations indicated that to eliminate CSOs without resulting in additional adverse impacts, a high level of I/I reduction along with system optimization measures would likely need to be implemented. It was necessary to evaluate these technologies in combination to determine if CSO elimination is achievable without causing adverse hydraulic impacts, such as surcharging and SSOs, or financial impacts. One scenario was developed to incorporate the selected technologies to the maximum extent called the Elimination scenario (E1). This scenario included all projects identified in the Baseline scenario. The control technologies identified for scenario E1 are:

- Removal of 100 percent of all public and private inflow sources in the City of Newport.
- Removal of 100 percent of all inflow sources in the town of Middletown and Navy.
- Raising the five twin 54-inch weirs 1.5 feet.
- Raising the Wellington Avenue weir 1.2 feet.
- Increased pumping at WACSOTF’s sanitary pumps and at the Long Wharf Pump Station.

Additional stormwater technologies were considered for this scenario to address the projected stormwater volume and pollutants that may affect water quality once inflow sources are disconnected. These technologies include:

- Stormwater Treatment at the WACSOTF: converting the CSO facility to a stormwater treatment including demolition of the existing microstrainers, replacement of the existing bar screen with a mechanical fine screen, retrofitting of the microstrainer basin with a new vortex particle separator and retrofitting of the existing microstrainer tank for UV disinfection.
- Stormwater Treatment at the WSCSOTF: retrofitting the existing CSO facility to include lamella plates for sedimentation and adding dechlorination.
- Stormwater Conveyance Improvements: replacement and/or addition of stormwater piping to convey additional stormwater to the new stormwater treatment facilities and/or to the waterways.

A summary of the control technologies and costs included in E1 is below in Table ES-4. No project costs were estimated for the town of Middletown or the Naval Station Newport because the City would not be responsible for the costs in those communities.

TABLE ES-4
Summary of Control Technologies and Costs for Scenario E1

Project Code	Name/Brief Description	Total Capital Cost	Change in Annual O&M Cost	Equivalent Annual Cost
BL	Baseline (includes all Baseline projects)	$ 31,487,000	$ (8,000)	$ 1,029,000
SO-3	Weirs	$ 189,000	$ -	$ 6,000
SO-2	Increased Pumping Capacity/Better Use of System Capacity	$ -	$ 22,000	$ 22,000
II-4	Downspout Disconnection	$ 13,630,000	$ (27,000)	$ 472,000
II-A	Inflow Reduction - Private Sources (Not Including Downspouts)	$ 58,783,000	$ (63,000)	$ 2,089,000
II-B	Inflow Reduction - Public Sources	$ 1,862,000	$ (3,000)	$ 65,000
II-14	Inflow Removal for Middletown			
II-15	Inflow Removal for the Naval Station Newport			
SW-1	Stormwater Treatment - WSCSO Facility	$ 3,408,000	$ 98,000	$ 221,000
SW-2	Stormwater Treatment - WACSO Facility	$ 16,554,000	$ 428,000	$ 1,026,000
CU-6	Stormwater Conveyance Improvements for E1	$ 75,725,000	$ -	$ 2,737,000
	Scenario Totals:	$ 201,636,000	$ 447,000	$ 7,667,000

Because of the challenges associated with implementing E1, including removal of 100 percent of the rainfall-derived inflow and the large program costs; additional CSO control measures were considered. As described in CD Item 65 this evaluation included: treatment; offline, in-line, and pump back storage, upgrades to the WPCP to increase its design flow; and low impact development technologies. To support this evaluation, a preliminary screening of 55 control technologies was conducted with the input of the CSO Stakeholder Workgroup. Fifteen selected technologies identified through the screening process were then evaluated through preliminary hydraulic modeling to determine how they may contribute to CSO reduction. The evaluation considered 11 control scenarios organized into four general categories: treatment, storage, conveyance, and a category that included a mix of control technologies within a single scenario.

The costs and performance of the 11 scenarios were evaluated. Performance of each scenario was evaluated for a variety of design events using the 2012 hydraulic model. Results from these evaluations were compared with Existing Conditions (EC) and Baseline (BL) scenarios and discussed with the CSO Stakeholder Workgroup. Feedback from the stakeholders shown below in Figure ES-4 led to the selection of scenarios Conveyance 1 (C1) and Storage 3 (S3) for additional study.

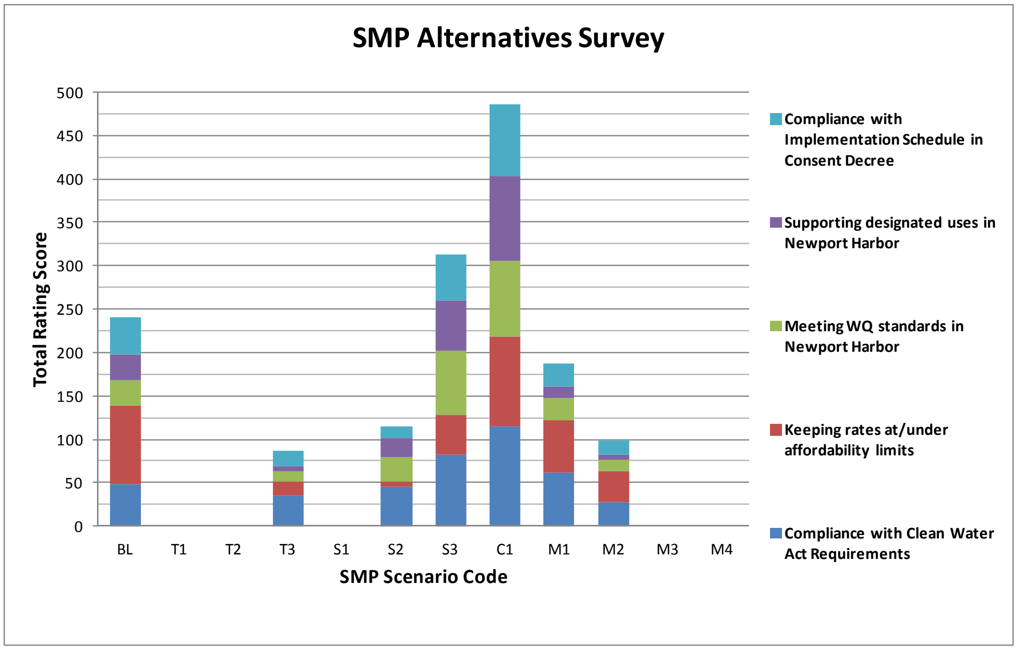


Figure ES-4. Results of Stakeholder Survey on SMP Control Scenarios

Scenarios C1 and S3 were reviewed to identify potential control technologies that should be added to address the regulatory framework or to better meet the stakeholder priority criteria. For example, for scenario C1, dechlorination was added to the WSCSOTF to improve the effluent discharge quality. For scenario S3, a pump station and downspout disconnection were added to the scenario, which eliminated discharges at both the CSO treatment facilities for up to a 10-year, 6-hour event. CEPT was also added to improve the effluent discharge quality due to the extended peak WWFs at the plant. The scenario IDs were updated to reflect the modifications of the C1 and S3 scenarios to C1A and S3A, respectively. A summary of the control technologies and costs for scenarios C1A and S3A is shown below in Tables ES-5 and ES-6.

TABLE ES-5

Summary of Control Technologies and Costs for Scenario C1A

Project Code	Name/Brief Description	Total Capital Cost	Change in Annual O&M Cost	Equivalent Annual Cost
BL	Baseline (includes all Baseline projects)	$ 31,487,000	$ (8,000)	$ 1,029,000
WPCP-1.2	WPCP Upgrade & Expansion, Option 2 (primary clarifiers)	$ 6,130,000	$ -	$ 243,000
WPCP-1.3	WPCP Upgrade & Expansion, Option 3 (aeration tank & final clarifier)	$ 10,842,000	$ -	$ 392,000
SO-1	WPCP Flow Optimization	$ -	$ -	$ -
SO-3	Weirs	$ 189,000	$ -	$ 6,000
CU-2	Catchment 10 Reroute (new 3.5 mgd PS)	$ 4,788,000	$ 68,000	$ 241,000
CU-4	Additional Pumping of WACSOTF Sanitary Pumps (2 mgd)	$ 861,000	$ 15,000	$ 46,000
CU-5	Upsize Wellington Forcemain	$ 204,000	$ -	$ 7,000
CU-7	Stormwater Conveyance Improvements for C1A	$ 8,224,000	$ -	$ 297,000
II-4	Downspout Disconnection	$ 13,630,000	$ (27,000)	$ 472,000
II-C	Additional Inflow Removal (to Achieve 50% Inflow Removal)	$ 23,183,000	$ (46,000)	$ 802,000
CSOT-2	Modify Treatment with Dechlor at Washington	$ 164,000	$ 1,000	$ 7,000
	Scenario Totals:	$ 99,701,000	$ 2,000	$ 3,542,000

TABLE ES-6
Summary of Control Technologies and Costs for Scenario S3A

Project Code	Name/Brief Description	Total Capital Cost	Change in Annual O&M Cost	Equivalent Annual Cost
BL	Baseline (includes all Baseline projects)	$ 31,487,000	$ (8,000)	$ 1,029,000
WPCP-1.2	WPCP Upgrade & Expansion, Option 2 (primary clarifiers)	$ 6,130,000	$ -	$ 243,000
WPCP-1.3	WPCP Upgrade & Expansion, Option 3 (aeration tank & final clarifier)	$ 10,842,000	$ -	$ 392,000
WPCP-1.4	WPCP Upgrade & Expansion, CEPT	$ 8,519,000	$ 424,000	$ 732,000
OS-11	Washington CSO Facility Storage (3MG)	$ 21,567,000	$ 26,000	$ 759,000
OS-19	King Park, Wellington Ave by CSO Facility, Storage (0.9MG)	$ 17,629,000	$ 27,000	$ 626,000
SO-1	WPCP Flow Optimization	$ -	$ -	$ -
SO-2	Increased Pumping Capacity/Better Use of System Capacity	$ -	$ 22,000	$ 22,000
SO-3	Weirs	$ 189,000	$ -	$ 6,000
CU-2	Catchment 10 Reroute (new 3.5 mgd PS)	$ 4,788,000	$ 68,000	$ 241,000
II-4	Downspout Disconnection	$ 13,630,000	$ (27,000)	$ 472,000
	Scenario Totals:	$ 114,780,000	$ 531,000	$ 4,520,000

System Master Plan (SMP) Recommendations

Based on a review of regulatory requirements, program goals and priorities identified by the CSO Stakeholder Workgroup, the recommended system improvements and control technologies for the SMP are those included in scenario C1A. The recommended control technologies include:

- Disconnecting or removing private and public inflow sources to achieve a 50 percent reduction in rainfall-derived inflow.
- Upgrading the primary clarifiers and secondary treatment (aeration tank and final clarifier) at the WPCP to increase the wet weather capacity to 30 MGD.
- Raising six existing weirs in the collection system: five weirs by 1.5 feet along the twin 54-inch diameter sewer on Long Wharf Mall and one weir by 1.2 feet in the overflow pipe on Wellington Avenue from the Thames Street Interceptor.
- Installing a new 3.5-MGD pump station on Van Zandt Avenue near the railroad to reroute flows currently going to the Long Wharf Pump Station directly to the Long Wharf force main and the WPCP.
- Upsizing two sanitary pumps at the WACSOTF to 2 MGD and upsizing the existing force main to convey the additional flows. Modifying the existing CSO treatment at the WSCSOTF by adding dechlorination, which includes installing chemical storage and dosing units.
- Installing new or upgrading existing stormwater conveyance pipe (approximately 7,000 linear feet).

A 20-year implementation schedule was developed for the program. This schedule was developed based on 5 key objectives:

1. Keep rates at or under affordability limits.
2. Complete low-cost and low-effort projects first in an effort to provide immediate water quality benefit.
3. Stage large capital projects in a manner that would achieve the greatest CSO reduction earlier in the implementation schedule.

4. Stage projects so that capacity upgrades are completed prior to conveyance modifications to ensure that required capacity would be available.
5. Build in regularly scheduled program evaluation periods to evaluate whether the CSO Program implementation efforts are achieving established targets.

TABLE ES-7
Summary of Implementation Schedule

Implementation Period	Time Frame	Projects to be Implemented
1	2013 to 2017	• Beach, Ruggles and Wellington Pump Station Improvements • Long Wharf Pump Station SCADA Operational Adjustments • Sanitary Sewer Improvements o Garfield, Homer, Butler and South Mayd Streets o J.T. Connell Highway near Dyre Street PS o Marchant Street o Goat Island Causeway/Connector • Weirs at America's Cup and Wellington • Early WPCP upgrades • Phase 1 inflow removal
2	2017 to 2022	• Final WPCP upgrades • New Catchment 10 pump station • Phase 2 inflow removal
3	2022 to 2027	• Phase 3 inflow removal
4	2027 to 2032	• Phase 4 inflow removal

Although the recommendations described in this report are based on a systematic evaluation process and an improved understand of system's performance, the tolerances of its costs, implementation schedule and the expected benefits for its components vary. The large capital projects are defined at a planning level and should generally be designed and constructed within tolerances typical of public works projects. Other elements of the program, like the inflow removal program, are less certain. Some elements of risk or uncertainty will be reduced as the program progresses, design projects are completed and system performance is re-evaluated. Key considerations related to the remaining engineering evaluations and expected benefits include the following:

1. As additional field investigations are performed to identify inflow sources, the cost-effectiveness of mitigation measures for both public and private reduction should be re-evaluated.
2. The secondary impacts associated with disconnecting downspouts, drains, and sump pumps should be evaluated including improvements to the storm sewer system related to inlet and conveyance capacities.
3. The improvements to the WPCP and the expected benefits to system performance require review and modification of the City's discharge permit.
4. The City should continue to consider use of Green Technologies as a component of its inflow reduction and stormwater drainage system improvements.

5. The potential impacts associated with climate change should be addressed during the design of system improvements. This should include consideration of mitigation measures to address storm surge, rising sea-levels, and increases in the frequency of severe events.
6. The actual and expected water quality benefits associated with the control plan should be re-evaluated on a periodic basis.
7. Recommendation for future improvements to public and private infrastructure should be re-evaluated on a periodic basis to address affordability pursuant to the Environmental Protection Agency's (EPA's) 1994 CSO Policy.

Pending the review and approval of this document, the City expects to prepare sewer system evaluation survey (SSES) reports for the Wellington Avenue and Washington Street service areas. Specific components of the SSES reports summarized from the CD include:

- A cost-effectiveness evaluation that determines which public sources to remediate.
- Proposals for design and construction of measures required to remove public inflow sources.
- A determination of cost-effectiveness for the redirection of private sources of inflow.
- A generalized assessment of conditions that may permit redirection of private inflow sources to the ground and an assessment of the municipal storm sewer's capacity to receive redirected inflow.
- An evaluation of changes to the City's ordinances that may facilitate implementation of planned remedial measures.
- A schedule for implementing public and private inflow reduction measures.

SECTION 1

Introduction

1.1 CSO Program Objectives

A formal objective statement was established at the beginning of the current planning project to guide the evaluation of combined sewer overflow (CSO) control alternatives. The statement's components were based on: regulatory requirements rooted in the Clean Water Act (CWA); the October 18, 2011 Consent Decree (CD) between Environment Rhode Island et al., the United States of America, the State of Rhode Island and the City of Newport (Civil Action No. 08-265S); and the City's history of investing in CSO controls. The objective statement was shared with the program's stakeholders throughout the planning process, and at three Council Briefing Workshops.

> *Continue to identify and implement the most cost-effective solution for reducing the number of CSOs to a level protective of Newport Harbor and acceptable to the community and regulatory agencies.*

In order to ensure that the CSO Program goals were met, especially the goal to be acceptable to the community, the City established the CSO Stakeholder Workgroup to provide input and feedback on the CSO Program. The Mission Statement for the Stakeholder Workgroup was:

- *To review proposed plans and projects for the CSO Program and provide recommendations to the City about the potential benefits and impacts of proposed plans and projects to all users of the system.*
- *To share CSO Program plans and project information with each stakeholder's organization to aid the City in its efforts to communicate CSO Program information.*
- *To support the CSO Program's public education efforts through participation in CSO Program public education activities.*

The Stakeholder Workgroup consisted of 20 representatives, identified by Newport City Council to support the planning process. The representatives were from a wide-range of organizations that may be affected by the outcomes of the CSO Program as well as four Newport residents to represent the typical Newport rate payer. The organizations represented on the Stakeholder Workgroup are shown in Figure 1-1. Each organization had one representative and one alternate. There were four residents-at-large.

CSO Program Workgroup Membership		
Ad-Hoc Committee Representative	Alliance for a Livable Newport	Beach Commission
City Council Liaison	City Planning Department	City Department of Public Services
EPA	Town of Middletown	Naval Station Newport
Newport County Chamber of Commerce	Newport County Convention & Visitor's Bureau (NCCVB)	Newport Harbor Master
Residents-at-Large (4)	RIDEM	Roger Williams University – School of Engineering
Save the Bay	Aquidneck Island Planning Commission	

Figure 1-1. CSO Stakeholder Workgroup Membership

Input from the CSO Stakeholder Workgroup was solicited through a series of 12 meetings and two surveys. This input was used to identify priority criteria and to rate potential CSO control technologies on their ability to achieve the priority criteria. In addition, as CSO control scenarios were developed, the CSO Stakeholder Workgroup reviewed results and provided suggestions for improvements to the scenarios until a recommended scenario was identified.

1.2 Current Regulatory Framework

The CWA, CSO Policy and the 2011 CD established the regulatory framework for the current CSO control program. Within the CD, it is Part VII – Remedial Measures that defines the elements of the City's Long Term Control Plan (LTCP) Implementation Project. Key elements of the project include:

- Collection System Operation and Maintenance (O&M) (CD Items 11-13)
- Geographic Information System (GIS) Map (CD Item 14)
- Pump Station/Force Main (PS/FM) Evaluations (CD Items 15-16)
- Water Pollution Control Plant (WPCP) Flow Optimization (CD Items 17-22)
- WPCP Repairs (CD Item 23)
- Wellington Avenue and Washington Street Combined Sewer Overflow Treatment Facilities (WACSOTF and WSCSOTF) (CD Items 24 – 28)
- Preference for Low Impact Development (CD Items 29-30)
- Wellington Avenue Outfall Sewershed Prior Extraneous Flow Investigations (CD Items 31-32)
- Initial CS Remediation and Replacement Measures (CD Items 33-47)
- Wellington Avenue Outfall Sewershed Private Extraneous Flow Investigations (CD Items 48-49)
- Wellington Avenue Outfall Additional Extraneous Flow Investigations (CD Items 50-51)
- Contents of Wellington Avenue Sewer System Evaluation Survey (SSES) Report (CD Item 52)
- Wellington Avenue SSES Report Implementation Schedule (CD Item 53)
- Washington Street Outfall Sewershed Extraneous Flow Investigations (CD Items 54-55)
- Contents of Washington Street SSES Report (CD Item 56)
- Washington Street SSES Report Implementation Schedule (CD Item 57)
- Hydraulic Model and Report (CD Items 58-62)
- Collection System Capacity Assessment (CSCA) (CD Items 63-68)
- Rainwater Harvesting Systems (CD Item 69)

The relationships between key elements of the CD are shown in Figure 1-2. These activities established the framework used to characterize the City's wastewater system and to identify control options aligned to the City's objectives and priorities identified by the CSO Stakeholder Workgroup.

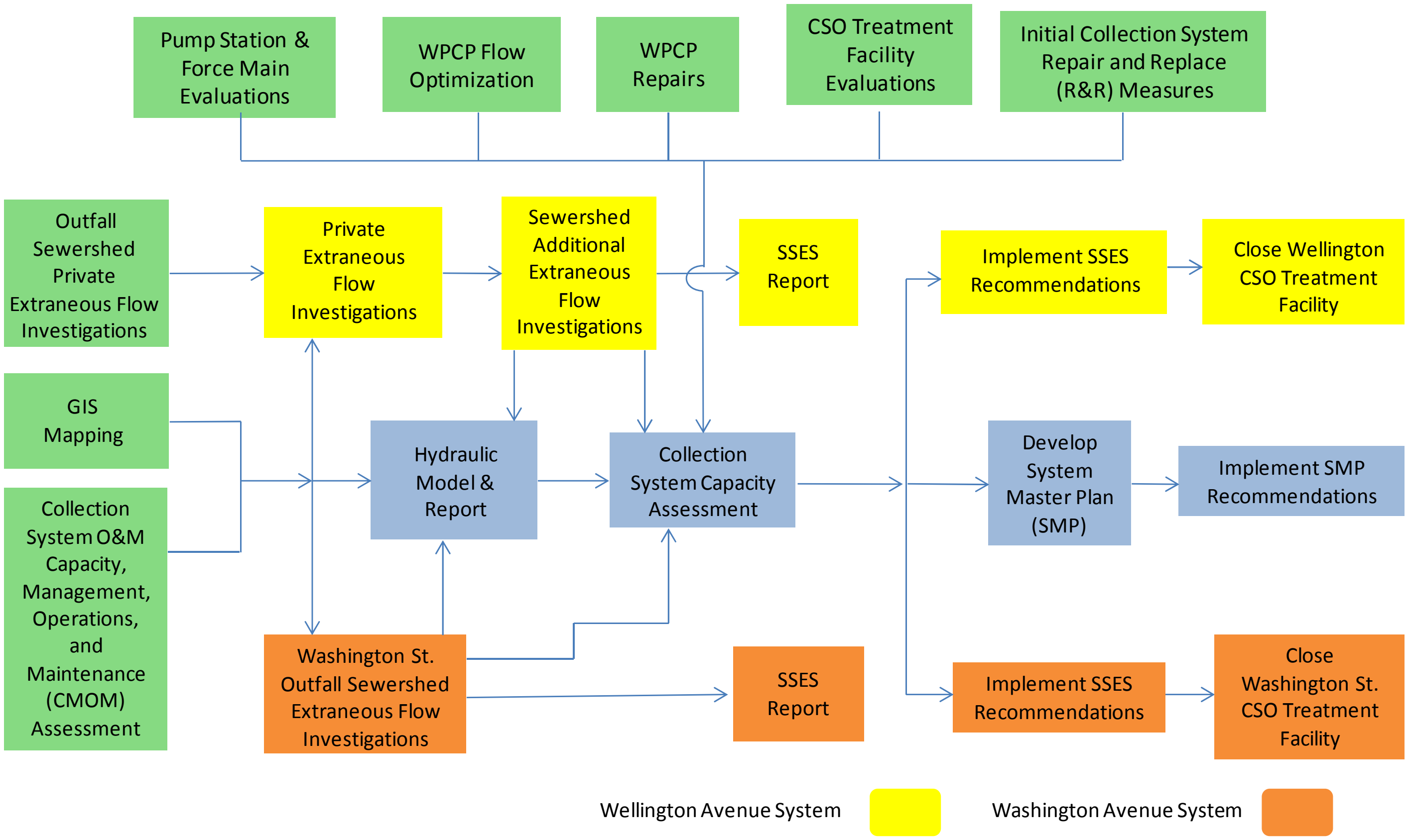


Figure 1-2. Newport CSO Regulatory Decision Framework

From this regulatory framework, there are two key regulatory questions for which the answers greatly impact what may be considered in the City's LTCP:

1. Is the City's collection system a combined sewer system or a separate sewer system?
2. Can collection system replacements and rehabilitation remedial measures, infiltration and inflow (I/I) removal programs and WPCP flow optimization (as defined by the requirements of the CSCA – CD Items 63-68) result in the elimination of CSOs, and if not, what additional measures will be taken by the City to eliminate such overflows as part of a System Master Plan (SMP)?

Related to question 1, the Environmental Protection Agency (EPA) issued a letter on May 15, 2012, stating that portions of the City's collection system are combined, and therefore, fall under the EPA's CSO Control Policy. This declaration was based upon review of the *Wellington Avenue Outfall Extraneous Flow Investigations Report* (CH2M HILL, 2011b) and the *Washington Street Outfall Extraneous Flow Investigations Report* (CH2M HILL, 2011a), submitted in July 2011 and September 2011, respectively.

This *Collection System Capacity Assessment and System Master Plan* addresses the engineering evaluations related to question 2. It presents the findings of the CSCA with regards to characteristics of the collection system that may contribute to in-system sanitary sewer overflows (SSOs) and CSOs. It also identifies cost-effective remedial measures that may be implemented to eliminate these overflows.

1.3 History of the CSO Program

The City owns and operates approximately 97 miles of gravity and FM sewer collection pipe delivering domestic, commercial, and industrial waste to one wastewater treatment facility. That collection system currently includes characteristics of both separated and combined sewers. The City also receives wastewater flow from the Town of Middletown through two FMs, flow from Naval Station Newport through three FMs, and flow from privately owned and operated FMs primarily located in the Newport Neck area.

During dry weather, sewage flows are conveyed to the Newport WPCP. All dry weather flows (DWFs) receive secondary treatment and disinfection at the WPCP prior to discharge into Newport Harbor. During wet weather, despite the sewer separation projects that have been completed, large quantities of stormwater enter the Newport combined sewer system and can overload the system. Relief points in the system divert the excess flow and allow it to discharge to Newport Harbor. These discharges are called CSOs. Newport currently has two permitted CSO outfalls, each served by a CSO treatment facility that provide partial treatment and disinfection prior to discharge to the harbor.

The City has invested a significant amount of effort and expense to control and treat CSOs through a series of sewer separation projects starting in the 1970s, as well as through construction of the WACSOTF (1978), the WSCSOTF (1991), and the Narragansett Avenue Storage Conduit (NASC).

The WACSOTF is located in a sensitive area as it is adjacent to the King Park Beach which was designated a Flagship Beach in 2003 by the EPA and Rhode Island Department of Environmental Management (RIDEM). For the City, this area has been a priority for controlling CSO events, and therefore was the focus of work to develop a LTCP. The work performed as part of the LTCP included an SSES, development of a hydraulic model, analysis of CSO control alternatives, and recommendation of a CSO Control Plan for the Wellington Avenue CSO Sewershed. The results of the SSES work are described in the *Phase 1, Part 2 CSO Control Plan, Wellington Avenue CSO Facility* report (AECOM, 2007). Development of the hydraulic model, analysis of CSO control alternatives, and a description of the recommended CSO control alternative for the Wellington Avenue CSO Sewershed are documented in the *Phase 2 CSO Control Plan Wellington Avenue CSO Facility* report, submitted to RIDEM in March 2009 (AECOM, 2009).

This *Collection System Capacity Assessment and System Master Plan* report includes findings from previous work as well as improvements and evaluations conducted from 2009 through 2012. It also builds upon the work previously focused only in the Wellington Service area by incorporating the Washington Street CSO Sewershed, the WPCP Sewershed, and flows received from the Town of Middletown and Naval Station Newport.

1.4 Organization of this Report

This report is organized into seven sections, each designed to address specific requirements of the CD. The following paragraphs provide a brief overview of the purpose of each section.

Section 1 – Introduction: Provides historical and regulatory background for the report in addition to laying out the report objectives and structure.

Section 2 - Recent System Improvements and Their Effects on CSOs: Documents recent progress by the City to rehabilitate or replace components of the system, and the effects of those improvements toward reducing CSOs. To address this requirement and to support the evaluation and planning of long term CSO controls, this section of the report contains:

- A summary of the City's most recent investments in the collection system including projects required to maintain reliable service and projects designed to improve the system's performance.
- Documentation of recent trends in discharges from the WACSOTF and WSCSOTF, and observations on the relationship between the recent improvements and changed behaviors.

- Updates to the Citywide hydraulic model that were implemented to simulate the system's most recent performance trends, including adjustments made to the model to reflect new infrastructure and the operational procedures that directly affect system capacity.

The objective of these materials is to establish a common understanding of both the magnitude of recent investments that the City has made in its collection system and the effects of these projects on system performance. Understanding the materials in this section provides an essential foundation for the evaluation of future investments in the collection system and their potential benefits.

Section 3 - Characterization of System Performance for a Typical Year: Provides a summary of the steps followed to characterize the performance of the City's collection system for a range of rainfall events, considering local rainfall data and critical antecedent in-system flow conditions. The objective is to identify the impact of rainfall events on peak wet weather flows (WWFs) throughout the City and to provide guidance on system improvement evaluations, including capacity-related CSOs. To address this, model simulations were conducted using a year-long rainfall time series representing the typical year (TY), which was identified following review of historical studies and rainfall data and gauge analyses. Results of model simulations include statistical summaries of CSO volumes, frequency and durations at the two CSO facilities and the WPCP.

Section 4 - Characterization of System Capacity Limitations: Provides a summary of the steps followed to identify those portions of the collection system that have capacity limitations, defined in Item 63a of the CD as, *"…those portions of the Collection System that experience, have caused, or are expected to cause or contribute to capacity-related Building/Private Property Backups, Collection System surcharges or overflows, or overflows from the Wellington Avenue or Washington Street outfalls;"*. This section of the report contains the findings of:

- Review of historical records, including SSO records, closed-circuit television (CCTV) records and O&M records.
- The City of Newport's Department of Utilities and the City's collection system operator, United Water, were consulted to provide insight into any areas that are currently experiencing backups or surcharging. This information was used to identify additional areas in the collection system which may benefit from future controls.
- An evaluation of the capacity of portions of the collection system upstream and downstream (US/DS) of the WSCSOTF and WACSOTF by primarily using the calibrated hydraulic model of the collection system.
- Because the permit limitations and effective treatment capacity of the WPCP causes the system's operator to throttle flow during wet weather, this section includes a capacity assessment evaluation for the WPCP to evaluate existing conditions as well as the potential for flow optimization during wet weather. This analysis is a follow up to the *Flow Optimization and Capacity Evaluation Report* submitted to the City of Newport, RI in March 2011 (CH2M HILL, 2011d), which included detailed flow analyses and process modeling results.

Section 5 - Evaluation of Potential Solutions for CSO Elimination: Presents the findings of an evaluation of the feasibility of eliminating the treated CSO discharges. The engineering evaluations were completed in two steps as described in the CD.

The first step provided an answer to the question of whether conveyance improvements, coupled with continued implementation of the City's public and private I/I reduction program and flow optimization at its WPCP, can be used to eliminate both SSOs and discharges from the CSO treatment facilities.

The second step was to perform an evaluation of additional measures, not limited to chemically-enhanced primary treatment (CEPT), in-line storage, WPCP upgrades, and offline storage, that could be used to eliminate these discharges.

Section 6 – System Master Plan Recommendations: Provides the final conclusions and recommendations from all of the CSCA-related evaluations. It includes the recommended SMP with a schedule for complete implementation of recommended remedial measures and remedial work. This section does recommend an alternate end date for the SMP implementation as defined in CD Item 66.

Section 7 – References: Contains the references used in the development of the materials for this report.

SECTION 2

Recent System Improvements and their Effects on CSOs (CD Item 63d)

2.1 Overview and Objectives

This section documents recent progress by the City to rehabilitate or replace components of the system, and the effects of those improvements toward reducing CSOs. Item 63d of the CD describes the requirements of this work:

> *"…a summary detailing the progress made to date on the improvements to the Collection System to eliminate overflows from the Wellington Avenue and Washington Street outfalls;…"*

To address this requirement and to support the evaluation and planning of long term CSO controls, this section of the report contains:

- A summary of the City's most recent investments in the collection system including projects required to maintain reliable service and projects designed to improve the system's performance.
- Documentation of recent trends in discharge volume and frequency from the WACSOTF and WSCSOTF and observations on the relationship between the recent improvements and changed behaviors.
- Documentation of recent trends in CSO effluent discharge quality and Newport Harbor water quality.
- Updates to the Citywide hydraulic model that were implemented to simulate the system's most recent performance trends, including adjustments made to the model to reflect new infrastructure and the operational procedures that directly affect system capacity.

The objective of these materials is to establish a common understanding of both the magnitude of recent investments that the City has made in its collection system and the effects of these projects on system performance. Understanding the materials in this section provides an essential foundation for the evaluation of future investments in the collection system and their potential benefits.

2.2 Summary of Recent Improvements

The City has a long history of proactive investment in its collection system and as a leader in the planning and implementation of CSO controls. As described in Section 1 of this report, the City implemented a series of projects to construct separate storm drains in the 1970s. The City constructed one of the region's first CSO treatment facilities at Wellington in 1978. It also constructed a storage facility to control discharges from the Washington service area in 1991. Relative to the status of CSO control efforts in other communities, these projects were early examples of innovative actions designed to reduce CSO discharges and related water quality impacts. The *Combined Sewer Overflows: Guidance for Long-Term Control Plan* (USEPA, 1995) cites the WSCSOTF as an example of "innovative and alternative approaches and technologies that achieve the objectives of the CSO Control Policy and the Clean Water Act."

The City continues to make large investments in improvements to its sanitary sewer collection system. These include a variety of projects in both the Washington Street and Wellington Avenue CSO Sewershed Areas. The driver for completing most of the larger projects has been rehabilitation or replacement of critical infrastructure that had reached the end of its useful life. Examples of this include the Long Wharf Force Main, Thames Street Sanitary Sewer Interceptor Rehabilitation, Railroad Interceptor, and Wellington Avenue Sanitary Sewer Replacement projects. These investments were necessary to restore or to maintain reliable service and to prevent loss of service or environmental impacts that may occur when assets are “run to failure.” A smaller number of projects were designed specifically to reduce rainfall-derived inflow by removing catch basins from the sanitary collection system and reconnecting them to the City’s storm drainage system. A list of the collection system improvement projects completed within the last 10 years, their year of completion, construction costs and the primary effects on system performance is provided in Table 2-1. These projects are also identified in the Sanitary and Combined Sewer System Condition Map provided in the GIS Submittals (the most recent map from the July 2012 GIS submittal is presented in Appendix D).

TABLE 2-1
Summary of Newport’s Recent Capital Improvement Projects for the Collection and Drainage Systems

Completion Date	City Project Number	Name	Project Type	Construction Cost	Effects on System Behavior
2003	Private	Newport Heights – Phase 1	Construction of new sanitary sewers	N/A	Redevelopment project
2007	Private	Newport Heights – Phase 2 & 3	Construction of new sanitary sewers	N/A	Redevelopment project
2008	Private	Newport Heights – Phase 4	Construction of new sanitary sewers	N/A	Redevelopment project
2008	08-001	Catch Basin Separation Project	Disconnect catch basins from sanitary system and reconnect to storm drainage system	$0.63M	Reduced inflow
2009	09-011	Wellington Service Area Manhole Rehabilitation Project	Manhole rehabilitation	$0.18M	Reduced inflow
2010	10-027	Area 6 Catch Basin Separation Project	Disconnect catch basins from sanitary system and reconnect to storm drainage system	$0.47M	Reduced inflow
2010	-	Long Wharf Force Main	Emergency repair of critical infrastructure	$11M	Maintained conveyance capacity
2010	10-007	Railroad Interceptor	Rehabilitation of Aged Infrastructure	$0.56M	Maintained conveyance capacity
2011	10-013	High Priority Sewer Replacement	Replacement of poor condition sewer	$1.1M	Maintained conveyance capacity
2011	11-001	Wellington Avenue Sanitary Sewer Rehabilitation Project	Replacement of poor condition sewer located adjacent to harbor	$1.3M	Increased local conveyance capacity and reduced inflow/infiltration (I/I)
2011	11-011	Thames Street Sanitary Sewer Interceptor Rehabilitation Project	Rehabilitation of Aged Infrastructure and removal of obstructing utilities	$4.3M	Increased conveyance capacity from Wellington to Washington Service Areas

TABLE 2-1
Summary of Newport's Recent Capital Improvement Projects for the Collection and Drainage Systems

Completion Date	City Project Number	Name	Project Type	Construction Cost	Effects on System Behavior
2011	11-018	Sherman Street Water, Sewer, and Drainage Improvements	Replacement of poor condition water, sewer, and storm drain infrastructure	$0.34M	Maintained conveyance capacity
2012	12-043	Sanitary Sewer System Manhole Rehabilitation Project	Replacement of vented manhole covers	$56K	Reduced inflow
Total				**$20 M**	

N/A – Not Applicable. Paid for by others.

In addition to capital investments to the City's collection system, a large number of repairs, replacements, and rehabilitation projects have been completed through the City's Operations Contract with United Water. These projects have addressed components of its collection system, pump stations, and the WPCP. Many of these improvements have increased system reliability and/or contributed to operational changes that directly or indirectly increased the system's capacity to convey and treat wet weather flows (WWFs). A summary of the projects completed through the City's operation contract is provided in Table 2-2.

TABLE 2-2
Summary of Newport's Recent Capital Improvement Projects for the Collection and Drainage Systems

Date Completed	CD Item #	Task	Description of End Product
9/30/2010	PS & FM	Engineering Evaluation Pump Stations and Force Mains	Report
11/30/2010	PS & FM	Hazard Road Pumping Station Electrical/Mechanical Upgrades	Electrical/mechanical upgrades
11/30/2010	CSO Facility Report	Washington CSO Tide Gate and Monitoring Station Construction	Construction complete
11/30/2010	CSO Facility Report	Wellington CSO Tide Gate and Monitoring Station Construction	Construction complete
2/15/2011	23e	Install new gear drive for effluent lift pump	Equipment installation
2/23/2011	WPCP Report	Install chemical induction mixers in chlorine contact tanks	Equipment installation
2/28/2011	PS & FM	Long Wharf Pumping Station main breaker repair	Repair or replace main breaker
2/28/2011	CSO Facility Report	Wellington -- Integrate Backwash Pumps in SCADA; Relocate Chlorine Feed Point	Facility Modifications
3/4/2011	WPCP Report	Rehabilitate primary clarifier #5	Facility Modifications
3/31/2011	CSO Facility Report	Washington CSO Sedimentation Basin Modifications	Facility Modifications
4/1/2011	23g	Install solids metering equipment	Equipment installation
4/15/2011	WPCP Report	Rehabilitate primary clarifier #6	Facility Modifications

TABLE 2-2
Summary of Newport's Recent Capital Improvement Projects for the Collection and Drainage Systems

Date Completed	CD Item #	Task	Description of End Product
4/15/2011	23b	Return 6 primary clarifiers to operational condition	Facility Modifications
4/30/2011	CMOM CAP	Formalize inventory tracking system	Inventory Tracking System
4/30/2011	PS & FM	Wellington Avenue Sanitary Pumps roof repair	Repaired Roof
4/30/2011	CSO Facility Report	Narragansett Ave Storage Conduit -- Cleaning and CCTV	CCTV Inspection
4/30/2011	CSO Facility Report	Narragansett Ave Storage Conduit -- Gate Inspection	Gate Inspection
5/20/2011	PS & FM	Coddington Wharf Pumping Station Pump Replacement	Replace pump
5/25/2011	23a	Return 4 grit blowers to operational conditions	Equipment operational
5/25/2011	23d	Return 5 chlorine feed pumps to operational conditions	Equipment operational
5/25/2011	PS & FM	Bliss Mine Force Main air-relief valve replacement	Two new air-relief valves installed
6/10/2011	WPCP Report	Rehabilitate final clarifier #1	Equipment operational
6/10/2011	23c	Return 4 secondary clarifiers to full operational condition	Equipment operational
6/30/2011	PS & FM	Long Wharf Pumping Station building repair and grit chamber rehabilitation	Structure and grit chamber improvements
8/15/2011	23e	Retrofit 1st primary effluent pump	Equipment installation
8/15/2011	23e	Retrofit 2nd primary effluent pump	Equipment installation
8/15/2011	WPCP Report	Retrofit primary effluent lift screw pumps with submersible pumps	Equipment installation
11/30/2011	CMOM CAP	Develop MH inspection program as part of on-going collection system maintenance.	Manhole inspection program description.
12/23/2011	WPCP Report	Improvements and replacement of solids handling equipment	Equipment installation
2/29/2012	CMOM CAP	Furnish and install SCADA system at Naval Station Newport	SCADA data output
6/1/2012	PS & FM	Maple Street Pumping Station structural repairs (if needed)	Structural Repairs
5/21/2012	PS & FM	Ruggles Avenue Pumping Station electrical upgrades	Electrical Upgrades

PS = pump station
FM = force main

2.3 Trends in Recent Performance

2.3.1 CSO Volumes and Frequency of Discharge

A review of measured flow data indicates that the cumulative effect of recent projects has significantly changed the collection system's characteristics related to CSO discharges.

The City's operations contractor measures precipitation data at the WPCP and at the discharge locations at each of the CSO treatment facilities. Precipitation is measured in a rain gauge that is read manually on an hourly basis. Discharges from the CSO treatment facilities are calculated from pump run times. The City has maintained records of daily precipitation depths and discharge volumes since 2001. This data is included in regulatory reports and shared with the public on the City's website shown below. A copy of the data posted through October 1, 2012 is provided in Table 2-3.

http://www.cityofnewport.com/departments/utilities/pollution_control/cso_info.cfm

The relationship between precipitation and discharge events is complicated. The system's behavior is influenced by a large number of hydrologic factors including: total precipitation, event duration, peak intensity, and antecedent conditions. Evaluation of historical records also indicates that the system's behavior is affected by other factors such as operational rules, equipment in/out of service, and discharge permit limits for its WPCP. The combination of these hydrologic and operational factors complicates development of statistically significant correlations between individual events and short term trends.

To better understand the system's long term performance trends, a comparison of cumulative precipitation and flow data was performed. This evaluation indicates that recent projects have changed the system's overflow characteristics. Data for the WACSOTF are shown in Figure 2-1. This figure shows how measured values for CSO volumes at Wellington have decreased from 0.67 to 0.38 and most recently to 0.08 million gallons (MG) per inch of rain during the period between 2001 and October 2012.

Long term performance of the WSCSOTF is shown in Figure 2-2. This figure shows how measured values for CSO volumes at Washington have increased slightly from 0.72 to 0.86 MG per inch of rain.

TABLE 2-3
Summary of Observed Precipitation and Discharge Volumes

Wellington Avenue CSO Facility CSO Discharges 2001-Current

Year	Day & Month of Discharge	Wellington CSO Total Discharge (gal)	Rainfall Total (inches)
2001	5-Feb	1,305,600	1.46
	25-Feb	307,200	0.75
	5-Mar	8,071,000	1.51
	9-Mar	190,000	0.85
	13-Mar	4,709,000	2.05
	22-Mar	8,064,000	2.13
	30-Mar	24,384,000	4.32
	6-Apr	192,000	0.22
	8-Apr	384,000	0.72
	12-Apr	4,480,000	0.51
	23-May	461,000	0.31
	25-May	307,400	0.63
	2-Jun	230,000	0.99
	3-Jun	115,000	0.13
	12-Jun	1,171,000	1.50
	17-Jun	2,460,000	1.60
	5-Jul	151,000	0.55
	11-Jul	110,000	0.56
	26-Jul	1,029,000	2.62
	13-Aug	220,000	0.93
	20-Aug	429,000	1.07
	21-Sep	135,000	0.65
	16-Oct	401,000	0.00
	24-Oct	108,000	0.46
	18-Dec	34,000	0.80
2002	7-Jan	52,000	0.59
	21-Jan	27,000	0.50
	3-Mar	36,000	0.80
	20-Mar	1,415,000	0.60
	26-Mar	1,451,000	0.36
	31-Mar	3,073,000	0.04
	25-Apr	470,000	0.08
	2-May	541,000	0.78
	13-May	1,616,000	0.70
	18-May	2,980,000	1.88
	7-Jun	833,000	2.00
	29-Jul	100,000	0.69
	2-Sep	462,000	0.76
	23-Sep	797,000	1.76
	16-Oct	297,000	1.06
	13-Nov	252,000	1.23
	17-Nov	2,880,000	1.22
	12-Dec	449,000	1.35
	14-Dec	264,000	1.65
	25-Dec	659,000	0.92

Washington Street CSO Facility CSO Discharges 2001-Current

Year	Day & Month of Discharge	Washington CSO Total Discharge (gal)	Rainfall Total (inches)
2001	13-Mar	5,836,000	2.05
	22-Mar	8,193,000	2.56
	30-Mar	16,323,000	3.12
	12-Jun	3,120,000	1.57
	14-Jun	6,489,600	2.55
	26-Jul	2,224,000	2.62
2002	27-Mar	2,600,000	1.80
	1-Apr	7,100,000	1.76
	25-Apr	1,300,000	0.80
	14-May	2,400,000	2.44
	18-May	4,400,000	1.88
	7-Jun	1,200,000	2.08
	2-Sep	400,000	2.61
	23-Sep	200,000	1.76
	26-Oct	400,000	2.93
	17-Nov	2,200,000	2.17
	14-Dec	2,100,000	1.65

TABLE 2-3
Summary of Observed Precipitation and Discharge Volumes

Wellington Avenue CSO Facility CSO Discharges 2001-Current

Year	Day & Month of Discharge	Wellington CSO Total Discharge (gal)	Rainfall Total (inches)
2003	1-Jan	880,000	0.20
	3-Jan	3,539,000	0.10
	22-Feb	4,352,000	1.45
	2-Mar	3,297,000	1.59
	9-Mar	216,000	0.00
	21-Mar	115,000	0.55
	22-Mar	307,000	0.28
	30-Mar	5,340,000	2.84
	9-Apr	209,000	0.41
	11-Apr	6,205,000	1.00
	22-Apr	870,000	1.34
	26-Apr	3,084,000	1.61
	1-May	120,000	0.17
	26-May	270,000	1.29
	5-Jun	1,319,000	1.18
	7-Jun	121,000	0.12
	18-Jun	120,000	0.70
	22-Jun	180,000	1.09
	3-Jul	180,000	0.87
	24-Jul	200,000	0.96
	8-Aug	2,055,000	2.05
	17-Aug	2,471,000	1.31
	15-Oct	300,000	1.53
	29-Oct	70,000	1.19
	11-Dec	346,000	0.90
	14-Dec	500,000	1.07
2004	6-Feb	140,000	1.92
	21-Mar	100,000	0.40
	31-Mar	4,550,000	1.71
	4-Apr	279,000	0.49
	13-Apr	2,717,000	2.01
	15-Aug	787,000	2.60
	31-Aug	102,000	0.73
	18-Sep	431,000	1.90
	29-Sep	2,590,000	2.89
	19-Oct	60,000	1.12
	28-Nov	152,000	0.98
	7-Dec	330,000	1.23
	10-Dec	1,168,000	1.50

Washington Street CSO Facility CSO Discharges 2001-Current

Year	Day & Month of Discharge	Washington CSO Total Discharge (gal)	Rainfall Total (inches)
2003	3-Jan	1,400,000	0.10
	22-Feb	6,400,000	1.45
	2-Mar	1,100,000	1.59
	30-Mar	3,800,000	2.84
	11-Apr	5,700,000	1.00
	26-Apr	1,100,000	1.61
	5-Jun	100,000	1.18
	8-Aug	300,000	2.05
	17-Aug	700,000	1.31
	11-Dec	100,000	0.90
	14-Dec	200,000	1.07
2004	6-Feb	2,100,000	1.92
	1-Apr	1,800,000	1.71
	13-Apr	4,300,000	2.01
	15-Aug	700,000	2.60
	18-Sep	900,000	1.90
	29-Sep	2,200,000	2.89
	11-Dec	2,500,000	1.50

TABLE 2-3
Summary of Observed Precipitation and Discharge Volumes

Wellington Avenue CSO Facility CSO Discharges 2001-Current

Year	Day & Month of Discharge	Wellington CSO Total Discharge (gal)	Rainfall Total (inches)
2005	12-Jan	152,388	0.61
	14-Jan	330,174	0.62
	16-Jan	203,184	0.05
	10-Feb	177,786	0.45
	8-Mar	1,066,716	1.47
	28-Mar	2,920,770	2.56
	2-Apr	2,412,810	1.72
	30-Apr	711,144	1.15
	30-Aug	761,940	3.17
	15-Sep	355,577	2.36
	14-Oct	7,797,186	2.09
	25-Oct	507,840	1.20
	22-Nov	4,216,000	3.90
	30-Nov	1,955,000	1.93
	9-Dec	254,000	1.05
	16-Dec	330,174	1.18
2006	3-Jan	965,124	1.81
	14-Jan	1,269,900	2.02
	18-Jan	203,184	0.83
	3-Feb	510,000	1.60
	13-May	16,051,536	6.24
	7-Jun	2,031,840	3.27
	24-Jun	1,320,696	2.91
	26-Jun	304,776	1.00
	6-Jul	42,333	0.53
	13-Jul	228,582	0.95
	28-Aug	406,368	2.15
	20-Sep	457,164	1.70
	1-Oct	42,330	0.91
	28-Oct	558,756	2.05
	23-Nov	2,108,034	2.86
	23-Dec	50,796	1.05
2007	1-Jan	507,960	1.65
	8-Jan	355,572	1.17
	14-Feb	609,552	1.49
	2-Mar	1,434,987	2.39
	17-Mar	2,641,392	2.34
	5-Apr	787,338	1.70
	12-Apr	838,134	1.78
	15-Apr	5,206,590	2.96
	27-Apr	507,960	1.28
	4-Jun	279,378	1.86
	18-Dec	50,796	0.83
	23-Dec	76,194	0.66

Washington Street CSO Facility CSO Discharges 2001-Current

Year	Day & Month of Discharge	Washington CSO Total Discharge (gal)	Rainfall Total (inches)
2005	14-Jan	147,100	0.62
	10-Feb	163,900	0.45
	8-Mar	1,586,800	1.47
	12-Mar	396,201	0.62
	28-Mar	4,286,999	2.56
	2-Apr	5,851,801	1.72
	1-May	532,601	0.42
	30-Aug	1,556,898	3.17
	15-Sep	404,301	2.36
	14-Oct	5,540,000	2.09
	25-Oct	635,401	1.20
	10-Nov	84,902	1.28
	22-Nov	8,924,800	3.90
	30-Nov	6,320,102	1.93
	4-Dec	269,600	0.14
	9-Dec	695,300	1.05
	16-Dec	1,075,500	1.18
2006	3-Jan	9,891,000	1.81
	14-Jan	8,000,000	2.02
	18-Jan	3,605,187	0.83
	23-Jan	2,210,598	0.92
	3-Feb	3,980,000	1.60
	13-May	13,447,098	6.24
	19-May	512,697	0.55
	7-Jun	5,375,603	3.27
	24-Jun	1,497,383	2.91
	28-Aug	209,100	2.15
	28-Oct	726,701	2.05
	23-Nov	1,686,000	2.86
2007	1-Jan	635,686	1.65
	8-Jan	190,016	1.17
	14-Feb	486,489	1.49
	2-Mar	1,956,708	2.39
	17-Mar	2,154,790	2.34
	5-Apr	310,106	1.70
	12-Apr	541,200	1.78
	15-Apr	6,732,093	2.96
	27-Apr	36,096	1.28
	4-Jun	596,109	1.86

TABLE 2-3
Summary of Observed Precipitation and Discharge Volumes

Wellington Avenue CSO Facility CSO Discharges 2001-Current

Year	Day & Month of Discharge	Wellington CSO Total Discharge (gal)	Rainfall Total (inches)
2008	1-Feb	25,400	1.17
	13-Feb	1,789,726	2.16
	27-Feb	25,398	0.56
	Mar 8-10	3,327,138	2.87
	Mar 20-21	482,560	1.13
	April 4-5	355,572	1.30
	July 24	76,500	1.70
	July 27-28	101,592	1.20
	September 7	50,796	2.80
	September 26	558,756	3.90
	Sept. 27-28	380,970	1.45
	October 26	152,388	1.35
	November 25	34,000	1.68
	Dec 11-14	5,892,336	4.15
	Dec 21	152,388	0.8 + snow melt
	Dec 24-26	1,625,472	0.85 + snow melt
2009	Jan 7-8	660,348	1.55+ snow melt
	Jan 28-29	761,940	2.35"
	March 29	50,796	1.15"
	April 3	50,796	0.80"
	April 6-8	3,454,128	3.08"
	April 11- 12	126,990	0.76"
	April 21	76,194	1.36"
	April 21-23	761,940	2.03"
	May 5	25,398	0.85"
	May 6	101,592	0.68"
	May 7	76,194	0.50"
	June 19	56,286	1.20"
	July 1-2	1,117,512	2.64"
	July 2-3	177,786	0.73"
	July 7-8	584,154	1.08"
	July 8-9	863,532	0.84"
	July 23-26	2,277,254	2.67"
	Aug 29-30	965,124	3.66"
	Oct 3	380,970	1.32"
	Oct 18	406,368	1.76"
	Oct 25	25,398	1.07"
	Oct 28-29	736,542	1.21"
	Dec 3	711,144	1.55"
	Dec 9-10	1,210,638	1.47"
	Dec 13	253,980	1.07"
	Dec 27	279,378	0.28" + snow melt

Washington Street CSO Facility CSO Discharges 2001-Current

Year	Day & Month of Discharge	Washington CSO Total Discharge (gal)	Rainfall Total (inches)
2008	13-Feb	4,645,196	2.16
	27-Feb	166,400	0.56
	Mar 8-13	7,881,395	3.03
	Mar 19-22	3,211,699	1.13
	Apr 4-5	1,346,201	1.3
	September 26	568,307	3.9
	Dec 11-14	4,612,697	4.15
	Dec 25	755,801	0.85 + snow melt
2009	Jan 7-8	463,693	1.55+ snow melt
	Jan 28-29	813,107	2.35"
	April 6-9	4,182,400	3.08"
	April 10-11	1,870,592	n/a
	April 11-12	79,104	0.76"
	April 21	590,082	1.36"
	April 21-23	968,691	2.03"
	April 23	5,504	n/a
	May 6	189,299	0.68"
	July 1-5	4,843,098	3.37"
	July 5	138,509	n/a
	July 7-11	5,154,406	1.84"
	July 11-12	61,287	n/a
	July 23-28	6,686,195	3.85"
	July 28	61,210	n/a
	Aug 29-30	830,612	3.66"
	Aug 31	169,408	n/a
	Oct 3	622,118	1.32"
	Oct 18-21	1,902,502	1.76"
	Oct 28-29	1,256,307	1.21"
	Dec 3	1,433,396	1.55"
	Dec 9-10	2,642,893	1.47"
	Dec 13-14	438,195	1.07"
	Dec 15	6,195	n/a

TABLE 2-3
Summary of Observed Precipitation and Discharge Volumes

Wellington Avenue CSO Facility CSO Discharges 2001-Current

Year	Day & Month of Discharge	Wellington CSO Total Discharge (gal)	Rainfall Total (inches)
2010	Jan 18	380,970	1.50"
	Jan 25-26	177,786	1.08"
	Feb 24-28	6,374,898	4.40"
	Feb 28	76,194	n/a
	Mar 13-18	2,052,378	4.46"
	Mar 23-27	6,552,684	3.94"
	Mar 27	76,194	n/a
	Mar 29 - Apr 4	14,324,472	7.23"
	Apr 4	33,864	n/a
	June 5	29,631	1.41"
	June 13	207,417	2.31"
	July 19	38,097	0.60"
	July 24	41,440	0.47"
	Oct 6	175,328	1.36"
	Oct 15	304,384	1.64'
	Nov 17	135,648	1.38"
	Dec 12	60,064	1.24"
2011	Feb 2	82,880	1.03" + snow
	Feb 6	62,280	0.44 + snow
	Feb 25	876,544	2.20"
	Feb 28	55,200	0.63"
	Apr 13-14	1,214,208	2.49"
	April 17	152,388	0.95"
	June 22	87,552	1.08"
	Aug 8	299,392	1.41"
	Aug 15	273,792	2.45"
	Aug 28	171,108	1.10"
	Sept 6	41,184	2.08"
	Sept 8	1,043,776	2.36"
	Sept 9	76,128	n/a
	Oct 4	86,208	1.09"
	Oct 13	75,293	1.37"
	Oct 19-20	1,750,000	2.77"
	Oct 30	266,679	1.81"
	Nov 10	27,467	1.25"
	Nov 23	1,049,921	2.66"
	Dec 8	404,801	2.36"
2012	Apr 23	139,689	2.55"
	May 10	874,835	2.93"
	July 28	101,592	3.94"
	Aug 10	177,786	1.58"
	Oct 29	761,940	0.43" + tidal surge

Washington Street CSO Facility CSO Discharges 2001-Current

Year	Day & Month of Discharge	Washington CSO Total Discharge (gal)	Rainfall Total (inches)
2010	Jan 18	904,960	1.50"
	Jan 25-26	101,004	1.08"
	Feb 24	1,270,604	see below
	Feb 25- Mar 1	7,300,290	4.40"
	Mar 13-18	11,558,592	4.46"
	Mar 23-28	5,204,404	3.94"
	Mar 29- Apr 4	64,429,952	7.23"
	June 13	1,483,000	2.31"
	Nov 17	185,000	1.38"
2011	Feb 2	3,141,000	1.03" + snow
	Feb 6	4,985,000	0.44" + snow
	Feb 8	334,000	0.32" + snow
	Feb 25-26	11,955,000	2.20"
	Feb 28	3,911,000	0.63"
	Apr 13-14	6,663,000	2.49"
	April 17	4,874,000	0.95"
	Aug 8	1,484,000	1.41"
	Aug 15	2,328,000	2.45"
	Aug 28	31,000	1.10"
	Sept 8	4,022,000	2.36"
	Oct 13	1,152,000	1.37"
	Oct 19-22	12,180,000	2.77"
	Oct 30-31	3,300,000	1.81"
	Nov 23-24	8,520,000	2.66"
	Dec 8-9	3,840,000	2.36"
2012	May 10-11	2,280,000	2.93"
	July 28-29	2,371,200	3.94"
	Aug 10	249,600	1.58"
	Aug 15	187,200	1.82"

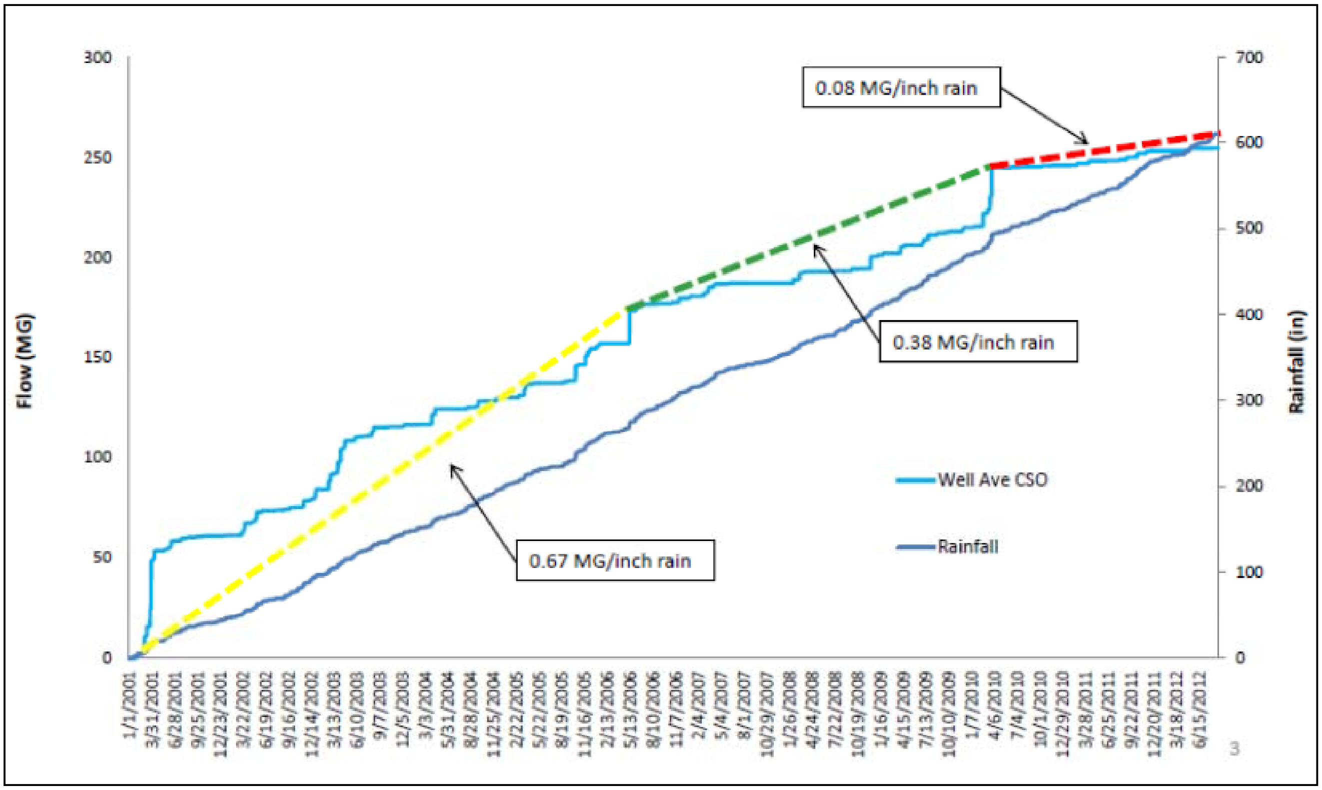


Figure 2-1. Historical Trends in Discharges from the Wellington CSO Treatment Facility

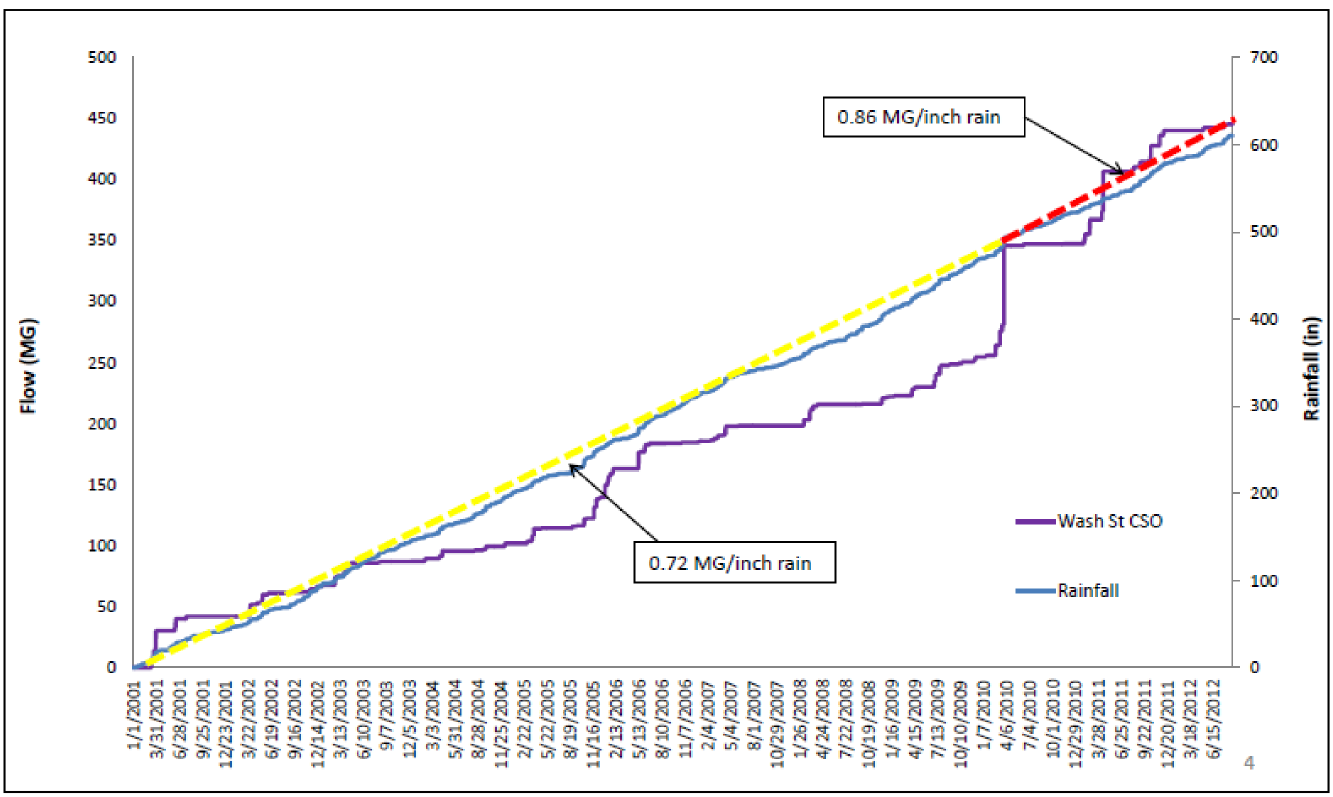


Figure 2-2. Historical Trends in Discharges from the Washington CSO Treatment Facility

The frequency of discharges from the CSO treatment facilities has also been affected by recent improvements and operational changes. Figure 2-3 shows the annual number of discharge events recorded at each facility. The frequency of events at Wellington shows a significant reduction, while the frequency of events at Washington has been relatively consistent.

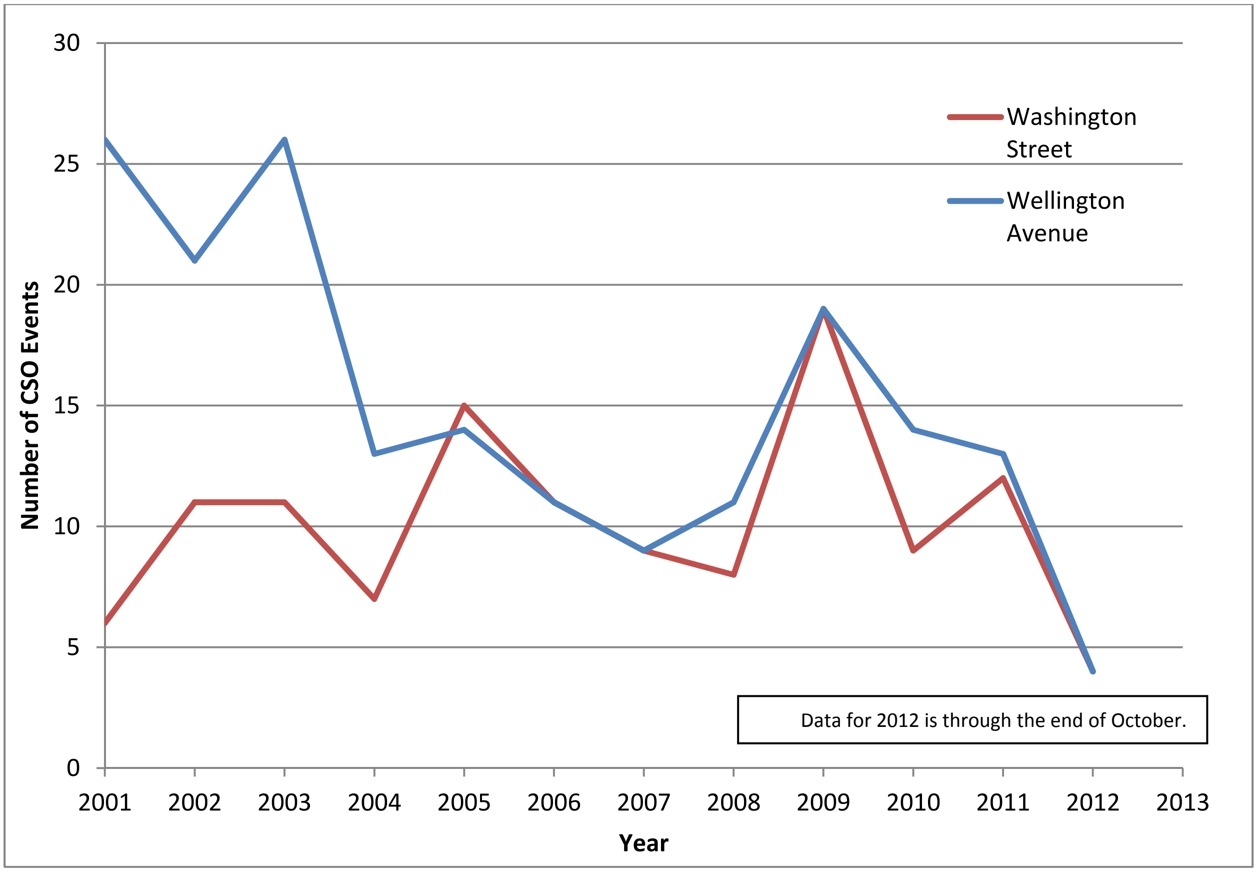


Figure 2-3. Discharge Frequency at CSO Treatment Facilities

Although the data shown in Figures 2-4 and 2-5 show a few recent discharges for smaller events, in recent years discharges have been eliminated from the WACSOTF and WSCSOTF for storms of up to 1 inch of precipitation. Two of the recent discharges for smaller events were at Wellington in the summer of 2010. The other two were related to back-to-back storms in February of 2011 that occurred on top of a snowpack.

