King County

North Beach CSO Reduction Facility Plan

September 2011

Barton, Murray, Magnolia & North Beach CSO Facilities Project

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Prepared for
KING COUNTY
DEPARTMENT OF NATURAL RESOURCES AND PARKS
WASTEWATER TREATMENT DIVISION
by Carollo Engineers

NORTH BEACH
COMBINED SEWER OVERFLOW CONTROL FACILITY PLAN

September 2011

This information is available in alternative formats on request at 206-684-1280 (voice) or 711 (TTY)

KING COUNTY WASTEWATER TREATMENT DIVISION

NORTH BEACH COMBINED SEWER OVERFLOW CONTROL FACILITY PLAN

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CERTIFICATION

The North Beach Combined Sewer Overflow Control Facility Plan for the King County Wastewater Treatment Division has been prepared under the direction of the following Registered Professional Engineer:

The undersigned has approved this document for and on behalf of Carollo Engineers Washington, P.C.

Vice President

Ave	average
2LAET	Second lowest apparent effects threshold
^{o}C	degrees Celsius
AACE	Association for the Advancement of Cost Engineering
ac/hr	air changes per hour
ADA	Americans with Disabilities Act
AQI	Air Quality Index
ASTM	American Society for Testing and Materials
BAT	best available technology
BI	base infiltration
BMP	Best Management Practice
CAD	computer-aided design
CCTV	closed-circuit television
CIP	Capital Improvement Program
CO	carbon monoxide
County	King County
CSL	cleanup screening level
CSO	combined sewer overflow
CSS	combined sewer system
CWA	Clean Water Act
DAHP	Washington State Department of Archaeology and Historic Preservation
Dims	dimensions
DNR	Washington State Department of Natural Resources
DNS	Determination of Nonsignificance
DW	dry weight
DWF	dry weather flows
ECA	Environmental Critical Area
Ecology	Washington State Department of Ecology
EL	elevation (Metro Datum)
ENR CCI	Engineering News Record Construction Cost Index
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ETS	evaporation time series
FEMA	Federal Emergency Management Agency
FM	Force main
fpm	feet per minute
FRP	Fiberglass reinforced plastic
ft	feet or foot
GIS	geographic information system
GMA	Growth Management Act
gpm	gallons per minute
GSI	Green Stormwater Infrastructure
HDD	Horizontal directional drill
HPA	Hydraulic project approval

HRC	high rate clarification
HVAC	heating, ventilation, and air conditioning
ID	Internal diameter
I/I	inflow and infiltration
INV	invert
LAET	lowest apparent effects threshold
LF	linear feet or foot
LID	low-impact development
LTS	long-term simulation
MAGCSO	King County Magnolia CSO Control Structure
MCC	motor control center
Metro	Municipality of Metropolitan Seattle (King County's predecessor agency)
MLLW	mean lower low water
MG	million gallon
MGD	million gallons per day
mg/L	milligrams per liter
MH	maintenance hole
mh/yr	manhours per year
mJ/sq cm	millijoules per square centimeter
mL	milliliter
MS4	Municipal separate storm sewer system
MSL	Mean sea level
NEPA	National Environmental Protection Act
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
NTU	nephelometric turbidity unit
O&M	operations and maintenance
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PHS	Priority Habitats and Species
PLC	programmable logic controller
PS	pump station
PSEP	Puget Sound Estuary Program
PVC	Polyvinyl chloride
PWTF	Public Works Trust Fund
PWWF	peak wet-weather flow
QA/QC	Quality Assurance/Quality Control
R^2	statistical correlation
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RDI	Rainfall-Dependent Infiltration
RII	Rainfall-Induced Infiltration

ROW	right-of-way
RSWP	Regional Wastewater Services Plan
SCADA	Supervisory Control and Data Acquisition
SD	Storm drain
SDOT	Seattle Department of Transportation
SDPD	Seattle Department of Planning and Development
SEPA	State Environmental Policy Act
SERP	State Environmental Review Process
SF	
SHPO	State Historic Preservation Officer
SLR	sea level rise
SMC	Seattle Municipal Code
SMTS	South Magnolia Trunk Sewer
SPU	Seattle Public Utilities
SQS	sediment quality standards
SRF	State Water Pollution Control Revolving Loan Fund
SS	Sanitary Sewer or stainless steel
TCE	temporary construction limit
TCP	Traditional Cultural Property
TDH	total dynamic head
TP	treatment plant
TPPS	Toxicant Pretreatment Planning Study
TYP	typical
UPS	uninterruptible power supply
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service
UV	ultraviolet
VFD	variable frequency drive
VOC	volatile organic contaminant
WAC	Washington Administrative Code
WHR	Washington Heritage Register
WPTP	West Point Treatment Plant
WQA	Water Quality Assessment for the Duwamish River and Elliott Bay
WTD	Wastewater Treatment Division
WWF	wet weather flow
WWHM	Western Washington Hydraulic Model
WWPUG	Wastewater Planning Users Group
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

1.1 BACKGROUND

The North Beach Basin, located in north Seattle on Puget Sound, is shown in Figure 1.1. The North Beach Basin covers approximately 633 acres and drains to the North Beach Pump Station along its northern edge. Its approximate eastern edge is 14th Avenue NW and its southern boundary generally follows NW 85th Street.

King County is proposing to construct a 0.23 million gallon (MG) storage pipeline located in Triton Drive NW and NW Blue Ridge Drive public right-of-way to control combined sewer overflows (CSOs). Existing facilities are inadequately sized to convey peak combined sewage (wastewater and stormwater) flows from the North Beach Basin to the West Point Treatment Plant. The capacity of the North Beach Pump Station and Force Main limits the peak flow rate that can be conveyed downstream to approximately 3 million gallons per day (mgd), but the peak wet-weather flow in the North Beach Basin is approximately 9.6 mgd, well in excess of this limit.

Flows in excess of 3 mgd overflow the system's fixed weirs into the existing outfalls that empty into Puget Sound. There were an average of 10 such CSOs annually from 1991 to 2009, with an average annual total overflow of 2.2 million gallons *2008 CSO Plan Update, King County, June 2008*.

This project was initiated to address the following:

- **Revised Code of Washington (RCW) 90.48.480:** This law requires "the greatest reasonable reduction of combined sewer overflows at the earliest possible date."
- **Washington Administrative Code (WAC) 173-245-020 (22):** "The greatest reasonable reduction' means control of each CSO in such a way that an average of one untreated discharge may occur per year."

Therefore, according to these regulatory requirements, CSOs must be controlled to an average of no more than one untreated discharge per year per outfall based on a long-term average. This Facility Plan outlines improvements to the King County conveyance system serving the North Beach Basin that are necessary to control CSOs in compliance with the RCW and WAC.

1.2 BASIS OF PLANNING

During the planning process, four CSO control approaches were considered potentially effective at controlling overflows to the required level. These approaches were:

- Storage.
- Convey-and-Treat.

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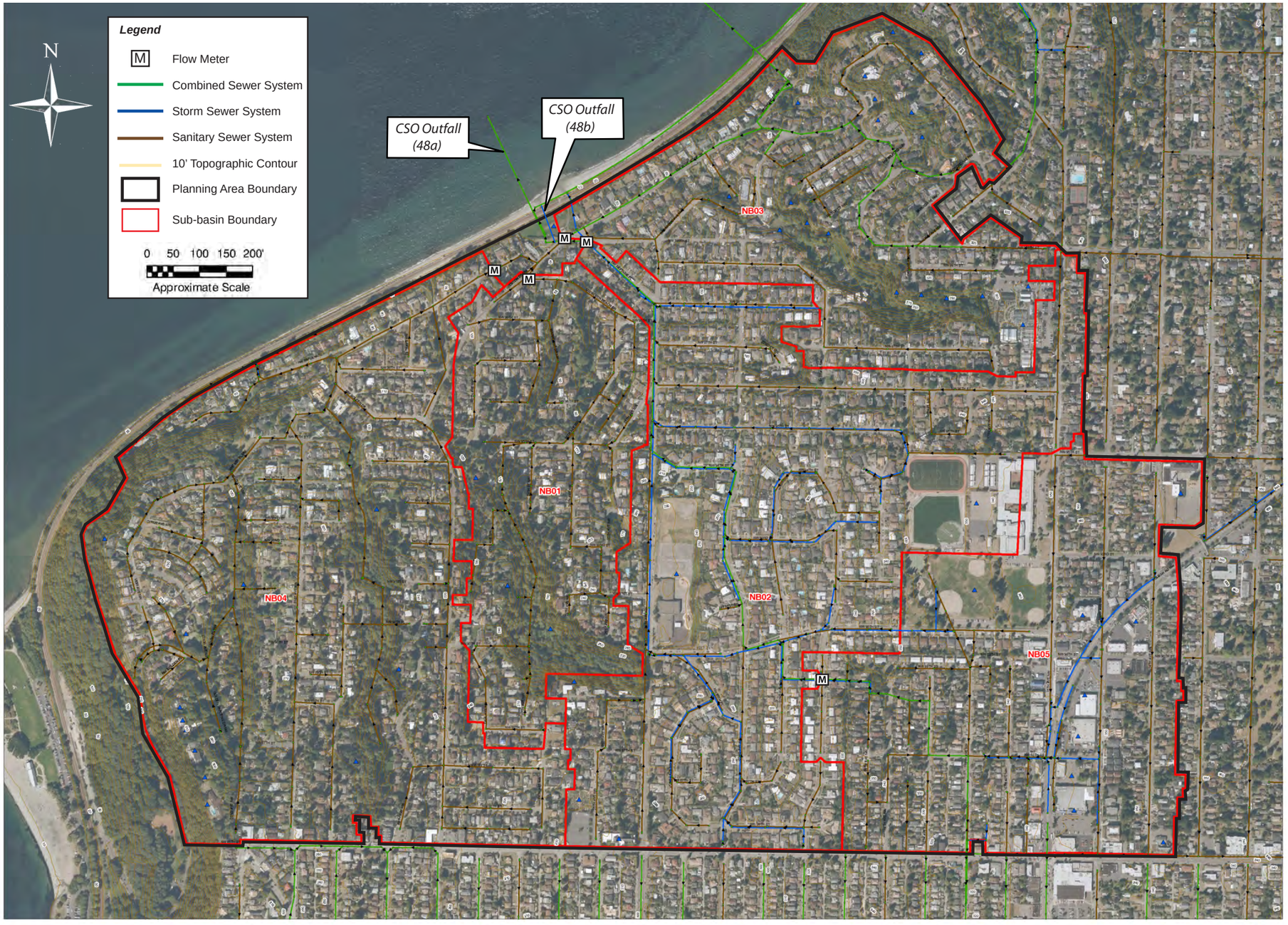

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Figure 1.1
NORTH BEACH BASIN OVERVIEW

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

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- End-of-Pipe Treatment.
- Peak-Flow Reduction (Demand Management).

In addition, a combination of these approaches was considered wherever feasible.

The North Beach Basin was modeled and calibrated based on historical flow monitoring to determine peak wet-weather flows and volumes. The calibrated models were run for a 30-year long-term simulation for the period from January 1, 1978 to June 30, 2008. Based on the modeling data, the required storage volume and peak flow rate were determined for the following conditions:

1. The long-term average from the entire rainfall record.
2. The average of 20-year averages.
3. The maximum 20-year rainfall period in the entire rainfall record.

The results of the three conditions were nearly the same (well within the accuracy of the analysis). Table 1.1 summarizes the resulting basis-of-planning requirements for the North Beach Basin.