The long term performance trends shown in these figures are consistent with the nature of the improvements made during this same time frame. In the Wellington Avenue CSO Sewershed area several projects have been completed that reduce rainfall-derived inflows. Several other projects have increased conveyance capacity. In particular, removing obstructing utilities during the Thames Street Sanitary Sewer Interceptor Rehabilitation project increased the system’s ability to convey WWFs from the Wellington Avenue CSO Sewershed area to the Long Wharf Pump Station and the WSCSOTF. The types, location and timing of these projects support the observed trends for both decreased frequency and volume of discharges from WACSOTF and maintained frequency and volume of discharges from WSCSOTF.

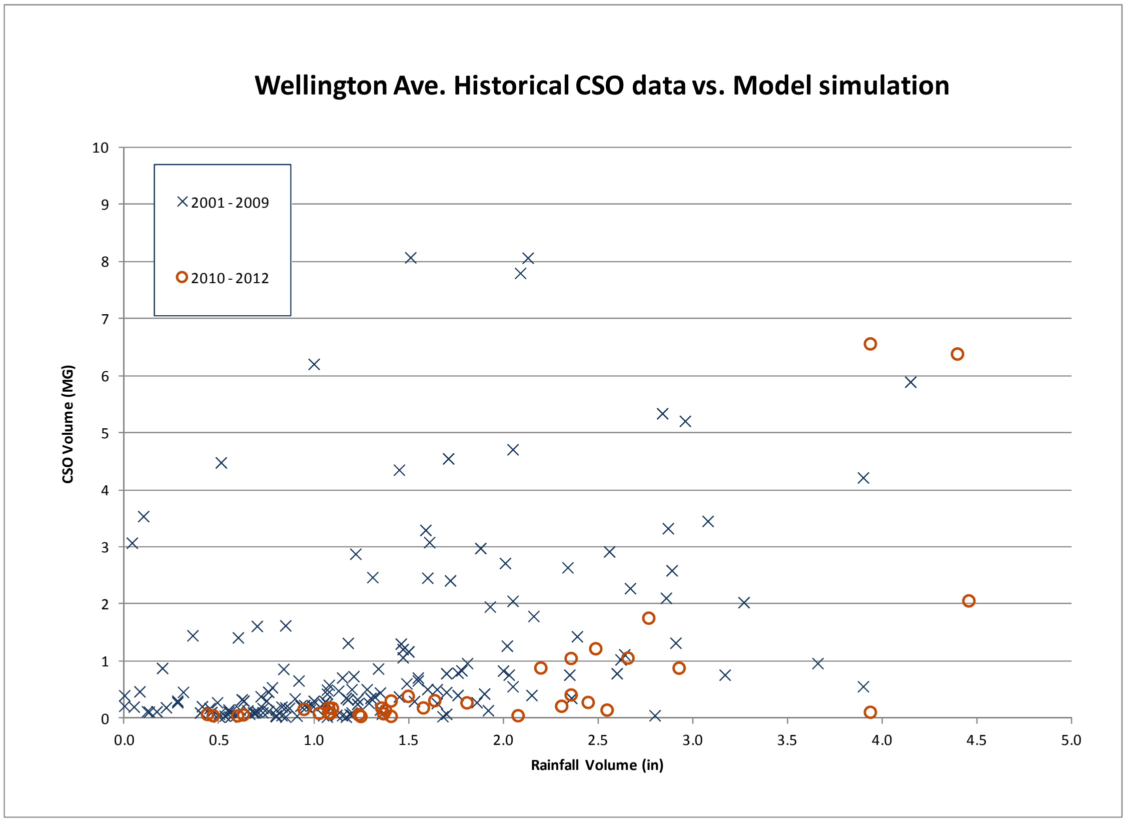


Figure 2-4. Measured CSO Volumes at WACSOTF as a Function of Rainfall Depth (2001-2012)

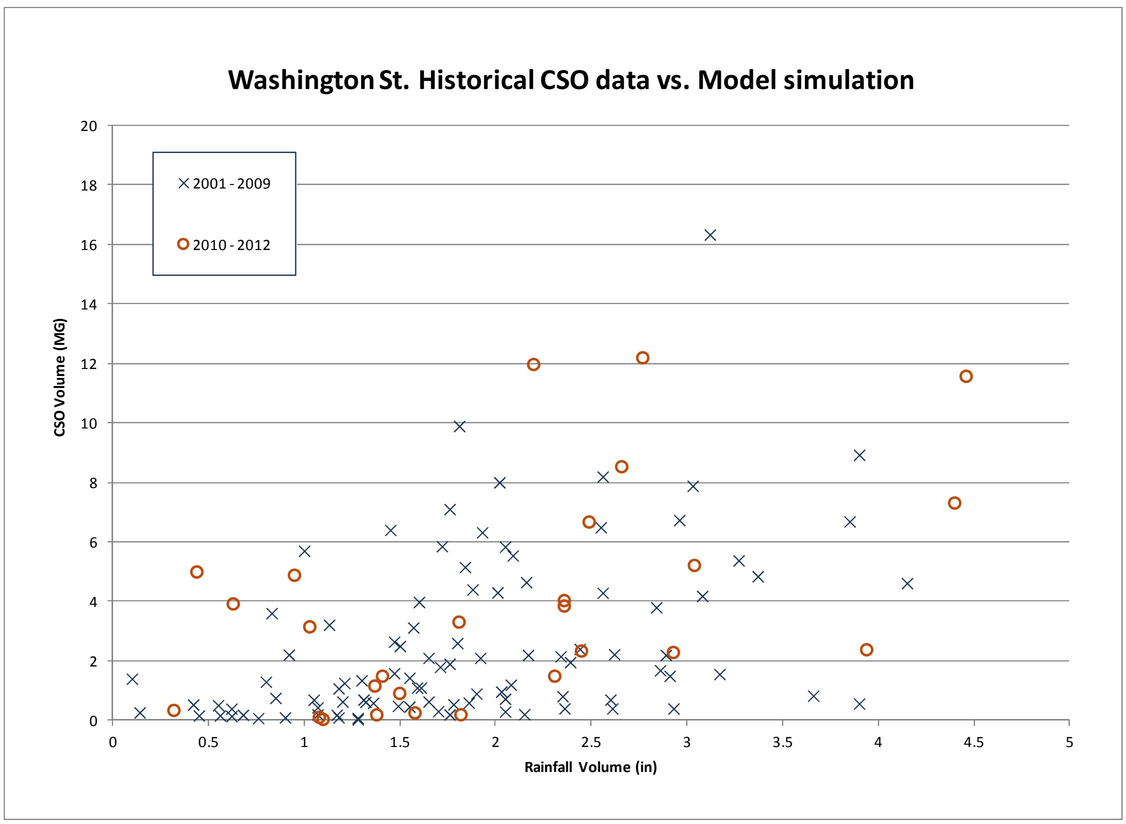


Figure 2-5. Measured CSO Volumes at WSCSOTF as a Function of Rainfall Depth (2001-2012)

2.3.2 WPCP Flows

In addition to work completed in the collection system, an analysis of WPCP flows between 2001 and August of 2012 was conducted to determine the overall trends in its performance. These data are summarized in Table 2-4. The historic annual average daily flow (ADF) has ranged from 8.15 to 11.44 million gallons per day (MGD), depending on annual rainfall depth. Comparing the historical average flow from 2011 of 10.45 MGD with the average monthly flow permit limit of 10.7 MGD, the WPCP is operating at 98 percent of its monthly average permit limit. As a result of the maximum monthly ADF shown in Table 2-4, there have been three or more exceedances of the 10.7 MGD monthly average permit limit every year, with more exceedances during wetter years. However, the exceedances of the 19.7 maximum day limit have significantly decreased such that no exceedances have occurred in 2011 and 2012. This indicates that improvements to the operation of the Long Wharf Pump Station during wet weather events, as described in the City of Newport *Operations and Maintenance Manual* (Sevee & Maher Engineers, Inc., et al., 2009/2011), has helped to limit WWFs to the WPCP and improve performance relative to the maximum day permit limit of 19.7 MGD. Additional details on how flows to the WPCP are throttled to meet its discharge permit are provided in Section 4.2.3 of this report.

TABLE 2-4
WPCP Flow Data between 2001-2012

Year	Total Rain (in.)	Annual ADF (MGD)	Maximum Monthly ADF (MGD)	Exceedances of 10.7 MGD Monthly ADF	Exceedances of 19.7 MGD Maximum Day
2001	43.89	8.17	16.05	3	8
2002	49.97	8.61	14.28	3	8
2003	53.1	10.48	14.81	5	15
2004	50.53	9.70	15.65	2	9
2005	55.61	10.62	14.07	7	10
2006	58.61	9.91	13.36	5	5
2007	41.89	8.15	15.32	3	6
2008	53.77	9.26	14.17	3	3
2009	61.92	11.44	15.29	6	2
2010	52.76	8.80	16.00	3	3
2011	57.65	10.45	13.56	6	0
2012[a]	30.55	5.43	10.55	0	0

[a] Partial data set available (through August 2012)

2.3.3 CSO Treatment Performance and Newport Harbor Water Quality Analysis

CSO treatment performance data and water quality data in Newport Harbor between 2006 and 2011 were analyzed to determine the effects of CSO discharges on water quality. A detailed technical memorandum describing RIDEM's water quality standards, Newport Harbor's classification and designated uses, and detailed characterization of the discharge of the CSO facilities is provided in Appendix B.

The City's National Pollutant Discharge Elimination System (NPDES) permit requires sampling at both the WACSOTF and WSCSOTF for every wet weather event during a CSO occurrence to characterize the treatment performance of the facilities relative to the following water quality parameters: total suspended solids (TSS), fecal coliform, total residual chlorine, oil and grease, and settleable solids. The sampling points for the two facilities were located inside the facilities until November 15, 2010, when both were relocated to the outside of the facilities. The new sampling points provide a better indication of water quality as they allow chlorine more time to disinfect pathogens.

The WACSOTF sampling point was moved to the stone pier approximately 3,200 feet from the facility and the WSCSOTF sampling point was moved to a location on the Goat Island Connector approximately 1,300 feet from the facility.

The sampling data at the WACSOTF and WSCSOTF for fecal coliform is shown in Figures 2-6 and 2-7 below. At the WACSOTF, increasing the mixing time reduces the average fecal coliform concentration from 295,000 most probable number (MPN) per 100 milliliters (mL) to 57,000 MPN/100 mL, while the average fecal coliform at the WSCSOTF decreased from 632,000 MPN/100 mL to 175,000 MPN/100 mL. As expected, the new sampling points and resulting increased mixing times improve fecal coliform concentrations and provide a more representative effluent discharge quality results from the facilities.

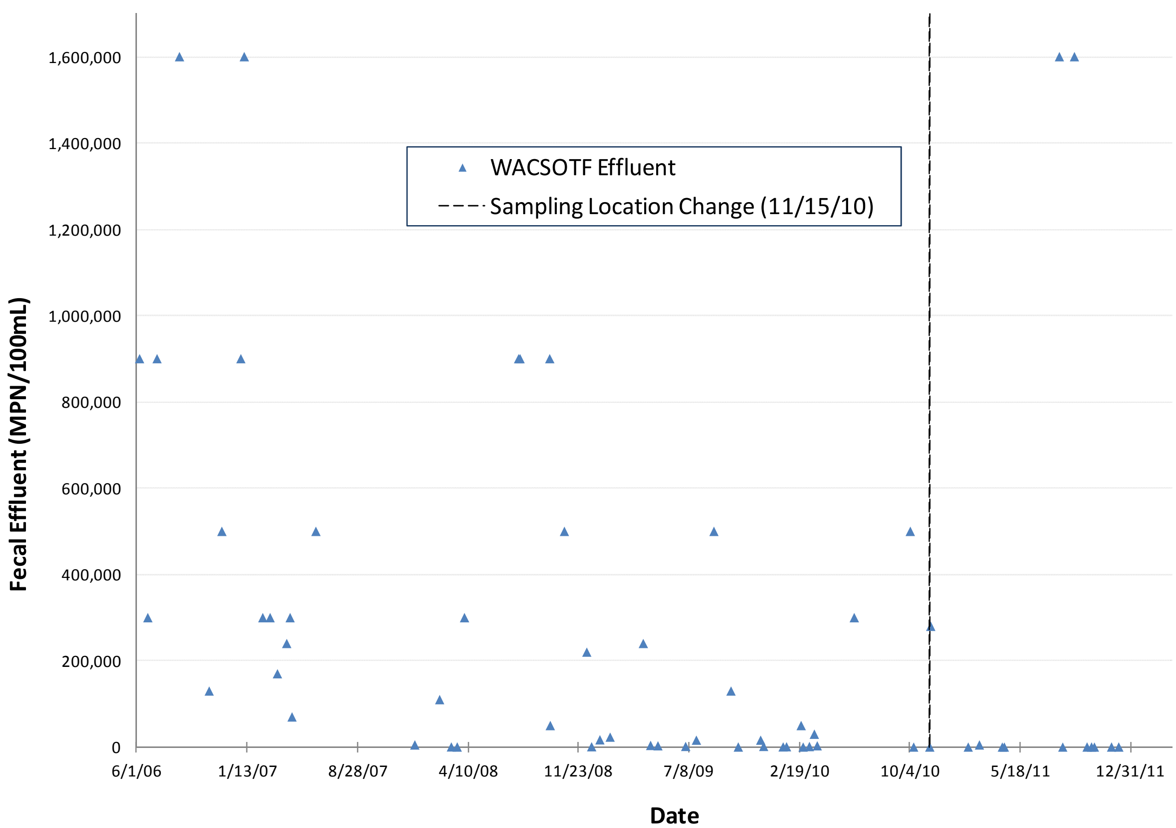


Figure 2-6. WACSOTF Effluent Samples for Fecal Coliform (2006-2011)

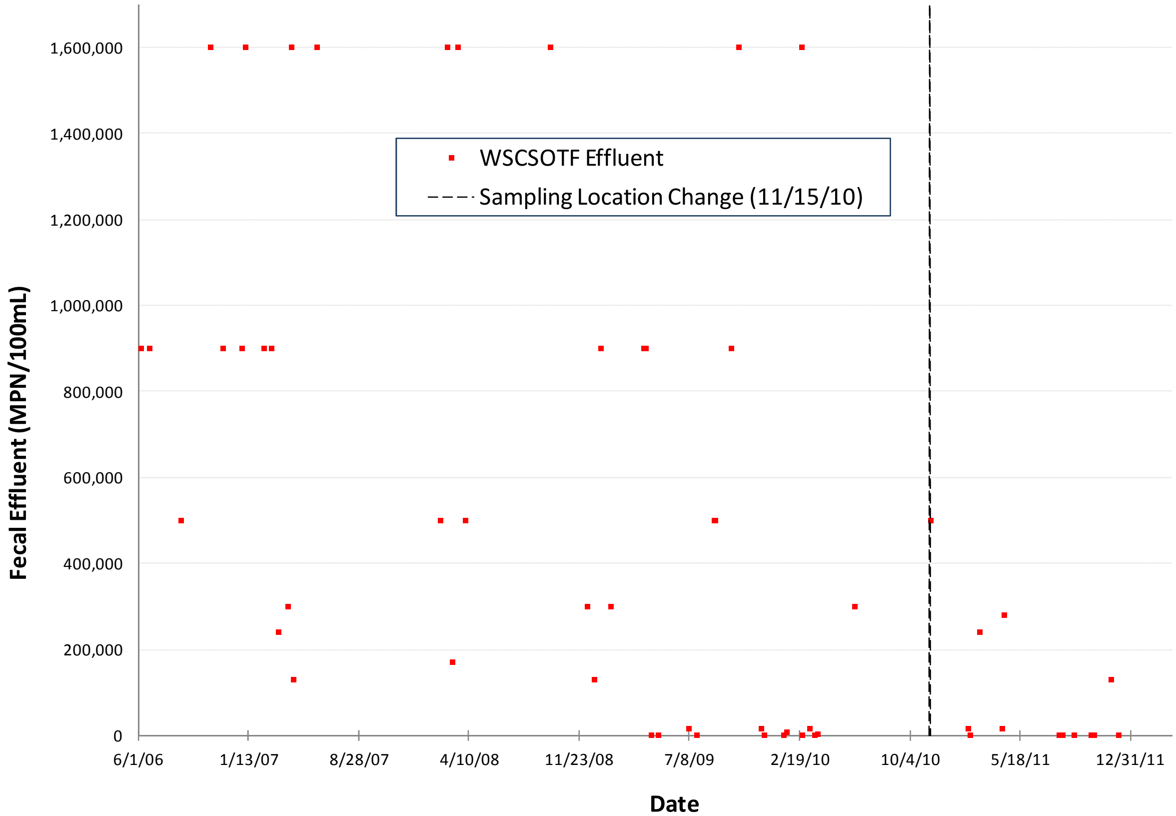


Figure 2-7. WSCSO Effluent Samples for Fecal Coliform (2006-2011)

Enterococci concentrations are primarily used to characterize Newport Harbor water quality as well as determine beach closures. Wet weather surface monitoring for Enterococci at both CSO treatment facilities is summarized below in Table 2-5. Between 2009 and 2011, a total of 12 wet weather events were sampled, with eight of them exceeding Enterococci limits during the event (33 percent compliance). However, when samples were taken 6 hours following an event, only three of them exceeded Enterococci limits (75 percent compliance). This suggests that effluent discharge from CSOs is diluted to an acceptable level within hours of a wet weather event.

TABLE 2-5
Wet Weather Enterococci Exceedances at Both CSO Facilities

	Sampling During CSO Event		Sampling 6 Hours After CSO Event		
Year	**Number of Samples**	**CSO Enterococci Exceedances**	**Number of Samples**	**Post-CSO Enterococci Exceedances**	**Months Sampled**
2009	4	3	4	0	July & October
2010	4	1	4	0	March, April and November
2011	4	4	4	3	August and September
Total	**12**	**8**	**12**	**3**	

A comparison of the complete sampling record of the Harbor water quality data was analyzed to determine the impacts of CSOs relative to wet weather and dry weather conditions without CSO discharges. A summary table of samples exceeding the Enterococci limit is shown below in Table 2-6.

TABLE 2-6
Harbor Enterococci Exceedance Sampling Conditions

Year	Total Samples Collected	Total Enterococci Exceedances[b]	Enterococci Exceedances Associated w/ Rainfall (but No CSO Event)	Enterococci Exceedances within 2 days of a CSO Event	Enterococci Exceedances Preceded by 24+ hrs of Dry Weather
2008[a]	130	9	0	6	3
2009	530	4	1	1	2
2010	520	10	4	5	1
2011	520	8	2	6	0
Total	**1700**	**31**	**7**	**18**	**6**

a) Partial Year beginning 10/02/2008
b) Enterococci levels were not exceeded at all 10 locations. For 11 of the 16 days, Enterococci levels were exceeded at only 1 station.

For each of the four years, there was typically one exceedance recorded that occurred in the absence of rain or CSO (i.e., dry weather conditions) and one exceedance recorded with the presence of rain but no CSO. These results indicate that CSOs are not the sole cause of Enterococci exceedances. Stormwater pollutants and/or local point source contamination, such as boat waste or bird excrement, are also critical factors in determining the water quality of Newport Harbor.

2.4 Updates to the System-wide Hydraulic Model

The hydraulic model for the City of Newport's collection system was developed using the MIKE URBAN (MU) software as part of the Phase 2 Long Term Control Plan project (2009) and was updated and expanded in 2010 per the requirements of CD Items 58 to 60. The model was then calibrated to three events and validated to an additional event per requirements of CD Item 61. A summary of the updates as well as calibration and validation results are described in the *Hydraulic Modeling Report* submitted in April 2011 (CH2M HILL, 2011c).

Subsequent to that report, as changes to the collection system were implemented, data improvements were available through GIS and/or as-built drawings, and additional flow metering data was available, the model was updated to incorporate the best available data. These improvements include: updated hydraulic features to reflect recent improvements described in Section 2.2, added hydraulic features (e.g., pumps, pipes, and manholes) and refined real-time controls (RTCs) to provide more accurate hydraulic modeling, and updated diurnal patterns to reflect seasonal and tidal influences. Table 2-7 provides a summary of the comparison between the previous (2010) and current (2012) models. Following the updates, the model was recalibrated and validated to reflect current conditions prior to analyzing CSO control alternatives.

TABLE 2-7
Comparison between Previous (2010) and Current (2012) Models

Parameter	Previous Model (2010)	Current Model (2012)
No. of Cross Section Shapes[a]:	3	3
No. of Curves and Functions:	21	52
No. of Pipe Materials:	16	17
No. of Head Loss Definitions:	5	5
No. of Cyclic Patterns:	27	58
No. of Nodes:	768	875
No. of Links:	756	851
Total Link Length:	173,480 feet	215,479 feet
No. of Pumps[b]:	22	60
No. Pump Stations	7	24
No. of Weirs:	12	13
No. of Orifices :	5	3
No. of Network Loading Points[c]:	560	570
No. of Subcatchments	120[d]	130

[a] A Cross Section Shape is a user-defined pipe or channel shape in MU.
[b] The number of individual pumps in the model.
[c] For dry weather flow (DWF) loading.
[d] Includes non-contributing subcatchments.

2.4.1 Hydraulic Updates

2.4.1.1 Links

Several pipes in the existing model were updated to reflect recent system improvements, as described in Section 2.2. The most significant hydraulic updates were as a result of the Wellington Avenue Sanitary Sewer Rehabilitation Project (11-001) and the Thames Street Sanitary Sewer Interceptor Rehabilitation Project (11-011). To reflect the Wellington Avenue Sanitary Sewer Replacement project, the model was updated from Halidon Avenue to near Marchant Street with new 12 to 24-inch diameter polyvinyl chloride (PVC) sewers. The Thames Street Sanitary Sewer Interceptor Rehabilitation Project updates included changing the pipe shape to reflect the new lining. The changes made to the shapes are shown in Figures 2-8A through 2-9B.

A total of 95 links were added to the 2010 model, mostly upstream and downstream of the added pump stations. Figure 2-10 shows the updated model with the new and existing pipes. The diameter, length, shape, inverts, and pipe material were imported from the GIS to the updated model. The following assumptions were made where data was missing or not available:

- Inverts: interpolated from upstream or downstream (US/DS) pipe slopes or field survey at critical locations
- Shapes: assumed MU circular shape
- Material: assumed the same pipe material as the nearest US/DS pipes with known pipe materials

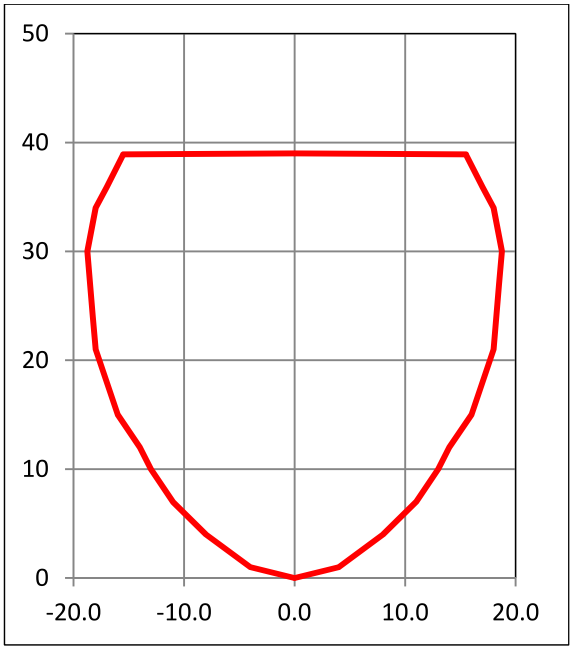


Figure 2-8a. Shape of Egg-shaped Brick Sewer from Morton Avenue to Carey Street (39" x 38"). Manning's *n* = 0.019.

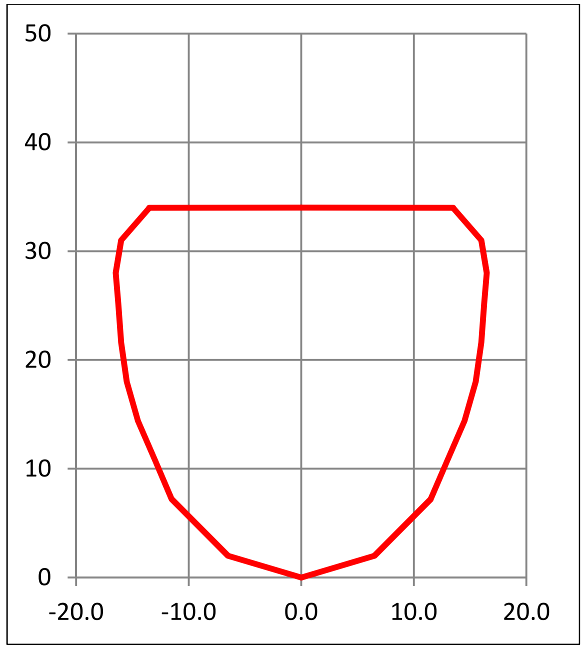


Figure 2-8b. Shape of New GRP Liner from Morton Avenue to Carey Street (33.98" x 32.95"). Manning's *n* = 0.010.

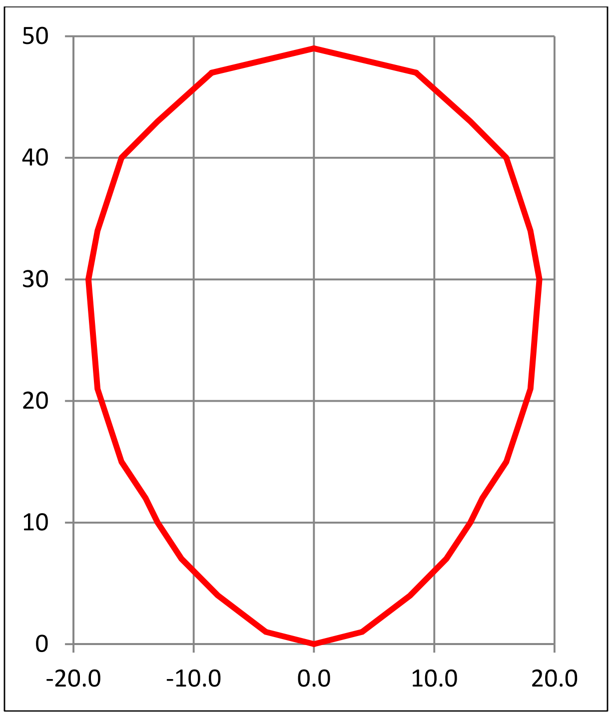


Figure 2-9a. Shape of Egg-shaped Brick Sewer from Carey Street to Touro Street (49" x 38"). Manning's *n* = 0.019.

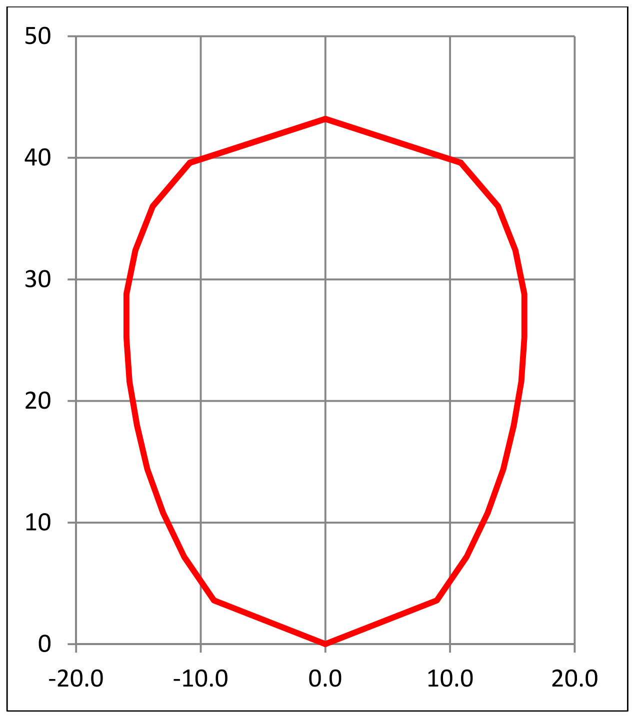


Figure 2-9b. Shape of New GRP Liner from Carey Street to Touro Street (43.03" x 32"). Manning's *n* = 0.010.

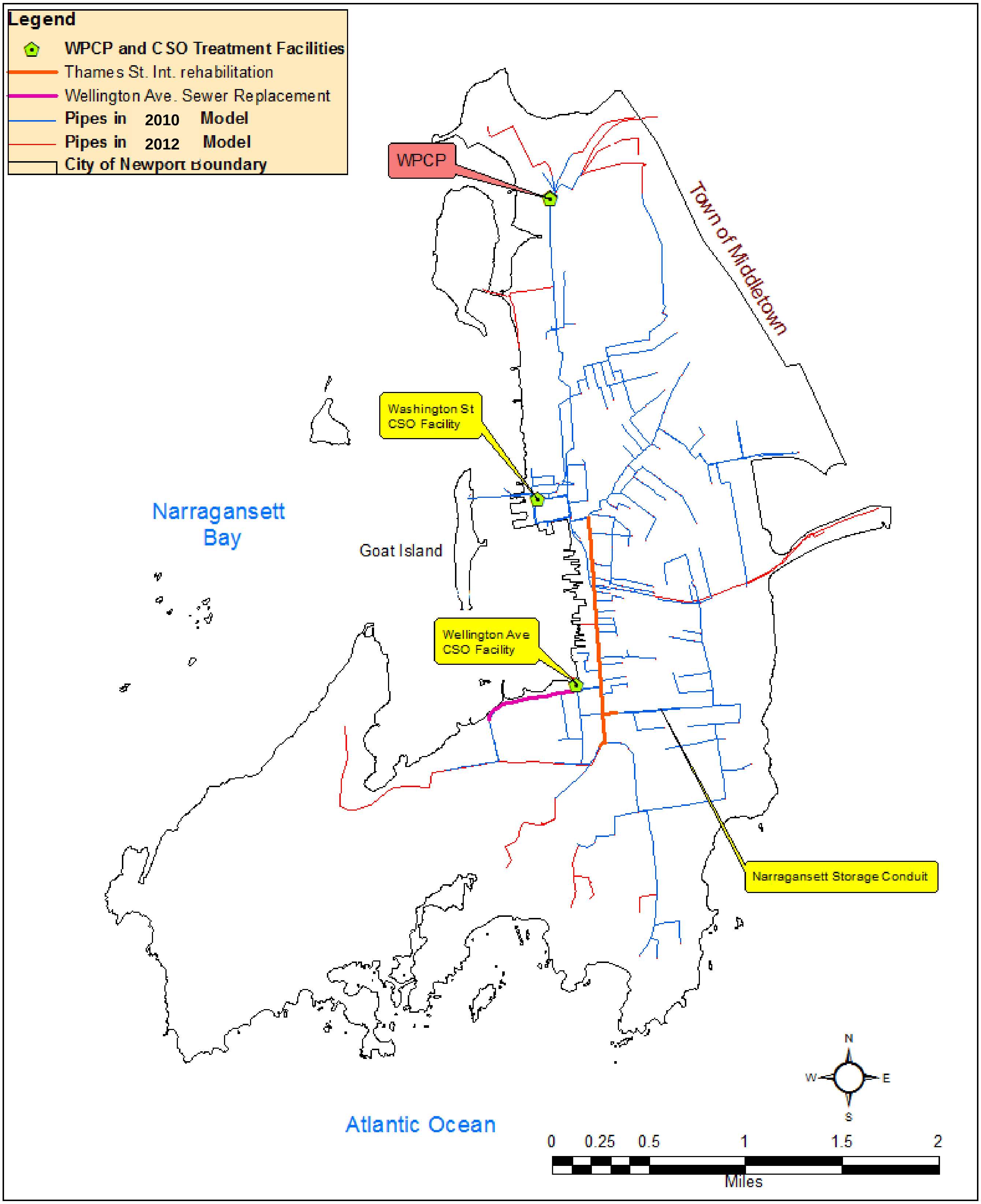


Figure 2-10. Previous and Current Pipes in the Hydraulic Model.

2.4.1.2 Nodes

A total of 107 nodes were added to the 2010 model where links were added to accommodate the addition of new pump stations, which is described in Section 2.4.1.4. Figure 2-11 shows the nodes in the 2010 and 2012 models. Node rim and invert elevations were updated in the model with available data using GIS data, 2011 United States Geological Survey (USGS) Statewide Provisional Light Detection and Ranging (LIDAR) data, as-built drawings or field investigation data. If the rim and invert elevation data were not available, the following assumptions were made:

1) Missing rim elevations were updated with the rim elevation from the nearest manhole or ground surface elevation in the immediate vicinity of the new node.
2) Missing inverts were interpolated based on the lowest inverts of downstream connected pipe or from the closest manholes within the same pipe branch.
3) If the invert elevation was missing and downstream or upstream pipes were lacking inverts, then the invert was set 10 feet below rim elevation.

2.4.1.3 Weirs and Orifices

Four orifices were removed from the 2010 model to reflect the removal of the four inverted weirs during the Thames Street Sanitary Sewer Interceptor Rehabilitation Project. One weir and two orifices were added to the 2010 model; the additional structures were added to connect the WACSOTF backwash wet well, microstrainer basin and storm wet well as shown in Figure 2-12. Tables C-1 and C-2 in Appendix C list the major model input parameters for each weir and orifice in the 2012 model.

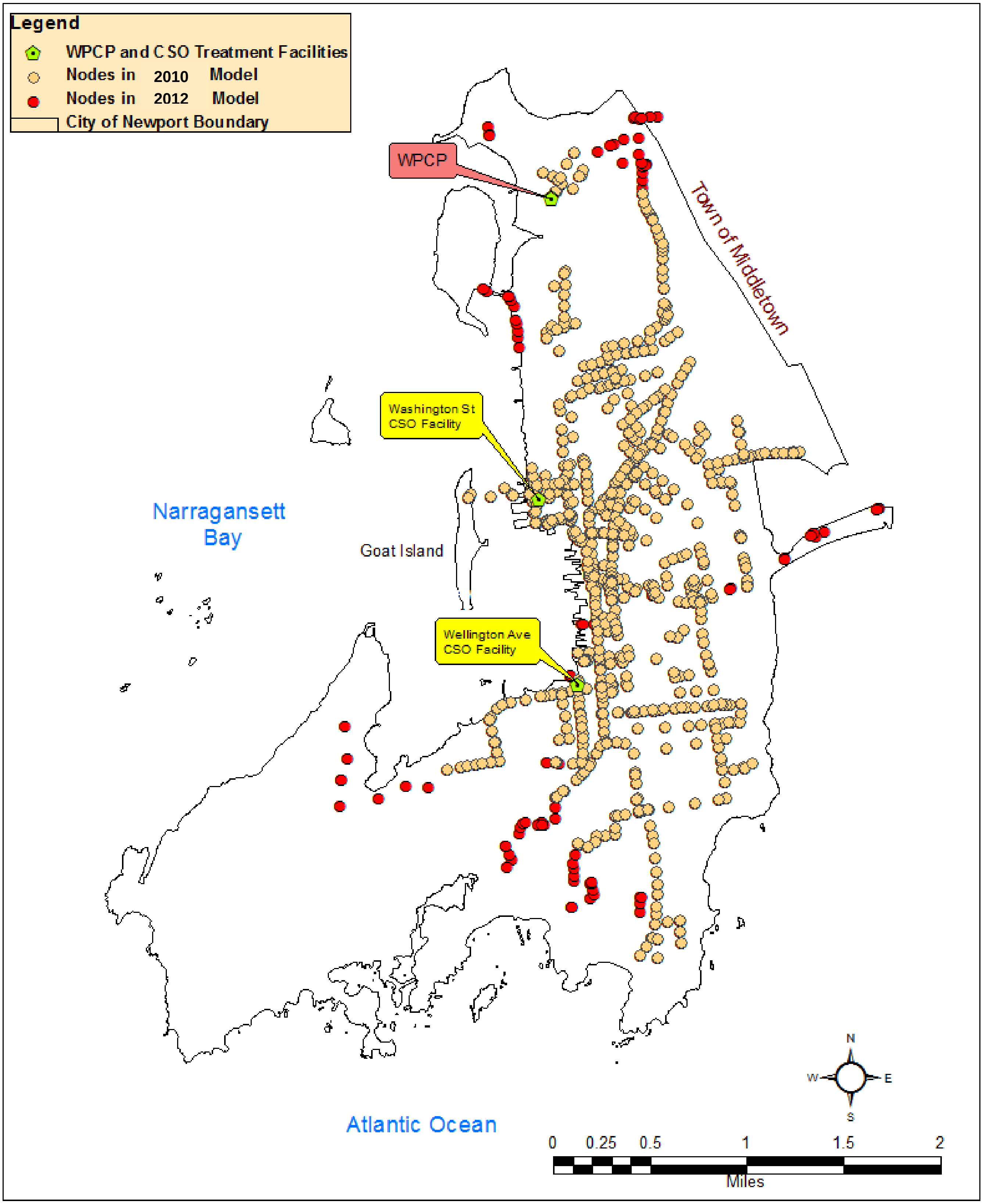


Figure 2-11. Previous (2010) and Current (2012) Nodes in the Hydraulic Model.

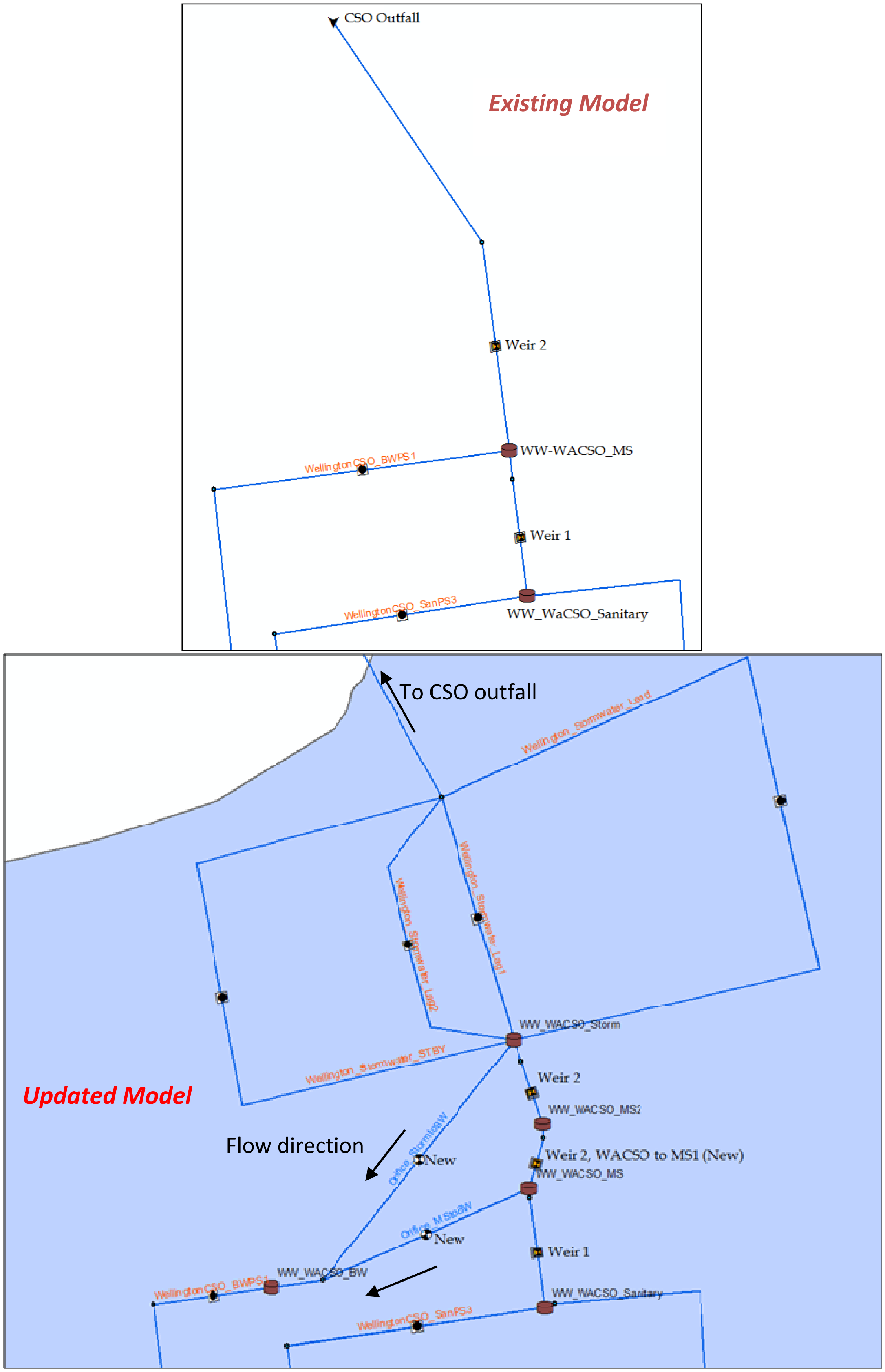


Figure 2-12. Previous (2010) and Current (2012) Model Setup at WACSOTF.

2.4.1.4 Pump Stations

A total of 17 pump stations were added to the 2012 model. Figure 2-13 displays existing updated pump stations in the model. Six pump stations were added to replace pump stations that were previously simulated by using time series of measured flows during the calibration and validation periods. The following pump stations were added (with flow meter ID):

- Middletown Wave Avenue (CH-03)
- Naval Station Fort Adams (CH-12)
- Hazard Road (CH-24)
- Ruggles Avenue (CH-13)
- Coddington Wharf (CH-17)
- Coddington Middletown (CH-23)

The other 11 pump stations were added to improve model calibration:

- Navy Coddington Cove
- Navy Coddington Point
- Ranger Road
- Maple Avenue
- Navy Training Station Road
- Beach Station
- Lee's Wharf
- WACSOTF Storm
- Carroll Avenue
- Alpond Drive
- Murray Place

Pump curves were used where data was available, otherwise constant pump rates were assumed. Force mains were added downstream of the new pump stations.

In addition, the start and stop elevations and levels were updated for the following nine pump stations:

- Bliss Mine Road
- Coddington Wharf
- Goad Island
- Hazard Road
- Lee's Wharf
- Long Wharf
- Ruggles Avenue
- Wellington Avenue Sanitary Pumps
- WSCSOTF Effluent

The capacity curve type was updated for the WSCSOTF dewatering pump to a constant flow type and the pump curves were refined for Long Wharf Pump Station to better reflect pumping operations. Tables C-3 and C-4 in Appendix C list the major model input parameters for each pump station. Several data sources are referenced, which provide the best data available to date. However, some assumptions were necessary to determine pump station characteristics when data was not available.

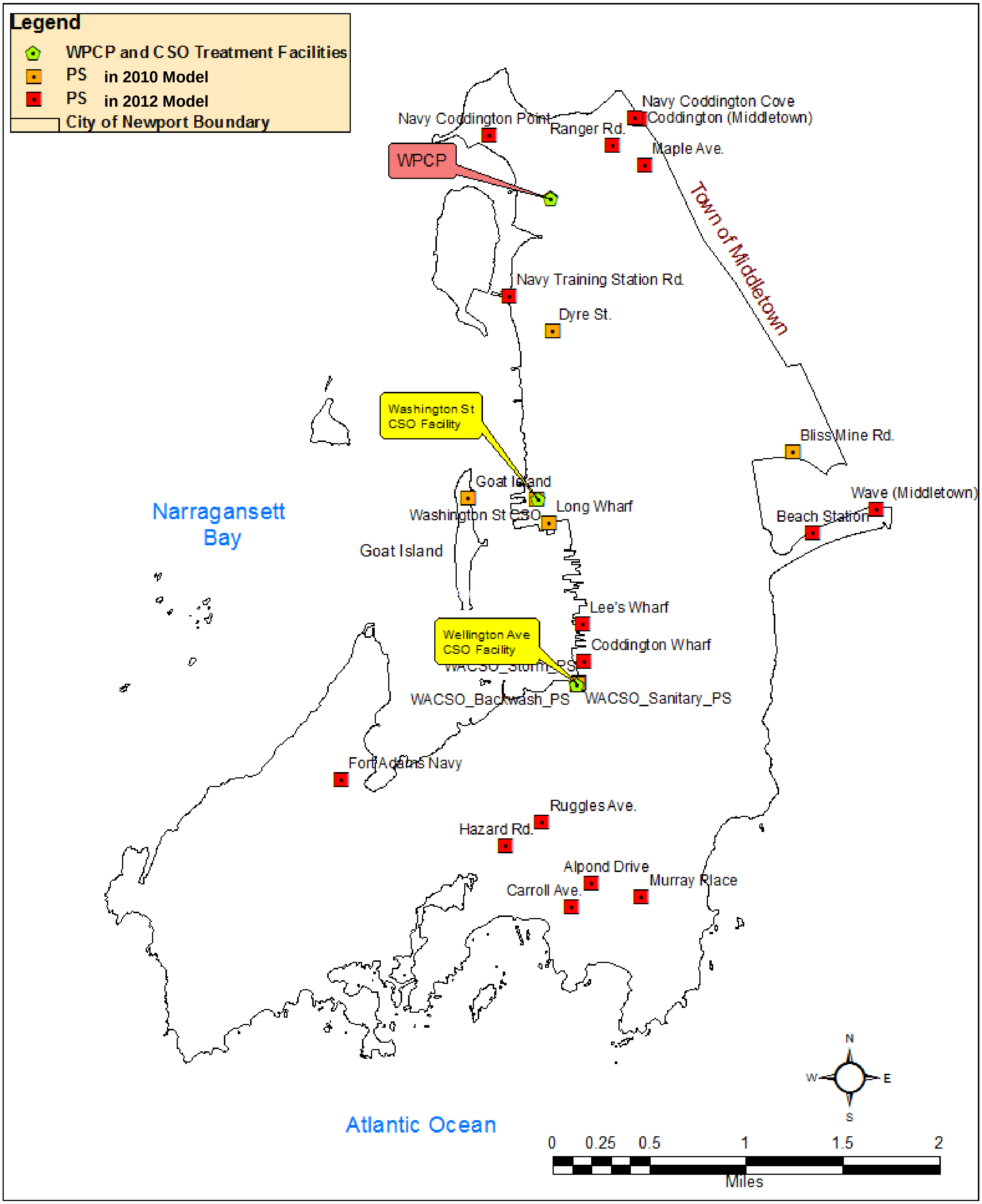


Figure 2-13. Previous (2010) and Current (2012) Pump Stations in the Hydraulic Model.

2.4.1.5 Real-Time Controls (RTCs)

RTC rules defined as noted in the Hydraulic Modeling Report submitted in April 2011 (CH2M HILL, 2011c) were refined at the Long Wharf Pump Station, WSCSOTF dewatering pump, and the Narragansett Avenue Storage Conduit (NASC) gate. These RTCs were defined to better simulate current automated SCADA controls at the WSCSOTF and the NASC gate as well as the manual second pump operation at the Long Wharf Pump Station. The RTC of the Long Wharf pumps simulate typical throttling operations to meet the WPCP's maximum day permit requirement of 19.7 MGD as described in the City of Newport *Operations and Maintenance Manual* (Sevee & Maher Engineers, Inc., et al., 2009/2011). These improvements also helped increase model stability and decrease model run times.

2.4.2 Hydrologic Updates

2.4.2.1 Diurnal Patterns

The influence of tidal oscillation and seasonal trends in groundwater table elevations and flow discharge at meter locations in Newport were examined per CD Item 54b. A summary of the complete analysis is provided in Appendix C. There were 31 locations where groundwater levels were recorded, of which, 18 had complete data sets and were used for further analysis. There were six groundwater meter locations that exhibited significant groundwater level variation: CH-09, CH-17, CH-21, CH-31, CH-33 and CH-34. The groundwater and flow data at these six locations were reviewed at short and long term time scales to determine the potential impact of tidal and rainfall influences. Short term groundwater fluctuations included those impacted by semi-diurnal (approximately every 12 hours) and semi-monthly tide cycles (approximately every 29 days). Long term groundwater fluctuations are typically driven by rainfall volume and soil conditions.

For the short term analyses, flow data at CH-17, CH-21, and CH-31 displayed a mild to strong temporal correlation with groundwater fluctuations. Rainfall was strongly correlated with flow data fluctuations at CH-09, CH-21 and CH-34. Flow data at CH-33 appeared to have no impact from either groundwater table fluctuations or rainfall. Analysis of long term seasonal trends in groundwater table elevation showed increased groundwater levels during the spring thaw which slowly declined during the summer months. Flow data at CH-34 showed a mild correlation with groundwater, while flow data at meters CH-09, CH-31 and CH-34 showed mild to strong correlations with rainfall in the long term. However, flow data fluctuations at CH-09 were mostly result of operational modifications instead of groundwater influences based on conversations with the City's collection system operator.

The flow data for the 18 meters with complete data sets were then compared to DWF diurnal patterns and rainfall-derived infiltration and inflow (RDII) parameter inputs from the 2010 model to determine if updates were needed to reflect potential groundwater influences. Overall, five meters were found to have appreciable peak flow and volume differences during DWF periods: CH-02, CH-08, CH-18, CH-22, and CH-09. Of these five meters, only CH-22 had consistent peak and volumetric differences due to short term tidal influences for the four DWF events analyzed. Based on these analyses, the diurnal pattern for CH-22 was updated in the hydraulic model to reflect tidal influences. Semi-monthly and long term groundwater impacts at the 18 meters were accounted for during recalibration by adjusting the slow response component (SRC) in the RDII module of the hydrologic model.

Subcatchments

The addition of new pump stations required geometry modifications to four previous subcatchments (2B_Direct, 3B_Direct, 6B_Direct and 12A_Direct), which were subdivided to create six new subcatchments (2F_Direct, 3N_Direct, 3M_Direct, 6G_Direct, 6F_Direct and 12G_Direct). Four new subcatchments were created to represent flows from Naval Station Newport and Middletown

(Fort_Adams_Direct, Navy_CCove_Direct, MiddWaveAv_Direct, and MiddCoddington_Direct). The corresponding network connections were also updated to reflect the new hydrologic inputs. Figure C-1 in Appendix C shows the location of these new subcatchments.

The subcatchment fast and slow response component parameters for the modified subcatchments as well as some of the other subcatchments were revised to reflect hydrologic changes through system improvements, such as I/I reduction. Tables C-5 through C-14 in Appendix C describe the updated parameters for all of the subcatchments.

2.4.3 Model Calibration and Validation

Following system updates, the model was recalibrated and revalidated to three 2011 events. The model was recalibrated to the April 13, 2011 event, which was a spring-time storm with a total rainfall of 2.35 inches at Rain Gauge 1 and a peak intensity of 0.92 inches per hour. To validate the recalibration of the model, two additional storm events of August 15, 2011 and October 19, 2011 were simulated. The August 15 event had a total rainfall of 2.3 inches and a peak intensity of 1 inch per hour, while the October 19 event had a total rainfall of 2.6 inches and a peak intensity of 0.6 inches per hour at Rain Gauge 1.

The modeled flows for the WACSOTF and WPCP were calibrated using SCADA data for the effluent from each facility provided by the City's operations contractor. In contrast, the modeled flows for the WSCSOTF were calibrated to data from a flow meter located just upstream of the WSCSOTF (meter CH-09). This meter was in place between April 15, 2010 and April 15, 2011 as part of the recent flow monitoring program. It was necessary to use the meter data for calibration of the WSCSOTF modeled flows because SCADA data for the effluent screw pumps at the WSCSOTF were found to significantly over estimate flow volumes when compared with inflows measured using flow meter CH-09. Modeled flows for the WSCSOTF were not able to be validated for the August or October events because the flow monitoring program had been concluded.

Comparisons of measured flows at the WACSOTF, WSCSOTF and the WPCP predicted by the 2012 model for the April, August and October events are presented in Tables 2-8 through 2-10. Graphs of the April 13, 2011 event for the WACSOTF, WSCSOTF and the WPCP are presented below in Figures 2-14 through 2-16. Additional comparisons between metered and modeled flows are in Appendix C.

TABLE 2-8
Metered and Modeled Volume and Peak Flow Results for the storm of April 13, 2011

Meter	Metered Volume (MG)	Modeled Volume (MG)	Percent Difference (%)	Metered Peak Flow (MGD)	Modeled Peak Flow (MGD)	Percent Difference (%)
WACSO	1.35	1.48	+9.71	5.96	4.75	-20.30
WSCSO[1]	6.31	5.42	-14.09	14.01	12.60	-10.08
WPCP	47.62	42.32	-11.13	21.51	22.47	+4.48

[1] Metered data for inflow to the WSCSOTF is from meter CH-09, which was in place as part of the April 15, 2010 through April 15, 2011 flow monitoring program.

TABLE 2-9
Metered and Modeled Volume and Peak Flow Results for the storm of August 15, 2011

Meter	Metered Volume (MG)	Modeled Volume (MG)	Percent Difference (%)	Metered Peak Flow (MGD)	Modeled Peak Flow (MGD)	Percent Difference (%)
WACSO	0.30	0.64	+116.74	5.47	9.50	+73.67
WSCSO[1]	N/A	0.11	N/A	N/A	4.17	N/A
WPCP	44.05	40.94	-7.06	22.14	23.62	+6.70

[1] Meter data for inflow to the WSCSOTF is not available for this event as the flow monitoring program had concluded.

TABLE 2-10
Metered and Modeled Volume and Peak Flow Results for the storm of October 19, 2011

Meter	Metered Volume (MG)	Modeled Volume (MG)	Percent Difference (%)	Metered Peak Flow (MGD)	Modeled Peak Flow (MGD)	Percent Difference (%)
WACSO	2.33	2.05	-11.95	7.13	9.50	+33.24
WSCSO[1]	N/A	5.56	N/A	N/A	28.47	N/A
WPCP	46.62	40.62	-12.88	21.63	21.80	+0.79

[1] Meter data for inflow to the WSCSOTF is not available for this event as the flow monitoring program had concluded.

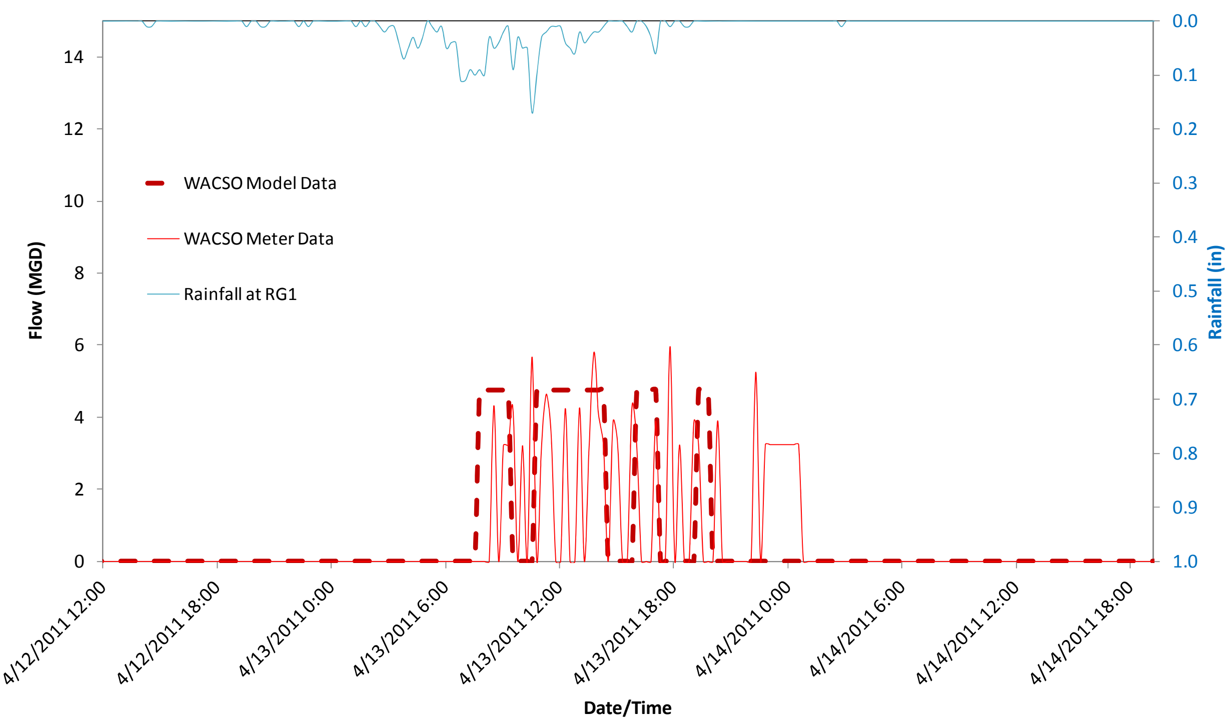


Figure 2-14. Measured and Modeled CSO Discharges at WACSOTF for the April 13, 2011 Event

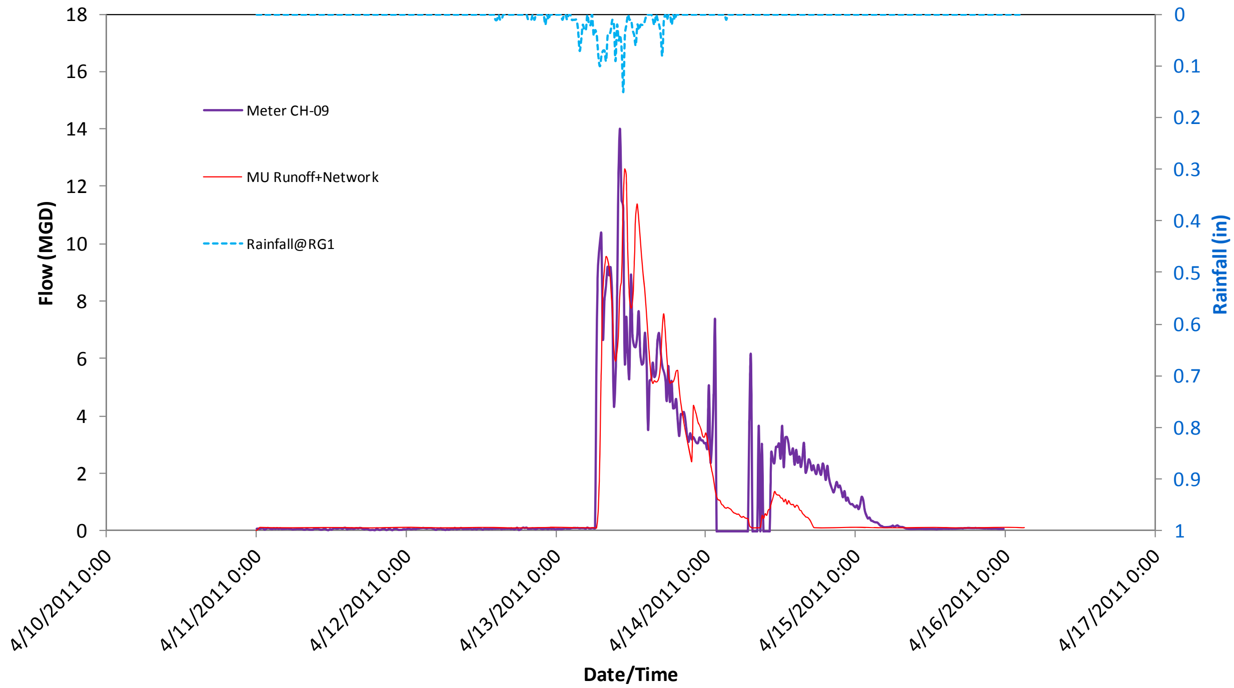


Figure 2-15. Measured and Modeled Flows at CH-09 (Inflow to WSCSOTF) for the April 13, 2011 Event

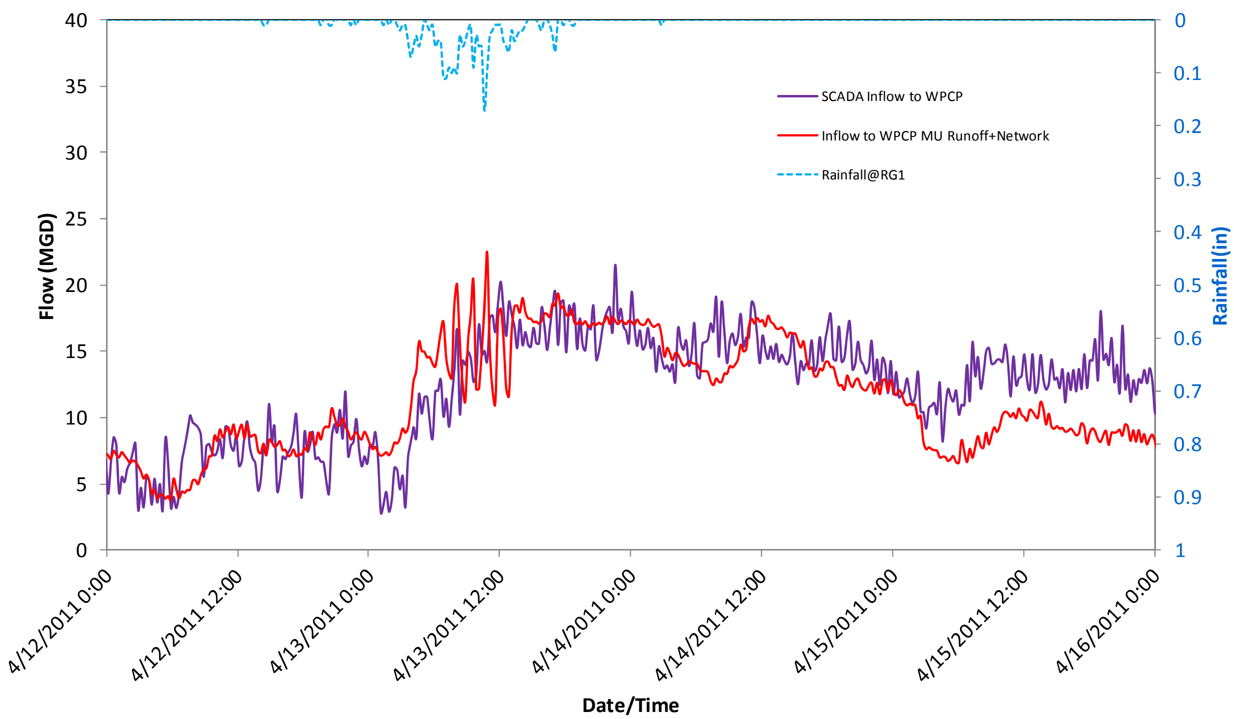


Figure 2-16. Measured and Modeled Inflows to the WPCP for the April 13, 2011 Event

Although the model replicates current *typical* operation of the CSO treatment facilities, the NASC gate and the public pump stations as described in the City of Newport's *Operation and Maintenance Manual* (Sevee & Maher Engineers, Inc., et al., 2009/2011), actual operations vary for each event. In particular, investigations performed using the model indicate that operation of the NASC gate and the Long Wharf Pump Station (e.g., throttling flows to meet Rhode Island Pollutant Discharge Elimination System (RIPDES) permit requirements) have a significant impact on CSO discharges at the WACSOTF and WSCSOTF. For the verification exercise, no adjustments were made to the model to account for fluctuations in the manual operation during the April, August and October events.

Overall, the updated model simulates the system's current behavior with a level of accuracy which is suitable for evaluating existing conditions as well as planning level evaluations for CSO controls. For the WACSOTF the model simulates measured flow volumes for the two larger storms closely (-12 to +9 percent) and provides a conservative estimate of discharge for the smaller summer-time event (0.64 vs. 0.30 MG). Model results for the April 13, 2011 event at the WSCSOTF also show a close alignment with the measured volumes (-14 percent). Graphical comparisons of SCADA data and modeled data for the calibration and validation events at the WSCSOTF are available in Appendix C.

SECTION 3

Characterization of System Performance for a Typical Year (CD Item 63b)

3.1 Overview and Objectives

This section summarizes the steps followed to characterize the performance of the City's collection system for a range of rainfall events, considering local rainfall data and critical antecedent in-system flow conditions. The requirements are described in Item 63b of the CD:

> *"…consider local rainfall data, critical antecedent in-system flow conditions and the impact of a range of rainfall events (based on return frequency and duration for an appropriate continuous period of rainfall records) on peak wet-weather flows within those portions of the City's Collection System that are tributary to, or contribute to , capacity-related overflows, including the Wellington Avenue and Washington Street Outfall overflows;…"*

To address this requirement, this section contains:

- Analyses of historical rainfall data and studies for the selection of the typical year.
- Evaluations of the existing collection system performance for a year-long rainfall time series representing the typical year, including statistical summaries of CSO volumes, frequency and durations at the two CSO facilities and the WPCP.
- Evaluations of typical annual pollutant load data from the two CSO facilities and the WPCP.

The objective is to identify the impact of rainfall events on peak WWFs throughout the City to provide guidance on system improvement evaluations, including capacity-related CSOs, and to set a baseline for the evaluation of CSO control alternatives.

3.2 Typical Rainfall Year Selection

To develop the rainfall database to use for alternatives analysis, rainfall data records were researched through the National Climatic Data Center (NCDC), part of the National Oceanic and Atmospheric Administration (NOAA) Satellite and Information Service. In addition, reviews of previous long term rainfall analyses were also conducted to review and compare historical typical rainfall year selections in the Newport Area.

3.2.1 Rainfall Data Source Selection

3.2.1.1 Rain Gauge Data

Three rainfall data sets were selected for analysis: 1) T.F. Green Airport in Providence, 2) Newport Rose Island, and 3) Newport State Airport. Figure 3-1 shows a map with the location of the three rain gauges at or in the vicinity of Newport. The NCDC data available for other rain gauges in the Newport vicinity were significantly incomplete and were excluded from further analysis. The data sets were analyzed to determine which were most complete . A summary of the three data sets used in the rainfall analysis is shown in Table 3-1. A graph depicting the three data sets is shown in Figure 3-2.

TABLE 3-1
Summary of Rain Gauge Date

Parameter	Location	Description	Sampling Interval	Start Date	End Date	Source
Rain	Rose Island (Newport)	Event-based	1-hr	1965	2002	NOAA-NCDC
	T.F. Green Airport, Warwick/ Providence, RI	Event-based	1-hr	1948	2009	NOAA-NCDC
	Newport State Airport	Event-based	24-hr	2004	2011	NOAA-NCDC

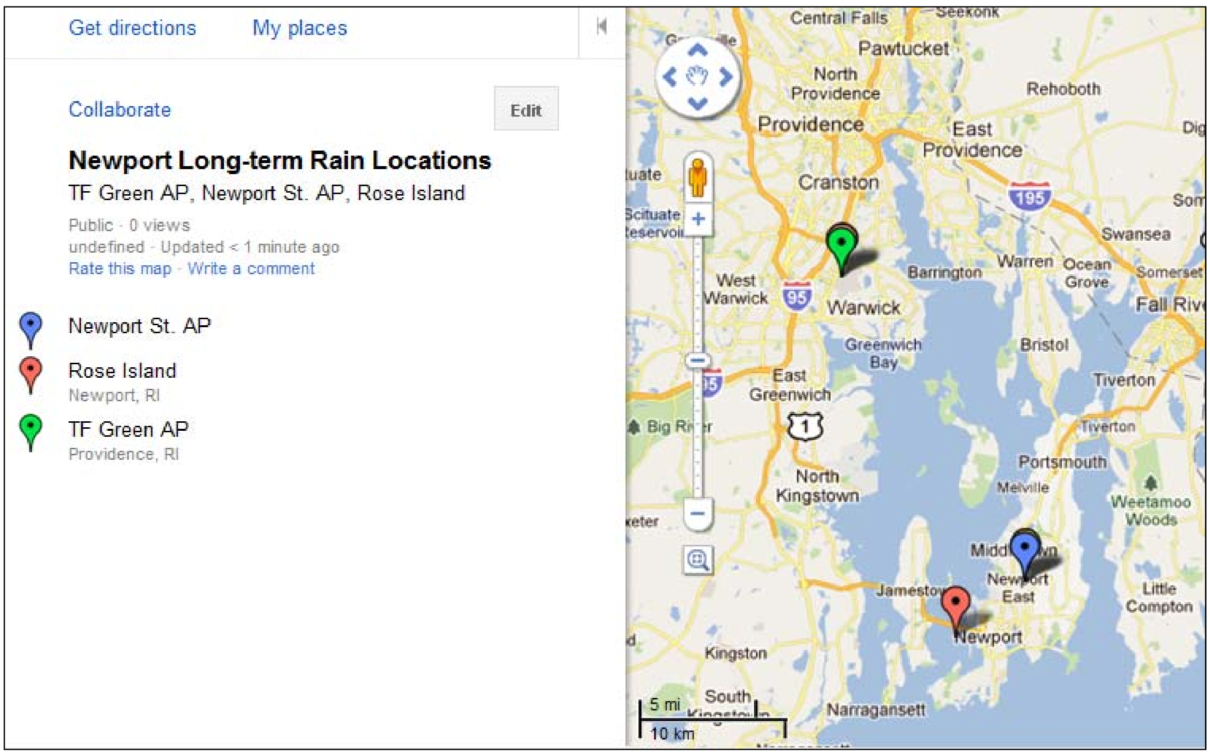


Figure 3-1. Location of the Rainfall Gages Selected for Analysis Near Newport, RI.