Table 1.1 North Beach Basis-of-Planning Requirements

Control Approach	Required Volume or Capacity
Convey-and-Treat	**6.6 mgd[1]**
Required Peak Convey-and-Treat Capacity	9.6 mgd
Existing Convey-and-Treat Capacity	3.0 mgd
Storage	**0.23 MG**
End-of-Pipe Treatment	**6.6 mgd[2]**
Peak Flow Reduction (Demand Management)	
Storage Volume for 25% Impervious Disconnection[3]	0.12 MG
Storage Volume for 50% Impervious Disconnection[3]	0.06 MG
Storage Volume for 75% Impervious Disconnection[3]	0.02 MG

Notes:
1. Convey-and-treat capacity is the difference between "required peak convey-and-treat capacity" and "existing convey-and-treat capacity".
2. End-of-pipe treatment capacity is the difference between "required peak convey-and-treat capacity" and "existing convey-and-treat capacity".
3. Represents the percentage of impervious surface currently connected to the combined sewer system that must be disconnected to reduce the required storage volume.

1.3 PRELIMINARY ALTERNATIVE DEVELOPMENT AND EVALUATION

Identification of preliminary alternatives included evaluation of suitable sites for facilities based on technical criteria. The initial screening resulted in identification of several parcels and right-of-way locations meeting the project requirements.

Using these potential sites, preliminary alternatives were developed based upon control approaches and basis-of-planning requirements. Nine preliminary alternatives were developed for the North Beach Basin as summarized in Table 1.2.

Table 1.2 Summary of North Beach Basin Preliminary Alternatives

Approach	Alternative	Description
Storage	1A	Rectangular storage at bottom of basin
	1B	Pipeline storage at bottom of basin in public right-of-way
	1C	Pump station at bottom of basin with storage at top of basin and conveyance to 8th Avenue Interceptor
	1D	Pump station at bottom of basin with storage at bottom of basin and conveyance to 8th Avenue Interceptor
Convey-and-Treat	2A	Pump station at bottom of basin and force main through beach alignment to Carkeek; additional treatment at Carkeek
	2B	Pump station at bottom of basin and force main through neighborhood alignment to Carkeek; additional treatment at Carkeek
End-of-Pipe Treatment	3A	Treatment plant at bottom of basin
	3B	Pump station at bottom of basin and treatment plant at top of basin
Combination	5A	Inflow Improvements with storage, infiltration improvements or green stormwater infrastructure (GSI)

The nine alternatives were refined and evaluated between August 2009 and February 2010. The preliminary alternatives were evaluated based upon a range of factors:

- Technical feasibility.
- Environmental impacts.
- Community impacts.
- Land use and permitting impacts.
- Property acquisition.
- Cost.
- Operations and maintenance.

The preliminary alternative development and evaluation process resulted in a short-list of three alternatives, Alternative 1A, 1B, and 1D, which were recommended for further evaluation.

1.4 REFINEMENT OF SHORT-LISTED ALTERNATIVES

The project team convened several focus group meetings between March 2010 and August 2010. The team reviewed updated and new information about these alternatives developed by the team and elicited from community input. The team refined the criteria and evaluation ratings as a result of this information.

In July 2010, the project team conducted a project implementation risk assessment workshop for the short-listed alternatives. The purpose of this workshop was to identify potential high-impact risks, such as Shoreline Permit appeals, that would have a high-probability (greater than 60%) of impacting the project schedule and/or cost.

Alternative 1A and 1D had a number of potential high-impact and high-probability risks. This resulted in higher cost and schedule risks for these alternatives which may affect meeting the permit compliance schedule and/or cost to County rate payers. Alternative 1B (Pipeline Bottom-of-Basin Storage) had one potential high-probability and high-impact risk, and so had much lower cost risk to the rate payers and risk to meeting the permit compliance schedule.

The team compiled evaluation results from the focus group meetings and convened a workshop in August 2010 to make a recommendation for a proposed alternative to carry forward for further environmental review. Table 1.3 contains a summary of the project team's analysis of the three short-listed alternatives.

Alternative 1B (Pipeline Bottom-of-Basin Storage) is the alternative proposed for further environmental review for the following reasons:

- Straightforward approach, similar to other county facilities, with minimal technical complexity.
- Minimal permitting/zoning issues.
- Private property acquisition not required.
- Preferred by the community.
- No known environmental issues of concern.
- Lowest capital and life-cycle costs.
- Lowest schedule and cost risk.

Conceptual design details and costs for the proposed alternative were further developed and refined subsequent to the August 2010 workshop. Details of the proposed alternative are presented in Section 1.5 and Chapters 6, 7 and 8.

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Table 1.3 North Beach Basin Short-Listed Alternative Data

	Alternative 1A: Rectangular Bottom-of-Basin Storage	**Alternative 1B: Pipeline Bottom-of-Basin Storage**	**Alternative 1D: Centralized Storage at Bottom of Basin with Conveyance to 8th Avenue Interceptor.**
Overall Evaluation Ratings	This alternative was in the middle for low-impact scores and tied with Alternative 1D for the most high-impact ratings.	This alternative had the most low-impact ratings and had the fewest high-impact ratings.	This alternative had the fewest low-impact scores and tied with Alternative 1A for the most high-impact ratings.
Technical Considerations	Passive diversion of flows and infrastructure similar to other county facilities. Shoring, groundwater, and physical space concerns for constructability. No street access required. Minimum staffing and maintenance requirements.	Passive diversion of flows and infrastructure similar to other county facilities. Shoring, groundwater, and physical space concerns for constructability. Street access may be required - concern about staff safety and street closure requirements. Increased staffing and maintenance requirements due to facilities in the right-of-way.	Passive diversion of flows and infrastructure similar to other county facilities. Shoring, groundwater and physical space concerns for constructability. Increased maintenance due to two-stage pumping. No street access required and minimum staffing and maintenance requirements.
Preliminary Cost Estimates[1]			
Construction	$5,850,000	$5,100,000	$18,800,000
Land/Easements	$600,000	$400,000	$785,000
Street Use Fees	$0	$350,000	$480,000
Additional Costs	$4,500,000	$4,000,000	$14,800,000
Total	**$10,950,000**	**$9,850,000**	**$34,865,000**
Community Input	Not as much support as Alternative 1B.	Support for this alternative.	Not as much support as Alternative 1B.
Real Estate	Opposition to acquisition of portion of Blue Ridge Park (private park owned by the Blue Ridge community).	No property acquisition required. Facilities within right-of-way or county property.	Opposition to acquisition of portion of Blue Ridge Park (private park owned by the Blue Ridge community).
Land Use Permits (in addition to the typical construction permits)	Shoreline Permit Council Conditional Use Permit – The storage tank would be located in a privately-owned park designated "Conservancy Recreation" (CR) in Seattle's Shoreline Master Program. Storage is considered a "Utility Service Use." Utility Service Uses are prohibited.	Council Conditional Use Permit - Would be straightforward because Seattle Municipal code says this is permitted and there is community support for this alternative.	Shoreline Permit Council Conditional Use Permit – The storage tank would be located in a privately-owned park designated "Conservancy Recreation" (CR) in Seattle's Shoreline Master Program. Storage is considered a "Utility Service Use." Utility Service Uses are prohibited.
Environmental Considerations	No known environmental issues of concern.	No known environmental issues of concern.	Known contaminated sites and potential to encounter contaminated soils in the vicinity of the drop structure and odor control facility site and pipeline alignment near Holman Road.

Notes:

1. Preliminary cost estimates are from the phase of work to refine and evaluate short-listed alternatives (August 2010). Preliminary costs estimates are based on the best available information at the time of the evaluation. Additional costs include non-construction capital costs except for specific itemized costs noted in the table. These costs do not necessarily match the refined costs for the proposed alternative presented in Section 1.5 and Chapter 7 of this Facility Plan. The refined costs are based on additional detailed information for the proposed alternative not necessarily available for the other alternatives.

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1.5 PROPOSED ALTERNATIVE

Alternative 1B includes a buried storage pipeline located in Triton Drive NW and NW Blue Ridge Drive public right-of-way. The pipeline provides 0.23 MG of storage volume for combined sewage. Ancillary facilities would be located on the North Beach Pump Station site. Figure 1.2 illustrates the alternative. It includes the following elements:

- A new diversion structure to redirect peak flows from the sewer to storage.
- A buried storage pipe nominally 325 feet long and 12 feet in diameter. The storage pipeline includes:
  - A 20-inch influent sewer.
  - A pump station to empty the pipeline contents over a 24-hour period following a wet-weather event.
  - A 6-inch effluent line to the local combined sewer system (CSS).
  - A flushing system, including a flap gate and utility water equipment, to facilitate cleaning the pipeline.
  - Access features for routine and long-term operations and maintenance.
- An ancillary equipment facility for odor control, mechanical, and electrical equipment including:
  - Control panels and motor control centers (MCC).
  - Standby power generator, including fuel storage tank.
  - Odor control system including mist eliminator, carbon scrubbers, and fans.
  - Ventilation system.
  - Utility water system including backflow preventer, air gap tank, pumps, and hydropneumatic tank.
- Site improvements including:
  - Improvements as required by the Seattle Department of Transportation (SDOT) along Triton Drive NW and NW Blue Ridge Drive.
  - North Beach Pump Station surface access improvements, fencing, and landscaping modification/restoration.

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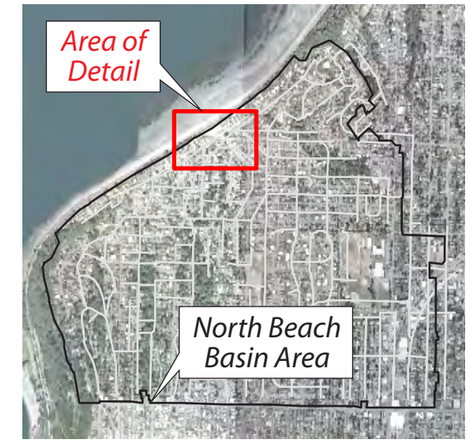

N

0 50 100 150'
Approximate Scale

Legend

- Combined Sewer System
- Storm Sewer System
- Sanitary Sewer System
- 10' Topographic Contour
- Feasible Area for Pipe Location

Figure 1.2
NORTH BEACH BASIN ALTERNATIVE 1B SITE PLAN

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Figure 1-2.ai

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Table 1.4 summarizes the total project cost estimate including engineering, construction management, and County administrative costs.

Table 1.4 Project Cost Summary

Item	Estimated Cost
Construction	$5,100,000
Land/Easement (Temporary construction easements for staging)	$400,000
Street Use Fee	$350,000
Additional Costs (Tax, allied costs, permit fees, and project contingency)	$4,000,000
Total	**$9,850,000**

Table 1.5 summarizes O&M costs for the first year of operation. Subsequent years are escalated at approximately 3 percent per annum for the life-cycle cost calculations.

Table 1.5 O&M Cost Summary

Item	Annual Cost 2014 ($/yr)
Operations and Maintenance Labor (Tank, Diversion Structure, Ancillary Facilities)	$34,900
Electricity (ventilation, power)	$ 4,700
Chemicals (activated carbon replacement once per two years)	$ 5,000
Standby Generator (fuel)	$ 1,200
Total	**$45,800**

The preliminary project schedule is summarized in Table 1.6. The dates are approximate and the schedule will be updated as the project progresses.

Table 1.6 Preliminary Project Schedule

Activity	Anticipated Dates
Facility Plan Development	June 2010 – December 2010
SEPA/SERP	November 2010 – May 2011
Facility Plan Approval	September 2011
Permitting and Property Acquisition	June 2011 – September 2012
Final Design Consultant Selection	December 2010 - July 2011
Final Design	August 2011 – December 2012
Construction	March 2013 – March 2015
Start-up	March 2014 – June 2015
Project Commissioning	October 2014 - May 2016 (2 wet seasons)[1]

Notes:

1. While it may not take a full 2 years for commissioning, North Beach facilities must be controlled in a way that does not impact the Carkeek CSO Treatment Plant. Therefore, some commissioning period will be required.

INTRODUCTION

2.1 PROJECT DESCRIPTION

2.1.1 Purpose and Scope

Currently, King County (County) is unable to consistently meet the combined sewer overflow (CSO) control regulation as defined by the State of Washington and as described in the 2008 *CSO Control Plan Update* (King County, June 2008). To address this problem, the County needs to make improvements to County infrastructure in the North Beach Basin (illustrated in Figure 2.1). The Barton, Murray, Magnolia, and North Beach CSO Facilities Project was initiated to identify improvements needed to meet the County's CSO control requirements. This report presents the "Facility Plan" for the North Beach Basin developed as a result of this work.

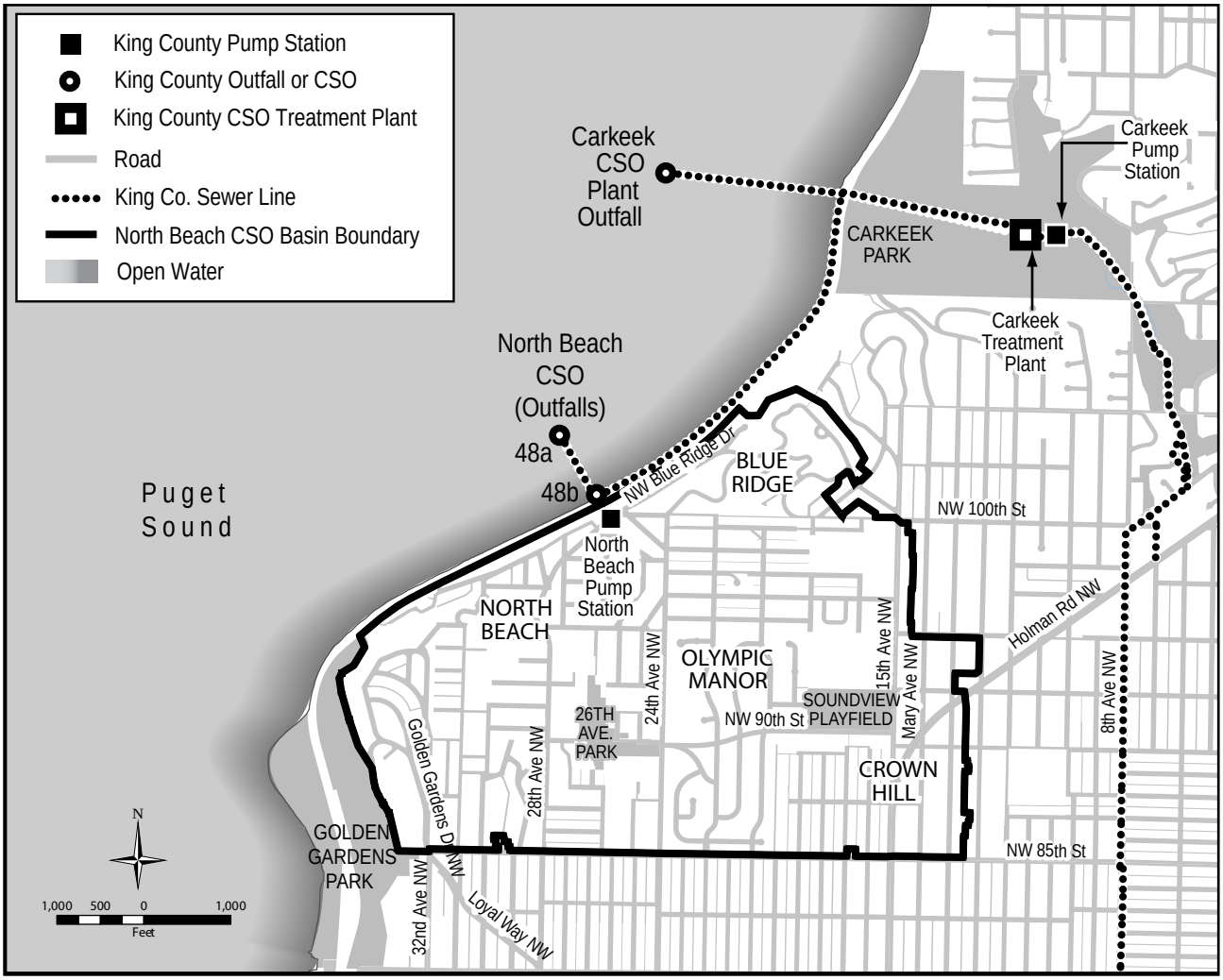
2.1.2 Problem Description

The North Beach Pump Station conveys wastewater from the North Beach Basin to the Carkeek Pump Station. From there it is pumped to the West Point Treatment Plant. The capacity of the North Beach Pump Station and Force Main limits the peak flow rate that can be conveyed downstream to approximately 3 million gallons per day (mgd), but the current 1-year peak wet-weather flow (PWWF) through the combined sewer system upstream of the North Beach Pump Station is approximately 9.6 mgd, well in excess of this limit.

Flows in excess of 3 mgd overflow the system's fixed weirs into the existing outfalls that empty into Puget Sound. There were an average of 10 such overflows annually from 1991 to 2009, with an average annual total overflow of 2.2 million gallons *2008 CSO Plan Update, King County, June 2008*. According to the Combined Sewer Overflow Control Program's 2009 *Annual Report* (King County, July 2010), there were 14 overflow events totaling 966,000 gallons in 2009. That year's weather was characterized by several small storms that caused small overflows, and a few large storms that produced the bulk of the overflow volume.

2.1.3 Project Goal

The goal of the Barton, Murray, Magnolia and North Beach CSO Facilities Project is to develop facility plans to meet the CSO control regulation - reduce overflows to no more than one event per year on a long-term average.



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NORTH BEACH COMBINED SEWER OVERFLOW CONTROL PROJECT VICINITY MAP

King County
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Wastewater Treatment Division

2.2 FACILITY PLAN REQUIREMENTS

This Facility Plan has been prepared in the format required by the Washington Administrative Code (WAC) 173-240-060, and the requirements of the State of Washington, *Criteria for Sewage Works Design* (also known as "the Orange Book") (Washington State Department of Ecology, August 2008). The requirements of these two documents are presented in Table 2.1. The chapter where those requirements are addressed in this Facility Plan are also presented in Table 2.1.

2.3 CONTACT INFORMATION

The owner of this project is King County. The project representative is:

Shahrzad Namini, Project Manager
King County Department of Natural Resources and Parks
Wastewater Treatment Division
King Street Center
KSC-NR-0507
201 S. Jackson St.
Seattle, WA 98104-3855
shahrzad.namini@kingcounty.gov
(206) 263-6038

Table 2.1 Facility Plan Requirements

WAC 173-240-060 Requirement	Location Addressed
• The name, address, and telephone number of the owner of the proposed facilities, and the owner's authorized representative.	Chapter 2
• A project description that includes a location map and a map of the present and proposed service area.	Chapter 2
• A statement of the present and expected future quantity and quality of wastewater, including any industrial wastes that may be present or expected in the sewer system.	Chapter 4
• The degree of treatment required based upon applicable permits and rules, the receiving body of water, the amount and strength of wastewater to be treated, and other influencing factors.	Chapters 2 and 4
• A description of the receiving water, applicable water quality standards, and how water quality standards will be met outside any applicable dilution zone.	Chapters 2, 3, and 4
• The type of treatment process proposed, based upon the character of the wastewater to be handled, the method of disposal, the degree of treatment required, and a discussion of the alternatives evaluated and the reasons they are unacceptable.	Chapters 4, 5, and 6
• The basic design data and sizing calculations of each unit of the treatment works, expected efficiencies of each unit and also of the entire plant, and anticipated effluent character.	Chapters 4, 5, and 6
• Discussion of the various sites available and the advantages and disadvantages of the site or sites recommended. The proximity of residences or developed areas to any treatment plant site and the various plant units.	Chapter 5
• A flow diagram that shows the general layout of the various units, the location of the effluent discharge, and a hydraulic profile of the system that is the subject of the facility plan and any hydraulic related portions.	Chapter 6
• A discussion of infiltration and inflow problems, overflows and bypasses, and proposed corrections and controls.	Chapters 4 and 5

Table 2.1 Facility Plan Requirements	
• A discussion of any special provisions for treating industrial wastes, including any pretreatment requirements for significant industrial sources.	Not Applicable
• Detailed outfall analysis or other disposal method selected.	Not Applicable
• A discussion of the method of final sludge disposal and any alternatives considered.	Not Applicable
• Provisions for future needs.	Chapter 6
• Staffing and testing requirements for the facilities.	Chapter 6
• An estimate of the cost and expenses of the proposed facility and the method of assessing these costs and expenses. The total amount shall include both capital and operations and maintenance costs for the life of the project, and must be presented in terms of the total annual cost and present worth.	Chapter 7
• A statement regarding compliance with any applicable state or local water quality management plan or any plan adopted under the Federal Water Pollution Control Act as amended.	Not Applicable
• A statement regarding compliance with the State Environmental Policy Act (SEPA) and the National Environmental Policy Act (NEPA), if applicable.	Chapters 6 and 9
Orange Book Requirement	**Location Addressed**
• Well documented site description, problem identification, and map.	Chapter 2
• Well documented description of discharge standards.	Chapter 2
• Background information including:	
– Existing environment (water, air, sensitive areas, flood plains, shore lands, wetlands, endangered species/habitats, public health, prime or unique farmland, archaeological and historical sites, any federally recognized “wild and scenic rivers,” threatened species).	Chapters 3 and 6

Table 2.1 Facility Plan Requirements

Orange Book Requirement	Location Addressed
– Demographic and land use (current population, present wastewater treatment, advanced wastewater treatment need evaluated, infiltration and inflow (I/I) studies, CSOs, sanitary surveys for unsewered areas, determination that I/I is not excessive).	Chapters 3 and 4
• Future conditions, including appropriateness of population data source, zoning changes, future domestic and industrial flows, and flow reduction options, future flows and loading, reserved capacity, future environment without project, discussion of whether recreation and open space alternatives could be incorporated.	Chapter 4
• Alternatives: list of specific alternative categories, including no action, collection system alternatives, sludge management/use alternatives, flow reduction, costs, environmental impacts, public acceptability, rank order, recommended alternative, description of innovative and alternative technologies.	Chapter 5
• Final recommended alternative: site layout, flow diagram, sizing, environmental impacts, design life, sludge management, ability to expand, O&M/staffing needs, design parameters, feasibility of implementation.	Chapter 6
• Financial Analysis: costs, user charges, financial capability, capital financing plan, implementation plan.	Chapters 7 and 8
• Other:	
– Conformance to water quality management plan.	Not Applicable
– SEPA approval, list required permits, environmental issues analysis.	Chapters 6, 8 and 9
– SERP compliance.	Chapter 9
– Documentation that the project is identified in a sewer general plan.	Chapters 2 and 9
– Capital improvement plan.	Chapter 7
– Documentation of adequate public involvement process.	Chapter 9

2.4 CSO CONTROL REQUIREMENTS

Amendments to the Federal Water Pollution Control Act, also known as the "Clean Water Act," or "CWA," were passed in 1972 and later expanded in 1977 and 1987. The purpose of this body of law is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (33 CFR 26.I§1251(a)). This objective translates into two overarching goals: 1) to eliminate the discharge of pollutants into the nation's waters, and 2) to achieve and maintain fishable and swimmable waters. The first goal, elimination of pollutant discharge, is met, in part, through the National Pollutant Discharge Elimination System (NPDES) permitting program. The second goal, restoration and maintenance of water quality, is being addressed by developing pollution control programs to meet specific water quality standards for specific water bodies.