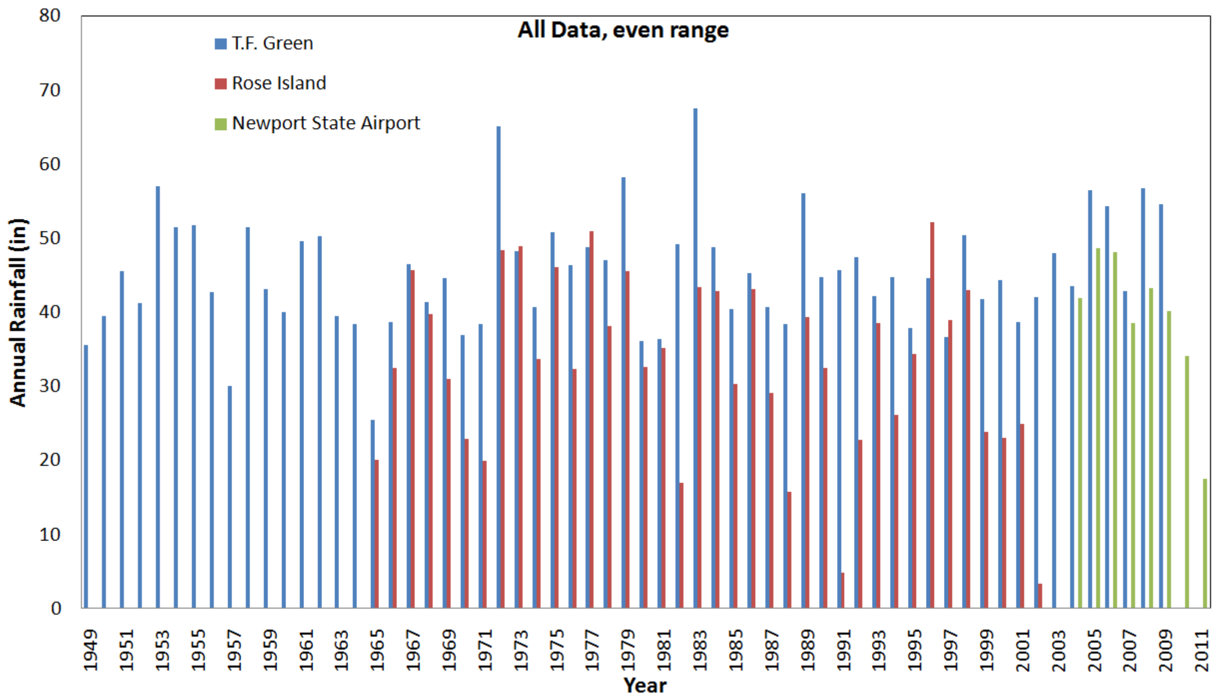


Figure 3-2. Historical Annual Precipitation at T.F. Green Airport, Newport Rose Island, and the Newport State Airport.

3.2.1.2 Rainfall Data Statistical Analysis

Although rainfall data collected at the Newport State Airport is geographically closest to the project area, it does not contain a long enough period to support long term statistical analysis needed to determine the representative or typical rainfall year, as observed in Table 3-2. Consequently, the Newport State Airport data set was removed from consideration and the T.F. Green Airport and Rose Island data sets were further analyzed for relative accuracy. A correlation analysis was conducted to compare the two data sets to determine if the two data sets show a tendency to vary together. The correlation of the two data sets will approach 1 if the two are related. The correlation factors between the rainfall data sets are shown in Table 3-2.

It was observed that T.F. Green has a good correlation (Correlation Coefficient = 0.83) with the Newport State Airport data set in addition to having the most complete and continuous data record, spanning from 1948 to 2009. As a result, the T.F. Green Airport rainfall data set was selected for the long term rainfall analysis to determine a typical rainfall year.

TABLE 3-2
Summary of Rainfall Data Quality and Statistics

	T.F. Green Airport	Year	Rose Island, Newport	Year	Newport State Airport	Year
Years with good data[a]	61		11		6	
Coverage (% years good data)	100		69 (28[b])		98	
Max (in)	67.5	1983	52.2	1996	48.7	2005
Min (in)	25.4	1965	32.4	1976	34.1	2010
Mean (in)	45.3		41.5		42.2	
Median (in)	44.6		39.7		41.7	
Correlation Coefficient (versus Newport S.A.)	0.83		0.62		1.00	

a) A year with good data is a year with continuously recorded precipitation data (no data gaps).
b) According to Phase 2 CSO Control Plan report (AECOM, 2009), Rose Island has 69% coverage; however, only 11 of 39 years (28%) have continuous data.

3.2.2 Long Term Rainfall Analysis and Determination of a Typical Rainfall Year

3.2.2.1 Review of Previous Studies

Two previous studies have looked at the data from T.F. Green to determine a typical rainfall year. The Narragansett Bay Commission (NBC) reviewed the data as part of the Combined Sewer Overflow Control Facilities Program, *Concept Design Report Amendment* (Louis Berger & Associates, 1998). They used the data set from 1949 to 1982 to develop synthetic design storms and determine a typical year rainfall. The NBC's analysis concluded that the years of 1951 and 1978 were adequate to develop annual statistics of CSO volumes and frequencies for CSO control alternatives evaluations. Table 3-3 is from the NBC's analysis and compares the number of storms in 1951 to 1978 for different return periods.

TABLE 3-3
Comparison of 1951 and 1978 from NBC Report[a,b]

Year	Total Precipitation (in.)	Number of Storms	Average Storm depth (in.)	>1 year	> 3 Months	> 1 Month
1951	45.60	96	0.48	1	7	16
1978	47.01	72	0.65	2	10	20

a) A minimum inter-event time of 10 hours was used to define storm events in order to obtain the same number of storms
b) Louis Berger & Associates, 1998 (NBC CSO Facilities Program Report)

The analysis selected the year 1951 as the typical year based on total annual volume and total number of storms. Table 3-4 summarizes the 1951 rainfall data based on depth and intensity. The 1951 year has 10 events based on intensity and 18 events based on rainfall depth, most of which are of a 1-month return period.

TABLE 3-4
Summary of Storms in 1951 based on NBC Design Storms[a]

Return Period	Precipitation Depth (in.)	Peak Intensity (in./hr)	Number of Storms based on Intensity	Number of Storms based on Depth
1 Month	0.94	0.38	8	8
2 Months	1.36	0.55	1	3
3 Months	1.61	0.62	0	7
6 Months	2.03	0.78	0	0
1 Year	2.46	0.90	1	0

a) Louis Berger & Associates, 1998 (NBC CSO Facilities Program Report)

Further rainfall analyses were performed as part of the City of Newport's Phase 2 CSO Control Plan report (AECOM, 2009). The Phase 2 report reviewed the T.F. Green Airport data and available CSO data from 1949-2007 to determine if 1951 could be used for the evaluation of CSO control alternatives in Newport. The report determined that CSOs are typically driven by storm peak intensities and there is only one storm greater than a 1-year storm in peak intensity during 1951 and the remaining storms have intensities less than a 3-month event. An analysis of the entire period of record at the T.F. Green Airport rain gauge was determined to be required to develop another typical period that included at least a 1-year storm for depth and a 1-year storm for peak intensity.

The evaluation processes to determine the typical rainfall year included long term statistical analyses and the development of a scoring system based on standard deviation to correlate the yearly data sets to the long term average based on various statistics. The analysis indicated that 1996 was the year that was most typical in the period of record. However, 1996 did not have any storms with a peak intensity greater than 1 inch per hour, which was typically present in yearly rainfall sets according to long term statistical analyses. Similar to other studies where typical years were 'typicalized', most notably the typical year developed for the Massachusetts Water Resources Authority's CSO Facilities Plan (MWRA, 1997), the 1996 rainfall data set was revised to include the June 11, 2001 storm, which had a 1.07-inch per hour peak intensity. This typicalized 1996 rainfall data was used for the evaluation CSO control alternatives in the Phase 2 CSO Control Plan report (AECOM, 2009).

3.2.2.2 Selection of the Typical Year Rainfall

The selection of the typical year to address item 63b of the CD included re-evaluating the available rainfall data for the selected rain gauge located at T.F. Green Airport. Hourly rainfall data is available from T.F. Green Airport starting in May 1, 1948 to 2009. Storms for all complete years at T.F. Green Airport (1949-2008) were analyzed to characterize typical annual rainfall. The statistical analysis of the 60 years of data indicated that a minimum inter-event time of 6 hours should be used to define rainfall events to achieve statistical independence. Storm events were then identified and summarized based on total duration, peak intensity, and total depth.

Long term averages for the entire period of record were compared to the averages for the past 10 and 30 years. It was observed that there are minimal differences between the three periods evaluated. Therefore, it was determined that the typical year would be selected based on a comparison to statistics describing the entire period of record.

Similar to the analyses provided in the Phase 2 CSO Control Plan report (AECOM, 2009), a scoring system was developed based on the number of standard deviations from the long term averages for statistics including total depth and number of storms in defined intensity and depth ranges. The sum of the standard deviations provided the total score, and the lowest score was selected as the typical year. Table 3-5 summarizes the statistical categories for the years displaying the five lowest scores with respect to average values for the entire period of record 1949-2009.

TABLE 3-5
Summary of Years with Lowest Scores in the Period of Record

Statistic		Average	1996	1991	1994	1973	1974
# of Storms		105.8	112	99	101	104	111
Total Depth (in)		45.0	44.61	45.69	45.23	48.12	40.79
Count of Storms with Depth	0.25 to 0.5	16.1	20	17	12	16	19
	0.5 to 1.0	15.7	17	18	16	19	15
	1.0 to 2.0	9.6	9	12	10	9	10
	2.0 to 2.5	1.8	2	1	2	1	2
	> 2.5	1.9	2	2	3	3	0
Count of Storms with Intensity	0.1 to 0.25	26.3	27	28	26	28	28
	0.25 to 0.50	13.6	14	14	11	15	12
	0.50 to 1.0	3.6	4	3	5	5	4
	> 1	0.5	0	1	0	0	0
	Score	-	**3.6**	**4.6**	**4.8**	**5.4**	**5.4**

Based on the scoring analysis, the year 1996 was selected as the most typical year in the period of record at T.F. Green airport. However, as previously stated, the year 1996 does not have any storms with peak intensity greater than 1 inch per hour, though there is often one such storm according to long term averages. Therefore, the 1996 rainfall year needed to be typicalized. As with the Phase 2 report, the June 11, 2001 storm event was determined to be a representative storm of peak intensity greater than 1 inch per hour. This storm has a 1.07-inch per hour peak intensity, 2.02 inches total depth and lasted 11 hours.

To determine where in the rainfall data set the June 11, 2011 storm should be inserted, an analysis was performed on the inter-event times. Analysis of all storms within the period of record indicated that the average inter-event time for storm events is approximately 76 hours. In addition, most of the storms with peak intensities greater than 1 inch per hour (78 percent) occurred during the summer months (June, July, and August). Based on these parameters, June 13, 1996 was selected as the insertion date, which allows for approximately 76 hours of inter-event time before and after the storm and is within summer months.

Figure 3-3 illustrates the rainfall data for the selected typical year of 1996 and the 1.07-inch per hour storm inserted for typicalization. With this additional event, the total annual rainfall for 1996 results in 46.67 inches, representing a variation on about +5 percent with respect to the median rainfall of 44.6 inches. Therefore, removing rainfall events from the record to account for the inserted event was omitted.

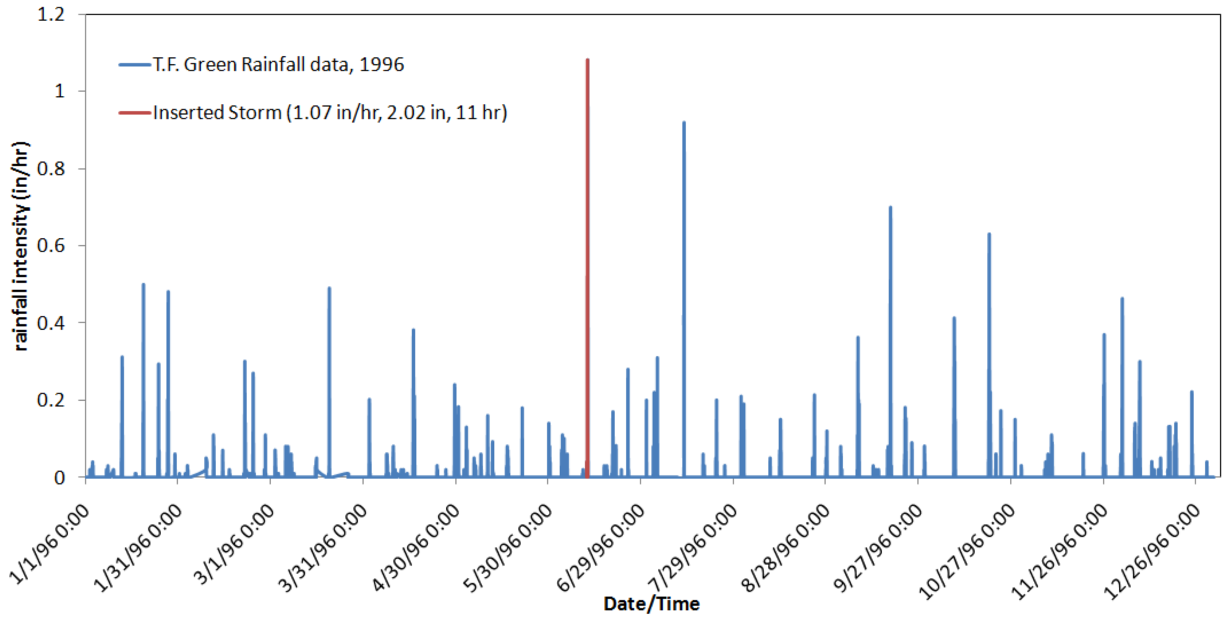


Figure 3-3. Historical and Typical Precipitation Year 1996

3.3 Collection System Model Results and Analysis for a Typical Year

3.3.1 Effluent Flow Data

The hydraulic model was used to simulate flows under existing conditions (through 2011) for the typicalized rainfall year of 1996. Results of the simulations are shown in Figures 3-4 and 3-5 for the WSCSOTF and WACSOTF, respectively. Tables 3-6 and 3-7 summarize the dates of CSO occurrences in addition to rainfall intensity, rainfall depth, CSO volume and CSO duration.

The total simulated CSO volumes for the typical year are 27.73 MG and 11.14 MG at the WSCSOTF and WACSOTF, respectively. Out of a total of 113 storms for the typicalized year there were 12 total simulated CSOs at both facilities, which is comparable to the median number of CSO events recorded at the WSCSOTF and WACSOTF (17 and 11, respectively) during the 2001-2012 period (as shown in Table 2-3 in Section 2.3). Figure 3-6 exhibits the dependence of simulated CSO volume as a function of rainfall depth for the WSCSOTF and WACSOTF. Simulated results show that both CSO facilities are typically not discharging for less than a 1-inch rainfall depth. Also, CSO volumes at the WSCSOTF are two to three times more than the WACSOTF for the same size event. The simulated results correspond with the data presented in Section 2, which indicates that the CSO treatment facilities have not been discharging for less than a 1-inch rainfall depth and the majority of CSO volume is discharging from the WSCSOTF .

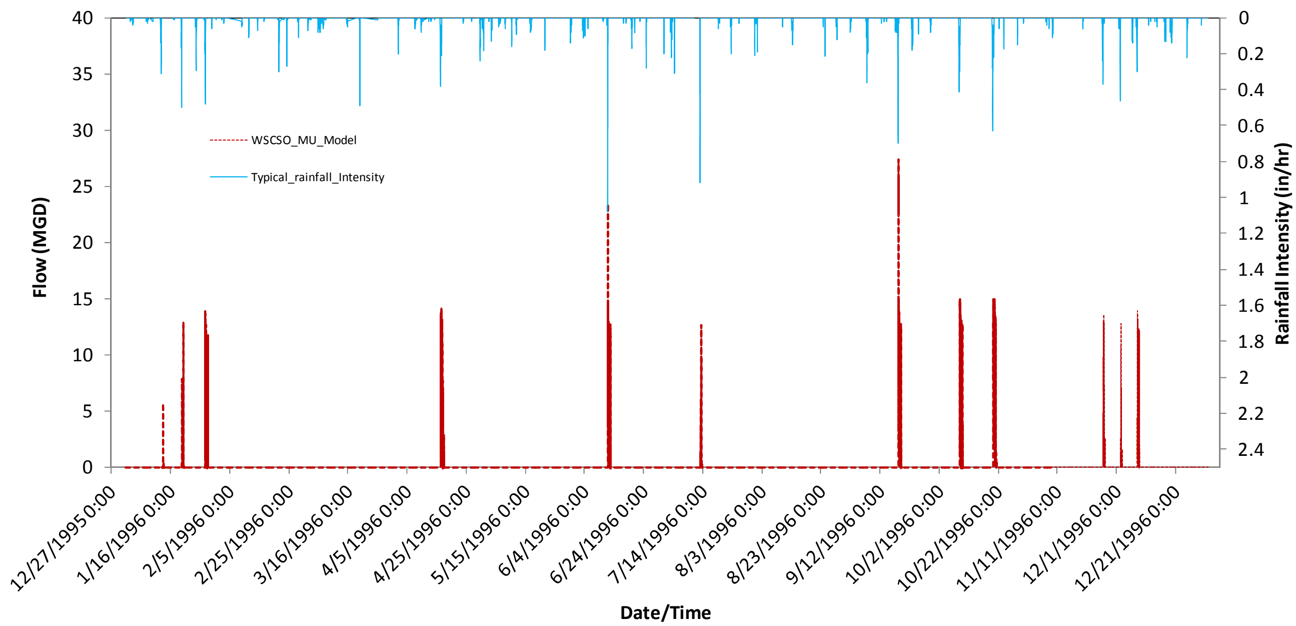


Figure 3-4. Modeled CSOs at WSCSOTF for the Typical Rainfall Year (1996).

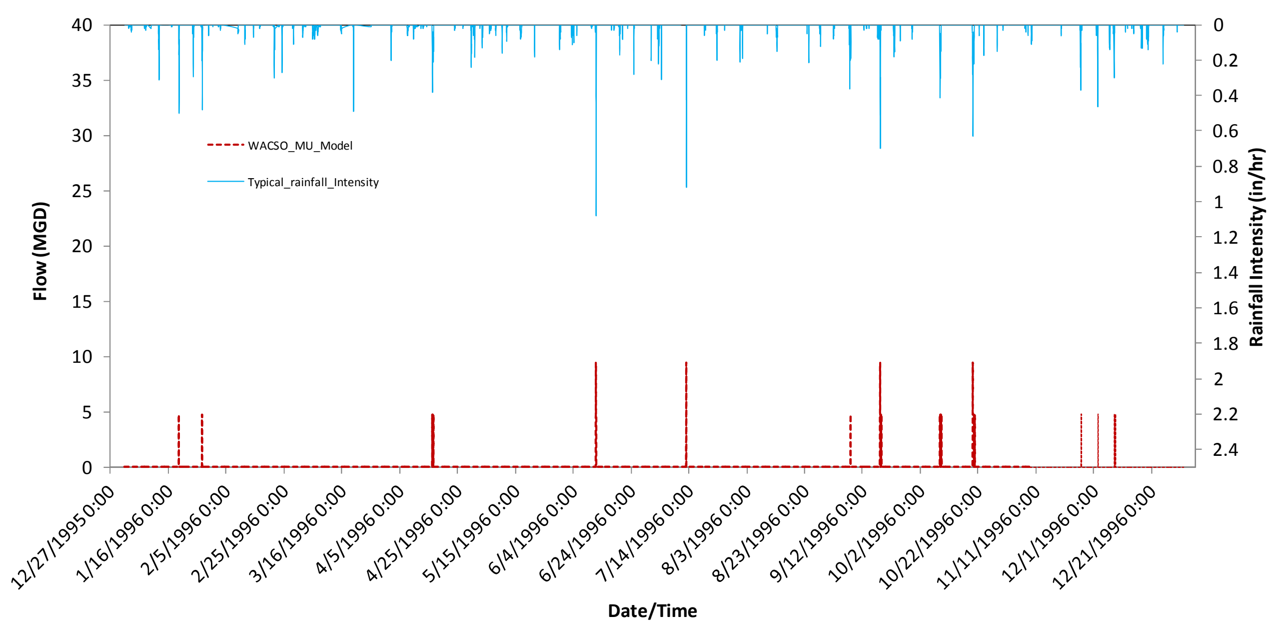


Figure 3-5. Modeled CSOs at WACSOTF for the Typical Rainfall Year (1996).

TABLE 3-6
Modeled CSOs at WSCSOTF for the Typical Rainfall Year 1996 under Current System Conditions

WSCSOTF Event #	Date of CSO Occurrence	Total Rainfall (in.)	Peak intensity (in./hr)	CSO Duration (hrs)	CSO Volume (MG)	CSO Peak (MGD)
1	1/12/1996	1.08	0.31	21.75	0.12	5.71
2	1/19/1996	0.98	0.50	19.75	0.24	12.94
3	1/27/1996	1.42	0.48	23.25	1.16	13.88
4	4/16/1996	2.00	0.38	28.00	3.30	14.16
5	6/11/1996	2.02	1.07	21.00	2.82	23.42
6	7/13/1996	1.40	0.92	16.00	0.82	12.68
7	9/18/1996	2.78	0.70	21.75	4.20	27.42
8	10/8/1996	2.36	0.41	23.50	4.25	14.98
9	10/20/1996	3.05	0.63	26.75	6.85	14.98
10	11/26/1996	1.40	0.37	17.00	1.23	13.41
11	12/2/1996	1.28	0.46	15.75	0.75	12.78
12	12/8/1996	1.50	0.30	19.25	1.99	13.70
Totals		**21.27**			**27.73**	

TABLE 3-7
Modeled CSOs at WACSOTF for the Typical Rainfall Year 1996 under Current System Conditions

WACSOTF Event #	Date of CSO Occurrence	Total Rainfall (in.)	Peak intensity (in./hr)	CSO Duration (hrs)	CSO Volume (MG)	CSO Peak (MGD)
1	1/19/1996	0.98	0.50	0.75	0.20	4.75
2	1/27/1996	1.42	0.48	1.75	0.40	4.75
3	4/16/1996	2.00	0.38	11.00	1.09	4.75
4	6/11/1996	2.02	1.07	4.00	1.14	9.50
5	7/13/1996	1.40	0.92	1.75	0.58	9.50
6	9/7/1996	1.16	0.36	0.50	0.15	4.75
7	9/18/1996	2.78	0.70	13.25	1.73	9.50
8	10/8/1996	2.36	0.41	15.50	1.66	4.75
9	10/20/1996	3.05	0.63	18.50	2.67	9.50
10	11/26/1996	1.40	0.37	4.75	0.45	4.75
11	12/2/1996	1.28	0.46	1.50	0.35	4.75
12	12/7/1996	1.5	0.30	11.75	0.74	4.75
Totals		**21.35**			**11.14**	

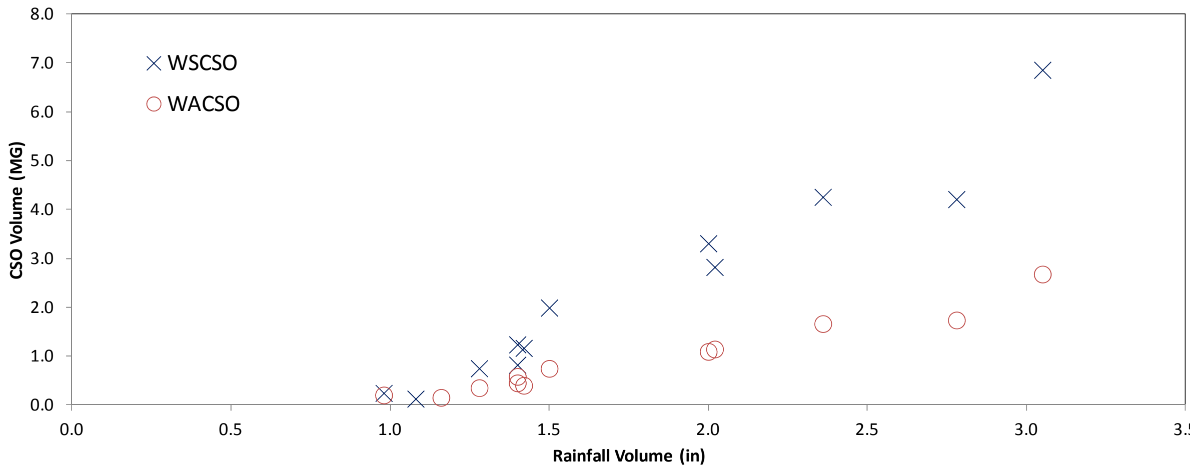


Figure 3-6. Simulated CSO volumes at WSCSOTF AND WACSOTF as a Function of Rainfall Depth during the Typical Year 1996.

Additional evaluations of the model results for the simulated typical year included comparisons to metered data at the WSCSOTF and WACSOTF between 2001 and August 2012 (as shown in Table 2-3 in Section 2.3). The WSCSOTF data, shown in Figure 3-7, indicates that the facility is experiencing similar CSO discharge volumes relative to rainfall depth for the simulated typical year compared to historical data. Results for the WACSOTF, shown in Figure 3-8, indicate that historical CSO discharge volumes have decreased over the last 10 years relative to the rainfall depth and the simulated typical year results are in-line with recent trends. The analysis indicates that the model accurately reflects current system operation and is adequate for simulation of CSO volume and frequency for CSO control alternatives.

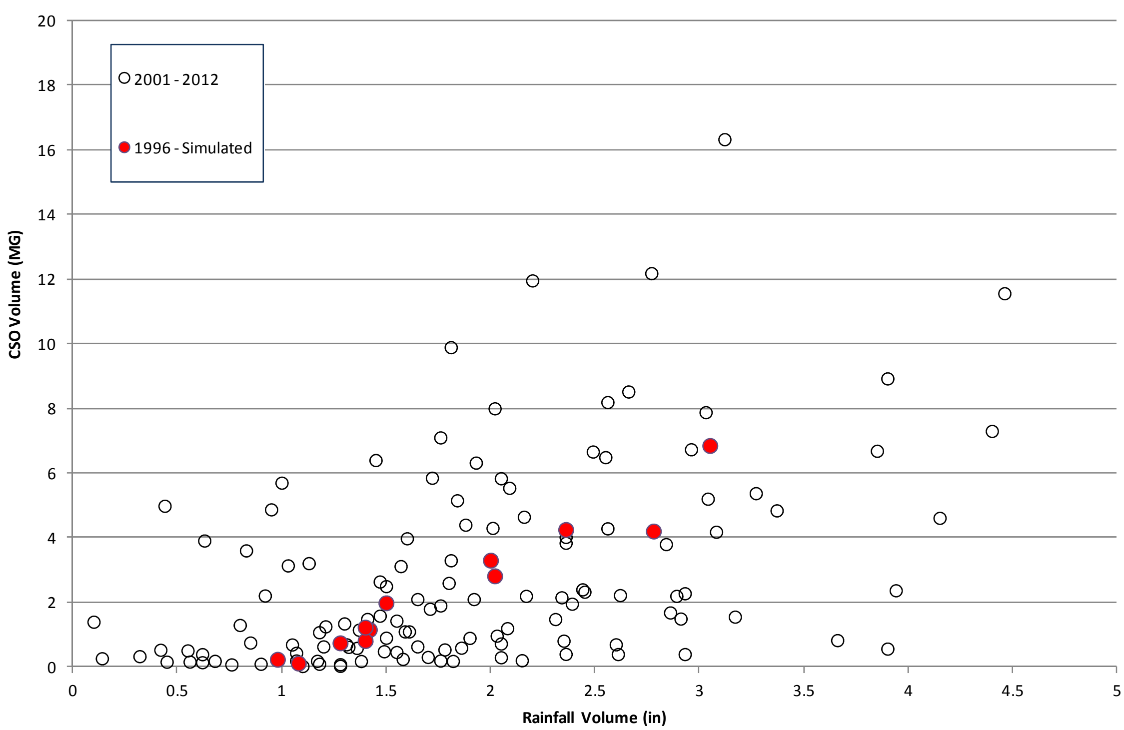


Figure 3-7. Measured CSO Volumes at WSCSOTF as a Function of Rainfall Depth between 2001-2012 Compared to the Simulated Typical Year (1996)

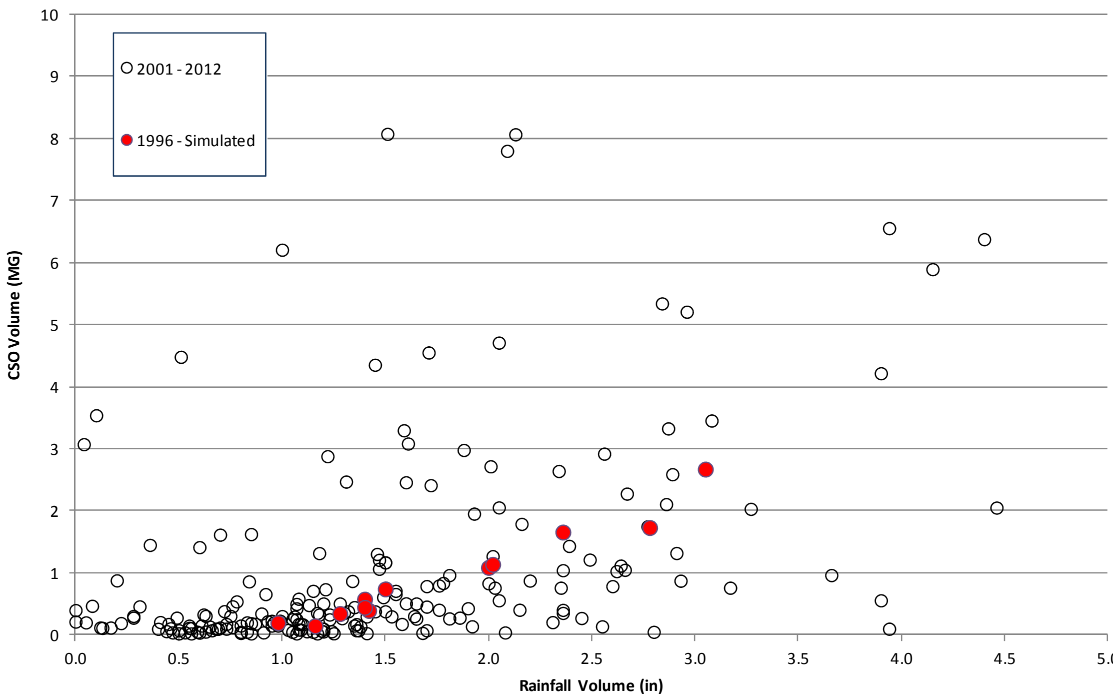


Figure 3-8. Measured CSO Volumes at WACSOTF as a Function of Rainfall Depth between 2001-2012 Compared to the Simulated Typical Year (1996)

Results from the annual simulation were used to quantify flows to the WPCP. This analysis was performed to demonstrate the system's performance relative to its Rhode Island Pollutant Discharge Elimination System (RIPDES) permit and to establish a baseline for the comparison of proposed improvements to the system. The City's current permit limits WPCP discharges to Narragansett Bay to a monthly average of 10.7 MGD and a maximum day flow of 19.7 MGD. Historical records indicate that the limit for maximum day flow was exceeded 69 times per year between 2001 and 2010. However, recent changes to operating protocols (e.g. flow throttling at the Long Wharf Pump Station) have been successful in eliminating excursions of the daily maximum limit from January of 2011 through August of 2012, as mentioned in Section 2.

Table 3-8 summarizes the model results at the WPCP for volumes and exceedances of its RIPDES permit limits. These data show that the system could be operated to maintain flows within its monthly average and maximum day permit limits. These results are consistent with the WPCP's most recent performance.

TABLE 3-8
Typical Year Simulation Results for Monthly Average and Maximum Day Inflows to WPCP

Month	Volume (MG)	Monthly Average Volume (MG)	Count of Months Over 10.7 MGD	Count of Days Over 19.7 MGD
January	277.4	8.9	0	0
February	235.2	8.1	0	0
March	253.9	8.2	0	0
April	255.3	8.5	0	0
May	257.1	8.3	0	0
June	255.8	8.5	0	0
July	257.9	8.3	0	0
August	244.3	7.9	0	0
September	268.2	8.9	0	0
October	275.4	8.9	0	0
November	239.0	8.0	0	0
December	300.6	9.7	0	0
Totals	**3,120.4**		**0**	**0**

3.3.2 Pollutant Load Data

Pollutant loading from the CSO facilities and WPCP discharges were analyzed to determine the impact of effluent flows on water quality for a typical year. The analysis included evaluations of the three water quality indicators: biochemical oxygen demand (BOD), total suspended solids (TSS) and fecal coliform. Fecal coliform was used in place of evaluating Enterococci because the City currently does not collect Enterococci data at the CSO effluent sampling points.

The event mean concentrations used for the pollutant load analysis are presented below in Table 3-9. The event mean concentrations for the effluent CSO facilities and the WPCP were developed based on concentrations from measured data. The concentrations at the two treatment facilities are based on median concentration of samples taken from the facilities after the sampling points were moved between November 16, 2010 and December 31, 2011. The concentrations at the WPCP are based on median concentrations during wet weather. The pollutant load data based on the discharge volumes at the CSO facilities and the WPCP for a typical year are presented in Table 3-10.

TABLE 3-9
Event Mean Concentrations of Effluent for TSS, BOD and Fecal Coliform

Location	TSS (mg/L)	BOD (mg/L)	Fecal Coliform (MPN/ 100 mL)
WACSO	54	51	100
WSCSO	26	32	2
WPCP	16	14	5

mg/L = milligrams per liter
MPN = most probable number

TABLE 3-10
Pollutant Loads of TSS, BOD and Fecal Coliform for a Typical Year

Location	Total Annual Effluent Discharge Volume (MG)	TSS (lb/year)	BOD (lb/year)	Fecal Coliform (MPN/year)
WACSO	11.14	5,021	4,742	8.4E+10
WSCSO	27.73	6,017	7,405	2.1E+09
WPCP	566.28[a]	75,613	66,161	1.1E+11

[a] Wet weather flows only
TSS = total suspended solids
BOD = biochemical oxygen demand

SECTION 4

Characterization of System Capacity Limitations (CD Items 63a, 63c, and 63e)

4.1 Overview and Objectives

This section summarizes the steps followed to characterize the collection system performance, including determining available system capacity and system limitations that may contribute to surcharging, SSOs or CSOs. The requirements are described in Items 63a, 63c and 63e of the CD.

> *"…identify the capacities of the portions of the Collection System upstream and downstream of the Wellington Avenue and Washington Street Outfalls and compare those capacities to existing and future projected wet-weather flows. The Capacity assessment shall identify those portions of the Collection System that experience, have caused or are expected to cause or contribute to capacity-related Building/Private Property Backups, Collection System surcharges or overflows, or overflows from the Wellington Avenue or Washington Street Outfalls;…"*
>
> *"…characterize the Collection System performance by identifying, for each condition considered, each pipe segment operating in surcharged condition and each manhole or structure at which a surcharged condition or overflow might be expected to occur;…"*
>
> *"…include recommendations and a schedule for implementation of structural measures required to prevent Collection System surcharges and overflows. The analyses shall also include a map noting the location of any potential relief or replacement of sewers and size of all downstream interceptors and pumping stations;…"*

To address these requirements and support the evaluation and planning of long term CSO controls, this section of the report contains:

- A summary of historical data to identify the locations of historical SSOs and capacity limitations.
- Evaluations of current collection system capacity were performed by simulating a range of design storm events with the collection system model and reviewing calculations of surcharges, SSOs and CSOs.
- Evaluations of WPCP capacity using flow data analyses and process models to evaluate existing conditions. This analysis is a follow up to the *Flow Optimization and Capacity Evaluation Report* submitted to the City of Newport, RI on March 2011 (CH2M HILL, 2011d).

The objective of these evaluations is to understand system limitations in order to be able to provide the required recommendations to address these issues and improve system performance. Understanding the materials in this section provides a foundation for understanding if replacement and rehabilitation measures would provide reduction or elimination of overflows.

4.2 Review of Historical Data on Capacity Limitations

Historical SSO records, CCTV records, and O&M records were reviewed to identify known locations of capacity limitations that may have contributed to the causes of SSOs or prevented maximization of flow to the WPCP that caused additional CSOs. In addition, the City of Newport's Department of Utilities and the City of Newport's collection system operator were consulted to verify the current performance of the collection system and provide additional information on potential capacity limitations.

4.2.1 Historical Sanitary Sewer Overflows

The City's collection system operator, United Water, collects and documents SSOs per RIDEM reporting requirements. The information documented includes:

- Location
- Date
- Start and stop time
- Name of nearest receiving water, building, or land
- Conditions under which the event occurred
- Estimated gallons of SSO
- Description of efforts to reduce, eliminate, or prevent recurrence of the event
- Date of last overflow in same general location

From the beginning of 2003 to October 2012, 88 SSOs were documented by the City and reported to RIDEM. The reported SSOs are summarized in Table 4-1 and detailed in Tables D-1 through D-3 in Appendix D. Maps created for the GIS map submittals (CD Item 14) showing the locations of the SSOs are provided in Appendix D. The causes of the 88 reported SSOs can be summarized as follows:

- Approximately 55 percent were a result of pipe blockages such as sediment, debris, or grease.
- Approximately 25 percent were collection system issues, including collapsed pipes or pump station failures.
- The remaining 20 percent were caused by wet weather.

Areas where repeated SSOs have occurred were primarily a result of debris, sediment or other types of blockages. These blockages were removed at the time of the SSO, typically through jetting or flushing the line. Additional pipe cleaning of these and other areas was performed as part of the CCTV inspections between 2009 and 2012. Furthermore, areas with frequent sediment and debris buildup are maintained by regularly flushing the sewers through the maintenance program as described in Section 4.2.3. SSOs caused by collection system issues were typically one-time occurrences that are remediated or rehabilitated at the time of the SSO, such as the replacement of a section of pipe. As a result, SSOs have significantly decreased in the last few years, such that only two SSOs have been reported in 2012 through the October 2012 data analysis cutoff date.

The location of the two 2012 SSOs are along the Goat Island Causeway/Connector, where six SSOs have occurred since 2003. This location has historically experienced SSOs due to blockages primarily due to sediment and debris buildup. Regular jetting of this area occurs monthly through the City's maintenance program to remove potential blockages (as noted in Section 4.2.3). Following the last SSO at this location, a pipe saddle, new vent pipe, ball valve, and new air release valve were installed to prevent further SSOs at this location.

Locations with recurring SSOs as a result of wet weather include: Homer and Garfield Streets, South Mayd and Butler Streets, the WPCP and the Ruggles Avenue Pump Station. These locations, with the exception of South Mayd and Butler Streets, have experienced SSOs within the last two years. However, the collection system operator noted that the areas of Homer and Garfield Streets and South Mayd and Butler Streets frequently experience sediment buildup, which may have limited pipe capacity and contributed to SSOs.

TABLE 4-1

Summary of SSOs as Reported by the City's Operations Contractor from 2003 to October 2012

Location	Event Date	Cause of SSO	Est. SSO Volume (Gallons)	Resolution of SSO	Previous SSO Event Date
Goat Island Causeway	10/17/2012	Air vent corroded and leaking	36	Contractor inspected and repaired leak by installing a pipe saddle, new vent pipe, ball valve, and new air release valve.	4/8/2012
Goat Island Causeway	4/8/2012	Hydraulic overload of FM (FM pipe leaking during pumping)	50	SOP limiting pump rate by operations staff.	5/20/2008
Connell Highway	11/1/2011	Grease blockage	50-75	Jetted and flushed line.	7/10/2009
Newport WPCF	8/28/2011	Hurricane Irene	1000	Generator tripped out momentarily.	
4 Vaughan Avenue	8/2/2011	Blockage	100	Root blockage.	
4 Brenton Road	4/18/2011	Adult diapers	10-15	Jetted and flushed line.	
Third Street and Marsh Street	2/25/2011	Heavy rains	100000	Failed bar screen at WSCSOTF; repaired screen.	
Goat Island Connector	12/22/2010	Grease blockage	150	Jetted and flushed Line.	3/30/2008
Admiral Kalbfus Blvd.	9/15/2010	Grease blockage	100	Jetted and flushed Line.	
94-98 Washington Street	6/14/2010	Blockage	500	Broken Main; repaired.	
3 Leal Terrace	4/16/2010	Blockage	1000	Jetted Line; notified neighbor of a massive root intrusion from their lateral.	
4 Brenton Road	4/13/2010	Blockage	50	Jetted line.	8/15/2008
Homer Street and Garfield Street	3/31/2010	Heavy rains	200	The area of South Mayd / Butler and Homer / Garfield are located in the Prescott Hall neighborhood.	7/1/2009
Ruggles Avenue Pump Station	3/23/2010	Heavy rains	500	Used vac-truck to reduce spill; ordered new pump.	4/12/2003
70 Ellery Road	3/19/2010	PLC failure	500	Replaced PLC.	
Ruggles Avenue	2/26/2010	Heavy rains	60	Used vac-truck to reduce spill.	
Newport WPCF	1/2/2010	Heavy rains	50-100	Cleaned grit from line between grit chambers and primary clarifiers.	12/3/2010
Newport WPCF	12/3/2009	Heavy rains	1000	Cleaned grit from chambers due to bypass pumping.	11/20/2009
Newport WPCF	11/20/2009	PLC failure	500	Shut down a pump.	

TABLE 4-1
Summary of SSOs as Reported by the City's Operations Contractor from 2003 to October 2012

Location	Event Date	Cause of SSO	Est. SSO Volume (Gallons)	Resolution of SSO	Previous SSO Event Date
Elm Street	11/10/2009	Emptied CSO tanks too fast; backed into 2 homes; sump pumps pumped onto street.	200	Shut down a pump.	
Long Wharf Mall	9/13/2009	Private PS failure	50	Shut down station.	
Dyre Street	8/30/2009	Bypass piping leaking	500	Long Wharf bypass piping leaked; pumped to sewer manhole.	
Navy Station	7/24/2009	Bypass pumping	100	Bypass pipe failure related to Long Wharf force main.	
Connell Highway	7/10/2009	Grease blockage	150	Followed up by the IPP coordinator. Restaurants upstream inspected and Notices of Violation issued, if needed.	
Washington Street CSO	7/6/2009	Bypass pumping / emptied CSO tanks too fast. Sewage bubbled from manhole.	15	Shut down a pump.	
Homer Street and Garfield Street	7/1/2009	Heavy rains	300	The area of South Mayd / Butler and Homer / Garfield are located in the Prescott Hall neighborhood.	4/6/2009
Third Street	6/11/2009	Bayside apartments lateral, private	50		
America's Cup Avenue	6/2/2009	Bypass pumping	2500	Bypass pipe failure related to Long Wharf FM	
Newport WPCF	4/21/2009	Bypass pumping	5000	Exceeded hydraulic capacity of plant during Long Wharf FM by-pass pumping	
Homer Street and Garfield Street	4/6/2009	Heavy rains	2500	The area of South Mayd / Butler and Homer / Garfield are located in the Prescott Hall neighborhood.	3/2/2007
Maple Avenue	4/1/2009	Grease blockage	50	Jetted and flushed line.	2/15/2009
Maple Avenue	2/15/2009	Blockage	100	Jetted and flushed line.	
208 Carroll Avenue	2/5/2009	Blockage	25	Jetted line.	
Ridge Road	1/13/2009	Cleanout Cap Leaking	100	Shut down PS to repair.	
Harrison Avenue	12/18/2008	FM vent leaking	25	Closed valve; Navy to repair.	11/10/2008
Harrison Avenue	11/10/2008	FM vent leaking	25	Closed valve; Navy to repair.	

TABLE 4-1
Summary of SSOs as Reported by the City's Operations Contractor from 2003 to October 2012

Location	Event Date	Cause of SSO	Est. SSO Volume (Gallons)	Resolution of SSO	Previous SSO Event Date
57 Bliss Road	9/26/2008	Blockage	NA	Jetted line.	7/23/2003
59 Bliss Road	9/26/2008	Blockage	NA	Jetted line.	7/23/2003
4 Brenton Road	8/15/2008	Collapsed main	NA	Replaced section of line.	
Connell Highway	8/2/2008	Grease blockage	100	Followed up by the IPP coordinator. Restaurants upstream inspected and Notices of Violation issued, if needed.	
Long Wharf Pump Station	7/24/2008	Gasket leak on bypass pump	150-200	Removed temporary pumps.	
Bliss Mine Road	7/5/2008	FM air relief rotted	25-50	Repaired.	
Ruggles Avenue	6/24/2008	Rags and debris	250	Jetted and flushed line.	
West Howard Wharf	6/11/2008	Private main break	25	Owner repaired.	
Goat Island Connector	3/30/2008	Blockage	100-200	Jetted and flushed line.	12/16/2005
Maple Avenue	1/27/2008	Blockage	NA	Jetted line.	
Washington Street CSO	1/3/2008	FM Failure	2400	Repaired.	
64 Halsey Street , Unit 5	12/21/2007	Blockage	NA	Jetted line.	
Connell Highway	11/28/2007	Grease blockage	75	Followed up by the IPP coordinator. Restaurants upstream inspected and Notices of Violation issued, if needed.	
Dyre Street	11/6/2007	Blockage	75	Jetted and flushed line.	
57 Toppa Boulevard	7/6/2007	Blockage	NA	Jetted line.	
4 Pleasant Street	6/4/2007	Blockage	NA	Jetted line.	12/12/2004
Navy Station	4/17/2007	Heavy rains	NA	Newport WPCF outfall manhole cover; bolted down.	
Homer Street and Garfield Street	3/2/2007	Heavy rains	400-500	Used vac-truck to reduce spill.	11/22/2005
33 Catherine Street	11/30/2006	Blockage	NA	Jetted line.	1/29/2004
26 Clinton Avenue	3/20/2006	Blockage	NA	Jetted line.	

TABLE 4-1
Summary of SSOs as Reported by the City's Operations Contractor from 2003 to October 2012

Location	Event Date	Cause of SSO	Est. SSO Volume (Gallons)	Resolution of SSO	Previous SSO Event Date
412 Lincoln Avenue	3/20/2006	Blockage	NA	Jetted line.	
Goat Island Causeway	12/16/2005	Rags and debris	500	Jetted and flushed line.	
Memorial Boulevard	12/11/2005	FM Failure	Unknown	Middletown replaced.	
Homer Street and Garfield Street	11/22/2005	Heavy rains	50000	The area of South Mayd / Butler and Homer / Garfield are located in the Prescott Hall neighborhood.	10/15/2005
Homer Street and Garfield Street	10/15/2005	Heavy rains	Unknown	The area of South Mayd / Butler and Homer / Garfield are located in the Prescott Hall neighborhood.	
6 Sagamore Street	4/5/2005	Blockage	NA	Jetted line.	
50, 70, & 105 Bliss Mine Road	1/26/2005	PS Failure	NA	Reset pumps.	
4 Pleasant Street	12/12/2004	Blockage	NA	Jetted line.	
South Mayd and Butler Street	8/15/2004	Heavy rains	Stopped on arrival	The area of South Mayd / Butler and Homer / Garfield are located in the Prescott Hall neighborhood.	8/8/2003
19 & 25 Broadway	6/14/2004	Blockage	NA	Jetted line.	
1 Stevenson Place	4/14/2004	Blockage	NA	Jetted line.	
58 Kingston Avenue	4/14/2004	Blockage	NA	Jetted line.	
139 Kay Street	4/1/2004	Blockage	NA	Jetted line.	3/3/2004
81 Annandale Road	3/21/2004	Blockage	NA	Jetted line.	
136 Kay Street	3/3/2004	Blockage	NA	Jetted line.	1/17/2004
139 Kay Street	3/3/2004	Blockage	NA	Jetted line.	1/17/2004
176 Eustis Avenue	2/13/2004	Blockage	NA	Jetted line.	
33 Catherine Street	1/29/2004	Blockage	NA	Jetted line.	
21 Mount Vernon Street	1/27/2004	Blockage	NA	Jetted line.	

TABLE 4-1
Summary of SSOs as Reported by the City's Operations Contractor from 2003 to October 2012

Location	Event Date	Cause of SSO	Est. SSO Volume (Gallons)	Resolution of SSO	Previous SSO Event Date
139 Kay Street	1/17/2004	Blockage	NA	Jetted line.	
Maple Avenue PS	8/26/2003	Contractor broke 6" FM while installing new 8" gravity main	NA	Shut down station.	
11 Andrew Street	8/17/2003	Charged line, basement bathroom, heavy rain	NA		
South Mayd and Butler Street	8/8/2003	Heavy rains	Unknown	The area of South Mayd / Butler and Homer / Garfield are located in the Prescott Hall neighborhood.	3/2/2003
182 Eustis Avenue	7/27/2003	Blockage	NA	Jetted line.	
8 Bliss Road	7/23/2003	Blockage	NA	Jetted line.	
16 Coddington Wharf, #3	7/12/2003	Blockage	NA	Jetted line.	
Third Street at Rotary	6/14/2003	Grease blockage	1000	Followed up by the IPP coordinator. Restaurants upstream inspected and Notices of Violation issued, if needed.	
Ruggles Avenue PS	4/12/2003	Heavy rains	400	Pump failure.	
America's Cup and Thames Street	3/22/2003	Grease blockage	1000	Followed up by the IPP coordinator. Restaurants upstream inspected and Notices of Violation issued, if needed.	
South Mayd and Butler Street	3/2/2003	Heavy rains	300	The area of South Mayd / Butler and Homer / Garfield are located in the Prescott Hall neighborhood.	
Goat Island Causeway	2/16/2003	Blockage	50	Jetted line.	
Friendship Street, Newport Hospital	1/27/2003	Blockage	NA	Jetted line.	

PS = Pump Station
FM = Force Main

In addition to the reported SSOs, there are two locations that have experienced capacity limitations as identified by the City's collection system operator:

- Capacity limitations have been reported along Marsh Street, upstream of the diversion weir that takes flows from Catchment 10 to the WSCSOTF. Pipes in the neighborhood of the WSCSOTF and the Long Wharf Pump Station are subject to groundwater inflow which could reduce available pipe capacity during wet weather events.

- Wet weather-related backups have been reported at 24 McCormick Road and near the intersection of Annandale Road and Narragansett Avenue. The latter issue seems to be caused by the invert elevation of the lateral being lower than the overflow elevation of the NASC.

4.2.2 Historical Closed-Circuit Television Data

The City's collection system operator is currently working with a subcontractor, Inland Waters, to perform CCTV inspections of the City's collection system. The purpose of CCTV inspections is to collect data necessary to characterize the condition of the collection system per CD Item 11a.
CH2M HILL has performed an assessment of the defect logs collected during these inspections using SCREAM™, which is a system of assessment algorithms that convert the Pipeline Assessment Certification Program (PACP) database defect codes into a 0 to 100 numerical scale representation of the structural, maintenance and RDII performance condition of the asset. A score of 100 is the worst (abandoned survey) and 0 is the best. The Sanitary and Combined Sewer System Condition Map submitted on July 30, 2012 (as part of CD Item 14) shows the progress of the CCTV inspections along with the SCREAM™ scores in Appendix D.

CCTV data indicates that there were several areas where sediment and debris buildup results in limited conveyance capacity. One of these areas is along Marchant Street, between Connection Street and Wellington Avenue, and along Connection Street between Houston Avenue and Marchant Street. It was noted during CCTV inspections that there were sags and flat pipe slopes at the end of the pipe on Marchant Street, near Wellington Avenue, which promoted sediment settling. Other areas that were noted to require heavy cleaning prior to CCTV inspections include: the area of South Mayd and Butler Streets and Homer and Garfield Streets and several pipes in Catchments 11 and 12 including Broadway, Kay Street, and Bliss Road, which were streets noted in Table 4-1 to had SSO-inducing blockages.

4.2.3 Historical Operations and Maintenance

The City of Newport has an *Operations and Maintenance Manual* that was reviewed and updated in 2011 (Sevee & Maher Engineers, Inc., et al., 2009/2011). The O&M Manual provides procedures and protocols necessary to manage dry and wet weather flows to comply with the RIPDES permit and to minimize flows treated and discharged at the two CSO treatment facilities. Section 5.1.1.2 of the O&M Manual specifically describes actions to minimize discharge from the CSO treatment facilities, including several recent improvements to promote in-system storage and flow management with the collection system upstream of the WPCP. These improvements include SCADA system updates at the WACSOTF, removal of the four inverted Thames Street Interceptor Weirs, and operations at Long Wharf Pump Station to run at full capacity while meeting the WPCP's current RIPDES maximum daily flow limit of 19.7 MGD. Operations to keep the plant within the 19.7 MGD limit include monitoring daily flow totals and throttling flows at Long Wharf Pump Station as necessary during wet weather events. The O&M Manual states:

> *"When flows exceed the treatment capacity of the WPCP or the flows are on a pace to exceed the Maximum Daily Flow permit limit, the flows are throttled at Long Wharf Pumping Station, directing flows to the Washington Street CSO facility. One pump is left in the 'auto' mode of operation and a second pump is placed in the 'hand' mode of operation. The operations staff then manually adjusts the pump speed from the SCADA node at the WPCP based on the calculations on the flow matrix. Once the wet well level [at Long Wharf Pump Station] reaches twelve feet, overflow to the Washington Street CSO facility occurs."*

This pattern of throttling at the WPCP and consequential overflows to the WSCSOTF is present in the flow meter and SCADA data available. Examples shown below in Figures 4-1 and 4-2 below are for the April 13, 2011 event and the October 19, 2011 event, respectively.

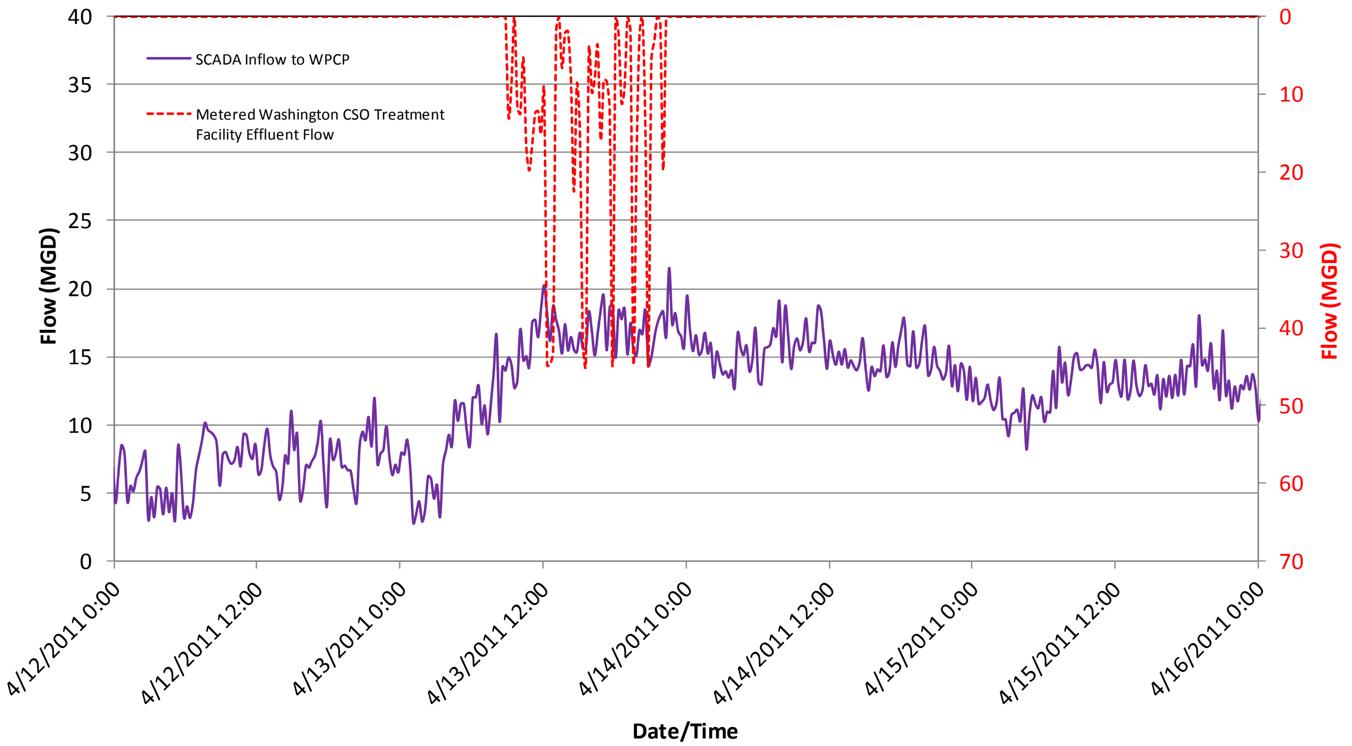


Figure 4-1. Influent Flows at WPCP and Effluent Flows at the WSCSOTF for the April 13, 2011 Event.

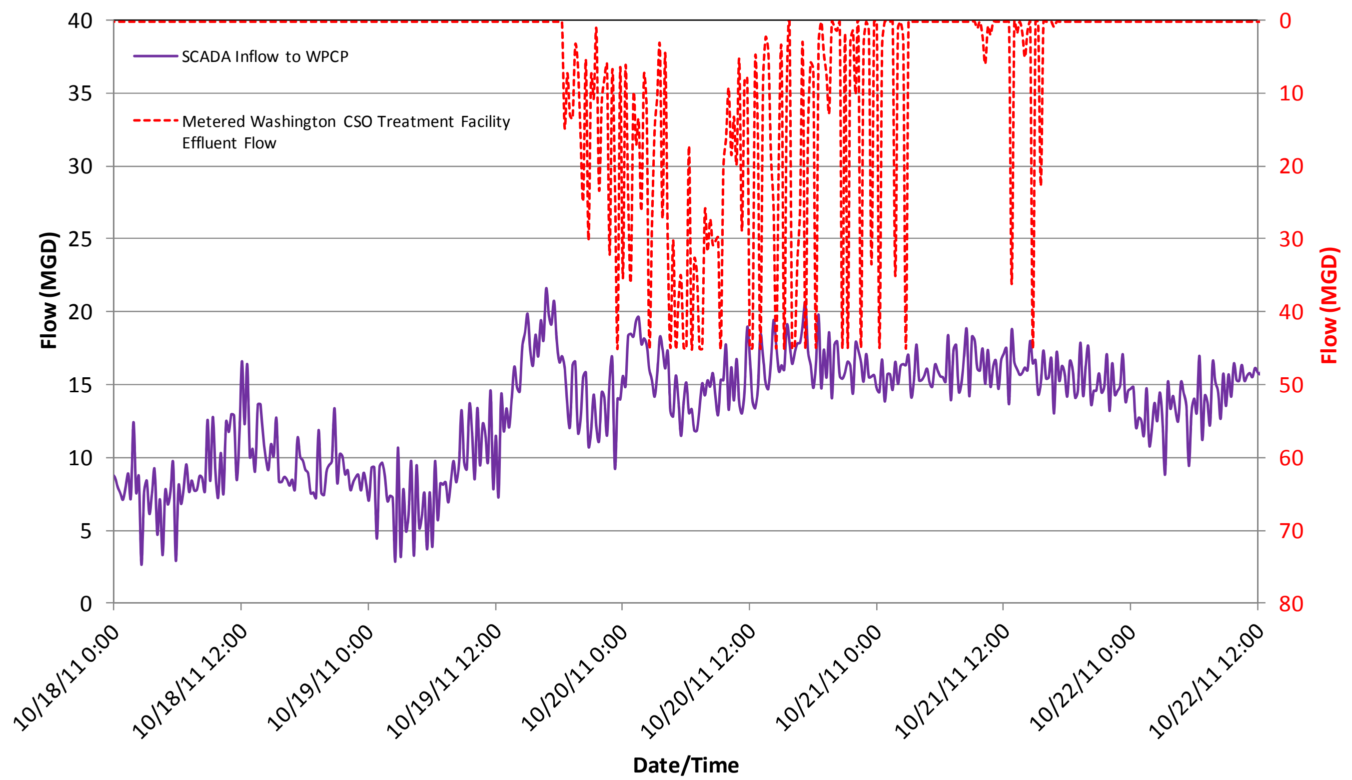


Figure 4-2. Influent Flows at WPCP and Effluent Flows at the WSCSOTF for the October 19, 2011 Event.

As noted in Section 2, the improvements to the system and operations have reduced the frequency and volume of CSO discharge at the WACSOTF, eliminated exceedances of the 19.7 MGD maximum daily flow permit limit at WPCP and continued to allow the City to meet the effluent quality limitations of the RIPDES permit. However, as seen in the SCADA and flow meter data, current operation at Long Wharf Pump Station including throttling and limiting flows to the WPCP consequently results in additional CSO discharge at the WSCSOTF. The available capacity at the WPCP could be used to reduce CSO discharges at the WSCSOTF for some events, as described in Section 5.

The O&M manual also describes a maintenance program, which includes regular catch basin and sewer cleaning to remove sediment and debris buildup to maximize conveyance. The program includes semi-annual, quarterly, monthly, bi-monthly and bi-weekly flushing or jetting of sewers, as shown in Table D-4 and the SSO and Maintenance Program Map from the January and July 2012 GIS submittal in Appendix D. Approximately 27,000 ft of sewer is cleaned through the maintenance program. Sewers are also cleaned prior to CCTV inspections, which are ongoing. Regular maintenance in these locations has helped to maximize conveyance capacities and greatly reduce the frequency of SSOs throughout the collection system.

4.3 Model Evaluations to Identify System Capacity Limitations

To supplement records of observed capacity limitations and to identify potential remedial measures, the citywide hydraulic model was used to evaluate the existing system performance by simulating design storms of varying intensity and duration. Two methods of analysis were performed: individual simulations and a continuous simulation of sequential events. The latter was performed to determine potential conveyance limitations as a result of antecedent conditions in the collection system.

The design storms of durations larger than 1 year were selected from *Technical Paper No. 40: Rainfall Frequency Atlas of the US* (TP-40) (Hershfield, 1961). The design storms of durations smaller than 1 year were obtained from the NBC CSO Facilities Program report (Louis Berger & Associates, Inc., 1998). The TP-40 hyetographs were determined using the Type III distribution from the Natural Resources Conservation Service (NRCS) with 30-minute increments. Table 4-2 summarizes available synthetic design storms to evaluate the conveyance capacity of the collection system of Newport and to investigate potential solution alternatives for eliminating CSOs at the WACSOTF and WSCSOTF. These design storms encompassed the intensity, duration, and magnitude of wet weather events observed during collection system metering activities from April 2010 through December 2011.

TABLE 4-2
Available Synthetic Design Storms

Return Period	30 Min Depth (in)	1 Hr Depth (in)	2 Hrs Depth (in)	6 Hrs Depth (in)	24 Hrs Depth (in)
1 Month				0.94	
3 Months	**0.51** S	**0.63** S, I	**0.8** I	**1.6** I	
6 Months	0.7	0.8	1.0	**2.0** I	
1 Year	0.8	**0.9** S	1.2	**2.2** I	**2.8** I
2 Years	1.0	1.3	**1.42** S	2.4	3.4
5 Years	1.2	1.5	2.0	**2.9** S	**4.4** I
10 Years	1.4	1.7	2.1 S	3.5	5.0
25 Years	1.7	2.2	2.8	3.9	5.8

Notes: **BOLD** selected for evaluation
(I) Considered for Individual storm event simulations
(S) Considered for Sequence of storm events.

4.3.1 Individual Design Storm Events

Individual design storm event simulations were conducted to evaluate collection system responses to a range of rainfall depths and intensities. This analysis executed the following sequence of individual simulations:

1. 3-Month, 60- Minute
2. 3-Month, 2- Hour
3. 3-Month, 6- Hour
4. 6-Month, 6- Hour
5. 1-Yr, 6- Hour
6. 1-Yr, 24- Hour
7. 5-Yr, 24- Hour

The 1-year, 6-hour design storm is the typical design storm documented in the NBC CSO Facilities Program report (Louis Berger & Associates, 1998) and the design storm event mentioned in the WPCP’s RIPDES permit (RIDEM, 2007). The selected design storm events and associated return periods and durations are suitable for design of sewer infrastructure such as combined sewers, manholes, and storage facilities such as those in the Newport collection system.

4.3.2 Continuous Simulation of Sequential Events

After evaluating the individual design event simulations, a sequence of storm events were executed in one continuous simulation to evaluate system response to antecedent conditions caused by previous storm events. An analysis of the wet weather events used for calibration and validation of the collection system model revealed that that the time required for system flows to return to base sanitary flow varies between 8 and 18 hours after the peak of an event. Therefore, to simulate antecedent conditions in the system, an inter-event period of 6 hours was chosen.

The following sequence of storms was executed for the continuous simulation:

1. 3-month, 30-minute
2. 1-year, 1-hour
3. 2-year, 2-hour
4. 5-year, 6-hour
5. 10-year, 2-hour

The time span between the last two storms is 12 hours, since the second to last storm is 6 hours in duration and the hydrograph tail extends beyond the 6-hour inter-event time.

4.3.3 Summary of Collection System Modeling Evaluations

Model calculations from the hydraulic evaluations using the events described in Sections 4.3.1 and 4.3.2 combined with historic data indicate that a large majority of Newport's collection system has sufficient capacity to convey WWFs during the broad range of storm events that were evaluated. However, the analysis identified five areas of the collection system with recurring SSOs and/or some characteristics of capacity limitations. The location of each of these areas is shown in the map in Figure 4-3 and discussed below. Further detail of these locations (including plan and profile views) as well as results from other areas in the collection system is provided in Appendix D.

- **Area 1**: Surcharges are calculated east of the intersection of Garfield and Homer Streets and at the intersection of Butler and South Mayd Streets during the individual simulation of the 5-year, 24-hour event. Historical SSOs have been reported during wet weather events in this area as well. Historical SSOs are attributed by the City's collection system operator to debris and sediment buildup which has since been removed and no SSOs have been reported since 2010. The modeled surcharges are primarily a result of adverse and flat slopes in this area, which are likely contributing to debris and sediment buildup.

- **Area 2**: Surcharges are calculated on J.T. Connell Highway and the pipe that conveys flow from Halsey Street, both which contribute to the Dyre Street Pump Station. Surcharges are calculated for several storm events for both the individual and sequential simulations. Surcharges are primarily caused by a flat pipe slope in the downstream pipes that are between J.T. Connell Highway and the Dyre Street Pump Station. Historical SSOs have occurred along J.T. Connell Highway and near the Dyer Street Pump Station, but were primarily a result of blockages (debris and grease). Preventative maintenance regularly occurs in this area to address potential blockages.