The CWA requires all wastewater treatment facilities and industries that discharge effluent into surface waters to have NPDES permits. In Washington State, NPDES permits are issued by the Washington State Department of Ecology (Ecology). These permits define appropriate technology controls and specify limits on the allowed quality and quantity of effluent discharged from point sources such as treatment plants, CSOs, and industrial facilities.

CSOs were recognized by Ecology in the early 1980s as a unique category of discharge that was not adequately covered by existing federal or state regulations.

In 1984, Ecology introduced legislation requiring agencies with CSOs to develop plans for "the greatest reasonable reduction [of CSOs] at the earliest possible date". In January 1987, Ecology published a new regulation (WAC 173-245) that defined the greatest reasonable reduction in CSOs as "control of each CSO such that an average of one untreated discharge may occur per year". The new regulation also defined standards for treated CSOs, which were essentially technology standards. Water Quality Standards allow a once-per-year

Regulations that Affect CSO Control Planning

Clean Water Act (CWA)—Adopted in 1972 (and expanded in 1977 and 1987) to eliminate the discharge of pollutants into the nation's waters and to achieve and maintain fishable and swimmable waters.

National Pollutant Discharge Elimination System (NPDES)—The Washington State Department of Ecology (Ecology) implements the CWA by issuing NPDES permits to wastewater agencies and industries that discharge effluent (including combined sewer overflows, or CSOs) to water bodies.

Water Quality Standards—To implement the CWA, Ecology has developed biological, chemical, and physical criteria to assess a water body's health and to impose NPDES permit limits accordingly.

State CSO Control Regulations—Ecology requires agencies to develop plans for controlling CSOs at the earliest possible date, so only an average of one untreated discharge per year occurs at each location.

Wet Weather Water Quality Act of 2000 (based on the CSO Control Policy)—The U.S. Environmental Protection Agency (EPA) requires agencies to implement "Nine Minimum Controls," and to develop long-term CSO control plans.

Sediment Quality Standards—Ecology developed chemical criteria to characterize healthy sediment quality and identified a threshold for sediment cleanup.

Endangered Species Act (ESA)—Three fish species that use local water bodies where CSOs occur have been listed as threatened under the ESA.

exemption from the mixing zone standards for “one untreated discharge” from CSO treatment facilities. Water quality–based effluent limits also apply to treated CSO discharges where determined needed.

The United States Environmental Protection Agency’s (US EPA’s) 1994 CSO Control Policy was codified as the Wet Weather Water Quality Act of 2000 (H.R. 4577, 33 U.D.C. 1342(q)). This act requires implementation of “Nine Minimum Controls” for CSOs and the development of long-term CSO control plans. The purpose of the Nine Minimum Controls is to implement early actions that can improve water quality before the protracted and more expensive capital projects in a control plan are built. EPA has determined that the Nine Minimum Controls are equal to the Best Available Technology (BAT). Agencies must show that water quality standards are met after implementation of their CSO control plan. The requirements of this act are incorporated in the NPDES permit for the West Point Treatment Plant.

2.5 CSO CONTROL PROGRAM OVERVIEW

In 1958, the Municipality of Metropolitan Seattle (Metro) was formed to clean up the waters of Lake Washington and the Seattle waterfront. In the 1960s, Metro assumed ownership of the City of Seattle’s wastewater treatment plants and portions of its sewer system. It built large pipes, called interceptors, to carry regional wastewater from local systems to the treatment plants. In 1994, King County assumed Metro’s responsibilities for regional wastewater management. In most of the Seattle area, wastewater and stormwater were combining in one conveyance system. The regional improvements in collecting, conveying, and treating wastewater that were made after the formation of Metro continue to be effective, even as the population and regional development have grown dramatically over the intervening decades.

In response to the Clean Water Act of 1972, Metro adopted the Combined Sewer Overflow Control Program in 1979. Since adoption of this first program, Metro, and then King County, have modified their CSO plans as CSO regulations have evolved and changed, including Ecology’s current control standard of no more than one untreated discharge per year on average at each CSO location.

Strategies for reducing or mitigating the effects of CSOs include: pollution prevention through source control, stormwater management, operational controls that transfer as much CSO flow as possible to regional treatment plants, upgrades of existing facilities, and construction of CSO control facilities.

Construction of CSO control facilities in the region began in the late 1970s. Figure 2.2 illustrates the positive impact these CSO control efforts have had on sewer overflows. Since 1988, when systematic monitoring and measuring of CSO flows began, CSO volumes have dropped by more than half due to various improvement projects, from an estimated 2.4 billion gallons per year to approximately 900 million gallons per year.

So far, about $360 million (in 2008 dollars) has been spent by the County to control CSOs. Another $400 million in expenditures is planned to implement the CSO control projects in the long-term control plan approved in 1999 as part of the County’s Regional Wastewater

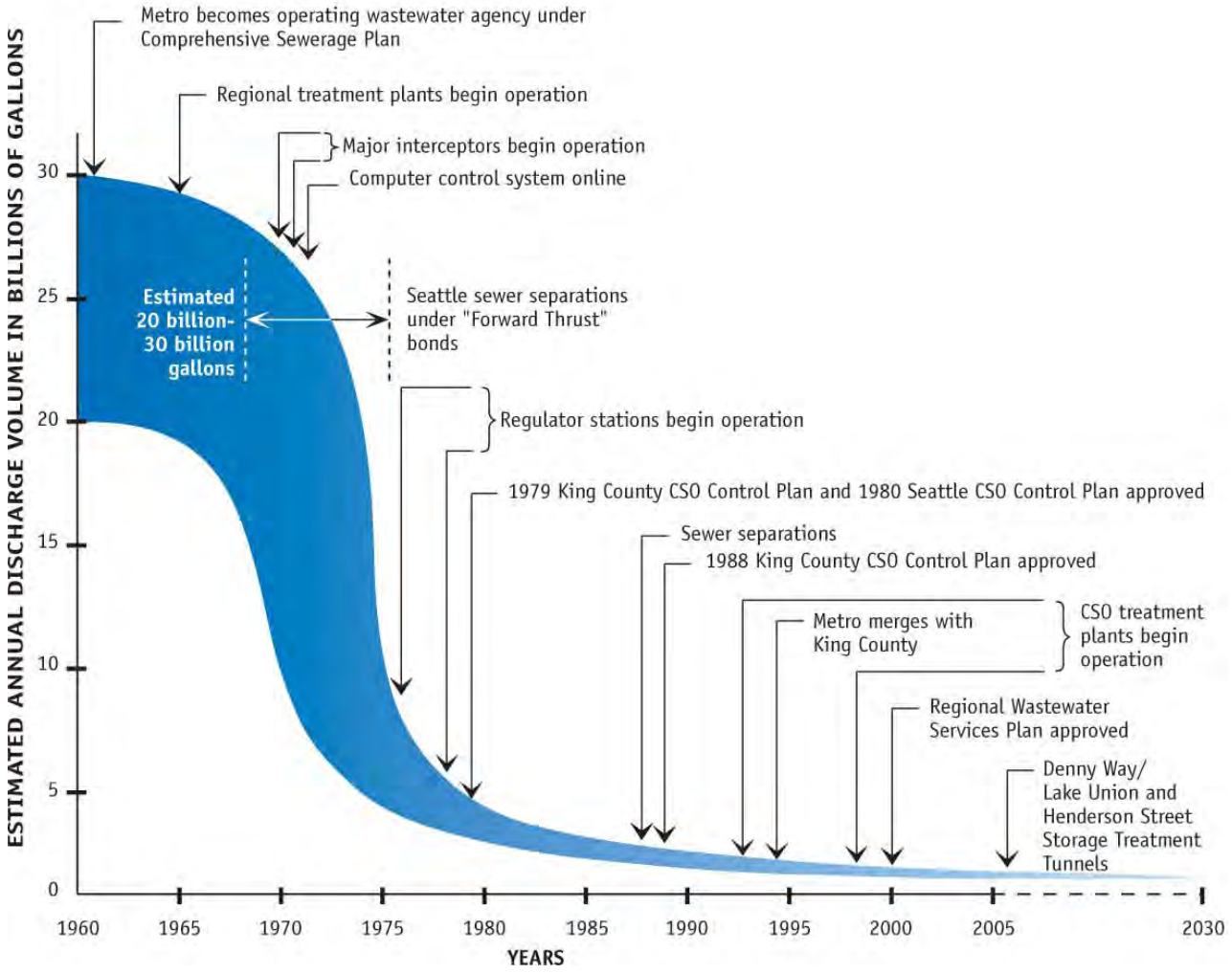

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Figure 2.2
KING COUNTY CSO CONTROL PROGRAM OVERVIEW

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Services Plan (RWSP). Many early projects involved sewer separation, flow diversion, and construction of storage tunnels. Most current and future CSO projects involve the construction of conveyance improvements, storage tanks, and treatment facilities.

The most recent update to the King County CSO Control Program is described in the 2008 *CSO Control Plan Update* (King County, June 2008) and in the Regional Wastewater Services Plan (2008 Annual Report).

Control facilities that were under construction prior to RWSP adoption - the Mercer/Elliott West and the Henderson/Norfolk CSO control systems - were brought on-line in 2005. Now, based on the last seven years of monitoring, 13 of King County's 38 CSOs are controlled to Ecology's standard. The control status at five more CSO sites where projects have been completed will be assessed after the facilities have operated a sufficient number of years. The remaining 20 uncontrolled CSOs will meet state standards as capital improvement projects are completed between 2013 and 2030.

The North Beach CSO control project is one of four Priority 1 projects, as shown in Figure 2.3 (RWSP Annual Update, September 2009). (Note: The SW Alaska project was removed from the priorities list subsequent to the 2008 update as this CSO is now adequately controlled as a result of the Alki Transfer Project.) The CSO projects after Mercer/Elliott West and Henderson/Norfolk given the highest priority were at locations with recreational uses, such as swimming, where direct human contact with the water is likely to occur. Priorities for future projects may change based on upcoming CSO Program reviews and updates.

2.6 PREVIOUS STUDIES

King County and its predecessor agency, Metro, have consistently relied on scientific information to inform their wastewater management decisions. When information has not been available, they have initiated or participated in special studies to develop the needed data. This section describes the foundational studies that have shaped King County's decisions on CSO control.

2.6.1 1958 Metropolitan Seattle Wastewater and Drainage Study

Beginning with the 1958 *Metropolitan Seattle Wastewater and Drainage Study*, regional agencies have collaborated on studies to identify major environmental protection needs, and to identify and prioritize corrective actions. This study recognized that providing better wastewater management would result in the most environmental improvement. As part of a larger three-stage schedule of projects, this study recommended a program of sewer separation and storage, as needed, to control overflows in the City of Seattle.

2.6.2 1978 Area-wide Section 208 Water Quality Plan

In the late 1970s, Metro completed a two-year water quality investigation under Section 208 of the CWA. Toxic chemicals were identified as one of the five main water quality problems facing the Seattle-King County region. The plan recommended CSO control as part of improved wastewater management, and identified the need for more understanding of the toxic impacts of CSOs on the local environment.

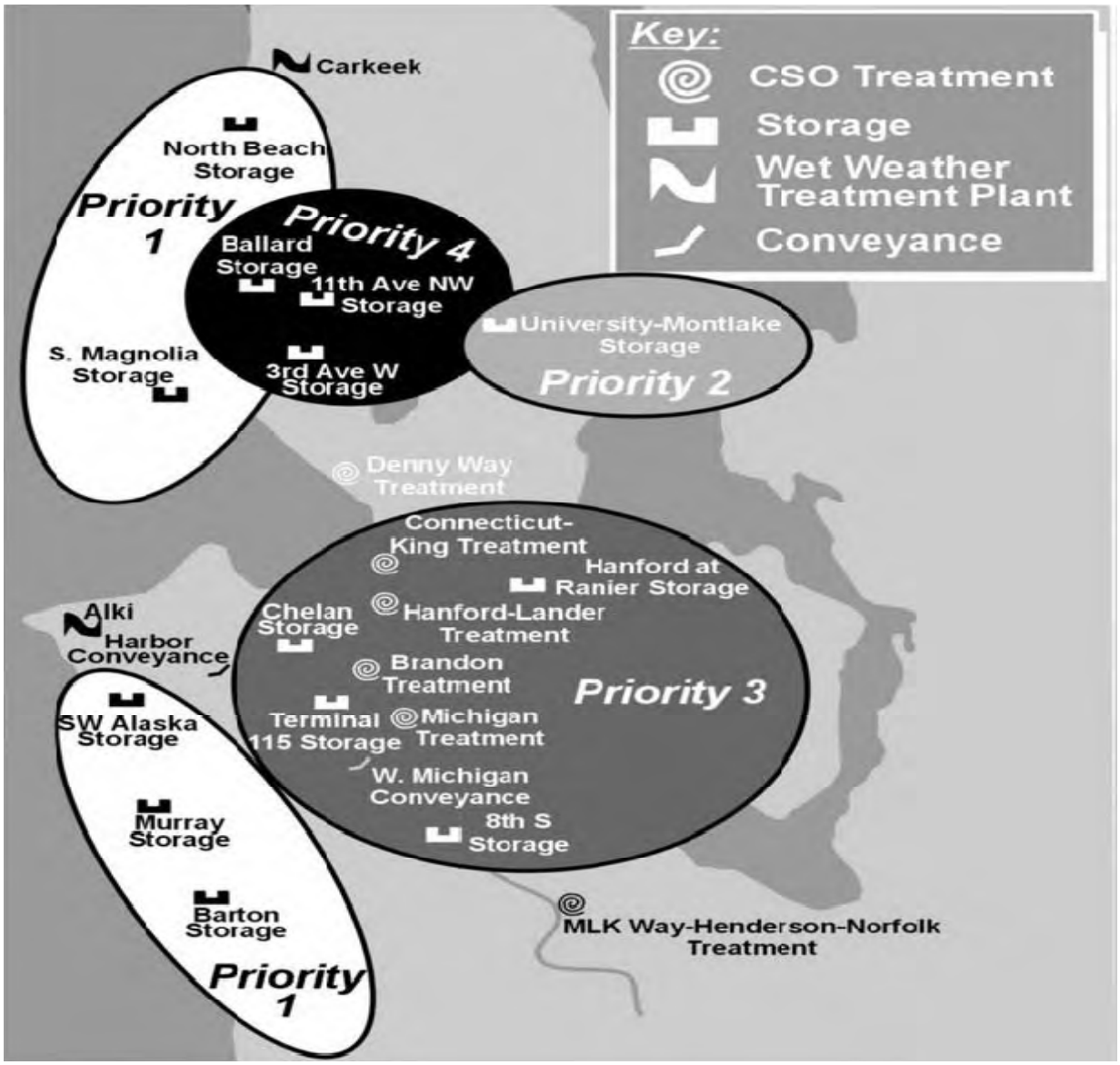

Figure 2.3
CSO CONTROL PROJECT PRIORITIES

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Figure 2-3.ai

2.6.3 1979–1984 Toxicant Pretreatment Planning Study

In 1979, Metro, with the support of the EPA and Ecology, initiated a 5-year, $7-million (in 1979 dollars) study—the *Toxicant Pretreatment Planning Study* (TPPS)—to develop a better understanding of what toxic chemicals were present in the local environment and wastewater, what the impacts of these toxicants were, and the treatability of these flows. A scientific advisory panel provided advice, oversight, and review during the study. The TPPS recommended that CSO control should be part of a coordinated Elliott Bay Action Plan, and that source control, including enhancing Metro's pretreatment program, should be a priority.

2.6.4 1983 Water Quality Assessment of the Duwamish Estuary

Because of the potential conflict between uses of the Duwamish Waterway, the EPA and Ecology have classified this estuary as a high-priority study area. In a 1982 state/EPA agreement, both agencies identified the Duwamish Waterway as having one of the four worst water quality problems in Washington. As the designated water quality management agency for the Green/Duwamish basin, Metro was awarded a grant to inventory pollutants entering and impacting the waterway, and to develop a strategy for improved pollution control. The 1983 *Water Quality Assessment of the Duwamish Estuary* (also known as the Harper-Owes Study) documented this work. It overlapped TPPS activities in some areas.

This assessment synthesized the findings of the many Duwamish studies performed through July 1982 in order to identify data strengths, deficiencies, and gaps. Public input and interagency task force review comments were considered in developing a ranked list of beneficial uses of the estuary. Mass balances were performed on 20 parameters to identify pollutant impacts to beneficial uses. Upstream sources were found to contribute more than two-thirds of the total sediment, iron, and mercury load, as well as much of the organic carbon and pesticides. Major negative impacts to beneficial uses were attributed to ammonia, residual chlorine, copper, lead, mercury, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs). Temperature, dissolved oxygen demand, nitrite, cadmium, DDT, pathogens, and sediments were found to produce only minor effects.

The Renton Treatment Plant (now called the South Treatment Plant) was found to contribute nearly 80 percent of the total ammonia load. The anticipated diversion of plant effluent out of the Duwamish River in 1986 was expected to result in marked reductions in ammonia, chlorine, dissolved oxygen demand, nitrite, and cadmium impacts to the Duwamish Estuary. In contrast, although CSOs were found to be a source of all the pollutants measured, their contribution was comparatively small. One exception was fecal coliform bacteria. An estimated 80 percent of the total pathogens released to the estuary were estimated to originate from CSOs. While concentrations of toxicants were found to be relatively high in the CSO flows, the small annual overflow volume made them only a minor source of contaminants.

The most significant finding was that the majority of metal and organic toxicants found in the estuary could not be attributed to documented sources. This shifted attention to the heavy industrial and commercial activity along the river. Future conditions were projected to adversely impact beneficial uses. Temperature, sediment, pathogens, copper, lead,

mercury, PCBs, and PAHs were identified as the greatest contributors to future adverse impacts.

At the conclusion of this work, CSOs were identified as a minor contributor to the larger pollution problem and CSO control was recommended as a part of the solution.

2.6.5 1988 Draft Elliott Bay Action Plan

In 1985, the Puget Sound Estuary Program (PSEP) was formed to minimize toxic chemical contamination of Puget Sound and to protect its living resources. The Urban Bay Action Program, an element of the PSEP, developed the 1988 *Action Plan* (King County, 1988) for the Elliott Bay Action Program. Its objectives were as follows:

- Identify specific toxic areas of concern in the Bay and the Duwamish Waterway based on chemical contamination-associated adverse biological effects;
- Identify historical and on-going sources of contamination;
- Rank toxic problem areas and sources (to the extent possible) in terms of priority for development of corrective actions; and
- Implement corrective actions to reduce or eliminate sources of on-going pollution and restore polluted areas to support natural resources and beneficial uses.

Early accomplishments of the Elliott Bay Action Program included more than 175 inspections at 102 sites, identification of 42 unpermitted discharges, and the development of permits and best management practices for shipyards. Fifteen contaminated upland sites were identified for cleanup, two cleanups were completed, and negotiations of cleanup for 12 additional sites were finalized. By September 1987, enforcement actions included 36 notices of violation, 22 administrative orders, and 28 fines totaling $44,500 (in 1988 dollars).

Through these efforts, most known direct industrial discharges to the Bay and River were terminated or routed to the municipal sewer system under permits. In addition, the effluent discharge point from the Metro Renton Treatment Plant was relocated from the Duwamish River to Puget Sound off Duwamish Head in 1987. The remaining on-going contaminant sources were believed to include contaminated groundwater, storm drains, CSOs, and a few unidentified direct discharges.

To characterize contaminant inputs from CSOs and storm drains (SDs), sediment was collected from the downstream end of seven CSOs, 20 SDs, and 15 combination CSO/SDs. These in-line sediments were compared to off-shore sediments to evaluate CSO and SD contributions to the contamination in priority areas and stations. Ten priority drainages were identified for source-control activities.

Control of direct discharges and stormwater sources were identified as the greatest needs; these controls were expected to improve CSO discharge quality. Metro's Denny Way and Michigan CSOs were identified as priorities for control. Although the Denny Way CSO was not identified as a candidate for source control activities, it was determined that controlling the site would benefit the Denny Way "problem area."

2.6.6 1988–1996 Metro Receiving Water Monitoring Program

In Administrative Order DE-84-577, Ecology instructed Metro to develop and implement a plan for monitoring receiving waters in the vicinity of its primary treatment plants—West Point, Alki, Carkeek, and Richmond Beach—and in other point-source discharge areas. (The Renton plant provided secondary treatment.) The proposed plan included:

- Water column surveys of fecal coliform and enterococcus bacteria;
- Sub-tidal sediment surveys including benthic taxonomy and amphipod bioassays;
- Analysis of conventional constituents (particle size distribution, total organic carbon, oil, and grease), metals, and extractable organic priority pollutants, plus a survey;
- Intertidal monitoring of water for bacteria, and monitoring of sediments for metals and extractable organic priority pollutants; and
- Analysis of clam and algae tissue samples for the presence of bacteria, metals, and extractable organic priority pollutants.

Monitoring was to occur quarterly to biennially at a range of stations near the treatment plants and nearby shorelines.

This “point source” monitoring program was approved by Ecology on April 5, 1988, in a first amendment to Administrative Order DE-84-577. Data were reported to Ecology as quality assurance/quality control (QA/QC) was completed. These data were also summarized in annual marine water quality status reports. The monitoring program was implemented until the 1996 NPDES permit for the West Point plant was issued, which was upgraded to provide secondary treatment after closure of the Richmond Beach plant. Post-1996, Metro focused its monitoring program on collecting data on key parameters that could be used in long-term trend assessments. In parallel, an ambient monitoring program was implemented to provide background data that could be compared to the point-source monitoring data. This comparison helps identify impacts related to Metro discharges, and helps ensure that water quality improvements are not undermined.

These monitoring efforts affirmed that CSO control was a minor-to-moderate part of a larger wet-weather problem. While CSO control was part of the solution, it would not bring the largest benefit.