- **Area 3**: Surcharges are calculated on Marchant Street between Narragansett Avenue and Atlantic Street for both the individual and sequential simulations. The surcharges are primarily a result of flat pipe slopes on Marchant Street between Narragansett Avenue and Wellington Avenue and a pipe diameter reduction on Marchant Street at Connection Street from 18 to 12 inches. There are no historical SSOs at this location, although CCTV data indicated that there was sediment buildup.

- **Area 4**: Surcharges are calculated on McCormick Road for the individual and sequential simulations for both the individual and sequential simulations. Surcharging above ground level is attributed to shallow manholes, although there is a pipe size reduction from 12 to 10 inches near McCormick Road and Ruggles Avenue. Historical wet weather-related backups have also occurred in this area, primarily due to surcharging in pipes. Pipes downstream of this location were recently replaced through the High Priority Sewer Replacement Project (10-013) and no additional wet weather backups have been reported since construction was completed.

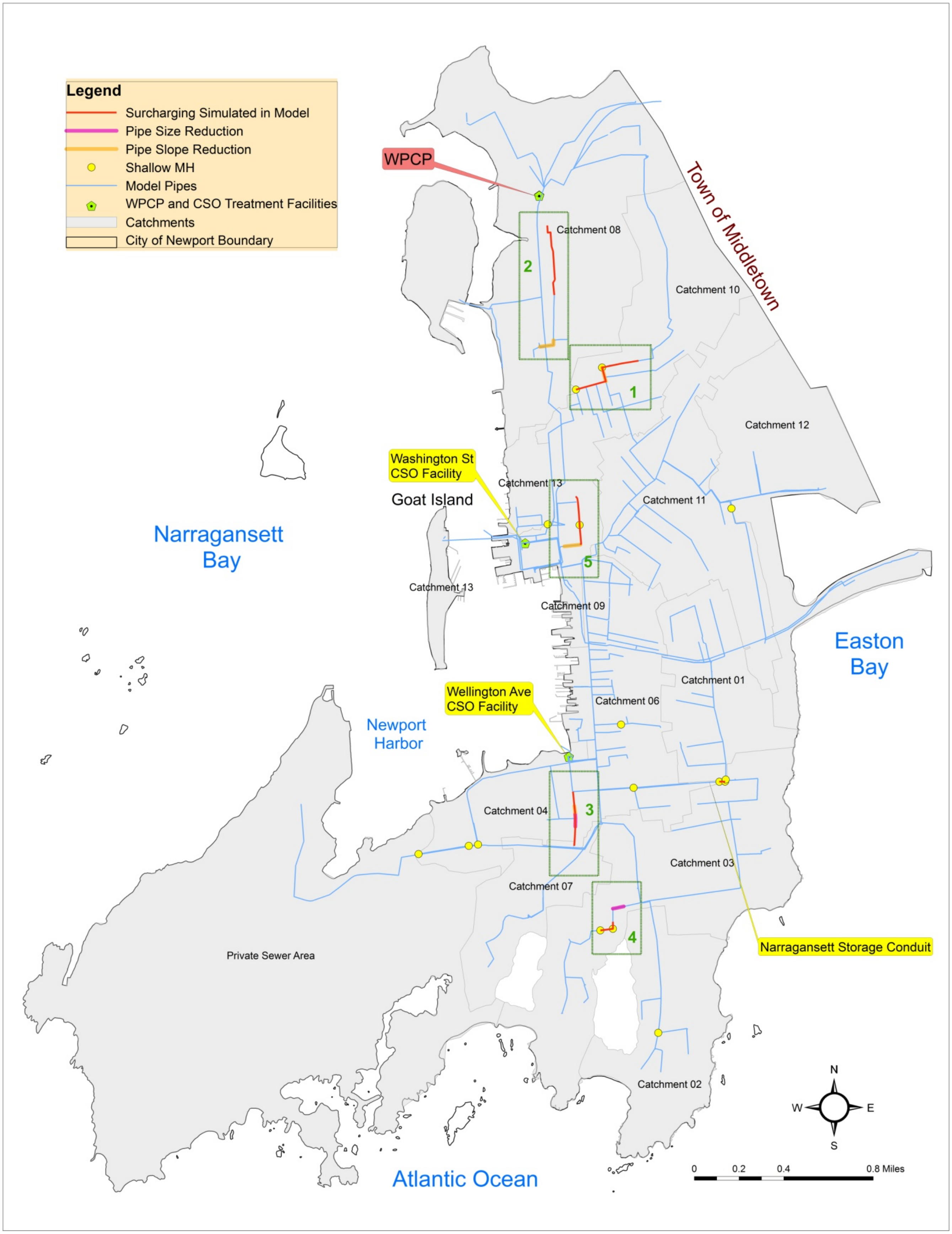


Figure 4-3. Simulated Potential Capacity Limitations in the Collection System

- **Area 5**: Surcharges are calculated along Thames Street and Marlborough Street near the Long Wharf Pump Station for both the individual and sequential simulations. Above-ground surcharging is attributed to shallowness of the manholes in the area. No historical SSOs have been reported at this location.

Overall, areas where surcharging was identified through hydraulic model simulations appear to have no influence on the frequency or volume of CSO discharges as these are upstream, localized capacity issues. In general, the collection system, including the Long Wharf Pump Station, has the capacity to deliver much more flow to the WPCP during wet weather than is supported by its effective treatment limits and the limits defined in the WPCP's RIPDES permit. The restrictions result in a larger volume of overflows at the WSCSOTF than what might otherwise occur due to forced conveyance limitations. This is discussed further in Section 5.

4.3.4 Summary of Water Pollution Control Plant Capacity Assessment

In March 2011, the *Flow Optimization and Capacity Evaluation Report* was submitted to the EPA detailing dry and wet weather flows and loads as related to the RIDEM permit limits, an engineering evaluation of the plant's hydraulic and functional capacities, and a chemically-enhanced primary treatment (CEPT) evaluation (CH2M HILL, 2011d). The review of flows and loads determined that the plant cannot reliably meet existing design capacities (10.7 average monthly flow, 19.7 maximum day flow) due to deficiencies and bottlenecks at the plants headworks, primary clarifiers, secondary clarifiers, disinfection system and solids handling system. The following is the summary of the updated capacity assessment evaluation of the existing facilities.

The treatment capacities of each process are summarized in Table 4-3. Based on the process modeling and recent plant operation data analysis (Nov. 2008 to Oct. 2011), the existing plant capacity is less than its original design capacity due to the following constrains:

1. Two-inch bar racks at the headworks are inadequate for rag and debris removal during wet weather. The aerated grit chambers are not functioning as designed and basically act as flow-through chambers while grit fills in the bottom of the channel and sump in the grit tanks. The current limitation in grit removal capability results in the risk of overloading downstream processes, wearing out process equipment, and subsequently reducing reliability of the plant performance.
2. The plant has often operated at the condition that sludge volume index (SVI) values are much higher than typical threshold of 150 mL/g as shown in Figure 4-4. Subsequently, the plant operator must adjust surface loading rates to the final clarifiers and often needs all four final clarifiers during high flow periods to meet the effluent TSS limit.
3. The existing chlorine contact tank provides less than 15 minutes of contact time during peak hourly flow. Typically, for reliable bacteria kills and especially during periods when effluent TSS concentrations are high; a minimum of 30 minutes of contact time (recommended in the Great Lakes Upper Mississippi River Board's *Ten States Standards* (GLUMRB, 2004) and the New England Interstate Water Pollution Control Commission's Technical Report #16 (NEIWPCC, 2011)) and/or other means of disinfection technology (e.g. UV disinfection) are needed.
4. There is only one gravity belt thickener (GBT) installed in the plant. It was designed to operate at approximately 120 gpm capacity. At the time of the WPCP evaluation, the GBT was loaded at more than 200 gpm continuously for 24 hours per day during high flow conditions. Since this evaluation, a gravity sludge thickener rehabilitation project has been completed and it now provides up to 72,000 gallons of sludge storage. However, the gravity sludge thickener does not provide enough storage to allow the GBT to operate at its design capacity.

Wet weather capacities are often equivalent to process hydraulic capacities (or peak hourly/instantaneous flow capacities). Wet weather capacities are the maximum flows that can pass through structures of the unit operations or processes safely while maintaining adequate treatment or removal rates to meet design and permit criteria under a short time duration basis. Estimated wet weather capacities are, by no means, representative of the plant's sustained treatment capacity under more stable loading conditions. A summary of wet weather capacities of each process are listed in Table 4-3.

TABLE 4-3
Summary of the Treatment Capacities of Newport WPCP

Unit Operation/Process	[a]Average Day (MGD)	[b]Maximum Day (MGD)	[c]Wet Weather Capacity (MGD)	Note
Headwork	11	22	22	Minimal grit removal capability provided.
Primary Clarifier	14	20	20	Based on 50% TSS removal requirement.
Secondary	15	18	22	Limited by secondary clarifier capacity.
Disinfection	14	14	14	Based on 30 minutes of contact time.
Solid Processing	11	n/a	n/a	Based on operation experience and no redundancy considered
Overall Plant Capacity	**11**	**14**	**14**	

[a]Sustained treatment capacity with one of the largest units as a redundant unit.
[b]Sustained treatment capacity without redundancy.
[c]Peak hourly flow or instantaneous flow capacity.

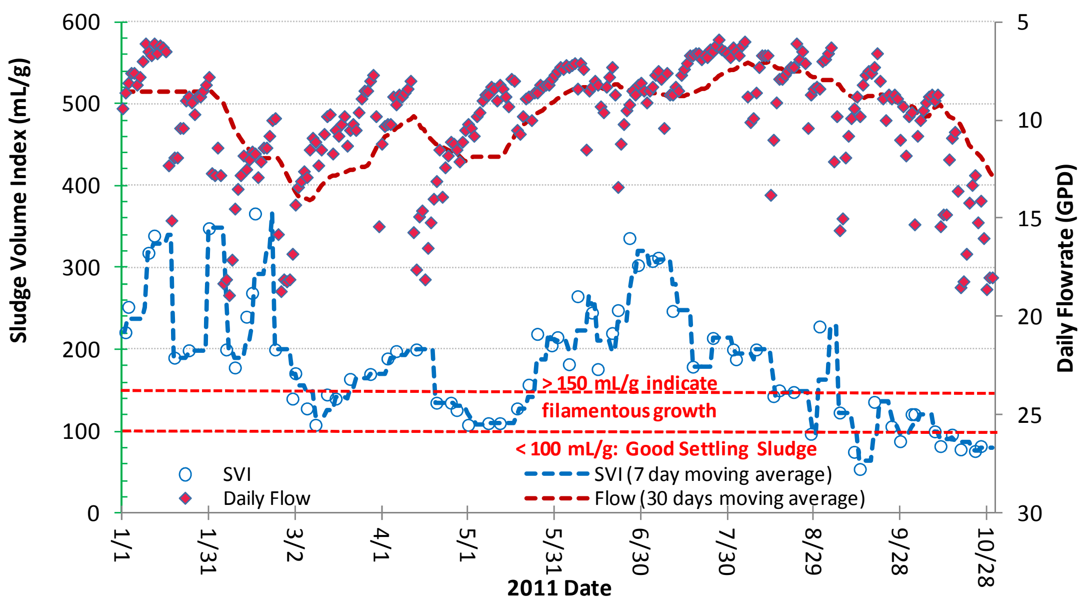


Figure 4-4. SVI of Secondary Effluent Under 2011 Operation Conditions

4.4 Recommendations for Improving System Capacity

Preliminary recommendations based on the evaluations described above were developed to address capacity limitations identified in Sections 4.2 and 4.3 for the collection system and the WPCP that have not already been remediated to date. These recommendations are to improve conveyance capacities, reduce or eliminate capacity limitations, reduce structural causes of SSOs and reduce CSOs. Additional upgrades to improve system operation and/or treatment are described in Section 5.

4.4.1 Recommended Collection System Capacity Improvements

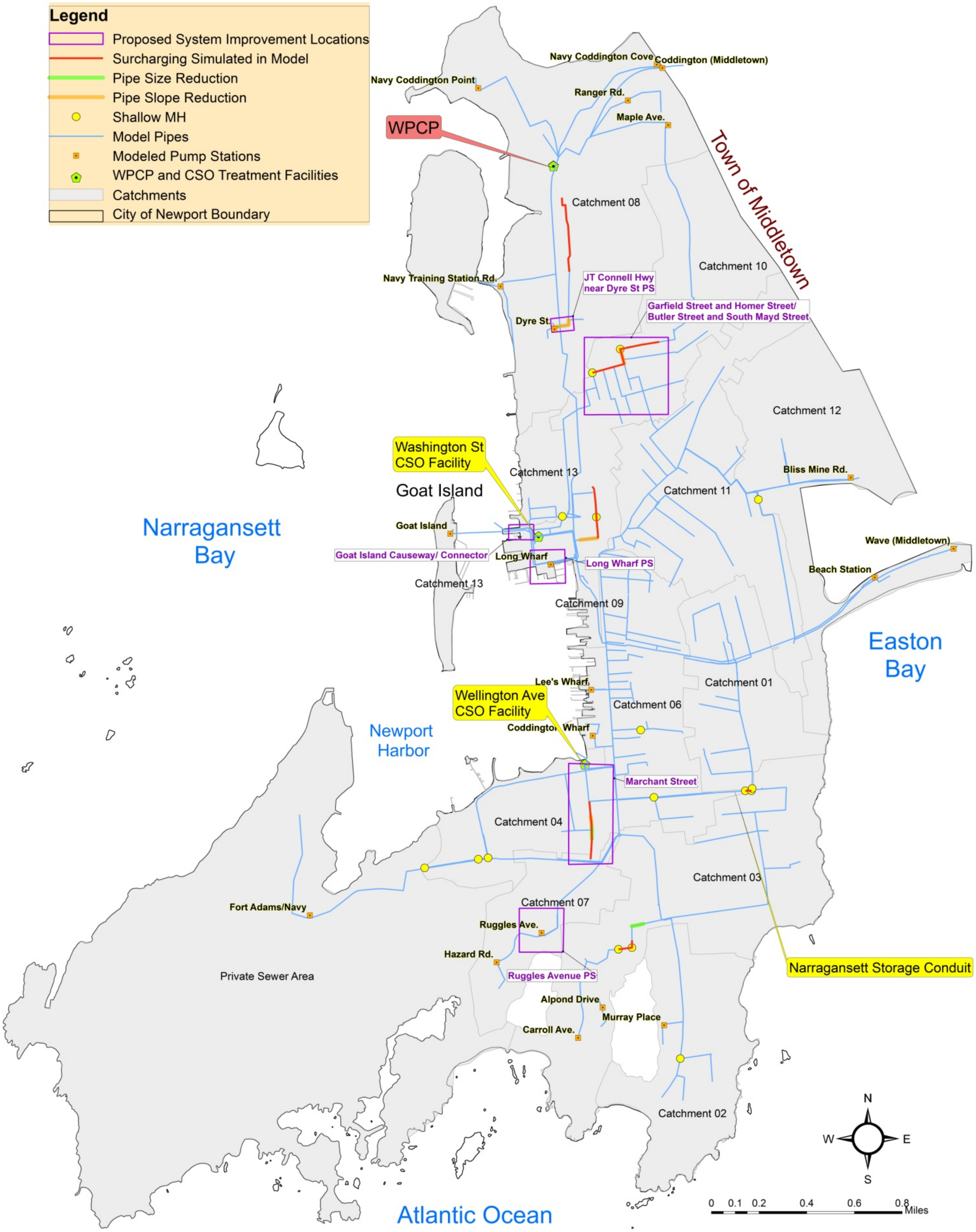
Several of the collection system capacity limitations that caused historic SSOs were a result of blockages caused by sediment or debris. Most of these issues have been resolved with regular maintenance through flushing or jetting pipes or through pipe cleaning performed prior to CCTV inspections. In addition, there are only five areas identified through hydraulic modeling that are experiencing surcharging and none that are contributing to CSO discharges. Consequently, few areas require capacity improvement recommendations. However, there were some locations where conveyance limitations may need to be addressed through regular maintenance, further engineering evaluations and/or improvements. The recommendations listed below are based on a combination of historic SSO records, CCTV inspections, scheduled maintenance activities, and hydraulic modeling results:

- **Long Wharf Pump Station:** As noted in Section 4.2.3, the second pump at the Long Wharf Pump Station is operated manually during wet weather events to throttle flows to meet the 19.7 MGD maximum day permit limit at the WPCP. It is recommended that the wet weather operations of the Long Wharf Pump Station be automated through SCADA similar to dry weather operations and a programmable logic controller be used to limit flows to 19.7 MGD to maximize the volume to the WPCP during wet weather events.
- **Garfield Street and Homer Street/Butler Street and South Mayd Street:** These areas have had recurring SSOs during wet weather, although sediment buildup may have contributed to capacity limitations. Sediment buildup was removed during CCTV inspections and continues to be addressed through regular sewer cleaning as part of the City's maintenance program; Garfield Street is flushed monthly, while Homer, Butler and South Mayd Streets are jetted semi-annually. The CCTV condition assessment scoring indicated that the sewers were of moderate priority for repair. The hydraulic modeling analysis indicated that these areas experience surcharging for a 5-year, 24-hour event. Based on these results, it is recommended that: 1) the sewers in this area continue to be regularly cleaned through the City's scheduled maintenance program; and 2) that a structural solution be evaluated to mitigate sediment buildup, correct observed defects in pipe condition, and improve conveyance capacity. The structural solutions may include point repairs, lining, and/or pipe replacement as determined on a segment by segment basis.
- **J.T. Connell Highway near the Dyre Street Pump Station:** Recurring historical SSOs caused by sediment and grease blockages have been reported on J.T. Connell Highway and Dyre Street. Blockages were removed at the time of the event and sediment has since been removed through sewer cleaning during the CCTV inspections and during regular monthly flushing as part of the maintenance program. The CCTV condition assessment scoring indicated that the sewers on J.T. Connell Highway near Dyre Street are of moderate priority for repair. Hydraulic modeling results indicate that a pipe slope reduction underneath J.T. Connell Highway results in surcharging upstream for several design storm events. Based on these results, it is recommended that: 1) the sewers underneath J.T. Connell Hwy to the Dyre Street Pump Station continue to be regularly cleaned through the City's scheduled maintenance program; and 2) that a structural solution be evaluated to

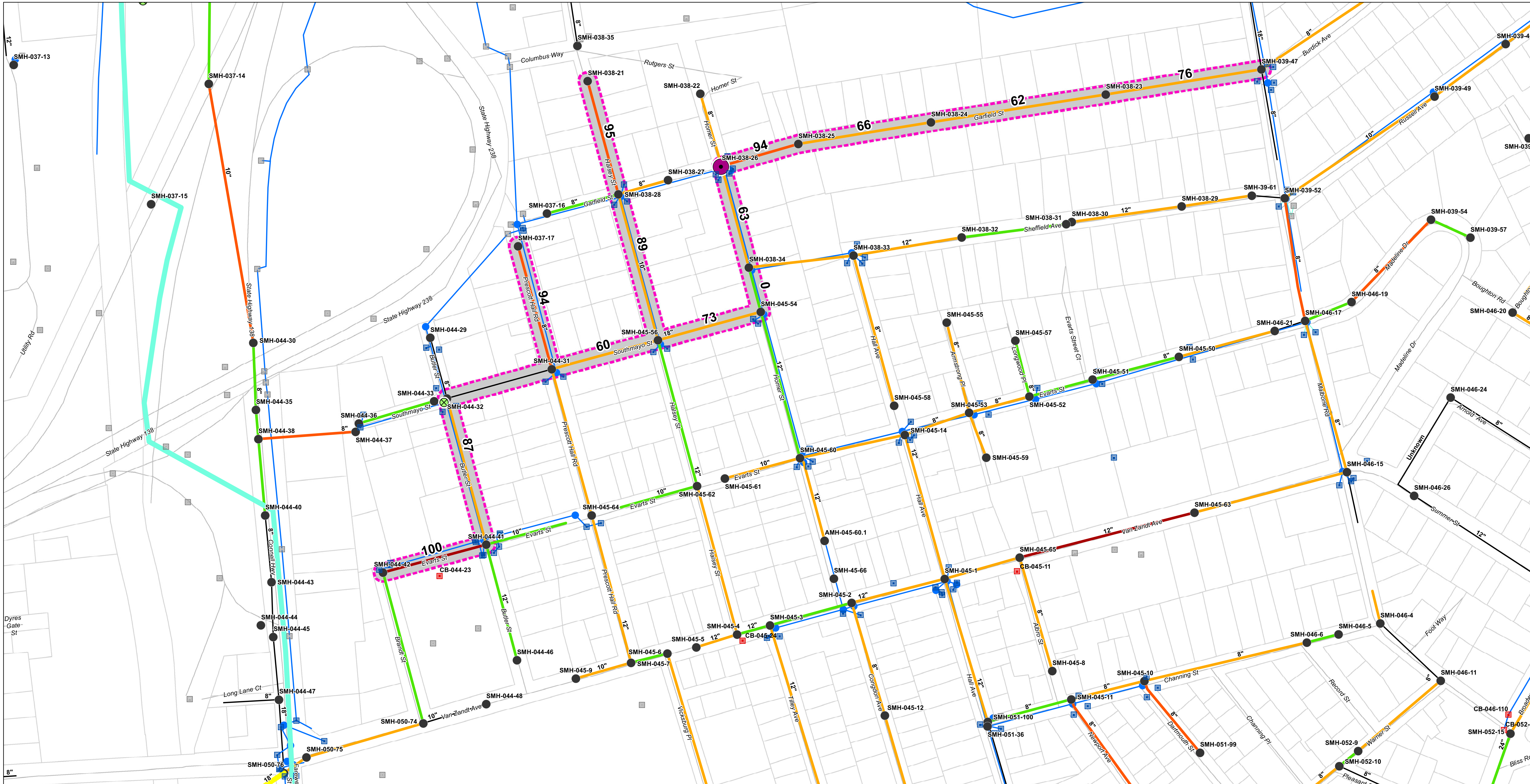
mitigate sediment buildup, correct observed defects in pipe condition, and improve conveyance capacity. The structural solutions may include point repairs, lining, and/or pipe replacement as determined on a segment by segment basis.

- **Marchant Street:** No historical SSOs have occurred at this location and this area is not regularly cleaned as part of the City's maintenance program. However, CCTV inspection results indicated that there were sags and flat pipe slopes that contributed sediment buildup, although the condition assessment score indicated that the sewers are of low to moderate priority for repair. Hydraulic modeling results indicated that surcharging occurs on Marchant Street from Wellington Avenue to Atlantic Street due to flat pipe slopes and a pipe size reduction from 18 to 12 inches at Narragansett Avenue. Because there have been no historical conveyance limitations noted at this location, it is recommended that the pipes on Marchant Street between Atlantic Street and Wellington Avenue be regularly cleaned semi-annually through the City's maintenance program to eliminate potential capacity limitations. In addition, sewers on Marchant Street from Narragansett Avenue to Wellington Avenue should be evaluated for replacement in the future to increase the pipe size from 12 to 18 inches to remove capacity limitations.
- **Ruggles Avenue Pump Station:** Recurring historical SSOs have occurred at this pump station during wet weather events. It is recommended that a detailed engineering evaluation be completed on the Ruggles Avenue pumps and force main to determine the necessary capacities to convey the WWFs downstream and eliminate SSOs.
- **Goat Island Causeway/Connector:** Historical SSOs along these pipes have reoccurred primarily due to sediment and debris buildup that was removed at the time of the event. The sewers along the Goat Island Causeway are also regularly cleaned through the City's maintenance program. The two 2012 SSOs at this location were due to a leaking sewer that was repaired following the second SSO. Hydraulic modeling results do not indicate surcharging along the Goat Island Causeway sewers, but a pipe slope reduction at Washington Street may be contributing to sediment buildup. It is recommended that the pipes in the area of the connection between Goat Island Causeway and Washington Street be evaluated for structural repairs to mitigate sediment buildup, correct observed defects in pipe condition, and improve conveyance capacity. The structural solutions may include point repairs, lining, and/or pipe replacement as determined on a segment by segment basis.

An overall map of the recommended system improvements noted above is presented in Figure 4-5 and detailed location maps showing the potential pipes to be evaluated for structural rehabilitation or replacement are shown in Figures 4-6 to 4-9. Improvements to the collection system to address pipes that were identified as high priority during the recent condition assessment (as described in Section 4.2.2) should be incorporated in the City's ongoing asset management program.



Figures 4-5. Map of Recommended System Improvement Locations



Legend

- System Improvement Locations
- Gravity Mains
- Force Main
- Sanitary Manholes
- Storm Main
- Storm Manhole
- Storm Lateral
- Combined Catch Basin
- Separated Catch Basin
- Unverified Catch Basin

Gravity Main Condition Assessment Score
(Score Labeled in Bold Black)

- <50 (Low Priority)
- 50-<90 (Moderate Priority)
- >=90 (High Priority)
- 100 (Abandoned)

Observed SSOs
Total SSOs, Year of Most Recent SSO

- SSOs before 2010
- 1 SSO, 2010 - 2011
- 2 SSOs, 2010 - 2011
- 3 SSOs, 2010-2011
- 6 SSOs, 2010-2011
- 2 SSOs, 2012

Recent Capital Improvement Projects

- Gravity Main
- Force Main
- Manholes

Ongoing Capital Improvement Projects

- Sanitary Sewer Improvements

- Parcels
- Roads

Figure 4-6: Recommended Collection System Capacity Improvements

Garfield Street and Homer Street/ Butler Street and South Mayd Street

N W E S

0 50 100 200
Feet

Map prepared November 2012
Locations of SSOs are approximate

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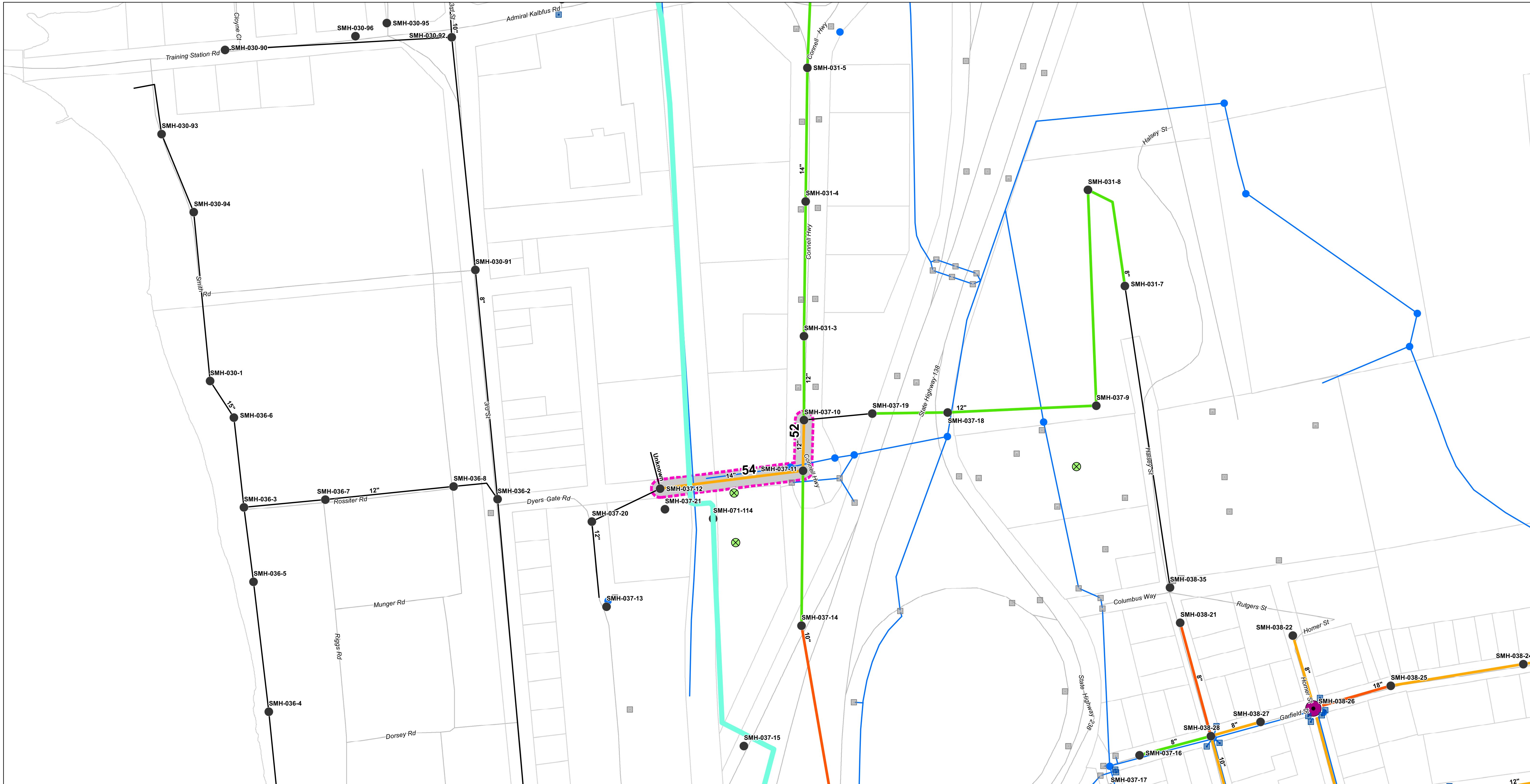


Legend

System Improvement Locations	Combined Catch Basin	**Gravity Main Condition Assessment Score (Scores Labeled in Bold Black)**	**Observed SSOs** **Total SSOs, Year of Most Recent SSO**	**Recent Capital Improvement Projects**	Parcels
Gravity Mains	Separated Catch Basin	<50 (Low Priority)	SSOs before 2010	Gravity Main	Roads
Force Main	Unverified Catch Basin	50-<90 (Moderate Priority)	1 SSO, 2010 - 2011	Force Main	
Sanitary Manholes		>=90 (High Priority)	2 SSOs, 2010 - 2011	Manholes	
Storm Main		100 (Abandoned)	3 SSOs, 2010-2011	**Ongoing Capital Improvement Projects**	
Storm Manhole			6 SSOs, 2010-2011	Sanitary Sewer Improvements	
Storm Lateral			2 SSOs, 2012		

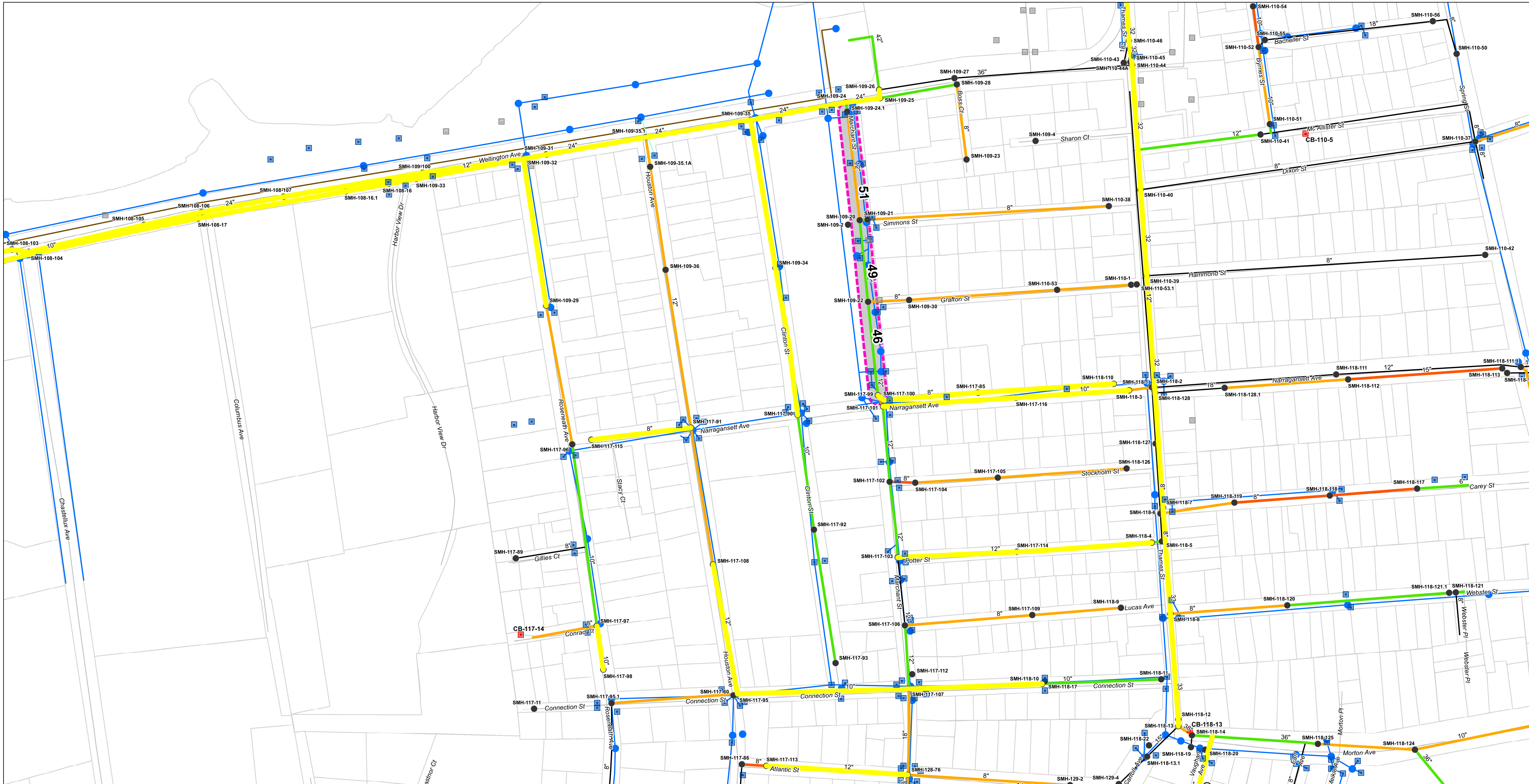
Figure 4-7: Recommended Collection System Capacity Improvements

J.T. Connell Highway near the Dyre Street PS

0 50 100 200
Feet

Map prepared November 2012
Locations of SSOs are approximate

CH2MHILL



Legend

- System Improvement Locations
- Gravity Mains
- Sanitary Manholes
- Force Main
- Storm Main
- Storm Manhole
- Storm Lateral
- Combined Catch Basin
- Separated Catch Basin
- Unverified Catch Basin

Gravity Main Condition Assessment Score
(Score Labeled in Bold Black)
- <50 (Low Priority)
- 50-<90 (Moderate Priority)
- >=90 (High Priority)
- 100 (Abandoned)

Observed SSOs
Total SSOs, Year of Most Recent SSO
- SSOs before 2010
- 1 SSO, 2010 - 2011
- 2 SSOs, 2010 - 2011
- 3 SSOs, 2010-2011
- 6 SSOs, 2010-2011
- 2 SSOs, 2012

Recent Capital Improvement Projects
- Gravity Main
- Force Main
- Manholes

Ongoing Capital Improvement Projects
- Sanitary Sewer Improvements

- Parcels
- Roads

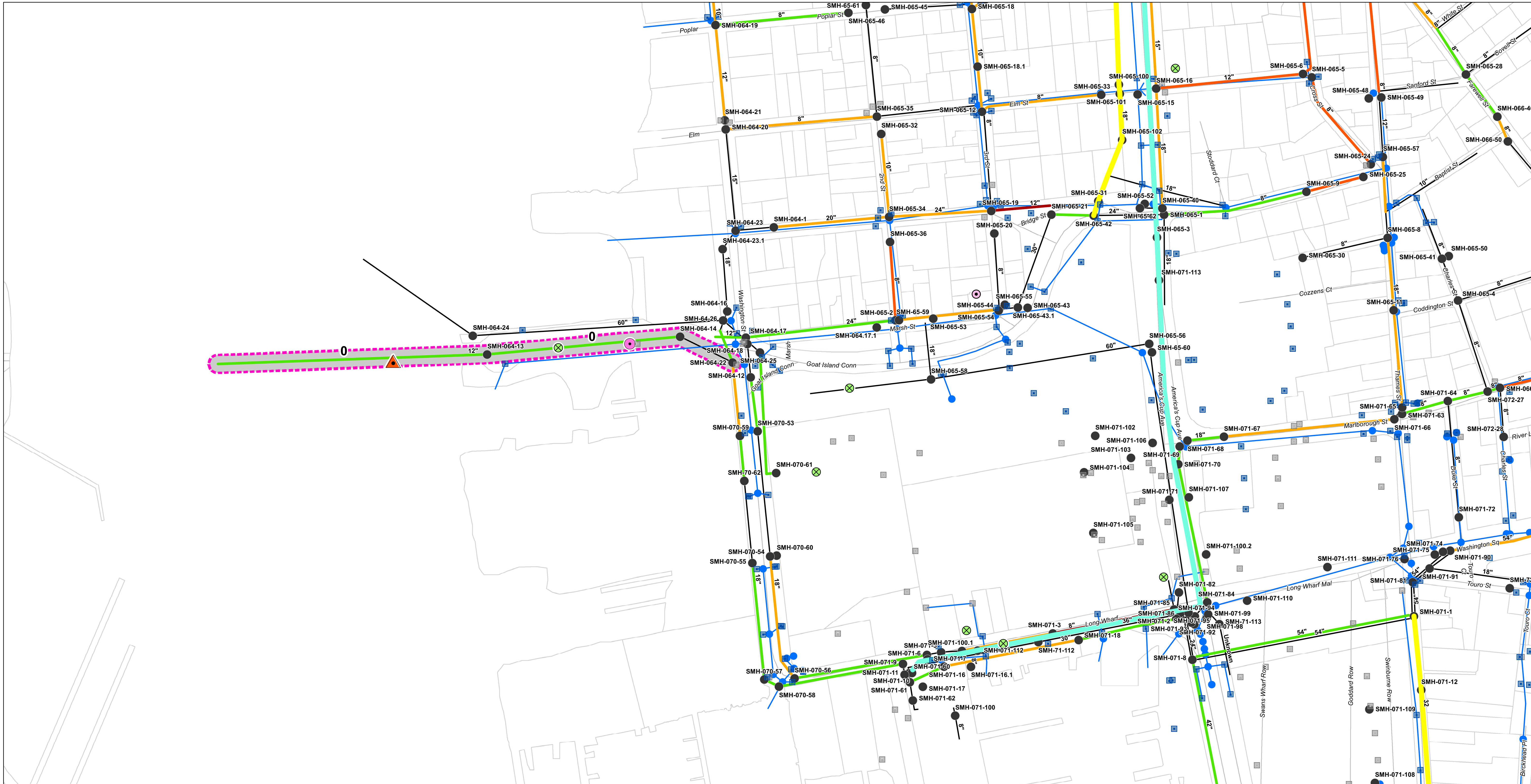
Figure 4-8: Recommended Collection System Capacity Improvements

Marchant Street

0 50 100 200
Feet

Map prepared November 2012
Locations of SSOs are approximate

CH2MHILL



Legend

System Improvement Locations	Combined Catch Basin
Gravity Mains	Separated Catch Basin
Force Main	Unverified Catch Basin
Sanitary Manholes	
Storm Main	
Storm Manhole	
Storm Lateral	

Gravity Main Condition Assessment Score
(Score Labeled in Bold Black)
- <50 (Low Priority)
- 50-<90 (Moderate Priority)
- >=90 (High Priority)
- 100 (Abandoned)

Observed SSOs
Total SSOs, Year of Most Recent SSO
- SSOs before 2010
- 1 SSO, 2010 - 2011
- 2 SSOs, 2010 - 2011
- 3 SSOs, 2010-2011
- 6 SSOs, 2010-2011
- 2 SSOs, 2012

Recent Capital Improvement Projects
- Gravity Main
- Force Main
- Manholes

Ongoing Capital Improvement Projects
- Sanitary Sewer Improvements

- Parcels
- Roads

Figure 4-9: Recommended Collection System Capacity Improvements

Goat Island Causeway/Connector

0 50 100 200
Feet

Map prepared November 2012
Locations of SSOs are approximate

CH2MHILL

4.4.2 Recommended Water Pollution Control Plant Capacity Improvements

The recommended improvements include upgrading headworks, disinfection and solids handling processes to meet current design capacities. These are the main capacity bottlenecks for the existing plant. Upgrades to each treatment process are detailed below and summarized in Table 4-4.

- **Headworks**: The pretreatment offered by the existing headworks is not adequate to protect downstream process equipment. Proper pretreatment with grit removal and screening of the incoming wastewater is important to ensure the reliable operation and performance of downstream unit processes. At a minimum, renovation of the headworks requires a better grit removal system or replacement with a new system, and replacement of the existing coarse screens with two new fine screens (e.g., ¼-inch spacing).
- **Disinfection**: The existing plant disinfects only with liquid sodium hypochlorite. Additional disinfection capacity is required to improve performance and reliability in meeting effluent limits. Additional studies (e.g., computation fluid dynamic (CFD) study) are recommended to optimize the chlorine contact tanks performance under wet weather conditions. If studies find that chlorine disinfection cannot achieve sufficient removals, additional tank volume, higher chlorine dosage and UV disinfection for a portion of the dry weather flow can be considered. For this memorandum, additional tank volume calculated by using a 30-minute contact time at peak flows (as required by Technical Report #16 (NEIWPCC, 2011) and *Ten States Standards* (GLUMRB, 2004)) is used to estimate the cost.
- **Solids Processing Capacity**: Currently, one small GBT operates nearly continuously to process the primary and secondary solids generated at the WPCP. Significantly higher solid processing throughput capacity is required to reduce the hours of operation to a more manageable schedule. At a minimum, two 2-meter GBTs or two centrifuges are required to provide for system redundancy and reliability.

TABLE 4-4
Summary of the Current and Future Capacities with Recommended Improvements

Unit Operation/Process	Current Average Day Effective Treatment Capacity (MGD)	Future Average Day Treatment Capacity (MGD) [a]	Current Maximum Day Effective Treatment Capacity (MGD)	Future Maximum Day Treatment Capacity (MGD) [b]	Recommended Future Improvements
Headworks	11	15.3	22	30	New headworks including mechanical screen (1/4") and aerated grit removal system
Disinfection	14	15.3	14	20 [c]	More tank volume or additional UV disinfection unit
Solid Processing	11	15.3	N/A	20 [c]	Additional GBT unit or other solid handling units
Overall Plant Capacity	**11**	**15.3**	**14**	**18** [d]	

[a] Sustained treatment capacity with one of the largest units as redundant unit.
[b] Sustained treatment capacity without redundancy.
[c] Capacities are dependent on upgrade options and can be higher than 20 MGD. Only considered upgrade to 20 MGD because the plant capacity is limited to 20 MGD due to capacity constraints of the primary clarifier.
[d] Future maximum day treatment capacity is limited by the existing treatment capacities of the aeration tanks and final clarifier of 18 MGD as shown in Table 4-3.

A headworks upgrade would provide adequate screening and grit removal capability which would protect the downstream processes and improve treatment reliability and operation performance. An upgrade to the existing solid handling process could not only increase capacity but also provide redundancy and allow more operation flexibility. These two upgrades could increase the average day capacity from 11 to 14 MGD. An upgrade to disinfection process provides consistent bacterial kill efficacy and increase the maximum day capacity and wet weather capacity from 14 MGD to 20 MGD.

4.4.3 Recommended Implementation Schedule

The recommended implementation schedule for the collection system and WPCP improvements noted in Sections 4.4.2 and 4.4.1 is described in Section 6.

SECTION 5

Evaluation of Potential Solutions for CSO Elimination (CD Items 63f and 65)

5.1 Overview and Objectives

5.1.1 Regulatory Framework

The evaluation of the potential solutions for combined sewer overflow (CSO) elimination was completed to address the City of Newport's (the City's) requirements in its Consent Decree (CD). Item 63f of the CD describes the requirements of this work:

"... evaluate the City's ability to eliminate the Wellington Avenue and Washington Street Outfall overflows based on the Collection System work performed and Collection System rehabilitation and remedial measures planned for the future."

Additional requirements are in Item 65 of the CD, which states:

"If the City determines that its proposed Collection System replacement and rehabilitation remedial measures, its public infiltration/inflow, private rainfall-induced infiltration and inflow removal programs, and its WPCP flow optimization will not result in the elimination of overflows, including overflows from the Wellington Avenue and Washington Street Outfalls, then the Capacity Assessment shall include an identification and evaluation of additional measures to eliminate such overflows ("System Master Plan") including, but not limited to implementation of CEPT, off-line and in-line storage, upgrades to the WPCP to increase its design flow, and pump back storage (e.g., tunnels). The System Master Plan shall also integrate the results of the WPCP evaluation and the CEPT feasibility studies, along with other measures including the City's on-going Collection System replacement and rehabilitation remedial measures, sewer separation options, the City's public infiltration/inflow and private rainfall-induced infiltration and inflow removal programs, and other specific short- and long-term measures for preventing (and, to the extent they may not be able to be prevented, for controlling and treating) overflows.",

Based upon these requirements, the initial evaluation considered potential solutions utilizing: replacement and rehabilitation remedial measures, public infiltration and inflow (I/I), private rainfall-induced I/I removal programs, and Water Pollution Control Plan (WPCP) flow optimization is presented in 5.2 Evaluation of System Rehabilitation and Inflow Reduction Measures.

Based on the findings from the initial evaluations, it was determined that additional control measures should be evaluated to control and treat the overflows from the WACSOTF and WSCSOTF. In addition to the findings from the initial evaluation, a May 2012 letter issued by the EPA acknowledged that portions of the City's collection system are combined. Therefore, the planning of system improvements falls under the EPA's CSO Control Policy, which allows for additional control measures to be included in the evaluation of CSO control. Because it was determined that the City's combined collection system falls under the EPA's CSO Control Policy, implementation schedules varying from the implementation schedule in the CD could be proposed. Section 5.3 presents the Evaluation of Additional Control Measures.

The comparison of the results of the evaluation of additional control measures is presented in Section 5.4 Comparison of Control Scenarios, and includes comparisons of:

- Discharge reduction
- Water quality benefits

- Costs
- Affordability
- Alignment with regulatory framework

5.1.2 Evaluation Criteria and Priorities Established by the CSO Stakeholder Workgroup

A goal statement was developed to summarize the regulatory framework provided by the CD and to support the communication of program requirements to stakeholders. The goal statement for the program is:

Continue to identify and implement the most cost-effective solution for reducing the number of CSOs to a level protective of Newport Harbor and acceptable to the community and regulatory agencies.

To ensure the program was executed in a manner acceptable to the community, the City established a CSO Stakeholder Workgroup to provide input and feedback on the CSO Program. The Stakeholder Workgroup consisted of 20 representatives, identified by Newport City Council to support the planning process. The representatives were from a wide-range of organizations (including the business community, residents, wholesale customers, other City departments, local commissions, and regulatory agencies) that may be affected by the outcomes of the CSO Program as well as four Newport residents to represent the typical Newport rate payer. The key input from the stakeholders was provided through two surveys on priority criteria and System Master Plan (SMP) Control Scenarios. This section will present the results of the survey on priority criteria established by the stakeholders.

CSO Stakeholders participated in and provided feedback at 12 meetings. The agendas, presentations, handouts and meeting minutes from these meetings are included in Appendix A. The purpose of the first five meetings was to provide background information to the stakeholders to enable them to provide informed input and feedback to the CSO Program. During meeting 6, the stakeholders discussed four priority criteria categories that affect the selection of CSO control options:

- Regulatory Compliance
- Water Quality
- Social/Community Impacts
- Rates & Affordability

Following a discussion, the stakeholders were asked to complete a survey identifying their priority criteria across the four evaluation categories by weighting them from 0 to 10, with 10 being of the highest importance and 0 being of no importance. The survey completed by the stakeholders is shown in Figure 5-1. The results of the survey were presented to the stakeholders at meeting 6A and are presented in Figure 5-2. The top four priority criteria identified by the stakeholders from this survey were:

1. Compliance with Clean Water Act (CWA) requirements
2. Keeping rates under/at affordability limits
3. Reduction of beach closures/ more swimming days
4. Meet water quality standards in Newport Harbor

At meeting 6A, the stakeholders discussed the results as well as how they determined their weightings for the priority criteria. Following the discussion, the stakeholders were given their original surveys as well as blank priority criteria surveys to reevaluate their priorities in a second survey. The results of the second survey were presented to the stakeholders at meeting 7, and are presented in Figure 5-3. The top four priority criteria identified by the stakeholders from the second survey were:

1. Meeting CWA requirements
2. Keeping rates under/at affordability limits
3. Meet water quality standards in Newport Harbor
4. (tie) Compliance with Implementation Schedule in CD
4. (tie) Support Designated Uses in Newport Harbor

Factors	Weight
Regulatory	
- Compliance with Clean Water Act requirements	
- Compliance with National CSO Policy	
- Compliance with implementation schedule set forth in CD	
Water Quality	
- Meet WQ standards in Newport Harbor	
- Support designated uses in Newport Harbor	
- Elimination of CSOs	
- Control of other sources of pollutants	
Social/Community Impacts	
- Reduction of beach closures/more swimming days	
- Associated public improvements (beautification, etc. from green controls) – or protection of existing public space?	
- Inconvenience to private property owners	
- Reduce in-system surcharging, basement backups & SSOs	
- Sustainability	
Costs/Affordability	
- Cost effectiveness based on $/gallon CSO removed	
- Cost effectiveness for $/CSO event eliminated	
- Cost effectiveness based on $/days violation eliminated	
- Minimizing capital cost	
- Minimizing long-term O&M costs	
- Keeping rates under/at affordability limits	

Figure 5-1. Survey Form for Prioritization of Evaluation Criteria

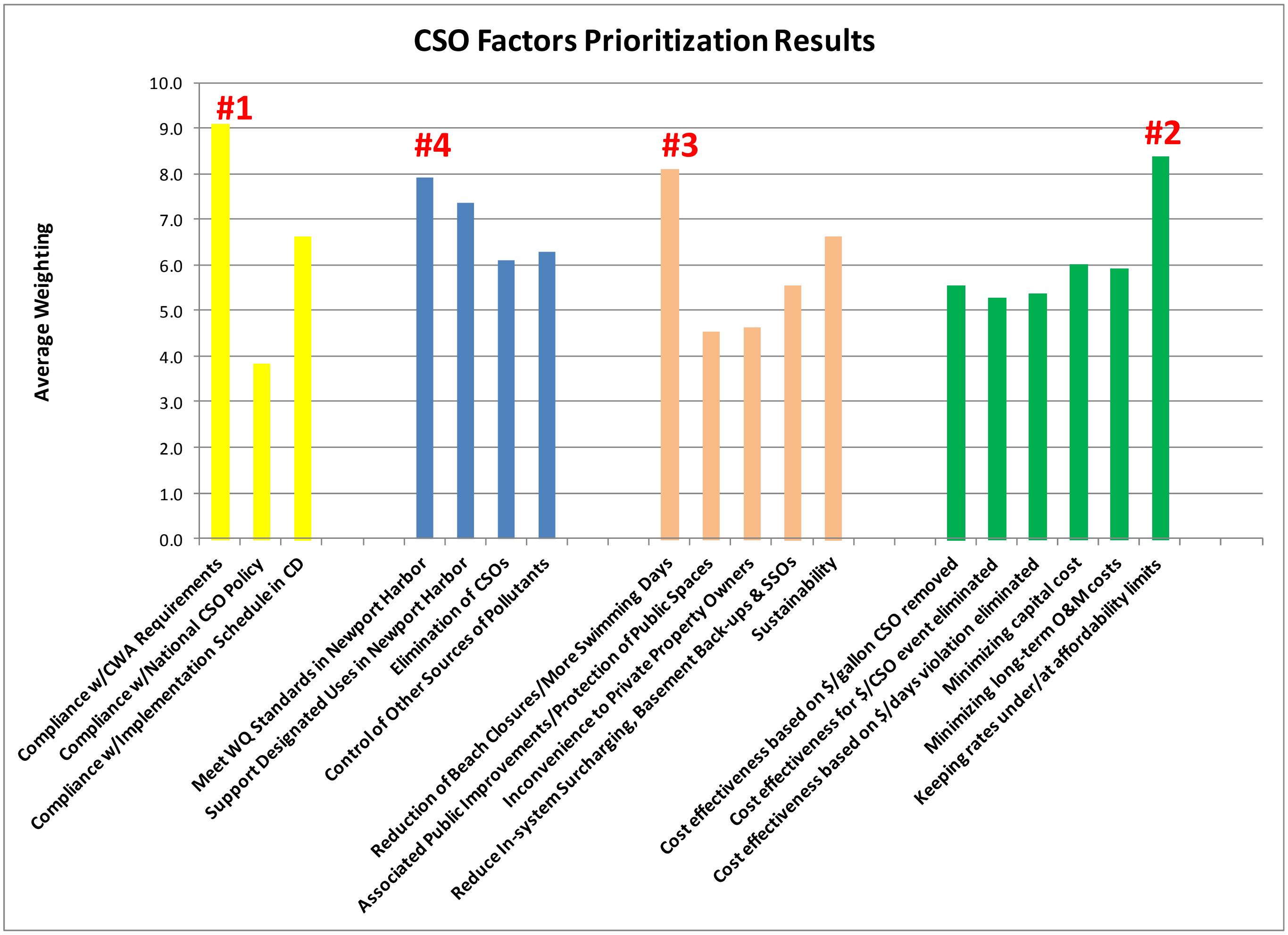


Figure 5-2. Results from Initial Survey on Evaluation Criteria

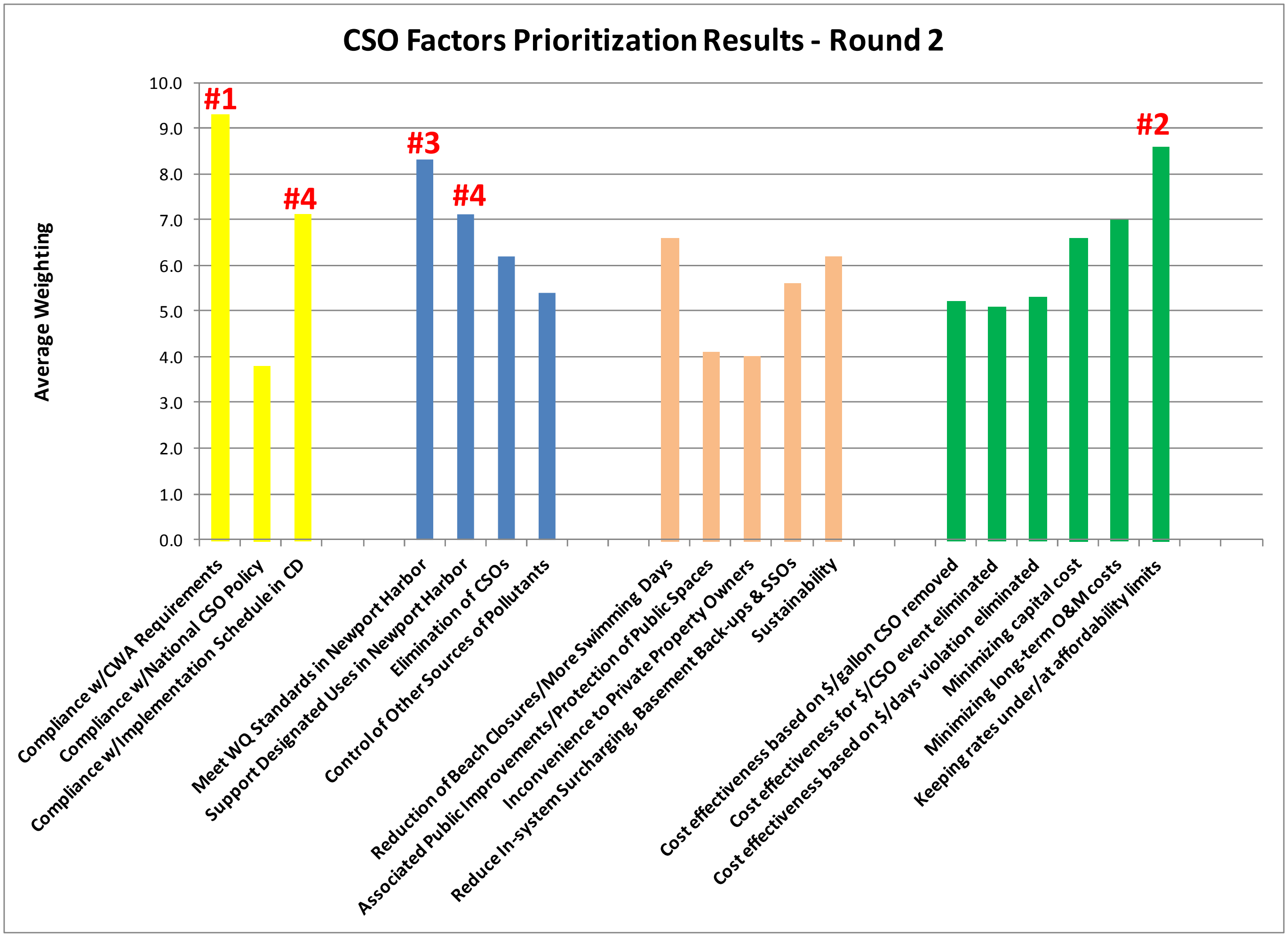


Figure 5-3. Results from Second Survey on Evaluation Criteria

The final priority criteria weightings were then used to determine which CSO control technologies would best achieve the priorities of the stakeholders as described in Section 5.3

5.1.3 Approach for Performance Evaluations

It is necessary to follow a systematic approach to evaluate system improvements or technologies for CSO control to determine whether CSO elimination can be achieved while avoiding adverse impacts such as increased frequency of sanitary sewer overflows (SSOs). Because of the large number of candidate projects and the hydraulic interactions between them, a tiered planning approach was used to objectively evaluate system performance towards the goal of CSO elimination. The tiered approach applies progressively more selective filters to the collection system hydraulic model run combinations to determine whether the requirements of the regulatory framework and the goals of the stakeholders can be met. This approach is summarized in Table 5-1.

TABLE 5-1
Tiered System Planning Approach

Evaluation Step	Resolves	Cost Basis	General Note
1. Preliminary Engineering Evaluation	Identifies viable system improvements and technologies	Unit cost data	All improvements and technologies identified in the Consent Decree are considered.
2. Hydraulic Screening-Individual System Improvements	What is the impact of specific, isolated changes to the system	Project cost data	Several improvements may be considered. Focus is on hydraulic impact.
3. Control Scenario Evaluations	How effective are system improvements in combination	Preliminary scenario costs	Aggregate impact of system improvements may vary dependent on improvement types and events evaluated.
4. Optimization	Refinement of options in Step 3. Evaluate select scenarios.	Update scenario costs	Level of optimization dependent on scenarios
5. Verification	How do the best scenarios function over a range of anticipated conditions	Scenario costs already developed	Verify performance for a typical year

5.1.3.1 Design Event Selection

Evaluation of system characteristics and controls required to achieve the program's goals is tightly linked to consideration of a wide variety of precipitations events. Correspondingly, several design storms and a long term simulation were used during the alternatives evaluation process.

Hydraulic Screening

The 2-year, 6-hour design storm event (with 2.4 inches, and 1.7 inches per hour of peak intensity) was selected for screening evaluation of system improvements for CSO control since it is comparable to the April 13, 2011 storm event the model was calibrated to as well as the previous calibration events used during the 2010 model calibration. Furthermore, the selected event is conservative with respect to Newport's typical year (as described in Section 2) as well as the typical 1-year, 6-hour design storm event used by the NBC's Combined Sewer Overflow Control Facilities Program, as noted in the *Concept Design Report Amendment* (Louis Berger & Associates, 1998).

Control Scenario Evaluations

After the screening phase was completed, the control scenarios (combinations of the individual control technologies and projects) were then evaluated against a range of design storms, including 2-year, 5-year and 10-year events with a critical duration of 6 hours. These events helped to provide greater insight about performance of the wet weather control combinations over a larger range of events, particularly the limitations of CSO elimination. The 10-year, 6-hour event was selected as the largest design event supported by the model calibration. The selected and optimized control scenarios were also run with these three design storms to verify performance for a range of rainfall events.

Verification of Selected and Optimized Control Scenarios

The selected and optimized control scenarios were evaluated for CSO and SSO control against a long term simulation using the typicalized 1996 rainfall data. The purpose of the long term simulation is to evaluate the performance and the effectiveness of the combined rehabilitation and remedial control measures on CSO and SSO volumes and frequencies over multiple events under seasonal and antecedent flow conditions.

5.1.3.2 Baseline Conditions

The City has projects in their existing Capital Improvement Project (CIP) (fiscal year (FY) 2013 to FY 2017) and recommended future CIP (beginning FY 2018) that are intended to address system capacity limitations, maintain assets and reliable system operation, and continue to improve system performance. The existing system with these identified CIP improvements is considered to be baseline conditions (Baseline (BL) scenario); projects in the BL are included in all of the scenarios evaluated during the tiered planning approach. These projects and costs are summarized in Table 5-2. The project codes correspond to those identified in Section 5.2. Detailed project costs are available in Appendix G.

TABLE 5-2
Baseline Scenario Projects and Costs

Project Code	Name/Brief Description	Total Capital Cost	Change in Annual O&M Cost	Equivalent Annual Cost
City of Newport CIP Projects FY2013-2017				
	Bridge Street Tide Gates	$ 85,000	$ -	$ 3,000
	Almy Pond - TMDL	$ 170,000	$ -	$ 9,000
	Sanitary Sewer Improvements	$ 11,000,000	$ -	$ 299,000
II-1	Catch Basin Disconnections	$ 2,000,000	$ (8,000)	$ (0)
	Beach PS Improvements	$ 305,000	$ -	$ 11,000
	Audit - UW Service Agreement	$ 100,000	$ -	$ 5,000
	CSO Program Management	$ 1,000,000	$ -	$ 51,000
WPCP-1.1	Headworks and Disinfection Improvements	$ 2,250,000	$ -	$ 89,000
WPCP-1.1	WPCP Improvements	$ 1,500,000	$ -	$ 54,000
	Subtotal	$ 18,410,000	$ (8,000)	$ 521,000
Recommended Projects				
WPCP-1.1	WPCP Improvements (Headworks, Disinfection and Solids Handling)	$ 9,985,000	$ -	$ 395,000
	Wellington Pump Station Improvements	$ 2,886,000	$ -	$ 104,000
	Ruggles Pump Station Improvements	$ 206,000	$ -	$ 7,000
	Subtotal:	$ 13,077,000	$ -	$ 507,000
	Scenario Totals:	$ 31,487,000	$ (8,000)	$ 1,029,000

5.1.4 Approach for Developing Costs

Costs are an important criterion to consider in evaluating the system improvements and technologies for CSO control. Costs were estimated to compare control scenarios and establish whether the control scenarios fall within the affordability guidelines for the City. This Section documents the approach for developing planning level cost estimates and includes the following:

- The general approach used to develop cost estimates.
- Cost estimate classification, including the level of accuracy of cost estimates.
- Markups used to calculate capital costs.
- Assumptions and methods for calculating life cycle costs.
- Approach and assumptions for calculating operations and maintenance (O&M) costs.

The estimated costs for each system improvement or technology are presented in Section 5.3.3. A summary of the costs for the key scenarios is provided in Section 5.3.4.3. A comparison of estimated costs to affordability guidelines is provided in Section 5.4.4.

5.1.4.1 Summary of Approach

Unit cost and project cost estimates were developed for the system improvements and technologies identified and assessed during the initial engineering and hydraulic screening evaluations, respectively.

Project cost estimates include construction costs, other capital costs (e.g. engineering and construction management), O&M costs, and life cycle costs. A summary of the cost estimating approach is presented in this subsection, and more detailed information is provided in the subsequent subsections.

Conceptual-level construction cost estimates were developed using unit cost data and project-specific cost data from several sources that are summarized in Table 5-3. The unit costs were applied to quantities developed for each project component to calculate estimated construction costs.

TABLE 5-3
Construction Cost Estimating Approach Summary

Alternative Component	Cost Development Approach	Primary Input Factors
Infiltration Reduction	Unit cost indices for sewer lining and manhole rehabilitation	Regional and local indices based on recent Newport projects such as Thames/Wellington.
Inflow Reduction	Unit cost indices for commercial and residential roof leader and sump pump disconnects, catch basin disconnects, etc.	Regional and local indices developed from CH2M HILL projects with local adjustments and recent Newport projects.
Sewer Repair and Replacement	Unit cost indices for sewer repair and replacement	Regional and local indices developed from past Newport projects and recent CH2M HILL projects.
Increased Pumping	Unit costs for pumps, force mains, etc.	Regional and local indices developed from past projects with updated quantities and escalation.
Weir Adjustments	Project-specific costs of increasing weir heights in existing structures, based on record drawings.	Costs developed by CH2M HILL cost estimator.
WPCP Improvements	Project-specific costs for improvements identified to optimize flow.	Costs developed using CH2M HILL cost database and specific site conditions.
Treatment Improvements	Project-specific costs of treatment facilities and related structures.	Costs developed by CH2M HILL cost database and specific site conditions.
Storage Improvements	Project-specific costs of storage facilities plus dewatering pump and force mains, where needed	Costs developed by CH2M HILL cost estimator.

Standard markups were applied to the estimated construction costs to account for contingency and other capital costs (engineering, administration, legal, etc.). These markups are described in detail in Section 5.1.4.3.

Life cycle costs were developed to allow a comparison of alternatives that accounts for both the estimated capital costs and O&M costs. O&M costs were estimated using data from current operations at the Newport CSO Treatment Facilities and WPCP. Life cycle costs were calculated using standard assumptions and using rates reflecting current economic conditions in Newport, as described in Section 5.1.4.4.

5.1.4.2 Construction Cost Estimate Classification

Construction cost estimating can occur at various stages of project development, and will result in varying levels of accuracy depending on the degree of project definition at the time of the estimate. Table 5-4 lists a summary of standard cost estimating level descriptions, accuracy ranges, and recommended contingencies based on the level of the project. This data was compiled from the Association for the Advancement of Cost Engineering (AACE). This alternatives evaluation typically used construction cost estimates that are considered to be Class 5 estimates, or Planning Level estimates, as defined by AACE and as designated in ASTM E2516-06 Standard Classification for Cost Estimate Classification System. Class 5 estimates are based only on a conceptual project definition and are considered to be accurate from -30 to +50 percent. For projects where more detail was available, Class 4 or conceptual level cost estimates were performed, which are accurate from -15 to +30 percent. These projects include: weir modifications, pumping station upgrades, and storage facilities. The summarized costs for each project in Sections 5.4.5 through 5.4.8. Detailed costs are provided in Appendix G.

TABLE 5-4
Standard AACE Cost Estimating Guidelines[a]

Cost Estimate Class (a)	Project Level Description	Estimate Accuracy Range	Recommended Estimate Contingency
Class 5	Planning	-30 to +50%	30 to 50%
Class 4	Conceptual (1 to 5% Design)	-15 to +30%	25 to 30%
Class 3	Preliminary (10 to 30% Design)	-10 to +20%	15 to 20%
Class 2	Detailed (40 to 70% Design)	-5 to +15%	10 to 15%
Class 1	Final (90 to 100% Design)	-5 to +10%	5 to 10%

[a] AACE, 1997. International Recommended Practices and Standards.

The cost estimates presented in this report are in 2012 dollars and have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor and material costs, competitive market conditions, final project details, implementation schedule, and other variable factors. As a result, the final project costs will vary from the estimate presented herein. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific financial decisions to help ensure proper project evaluation and adequate funding.

5.1.4.3 Capital Cost Markups

Capital costs for the control projects were developed using the estimated construction costs with allowances added for engineering costs, construction management and administration costs, and overall project contingency. The capital cost markups were applied as follows:

- Engineering: 15 percent of Total Construction Cost.
- Construction Management and Administration: 10 percent of Total Construction Cost.
- Total Project Cost will be calculated as the sum of the Total Construction Cost, Engineering, and Construction Management and Administration.
- Project Contingency: 30 percent of Total Project Cost. Construction contingency was included in the construction costs estimates to account for unknown or undefined elements within each project component. Project contingency accounts for unknown or undefined elements needed to implement the alternative as a whole.
- Total Capital Cost will be calculated as the sum of the Total Project Cost and the Project Contingency.