2.6.7 1988–1997 Metro/King County CSO Discharge and Sediment Characterization Study

In approving Metro’s 1988 CSO control plan, Ecology required CSO and sediment characterization. The purpose of the effort was to obtain additional information to be used in setting site-control priorities and a control project schedule. Because some sampling had already been done, the approved monitoring plan called for taking four discharge samples at five active overflow sites per year until all the sites had been sampled. This sampling was completed in 1994. Sediment sampling was also completed for all sites at the rate of five sites per year. When the state promulgated the Sediment Management Standards and

attendant testing protocols, additional sediment sampling was done to fully meet these requirements. This additional sampling was completed in 1997.

Analysis of overflow samples showed that the variability between different samples at a given site was generally greater than the variability among sites. Sediment sampling confirmed that the local sediments had been significantly impacted by pollution and that the contamination resulted from many sources. Recognizing that further understanding of sediment contamination was needed, the County made it a focus of both the 1999 *CSO Water Quality Assessment for the Duwamish River and Elliott Bay* and the 1999 *Sediment Management Plan*.

The Denny Way CSO, overflow from the Elliott Bay Interceptor which is transported via the Interbay Pump Station, was slightly higher in pollutant concentrations than the other CSOs, affirming it as a priority site for control; chemistry at other overflows did not greatly influence their control priority.

2.6.8 1999 Combined Sewer Overflow Water Quality Assessment for the Duwamish River and Elliott Bay

King County completed the 1999 *CSO Water Quality Assessment for the Duwamish River and Elliott Bay* (WQA) with support from a large stakeholder group and a peer-review panel. The WQA reviewed the health of the Duwamish River and Elliott Bay Estuary and the effects of CSO discharges. A computer model was developed to predict existing and future water and sediment quality conditions, and a risk assessment was undertaken to identify risks to aquatic life, wildlife, and human health. Findings identified during the course of the WQA were taken into account during development of the RWSP CSO control program.

The findings of the WQA affirmed that CSO pollution is a very small part of a larger problem, mainly because of the low pollutant concentrations in CSOs and the brief and infrequent exposure of the estuary to CSOs. It recommended that CSO control continue to meet state regulations and helped determine the priority of the CSO projects in the RWSP. It recommended that locations with greater potential for human contact - the Puget Sound beaches - be controlled first. It identified sediment contamination as the largest risk in the river environment.

2.6.9 1999 Sediment Management Plan

The *Sediment Management Plan* (King County, June 1999) assessed areas near seven county CSOs listed on the Washington State Contaminated Sites list. These areas were assessed for their risk, preferred cleanup approach, partnering opportunities, and potential for recontamination after remediation.

The *Sediment Management Plan* highlighted the growing interest in sediment management as a factor in CSO control planning and the need for more information about CSOs as an on-going or historical contributor to contamination. The Sediment Management Program was formed to implement the *Plan* and any new projects developed after the *Plan* in the broader context of wastewater planning. The program addresses sediment quality issues near CSO discharges and treatment plant outfalls, evaluates and addresses emerging

wastewater treatment sediment quality issues, and incorporates sediment quality considerations into the County's comprehensive long-term planning.

2.6.10 1999 Regional Wastewater Services Plan

In 1999, King County adopted the *Regional Wastewater Services Plan* (King County, November 1999), a comprehensive 30-year wastewater plan. RWSP CSO policies are intended to guide the County in controlling CSO discharges so that all CSO locations meet state and federal regulations by 2030. In setting schedules for implementing CSO control projects, the RWSP gives the highest priority to locations with the greatest potential to impact human health, bathing beaches, and ESA-listed species. These policies call for regular assessment of CSO projects, priorities, and opportunities using the most current data available. Another CSO control policy addresses the cleanup of contaminated sediments near county CSOs. The policy directs the County to implement its long-range sediment management strategy and, where applicable, to participate with partners in sharing the responsibilities and costs of cleaning up sites. Sediments near the North Beach CSO outfalls do not require any cleanup at this time. However, pre-construction monitoring will be performed as part of the project to re-evaluate this conclusion.

2.6.11 2000 and 2008 CSO Control Plan Updates

The 2000 *CSO Control Plan* (King County, June 2000) documents King County's compliance with state and federal CSO requirements and updates the CSO Control Plan in the 1999 RWSP. Updates include: redefining the definition of a CSO event, studying alternative methods for CSO control and treatment, researching potential total maximum daily load requirements, developing watershed management programs, studying sediment contamination, developing a sediment management plan, developing a CSO posting and notification program, and listing Chinook salmon under the Endangered Species Act.

The 2008 *CSO Control Plan Update* (King County, June 2008) provides updates required to the County's 2000 *CSO Control Plan*. An Ecology CSO regulation (WAC 173-245) requires that updates coincide with each NPDES permit renewal for the West Point Treatment Plant. Updates are intended to document progress on implementing the county's previous CSO control program and identify the plan for the next five years.

2.6.12 Sediment Quality Summary Report for CSO Discharge Locations

The *Comprehensive Sediment Quality Summary Report for CSO Discharge Locations* (King County, December 2009) documents sediment sampling near the North Beach outfalls.

Sediment samples were collected from six locations proximal to the North Beach Pump Station discharge point in October 1996. Five of the stations formed a transect perpendicular to the end of the outfall and the sixth station was located approximately 1,000 feet from the outfall. Organic carbon concentrations in these six samples ranged from 867 to 1,970 mg/Kg dry weight or approximately 0.09 to 0.20 percent dry weight. Because of these low organic carbon concentrations, organic data from this site were compared to the lowest apparent effects threshold (LAET) and second lowest apparent effects threshold (2LAET) values rather than Sediment Quality Standards (SQS) and cleanup screening level (CSL) chemical criteria for those compounds generally normalized to organic carbon. The phenol

concentration of 461 μg/Kg dry weight detected in the sample collected from one station exceeded the dry weight normalized SQS of 420 μg/Kg dry weight. This station is located approximately 230 feet from the end of the outfall. All other detected chemical concentrations were less than their respective SQS criteria or LAET values. No sediment remediation activity is planned at this time.

2.7 PROJECT PLANNING PERIOD

The North Beach Basin CSO Control Project is one of four CSO control projects undertaken as part of the King County long-term control plan. CSO control volumes described in this Facility Plan to meet the CSO control requirements have been determined based on historical flow monitoring from December 2007 through June 2008, pump tests performed in December 2008 and November 2009, and modeling using long-term rainfall records. The proposed facilities have been evaluated based on an anticipated construction start date of 2013 and a project life of 35 years.

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EXISTING CONDITIONS

This chapter provides background information on the current conditions of the North Beach Basin, including the existing human, physical, and natural environment.

3.1 HUMAN ENVIRONMENT

The North Beach Basin is located on the shores of Puget Sound in northern Seattle, as shown in Figure 3.1. The North Beach Basin covers approximately 633 acres and drains to the North Beach Pump Station along its northern edge. Its approximate eastern edge is 14th Avenue NW and its southern boundary generally follows NW 85th Street.

3.1.1 Land Use

The North Beach Basin is almost completely developed, predominantly with single-family homes. Neighborhood commercial development and low-rise multi-family housing are primarily located along 15th Avenue NW and Holman Road.

The Basin has numerous neighborhood parks, including Soundview Playfield, 26th Avenue Park, and Blue Ridge Park (privately owned). Several schools are also located there, including North Beach Elementary, Whitman Middle School, and the former Crown Hill Elementary School. A Burlington Northern Santa Fe (BNSF) Railroad line runs along the northern edge of the Basin adjacent to Puget Sound.

Table 3.1 describes the distribution of land uses in the Basin and Figure 3.2 shows the current zoning map.

Table 3.1 Land Use in the North Beach Basin

Land Use Type	Area (acres)[1]	Percent of Total
Single-Family Residential	396.9	62.7%
Multi-Family Residential	19.6	3.1%
Commercial	17.7	2.8%
Institutional	31.0	4.9%
Government/Industrial	0.0	0.0%
Parks	76.6	12.1%
Vacant	91.8	14.5%
Public/Utility	0.0	0.0%
Total	633.0	100.0%

Notes:
1. Source: King County GIS database (2008).