At this time, escalation has not been included in the estimated capital cost. However, escalation was assumed when evaluating affordability and rate impacts for the City, as described in Section 5.4.

5.1.4.4 Life Cycle Cost Approach

Life cycle costs were calculated for the rehabilitation and remedial measures alternatives in order to compare costs based on both capital and O&M costs. Equivalent annual costs were calculated based on the following assumptions:

- Project life: 25 years
- Discount rate: 2 percent
- Inflation: 0 percent
- Life expectancy:
  - Equipment: 20 years
  - Structures: 50 years
  - Piping: 70 years

The life cycle cost for each alternative was calculated as the sum of the total capital cost plus the present worth of annual O&M costs.

5.1.4.5 O&M Cost Approach

Annual O&M costs were estimated for system improvements and technologies that would require costs outside what is already paid by the City. Technologies that involve O&M costs above existing costs are:

- Pumping Operations
- CSO Operations
- WPCP Improvements
- Treatment Operations
- Storage Operations

The reduction in annual O&M costs resulting from a reduced number of CSO events was also estimated. With a reduced number of CSO events, the Wellington Avenue and Washington Street CSO treatment facilities (WACSOTF and WSCSOTF) would operate less frequently and therefore incur lower annual O&M costs.

Assumptions and methods for estimating increases and decreases to existing O&M costs are described below. The project O&M costs are summarized in Section 5.4. 3.

Infiltration and Inflow Reduction O&M Costs

The implementation of the I/I reduction measures results in the reduction of pumping and treatment costs throughout the system as well as reduction or elimination of CSO overflows from the WACSOTF and WSCSOTF. The reduction or elimination of CSOs would result in the reduction or elimination of O&M costs including operation of screens and effluent pumps, labor during CSO events, equipment parts, and chemical costs. The reduction in O&M costs associated with the reduction in CSO activity was calculated based on the following assumptions:

- Electric rates: $0.12/kw-hr
- Monthly electric demand charge: $7/kw
- Pump efficiency: 95 percent
- Equipment parts: Estimated for individual facilities based on prior experience
- Labor Wage Rate: $38
- Number of events: 12 per year

- Duration of CSO event operation: 12 hours per event

Pumping/System Optimization O&M Costs

New pump stations, upgraded pump stations, and projects that involve operating existing stand-by pumps during peak wet weather events would result in added power costs. It was assumed that there would not be additional labor costs because the pump stations would be manned regardless of the number of pumps in operation. The estimated O&M costs were developed using input provided by the City's contract operator based on their experience and actual costs for Newport operations. The following assumptions were used to estimate the annual O&M costs for pump operations:

- Electric rates: $0.12/kilowatts (kw) per hour
- Monthly electric demand charge: $7/kw
- Pump efficiency: 95 percent
- Equipment parts: Estimated for individual facilities based on prior experience

The duration of additional pump operation was based on the number of CSO events during the typicalized 1996 rainfall year as determined by hydraulic modeling (see Section 3), and by estimating the time during each storm that peak flows would occur. The following values were used to estimate additional pumping operational costs:

- Number of events: 12 per year
- Duration of additional pumping: 6 hours per event

CSO Facility O&M Costs

The implementation of the rehabilitation and remedial measures alternatives results in the reduction or elimination of CSOs from the WACSOTF and WSCSOTF. The reduction or elimination of CSOs would result in the reduction or elimination of O&M costs including operation of screens and effluent pumps, labor during CSO events, equipment parts, and chemical costs. The reduction in O&M costs associated with the reduction in CSO activity was calculated based on the following assumptions:

- Electric rates: $0.12/kw per hour
- Monthly electric demand charge: $7/kw
- Pump efficiency: 95 percent
- Equipment parts: Estimated for individual facilities based on prior experience
- Labor Wage Rate: $38
- Number of events: 12 per year
- Duration of CSO event operation: 12 hours per event

Treatment O&M Costs

O&M costs associated with the proposed treatment at the WPCP and the WACSOTF and WSCSOTF were determined by estimating the additional costs for operation as well as chemicals needed for the proposed processes. The following assumptions were used to calculate the O&M costs:

- Electric rates: $0.12/kw per hour
- Monthly electric demand charge: $7/kw
- Labor Wage Rate: $38
- Polymer cost: $2.00/lb
- Microsand cost: $0.40/lb
- Chemical (ferric) cost: $0.40/lb

- Number of wet weather events with additional flow to WPCP: 40 events per year
- Number of wet weather events to the CSO facilities: 12 events per year
- Duration of wet weather events: 12 hours per event

Storage Facility O&M Costs

O&M costs associated with operation of the proposed storage facilities were determined by estimating the additional power costs and costs for parts for operating the dewatering pumps following CSO events. The following assumptions were used to calculate the increased O&M costs:

- Electric rates: $0.12/kw per hour
- Monthly electric demand charge: $7/kw
- Pump efficiency: 95 percent
- Equipment parts: Estimated for individual facilities based on prior experience
- Labor Wage Rate: $38
- Number of wet weather events with additional flow to WPCP: 12 events per year
- Duration of CSO event operation: 8 hours per event

5.2 Initial Evaluation of System Rehabilitation Measures (CD Item 63f)

5.2.1 Identification and Costs of Control Technologies

Per the regulatory framework described in Section 5.1.1, the technologies that must first be considered include collection system replacement and rehabilitation remedial measures, I/I removal programs, and WPCP flow optimization. Table 5-5 shows the control technologies considered.

TABLE 5-5
Control Technologies Considered in Preliminary Screening

Description	Project Code
Infiltration/Inflow Reduction Options	
Catch Basin Disconnections	II-1
Manhole Cover Replacements	II-2
Manhole Rehab & Replacement	II-3
Downspout Disconnection	II-4
Driveway Drain Disconnection	II-5
Area Drain Disconnection	II-6
Foundation Drain Disconnection	II-7
Stairwell Drain Disconnection	II-8
Window Well Drain Disconnection	II-9
Leaking Service Lateral Repair	II-10
Sump Pump Disconnection	II-11
Capping Uncapped Cleanout	II-12
Pipe Replacement	II-13

TABLE 5-5

Control Technologies Considered in Preliminary Screening

Description	Project Code
System Optimization Options	
WPCP Flow Optimization	SO-1
Increased Pumping Capacity/Better Use of System Capacity	SO-2
Weirs	SO-3
Gates	SO-4

5.2.1.1 Infiltration and Inflow Reduction Technologies

Extraneous flow investigations to identify I/I sources have been occurring in the City of Newport since 2005. Initial field investigations were performed as part of the City's Long Term Control Plan (LTCP), which are summarized in the *Phase 1 Part 2 CSO Control Plan, Wellington Avenue CSO Facility* (AECOM, 2007) report. Subsequent field investigations in the Wellington and Washington CSO Sewersheds have been performed since 2010 as part of the CD (Items 48-51 and 54-55) to continue to identify I/I sources. The most recent published data on field investigations were the Extraneous Flow Reports for the WACSOTF and WSCSOTF (CH2M HILL, 2011a and 2011b) which were submitted to the EPA in July and September, 2011, respectively.

An engineering evaluation of the I/I reduction technologies was performed to determine the projected impacts on the system as well as the representation of the technologies in the hydraulic model. Schematics for disconnection of select inflow sources were developed and are presented in Appendix E. A summary of the engineering evaluation is provided below.

Major Rainfall-Derived Infiltration and Inflow (RDII) Sources

Based on the analysis of I/I source counts and projected RDII rates in the Extraneous Flow Reports (CH2M HILL, 2011a and 2011b), the largest contributors of RDII were inflow sources, primarily catch basins (i.e. curb inlets), downspouts and sump pumps. Other significant contributors were additional private inflow sources such as area drains and driveway drains. The I/I source counts identified in the reports were based on the inspections completed through July 2011 for the portions of the system found to contain the highest RDII rates. The inspections identified a portion of the actual I/I sources in the system. According to the analysis of the sources compared to modeled flows for the 1-inch, 24-hour storm (described in Section 7 of each of the Extraneous Flow Reports), the sources identified only accounted for approximately 48 percent of the total flows in the system. Consequently, prorating RDII source counts was necessary to be able to adequately quantify the number of inflow sources in the system that the modeled RDII is representing.

For metersheds that have been partially investigated, RDII sources were projected for the remaining buildings and features that have not been inspected based on the current RDII source count ratios within the metersheds as defined in our inspection records as of July 31, 2012. For metersheds where no data or limited inflow source data was available, public RDII source counts were projected using a Citywide ratio. For private RDII source counts, ratios of metersheds with similar average RDII rates (as identified in the Extraneous Flow Reports) were used.

Table 5-6 shows the projected RDII source counts for catch basins, sump pumps, and downspouts. Appendix F provides the actual and project counts for other public and private sources as well as maps and tables on the field investigation data.

Some of the identified building connections were reported as abated (disconnected from the sanitary system, plugged, etc.) prior to July 2012. These sources are removed from the count of projected connections represented in the model because it is assumed that the related RDII flow is no longer contributing to the combined sewer system.

Effective Impervious Area of RDII sources

The effective impervious areas are unique to each inflow source type and can be unique to the condition of each individual RDII source, as defined in the Extraneous Flow Reports. However, for these analyses it was assumed that the condition of each inflow source and therefore the contributing area of the inflow source (metershed) were not significantly different between metersheds. The effective impervious areas were estimated from field investigations and GIS data available as of December 1, 2011 and January 31, 2012, respectively.

Catch Basins

The effective impervious area contributing to catch basins was evaluated by calculating the number of catch basins per length of sanitary pipe, both by metershed and Citywide. By metershed, the number of curb inlets per 1,000 ft of pipe ranged between 1.6 and 17.1, with an average of 6.7 and a median of 6.1. Citywide there are approximately 6.6 curb inlets per 1,000 feet of pipe. Assuming the median value by metersheds, which is more conservative and incorporates the variance between metersheds, the length between curb inlets would be approximately 163 feet. The width of the contributing right-of-way was estimated to be 30 feet, which a conservative estimate that excludes driveways, parking lots and other projected runoff from adjacent surfaces. Based on these values, the effective impervious area contributing to curb inlets is approximately 4,900 square feet (ft^2).

TABLE 5-6
RDII Source Counts[a]

			Inflow Sources Connected to the Sanitary Sewer [a]			Projected Quantity of Inflow Sources – Citywide Totals [a]		
Meter	**Catchment**	**Total E911 Addresses**	**Catch Basins**	**Identified Downspouts**	**Identified Sump Pumps**	**Catch Basins**	**Projected Downspouts**	**Projected Sump Pumps**
CH-01	3	474	5	526	58	6	832	106
CH-02	4	387	3	291	24	3	468	51
CH-04	6	987	10	604	139	10	735	197
CH-05	7	373	4	18	2	4	237	65
CH-07	6	89	2	57	20	1	109	38
CH-08	10, 13 (Goat Island)	28	0	0	0	0	9	7
CH-09	10	14	0	6	0	0	9	0
CH-10	6	325	1	218	73	3	274	117
CH-11	Private	35	1	0	0	0	11	9
CH-12	Private	20	0	0	0	0	6	5
CH-13	7	32	0	0	0	1	10	8
CH-14	11	99	5	43	26	5	79	49
CH-15	10	571	3	52	60	3	126	152
CH-16	8	266	0	0	0	1	84	66
CH-17	6	73	0	31	6	1	47	9
CH-18	13	385	2	70	47	3	122	95
CH-19	10	136	1	23	10	1	40	17
CH-20	10	684	0	27	14	2	365	177
CH-21	8, Navy	175	2	0	0	2	175	52
CH-22	10	23	0	0	1	0	0	2
CH-23	8	22	0	0	0	0	7	5
CH-24	7	25	0	0	0	1	8	6
CH-25	1	448	1	268	73	2	378	111
CH-26	2	225	3	0	0	3	71	56
CH-30	11	1541	8	560	271	8	1025	520
CH-31	10	52	0	5	5	0	9	12
CH-32	10	230	0	31	11	1	137	49
CH-33	12	49	0	0	0	0	23	15
CH-34	12	894	1	6	6	2	283	221
CH-35	8 (Navy)	49	0	0	0	0	16	12
CH-36	1	208	5	193	40	5	234	49
CH-37	11	212	0	105	40	2	196	80
CH-38	4	224	0	98	17	1	135	29
Long Wharf PS	10	11	0	0	0	0	0	0
WPCP	8	99	0	0	0	1	31	24
WPCP	Navy	70	0	0	0	0	22	17
Total		9535	57	3232	943	72	6313	2428
Total City of Newport		**9241**	**55**	**3232**	**943**	**70**	**6100**	**2347**
Total Other (Navy, State)		**294**	**2**	**0**	**0**	**2**	**213**	**81**

[a] Data presented in this table are based on extraneous flow investigation work completed before July 31, 2012. Excludes sources abated through July 2012.

Downspouts

The effective impervious roof area contributing to downspouts was also evaluated by metershed and Citywide. The contributing area is based on a typical roof area as well as a typical number of downspouts per building.

The roof areas in GIS include a variety of building types, from garages to university buildings, from residential to commercial uses. Consequently, median values and the 25 percent trimmed means (removal of 25 percent of the data from each end of the distribution) were evaluated to reduce influence by outliers. By metershed, the median values ranged from approximately 620 to 4,390 ft^2, while the 25 percent trimmed mean values ranged from 580 to 1,340 ft^2. The average value of the 25 percent trimmed mean value is 1,040 ft^2. Citywide the median value was 1,060 ft^2 and the average of the 25 percent trimmed mean was 1,070 ft^2. Due to the small amount of variance between metershed and Citywide evaluations, the Citywide median value of 1,060 ft^2 was used as the typical roof area.

The number of downspouts per building was estimated to be four, which is based on information from the inspection records as well as other downspout inspection and disconnection programs. Based on that assumption, the effective impervious roof area per downspout is approximately 265 ft^2.

Sump Pumps

The effective impervious area contributing to a sump pump was based on two factors: typical sump pump flows and how flows may translate into RDII (area) reduction in the model. Sump pumps typically have a capacity of 35 gallons per minute (gpm) with a pit capacity of 5 to 10 gallons. Initial peak flow may be significant, but these peaks are attenuated immediately as it enters the system such that contributing peak flows are actually close to 3 to 5 gpm.

These contributing flows can be converted into RDII reduction by using the rational method:

$$Q = CiA$$

Where: Q= peak RDII per source (gpm)

C = RDII coefficient per defect (unit less)

i = peak rainfall intensity (inch per hour)

A = tributary area per defect (ft^2)

Assuming an acceptable RDII coefficient range of 0.5-0.9, an intensity equal to the 2-year, 6-hour event (1.7 inches per hour) and a peak RDII per sump pump around 3 gpm, the tributary area would range between 190 and 340 ft^2. The average of these values is 265 ft^2. For a 10-year, 6-hour event (2.47 inches per hour), the peak RDII rate would be approximately 4.8 gpm, which is within the estimated peak flow range. Based on this evaluation, the effective impervious area for sump pumps was assumed to be 265 ft^2.

Other Public and Private I/I Sources

Effective impervious areas for other public and private inflow sources, shown in Table 5-7, were assumed based on average tributary areas identified in field investigation data. For public and private infiltration sources, a total effective impervious area was estimated in place of individual effective impervious areas due to the difficulty in estimating infiltration defects. The total effective impervious area was estimated to be 1 percent of the total Citywide impervious area, which is approximately 64,000 ft^2.

TABLE 5-7
Effective Impervious Areas for Other Public and Private Inflow Sources

Source	Estimated Effective Impervious Area (ft^2)
Area Drains	2,000
Driveway Drains	500
Foundation Drains	100
Stairwell Drains	100
Uncapped Cleanouts	50
Window Well Drains	50
Cover to Rim	50
Vented Cover	100
Indirect Storm	50
Frame Seal	50

Estimated Planning Level I/I Reduction

A planning level of projected RDII reduction was estimated to determine the projected extent of I/I source removal. The planning level estimate was determined by multiplying the total number of actual and projected RDII sources by the assumed effective impervious areas by source to obtain a total effective impervious area Citywide. The total effective impervious area was then compared to the total model impervious area to determine the potential Citywide RDII percent reduction, which was estimated to be approximately 50 percent. No RDII reduction was assumed for the Navy or Middletown contributing areas. Although the Citywide projections were estimated at 50 percent, the projected I/I reduction in each metershed can vary significantly between 0 to 80 percent based on the analysis of RDII source counts and practical limitations based on project data from other communities.

Literature review of communities with similar I/I reduction programs indicate that, on average, a typical I/I reduction program will successfully remove approximately 42 percent of RDII contributing flows. A summary of the information provided by the literature review is shown below in Table 5-8.

TABLE 5-8
Summary of Literature Review for Planning Level I/I Reduction

Statistic	Value
Number of Locations Evaluated	259
Range of Years of Data	1980 - 2006
Average Maximum I/I Reduction Reported	42%
Median Maximum I/I Reduction Reported	48%
Lower Quartile I/I Reduction	24%
Upper Quartile /I Reduction	62%
Number of Locations Reporting > 50% I/I Reduction	107 (41%)
Number of Locations Reporting > 80% I/I Reduction	20 (8%)

5.2.1.2 I/I Reduction Construction Costs

Construction costs for I/I reduction technologies were estimated using unit costs and applying the unit costs to specific quantities defined for each alternative. Unit costs were developed for the types of I/I sources identified in the preliminary screening (Section 5.2.1.1). The unit costs for I/I reduction are presented in Tables 5-9 and 5-10. The tables include each source of I/I that was included in the analysis, and one or more methods of repair for each source. The unit cost and the data source are listed for each type of repair. The unit costs include factors to account for the complete cost of construction for each I/I source. For example, the cost of pipe replacement includes excavation, surface restoration, bypass pumping, contractor mobilization, and similar construction cost elements in addition to the cost of the pipe. Each unit cost includes a 20 percent construction contingency allowance.

TABLE 5-9
Estimated Unit Costs for Inflow Reduction

Inflow Source	Repair	Unit	Unit Cost Range	Estimated Unit Cost	Source
		Public Sources			
Vented Manhole Cover or Poor Cover/Frame Fit	Manhole cover, frame and seal replacement	Per manhole	NA	$1,510	Newport Project Bid Tab
Poor Frame Seal	Replace manhole frame seal	Per manhole	NA	$720	CH2M HILL Project Database
Indirect Storm Connection	Disconnect storm connection and reroute	Per disconnection	NA	$6,600	CH2M HILL Project Database
Catch Basin	Replace Catch Basin and Install Pipe to Nearest Storm Drain	Per disconnection	$6,400 - $105,000	$21,000	Newport Project
		Private Sources			
Foundation Drain	Foundation Drain Disconnect	Per disconnection	$1,650 - $8,590	$6,410	CH2M HILL Project Database
Sump Pump Discharge to Sanitary	Disconnect sump pump from sanitary and connect to storm drain for typical residents (i.e. external reroute to storm drain)	Per disconnection	$1,000 - $4,300	$3,000	CH2M HILL Project Database
	Re-route interior plumbing and connect to storm drain for commercial properties (i.e. internal reroute to storm drain)	Per property	NA	$25,000	CH2M HILL Project Database
Downspout	Cut downspout and discharge to splash block (i.e., Cut and splash)	Per disconnection	$53- $1,000	$375	CH2M HILL Project Database
	Disconnect downspout from sanitary and connect to storm drain for typical residents (i.e. external reroute to storm drain)	Per property	$1,000 - $3,000	$2,500[a]	CH2M HILL Project Database

TABLE 5-9
Estimated Unit Costs for Inflow Reduction

Inflow Source	Repair	Unit	Unit Cost Range	Estimated Unit Cost	Source
	Re-route interior plumbing and connect to storm drain for commercial properties (i.e. internal reroute to storm drain)	Per property	$10,000 - $25,000	$25,000[a]	CH2M HILL Project Database
Driveway Drain	Driveway Drain Disconnect	Per disconnection	$2,340 - $8,250	$5,400	CH2M HILL Project Database
Stairwell Drain	Stairwell Drain Disconnect	Per disconnection	$1,650 - $4,600	$4,380	CH2M HILL Project Database
Uncapped Cleanout	Replace Cleanout Cap	Per cleanout	$55 - $500	$370	CH2M HILL Project Database
Private Area Drain	Area Drain Disconnect	Per disconnection	$2,350 - $4,600	$4.340	CH2M HILL Project Database
Window Well Drain	Window Well Disconnect	Per disconnection	$825 - $4,600	$2,830	CH2M HILL Project Database

[a] Costs per disconnection were estimated by assuming each property would have two downspouts that would be disconnected using this repair method. (i.e. costs per connection for external and internal reroute to storm drain are $1,250 and $12,500, respectively).

TABLE 5-10
Estimated Unit Costs for Infiltration Reduction

Infiltration Source	Repair	Unit	Unit Cost Range	Estimated Unit Cost	Source
Chimney Fair Condition	Chimney Rehabilitation	EA	N/A	$780	CH2M HILL Project Database
Chimney Poor Condition	Replace Frame Seal/Chimney	EA	$1,430 - $1,500	$1,800	Recent New England Projects
Corbel Fair Condition	Corbel Rehabilitation	EA	$330 - $500	$600	Recent New England Projects
Corbel Poor Condition	Corbel Replacement	EA	N/A	$2,120	CH2M HILL Project Database
Wall	Wall Rehabilitation	EA	$330 - $850	$1,020	Recent New England Projects
Bench Fair Condition	Bench/Trough Rehabilitation	EA	$440 - $550	$660	Recent New England Projects
Bench Poor Condition	Replace Bench/ Trough	EA	$880 – $1,200	$1,440	Recent New England Projects
Unsealed Precast Joints	Seal Precast Joints	EA	N/A	$660	CH2M HILL Project Database
Pipe Fair Condition	Sewer Lining 6-18" Pipe	LF	$40 - $115	$140	Recent New England Projects
	Sewer Lining 18-36” Pipe	LF	$85 - $220	$260	Recent New England Projects

TABLE 5-10
Estimated Unit Costs for Infiltration Reduction

Infiltration Source	Repair	Unit	Unit Cost Range	Estimated Unit Cost	Source
Pipe Poor Condition	Replace Pipe 6-10”	LF	$110 - $580	$320	Recent New England Projects
	Replace Pipe 12-18”	LF	$180 - $1,270	$590	Recent New England Projects
	Replace Pipe 18”-24”	LF	N/A	$655	Recent New England Projects
	Replace Pipe 24-36”	LF	$380 - $820	$720	Recent New England Projects
	Replace Pipe 36” – 48”	LF	N/A	$840	CH2M HILL Project Database
	Replace Pipe 48-60" (Micro tunneling)	LF	$4,020 - $4,900	$4,460	CH2M HILL Project Database
	Replace Pipe 52-60" (Open Cut)	LF	$870 - $1,910	$1,020	CH2M HILL Project Database

The following assumptions were made in applying the inflow reduction unit costs:

- Catch basins: Appendix F contains a sketch showing an example of the permanent remediation of a catch basin connected to the sanitary sewer. All catch basins would be repaired by replacing the catch basin and installing new storm drain pipe to the nearest existing storm drain. The length of new storm drain pipe was based on the average length (80 linear feet) as indicated from GIS data.
- Downspouts: Appendix F contains sketches showing permanent disconnection details for typical cut and splash downspouts. Repairs were assumed to have the following distribution:
  - 50 percent would be repaired by the cut and splash method.
  - 45 percent would be externally rerouted to the stormwater collection system.
  - 5 percent would be rerouted internally within the building structure to the stormwater collection system.
- Sump Pumps: Appendix F contains sketches showing permanent rerouting details for sump pumps. Repairs were assumed to have the following distribution:
  - 95 percent would be externally rerouted to the stormwater collection system.
  - 5 percent would be rerouted internally within the building structure to the stormwater collection system.

An example of a detailed construction cost estimate for downspout disconnection is presented in Table 5-11. Construction costs for all sources of inflow reduction were calculated using the assumptions noted above as well as the unit costs and I/I source counts in Tables 5-12. These costs do not include engineering or program management. Construction costs for infiltration reduction were not calculated. These costs are included in the continuing asset management projects (sanitary system improvements) as identified in the City’s CIP Budget for FY 2013- 2017 and beyond.

TABLE 5-11
Downspout Disconnection Cost Example

Inflow Source	Inflow Source Counts (Actual + Projected)	Repair Type	Percentage	Number of Downspouts to be Repaired	Unit Cost	Total Cost
Downspout	6,100	Cut and Splash	50%	3,050	$375/disconnection	$1,144,000
		External Reroute to Storm Drain	45%	2,745	$1,250/disconnection	$3,431,000
		Internal Reroute to Storm Drain	5%	305	$12,500/disconnection	$3,813,000
Totals	6,100		100%	6,100		$8,388,000

TABLE 5-12
Estimated Total Construction Costs for Identified Inflow Sources

Project ID	Inflow Source	Repair Type	Inflow Source Counts (Actual + Projected)	Unit Cost (per repair/ disconnection)	Total Construction Cost
		Public Sources			
II-2	Vented Manhole Cover	Manhole cover, frame and seal replacement	38[a]	$1,510	$57,400
II-2	Poor Cover/Frame Fit	Manhole cover, frame and seal replacement	6	$1,510	$9,100
II-3	Poor Frame Seal	Replace manhole frame seal	112	$720	$80,700
	Indirect Storm Connection	Disconnect storm connection and reroute	16	$6,600	$105,600
II-1	Catch Basin	Replace Catch Basin and Install Pipe to Nearest Storm Drain	15[b]	$21,000	$315,000
		Private Sources			
II-7	Foundation Drain	Foundation Drain Disconnect	11	$6,410	$70,500
II-11	Sump Pump Discharge to Sanitary	External reroute to storm drain	2230	$3,000	$6,690,000
		Internal reroute to storm drain	117	$25,000	$2,925,000
II-4	Downspout	Cut and splash	3,050	$375	$1,144,000
		External reroute to storm drain	2,745	$1,250[c]	$3,432,000
		Internal reroute to storm drain	305	$12,500[c]	$3,813,000
II-5	Driveway Drain	Driveway Drain Disconnect	251	$5,400	$1,356,000
II-8	Stairwell Drain	Stairwell Drain Disconnect	133	$4,380	$583,000

TABLE 5-12
Estimated Total Construction Costs for Identified Inflow Sources

Project ID	Inflow Source	Repair Type	Inflow Source Counts (Actual + Projected)	Unit Cost (per repair/ disconnection)	Total Construction Cost
II-12	Uncapped Cleanout	Replace Cleanout Cap	242	$370	$89,600
II-6	Private Area Drain	Area Drain Disconnect	340	$4,340	$1,476,000
II-9	Window Well Drain	Window Well Disconnect	168	$2,830	$476,000
Totals			9,779		$22,622,900

[a] Actual and projected counts of vented manhole covers that are subject to ponding and can be a source of RDII.

[b] Projected counts only. Actual found sources have been or will be repaired through projects identified in the City's CIP.

[c] Costs per disconnection were estimated by assuming each property would have two downspouts that would be disconnected using this repair method. (i.e. costs per connection for external and internal reroute to storm drain are $1,250 and $12,500, respectively).

5.2.1.3 System Optimization Projects

WPCP Flow Optimization (Project Code SO-1)

The WPCP Flow Optimization Project would optimize peak wet weather flows (WWFs) to the WPCP up to the permitted maximum day flow of 19.7 million gallons per day (MGD) and a peak instantaneous flow of up to 30 MGD (for 1 to 2 hours) assuming the WPCP is upgraded to meet design flow conditions (as described in Section 4). It would also require additional pumping at the Long Wharf Pump Station facility, as described below.

Increased Pumping Capacity /Better Use of System Capacity (Project Code SO-2)

This project would increase pumping capacity at the WACSOTF sanitary pumps and the Long Wharf Pump Station during peak wet weather by operating the standby pumps at these facilities. Increasing sanitary flow at the WACSOTF would require all three pumps operating and would allow a peak flow rate of 4.2 MGD to be sent to the Thames Street Interceptor. Similarly, all three pumps at the Long Wharf Pump Station would be operating and would allow an instantaneous peak rate of 30 MGD to be sent to the WPCP.

Weirs (Project Code SO-3)

There are currently 11 weirs and two overflows that regulate flow in the collection system. Of those 13 locations, the weirs that have the most significant hydraulic impact include the five weirs that are located between the twin, parallel 54-inch pipes on Long Wharf Mall and the weir on Wellington Avenue from the Thames Street Interceptor. The existing twin 54-inch pipes are parallel pipes designed such that one pipe acts as a main interceptor conveying flow to the Long Wharf Pump Station and the second pipe acts as an overflow pipe conveying flow to WSCSOTF. The five regulator structures are located in series along the twin pipes and provide five relief points where high level flows in the main interceptor can be relieved over a weir into the overflow pipe. The Wellington Avenue regulator structure is located in the 3 x 4-feet Thames Interceptor and the overflow pipe in the regulator leads to the WACSOTF. The existing 36-inch overflow is designed such that once flow in the Thames interceptor reaches the crest of the weir flow is split between the Thames interceptor and the 36-inch pipe that leads to the WACSOTF sanitary pumps.

Preliminary engineering evaluations were performed on the five weirs on the twin parallel 54-inch pipes and a conceptual sketch was developed for each weir. An example of one of these sketches is shown in

Figure 5-4. Based on the existing weir configurations, the five weirs may be raised up to 1.5 feet, which provides a minimum clearance of one foot between the weir crest and the regulator structure ceiling. The improvement projects would include adding bricks to the existing weir and adding new manholes for additional access. The preliminary evaluation and the conceptual layout for the Wellington Avenue/Thames Street weir was developed as shown in Figure 5-5. Based on the existing weir configuration and invert elevations, the weirs may be raised up to 2 feet, but it is recommended that the weir only be raised approximately 1.2 feet to allow a minimum clearance of one foot between the weir crest and the regulator structure ceiling.

Gates (Project Code SO-4)

The only existing gate in the collection system is the Narragansett Avenue Storage Conduit (NASC) knife gate, which was recently replaced in 2011. This gate was evaluated to determine if the operational settings could be adjusted to optimize the volume and duration of in-system storage. Currently, the operation is dependent on the wet well level of the WACSOTF sanitary pumps; the gate closes at 8 feet above the invert elevation of the wet well (-15 feet) and opens when the water level is at 6.5 feet above the invert elevation of the wet well. It was determined that the NASC gate could be closed earlier at a level between 7 to 7.5 feet above the wet well invert and opened at a level between 5.5 and 6 feet above the wet well invert. Other locations within the collection system were evaluated to determine if gates could be installed to provide temporary in-system storage. Ideal locations for adding gates were not viable due to the close proximity to pump stations or other facilities, steep pipe slopes and/or potential for causing negative upstream impacts. Therefore, no additional gates were considered further for control scenarios.

5.2.1.4 System Optimization Construction Costs

WPCP Flow Optimization (Project Code SO-1)

There are no additional construction costs related to optimizing flow to the WPCP. There are additional O&M costs related to the additional pumping required at the Long Wharf Pump Station, which are described in Section 5.1.4.5.

Increased Pumping Capacity /Better Use of System Capacity (Project Code SO-2)

There are no additional construction costs related to increasing pumping at either the WACSOTF sanitary pumps or the Long Wharf Pump Station by operating the standby pumps at these facilities. There are additional O&M costs which are described in Section 5.1.4.5.

Weirs (Project Code SO-3)

A conceptual level cost estimate was developed for each structure by a CH2M HILL cost estimator. The construction costs for the six weirs are presented in Table 5-13. Each weir cost includes a 20 percent construction contingency allowance.

TABLE 5-13
Weir Construction Costs

Project ID	Weir Location	Description	Max Weir Height Increase (ft)	Construction Cost
SO-3	Thames St and Wellington Avenue	Weir to WACSOTF	1.2	$11,800
	Washington Sq and Duke St	Between twin 54" pipes	1.5	$21,200
	Thames St and Touro St (North)	Between twin 54" pipes	1.5	$21,500
	Thames St and Touro St (South)	Between twin 54" pipes	1.5	$22,600
	America's Cup and Long Wharf Mall (North)	Between twin 54" pipes	1.5	$23,400
	America's Cup and Long Wharf Mall (South)	Between twin 54" pipes	1.5	$15,100
			Total	$116,000

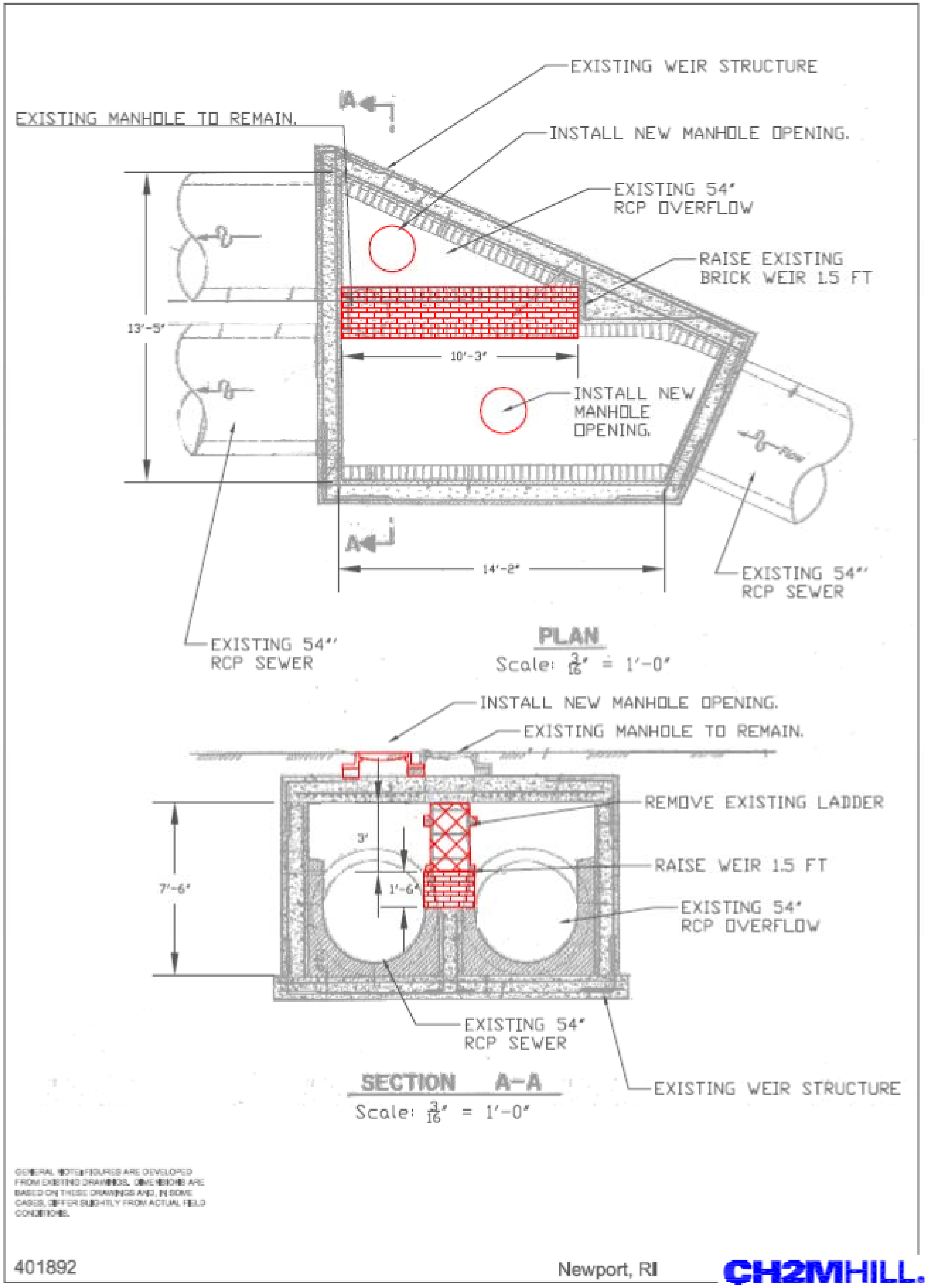


Figure 5-4. Preliminary Conceptual Layout for the Weir near Duke Street and Washington Square

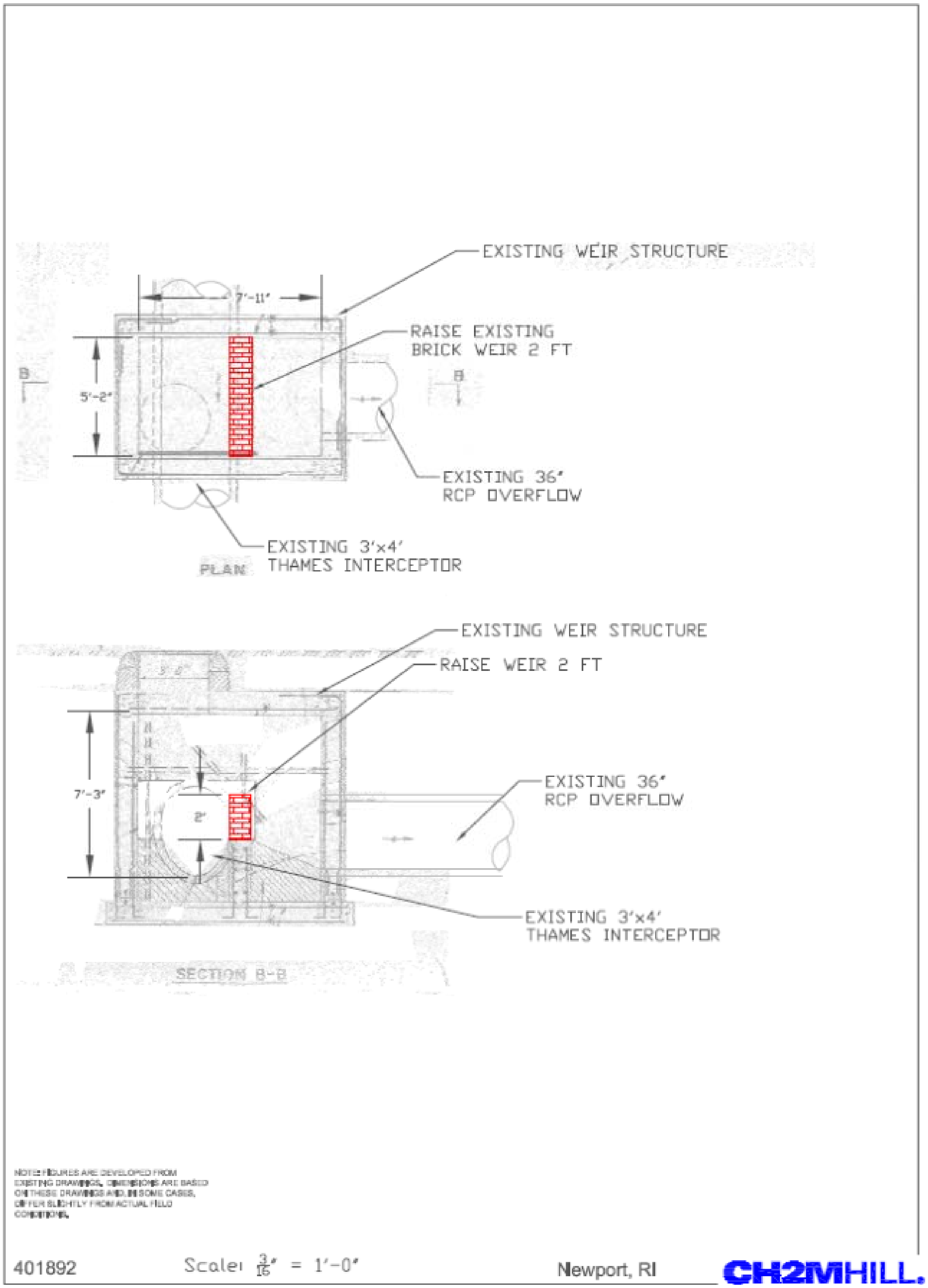


Figure 5-5. Preliminary Conceptual Layout for the Weir from Thames Street to Wellington Avenue

5.2.2 Definition of Control Scenario Components and Costs

5.2.2.1 Preliminary Evaluation of Individual Control Technologies and Projects

To determine how the individual control technologies and projects may be used in control scenarios to achieve the objectives established in Sections 5.1.1 and 5.1.2, it was necessary to evaluate their hydraulic performance and projected benefits and adverse impacts in the collection system by performing a hydraulic screening using the 2-year, 6-hour event. Adverse impacts evaluated include the increased frequency and volume of SSOs and/or increased surcharging in the collection system.

Different levels of Citywide I/I reduction were evaluated by varying the levels of I/I reduction within the different metersheds of the Wellington Avenue and Washington Street CSO Sewersheds. For the system optimization projects, adjustments were made to evaluate projected improvement ranges up to the maximum allowed as identified through preliminary engineering evaluations. For select individual scenarios, the CSO treatment facilities were closed (i.e. CSO effluent pumps were turned off) to evaluate the performance of the system. The individual scenarios evaluated are shown in Table 5-14 and the results are shown in Figures 5-6 and 5-7. In addition to the individual control technologies and projects, the pipe upsizing recommendations from Section 4 were evaluated to determine if providing additional in-system capacity could reduce CSOs at the WACSOTF and WSCSOTF.

Overall, the results from the preliminary hydraulic performance evaluations indicated that to eliminate CSOs without resulting in additional adverse impacts, a high level of I/I reduction along with system optimization measures would likely need to be implemented. Also, results showed that some individual system optimization measures have limited benefit, including the real-time control (RTC) adjustments to the NASC gate settings and pipe upsizing measures. These control technologies were not considered further for control scenarios. In addition, further evaluation of the I/I reduction impacts indicate that inflow sources have more significant impact than infiltration sources on modeled CSO frequency and volumes, so infiltration sources were also not considered for further evaluation in control scenarios.

TABLE 5-14
Preliminary Hydraulic Performance Results for Individual Controls Technology Scenarios

			Percent CSO Reduction			
Scenario #	**Run Type**	**Scenario Description**	**Overall**	**Wellington**	**Washington**	**Adverse Impacts[a]**
4480	I/I	8% Citywide I/I reduction (based on RDII source counts)	14.13%	14.71%	12.86%	
4479	I/I	15% Citywide I/I reduction (based on RDII source counts)	25.29%	27.61%	20.17%	
4471	I/I	22% Citywide I/I reduction (based on RDII source counts)	35.90%	40.65%	25.44%	
4478	I/I	27% Citywide I/I reduction (based on RDII source counts)	43.59%	50.80%	27.71%	
4470	I/I	31% Citywide I/I reduction (based on RDII source counts)	47.13%	54.97%	29.88%	
4483	I/I	31% Citywide I/I reduction (based on RDII source counts) and CSOs Closed	100.00%	100.00%	100.00%	Yes
4475	I/I	34% Citywide I/I reduction (based on RDII source counts)	52.63%	62.45%	31.05%	
4474	I/I	35% Citywide I/I reduction (based on RDII source counts)	54.70%	63.60%	35.13%	
4482	I/I	35% Citywide I/I reduction (based on RDII source counts) and CSOs Closed	100.00%	100.00%	100.00%	Yes
4467	I/I	36% Citywide I/I reduction (based on RDII source counts)	55.05%	63.87%	35.66%	
4481	I/I	36% Citywide I/I reduction (based on RDII source counts) and CSOs Closed	100.00%	100.00%	100.00%	Yes
4466	I/I	62% Citywide I/I reduction (based on flow metering data)	98.55%	97.90%	100.00%	
4495	System Opt.	Raise weir to WACSOTF from Thames by 1 ft	-1.59%	40.19%	-20.59%	
4494	System Opt.	Raise weir to WACSOTF from Thames by 2 ft (max)	-1.17%	70.45%	-33.74%	Yes
4496	System Opt.	Change NASC Gate	0.00%	0.00%	0.00%	
4497	System Opt.	Raise weirs on twin 54" pipes parallel to Long Wharf Mall (twin 54" weirs) by 1 ft	17.66%	-0.02%	25.70%	
4498	System Opt.	Raise twin 54" weirs by 2 ft (max)	26.40%	-0.21%	38.50%	Yes
4486	System Opt.	30 MGD throttling limit at WPCP	-0.18%	-0.03%	-0.25%	
4487	System Opt.	25 MGD throttling limit at WPCP	1.61%	0.02%	2.33%	
4489	System Opt.	30 MGD throttling limit at WPCP and additional pumping at Wellington PS and Long Wharf PS	3.39%	22.19%	-5.15%	

TABLE 5-14
Preliminary Hydraulic Performance Results for Individual Controls Technology Scenarios

			Percent CSO Reduction			
Scenario #	**Run Type**	**Scenario Description**	**Overall**	**Wellington**	**Washington**	**Adverse Impacts[a]**
4488	System Opt.	Additional pumping at WACSOTF sanitary pumps and Long Wharf PS (3rd pumps turned on)	4.31%	22.17%	-3.81%	
4485	System Opt.	Upsize bottleneck pipes to largest evaluated diameter.	0.64%	-0.04%	0.95%	
4484	System Opt.	Upsize bottleneck pipes to middle evaluated diameter.	0.77%	-0.04%	1.14%	
4493	System Opt.	30 MGD throttling limit at WPCP, additional pumping at WACSOTF sanitary pumps and Long Wharf PS	5.30%	24.12%	-3.25%	
4500	System Opt.	Raise twin 54" weirs by 2 ft, 30 MGD throttling limit at WPCP, additional pumping at WACSOTF sanitary pumps and Long Wharf PS	46.48%	24.04%	56.68%	Yes
4499	System Opt.	Max change for identified conveyance features	49.72%	76.41%	37.59%	
4501	System Opt.	Max change for identified conveyance features and CSOs closed	100.00%	100.00%	100.00%	Yes

[a] Adverse impacts evaluated include increased frequency of SSOs or surcharging 6 inches above the hydraulic grade line calculated in the hydraulic model during existing condition simulations.
PS = pump station

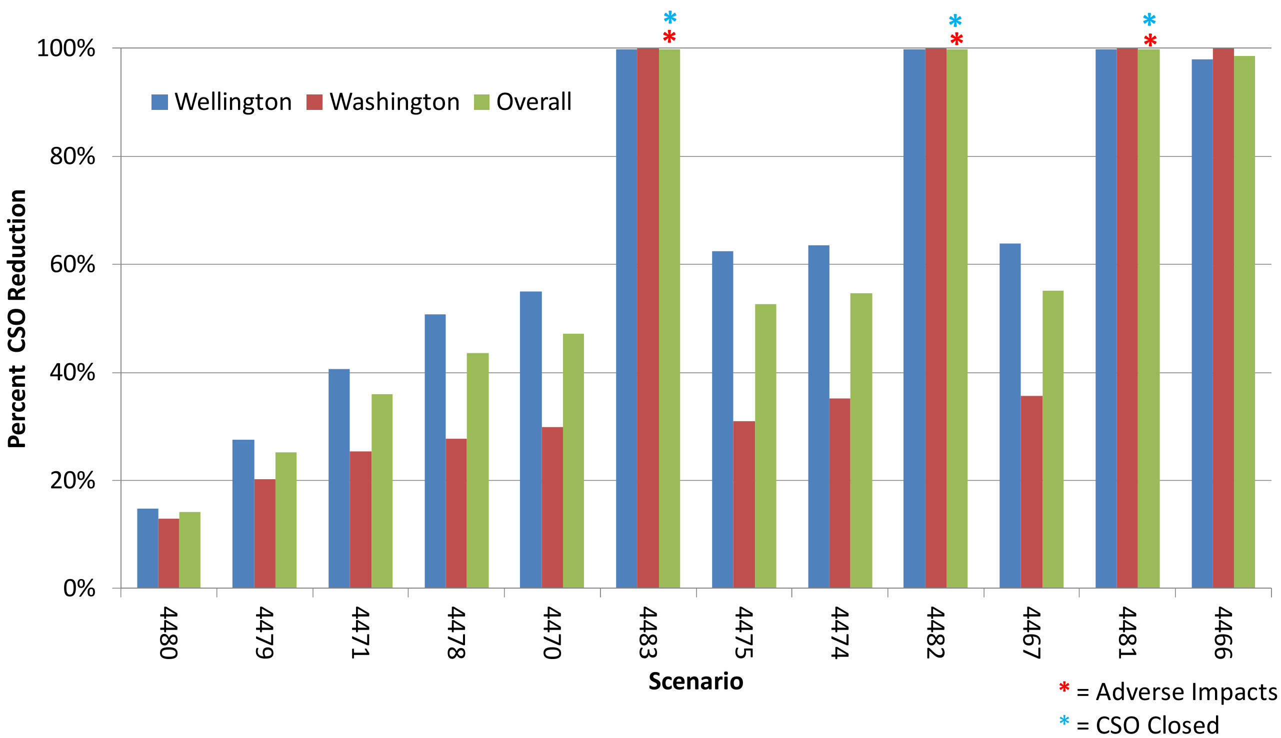


Figure 5-6. Performance Evaluations for I/I Reduction Technologies for a 2-yr, 6-hr Event

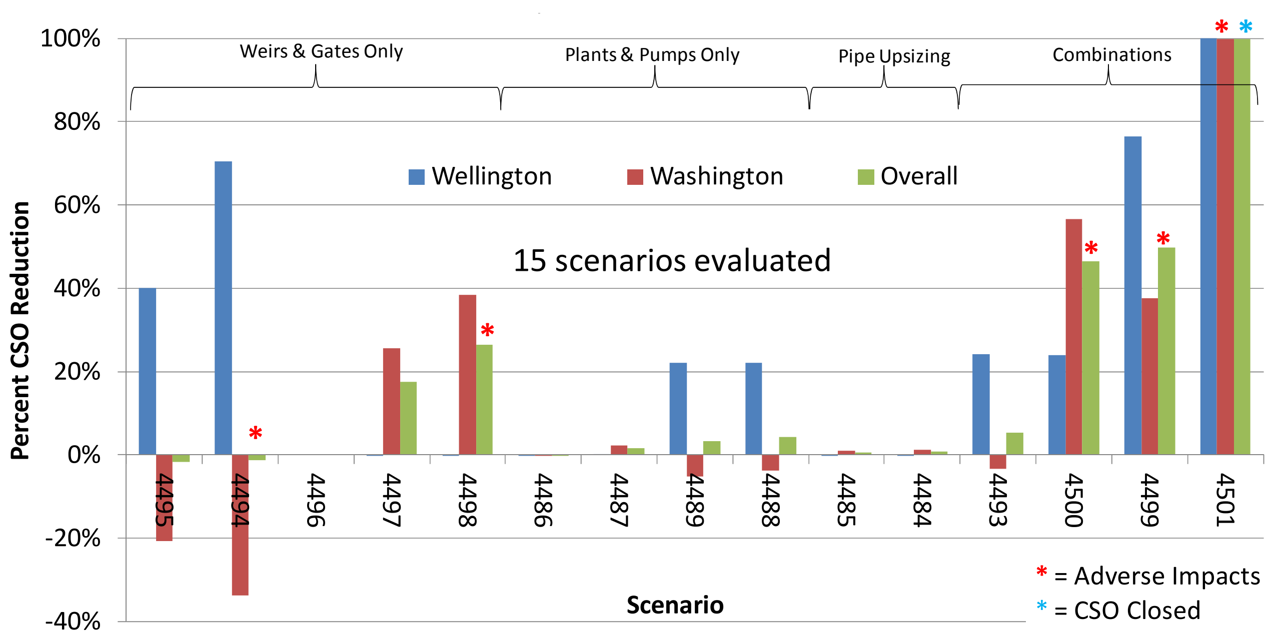


Figure 5-7. Performance Evaluations for System Optimization Projects for a 2-yr, 6-hr Event

5.2.2.2 Identification of Control Scenarios

The next step in the system planning approach was to identify control scenarios to evaluate the technologies and projects in combinations and determine if CSO elimination is achievable without causing adverse hydraulic impacts or financial impacts. For the initial evaluation of system rehabilitation measures, one scenario was developed to incorporate the available technologies called the Elimination scenario (E1). This scenario includes all projects identified in the Baseline scenario. The control technologies identified for scenario E1 are:

- Removal of 100 percent of all public and private inflow sources in the City of Newport.
- Removal of 100 percent of all inflow sources in the town of Middletown and Navy.
- Raising the five twin 54-inch weirs 1.5 feet.
- Raising the Wellington Avenue weir 1.2 feet.
- Increased pumping of the WACSOTF sanitary pumps and Long Wharf Pump Station

The elimination of inflow sources in the City in scenario E1, along with system remediation and optimization measures, is intended to provide definitive results to determine if CSOs can be eliminated or if an SMP is needed, as described in the regulatory framework in Section 5.1.1. However, a complete elimination of inflow sources is not realistically achievable per the information provided in Section 5.2.1.1.

Because of the large volume of stormwater re-directed to the stormwater drainage system, additional stormwater technologies were considered for this scenario. These technologies address the conveyance and treatment of additional stormwater flows and pollutants that may affect water quality once inflow sources are disconnected. These technologies include:

- Stormwater Treatment at the WACSOTF: converting the CSO treatment facility to a stormwater treatment including demolition of the existing microstrainers, replacement of the existing bar screen with a mechanical fine screen, retrofitting of the microstrainer basin with a new vortex particle separator and retrofitting of the existing microstrainer tank for UV disinfection.

- Stormwater Treatment at the WSCSOTF: retrofitting the existing CSO treatment facility to include lamella plates for sedimentation and adding dechlorination.

- Stormwater Conveyance Improvements: replacement and/or addition of stormwater piping to convey additional stormwater to the new stormwater treatment facilities and/or to the waterways. The cost shown in Table 5-15 assumes that approximately 25 percent of the total length of existing stormwater system conveyance would need to be replaced or supplemented in locations where stormwater conveyance is needed to convey the additional stormwater runoff. The pipe length is approximately 64,400 feet. A pipe size of 24 to 36 inches in diameter was assumed with a corresponding unit cost of approximately $720/linear feet.

A summary of the construction costs for the proposed stormwater improvements are in Table 5-15.

TABLE 5-15
Stormwater Improvement Construction Costs

Project ID	Improvement Option	Location	Description	Construction Cost
CU-6	Stormwater Conveyance	In catchments with high RDII rates (as identified by flow monitoring, 1, 3 and 6)	Replace existing or install new stormwater pipe	$46,000,000[a]
SW-1	Stormwater Treatment	WSCSO Facility	Retrofit existing facility for stormwater treatment including dechlorination and lamella plates	$2,097,000
SW-2		WACSO	Retrofit existing facility for stormwater treatment: remove microstrainer and install new fine screen, vortex particle separator and UV disinfection	$10,187,000
			Total	$34,378,000

a) Assumes 64,400 ft of 24-inch to 36-inch diameter pipe would be replaced or installed in the stormwater drainage system.

5.2.2.3 Scenario Costs

A summary of the control technologies and costs included in scenario E1 is in Table 5-16. Detailed project costs for scenario E1 are presented in Appendix G. No project costs were estimated for the inflow removal in town of Middletown or the Naval Station Newport because the City would not be responsible for the costs in those communities.

TABLE 5-16
Summary of Control Technologies and Costs for Scenario E1

Project Code	Name/Brief Description	Total Capital Cost	Change in Annual O&M Cost	Equivalent Annual Cost
BL	Baseline (includes all Baseline projects)	$ 31,487,000	$ (8,000)	$ 1,029,000
SO-3	Weirs	$ 189,000	$ -	$ 6,000
SO-2	Increased Pumping Capacity/Better Use of System Capacity	$ -	$ 22,000	$ 22,000
II-4	Downspout Disconnection	$ 13,630,000	$ (27,000)	$ 472,000
II-A	Inflow Reduction - Private Sources (Not Including Downspouts)	$ 58,783,000	$ (63,000)	$ 2,089,000
II-B	Inflow Reduction - Public Sources	$ 1,862,000	$ (3,000)	$ 65,000
II-14	Inflow Removal for Middletown			
II-15	Inflow Removal for the Naval Station Newport			
SW-1	Stormwater Treatment - WSCSO Facility	$ 3,408,000	$ 98,000	$ 221,000
SW-2	Stormwater Treatment - WACSO Facility	$ 16,554,000	$ 428,000	$ 1,026,000
CU-6	Stormwater Conveyance Improvements for E1	$ 75,725,000	$ -	$ 2,737,000
	Scenario Totals:	$ 201,636,000	$ 447,000	$ 7,667,000

5.2.3 Evaluation of Control Scenario Performance

The performance of the two scenarios, BL and E1, were evaluated using design events as noted in Section 5.1.3 and compared to existing conditions using the calibrated 2012 hydraulic model. Table 5-17 summarizes the CSO discharge volumes for the simulated design events. Figure 5-8 summarizes the CSO reduction at the WACSOTF and WSCSOTF for the 2-year, 5-year, and 10-year, 6-hour design events, respectively.

TABLE 5-17
CSO Discharge Volumes the System Remediation Control Scenarios

	CSO Discharge Volumes (MG)					
	2-year, 6-hour event		5-year, 6-hour event		10-year, 6-hour event	
Scenario	**WACSOTF**	**WSCSOTF**	**WACSOTF**	**WSCSOTF**	**WACSOTF**	**WSCSOTF**
EC	1.29	3.24	1.83	5.05	2.71	6.76
BL	1.09	2.61	1.78	4.07	2.67	5.81
E1	0	0	0	0	0	0

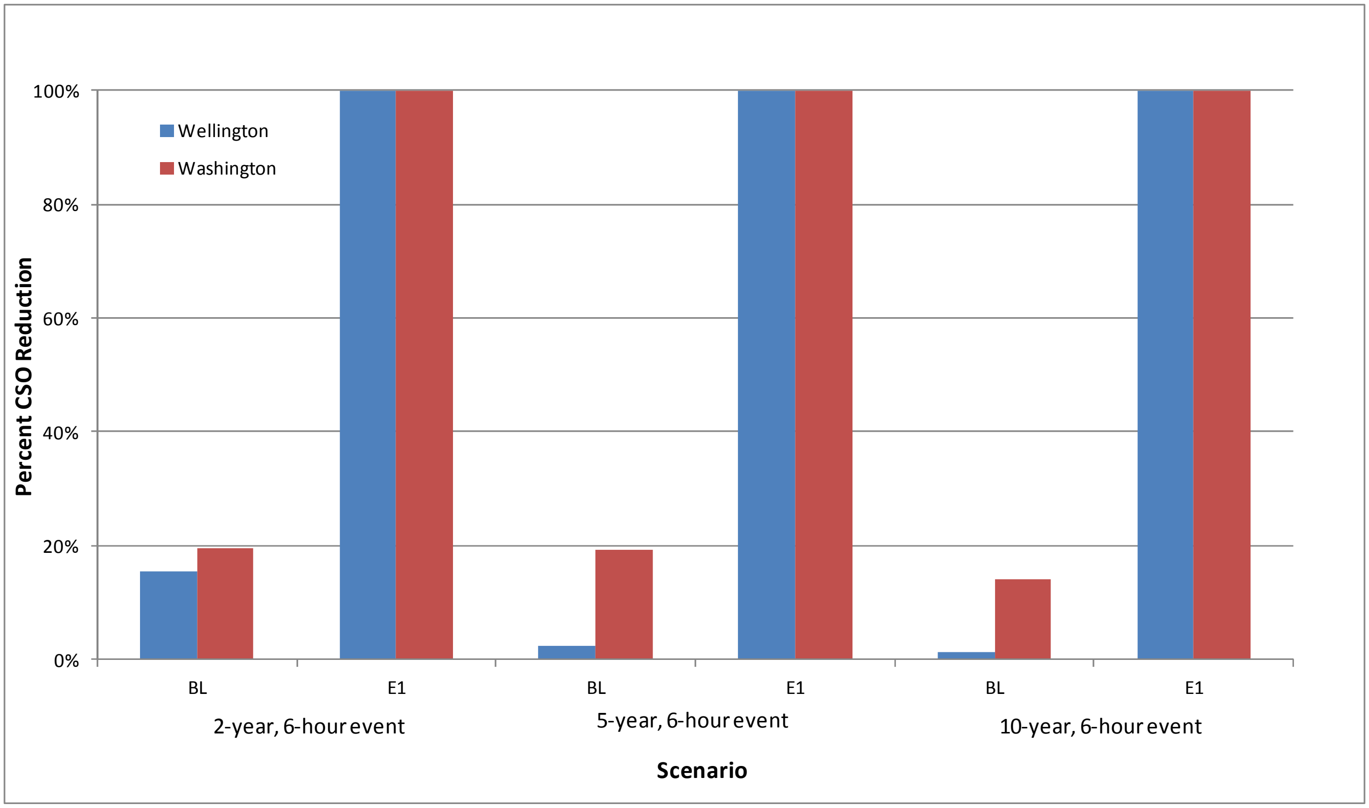


Figure 5-8. CSO Reduction for the WACSOTF and WSCSOTF for 2-year, 5-year and 10-year, 6-hour Events

The result of the evaluations indicate that the baseline improvements reduce CSO volume, but the E1 scenario will likely eliminate CSO discharges for up to a 10-year, 6-hour event. A preliminary pollutant load analysis was performed for total suspended solids (TSS), biochemical oxygen demand (BOD) and fecal coliform loads for the 10-year, 6-hour event to determine the effluent discharge quality for a large event, as shown in Figures 5-9, 5-10, and 5-11, respectively. The pollutant loadings from stormwater were evaluated in addition to the effluent discharges at the two CSO treatment facilities and the WPCP due to the significant amount of inflow reduction considered for E1. The event mean concentrations used for the pollutant loadings at two CSO treatment facilities and the WPCP are available in Table 3-9 in Section 3. The event mean concentrations for stormwater are presented in Table 5-18. The stormwater pollutant load concentrations are assumed based on data from the report *Results of the Nationwide Urban Runoff Program* (USEPA, 1983).

TABLE 5-18
Event Mean Concentrations of Effluent for TSS, BOD and Fecal Coliform[a]

Source	TSS (mg/L)	BOD (mg/L)	Fecal Coliform (MPN/ 100 mL)
Stormwater	54.5	10	1500

[a] Data from USEPA, 1983.
mg/L = milligrams per liter

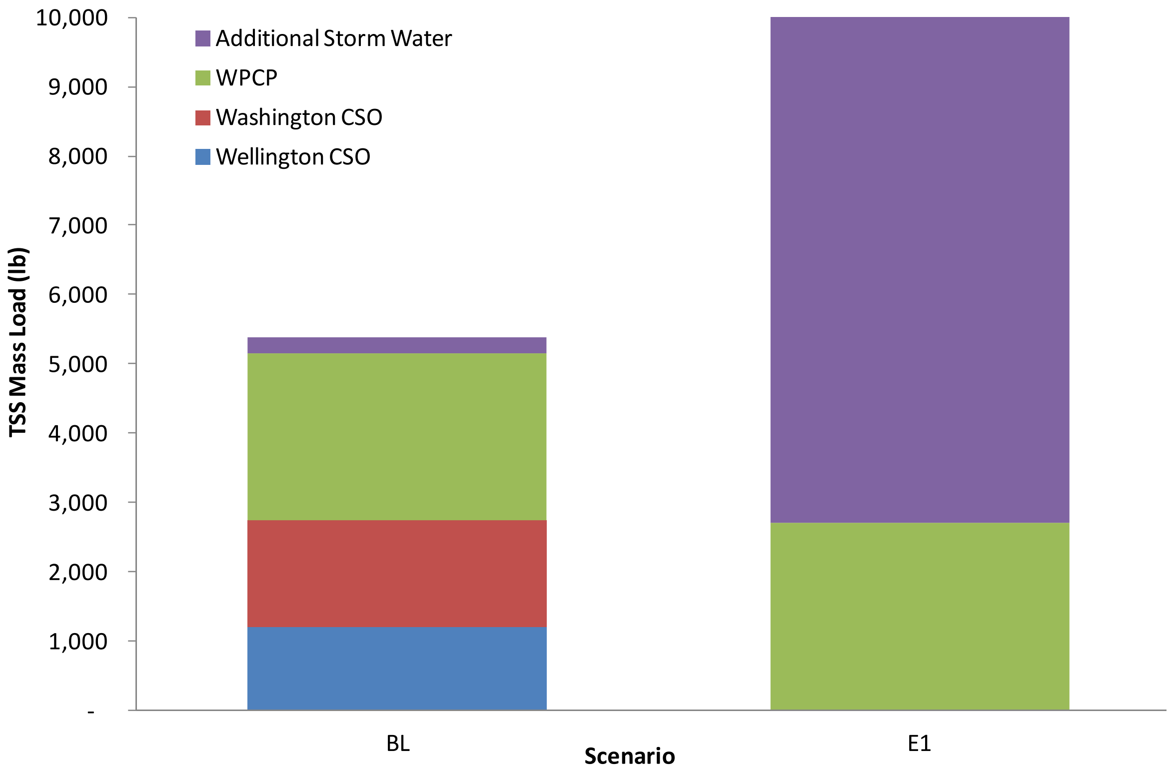


Figure 5-9. TSS Load for a 10-year, 6-hour Event

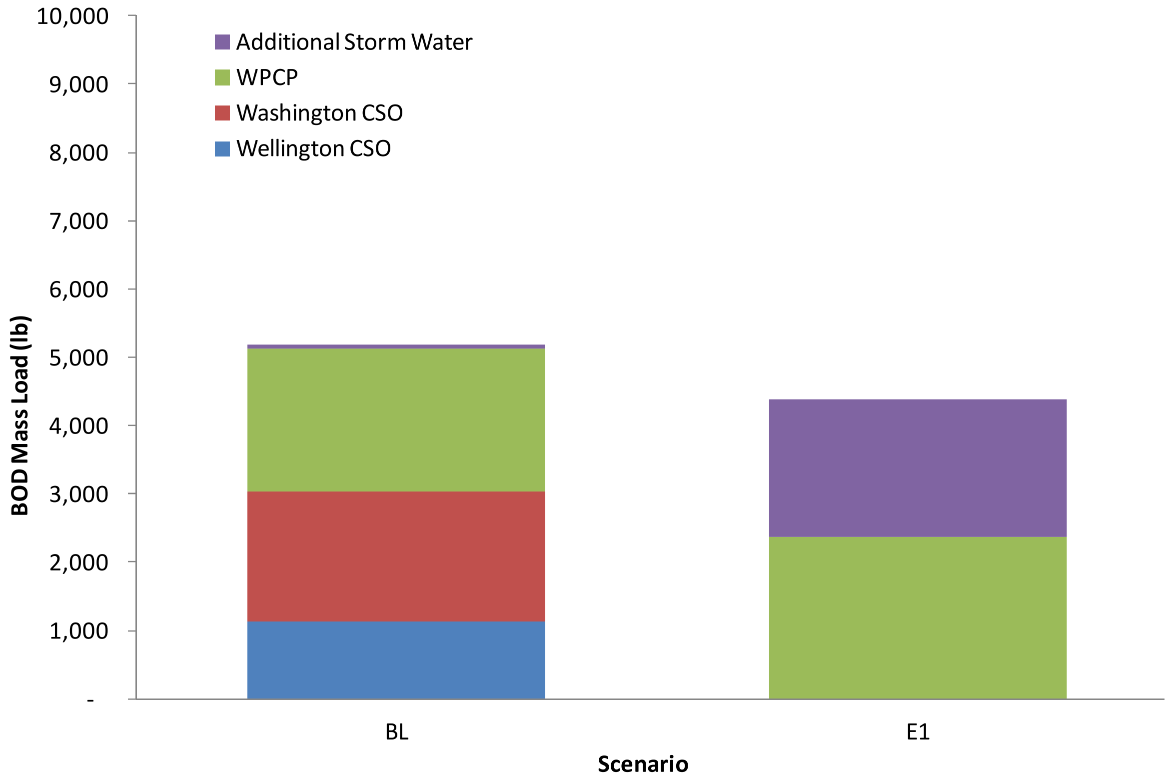


Figure 5-10. BOD Load for a 10-year, 6-hour Event

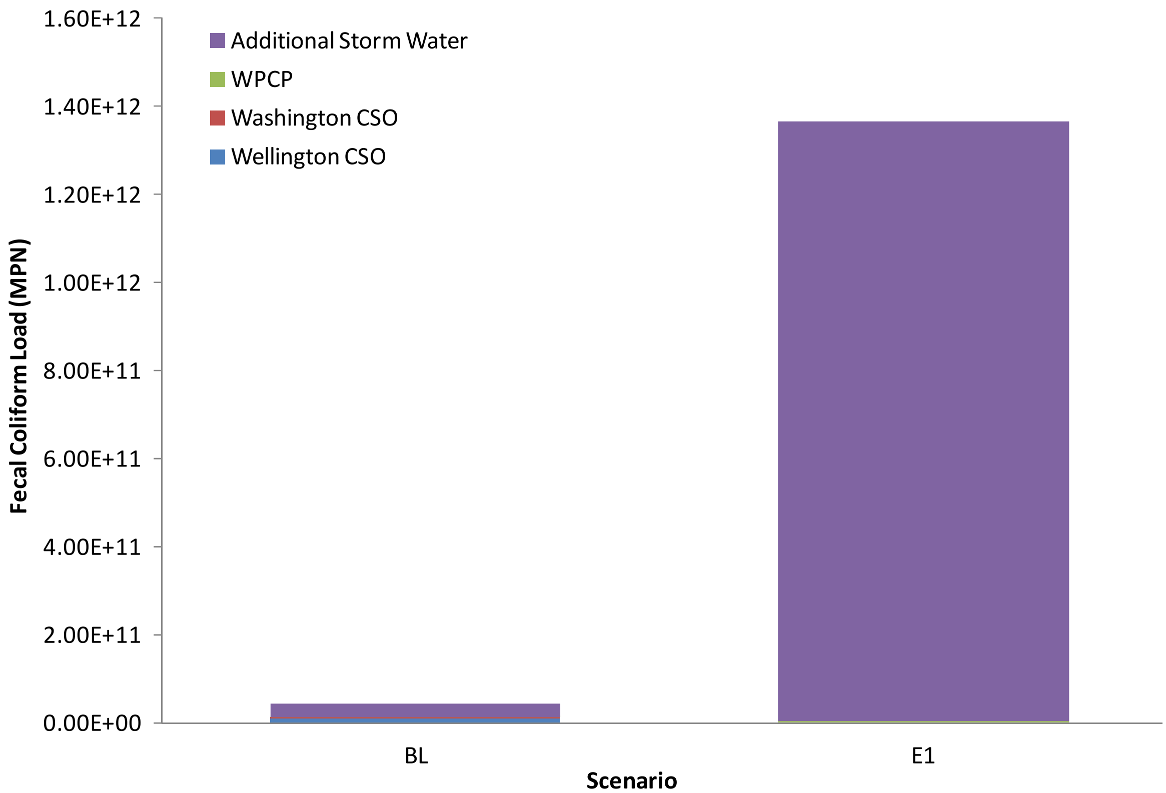


Figure 5-11. Fecal Coliform Load for a 10-year, 6-hour Event

5.2.4 System Remediation Measure Effectiveness

The performance and costs of the BL and E1 scenarios were compared to the regulatory framework defined in Section 5.1.1 and the Stakeholder's priority criteria in Section 5.1.2 and are summarized in Table 5-19. The comparison was used to determine the effectiveness in meeting the goals of the program. Overall, both scenarios were able to reduce CSO volumes, with scenario E1 eliminating CSO discharges for up to a 10-year, 6-hour event. Both scenarios were also generally successful at addressing the Stakeholder's priority criteria.

However, it is unlikely that scenario E1 will meet the implementation schedule as noted in the CD, which identifies a June 30, 2018 completion date for the recommended measures and remedial work. The projects identified in scenario E1 include significant inflow reduction and rehabilitation of existing facilities, which would take several years to implement within the current framework of the City's inflow reduction program and the operation of the existing collection system, which currently uses both CSO treatment facilities. A City-managed program to enforce inflow removal by 2018, similar to a program currently underway in the City of Hartford, Connecticut, would likely require additional program costs to provide services and/or incentives to require homeowners to disconnect inflow sources. Beyond these considerations, it is not likely that the City could achieve 100 percent reduction of inflow sources based on data from other communities in Section 5.2.1.1. Furthermore, additional costs above those identified in the scenario cost presented in Section 5.2.2.3 will make it more likely that the City will not be able to maintain affordable rates.

However, because both scenarios generally meet the requirements defined by the regulatory framework and priority criteria of the Stakeholders, both scenarios are further evaluated through the optimization and verification evaluation steps (identified in Section 5.1.3), which are detailed in Section 5.4 . The affordability and rate impacts of both scenarios are presented in Sections 5.4.4 and 5.4.5.

TABLE 5-19
Evaluation of Scenario Effectiveness for System Remediation Measures

Category	Criteria	Scenario	
		BL	**E1**
Regulatory Framework	Eliminate CSO Discharges	Does not meet criteria, but reduces CSOs	Meets criteria for up to the 10-year, 6-hour event
Stakeholder Priority Criteria	Meeting CWA Requirements	Meets criteria	Meets criteria
	Maintaining affordable rates[a]	Likely meets criteria	Likely does not meet criteria
	Meeting water quality standards	Likely meets criteria	Likely meets criteria
	Compliance with implementation schedule	Meets criteria	Likely does not meet criteria
	Supporting designated uses in Newport Harbor	Meets criteria	Meets criteria

[a] Affordability was not incorporated during the initial evaluation of system remedial measures.

5.3 Evaluation of Additional Control Measures (CD Item 65)

5.3.1 Identification of Additional Control Technologies

Per the regulatory framework described in Section 5.1.1, if elimination of overflows is not achievable, additional control measures may be considered, including, but not limited to: treatment; offline, in-line, and pump back storage; upgrades to the WPCP to increase its design flow; and low impact development technologies (CD Item 29). A Citywide preliminary screening of control technologies was conducted with the assistance of the stakeholder workgroup as a first step to identify what measures are preferred based on the City's collection system and the goals of the program. Table 5-20 and Figure E-15 in Appendix E show the additional control technologies and projects considered beyond those already identified in Section 5.2, which were also included in the preliminary screening.

TABLE 5-20
Additional Control Technologies and Projects Considered in Preliminary Screening

Description	Project Code
CSO Treatment Options	
CSOT-1 Enhanced CSO Treatment	CSOT-1
Capacity Upgrades	
Upsize of Force Main	CU-1
Catchment 10 Reroute (New Pump Station)	CU-2
Additional Pumping at Long Warf Pump Station	CU-3
Additional Pumping at WACSOTF sanitary pumps	CU-4
Green Controls	
Green Controls (Low Impact Development)	GC-1
In-Line Storage Options	
In-line Storage Along Railroad Row	IS-1
In-line Storage on Memorial Blvd, West of Bellevue Ave	IS-2
Narragansett Ave Storage Conduit Expansion	IS-3
In-line Storage on Ruggles Ave	IS-4
Offline Storage Options	
Offline Storage in Middletown	OS-1
Offline Storage at WPCP	OS-2
Offline Storage at J.T. Connell Rd. and Maple Ave	OS-3
Offline Storage on Hillside Ave	OS-4
Offline Storage at Connell Hwy Rotary	OS-5
Offline Storage along Rt. 138, Between Halsey St. and Malbone Rd.	OS-6
Offline Storage on Riggs Rd. Along Waterfront	OS-7
Offline Storage at the Intersection of Rt. 238 and Rt. 138A	OS-8

TABLE 5-20

Additional Control Technologies and Projects Considered in Preliminary Screening

Description	**Project Code**
Offline Storage at Van Zandt Ave/Field	OS-9
Offline Storage North of Easton Pond, J Paul Braga Jr. Memorial Field)	OS-10
Offline Storage at the Washington CSO Facility	OS-11
Offline Storage in the Mary St. Parking Lot	OS-12
Offline Storage at Queen Anne Square	OS-13
Offline Storage at America's Cup Ave by Long Wharf	OS-14
Offline Storage on the harbor from Wellington CSO Facility to Long Warf	OS-15
Offline Storage at Aquidneck Park, Bowery St.	OS-16
Offline Storage at Bellevue Ave	OS-17
Offline Storage at Freebody Park, Middleton Ave	OS-18
Offline Storage at King Park adjacent to Wellington Ave by CSO Facility	OS-19
Offline Storage on South Side of Wellington Ave Along Clinton St.	OS-20
Offline Storage at the Intersection of Narragansett Ave and Annandale Rd.	OS-21
Offline Storage at Morton Park, Spring St.	OS-22
Offline Storage on Broadway by Gould St.	OS-23
Offline Storage near Wave Ave PS - Middletown	OS-24
Offline Storage on Lawrence Ave	OS-25
Offline Storage at Old Fort Rd.	OS-26
WPCP Options	
WPCP Upgrade & Expansion	WPCP-1
Chemically-Enhanced Primary Treatment (CEPT)	WPCP-2

5.3.2 Selection of Top Control Projects

The additional control measures and the successful system remediation and inflow reduction measures were then screened further through a rating system that was intended to objectively assess the relative ability of each control project and eliminate technologies and/or projects that are not cost-effective, technically feasible, acceptable to the community, or ineffective for achieving regulatory compliance or water quality improvement. The four categories evaluated include the 18 program priorities identified by the stakeholder workgroup, as described in Section 5.1.2. An additional category was added to assess engineering and technical feasibility, considering the five following criteria:

- ***Availability of Combined Flow.*** The availability of combined flow at the location of the CSO control option to have an effect on CSO reduction.
- ***Constructability.*** The ease of construction of the CSO control option based on, type of technology, siting, permitting and public acceptance.

- ***Operation Complexity and Maintenance.*** The level of O&M requirements and costs of the CSO control option**.**
- ***Construction Impacts.*** The relative impacts to the public, businesses and the environment from construction of the CSO control option.
- ***Flexibility.*** The ability for the CSO control option to allow adjustments to in system operations in the event of future changes to system flows.

In order to determine which CSO control technologies were most likely to achieve program goals, each control technology was rated from 0 to 10 for its ability to address the priorities set by the stakeholders and engineering and technical feasibility criteria. For example, a 0 would be assigned to a CSO control option that is least favorable to achieve the priority. A 10 would be assigned to a CSO control option that is most favorable to achieve the priority. A more detailed description of the qualitative rating system is provided in Table 5-21.

TABLE 5-21
Descriptions of the Qualitative Rating System

Rating	General Description
Excellent (10)	Most favorable – indicating the highest possible rating, compared to all other available alternatives. For example, an excellent rating for reliability would indicate that the technology is nearly fail-safe.
Very Good (7-9)	Favorable – indicating a better than average rating, compared to all other available alternatives; but not the best possible. For example, a very good rating for reliability would indicate that the technology is more reliable than most, but is not among the best.
Good (4-6)	Moderate or average – indicating a mid-range rating compared to all other available alternatives. For example, a good rating for reliability would indicate that reliability should not be a major concern. However, infrequent system breakdowns can be expected to occur.
Poor (1-3)	Unfavorable – indicating a worse than average rating, compared to other available alternatives; but not the worst possible. For example, a poor rating for reliability would indicate that the technology is less reliable than most, but is not among the least reliable.
Adverse (0)	Most unfavorable – indicating the lowest possible rating compared to all other available alternatives. For example, an adverse rating for reliability would indicate the technology may likely have excessive down time, and would often be unavailable when needed.

A final score for each CSO control project was generated by multiplying the qualitative rating by the priority rating scores as defined in Section 5.12. Because some categories had more evaluation criteria than others, the score for each category was summed and then divided by the number of evaluation criteria in that category. Finally, the total score for each category was summed to determine the total score for each CSO control project. The scoring results are detailed in Appendix E. The projects were then ranked based on their score and the top 15 CSO control projects were identified for more detailed evaluations, as shown in Figure 5-12. Based on the rankings, in-line storage and green controls were not preferred control technologies for reducing CSOs and were not considered for more detailed analysis, including conceptual design and modeling. However, green infrastructure and low impact development were identified as technologies to be considered in the future as means to potentially improve stormwater conveyance.

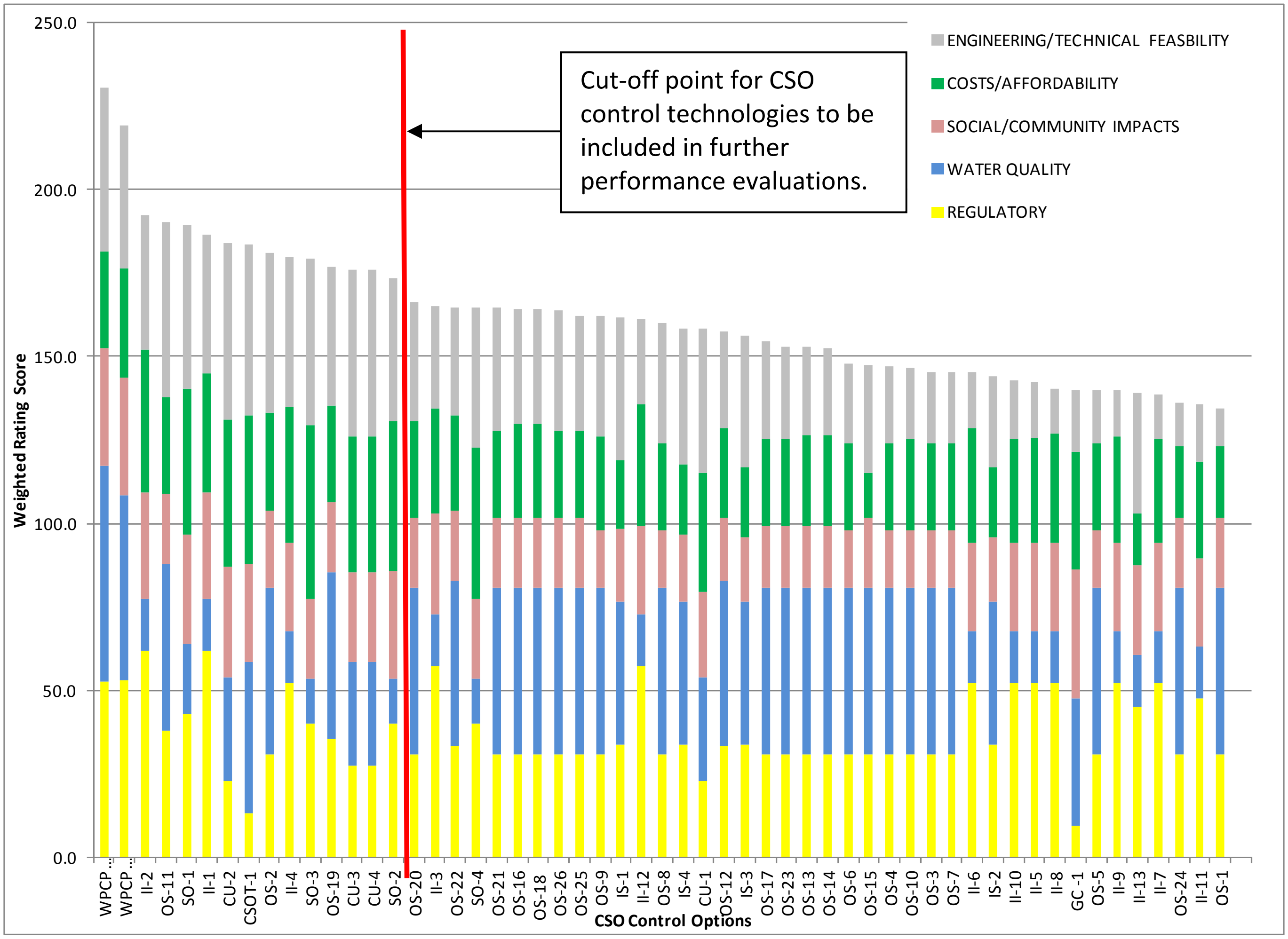


Figure 5-12. Results for Initial Screening of CSO Control Technologies and Projects

5.3.3 Engineering Evaluation and Costs of Feasible Control Projects

Prior to the hydraulic and hydrologic modeling of the top CSO control projects, preliminary engineering evaluations were performed and conceptual layouts were developed. For hydraulic improvements, the following project elements were evaluated:

- Conditions of existing facilities
- Locations of projects
- Available site space (e.g. footprint and maximum depth)
- Project configurations

For hydrologic improvements, we evaluated planning levels of inflow reduction, Citywide, based on the inflow reduction priorities from the preliminary screening, RDII rate analyses, and projected program success based on a literature review. Where applicable, preliminary sketches and schematics were created to demonstrate the concept.

5.3.3.1 CSO Treatment Technologies (Project Code CSOT-1)

High-rate clarification (HRC) is one of the main technologies that are considered advantageous for treating WWF at the CSO treatment facilities. It is a physical/chemical treatment process that utilizes flocculation and sedimentation to achieve rapid settling. Adding HRC treatment would improve effluent water quality by providing higher solid and BOD removal rates, allowing the CSO facilities to meet primary treatment standards. They are many different commercial technologies available on the market. Each technology contains proprietary designs that provide similar treatment efficiency. The costs of these commercial HRC technologies are competitive in the current market and generally similar when construction and O&M costs are factored into the analysis. Therefore, HRC was evaluated as a whole without considering specific differences between each commercial product. Three (3) HRC technologies, Actiflo, Densadeg and CoMag, are summarized in Table 5-22 and briefly discussed below.

TABLE 5-22
Summary of HRC Process Features

Commercial Brand Name	Manufacturer	Description	Features
Actiflo	Veolia Water	Microsand ballasted flocculation and lamella clarification	Microsand provides nuclei for floc formation. Floc is dense and settled rapidly. Lamella clarification provides high rate settling in a small tank volume
DensaDeg	Infilco-Degrmont	Two-stage flocculation with chemically-conditioned recycled sludge followed by lamella clarification	Settled sludge solids are recycled to accelerate floc formation. Dense floc is formed that settles rapidly. Lamella clarification provide high rate settling in a small tank volume
CoMag	Siemens	Magnetite infused flocculation and enhanced rapid settling by applying magnetic field	Floc infused magnetite particles. No need to form large floc as settling can be rapidly achieved under magnetic field. Majority of magnetite collected with magnetic drum can be recycled back to floc tank.

A preliminary conceptual design was developed for the WACSOTF (Project Code CSOT-1.1) and is shown in Figure 5-13. The existing mechanical screen would remain and the screened CSO influent would be diverted to proposed HRC unit. The existing microstrainer tank would be retrofitted and reconfigured into a disinfection tank of which the HRC effluent would pass through and be disinfected before entering the effluent wet well. The HRC sludge would be pumped into the existing sanitary pump station and subsequently discharge to Thames Street Interceptor. The improvements would include the following elements:

- Bulkhead or rise existing weir downstream of mechanic screen.
- Demolish the existing microstrainer tank and reconfigure it into disinfection tank.
- Construct a new HRC unit with 10 MGD capacity.
- Rehabilitate and reconfigure existing facility building to add chemical storage and dosing units for HRC.

Figure 5-13. Preliminary Conceptual Layout of the WACSOTF with HRC

A similar preliminary conceptual design was developed for WSCSOTF (Project Code CSOT-1.2) and is shown in Figure 5-14. The existing mechanical screen would remain and the screened CSO influent would be diverted to the proposed HRC unit. The existing sedimentation tank would be reconfigured to disinfection tank of which the HRC effluent would pass through and be disinfected before entering the effluent wet well. The HRC sludge would be pumped into the existing sanitary pump station and subsequently discharge to Long Wharf Pump Station. The improvements would include the following elements:

- Bulkhead or rise existing weir downstream of mechanic screen.
- Reconfigure the existing sedimentation tank into disinfection tank.
- Construct a new HRC unit with 20 MGD capacity.
- Rehabilitate and reconfigure existing facility building to add chemical storage and dosing units for HRC.

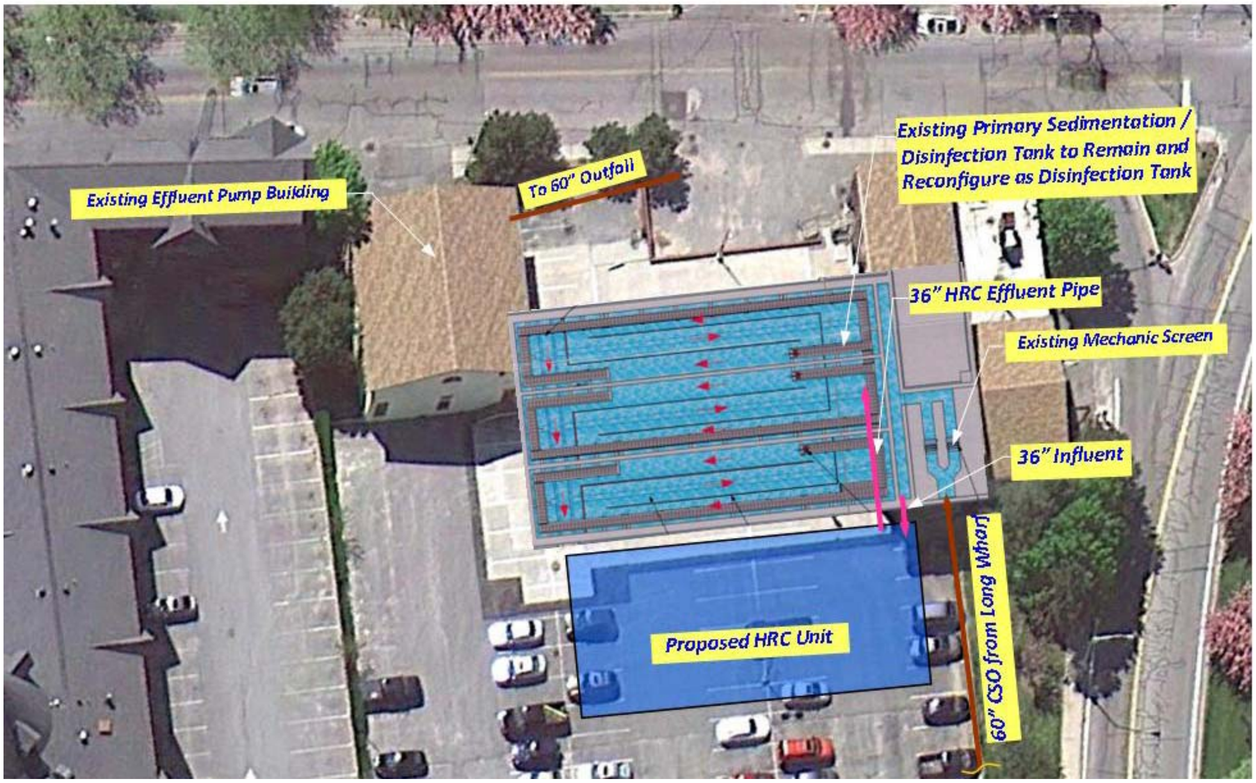


Figure 5-14. Preliminary Conceptual Layout of the WSCSOTF with HRC

For existing conditions at the WSCSOTF, dechlorination is recommended to improve the effluent discharge quality at that facility by reducing chlorine residual. This project would include adding chemical storage and dosing units that would be installed in the existing sedimentation/disinfection tank.

5.3.3.2 Enhanced CSO Treatment Construction Costs

A summary of the construction costs for the treatment upgrades is presented in Table 5-23.

TABLE 5-23
Treatment Costs

Project ID	Treatment Option	Location	Upgrade Description	Benefit	Construction Cost
CSOT-1.1	High Rate Treatment (HRT)	WACSOTF	Construct new HRC unit; Rehabilitate and reconfigure existing building to add chemical storage and dosing units	Provides full primary treatment	$14,500,000
CSOT-1.2		WSCSOTF	Construct new HRC unit; Rehabilitate and reconfigure existing building to add chemical storage and dosing units	Improves effluent water quality with higher solid and BOD removal rate	$23,650,000
				Total	$38,150,000

5.3.3.3 Capacity Upgrade Projects

Catchment 10 Reroute (Project Code CU-2)

This project consists of building a new pump station to convey flows from Catchment 10 from just upstream of the existing Railroad Interceptor to the Long Wharf Pump Station force main instead of south to the Long Wharf Pump Station. The purpose of this project is to prevent excess WWFs from entering the WSCSOTF. The pump station would be a duplex, submersible pump station with 3.5 MGD pumps located near the Railroad on Van Zandt Avenue. A gravity pipe would convey flow to the pump station from the manhole near the intersection of Farewell Street and Van Zandt Avenue. A force main would be constructed parallel to the existing railroad north to where the Long Wharf force main transitions from a 30 to a 36-inch diameter pipe near the on ramp of Highway 138. The existing 18-inch diameter pipe that flows to the south to the Railroad Interceptor could remain as an overflow pipe; a weir would be constructed in the manhole at Farewell Street and Van Zandt Avenue to prevent dry weather flows (DWFs) from entering the Interceptor. The preliminary conceptual layout is presented in Figure 5-15.

Additional Pumping at Long Wharf Pump Station (Project Code CU-3)

This project would allow additional pumping at the Long Wharf Pump Station using the existing pumps up to a wet weather capacity of up to 30 MGD if additional upgrades to the plant are implemented, including upgrades to the primary clarifier, aeration tank and final clarifier are made (Project Code WPCP-1) as well as the implementation of CEPT (Project Code WPCP-2). These upgrades are described further in Section 5.3.3.7.

Additional Pumping at WACSOTF Sanitary Pumps (Project Code CU-4)

This project would allow additional pumping at the WACSOTF sanitary pumps by installing new, larger pumps to send more flows to the Thames Street Interceptor. It is estimated that the additional pumping needed would require three 2-mgd pumps.

5.3.3.4 Capacity Upgrade Project Construction Costs

A summary of the construction costs are in Table 5-24. These are Class 4 or Conceptual Level cost estimates.

TABLE 5-24
Conveyance Construction Costs

Project ID	Pump Station	Location	Description	Construction Cost
CU-2	Catchment 10 Pump Station	Van Zandt Ave near Railroad	Install new 3.5 MGD pump station	$2,947,000
CU-4	WACSOTF Sanitary Pumps	At Wellington Ave CSO Treatment Facility	Upgrade existing pumps (three new 2 MGD pumps)	$530,000
CU-5	WACSOTF Sanitary Pumps	At Wellington Ave CSO Treatment Facility	Upgrade WACSOTF sanitary pumps force main	$126,000
			Total	$3,603,000

Figure 5-15: Preliminary Conceptual Layout for Catchment 10 Reroute (Project Code CU-2)

CH2MHILL.

Map prepared July 2012

5.3.3.5 Offline Storage Projects

Offline storage at WPCP (Project Code OS-2)

This project consists of building an offline storage tank at the WPCP site to allow for temporary detention of peak WWFs. Storage would be located on the south portion of the site and would have an available capacity of approximately 1.8 MG by using nine 8 by 14-foot box culverts. The conceptual layout is shown in Figure 5-16. Excess WWFs would enter the facility through a diversion valve chamber on the Long Wharf force main. Following a storm event, the storage tank would be emptied by dewatering pumps back into the Long Wharf force main and ultimately to the WPCP where it would be treated. It is assumed that there would be two 2 MGD pumps for dewatering and pump down would take an average of approximately 24 hours following a rain event.

Offline storage at the WSCSOTF (Project Code OS-11)

This project consists of building an offline storage tank at the WSCSOTF to allow for temporary detention of peak WWFs to reduce CSOs. Storage would be located east of the existing site underneath the existing parking lot, and would have an available capacity of approximately 2.7 MG by using 13 rows of 8 by 12-foot box culvert sections. The conceptual layout is shown in Figure 5-17. Excess WWFs would enter the existing WSCSOTF through the existing 60-inch diameter influent sewer and would be sent to the offline storage facility after passing through the existing mechanical screens. Once the storage facility was at capacity, any additional volume would overtop a weir and be sent to the existing settling tanks which have approximately 1 MG of storage and ultimately to the effluent pump station once full. After storm events have ended and the wet well level at the Long Wharf Pump Station returns to the normal operating range, both the offline storage and settling tanks will be dewatered by the existing dewatering pumps, per the City of Newport's *Operations and Maintenance Manual, Volumes I, II, and III* (Sevee & Maher Engineers, Inc., et al., 2009/2011).

Off-line storage at the WACSOTF (Project Code OS-19)

This project consists of building an offline storage tank adjacent to the WACSOTF to allow for temporary detention of peak WWFs to reduce CSOs. Storage would be located underneath the park area and would have an available capacity of approximately 0.9 MG. The conceptual layout is shown in Figure 5-18. Excess WWFs would enter the storage facility through an overflow weir near the intersection of Marchant Street and Wellington Avenue, where the 36-inch diameter overflow sewer from the Thames Street interceptor meets the 24-inch diameter sewer on Wellington Avenue. After storm events and after the WACSOTF sanitary pumps return to normal operating range, the offline storage would be dewatered through a dewatering pump station, which would be located on the north side of Wellington Avenue. The dewatering pump force main would be connected to the existing gravity main to the WACSOTF. It was assumed that there would be two 1 MGD pumps for dewatering and pump down would take approximately 12 to 24 hours following a rain event.

5.3.3.6 Off-line Storage Project Construction Costs

A summary of the construction costs for the three storage facilities is presented in Table 5-25. The costs were estimated using a CH2M HILL cost estimator based on the conceptual layouts shown in Section 5.3.3.7. These are Class 4 or Conceptual Level Planning Costs.

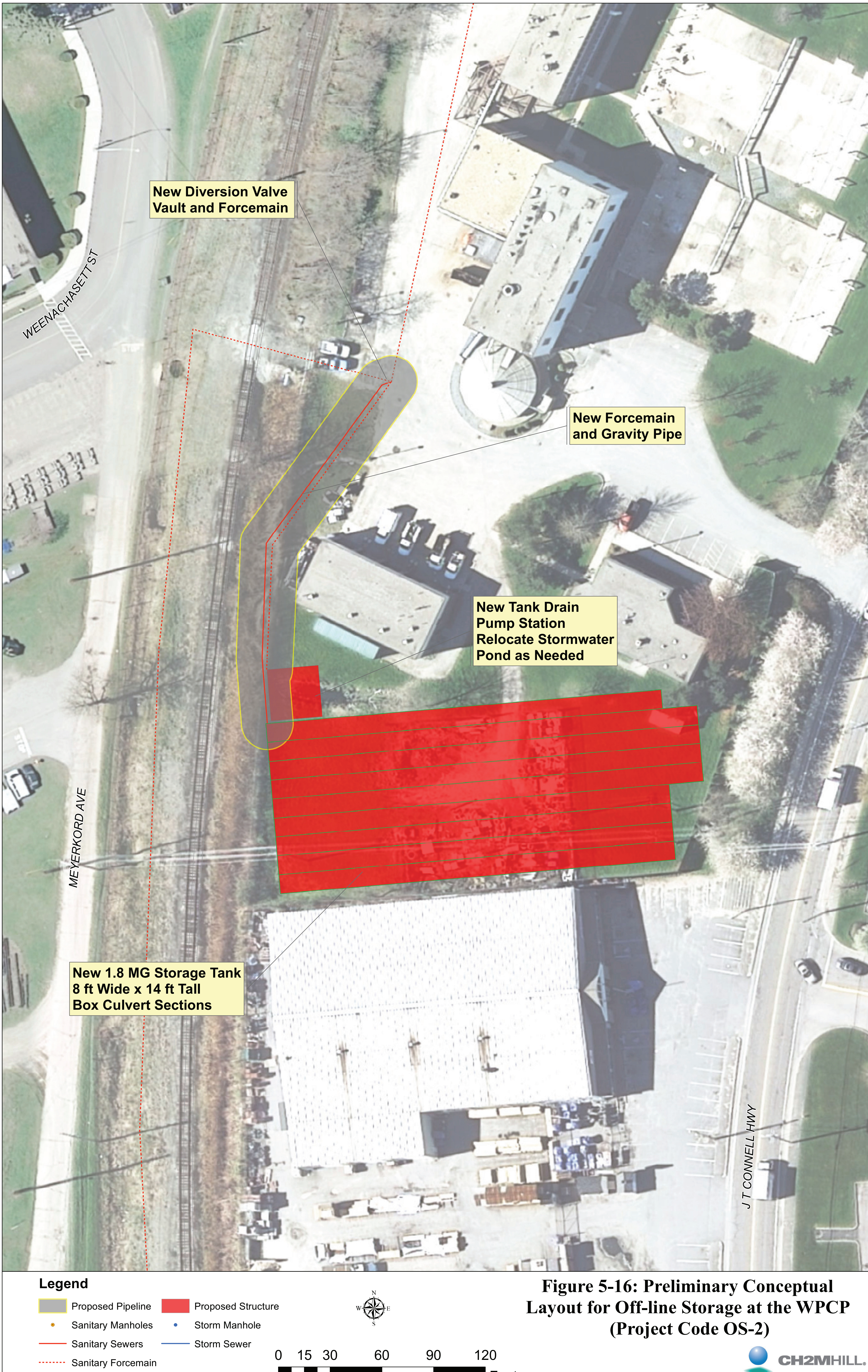
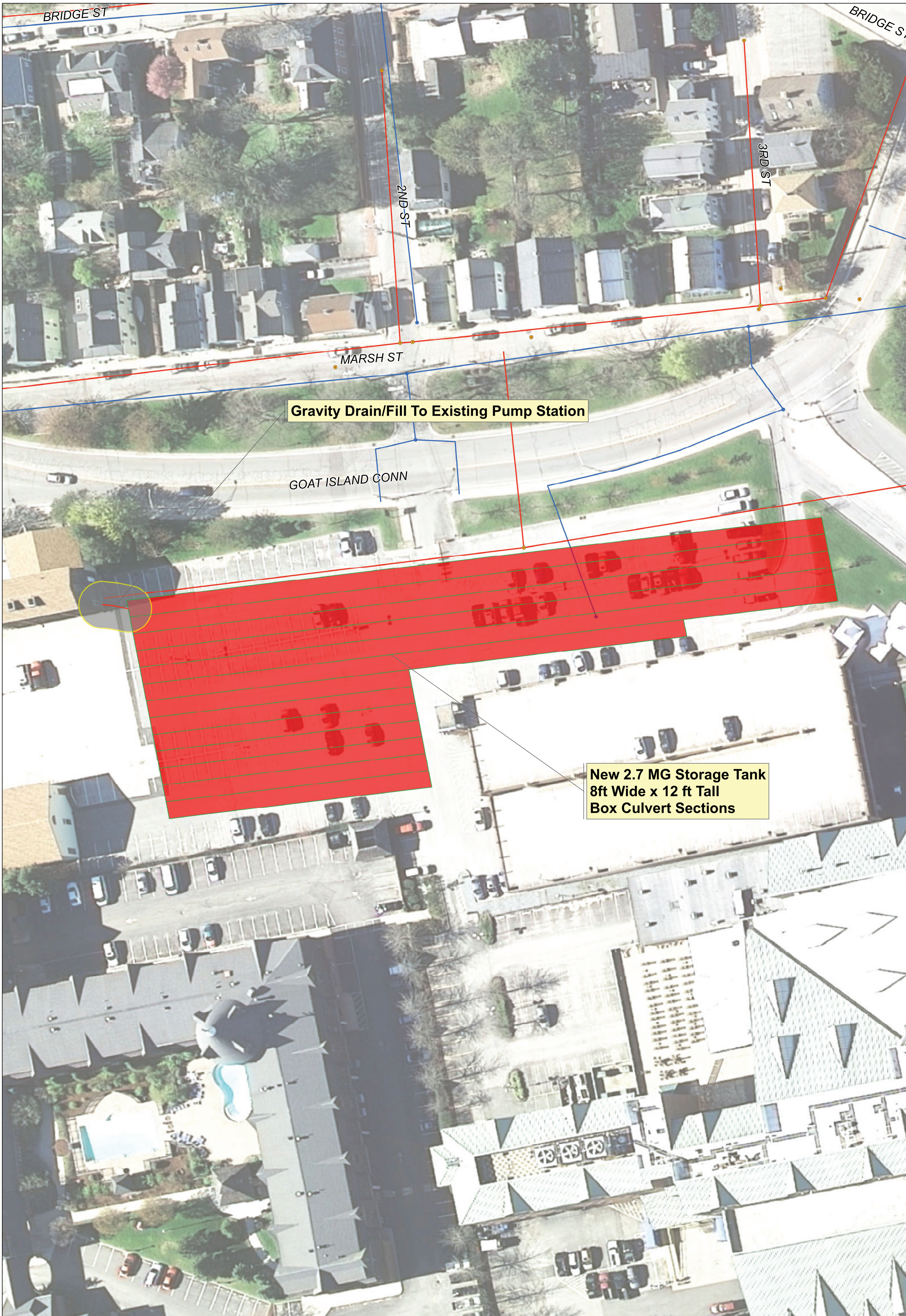


Figure 5-16: Preliminary Conceptual Layout for Off-line Storage at the WPCP (Project Code OS-2)



Legend

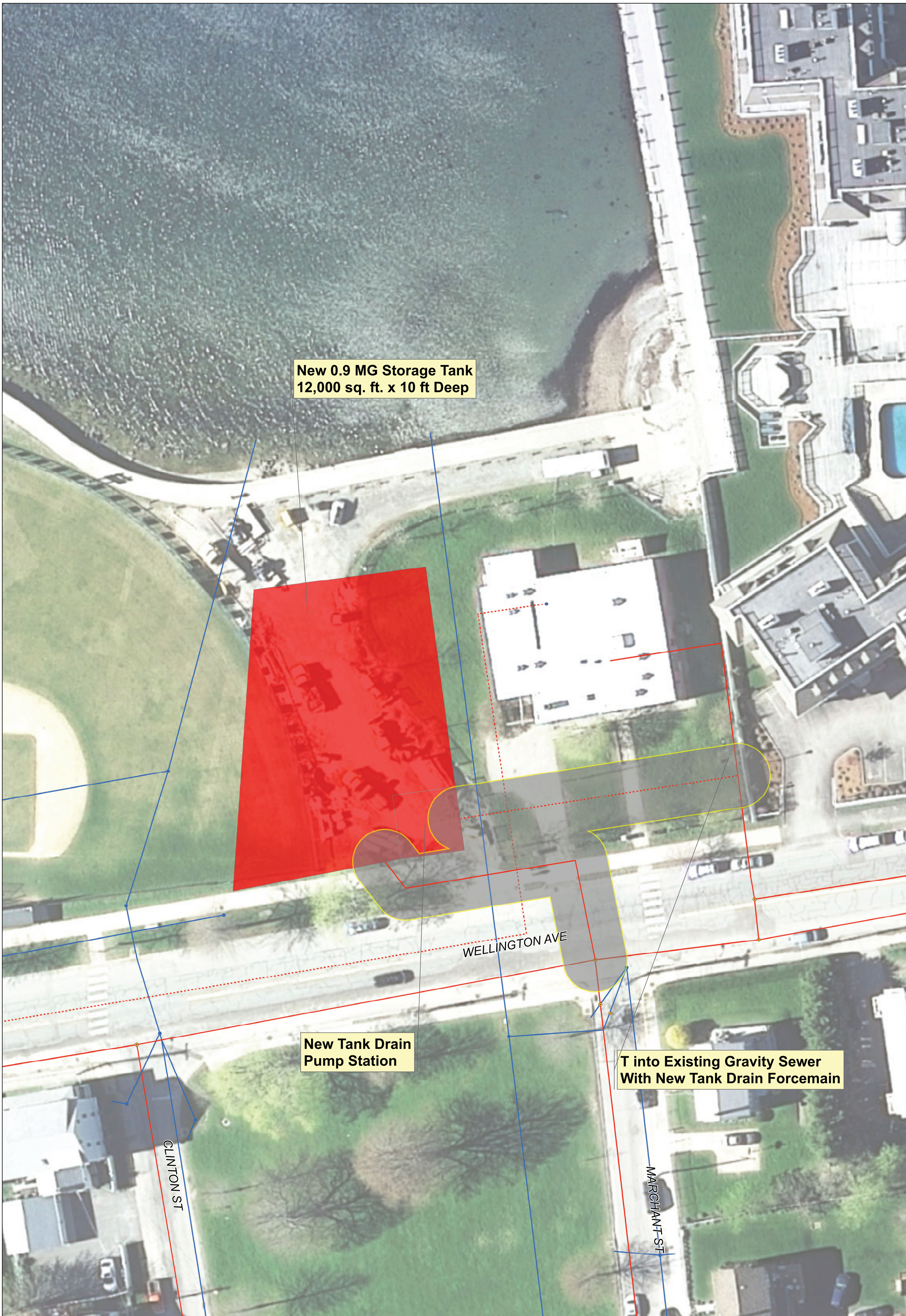
- Proposed Pipeline
- Proposed Structure
- Sanitary Manholes
- Storm Manhole
- Sanitary Sewers
- Storm Sewer
- Sanitary Forcemain

0 20 40 80 120 160 Feet

Figure 5-17: Preliminary Conceptual Layout for Off-line Storage at the WSCSOTF (Project Code OS-11)

CH2MHILL.

Map prepared July 2012



Legend

- Proposed Pipeline
- Proposed Structure
- Sanitary Manholes
- Storm Manhole
- Sanitary Sewers
- Storm Sewer
- Sanitary Forcemain

0 15 30 60 90 120 Feet

Figure 5-18: Preliminary Conceptual Layout for Off-line Storage at the WACSOTF (Project Code OS-19)

CH2MHILL.

Map prepared August 2012

TABLE 5-25
Storage Facility Construction Costs

Project ID	Storage Location	Description	Maximum Storage Volume	Construction Cost
OS-2	WPCP	Install new storage facility and dewatering pump with force main	1.8 MG	$10,257,000
OS-11	WSCSO Facility	Install new storage facility	2.7 MG	$13,272,000
OS-19	King Park, near the WACSO Facility	Install new storage facility and dewatering pump with force main	0.9 MG	$10,849,000
			Total	$34,378,000

5.3.3.7 WPCP Upgrade Projects

In addition to the WPCP improvements recommended in Section 4.4 to allow the plant to achieve their permitted design average monthly flow and maximum day flows, further improvements are recommended to increase the wet weather and treatment capacities and further reduce CSO discharges. These improvements would require an update to the existing RIDEM permit. These improvements include upgrades to the primary clarifier, aeration tank and final clarifier, which are summarized below. Figure 5-19 shows the process locations.

- **Primary Clarifiers:** The existing clarifier mechanisms are often operated under stress due to lack of adequate screening and grit removal capability. To improve the reliability of the plant operation, the mechanisms would need to be replaced. In addition, higher primary pumping capacity would increase the wet weather capacity once there is more solid handling capacity is available. Under current loading condition, the primary clarifier capacity is limited to 14.4 MGD while consistently achieving a TSS removal rate of 50 percent. It is possible to increase the surface loading with a lower removal rate but it would stress the final clarifier. Another option is to increase sludge settleability by adding metal salt (e.g., CEPT).
- **Secondary Treatment (Aeration Tanks and Final Clarifiers):** New clarifier mechanisms are needed to ensure reliable operation of the settling tanks. Recommended in-kind replacements include addition of energy dissipating inlets, enhanced scum removal, and improved flow splits to ensure balanced distribution of mixed liquor to the clarifiers and optimization of WWF. The aeration grids should be modified and mixers installed at the front end of the aeration tanks to serve as a selector zone and improve sludge settleability. Provisions to operate the activated sludge tanks in contact stabilization mode would be required to allow successful secondary treatment operation for flows above 15 MGD. However there will be an inability to continually meet the 85 percent removal requirement during periods of increased wet weather flows above 15 MGD.

These upgrades could be performed in two steps to increase the wet weather capacity incrementally. The first step would be to update the primary clarifier (Project Code WPCP-1.2). This will add relatively small capacity, but would provide for reliable operation performance and allows for the addition of sustained wet weather treatment, such as CEPT. The second step would be to upgrade the secondary treatment system (Project Code WPCP-1.3) and change the plant operation mode from a standard complete-mix activated sludge process to a contact stabilization mode process. This will address the chronic issue of high sludge volume index (SVI) that often limits final clarifier capacity. With this upgrade, the plant could achieve the maximum capacity.

A summary of the projected benefits of the improvements on average month, maximum day and WWFs are shown in Table 5-26.

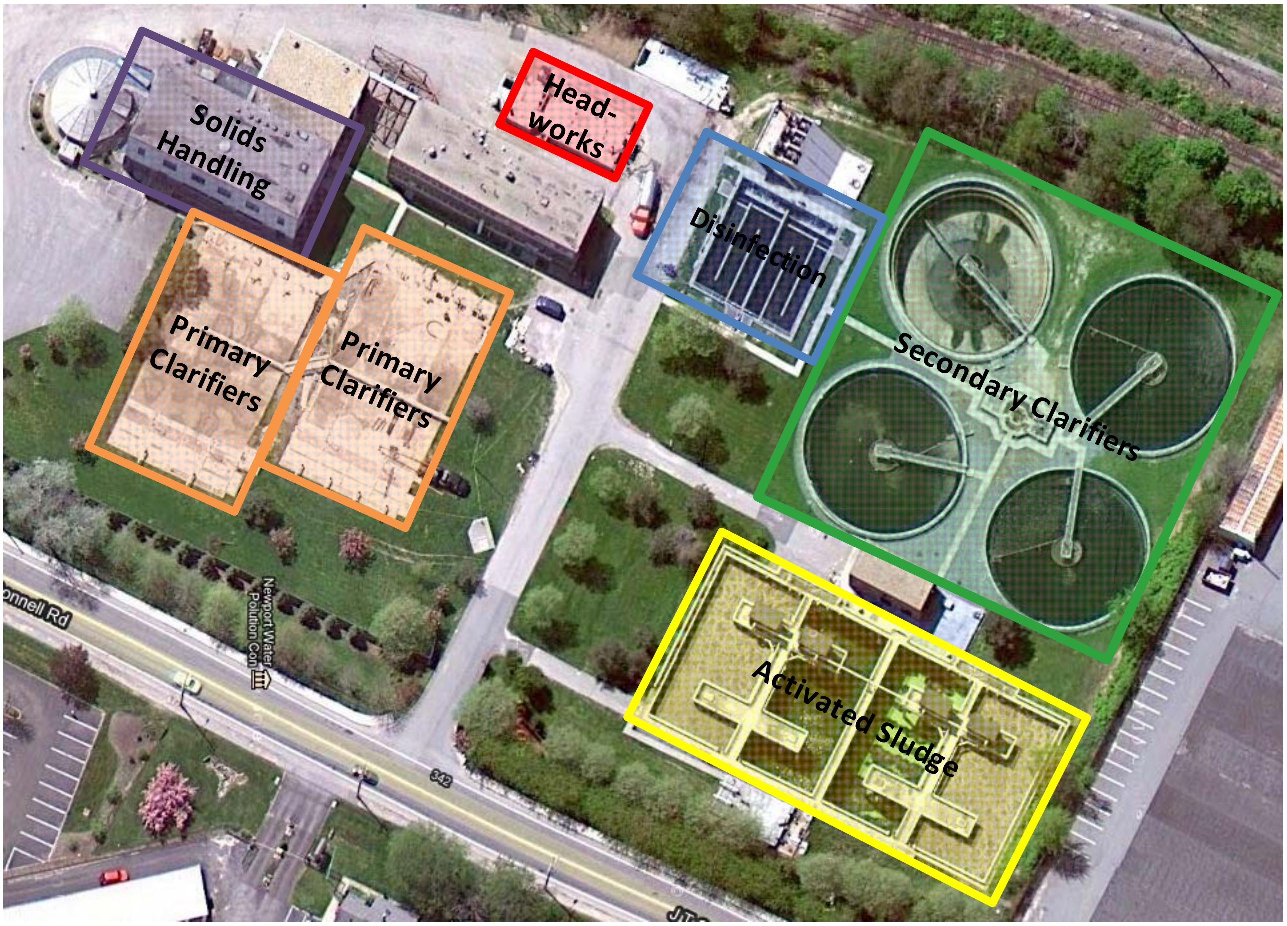


Figure 5-19. Recommended Improvements to WPCP for Increased Plant Capacity

TABLE 5-26
Summary of Future Upgrade Options

Project code	Unit Operation/ Process	Existing Plant Capacity			Future Plant Capacity		
		Average Day (MGD)	Max. Day (MGD)	Wet Weather Capacity (MGD)	Average Day (MGD)	Max. Day (MGD)	Wet Weather Capacity (MGD)
WPCP-1.1	Headworks[a]	11	22	22	15.3	30	30
WPCP-1.2	Primary Clarifier[b]	14	20	20	14.4	20	30
WPCP-1.3	Aeration Tank[c]	15	18	30	18	20	30
WPCP-1.3	Final Clarifier[c]	15	18	22	15.3	22	30
WPCP-1.1	Disinfection[a]	14	14	14	15.3	20	30
	Solid Processing[a]	11	n/a	n/a	15.3	20	n/a
Plant Capacities							
Overall Plant Capacity with Headwork, Disinfection and Solid Processing Improvements[a]					**14**	**18**	**20**
Overall Plant Capacity with Primary Clarifier Improvements[b]					**14.4**	**18**	**22**
Overall Plant Capacity with Secondary Treatment Improvements[c]					**14.4**	**20**	**30**

[a] Unit processes shaded in gray are the recommended improvements presented in Section 4.4.2.
[b] Unit processes shaded in pink are the recommended improvements for the primary clarifiers.
[c] Unit processes shaded in yellow are the recommended improvements for the aeration tanks and final clarifiers.

Chemically-Enhanced Primary Treatment (CEPT)

CEPT is the simplest enhancement to increase wet weather peak flow treatment capacity for conventional treatment plants with primary clarifiers. Chemical coagulants or metal salts, such as ferric chloride and alum, provide higher TSS and BOD removal rates at primary clarifiers while allowing higher peak overflow rates during peak flow events. This would minimize the clarifier surface area for peak flow events and subsequently increase the capacity of the primary clarifiers.

CEPT can be a full-time treatment method. However, it normally is implemented for peak WWF. CEPT combined with polymer addition (<1 mg/L), uses lower metal salt doses (20 to 40 mg/L). It typically includes the use of rapid mix and flocculation prior to the settling tank. Jar testing is essential for determining design chemicals, doses, and rapid mix and flocculation times. A settling column test quantifies the primary clarifier performance that can be obtained.

CH2M HILL performed a CEPT study for the City as part of the EPA CD (Item 19) to determine the feasibility for implementation at the WPCP. The procedures and results were detailed in *Flow Optimization and Capacity Evaluation for the Newport WPCP* (CH2M HILL, 2011d). The evaluation concluded that CEPT can provide much higher TSS and BOD removal rates at the primary clarifiers with maximum removals greater than 93 percent. The maximum TSS and BOD removal rates are summarized in Table 5-27 and Figure 5-20. A conceptual layout of the WPCP with CEPT is presented in Figure 5-21.

TABLE 5-27
Maximum Removal Rate Based on Jar T*esting and Settling Column Test*

	Ferric Chloride/Polymer Dosage, mg/L	Removal Rate	Alum/Polymer Dosage, mg/L	Removal Rate
Max % TSS Removal, Jar Test	75/3	98.3%	75/1	96.1%
Max % BOD Removal, Jar Test	75/3	86.5%	75/5	93.5%
Max TSS Removal, Column	60/3	95%, HRT = 30 min	60/5	87%, HRT = 30 min

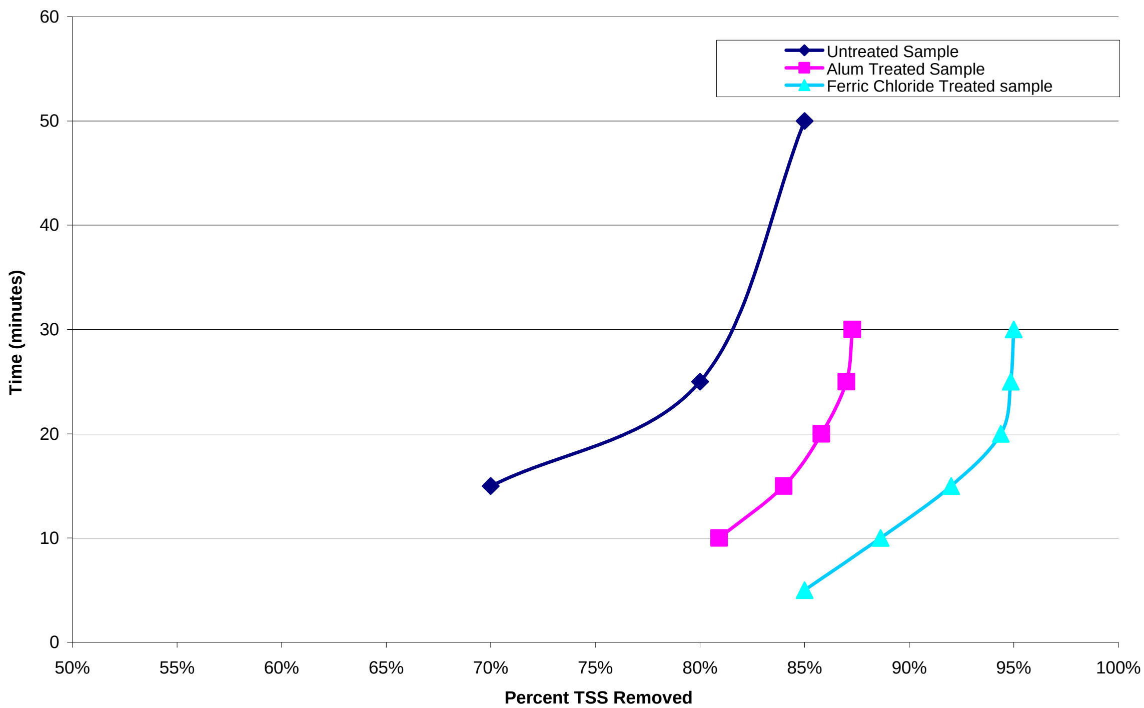


Figure 5-20. Percentage TSS Removal through Type II Column Settling

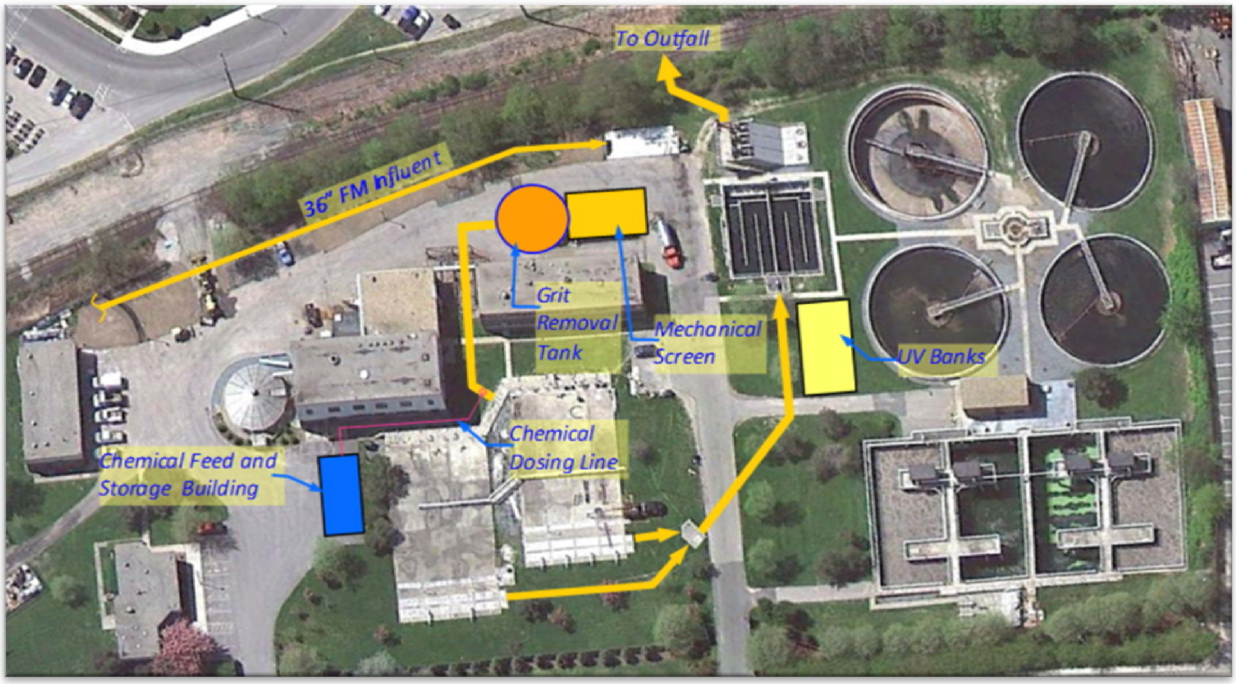


Figure 5-21. Conceptual Layout for CEPT at WPCP

5.3.3.8 WPCP Upgrade Project Construction Costs

Itemized costs were developed for each unit process being upgraded and allowances were added for the following facility-wide costs:

- Demolition: 5 percent
- General Sitework: 5 percent
- Yard Electrical: 5 percent
- Yard Piping: 7 percent

The following construction cost markups were incorporated into the construction cost estimate:

- Contractor Overhead, Profit, and Mobilization/Bonds/Insurance: 20 percent
- Construction Contingency: 30 percent

A summary of the construction costs for the WPCP process upgrades is presented in Table 5-28.

TABLE 5-28
WPCP Upgrade Construction Costs

Project ID	Unit Operation/Process	Upgrade Description	Benefit	Construction Cost
WPCP- 1.2	Primary Clarifier	Replace clarifier mechanisms and sludge pumps	Increases plant capacity and reliability	$3,772,000
WPCP- 1.3	Aeration Tank	Upgrade contact stabilization operation mode	Increases plant capacity and reliability	$4,100,000
WPCP- 1.3	Final Clarifier	Upgrade flow splitter and install new clarifier mechanism	Increases plant capacity and reliability	$2,572,000
WPCP-2	Chemically Enhanced Primary Treatment (CEPT)	Install melt-salt and polymer system chemical storage and feed system	Allows plant to achieve maximum wet weather treatment capacity	$5,243,000
			Total	$15,687,000

5.3.4 Definition of Additional Control Scenarios and Costs

5.3.4.1 Preliminary Evaluation of Control Projects

The selected additional technologies were evaluated through preliminary hydraulic model simulations to determine if the selected projects would help achieve CSO reduction. It was determined that all selected control scenarios would be applicable to the additional control scenarios.

5.3.4.2 Identification of Control Scenarios

Based on the categories of additional control technologies, there were three categories of control scenarios that focused on those main technologies: treatment, storage and conveyance. An additional category was created to combine these main control technologies called mixed control scenarios. There were 11 additional control scenarios created, all of which included the projects identified in the Baseline scenario. Table 5-29 summarizes the various control technologies included in each of the 11 scenarios. The scenarios are summarized as follows:

- **Treatment 1 (T1):** Install primary clarifier upgrades to the plant to add CEPT treatment and add HRC at the CSO facilities. Increase pumping at Long Wharf Pump Station up to wet weather capacity (25 MGD). This scenario adds treatment with very limited collection system improvements.
- **Treatment 2 (T2):** Improvements identified in T1, additional pumping at the WACSOTF sanitary pumps and raising weirs (all five twin 54-inch weirs and the Wellington Avenue weir). This scenario adds treatment with minor collection system improvements.
- **Treatment 3 (T3):** Improvements identified in T2, secondary treatment upgrades at the plant to increase the wet weather capacity to 30 MGD and installation of the Catchment 10 pump station. This scenario adds treatment with major WPCP and collection system improvements.
- **Storage 1 (S1):** Maximum storage at the WPCP, WSCSOTF, and WACSOTF. This scenario adds storage without any collection system improvements.
- **Storage 2 (S2):** Improvements identified in S2, upgrades to the WPCP to increase wet weather capacity to 25 MGD, increase pumping at Long Wharf Pump Station and WACSOTF sanitary pumps, and raising weirs (all five twin 54-inch weirs and the Wellington Avenue weir). This scenario adds storage with minor collection system improvements.

- **Storage 3 (S3):** Improvements identified in S2, except storage at the WPCP. Add secondary treatment upgrades to the WPCP to increase wet weather capacity to 30 MGD. This scenario adds storage only at the CSO outfalls with major improvements to the WPCP and minor improvements to the collection system.
- **Conveyance 1 (C1):** Major collection system improvements, including increasing pumping at the Long Wharf Pump Station and WACSOTF sanitary pumps, raising weirs (all five twin 54-inch weirs and the Wellington Avenue weir), installing the new Catchment 10 pump station, and disconnecting 100 percent of downspouts. Additional major WPCP improvements, including upgrading of the primary clarifier and secondary treatment, are needed to increase the wet weather capacity to 30 MGD. This scenario focuses on major improvements to the WPCP and collection system.
- **Master Mix 1 (M1):** Major collection system improvements, including increasing pumping at the Long Wharf Pump Station and WACSOTF sanitary pumps, raising weirs (all five twin 54-inch weirs and the Wellington Avenue weir), installing the new Catchment 10 pump station, and disconnecting 100 percent of downspouts. Major WPCP improvements, including upgrading of the primary clarifier and secondary treatment, are needed to increase the wet weather capacity to 30 MGD. Adding storage at the WSCSOTF. This scenario focuses on eliminating overflows at the WACSOTF, reducing overflows to the WSCSOTF, and sending more flow to the WPCP.
- **Master Mix 2 (M2):** Major collection system improvements, including increasing pumping at the WACSOTF sanitary pumps, raising weirs (all five twin 54-inch weirs and the Wellington Avenue weir), installing the new Catchment 10 pump station, and disconnecting 100 percent of downspouts. Adding storage at the WSCSOTF and King Park. This scenario focuses reduction of overflows to the CSO treatment facilities through major collection system improvements and storage at or near the two CSO treatment facilities.
- **Master Mix 3 (M3):** Major collection system improvements, including increasing pumping at the Long Wharf Pump Station and WACSOTF sanitary pumps, raising weirs (all five twin 54-inch weirs and the Wellington Avenue weir), installing the new Catchment 10 pump station, and disconnecting 100 percent of downspouts. Major WPCP improvements, including upgrading of the primary clarifier and secondary treatment to increase the wet weather capacity to 30 MGD and installing CEPT. Adding storage at the WPCP. This scenario focuses on conveying and treating more WWF at the WPCP.
- **Master Mix 4 (M4):** Major collection system improvements, including increasing pumping at the Long Wharf Pump Station and WACSOTF sanitary pumps, raising weirs (all five twin 54-inch weirs and the Wellington Avenue weir), installing the new Catchment 10 PS, and disconnecting 100 percent of downspouts. Major WPCP improvements, including upgrading of the primary clarifier to increase the wet weather capacity to 25 MGD and installing CEPT. Adding HRC at the WACSOTF and WSCSOTF. This scenario focuses on improving the collection system and WPCP, while treating CSO effluent at the CSO treatment facilities.

TABLE 5-29
Control Projects for the Additional Control Scenarios

	Scenario											
Control Project	**BL**	**T1**	**T2**	**T3**	**S1**	**S2**	**S3**	**C1**	**M1**	**M2**	**M3**	**M4**
Baseline Projects (Recently Completed or Planned CIP Projects)	•	•	•	•	•	•	•	•	•	•	•	•
WPCP-1 WPCP Upgrade & Expansion		•	•	•	•	•	•	•	•	•	•	•
WPCP-2 CEPT		•	•	•							•	•
OS-11 (Washington CSO Facility)					•	•	•		•	•		
SO-1 WPCP Flow Optimization		•	•	•		•	•	•	•		•	•
CU-2 (Catchment 10 Reroute)				•				•	•	•	•	•
CSOT-1 Enhanced CSO Treatment		•	•	•								•
OS-2 (WPCP)					•	•					•	
II-4 Downspout Disconnection								•	•	•	•	•
SO-3 Weirs			•	•		•	•	•	•	•	•	•
OS-19 (King Park, Wellington Avenue by CSO Treatment Facility)					•	•	•			•		
SO-2 Increased Pumping Capacity/Better Use of System Capacity		•	•	•		•	•	•	•	•	•	•

5.3.4.3 Scenario Costs

Summaries of the control projects and costs included in the 11 scenarios are in Tables 5-30 through 5-40. Detailed project costs for the scenarios are presented in Table G-1 in Appendix G.