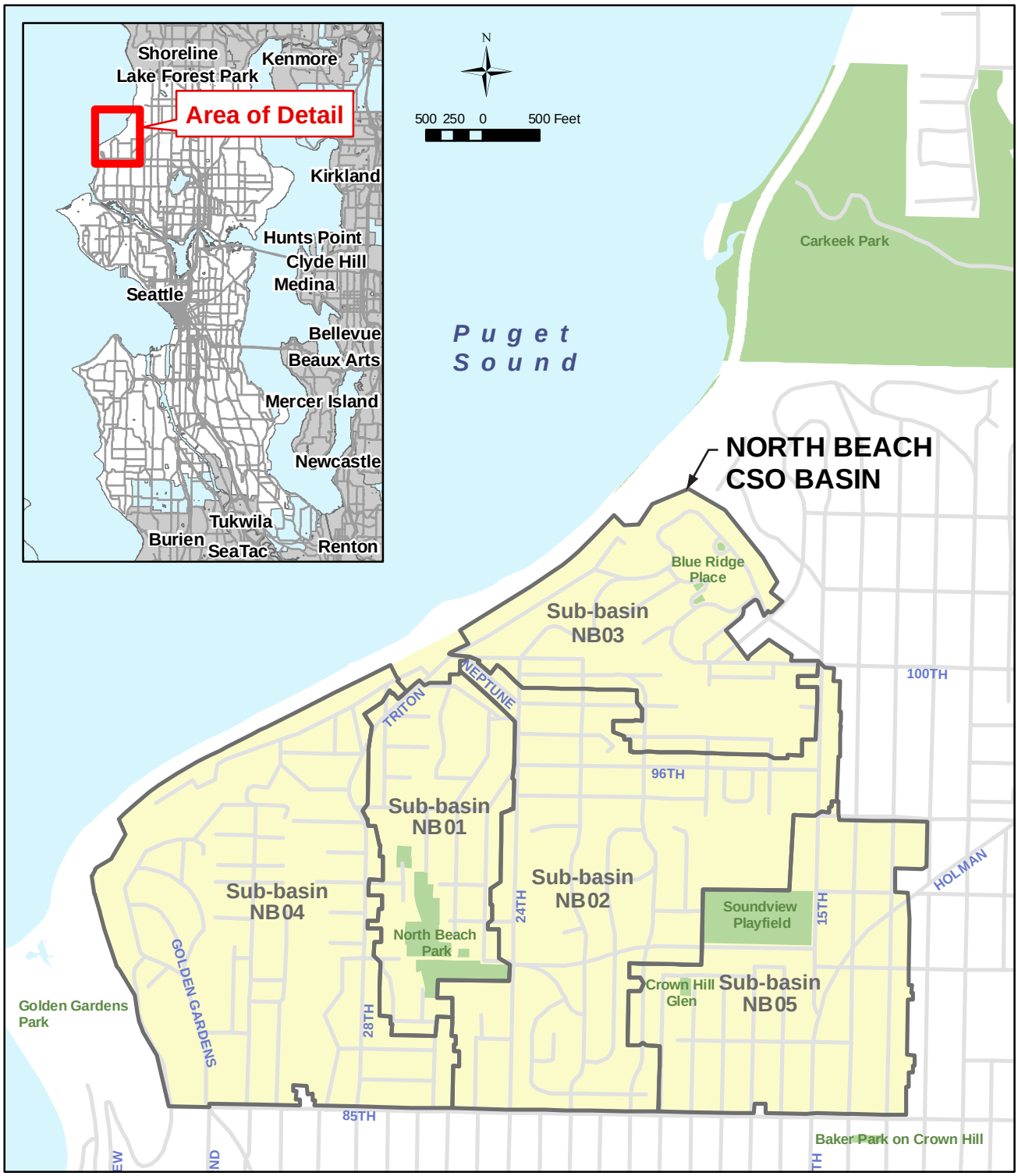


Figure 3.1
NORTH BEACH VICINITY MAP

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Figure 3-1.ai

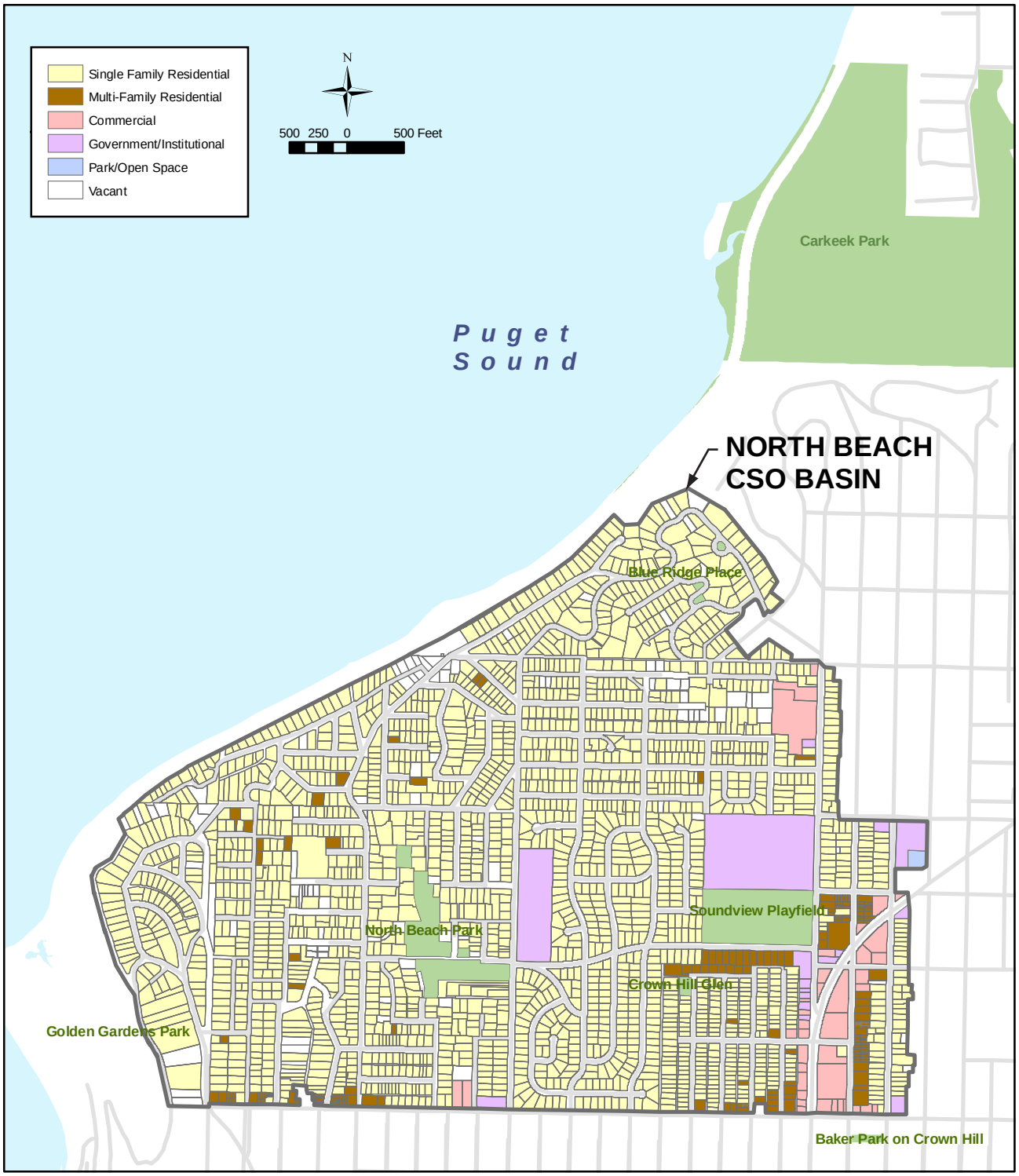


Figure 3.2
NORTH BEACH ZONING MAP

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Figure 3-2.ai

3.1.2 Wastewater System

3.1.2.1 Local Collection System

The local collection system for the North Beach Basin is shown in Figure 3.3. The system upstream of the North Beach Pump Station is owned and maintained by Seattle Public Utilities (SPU). It primarily serves single-family and multi-family residential customers and commercial customers. The North Beach Pump Station is located at the junction between the local collection system and King County's regional conveyance system.

The system consists of 8- to 18-inch-in-diameter gravity sewer pipes and stormwater pipes. As shown in Figure 3.1, the Basin is divided into five sub-basins (NB01 through NB05) based on the configuration of the collection system. Sub-basin NB05 drains to Sub-basin NB02. Sub-basins NB01, NB02, NB03, and NB04 converge at the bottom of the Basin, immediately upstream of the North Beach Pump Station.

A portion of the collection system is "separated" - the stormwater is separated from the sanitary sewer system. In this area (generally Sub-basin NB02), a municipal separated stormwater sewer system (MS4) serves streets and impervious areas of some private properties. A significant portion of the Basin is also considered separated since stormwater is conveyed through a ditch and culvert system in this area, and does not enter the sanitary sewer.

According to a GIS analysis, approximately 13 acres of impervious area, equivalent to about 320 residential properties, are connected to the combined sewer system (CSS) in the North Beach Basin. This includes limited rooftops and impervious private property areas.

3.1.2.2 Regional Conveyance System

Figure 3.4 shows the King County regional conveyance system in northwest Seattle. The North Beach Basin is the headwaters of the system in this area. Wastewater is pumped from the North Beach Pump Station through the North Beach Force Main to the Carkeek Pump Station.

A pump test on November 3, 2009 revealed that the capacity of the pump station is about 3 mgd. This is lower than the design capacity of 3.5 mgd. It is expected that sediment in the force main is limiting the maximum flow to its current tested capacity. There is also a sizable area that drains to the North Beach Pump Station force main and enters the force main by gravity in Carkeek Park. This flow may further limit the North Beach Pump Station force main capacity and will be investigated further during pre-design of the project.

From Carkeek, the wastewater is conveyed to the West Point Treatment Plant through the 8th Avenue Interceptor and Ballard Siphon. During peak wet-weather events, flows in excess of 9.2 mgd, approximately 2.25 times the average wet-weather flow (AWWF) in the entire Carkeek basin, are treated at the Carkeek CSO Plant and discharged through an outfall to Puget Sound.