TABLE 5-30
Summary of Control Projects and Costs for Scenario T1

Project Code	Name/Brief Description	Total Capital Cost	Change in Annual O&M Cost	Equivalent Annual Cost
BL	Baseline (includes all Baseline projects)	$ 31,487,000	$ (8,000)	$ 1,029,000
WPCP-1.2	WPCP Upgrade & Expansion, Option 2 (primary clarifiers)	$ 6,130,000	$ -	$ 243,000
WPCP-1.4	WPCP Upgrade & Expansion, CEPT	$ 8,519,000	$ 424,000	$ 732,000
SO-1	WPCP Flow Optimization	$ -	$ -	$ -
CSOT-1.1	Enhanced CSO Treatment (Wellington)	$ 23,563,000	$ 160,000	$ 1,012,000
CSOT-1.2	Enhanced CSO Treatment (Washington)	$ 38,430,000	$ 160,000	$ 1,549,000
SO-2	Increased Pumping Capacity/Better Use of System Capacity	$ -	$ 22,000	$ 22,000
	Scenario Totals:	$ 108,128,000	$ 758,000	$ 4,586,000

TABLE 5-31
Summary of Control Projects and Costs for Scenario T2

Project Code	Name/Brief Description	Total Capital Cost	Change in Annual O&M Cost	Equivalent Annual Cost
BL	Baseline (includes all Baseline projects)	$ 31,487,000	$ (8,000)	$ 1,029,000
WPCP-1.2	WPCP Upgrade & Expansion, Option 2 (primary clarifiers)	$ 6,130,000	$ -	$ 243,000
WPCP-1.4	WPCP Upgrade & Expansion, CEPT	$ 8,519,000	$ 424,000	$ 732,000
SO-1	WPCP Flow Optimization	$ -	$ -	$ -
CSOT-1.1	Enhanced CSO Treatment (Wellington)	$ 23,563,000	$ 160,000	$ 1,012,000
CSOT-1.2	Enhanced CSO Treatment (Washington)	$ 38,430,000	$ 160,000	$ 1,549,000
SO-3	Weirs	$ 189,000	$ -	$ 6,000
SO-2	Increased Pumping Capacity/Better Use of System Capacity	$ -	$ 22,000	$ 22,000
	Scenario Totals:	$ 108,317,000	$ 758,000	$ 4,592,000

TABLE 5-32
Summary of Control Projects and Costs for Scenario T3

Project Code	Name/Brief Description	Total Capital Cost	Change in Annual O&M Cost	Equivalent Annual Cost
BL	Baseline (includes all Baseline projects)	$ 31,487,000	$ (8,000)	$ 1,029,000
WPCP-1.2	WPCP Upgrade & Expansion, Option 2 (primary clarifiers)	$ 6,130,000	$ -	$ 243,000
WPCP-1.3	WPCP Upgrade & Expansion, Option 3 (aeration tank & final clarifier)	$ 10,842,000	$ -	$ 392,000
WPCP-1.4	WPCP Upgrade & Expansion, CEPT	$ 8,519,000	$ 424,000	$ 732,000
SO-1	WPCP Flow Optimization	$ -	$ -	$ -
CU-2	Catchment 10 Reroute (new 3.5 mgd PS)	$ 4,788,000	$ 68,000	$ 241,000
CSOT-1.1	Enhanced CSO Treatment (Wellington)	$ 23,563,000	$ 160,000	$ 1,012,000
CSOT-1.2	Enhanced CSO Treatment (Washington)	$ 38,430,000	$ 160,000	$ 1,549,000
SO-3	Weirs	$ 189,000	$ -	$ 6,000
SO-2	Increased Pumping Capacity/Better Use of System Capacity	$ -	$ 22,000	$ 22,000
	Scenario Totals:	$ 123,947,000	$ 826,000	$ 5,225,000

TABLE 5-33
Summary of Control Projects and Costs for Scenario S1

Project Code	Name/Brief Description	Total Capital Cost	Change in Annual O&M Cost	Equivalent Annual Cost
BL	Baseline (includes all Baseline projects)	$ 31,487,000	$ (8,000)	$ 1,029,000
OS-11	Washington CSO Facility Storage (3MG)	$ 21,567,000	$ 26,000	$ 759,000
OS-2	WPCP Storage (2MG)	$ 16,667,000	$ 24,000	$ 590,000
OS-19	King Park, Wellington Ave by CSO Facility, Storage (0.9MG)	$ 17,629,000	$ 27,000	$ 626,000
	Scenario Totals:	$ 87,349,000	$ 69,000	$ 3,003,000

TABLE 5-34
Summary of Control Projects and Costs for Scenario S2

Project Code	Name/Brief Description	Total Capital Cost	Change in Annual O&M Cost	Equivalent Annual Cost
BL	Baseline (includes all Baseline projects)	$ 31,487,000	$ (8,000)	$ 1,029,000
WPCP-1.2	WPCP Upgrade & Expansion, Option 2 (primary clarifiers)	$ 6,130,000	$ -	$ 243,000
OS-11	Washington CSO Facility Storage (3MG)	$ 21,567,000	$ 26,000	$ 759,000
SO-1	WPCP Flow Optimization	$ -	$ -	$ -
OS-2	WPCP Storage (2MG)	$ 16,667,000	$ 24,000	$ 590,000
SO-3	Weirs	$ 189,000	$ -	$ 6,000
OS-19	King Park, Wellington Ave by CSO Facility, Storage (0.9MG)	$ 17,629,000	$ 27,000	$ 626,000
SO-2	Increased Pumping Capacity/Better Use of System Capacity	$ -	$ 22,000	$ 22,000
	Scenario Totals:	$ 93,667,000	$ 91,000	$ 3,274,000

TABLE 5-35
Summary of Control Projects and Costs for Scenario S3

Project Code	Name/Brief Description	Total Capital Cost	Change in Annual O&M Cost	Equivalent Annual Cost
BL	Baseline (includes all Baseline projects)	$ 31,487,000	$ (8,000)	$ 1,029,000
WPCP-1.2	WPCP Upgrade & Expansion, Option 2 (primary clarifiers)	$ 6,130,000	$ -	$ 243,000
WPCP-1.3	WPCP Upgrade & Expansion, Option 3 (aeration tank & final clarifier)	$ 10,842,000	$ -	$ 392,000
OS-11	Washington CSO Facility Storage (3MG)	$ 21,567,000	$ 26,000	$ 759,000
SO-1	WPCP Flow Optimization	$ -	$ -	$ -
SO-3	Weirs	$ 189,000	$ -	$ 6,000
OS-19	King Park, Wellington Ave by CSO Facility, Storage (0.9MG)	$ 17,629,000	$ 27,000	$ 626,000
SO-2	Increased Pumping Capacity/Better Use of System Capacity	$ -	$ 22,000	$ 22,000
	Scenario Totals:	$ 87,842,000	$ 67,000	$ 3,076,000

TABLE 5-36
Summary of Control Projects and Costs for Scenario C1

Project Code	Name/Brief Description	Total Capital Cost	Change in Annual O&M Cost	Equivalent Annual Cost
BL	Baseline (includes all Baseline projects)	$ 31,487,000	$ (8,000)	$ 1,029,000
WPCP-1.2	WPCP Upgrade & Expansion, Option 2 (primary clarifiers)	$ 6,130,000	$ -	$ 243,000
WPCP-1.3	WPCP Upgrade & Expansion, Option 3 (aeration tank & final clarifier)	$ 10,842,000	$ -	$ 392,000
SO-1	WPCP Flow Optimization	$ -	$ -	$ -
CU-2	Catchment 10 Reroute (new 3.5 mgd PS)	$ 4,788,000	$ 68,000	$ 241,000
II-4	Downspout Disconnection	$ 13,630,000	$ (27,000)	$ 472,000
SO-3	Weirs	$ 189,000	$ -	$ 6,000
SO-2	Increased Pumping Capacity/Better Use of System Capacity	$ -	$ 22,000	$ 22,000
	Scenario Totals:	$ 67,065,000	$ 54,000	$ 2,404,000

TABLE 5-37
Summary of Control Projects and Costs for Scenario M1

Project Code	Name/Brief Description	Total Capital Cost	Change in Annual O&M Cost	Equivalent Annual Cost
BL	Baseline (includes all Baseline projects)	$ 31,487,000	$ (8,000)	$ 1,029,000
WPCP-1.2	WPCP Upgrade & Expansion, Option 2 (primary clarifiers)	$ 6,130,000	$ -	$ 243,000
WPCP-1.3	WPCP Upgrade & Expansion, Option 3 (aeration tank & final clarifier)	$ 10,842,000	$ -	$ 392,000
OS-11	Washington CSO Facility Storage (3MG)	$ 21,567,000	$ 26,000	$ 759,000
SO-1	WPCP Flow Optimization	$ -	$ -	$ -
CU-2	Catchment 10 Reroute (new 3.5 mgd PS)	$ 4,788,000	$ 68,000	$ 241,000
II-4	Downspout Disconnection	$ 13,630,000	$ (27,000)	$ 472,000
SO-3	Weirs	$ 189,000	$ -	$ 6,000
SO-2	Increased Pumping Capacity/Better Use of System Capacity	$ -	$ 22,000	$ 22,000
	Scenario Totals:	$ 88,631,000	$ 80,000	$ 3,163,000

TABLE 5-38
Summary of Control Projects and Costs for Scenario M2

Project Code	Name/Brief Description	Total Capital Cost	Change in Annual O&M Cost	Equivalent Annual Cost
BL	Baseline (includes all Baseline projects)	$ 31,487,000	$ (8,000)	$ 1,029,000
OS-11	Washington CSO Facility Storage (3MG)	$ 21,567,000	$ 26,000	$ 759,000
CU-2	Catchment 10 Reroute (new 3.5 mgd PS)	$ 4,788,000	$ 68,000	$ 241,000
II-4	Downspout Disconnection	$ 13,630,000	$ (27,000)	$ 472,000
SO-3	Weirs	$ 189,000	$ -	$ 6,000
OS-19	King Park, Wellington Ave by CSO Facility, Storage (0.9MG)	$ 17,629,000	$ 27,000	$ 626,000
SO-2	Increased Pumping Capacity/Better Use of System Capacity	$ -	$ 22,000	$ 22,000
	Scenario Totals:	$ 89,289,000	$ 107,000	$ 3,154,000

TABLE 5-39
Summary of Control Projects and Costs for Scenario M3

Project Code	Name/Brief Description	Total Capital Cost	Change in Annual O&M Cost	Equivalent Annual Cost
BL	Baseline (includes all Baseline projects)	$ 31,487,000	$ (8,000)	$ 1,029,000
WPCP-1.2	WPCP Upgrade & Expansion, Option 2 (primary clarifiers)	$ 6,130,000	$ -	$ 243,000
WPCP-1.3	WPCP Upgrade & Expansion, Option 3 (aeration tank & final clarifier)	$ 10,842,000	$ -	$ 392,000
WPCP-1.4	WPCP Upgrade & Expansion, CEPT	$ 8,519,000	$ 424,000	$ 732,000
SO-1	WPCP Flow Optimization	$ -	$ -	$ -
CU-2	Catchment 10 Reroute (new 3.5 mgd PS)	$ 4,788,000	$ 68,000	$ 241,000
OS-2	WPCP Storage (2MG)	$ 16,667,000	$ 24,000	$ 590,000
II-4	Downspout Disconnection	$ 13,630,000	$ (27,000)	$ 472,000
SO-3	Weirs	$ 189,000	$ -	$ 6,000
SO-2	Increased Pumping Capacity/Better Use of System Capacity	$ -	$ 22,000	$ 22,000
	Scenario Totals:	$ 92,251,000	$ 502,000	$ 3,726,000

TABLE 5-40
Summary of Control Projects and Costs for Scenario M4

Project Code	Name/Brief Description	Total Capital Cost	Change in Annual O&M Cost	Equivalent Annual Cost
BL	Baseline (includes all Baseline projects)	$ 31,487,000	$ (8,000)	$ 1,029,000
WPCP-1.2	WPCP Upgrade & Expansion, Option 2 (primary clarifiers)	$ 6,130,000	$ -	$ 243,000
WPCP-1.4	WPCP Upgrade & Expansion, CEPT	$ 8,519,000	$ 424,000	$ 732,000
SO-1	WPCP Flow Optimization	$ -	$ -	$ -
CU-2	Catchment 10 Reroute (new 3.5 mgd PS)	$ 4,788,000	$ 68,000	$ 241,000
CSOT-1.1	Enhanced CSO Treatment (Wellington)	$ 23,563,000	$ 160,000	$ 1,012,000
CSOT-1.2	Enhanced CSO Treatment (Washington)	$ 38,430,000	$ 160,000	$ 1,549,000
II-4	Downspout Disconnection	$ 13,630,000	$ (27,000)	$ 472,000
SO-3	Weirs	$ 189,000	$ -	$ 6,000
SO-2	Increased Pumping Capacity/Better Use of System Capacity	$ -	$ 22,000	$ 22,000
	Scenario Totals:	$ 126,735,000	$ 798,000	$ 5,305,000

5.3.5 Evaluation of Additional Control Scenario Performance

The performance of the 11 scenarios were evaluated using design events as noted in Section 5.1.3 and compared to existing conditions using the calibrated 2012 hydraulic model. Table 5-41 summarizes the CSO discharge volumes for the 2-year, 5-year, and 10-year design events. Figures 5-22, 5-23, and 5-24 summarize the projected CSO reduction at the WACSOTF and WSCSOTF for the 2-year, 5-year, and 10-year, 6-hour design events, respectively.

TABLE 5-41
CSO Discharge Volumes for Additional Control Scenarios

	CSO Discharge Volumes (MG)					
	2-year, 6-hour event		5-year, 6-hour event		10-year, 6-hour event	
Scenario	**WACSOTF**	**WSCSOTF**	**WACSOTF**	**WSCSOTF**	**WACSOTF**	**WSCSOTF**
EC	1.29	3.24	1.83	5.05	2.71	6.76
BL	1.09	2.61	1.78	4.07	2.67	5.81
T1	1.09	2	1.78	3.23	2.68	4.75
T2	0.2	0.63	0.64	2.02	1.29	3.4
T3	0.2	0	0.59	0.82	1.29	1.81
S1	0.6	0	1.24	0	1.98	1.11
S2	0	0	0	0	0.66	0
S3	0	0	0	0	0.65	0
C1	0	0	0	0	0.5	0.46
M1	0	0	0	0	0.5	0
M2	0	0	0	0	0	1.3
M3	0	0	0	0	0.74	0.24
M4	0	0	0	0.68	0.5	1.72

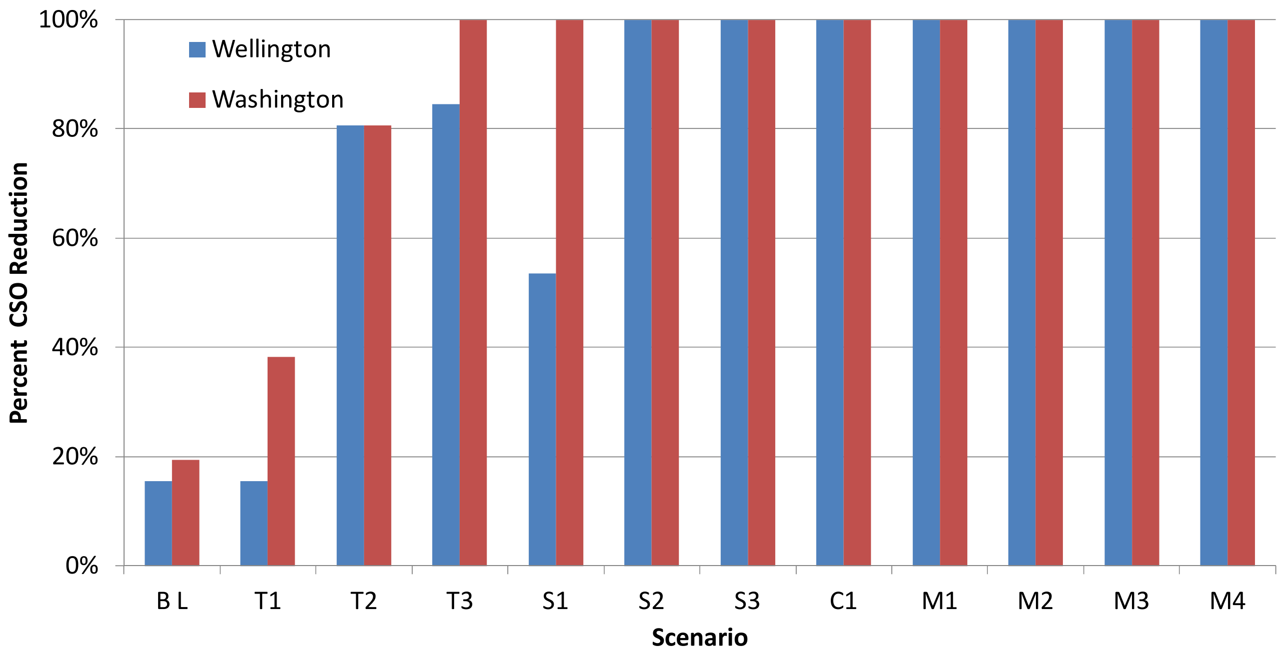


Figure 5-22. Percent CSO Reduction for the WACSOTF and WSCOTF for a 2-year, 6-hour Design Event

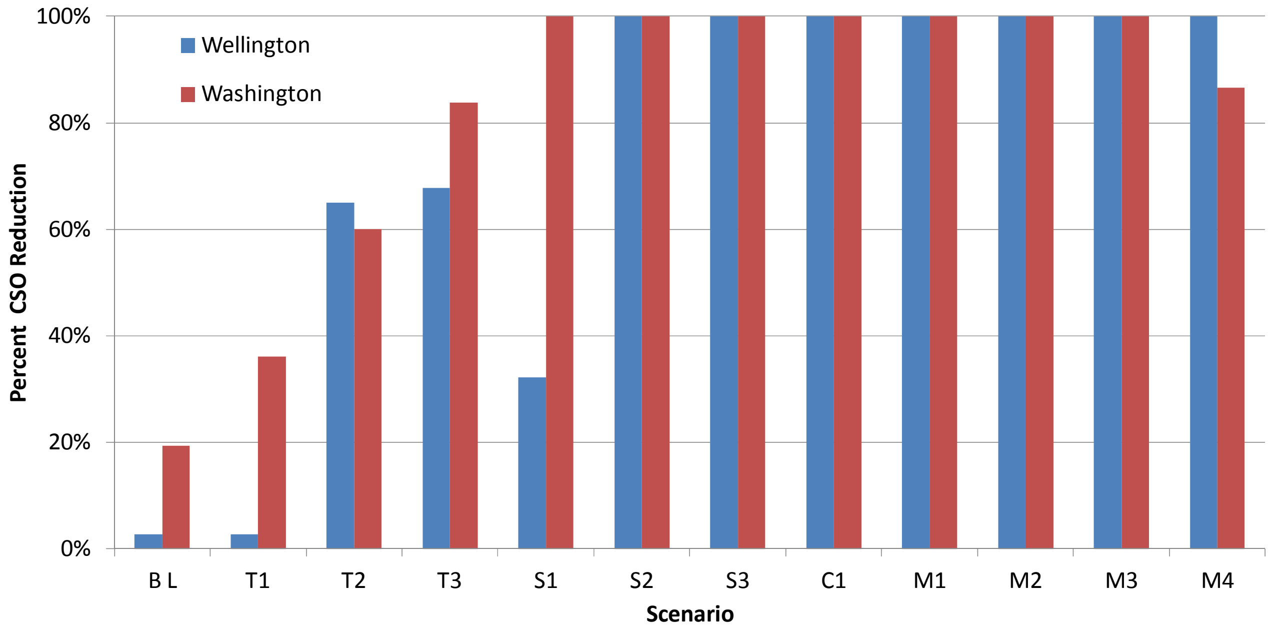


Figure 5-23. Percent CSO Reduction for the WACSOTF and WSCSOTF for a 5-year, 6-hour Design Event

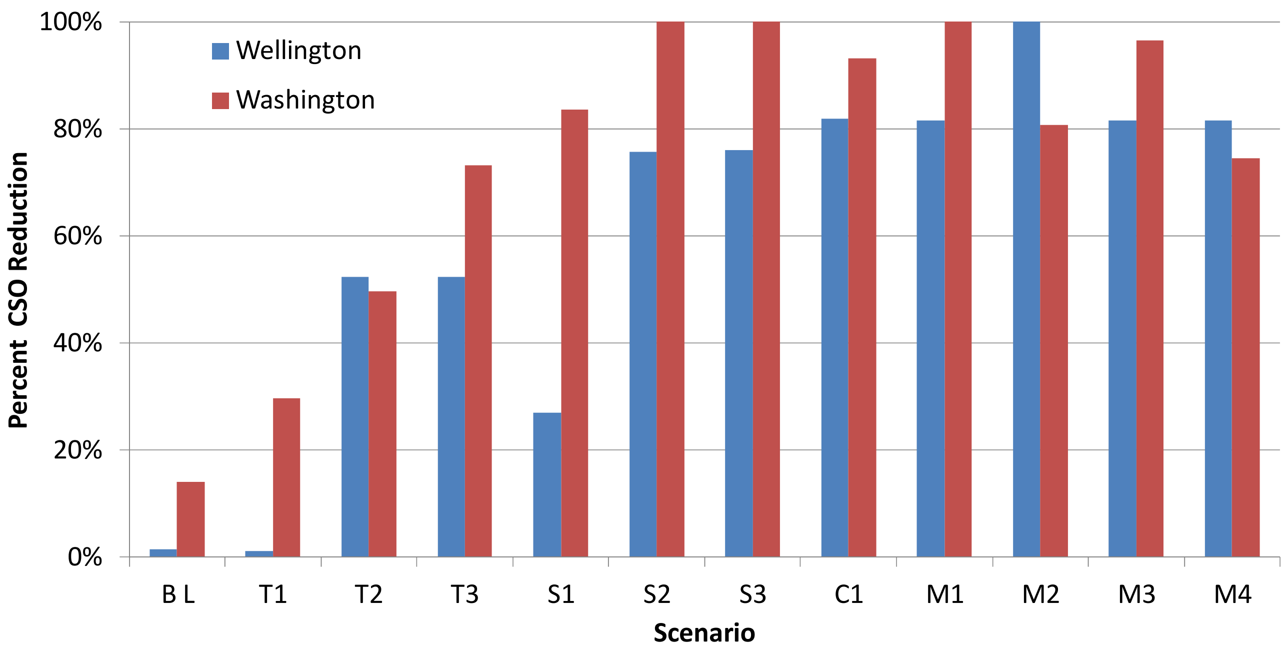


Figure 5-24. Percent CSO Reduction for the WACSOTF and WSCSOTF for a 10-year, 6-hour Design Event

The results indicate that there were no scenarios that were able to eliminate for a 10-year event and only six scenarios, S2, S3, C1, M1, M2, and M3, were successful at eliminating CSOs for a 5-year, 6-hour event. Evaluating the components within the scenarios that reduced CSO volumes most significantly, it is evident that storage along with conveyance improvements and inflow reduction were the most critical to the scenarios.

A preliminary pollutant load analysis was performed for TSS, BOD and fecal coliform loads for the 10-year, 6-hour design event to determine the impact on water quality for a large event as shown in Figures 5-25, 5-26, and 5-27, respectively. The pollutant load analysis results indicate that pollutant loads for TSS and BOD generally decrease compared to existing conditions and scenarios with storage have the most reduction. Also, fecal coliform loading significantly increases with the addition of untreated stormwater runoff as a result of inflow source reduction.

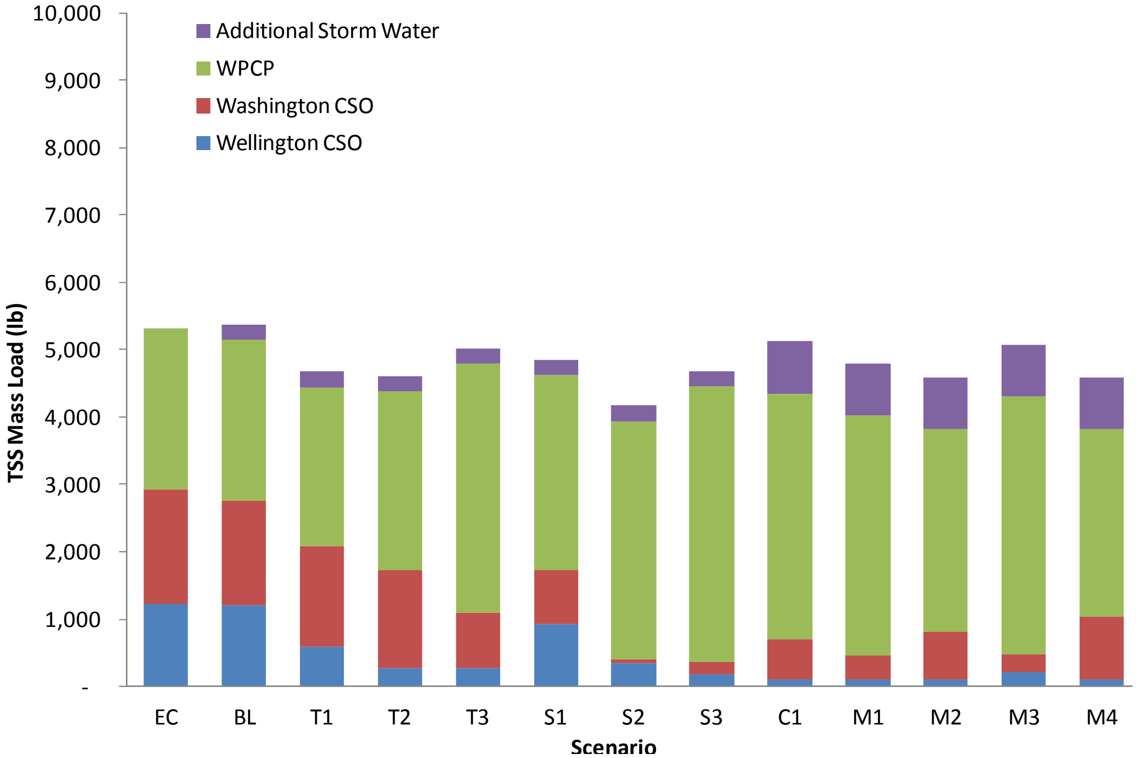


Figure 5-25. TSS Load for a 10-year, 6-hour Event

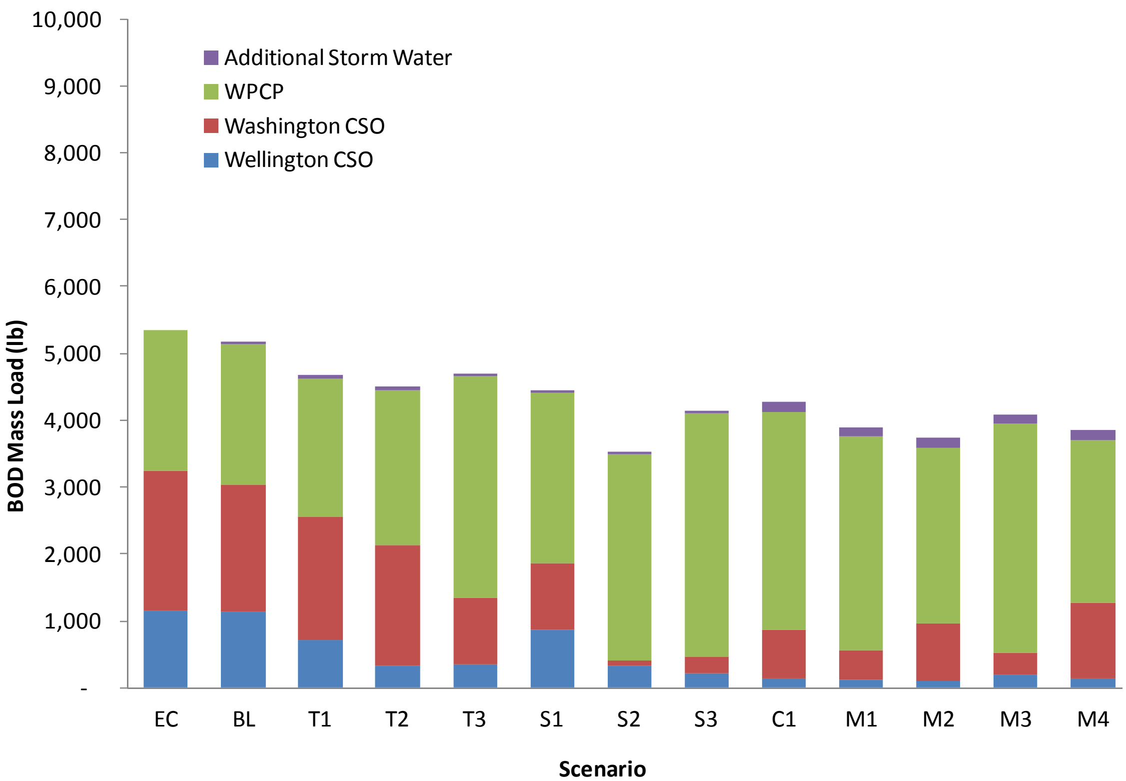


Figure 5-26. BOD Load for a 10-year, 6-hour Event

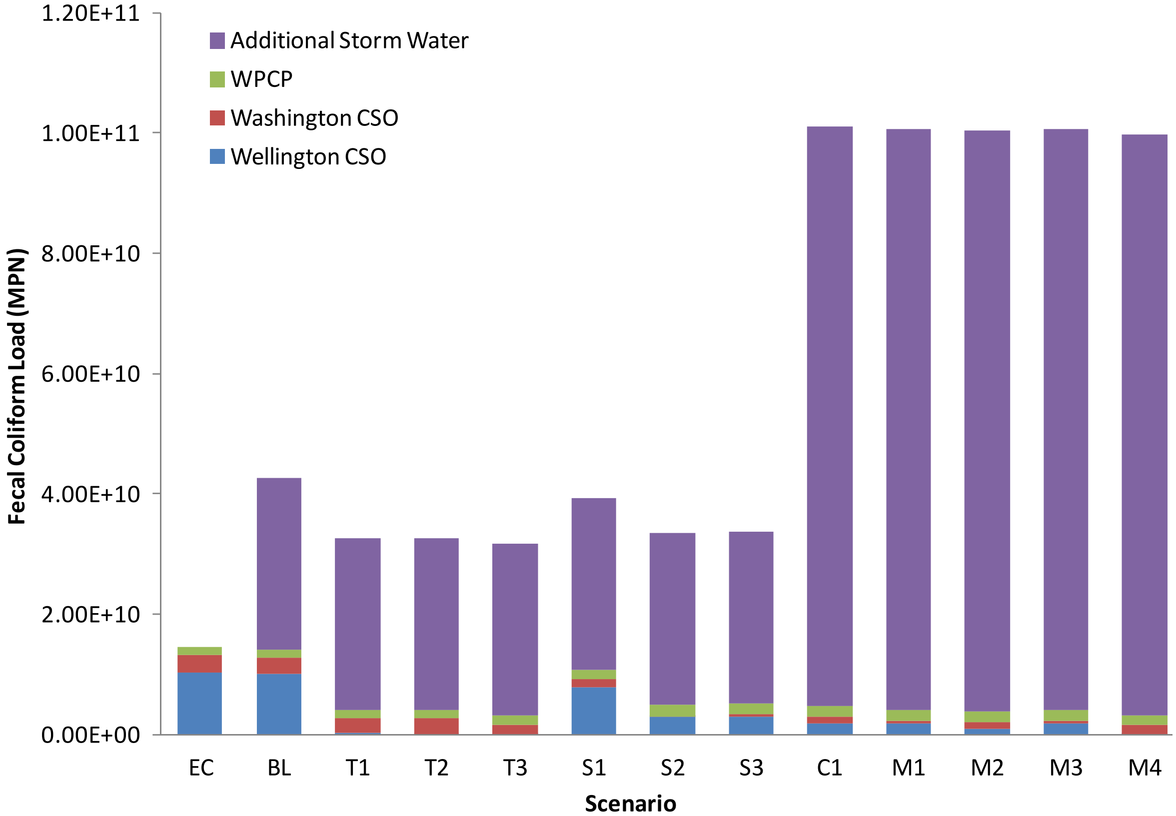


Figure 5-27. Fecal Coliform Load for a 10-year, 6-hour Event

5.3.6 Additional Control Scenario Effectiveness

The performance and costs of the 11 scenarios were compared to the regulatory framework defined in Section 5.1.1 and the Stakeholder's priority criteria in Section 5.1.2 and summarized in Table 5-42. The comparison was used to determine the effectiveness in meeting the goals of the program. Overall, all scenarios were able to reduce CSO volumes, with six scenarios eliminating CSO discharges for up to a 5-year, 6-hour event. Both scenarios were also generally successful at addressing the Stakeholder's priority criteria, although the scenarios with treatment were not as effective as others.

Because all scenarios generally met the requirements defined by the regulatory framework and priority criteria of the Stakeholders, the scenarios were further screened in the stakeholder workgroup and selected scenarios were evaluated through the optimization and verification processes (discussed in Section 5.1.3). The results of the evaluations are presented in Section 5.4.

TABLE 5-42
Evaluation of Scenario Effectiveness for the Additional Control Scenarios

	Regulatory Framework	Stakeholder Priority Criteria				
Scenario	**Eliminate CSO Discharges**	**Meeting CWA Requirements**	**Maintaining Affordable Rates[a]**	**Meeting Water Quality Standards**	**Compliance with implementation Schedule[a]**	**Supporting Designated Uses in the Harbor**
T1	Does not meet criteria, but reduces CSOs	Meets criteria	Likely does not meet criteria	May meet criteria	Likely does not meet criteria	May meet criteria
T2	Does not meet criteria, but reduces CSOs	Meets criteria	Likely does not meet criteria	May meet criteria	Likely does not meet criteria	May meet criteria
T3	Does not meet criteria, but reduces CSOs	Meets criteria	Likely does not meet criteria	May meet criteria	Likely does not meet criteria	May meet criteria
S1	Does not meet criteria, but reduces CSOs	Meets criteria	Likely meets criteria	May meet criteria	Likely meets criteria	May meet criteria
S2	Does not meet criteria, but eliminates CSO discharges up to a 5-year event	Meets criteria	Likely meets criteria	May meet criteria	Likely meets criteria	May meet criteria
S3	Does not meet criteria, but eliminates CSO discharges up to a 5-year event	Meets criteria	Likely meets criteria	May meet criteria	Likely meets criteria	May meet criteria
C1	Does not meet criteria, but eliminates CSO discharges up to a 5-year event	Meets criteria	Likely meets criteria	May meet criteria	Likely meets criteria	May meet criteria
M1	Does not meet criteria, but eliminates CSO discharges up to a 5-year event	Meets criteria	Likely meets criteria	May meet criteria	Likely meets criteria	May meet criteria
M2	Does not meet criteria, but eliminates CSO discharges up to a 5-year event	Meets criteria	Likely meets criteria	May meet criteria	Likely meets criteria	May meet criteria
M3	Does not meet criteria, but eliminates CSO discharges up to a 5-year event	Meets criteria	Likely meets criteria	May meet criteria	Likely meets criteria	May meet criteria
M4	Does not meet criteria, but eliminates CSO discharges up to a 2-year event	Meets criteria	Likely does not meet criteria	May meet criteria	Likely does not meet criteria	May meet criteria

[a] When determining whether a scenario would meet criteria for maintaining affordable rates and compliance with the implementation schedule, it was determined that a 30-year implementation period was the maximum implementation period that would be acceptable to stakeholders.

5.4 Comparison of Selected Control Scenarios

5.4.1 Selection of Preferred Scenarios

Per the advanced system planning approach outlined in Section 5.1.3, the next step in the evaluation process was to identify selected control scenarios. The selection of preferred scenarios was determined through a stakeholder screening process which involved completion of a survey and subsequent discussion of preferences. The preferred scenarios were then optimized based on Stakeholders feedback and evaluated through the verification process. A summary of this process is provided below.

5.4.1.1 Stakeholder Workgroup Surveys and Response

To identify the preferred scenario of the workgroup, the stakeholders were presented with a survey to re-rate their five priority criteria (from 1 to 5, 5 being the most important), select their top three preferred scenarios and rate the scenarios against the criteria using the rating system shown in Table 5-18. They were also encouraged to suggest improvements, if necessary, to their preferred scenario. The stakeholders were given an information packet that provided them with fact sheets on each scenario that included the following information: a summary; location map; list of included control projects along with costs (capital, O&M and equivalent annual cost); and summary of performance benefits, including characteristics of CSO discharges and water quality benefits. The survey, corresponding information packet and responses are in Appendix A. The E1 scenario was not included in this survey because this scenario is required to be evaluated per the CD (described in Item 65).

A total of six surveys were received. The ratings for each of the criteria for each scenario where then multiplied by the priority rating to give a score for each priority for each scenario. The scores for each scenario were then added to provide a total score. The scores for each scenario were then totaled and compared to determine which scenario was preferred. Figure 5-28 shows the results of the surveys. The stakeholders' responses were discussed with the group during stakeholder meeting 8. Each of the stakeholders present had an opportunity to discuss what scenario they preferred, why they preferred that scenario and what improvements they would like to see incorporated into a final selected scenario.

The results and subsequent discussion indicated that scenarios C1 and S3 were the preferred scenarios. Scenario C1 was preferred because it met all of the criteria determined by the stakeholders, particularly with keeping sewer rates at or below affordability limits. Scenario S3 was also preferred because it met stakeholder criteria, particularly concerning meeting water quality standards in Newport Harbor.

The stakeholders identified additional modifications to the preferred scenarios to be included in the final modification. These modifications include:

- Scenario C1: Identify control options to achieve a 10-year level of control at the WACSOTF
- Scenario S3: Include the Catchment 10 pump station (CU-2) and some level of I/I reduction.

These considerations were taken into account when the scenarios were finalized for final performance and effectiveness evaluations.

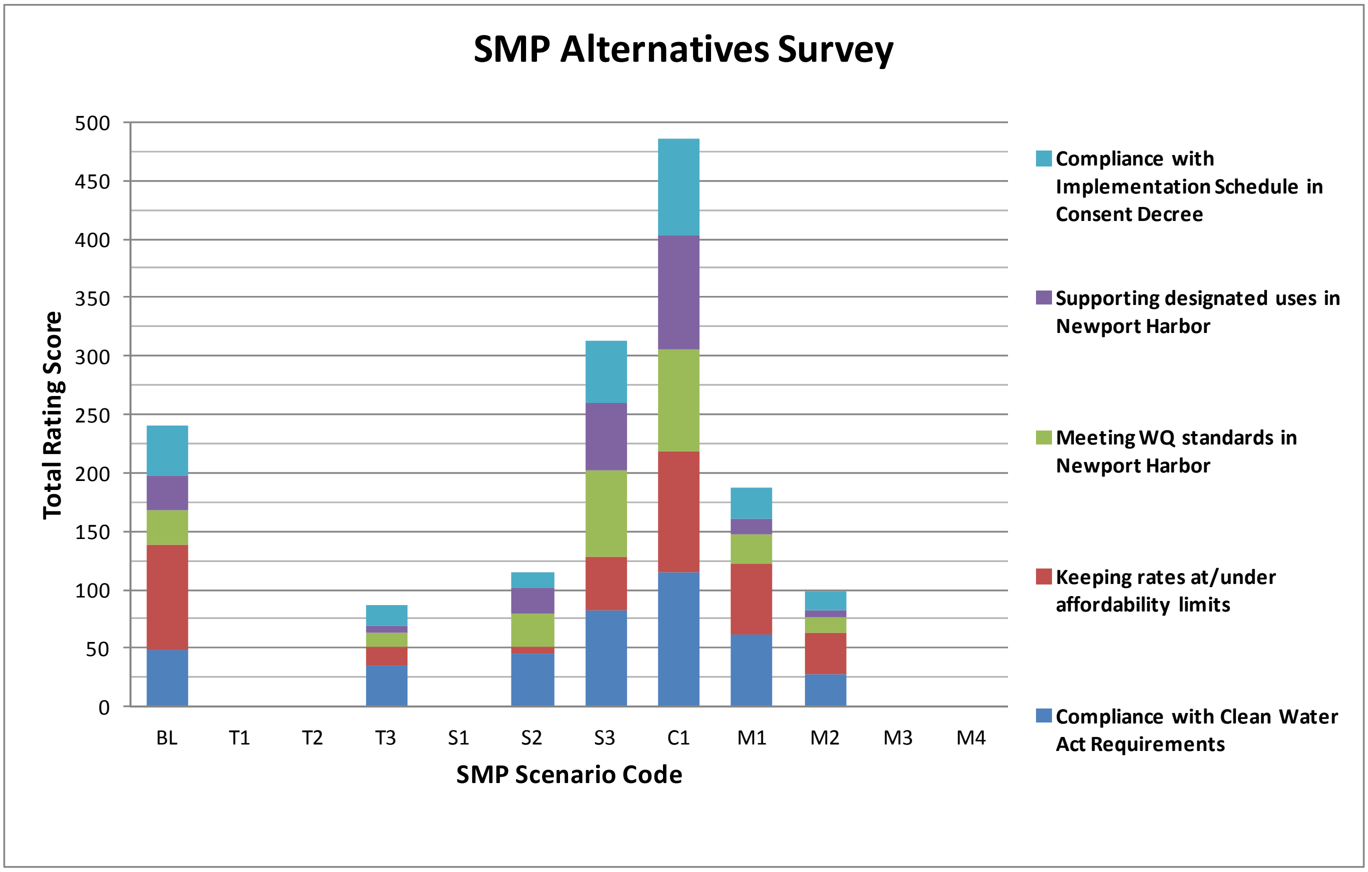


Figure 5-28. Results of Stakeholder Survey on SMP Control Scenarios

5.4.1.2 Optimization of Preferred Control Scenarios

Based on stakeholder feedback, scenarios C1 and S3 were re-evaluated to determine which control technologies may be optimized within or added to the scenario prior to final performance evaluations. Results from hydraulic model runs were reviewed and some existing components in the models were optimized to address stakeholder feedback as well as improve CSO reduction. For scenario C1, the level of inflow reduction was increased to 50 percent based on the planning level of I/I reduction estimated in Section 5.2.1.1 and the pump capacities for the pumps at the WACSOTF were increased to 2 MGD. These optimizations eliminated CSOs at the WACSOTF. No adjustments to existing scenario components were made for scenario S3.

Scenarios were then reviewed to identify potential control projects that should be added to address the regulatory framework or to better meet the stakeholder priority criteria. For scenario C1, dechlorination was added to the WSCSOTF to improve the effluent discharge quality. This project was given Project Code CSOT-2 and includes installing chemical storage and dosing units. The construction cost for this component is $101,000. For scenario S3, the Catchment 10 pump station and downspout disconnection were added to the scenario, which eliminated discharges at both the CSO facilities for up to a 10-year, 6-hour event. CEPT was also added to improve the effluent discharge quality due to the extended peak WWFs at the plant.

The scenario IDs were updated to reflect the modifications of the C1 and S3 scenarios to C1A and S3A, respectively. The modified control scenarios were presented to the stakeholders for final review during stakeholder workgroup meeting 9. One final modification was the addition of stormwater conveyance improvements to C1A. These improvements could include replacing or upgrading existing stormwater pipe as well as adding new stormwater pipe to convey additional stormwater volume. The estimated construction cost for improvements for scenario C1A is $5,061,000, which assumes that approximately 7,000 linear feet of 24 to 36-inch diameter pipe would be replaced or added at unit cost of $720/linear feet.

5.4.1.3 Final Selected Scenarios

The selected scenarios for final evaluations are: BL, E1, Conveyance 1A (C1A) and Storage 3A (S3A). Table 5-43 provides a summary of the control technologies used in each of the scenarios.

TABLE 5-43
Control Projects for the Final Selected Scenarios

	Scenario			
Control Technology	**BL**	**E1**	**C1A**	**S3A**
Baseline Projects (Recently Completed or Planned CIP Projects)	●	●	●	●
II-4 Downspout Disconnection		●	●	●
II-14 Inflow Removal for Middletown		●		
II-15 Inflow Removal for Navy		●		
II-A Inflow Reduction – Private Sources (Not Including Downspouts)		●		
II-B Inflow Reduction – Public Sources		●		
II-C Additional Inflow Removal (to Achieve 50% Inflow Removal)			●	
SO-1 WPCP Flow Optimization		●	●	●
SO-2 Increased Pumping Capacity/Better Use of System Capacity		●		●
SO-3 Weirs		●	●	●
CSOT-2 Modify Treatment with Dechlor at Washington			●	
CU-2 (Catchment 10 Reroute)			●	●
CU-4 Additional Pumping at WACSOTF sanitary pumps (2 MGD pumps)			●	
CU-5 Upsize Wellington Force Main			●	
CU-6 Stormwater Conveyance Improvements for E1		●		
CU-7 Stormwater Conveyance Improvements for C1A			●	
OS-11 (Washington CSO Facility)				●
OS-19 (King Park, Wellington Avenue by CSO Treatment Facility)				●
WPCP-1 WPCP Upgrade & Expansion		●	●	●
WPCP-2 CEPT				●
SW-1 Stormwater Treatment – WSCSO Facility		●		
SW-2 Stormwater Treatment – WACSO Facility		●		

5.4.2 Discharge Reduction and Water Quality Benefits

5.4.2.1 CSO Discharge Reduction for Design Events

The performance of the four scenarios were evaluated using design events as noted in Section 5.1.3 and compared to existing conditions using the calibrated 2012 hydraulic model. Table 5-44 summarizes the CSO discharge volumes for the 2-year, 5-year and 10-year design events. Figures 5-29, 5-30, and 5-31 summarize the projected CSO reduction at the WACSOTF and WSCSOTF for the 2-year, 5-year, and 10-year, 6-hour design events, respectively.

Results indicate that scenarios E1 and S3A eliminate CSO discharges for up to a 10-year, 6-hour event. Scenario C1A eliminates all CSO discharges at WACSOTF and 98 percent of CSO discharges at WSCSOTF for a 10-year, 6-hour event.

TABLE 5-44
CSO Discharge Volumes for Selected Control Scenarios

	CSO Discharge Volumes (MG)					
	2-year, 6-hour event		5-year, 6-hour event		10-year, 6-hour event	
Scenario	**WACSOTF**	**WSCSOTF**	**WACSOTF**	**WSCSOTF**	**WACSOTF**	**WSCSOTF**
EC	1.29	3.24	1.83	5.05	2.71	6.76
BL	1.09	2.61	1.78	4.07	2.67	5.81
E1	0	0	0	0	0	0
C1A	0	0	0	0	0	0.19
S3A	0	0	0	0	0	0

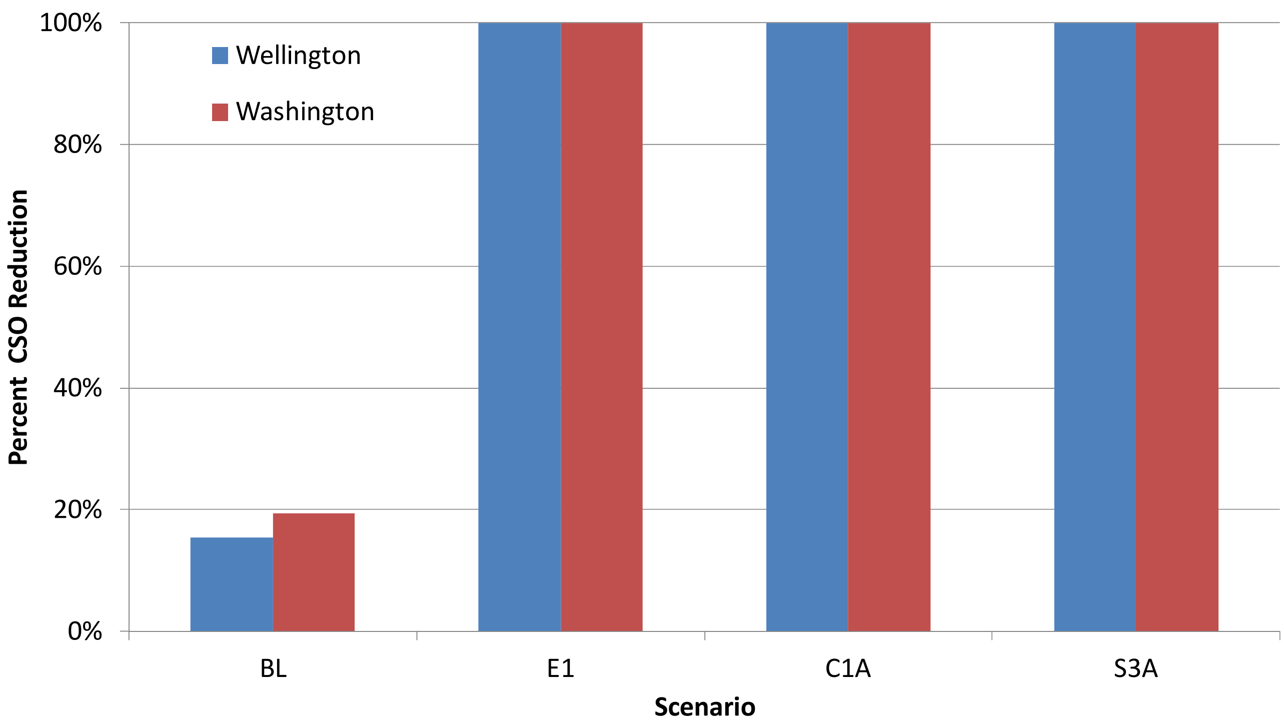


Figure 5-29. Percent CSO Reduction for the WACSOTF and WSCOTF for a 2-year, 6-hour Design Event

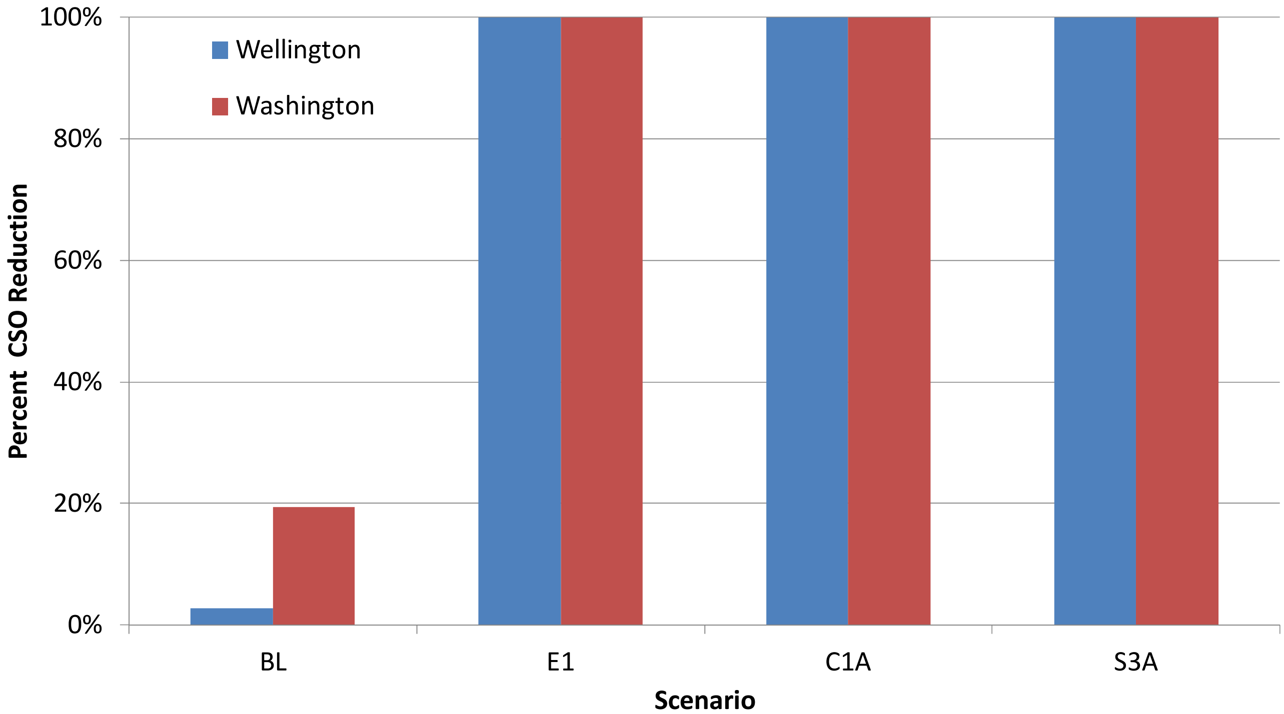


Figure 5-30. Percent CSO Reduction for the WACSOTF and WSCOTF for a 5-year, 6-hour Design Event

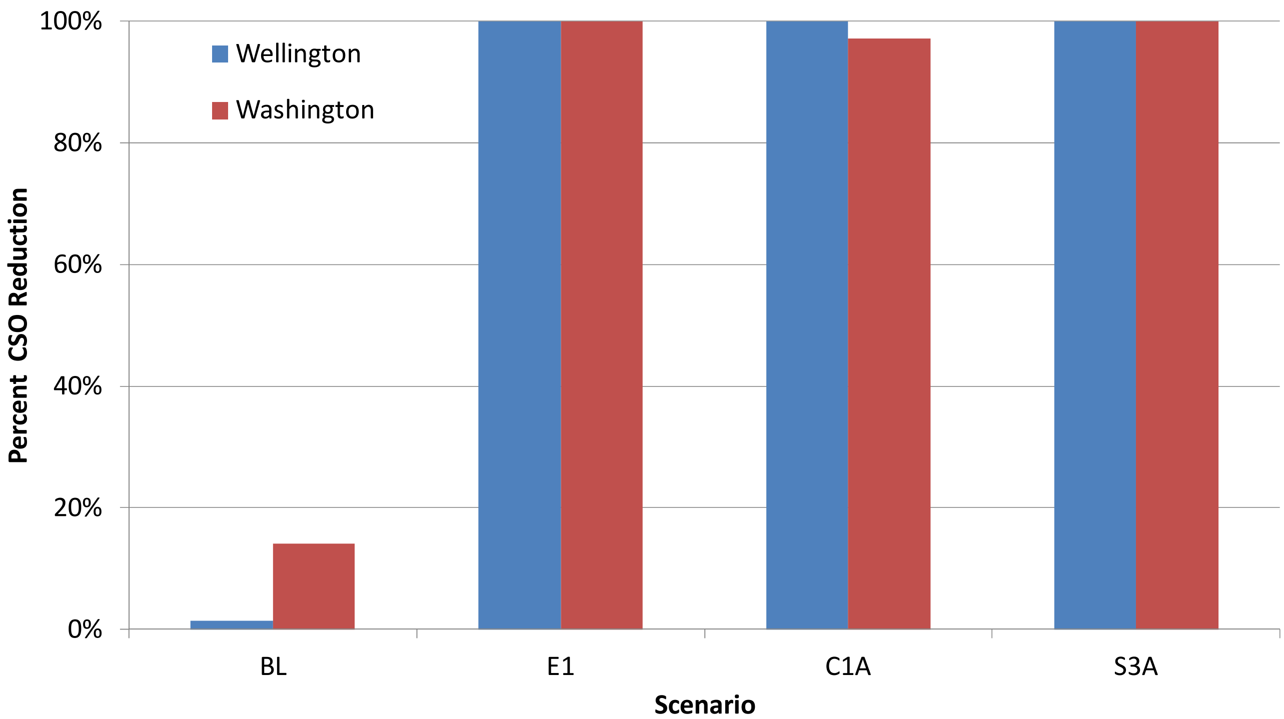


Figure 5-31. Percent CSO Reduction for the WACSOTF and WSCOTF for a 10-year, 6-hour Design Event

5.4.2.2 CSO Discharge Reduction for the Typical Year

A summary of the performance evaluation for the four selected scenarios for the 1996 typical year is shown in Table 5-45.

TABLE 5-45
CSO Discharge Reduction for a Typical Year

Scenario	Count of CSO Events		Total Volume of CSO Discharge		Percent CSO Reduction (compared to Existing Conditions)	
	WACSOTF	WSCSOTF	WACSOTF	WSCSOTF	WACSOTF	WSCSOTF
EC	12	12	11.1	27.7	NA	NA
BL	12	10	10.5	19.0	5.4%	31.4%
E1	0	0	0	0	100%	100%
C1A	0	0	0	0	100%	100%
S3A	0	0	0	0	100%	100%

Analysis of the typical year indicates that all scenarios provide CSO reduction compared to existing conditions. The BL scenario provides a small reduction at the WACSOTF, but a more significant reduction at the WSCSOTF, which is largely due to the improvements at the WPCP. Scenarios E1, C1A and S3A all eliminate CSOs for the typical year.

5.4.2.3 Water Quality Analysis for the Typical Year

A preliminary annual pollutant load analysis was performed for TSS, BOD and fecal coliform loads for typical year to determine the projected impact on water quality as shown in Figures 5-32, 5-33, and 5-34, respectively. The pollutant load analysis results indicate that pollutant loads for TSS and BOD generally decrease compared to existing conditions and scenarios with storage have the most reduction. Also, fecal coliform loading significantly increases with the addition of untreated stormwater runoff as a result of inflow source reduction.

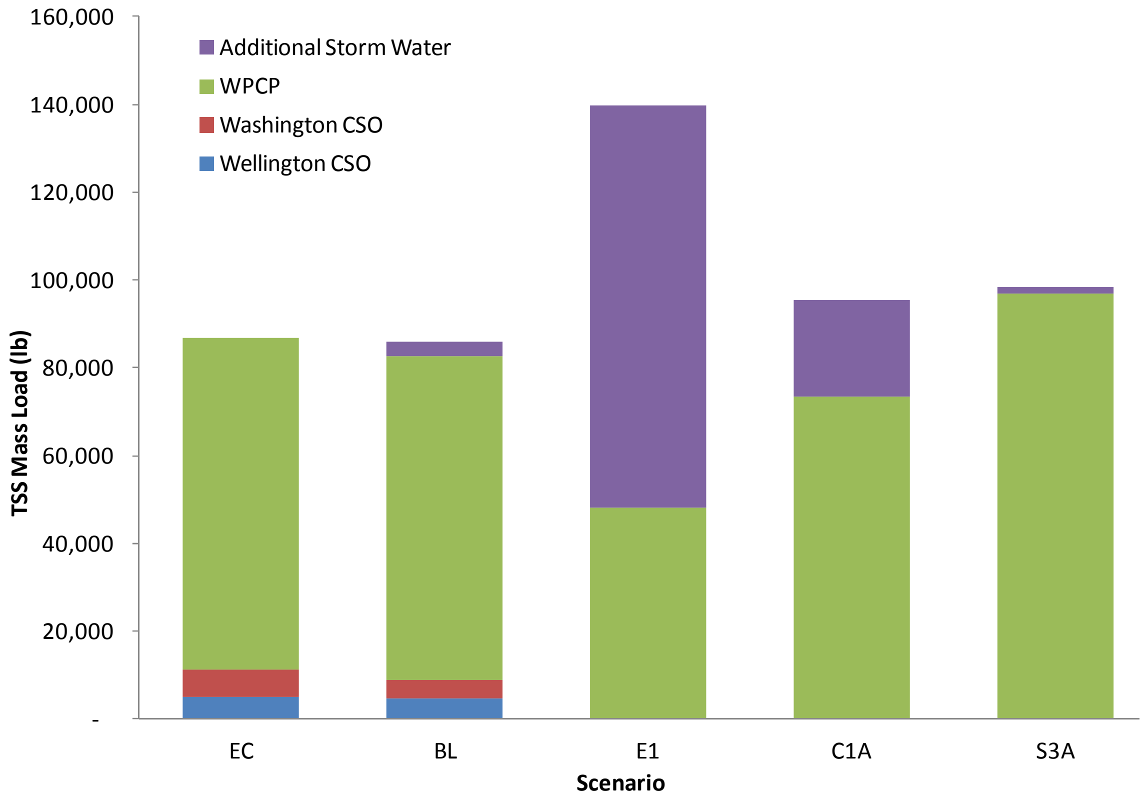


Figure 5-32. Projected Annual TSS Load

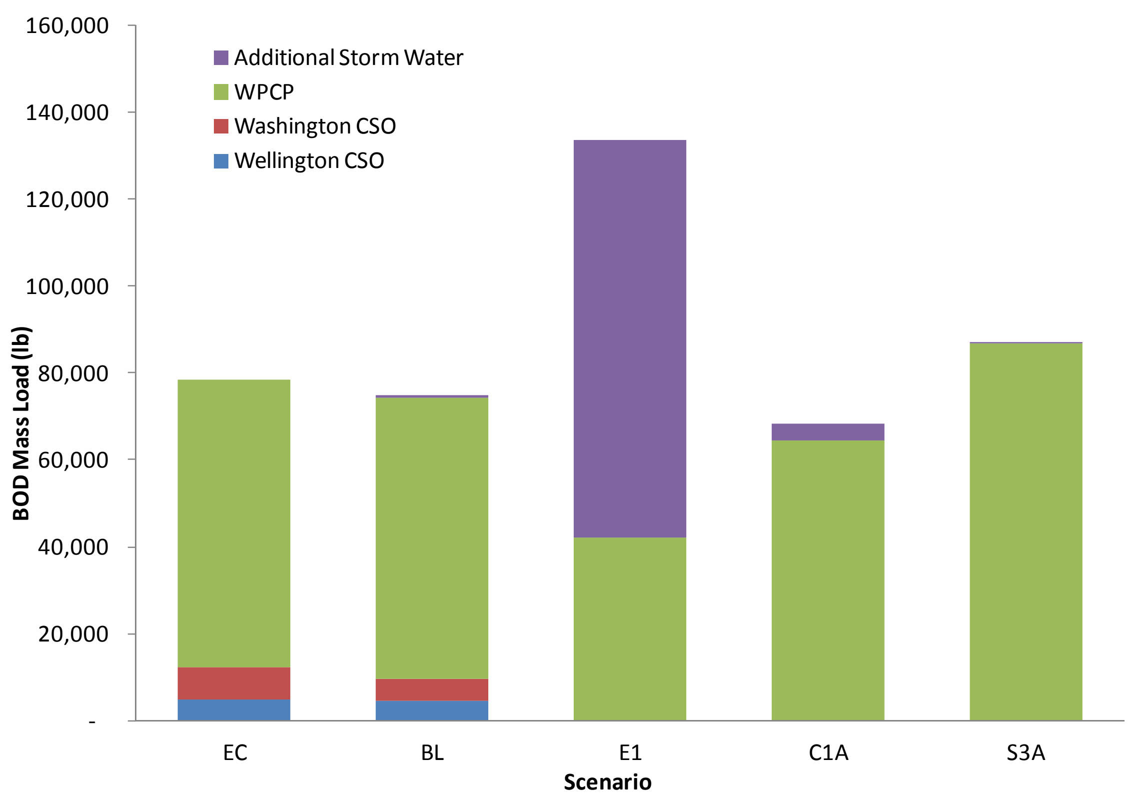


Figure 5-33. Projected Annual BOD load

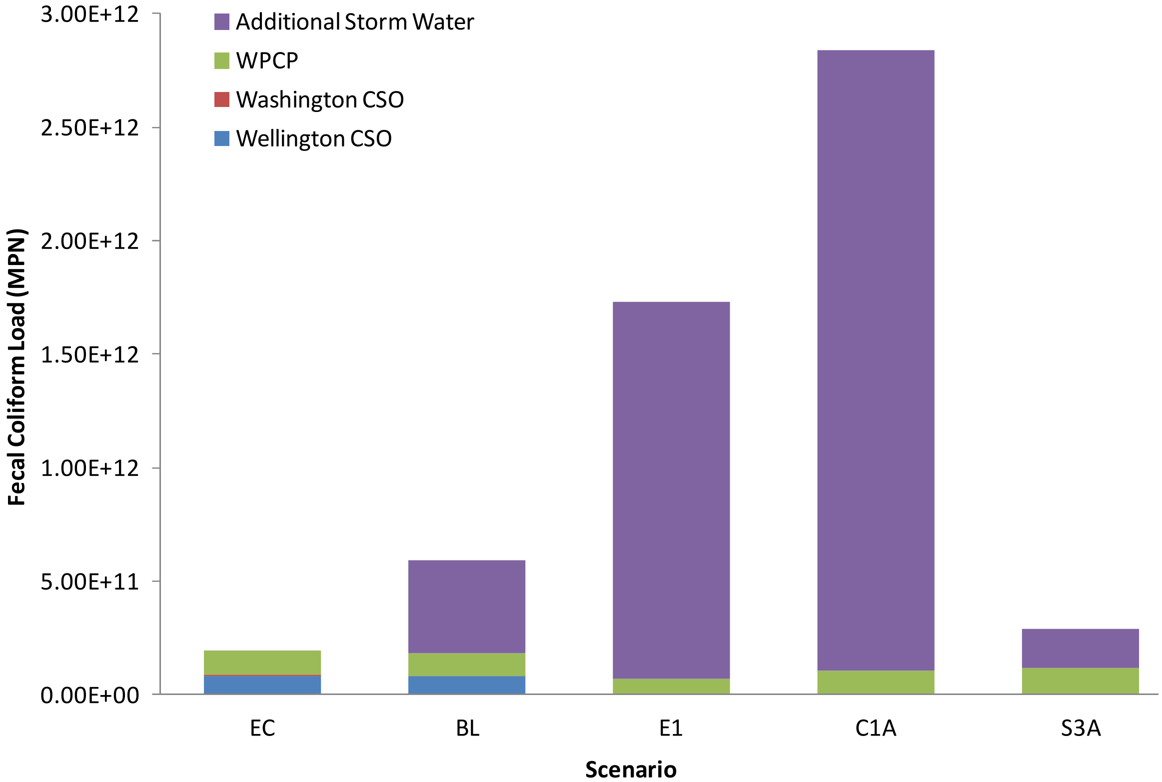


Figure 5-34. Projected Annual Fecal Coliform load

5.4.3 Scenario Costs

Summaries of the control technologies and costs included in the C1A and S3A scenarios are in Tables 5-46 and 5-47. Summaries of the control technologies and costs included in the BL and E1 scenarios can be found in Sections 5.1.3.2 and 5.2.2.4, respectively. Detailed project costs for the scenarios are presented in Table G-1 in Appendix G.

TABLE 5-46
Summary of Control Technologies and Costs for Scenario C1A

Project Code	Name/Brief Description	Total Capital Cost	Change in Annual O&M Cost	Equivalent Annual Cost
BL	Baseline (includes all Baseline projects)	$ 31,487,000	$ (8,000)	$ 1,029,000
WPCP-1.2	WPCP Upgrade & Expansion, Option 2 (primary clarifiers)	$ 6,130,000	$ -	$ 243,000
WPCP-1.3	WPCP Upgrade & Expansion, Option 3 (aeration tank & final clarifier)	$ 10,842,000	$ -	$ 392,000
SO-1	WPCP Flow Optimization	$ -	$ -	$ -
SO-3	Weirs	$ 189,000	$ -	$ 6,000
CU-2	Catchment 10 Reroute (new 3.5 mgd PS)	$ 4,788,000	$ 68,000	$ 241,000
CU-4	Additional Pumping of WACSOTF Sanitary Pumps (2 mgd)	$ 861,000	$ 15,000	$ 46,000
CU-5	Upsize Wellington Forcemain	$ 204,000	$ -	$ 7,000
CU-7	Stormwater Conveyance Improvements for C1A	$ 8,224,000	$ -	$ 297,000
II-4	Downspout Disconnection	$ 13,630,000	$ (27,000)	$ 472,000
II-C	Additional Inflow Removal (to Achieve 50% Inflow Removal)	$ 23,183,000	$ (46,000)	$ 802,000
CSOT-2	Modify Treatment with Dechlor at Washington	$ 164,000	$ 1,000	$ 7,000
	Scenario Totals:	$ 99,701,000	$ 2,000	$ 3,542,000

TABLE 5-47
Summary of Control Technologies and Costs for Scenario S3A

Project Code	Name/Brief Description	Total Capital Cost	Change in Annual O&M Cost	Equivalent Annual Cost
BL	Baseline (includes all Baseline projects)	$ 31,487,000	$ (8,000)	$ 1,029,000
WPCP-1.2	WPCP Upgrade & Expansion, Option 2 (primary clarifiers)	$ 6,130,000	$ -	$ 243,000
WPCP-1.3	WPCP Upgrade & Expansion, Option 3 (aeration tank & final clarifier)	$ 10,842,000	$ -	$ 392,000
WPCP-1.4	WPCP Upgrade & Expansion, CEPT	$ 8,519,000	$ 424,000	$ 732,000
OS-11	Washington CSO Facility Storage (3MG)	$ 21,567,000	$ 26,000	$ 759,000
OS-19	King Park, Wellington Ave by CSO Facility, Storage (0.9MG)	$ 17,629,000	$ 27,000	$ 626,000
SO-1	WPCP Flow Optimization	$ -	$ -	$ -
SO-2	Increased Pumping Capacity/Better Use of System Capacity	$ -	$ 22,000	$ 22,000
SO-3	Weirs	$ 189,000	$ -	$ 6,000
CU-2	Catchment 10 Reroute (new 3.5 mgd PS)	$ 4,788,000	$ 68,000	$ 241,000
II-4	Downspout Disconnection	$ 13,630,000	$ (27,000)	$ 472,000
	Scenario Totals:	$ 114,780,000	$ 531,000	$ 4,520,000

5.4.4 Financial Capability and Affordability Analysis

The affordability of wastewater services encompasses a number of elements that include the ability of a community to finance required facilities and the ability of individual customers to pay their bills for service.

In addition, for CSO and SSO programs, there is a regulatory element to the consideration of affordability. The negotiation of programs and schedules between local utilities and the Federal and state regulatory agencies are often closely tied to Federal guidance documents that define a framework for assessing the capability of communities to undertake the identified programs.

The primary Federal guidance document related to affordability for CSO programs is the February 1997 EPA document *Combined Sewer Overflows – Guidance for Financial Capability Assessment and Schedule Development* (the Guidance) (USEPA, 1997) and is described in Appendix H. Based on this guidance, the following section discusses the financial capability analysis for the City.

5.4.4.1 City of Newport Financial Capability Analysis

The results for the City of Newport for the Financial Capability Analysis were developed in the third quarter of 2011, based on best available information at that time. Sources of information used in developing this update include:

- Published information, such as U.S. Census Bureau data and information from State and Federal agency websites.
- Information contained on the City's website, including the adopted budget for fiscal year (FY) 2011-2012, the City's Comprehensive Annual Financial Report (CAFR) for FY 2010, and other recent financial and other information related to the utility system and the City's overall financial indicators.
- Information provided by the City to CH2M HILL related to some indicators, such as full market value and valuation conventions used by the City.

The Financial Indicator score that was developed for the City is presented in Figure 5-35. Newport's ratings for each indicator are highlighted by the category in which they fell: green for strong, yellow for mid-range, and red for weak.

Calculation of Newport's Financial Indicators Score					
Indicator	Newport Results	Score	Strong	Mid-Range	Weak
Bond Rating	AA - S&P	3	AAA-A (S&P) Aaa-A (Moody's)	BBB (S&P) Baa (Moody's)	BB-D (S&P) Ba-C (Moody's)
Overall Net Debt as a Percent of Full Market Property Value	0.84%	3	Below 2%	2% - 5%	Above 5%
Unemployment Rate	1% above the National Average (10.1% for Newport vs. 9.1% National Average)	2	More than 1 Percentage Point Below the National Average	1 Percentage point or less above or below the National Average	More than 1 Percentage Point Above the National Average
Median Household Income	1.11	2	More than 25% Above Adjusted National MHI	± 25% of Adjusted National MHI	More than 25% Below Adjusted National MHI
Property Tax Revenues as a Percent of Full Property Value	1.07%	3	Below 2%	2% - 4%	Above 4%
Property Tax Collection Rate	97.37%	2	Above 98%	94% - 98%	Below 94%
		2.50	MID-RANGE		

Figure 5-35. 2011 Newport Financial Indicators Scores

5.4.4.2 Additional Local Considerations for City of Newport Financial Capability Analysis

The local considerations evaluated during the City's financial capability analysis include the factors presented below.

Excluded Elements

The City has initiated an $85 million capital program related to its regional drinking water system. In addition, the City is constructing the Claiborne Pell Elementary School at a cost of approximately $24 million. These major capital obligations are excluded from the analyses summarized above because of limitations of the Guidance, but are being borne by the same rate payers. This affects the affordability issue for the City's customers in two ways. The outstanding debt from the drinking water program (and the wastewater program) is excluded from the Overall Net Debt as a Percent of Full Market Value indicator; if this debt were included, the City might not rate "strong' in this indicator. In addition, the substantial annual user charges that customers of the drinking water utility will have to pay to repay the debt for the drinking water CIP are not considered anywhere in this analysis, but they certainly do affect the ability of these customers to pay 2 percent of their household income for wastewater charges.

Snapshot Analysis

The City has seen some of its financial indicators (unemployment rate, household income, etc.) fluctuate up and down during the past 5-10 years based on local, national, and global economic factors. Over the course of a 20- or 30-year repayment period, there is a reasonable prospect that the City's financial situation could degrade from the point in time that the analysis was completed, but the methodology defined in the Guidance requires this type of single point in time analysis. Therefore it would be prudent to re-evaluate the City's financial capability on a regular basis and adjust the implementation schedule as necessary to ensure that wastewater charges do not become burdensome to the City's rate payers.

Income Profile Beyond MHI

Given the fact that Newport has an unemployment rate above 10 percent, it is likely that there are many households with incomes well below the MHI. The ability of those extremely low-income households to absorb wastewater charges related to the CSO Program is a greater challenge than for a household at or above the MHI. For some of these households, additional utility bills to find the CSO Program could be the final straw – the trigger that causes them to lose their homes, be forced out of their rental units, or other such severe personal financial consequences.

The impact of the wastewater program on commercial and industrial customers has not been studied in detail at this point. Because many types of commercial businesses use more water than residential customers, the possibility of significant financial impacts is very real. Given the tight overall economic climate, the prospect of significant increases in utility bills could be a trigger that causes businesses to reduce operations or close their businesses, aggravating the unemployment situation in a community with unemployment already above the national average.

5.4.4.3 Implementation Schedules

The implementation schedules for the three selected scenarios were evaluated to determine how project schedules and costs may be distributed based on project phasing and projected financial capability. The recommended implementation schedules follow EPA's *Combined Sewer Overflows: Guidance for Long-Term Control Plan* (USEPA, 1995), which recommends a phased and prioritized implementation approach "…based on the relative importance of adverse impacts on water quality standards and designated uses." Other considerations include time for pilot-testing, obtaining permits, and obtaining funding. Based upon good long-term planning practices, as well as the request of the CSO Stakeholder workgroup, it is suggested that the recommended implementation schedule include interim periods between phases to report CSO control results and monitoring program results.

The preliminary implementation schedules for the E1, C1A and S3A scenarios are presented in Figures 5-36, 5-37, and 5-38. The project phasing for all scenarios considered the most critical projects for reducing CSOs at the WACSOTF and WSCSOTF and consequently improving water quality, which included improvements at the WPCP, system optimization projects, and WACSOTF sanitary pump improvements. All schedules include phasing of I/I reduction as well as a program assessment every five years to determine the effectiveness of the I/I program as well as the effectiveness of the other CSO control projects and to reevaluate the City's financial capability.

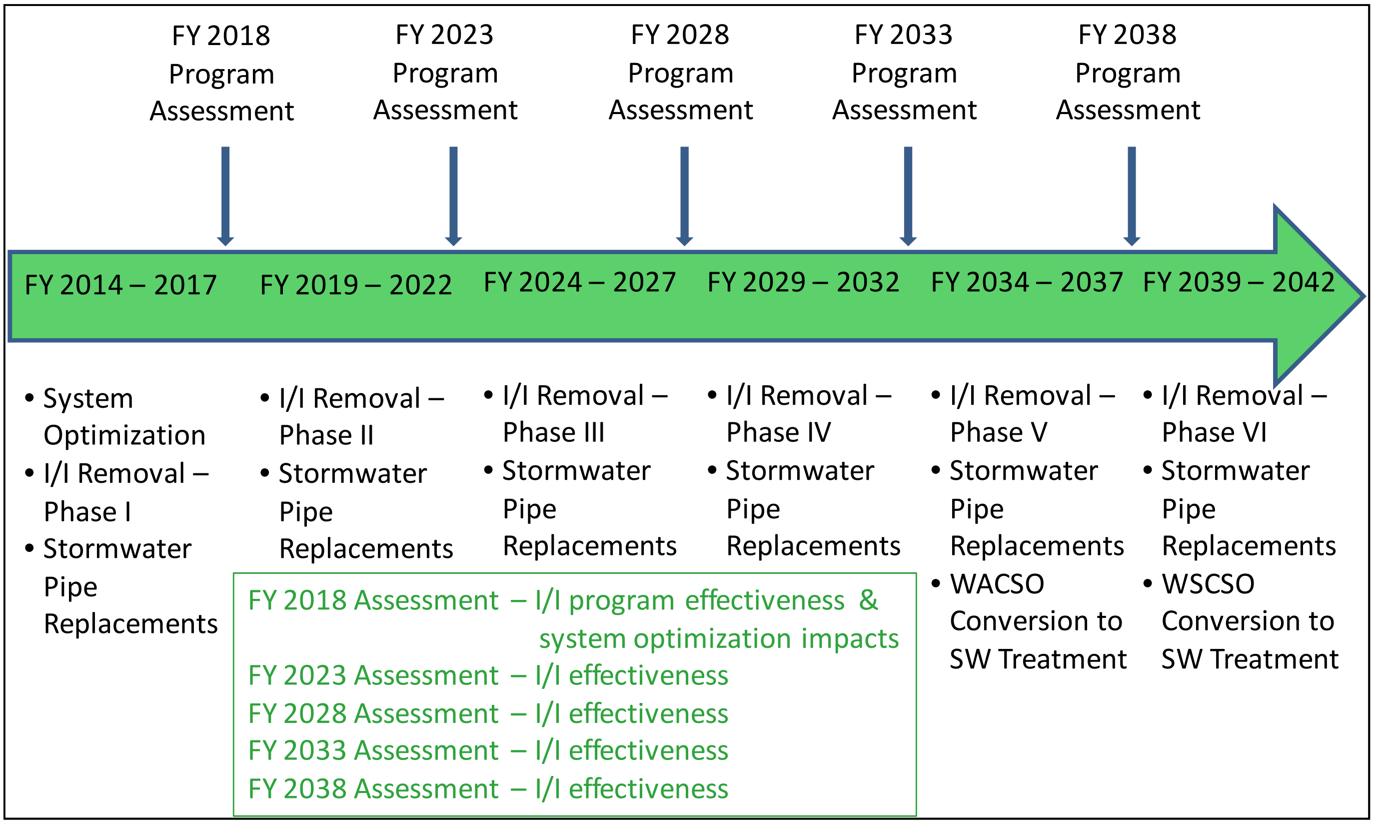


Figure 5-36. Implementation Schedule for Scenario E1

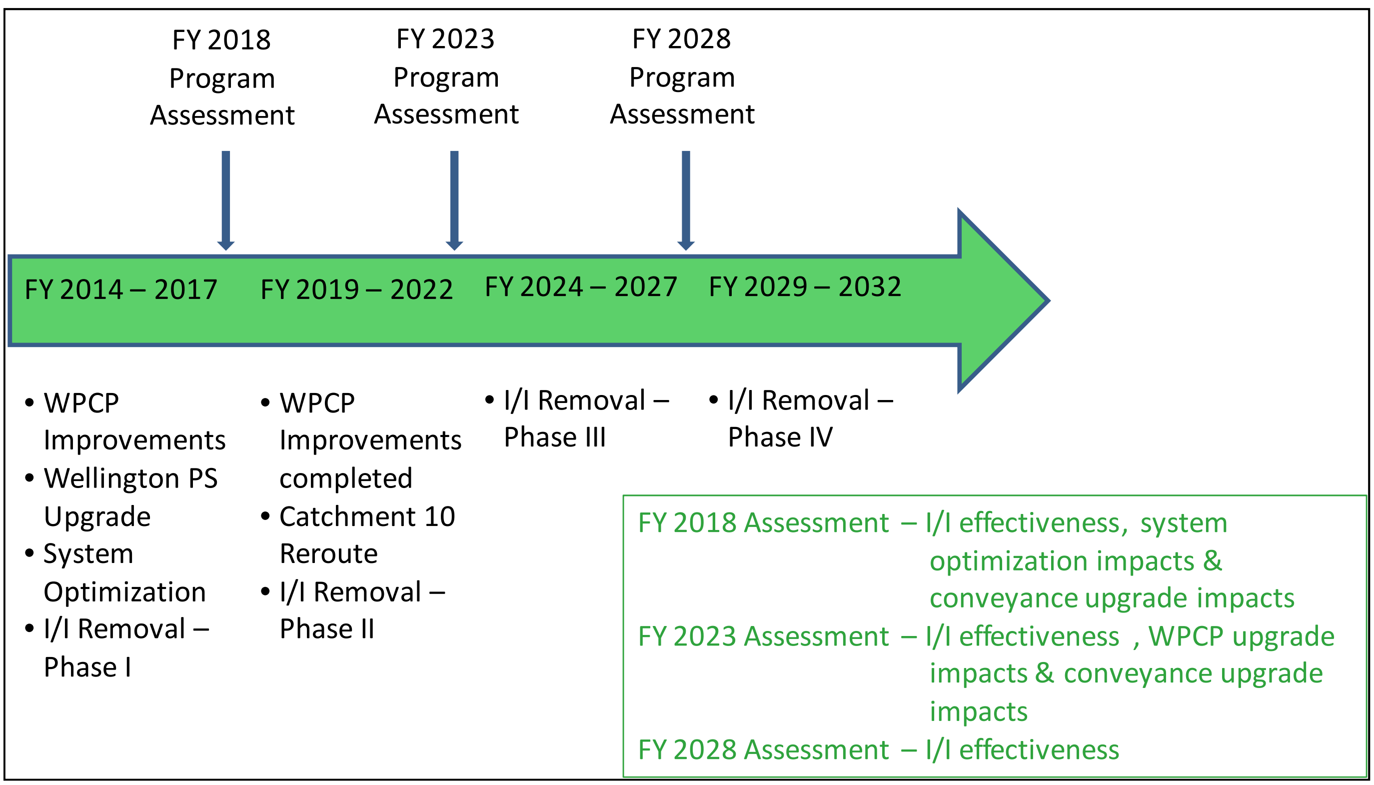


Figure 5-37. Implementation Schedule for Scenario C1A

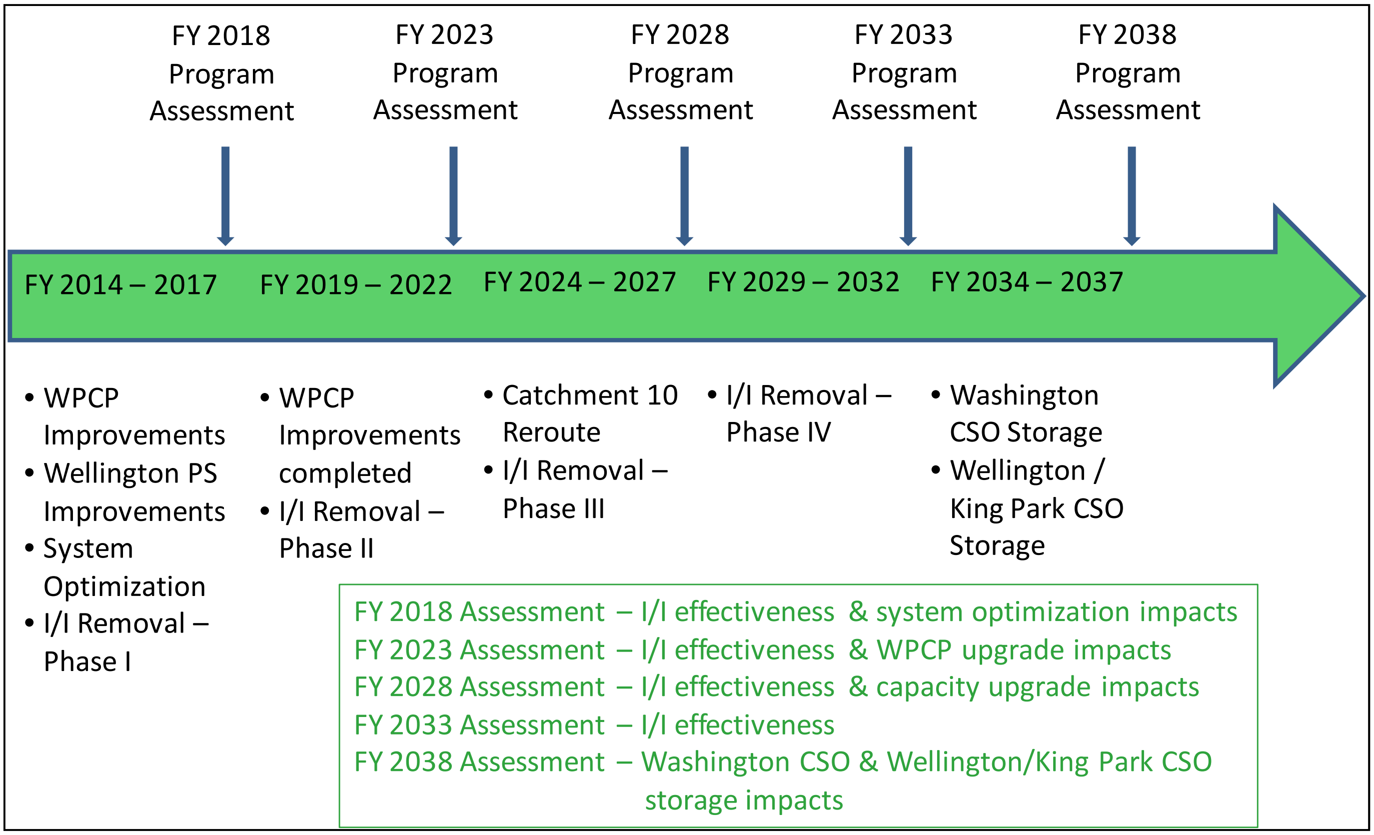


Figure 5-38. Implementation Schedule for Scenario S3A

5.4.4.4 Projected Rate Impacts

For purposes of this analysis, rate impacts are expressed in terms of typical residential sewer bill as a percentage of MHI. The average residential water consumption is approximately 12,000 gallons per quarter. The MHI is estimated based on 2010 Census and expressed in 2012 dollars based on Consumer Price Index (CPI). Projected typical residential rates are estimated based on the rate revenue requirements for each of the three selected scenarios, which include costs for wastewater treatment and CSO improvements.

Appendix H provides the financial data used for the evaluation of rate impacts and key assumptions and inputs for the evaluation of rate impacts associated with CSO projects. Appendix H also provides detailed tables and figures for the affordability projected rate impacts.

Based on the Financial Indicators Score of mid-range (see Figure 5-35), the Guidance indicates that a Newport household earning the median household income can afford to pay up to 2 percent of its annual income for wastewater programs before the charges impose an excessive burden. Table 5-48 shows the resulting estimate of the maximum affordable annual sewer bill for a Newport household earning the MHI. As shown in the table, based on an estimated MHI of $59,705 (2012 dollars), the Guidance document's methodology would result in a threshold of $1,194 (2012 dollars) for annual wastewater charges.

Because current wastewater charges are estimated at $733 ($192 CSO fixed Fee plus $541 sewer charge based on a rate of $11.27 per 1,000 gallons and water use of 12,000 gallons quarterly) for a typical residential customer, the Guidance's methodology indicates an estimated margin of approximately $461 before wastewater charges impose an excessive burden on residential customers.

TABLE 5-48
Summary of Control Technologies and Costs for Scenario S3A

Item	Value	Source / Assumption
Median Household Income (MHI)	$55,916	Newport MHI for 2009 was $55,916, per the Adopted 2011-12 budget, page 5.
CPI (2009)	214.537	Annual Average 2009, ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt
CPI (2012)	229.073	8/1/2012, ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt
Adjustment Factor	1.068	CPI (2012)/CPI (2009)
Adjusted MHI	$59,705	
2% of Adjusted MHI	$1,194	
Sewer Charge	$541	Assume 47,992 gallons per year, $11.27 per gal, effective July 1, 2011
CSO Fixed Fee	$192	< 1-inch meter, effective July 1, 2011
Total Sewer Bill for Typical Residential Customer	$733	
Remainder Available Within "Affordability Threshold"	$461	Subject to change based on future rate increases

It is important to understand that the rate impacts presented in this report are based on a high level rate analysis and are preliminary and based upon best available information. The projected rates are preliminary and are not final adopted rates for the City. Sewer rates are subject to additional review by Department of Utilities Administration and approval by the City. The rates that are implemented will be determined as part of a detailed cost of service rate study and approved by City Council.

Rate impacts are evaluated for three scenarios:

- E1
- C1A
- S3A

E1

For scenario E1, a 20-year and 30-year implementation periods were considered. In addition, the scenario considers the impacts of funding private I/I removal both with sewer rates and/or CSO fixed fee and by the property owner. This helps illustrate the magnitude of the projects and how the costs impact the rates. Figure 5-39 graphically summarizes the rate impacts for the 20-year implementation period. Figure 5-40 graphically summarizes the rate impacts for the 30-year implementation period. In comparison, scenario E1 exceeds the 2 percent affordability threshold. In year 2021, the 20-year implementation option exceeds the affordability threshold and peaks at over 3 percent of MHI in 2032. By extending projects out an additional 10 years, the 30-year implementation option exceeds the affordability threshold in 2024 and peaks at over 2.5 percent of MHI in 2036.

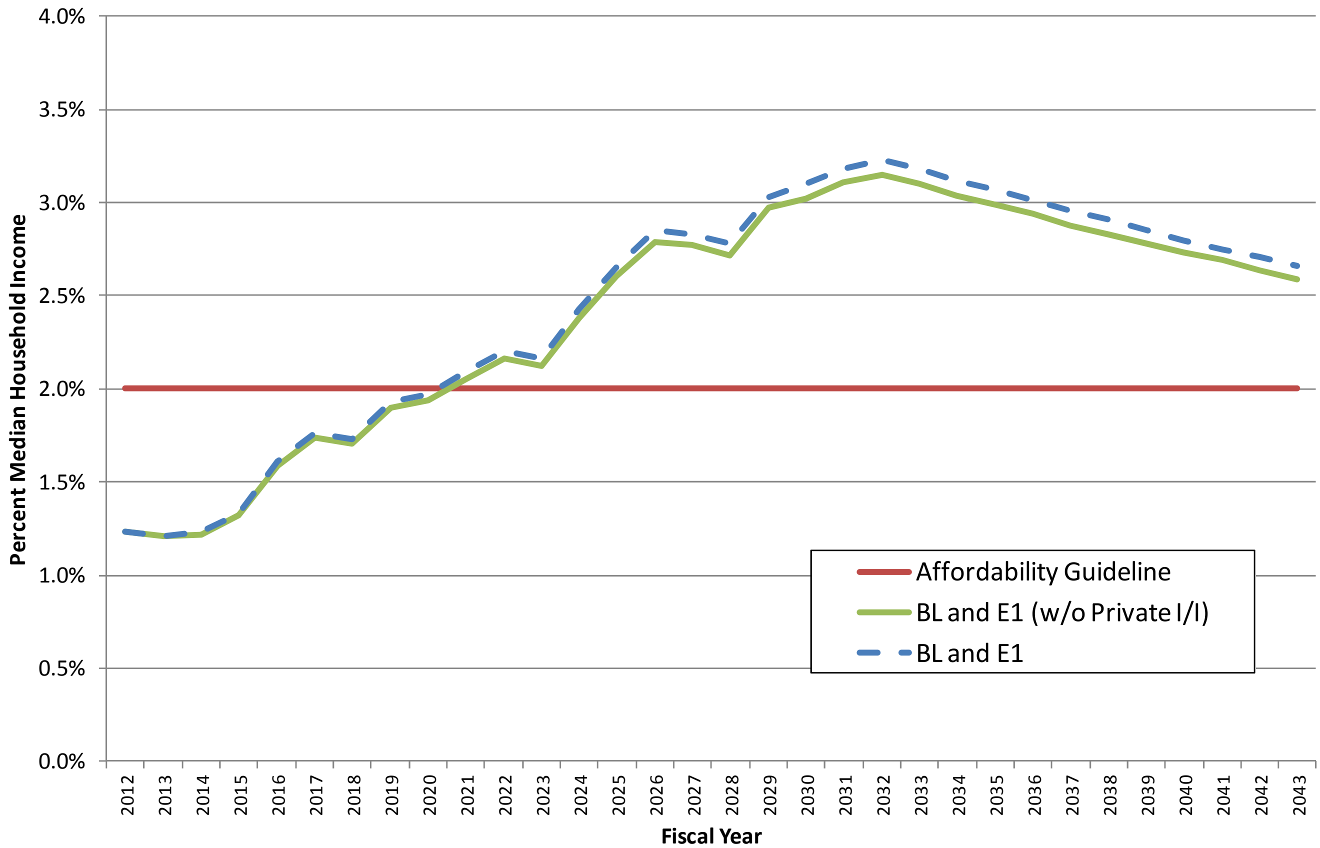


Figure 5-39. Typical Residential Annual Sewer Bill as a Percentage of MHI for the Elimination Scenario (20-Year schedule)

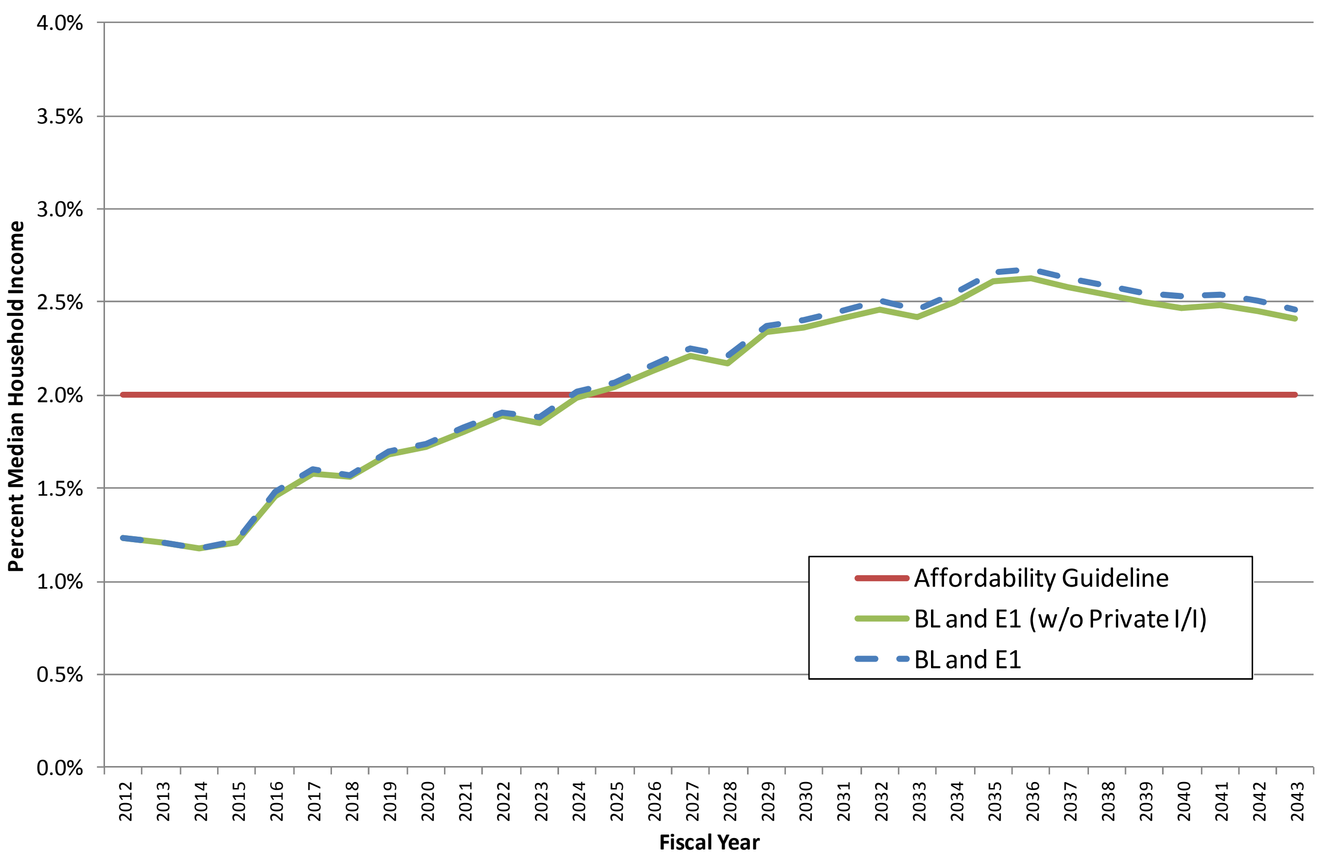


Figure 5-40. Typical Residential Annual Sewer Bill as a Percentage of MHI for the Elimination Scenario (30-Year schedule)

C1A

For scenario C1A, only a 20-year implementation period was considered. In addition, the scenario considers the impacts of funding private I/I removal both with sewer rates and/or CSO fixed fee and by the property owner. Figure 5-41 graphically summarizes the rate impacts for the 20-year implementation period. As shown, this scenario mostly remains below the affordability threshold, except for period 2030-2033 if the private property disconnections were to be funded through sewer rates. Given the timeframe, there is uncertainty whether these conditions would materialize depending on costs and funding of projects.

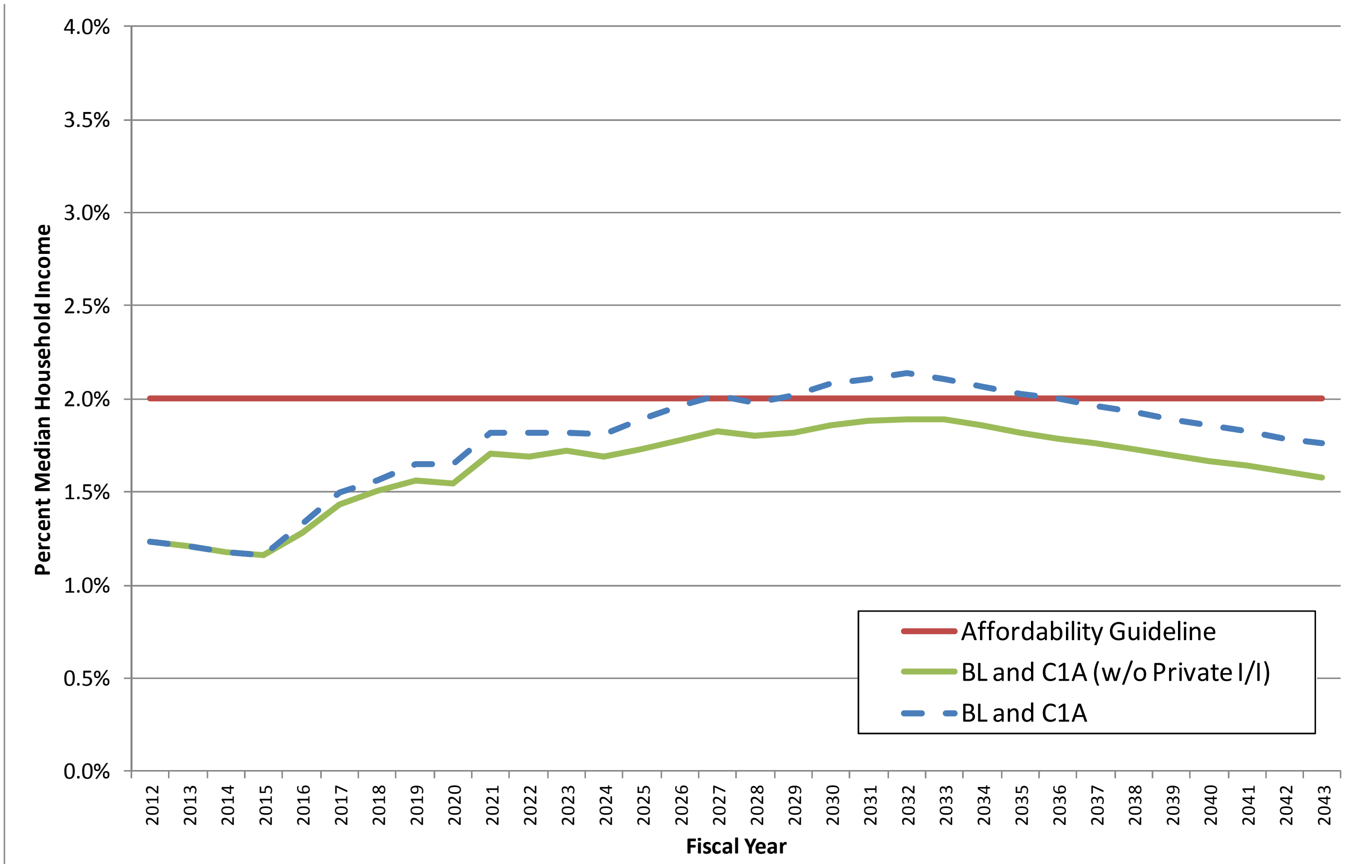


Figure 5-41. Typical Residential Annual Sewer Bill as a Percentage of MHI for the C1A Scenario

S3A

For scenario S3A, 20-year and 30-year implementation periods were considered In addition, the scenario considers the impacts of funding private I/I removal both with sewer rates and/or CSO fixed fee and by the property owner. This helps illustrate the magnitude of the projects and how the costs impact the rates. Figure 5-42 graphically summarizes the rate impacts for the 20-year implementation. Figure 5-43 graphically summarizes the rate impacts for the 30-year implementation period. In comparison, scenario S3A exceeds the 2 percent affordability threshold. In year 2025, the 20-year implementation period option exceeds the affordability threshold, and peaks in 2032 at almost 2.5 percent of MHI. The projects that are attributed to the spike are 'OS-11 Washington CSO Facility Storage' and 'OS-19 King Park Storage.' By extending projects out an additional 10 years, the 30-year implementation period option exceeds the affordability threshold in 2034 and peaks in 2035 around 2.2 percent of MHI.

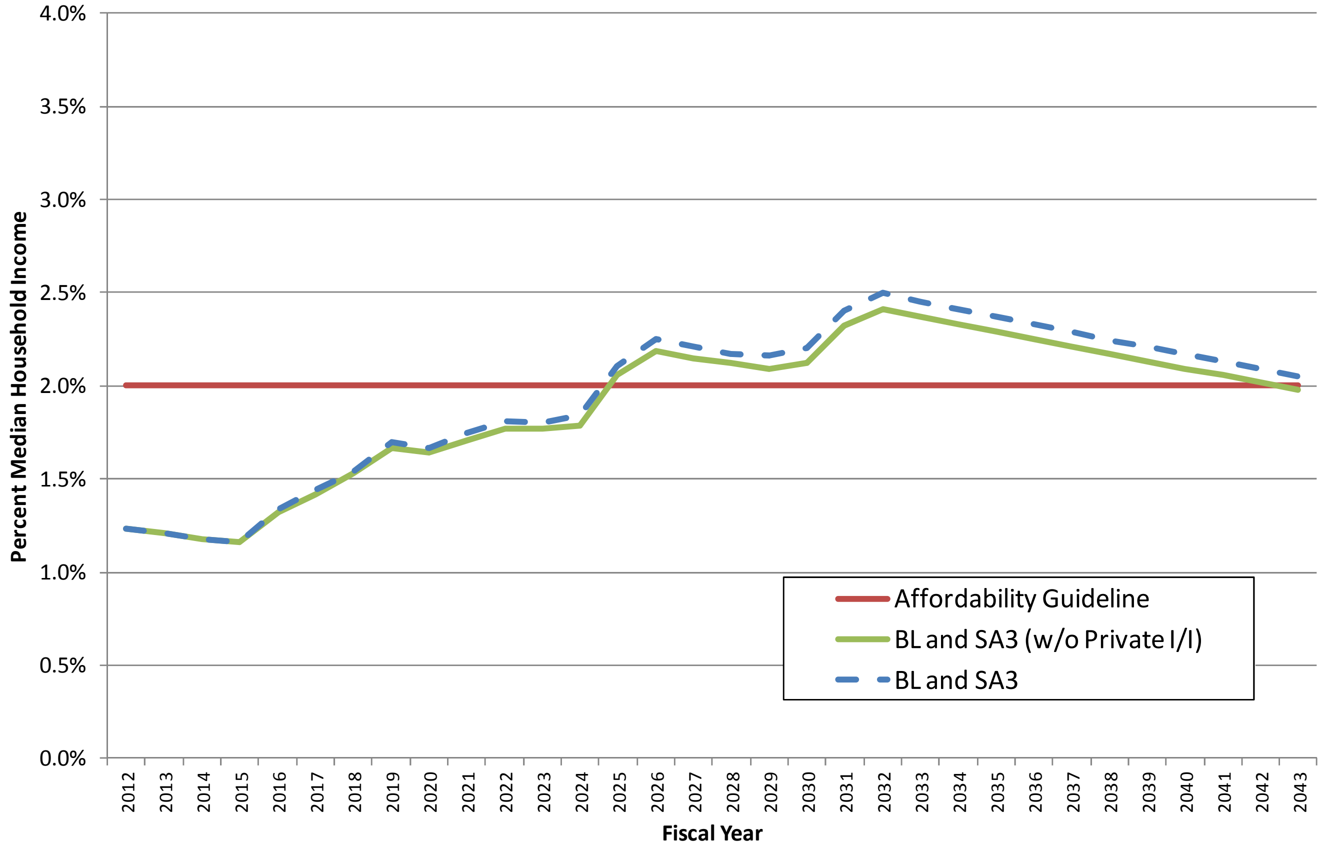


Figure 5-42. Typical Residential Annual Sewer Bill as a Percentage of MHI for the S3A Scenario (20-Year schedule)

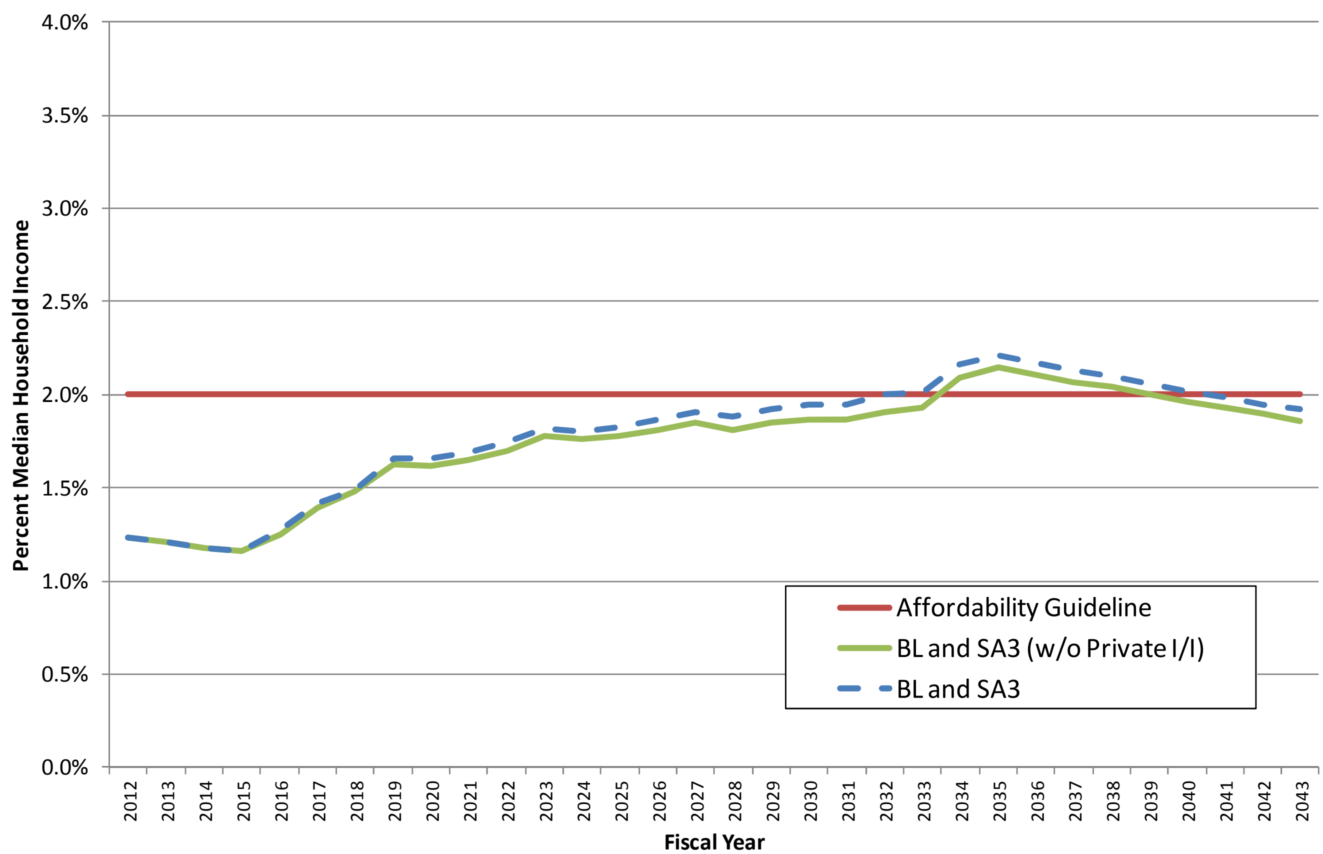


Figure 5-43. Typical Residential Annual Sewer Bill as a Percentage of MHI for the S3A Scenario (30-Year schedule)

5.4.5 Alignment with Regulatory Framework

The performance and costs of scenarios E1, C1A, and S3A were compared to the regulatory framework defined in Section 5.1.1 and the CSO Stakeholder Workgroup's priority criteria in Section 5.1.2 and summarized in Table 5-49. The comparison was used to determine the effectiveness of each scenario in meeting the goals of the program. Overall, all scenarios were able to reduce CSO volumes, with scenarios E1, C1A, and S3A eliminating CSO discharges for up to a 10-year, 6-hour event.

While scenarios E1, C1A and S3A are unlikely to meet the implementation schedule as noted in the CD, which identifies a June 30, 2018 completion date for the recommended measures and remedial work, it is likely that scenarios C1A and S3A could be implemented over a 20- to 30-year timeframe while maintaining affordable rates. Item 65 of the CD does allow for an extended implementation schedule if approved by all parties. Scenario E1 was determined to require a greater than 30-year implementation schedule in order to maintain affordable rates. It was determined that an implementation schedule greater than 30 years would likely be unacceptable to EPA as well as the stakeholders.

Because all three scenarios generally meet the requirements defined by the regulatory framework, the priority criteria identified by the stakeholders will define the control scenario that best meets the Program Goals.

TABLE 5-49

Evaluation of Scenario Effectiveness for the Final Selected Control Scenarios

Category	Criteria	Scenario			
		BL	**E1**	**C1A**	**S3A**
Regulatory Framework	Eliminate CSO Discharges	Does not meet criteria, but reduces CSOs	Meets criteria for up to the 10-year, 6-hour event	Meets criteria for up to the 10-year, 6-hour event	Meets criteria for up to the 10-year, 6-hour event
Stakeholder Priority Criteria	Meeting CWA Requirements	Meets criteria	Meets criteria	Meets criteria	Meets criteria
	Maintaining affordable rates[a]	Likely meets criteria	Not affordable in less than a 30-year implementation schedule	Affordable with a 20-year implementation schedule as long as private property disconnections are borne by the property owner and not rates	Not affordable in less than a 20-year implementation schedule. Borderline affordable with a 30-year implementation schedule.
	Meeting water quality standards	May meet criteria	Meets criteria	Meets criteria	Meets criteria
	Compliance with implementation schedule[a]	Likely meets	Does not meet criteria	Can meet proposed implementation schedule	May not meet proposed implementation schedule while maintaining affordable rates
	Supporting designated uses in Newport Harbor	May meet criteria	Meets criteria	Meets criteria	Meets criteria

[a] When determining whether a scenario would meet criteria for maintaining affordable rates and compliance with the implementation schedule, it was determined that a 30-year implementation period was the maximum implementation period that would be acceptable to stakeholders.

SECTION 6

System Master Plan Recommendations (CD Item 66)

6.1 Overview and Objectives

Section 6 of this report contains a summary of the findings and recommendations related to the Collection System Capacity Assessment (CSCA) and the System Master Plan (SMP). It summarizes the controls identified through the engineering evaluations described in Consent Decree Items 63 and 65. It also includes a schedule for implementation of the program's components as identified in CD Item 66. However, based on the evaluations described in Section 5 of this report, it is not affordable for the City to implement all of the recommended measures by the end date listed in the CD. Therefore, the end date for this implementation plan is subject to review and approval as described in the CD.

> *"The System Master Plan shall include a schedule for the complete implementation of recommended measures and remedial work by June 30, 2018, unless, based on the review and regulatory Approval of the recommendations of the System Master Plan, an alternate end date is agreed upon by the parties."*

The materials presented in this section are organized by three topics:

- Recommended System Improvements
- Recommended Implementation Schedule
- Additional Considerations and Next Steps

The objective of these materials is to establish a concise summary of the recommended system improvements and the schedule for their implementation. These materials should guide future investments in the City's wastewater collection, wastewater treatment, and storm drainage systems.

6.2 Recommended System Improvements

The recommended system improvements and control technologies for the SMP are those included in scenario C1A. The recommended control projects include:

- Disconnecting or removing private and public inflow sources to achieve a 50 percent reduction in rainfall-derived inflow. The details of this inflow reduction program are to be defined further in the Sanitary Sewer Evaluation Survey (SSES) reports to be submitted in 2013.
- Upgrading the WPCP to increase the wet weather capacity to 30 MGD. This includes upgrades in the BL, such as, upgrading the headworks, disinfection, and solids handling facilities. This project also includes upgrading the primary clarifiers and secondary treatment units. These upgrades are contingent upon approval of modifications to the WPCP's discharge permit, specifically increasing the maximum day flow from 19.7 to 30 MGD. The proposed modifications will also increase the WPCP's monthly average day flow capacity from 10.7 to 14.4 MGD. Other parameters of the permit that will require modification include the 85 percent monthly removal for BOD and TSS and pollutant loadings. These required modifications are discussed in more detail in the *Flow Optimization and Capacity Evaluation (CH2M HILL, 2011d).*
- Raising six existing weirs in the collection system: five weirs by 1.5 feet along the twin 54-inch diameter sewer on Long Wharf Mall and one weir by 1.2 feet in the overflow pipe on Wellington Avenue from the Thames Street Interceptor.

- Installing a new 3.5 MGD pump station on Van Zandt Avenue near the railroad to reroute flows currently going to the Long Wharf Pump Station directly to the Long Wharf force main and the WPCP.
- Upsizing the two existing pumps at the Wellington Avenue Sanitary Pumps to 2-MGD pumps and upsizing the existing force main to convey the additional flows.
- Modifying the existing CSO treatment at the WSCSOTF by adding dechlorination, which includes installing chemical storage and dosing units.
- Installing new or upgrading existing stormwater conveyance pipe (approximately 7,000 LF).

The costs of these improvements are summarized below in Table 6-1. The affordability analysis indicated that over a 20-year implementation schedule, scenario C1A would be at the threshold of affordability of 2 percent of median household income (MHI) assuming private inflow removal costs would be paid by the homeowners. If the City were to assume the costs of private inflow removal, and maintain the 20-year implementation schedule, scenario C1A would exceed the 2 percent threshold around the year 2030. Because the exceedance of MHI is relatively small, with rates peaking at about 2.2 percent of MHI, it is assumed that the City would be able to adjust the implementation of the inflow removal program to maintain rates below the 2 percent threshold if they decided to include private inflow removal costs within rates.

TABLE 6-1
Summary of Control Technologies and Costs for Scenario C1A

Project Code	Name/Brief Description	Total Capital Cost	Change in Annual O&M Cost	Equivalent Annual Cost
BL	Baseline (includes all Baseline projects)	$ 31,487,000	$ (8,000)	$ 1,029,000
WPCP-1.2	WPCP Upgrade & Expansion, Option 2 (primary clarifiers)	$ 6,130,000	$ -	$ 243,000
WPCP-1.3	WPCP Upgrade & Expansion, Option 3 (aeration tank & final clarifier)	$ 10,842,000	$ -	$ 392,000
SO-1	WPCP Flow Optimization	$ -	$ -	$ -
SO-3	Weirs	$ 189,000	$ -	$ 6,000
CU-2	Catchment 10 Reroute (new 3.5 mgd PS)	$ 4,788,000	$ 68,000	$ 241,000
CU-4	Additional Pumping of WACSOTF Sanitary Pumps (2 mgd)	$ 861,000	$ 15,000	$ 46,000
CU-5	Upsize Wellington Forcemain	$ 204,000	$ -	$ 7,000
CU-7	Stormwater Conveyance Improvements for C1A	$ 8,224,000	$ -	$ 297,000
II-4	Downspout Disconnection	$ 13,630,000	$ (27,000)	$ 472,000
II-C	Additional Inflow Removal (to Achieve 50% Inflow Removal)	$ 23,183,000	$ (46,000)	$ 802,000
CSOT-2	Modify Treatment with Dechlor at Washington	$ 164,000	$ 1,000	$ 7,000
	Scenario Totals:	$ 99,701,000	$ 2,000	$ 3,542,000

The system improvements and technologies included in scenario C1A were chosen because the combination of CSO controls best achieves the requirements of the regulatory framework. The intent of regulatory framework is to first identify in-system rehabilitation and remediation measures, I/I measures and plant flow optimization measures to provide additional in-system capacity and storage to reduce and/or eliminate CSOs and then identify additional control measures, if needed, to achieve CSO elimination. Scenario C1A optimizes the existing facilities (Long Wharf Pump Station and the WPCP) and flow regulating structures to maximize existing in-system storage and incorporates a high level of inflow reduction to reduce CSO discharges at the WACSOTF and WSCSOTF. Additional control measures, including installation of new pumps and pump stations and upgrades to wet weather capacity at the WPCP, maximize the available capacity in the collection system allowing more flow to be treated at WPCP and less CSO discharge at the two CSO treatment facilities. The performance evaluations of these improvements demonstrate that the elimination of CSO discharges at the WACSOTF and near elimination (97 percent CSO volume reduction) of the WSCSOTF may be achieved for up to a 10-year,6-hour design event. CSO discharges at both CSO facilities are eliminated for a typical year evaluation.

The scenario also achieves the goals of the Stakeholder workgroup as well as the CSO program. Overall, the intent of the goals is to identify an affordable scenario that reduces CSO discharges to a level protective of Newport Harbor and is acceptable to community and regulatory agencies. The elimination of CSO discharges will reduce water quality exceedances that occur as a result of CSOs. However, wet weather water quality exceedances (storm events without CSO discharges) may increase due to the additional stormwater runoff volume as a result of disconnecting inflow sources. Scenario C1A also meets the affordability guidelines by maintaining rates at or below 2 percent of MHI.

Lastly, scenario C1A was selected because the control technologies allow the SMP to be adaptable based on results from regular performance assessment periods that could include flow metering, water quality monitoring, and/or hydraulic modeling. System improvements and upgrades as well as inflow reduction can all be implemented in various phases and adjusted based on performance feedback, while other types of gray infrastructure, such as storage and tunnels, would be permanent structures that could be ineffective and costly if not fully utilized.

6.3 Recommended Implementation Schedule

In developing the recommended implementation schedule for scenario C1A, there were five key objectives to be achieved:

1. Keep rates at or under affordability limits.
2. Complete low-cost and low-effort projects first in an effort to provide immediate water quality benefit.
3. Stage large capital projects in a manner that would achieve the greatest CSO reduction earlier in the implementation schedule.
4. Stage projects so that capacity upgrades are completed prior to conveyance modifications to ensure that required capacity would be available.
5. Build in regularly scheduled program assessment periods to evaluate whether the CSO Program implementation efforts are achieving established targets.

These objectives were developed per guidance established in the EPA's CSO guidance documents (USEPA, 1994 and 1995). These guidance documents state that the implementation schedule of a CSO control program shall prioritize projects based on the relative importance of water quality impacts, address institutional constraints relative to affordability, and provide an adaptable program to eliminate CSOs. As noted in the EPA's *Combined Sewer Overflows: Guidance for Long-Term Control Plan* (USEPA, 1995), program flexibility, particularly project staging, allows for more projects to be implemented quicker and the opportunity to modify projects later in the implementation schedule due to changes in conditions.

Keep rates at or under affordability limits

In an effort to maintain rates at or under affordability limits, but still achieve CSO reduction as quickly as possible, a recommended annual cash flow cap was developed following the affordability analysis. Using this recommended annual cash flow cap as guidance, projects were staged to occur as early in the implementation schedule as possible without exceeding the annual cash flow cap.

Complete easily implemented projects early

As part of the evaluation of control measures, a number of low-cost, low-effort projects were identified such as:

- Beach Pump Station Improvements
- Ruggles Pump Station Improvements
- Additional weirs along America's Cup and from Wellington Avenue Pump Station to the Thames Street interceptor
- Wellington Avenue Pump Station and Force Main Improvements
- Addition of dechlorination to the WSCSOTF

Because these projects should be able to be implemented fairly easily and at relatively low-cost, it was decided to implement them in the first 2 years of the implementation period while larger scale projects are in the development and design phase.

Stage large capital projects to achieve the greatest CSO reduction early in the implementation period

The evaluation of control measures showed that the proposed upgrade of the WPCP would achieve the most significant CSO reduction of all the control measures evaluated, therefore it was determined to implement the WPCP upgrades early in the implementation period.

Stage projects to ensure capacity is available

As part of the staging of projects, it was determined that certain conveyance improvements such as the new pump station for Catchment 10, could not be implemented until capacity upgrades such as the WPCP upgrade, were completed. Therefore, the new pump station for Catchment 10 was staged to occur after the WPCP upgrade is completed.

Build in regularly scheduled program assessment periods

A key priority identified by the CSO Stakeholder Workgroup was to incorporate program assessment periods into the implementation schedule. The purpose of these program assessment periods is to determine if the CSO Program projects are achieving the CSO reduction targets, and to make adjustments if targets are not being achieved. While the evaluations done to develop the SMP were completed with a significant amount of information and detail, the results are just projections of CSO reductions based upon hydraulic modeling, and therefore, these program assessment periods will allow the City to evaluate the actual impacts of projects after they are implemented.

Three program evaluation periods were built into the implementation schedule, every 5 years. Table 6-2 summarizes which elements of the program will be evaluated during each of the CSO Program evaluation periods.

TABLE 6-2
Summary of Implementation Schedule

Evaluation Period	CSO Program Projects to be Evaluated
1 (2017)	• Pump station improvements • Early WPCP upgrades • Phase 1 inflow removal
2 (2022)	• Final WPCP upgrades • New Catchment 10 pump station • Phase 2 inflow removal
3 (2027)	• Phase 3 inflow removal

The types of evaluations that are anticipated to be part of the assessment periods are:

- Collection system metering to evaluate the effectiveness of the new weirs, the pump station improvements and the inflow removal efforts.
- Stormwater monitoring to determine the water quality benefits and impacts of the inflow removal efforts.
- Performance evaluation using the hydraulic model to evaluate program benefits and potential modifications for future efforts.
- Re-evaluation of affordability criteria per the 1994 EPA CSO Policy.

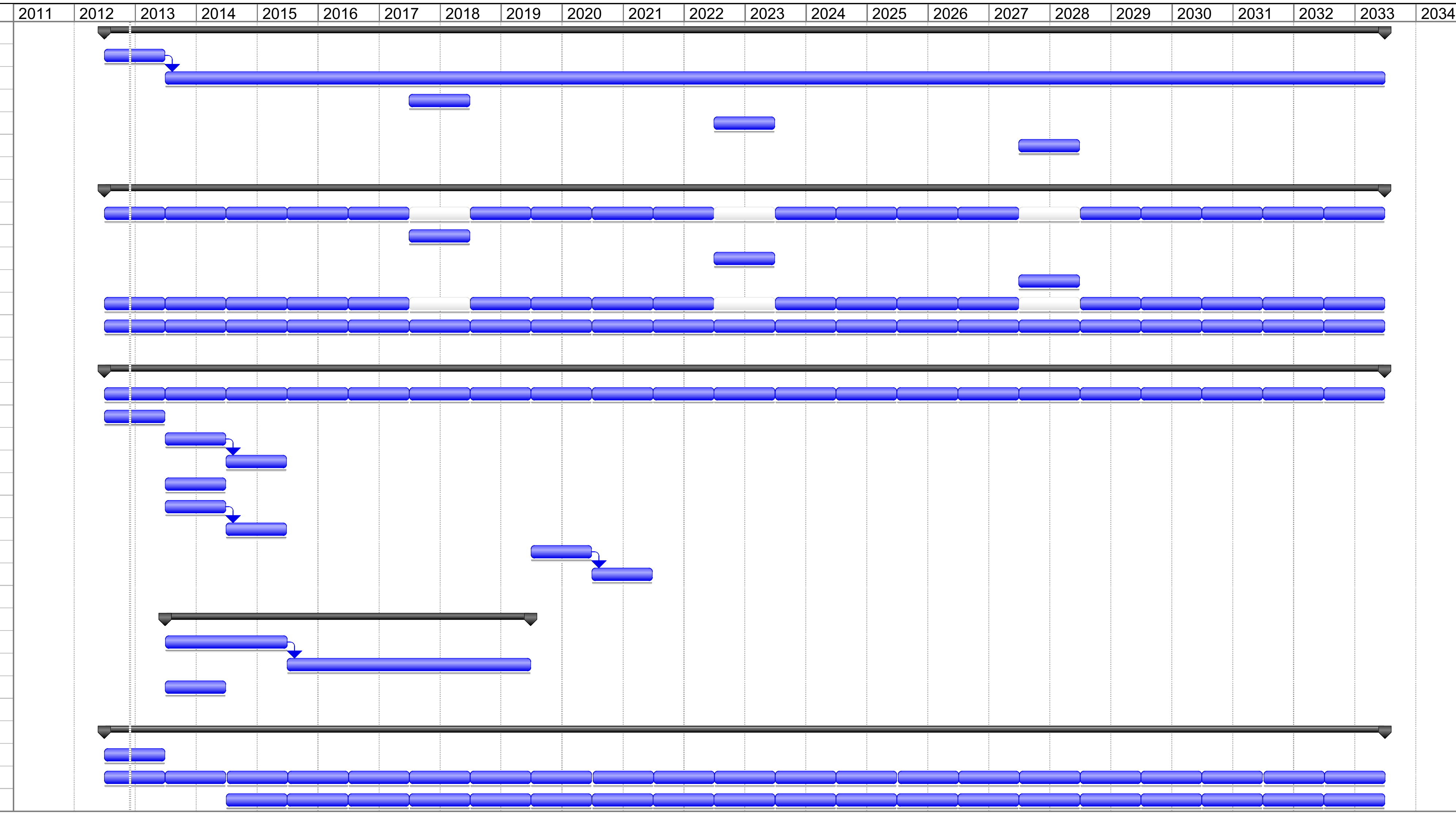
Based upon the outcomes of the above described assessments as well as other evaluations the City may perform, it is anticipated that there may be adjustments to the CSO Program and implementation schedule including, but not limited to:

- Re-evaluating inflow sources to determine the priority targets for inflow removal.
- Revising the priority areas for inflow removal.
- Revising inflow reduction targets based upon the effectiveness of the pump station improvements and WPCP upgrades.
- Revising the inflow removal schedule to allow for additional stormwater management to be implemented if needed.
- Re-evaluating the possibility of storage options depending upon the effectiveness of the inflow removal program.

Based upon achieving the five objectives defined above, a recommended implementation schedule for scenario C1A was developed and is shown in Figure 6-1. This implementation schedule also shows the planned asset management projects that the City anticipates it will need to complete during the CSO Program implementation period, which were also accounted for in the affordability assessment. The sanitary sewer system design and construction projects identified as part of the City's asset management program in Figure 6-1 would include implementation of the recommended improvements in Section 4.4 of this report.

Newport CSO Program
System Master Plan Implementation Schedule

ID	Project Code	AM - CSO	Task Name
1			**CSO Program Management**
2		CSO	SMP Development
3		CSO	SMP Implementation Oversight
4			CSO Program Reassessment 1
5			CSO Program Reassessment 2
6			CSO Program Reassessment 3
7			
8			**Inflow Reduction**
9	**II-3**	**CSO**	**SSES Investigations**
31		CSO	Inflow Program Reassessment 1
32		CSO	Inflow Program Reassessment 2
33		CSO	Inflow Program Reassessment 3
34	**II-1**	**CSO**	**Public Inflow Removal - Design and Construction**
56	**II-2**	**CSO**	**Private Inflow Program Management & Enforcement**
78			
79			**Wastewater Collection**
80		**AM**	**Sanitary Sewer System Design & Construction**
102		AM	Beach PS Improvement
103		CSO	Ruggles PS Improvements - Design
104		CSO	Ruggles PS Improvements - Construction
105	SO-3	CSO	New Weirs @ America's Cup & Wellington PS
106		CSO	Wellington PS & FM Improvements - Design
107		CSO	Wellington PS & FM Improvements - Construction
108	CU-2	CSO	Catchment 10 Reroute - Design
109	CU-2	CSO	Catchment 10 Reroute - Construction
110			
111			**Waste Water Treatment**
112	WPCP	CSO	WPCP Upgrades - design
113	WPCP	CSO	WPCP Upgrades - construction
114	CSOT-2	CSO	Washington CSO Dechlorination Design & Construction
115			
116			**Storm Drainage**
117		AM	Almy Pond TMDL
118		**AM**	**Storm Drainage System Improvements**
140	**CU-7**	**CSO**	**New Storm Drainage Infrastructure Design and Construction**



Project: Newport CSO SMP Implemen
Date: Tue 11/27/12

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

6.4 Additional Considerations

Implementing CSO controls has been and will continue to be a large investment for the City of Newport. The proposed improvements to the system will have a variety of impacts and benefits for the community. This section of the report outlines considerations related to implementation of the recommendations that are not already addressed in this report but may be required to achieve the program's goals and objectives.

Although the recommendations described in this report are based on a systematic evaluation process and an improved understanding of system performance, the tolerances related to its costs, the implementation schedule, and the expected benefits for its components vary. The large capital projects are defined at a planning level and should be designed and constructed within tolerances typical of public works projects. Other elements of the program, like the inflow removal program, are less certain. The required work, the pace of work and the potential benefits of the inflow removal program are a significant extrapolation from the program completed to-date. Correspondingly, although the projected costs and benefits of the program are documented in this report, the net results are uncertain. Some elements of risk or uncertainty will be reduced as the program progresses, design projects are completed and system performance is re-evaluated.

Considerations related to the remaining engineering evaluations, expected benefits, costs and implementation schedule are described below.

1. Additional field investigations will be performed to identify inflow sources as identified in the SSES reports which are described below. The cost-effectiveness of mitigation measures for both public and private reduction should be re-evaluated and compared with other technologies as a part of the SSES reports. This issue is described on pages 7 and 8 of the CD as follows:

   > *"…Infiltration/Inflow ("I/I") that can be cost-effectively eliminated from the Collection System as determined by a cost-effectiveness analysis that compares the costs of eliminating the I/I with the total costs of transportation, storage, and treatment of the I/I (including capital costs of increasing sewage facilities capacity and treatment and the resulting operating costs)."*

2. Secondary impacts associated with disconnecting downspouts, drains, and sump pumps will be documented in the SSES reports which are described below. These improvements require work on private properties, raising the issue of private property owners' responsibility and quality control. They may also require improvements to the storm sewer system related to inlet and conveyance capacities. The potential impacts of increasing stormwater flows, including the potential for downstream flooding and water quality effects should be considered. Lastly, the time frame for implementation of improvements on private property should be considered relative to the schedules outlined in the CD and the community's goals for a timely solution.

3. The improvements to the WPCP and the expected benefits to system performance require review and modification of the City's discharge permit. This includes provisions related to maximum day flows, monthly average flows, loads, and solids removal during wet weather. These provisions in the City's discharge permit will need to be reviewed and adjusted as part of the program assessment periods to account for the effects of inflow removal over time. Background information on this topic specific to the existing facilities was provided in the *Flow Optimization and Capacity Evaluation for the Newport WPCP* (CH2M HILL, 2011d). Additional information on flows, loads, and related improvements are contained in this report in Section 5.3.3.7 WPCP Upgrades.

4. The City should continue to consider use of Green Technologies as a component of its inflow reduction and in the design of stormwater drainage system improvements, in order to mitigate the potential increase in stormwater flows.
5. The potential impacts associated with climate change should be addressed during the design of system improvements. This should include consideration of mitigation measures to address storm surge, rising sea-levels, and increases in the frequency of severe events.
6. The actual and expected water quality benefits associated with the control plan should be re-evaluated on a periodic basis. The evaluation should be framed in context with the current uses, water quality standards, observed impairments, and recent data on potential sources of those impairments. This evaluation should include consideration of both stormwater discharges and discharges from the CSO treatment facilities.
7. Recommendation for future improvements to public and private infrastructure should be re-evaluated on a periodic basis to address affordability pursuant to the 1994 EPA CSO Policy. This should include consideration of the following:
    - households in the City's service area
    - the cost of existing debt service
    - the cost of future debt service
    - costs associated with operating and maintaining the City's collection and wastewater treatment systems
    - the cost of planned remedial measures and the impact of these expenditures on the rates paid by its customers

6.5 Next Steps

Pending the review and approval of this document, the City expects to prepare SSES reports for the Wellington Avenue and Washington Street service areas. A general description of these reports is provided in CD Items 52 and 56.

> "… shall identify remaining sources of Excessive I/I, and shall include a comprehensive plan for their elimination. The report will prioritize projects for the removal of I/I considering the amount of I/I, the location, the type of remedial action and other factors."

The groundwork for these SSES reports was established in the Extraneous Flow Reports previously published for each catchment area. The control objectives for the remediation work are defined in this CSCA and SMP. Specific components of the SSES reports summarized from the CD include:

- A cost-effectiveness evaluation that determines which public sources to remediate.
- Proposals for design and construction of measures required to remove public inflow sources.
- A determination of cost-effectiveness for the redirection of private sources of inflow.
- A generalized assessment of conditions that may permit redirection of private inflow sources to the ground and an assessment of the municipal storm sewer's capacity to receive redirected inflow.
- An evaluation of changes to the City's ordinances that may facilitate implementation of planned remedial measures.
- A schedule for implementing public and private inflow reduction measures.

SECTION 7
References

AECOM. 2006. *Phase 1 Part 1 CSO Control Plan, Wellington Avenue CSO Facility.* Final. Prepared for the City of Newport, Public Works Department.

AECOM. 2007. *Phase 1 Part 2 CSO Control Plan, Wellington Avenue CSO Facility.* Final. Prepared for the City of Newport, Public Works Department. January.

AECOM. 2009. *Phase 2 CSO Control Plan Wellington Avenue CSO Facility*. Final. Prepared for the City of Newport, Department of Utilities. March.

CH2M HILL. 2011a. *Washington Street Outfall Extraneous Flow Investigations Report.* Final. Prepared for the City of Newport, Department of Utilities. September.

CH2M HILL. 2011b. *Wellington Avenue Outfall Extraneous Flow Investigations Report.* Final. Prepared for the City of Newport, Department of Utilities. July.

CH2M HILL. 2011c. *Hydraulic Modeling Report.* Final. Prepared for the City of Newport, Department of Utilities. April.

CH2M HILL. 2011d. *Flow Optimization and Capacity Evaluation for the Newport WPCP.* Final. Prepared for the City of Newport, Department of Utilities. March.

City of Newport, Department of Utilities. 2011. *Newport Harbor Water Quality Monitoring*. http://cityofnewport.com/departments/utilities/pollution_control/harbor.cfm. Accessed January 2012.

City of Newport, Department of Utilities. *Summary of CSO Events since 2001*. http://cityofnewport.com/departments/utilities/pdf/CSO_Summary_2001-current.pdf. Accessed January 2012.

Great Lakes Upper Mississippi River Board (GLUMRB). 2004. *Recommended Standards for Wastewater Facilities*. http://10statesstandards.com/wastewaterstandards.html. Accessed March 2011.

Hershfield, David M. 1961. *Technical Paper No. 40 - Rainfall Frequency Atlas of the United States*. Washington, D.C. Engineering Division, Soil Conservation Service of the U.S. Department of Agriculture.

Louis Berger & Associates, Inc. 1998. *Combined Sewer Overflow Control Facilities Program, Concept Design Report Amendment.* Final. Prepared for the Narragansett Bay Commission. April 17.

Louis Berger & Associates, Inc. 1993. *Combined Sewer Overflow Control Facilities Program, Concept Design Report*. Draft Final. Prepared for the Narragansett Bay Commission. March 30.

Massachusetts Water Resource Authority (MWRA). 1997. Final. *Combined Sewer Overflow Facilities Plan*.

New England Interstate Water Pollution Control Commission (NEIWPCC). 2011. *Guides for the Design of Wastewater Treatment Works*. Technical Report #16.

Northeast Regional Climate Center (NRCC) and Natural Resources Conservation Service (NRCS). 2010-2012. *Extreme Precipitation in New York and New England*. http://precip.eas.cornell.edu/.

Rhode Island Department of Environmental Management (RIDEM). 2011. *State of Rhode Island 2010 303(d) List, List of Impaired Waters.* p. 31.

Rhode Island Department of Environmental Management (RIDEM). 2007. *Newport WPCP Final Permit RIPDES No. RI0100293.* pgs. 2-10. September 28.

Rhode Island Department of Health (RIDOH). 2011*. Water Quality Information*. Rhode Island Department of Health - Beach Monitoring. <http://www.ribeaches.org/search.cfm. Accessed January 2012.

Sevee & Maher Engineers, Inc. 2009. *Operations and Maintenance Manual, Volumes I, II and III*. Prepared for the City of Newport, Department of Utilities. Updated May 2011 by United Water, Wright-Pierce and CH2M HILL.

State of Rhode Island and Providence Plantations Department of Environmental Management, Office of Water Resources (RIDEM). 2009a. *Consolidated Assessment and Listing Methodology for Section 305(b) and 303(d) Integrated Water Quality Monitoring and Assessment Reporting.*

State of Rhode Island and Providence Plantations Department of Environmental Management, Office of Water Resources (RIDEM). 2009b. *Water Quality Regulations.* http://www.dem.ri.gov/pubs/regs/regs/water/h20q09a.pdf. Accessed January 2012.

U.S. Environmental Protection Agency (USEPA). 1997. *Combined Sewer Overflows: Guidance for Financial Capability Assessment and Schedule Development*. EPA 832-B-97-004. Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 1995. *Combined Sewer Overflows: Guidance for Long-Term Control Plan*. Washington, D.C. U.S. Environmental Protection Agency Office of Wastewater Management. EPA 832-B-95-002. Retrieved October 2012.

U.S. Environmental Protection Agency, Office of Water (USEPA). 1994. *Combined Sewer Overflows - CSO Control Policy*. EPA 830-B-94-001. Washington, DC.

U.S. Environmental Protection Agency (USEPA), Water Planning Division. 1983. *Results of the Nationwide Urban Runoff Program, Volume I.* Final. Washington, D.C. December.

United Water and Wright Pierce. 2010a. *Engineering Evaluation - Pumping Stations and Force Mains*. Prepared for the City of Newport, RI. September.

United Water and Wright Pierce. 2010b. *Engineering Evaluation - Wellington Avenue CSO Treatment Facility, Washington Street CSO Treatment Facility, and Narragansett Avenue Storage Conduit*. Prepared for the City of Newport, RI.