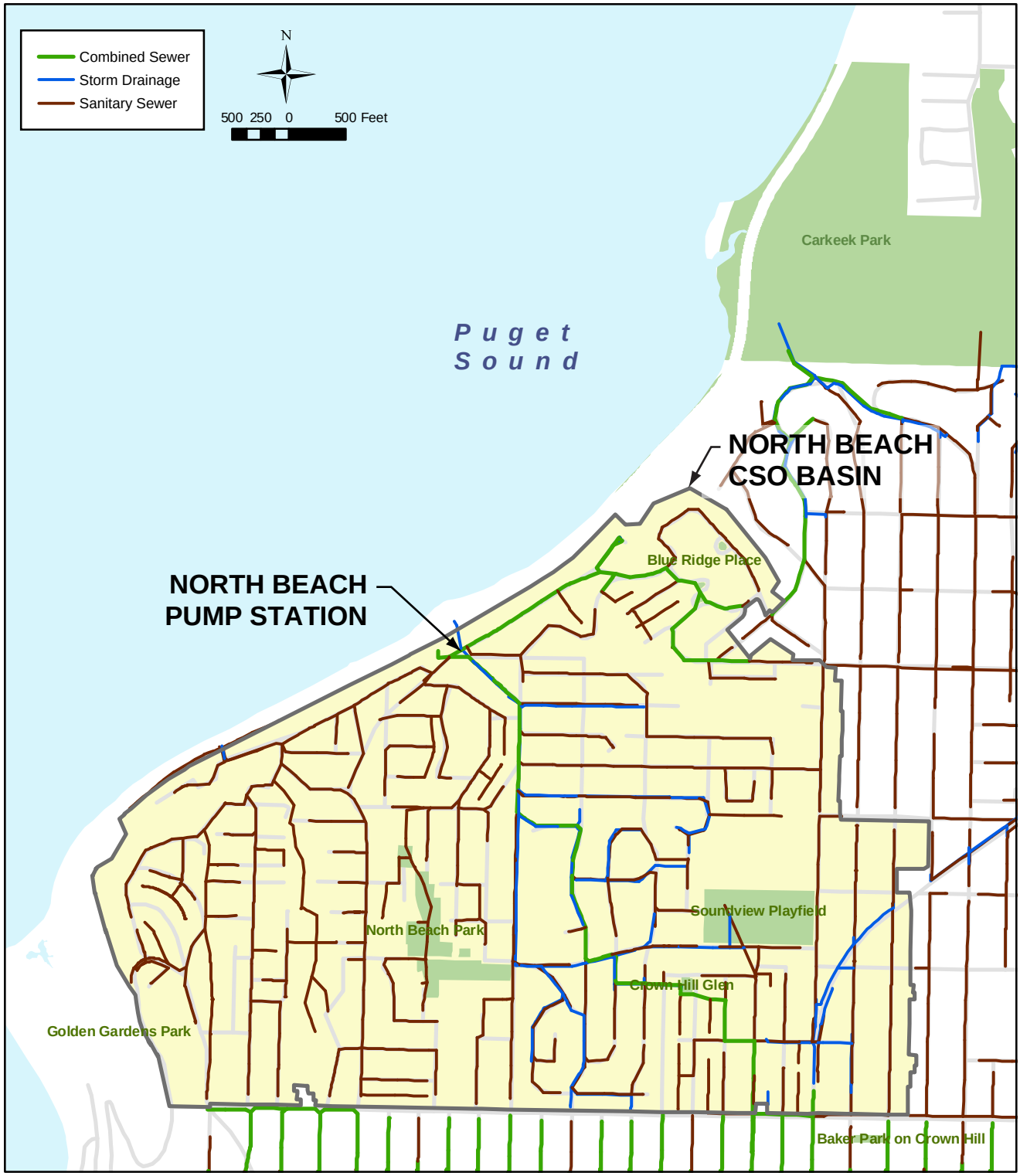


Figure 3.3
NORTH BEACH WASTEWATER COLLECTION SYSTEM

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Figure 3-3.ai

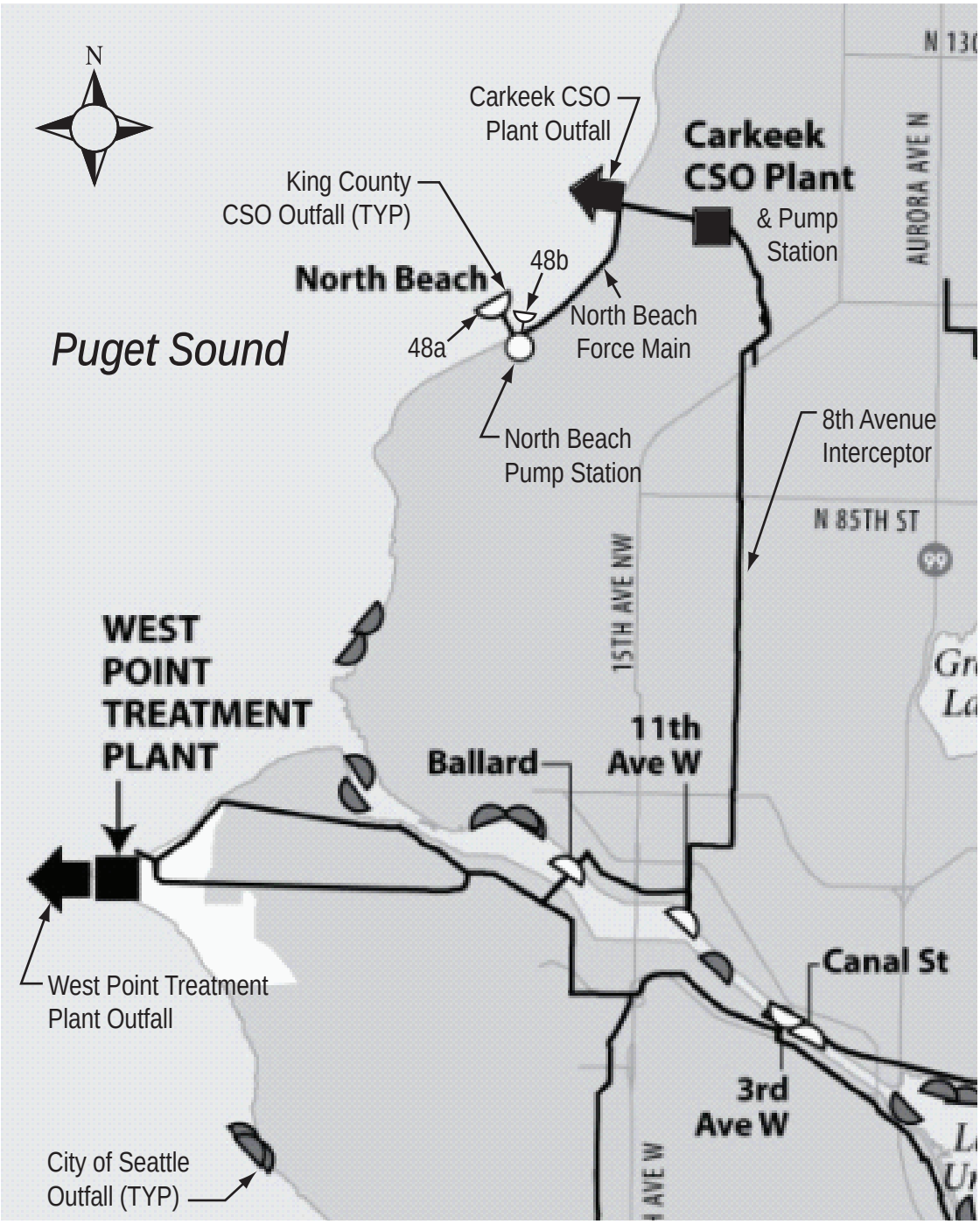


Figure 3.4
KING COUNTY REGIONAL CONVEYANCE SYSTEM IN VICINITY OF NORTH BEACH BASIN

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Figure 3-4.ai

3.1.2.3 CSO Control Structures and Outfalls

There are two CSO control structures for the North Beach Basin. One of these is an overflow weir in the North Beach Pump Station wet well. If flow into the pump station exceeds the pump station's capacity of 3 mgd, the water elevation in the wet well rises. Once the water elevation exceeds approximately Elevation 122.8 (Metro Datum), the combined sewage overflows the weir and is discharged to Puget Sound through an approximately 1,300 foot-long, 15- and 16-inch-in-diameter CSO outfall.

The second control structure is an overflow weir located in a manhole upstream of the North Beach Pump Station. If the flow exceeds the pump station's capacity of 3 mgd, the water elevation in the upstream collection system rises. Once the water elevation exceeds approximately Elevation 124.9 (Metro Datum), combined sewage overflows the weir and is discharged to Puget Sound through an approximately 400-foot-long, 30- and 54-inch–in-diameter stormwater pipe to the beach north of the BNSF railroad tracks.

3.1.2.4 Flows and Loads

The North Beach Basin averages ten CSO events per year. The average total annual volume of discharge from these events is 2.2 MG, based on historical reported information.

3.1.3 Public Health

CSOs are a public health concern as they carry pollutants, primarily in the form of untreated sewage and stormwater, into the receiving water bodies. These pollutants can pose a threat to aquatic life and the natural environment. CSOs can also pose a threat to human health through direct contact or the consumption of fish/shellfish harvested from areas where CSOs were recently discharged. Regulation of CSOs helps reduce and control these threats.

3.1.4 Cultural Resources

The known and potential (as yet undiscovered) cultural, archaeological, and historic resources in the North Beach Basin were reviewed. Based on the site characteristics and location, the project area has a low probability of containing such artifacts.

3.2 PHYSICAL ENVIRONMENT

3.2.1 Land

3.2.1.1 Soils/Geology

A preliminary investigation of the geologic conditions in the North Beach Basin area was conducted to understand the geotechnical limitations. The preliminary geologic/ geotechnical evaluation findings are provided in Appendix A. A geologic map of the North Beach Basin is provided in Figure 3.5.

Soil conditions near the bottom of the North Beach Basin are Vashon recessional outwash, typically consisting of medium dense, slightly silty to silty, gravelly sand, or sandy gravel.

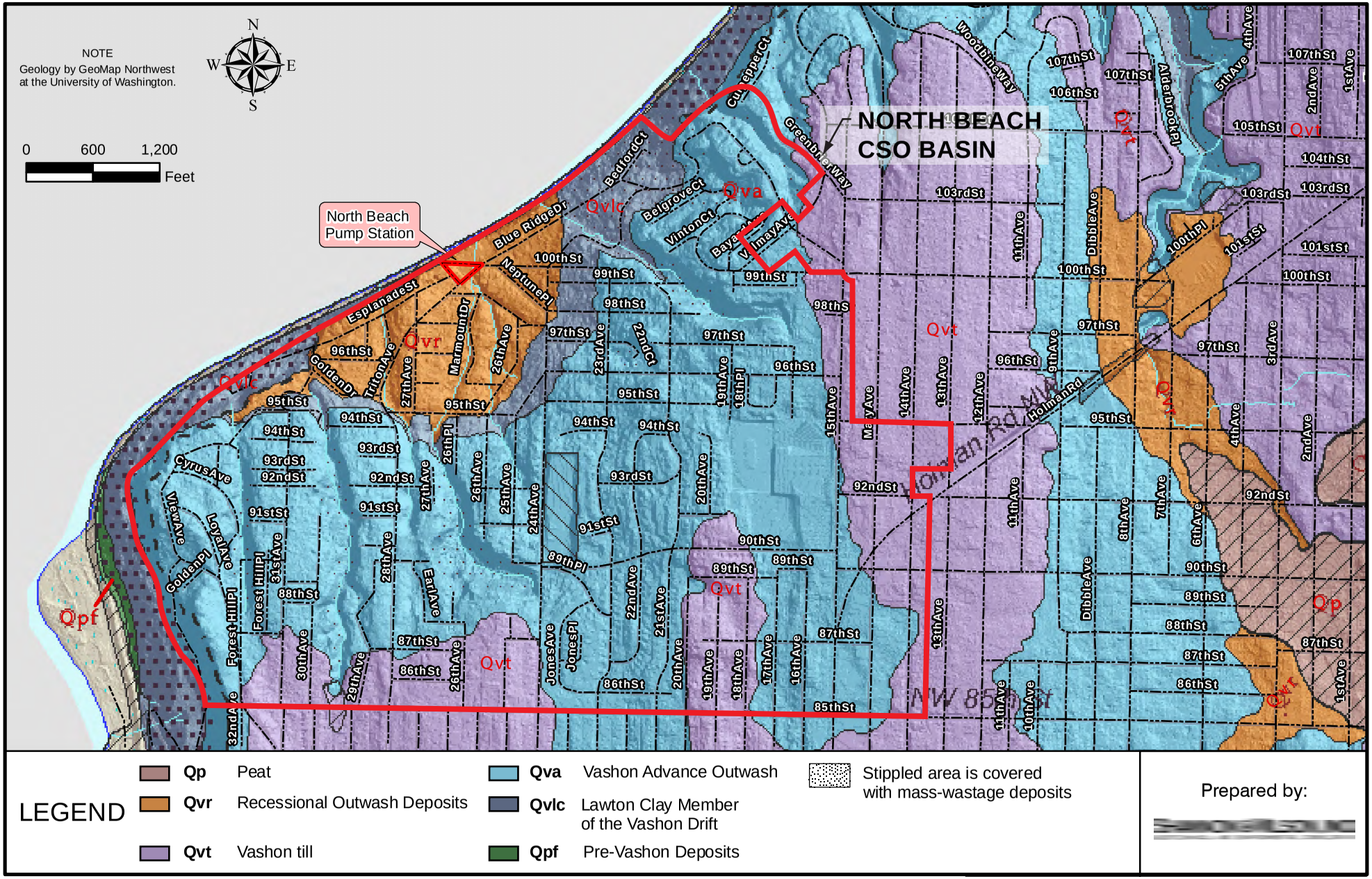


Figure 3-5.ai

Figure 3.5
NORTH BEACH BASIN GEOLOGY

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

This deposit appears to be underlain by glaciolacustrine silt and clay, commonly called "Lawton Clay." Typically, Lawton Clay is 50 feet thick or more with interbeds of fine sand.

The slope between the western edge of Blue Ridge Park and the railroad tracks did not appear to contain in situ soil. Because this slope was uneven and contained construction debris, it is likely artificial fill placed to make a level park surface. This fill thickness is unknown and probably overlies a recessional outwash.

3.2.1.2 Topography, Steep Slopes, and Landslides

A topographical map of the North Beach Basin is shown in Figure 3.6. The North Beach Pump Station is located at the lowest point of elevation in a large, semi-circular drainage basin. The top of the Basin is at approximately Elevation 440 (Metro Datum) and the North Beach Pump Station is at approximately Elevation 135 (Metro Datum). Slope inclinations in the Basin range from about 20 to 50 percent. From the North Beach Pump Station and adjacent Blue Ridge Park, the ground surface drops steeply (about 70 percent) to the north (about 10 feet distant) to the BNSF railroad double track alignment. The railroad bench seawall drops nearly vertically down about 8 to 10 feet to the Puget Sound beach.

The North Beach Basin critical areas map, shown in Figure 3.7, indicates that there are steep slopes throughout the Basin and many potential landslide areas. There are several known landslide areas and many more potential landslide regions. The areas of steep slope are primarily ravines adjacent to streams and open space along Puget Sound.

3.2.1.3 Soil and Groundwater Contamination

In general, there are few areas in the Basin that are known to contain soil or groundwater contamination. These are typically associated with commercial land uses along major arterial roads. Ecology maintains databases of contaminated site locations. Figure 3.7 shows the sites that have confirmed or suspected contamination or have leaking underground storage tanks according to Ecology's databases.

3.2.1.4 Liquefaction

There are no areas of potential liquefaction within the Basin.

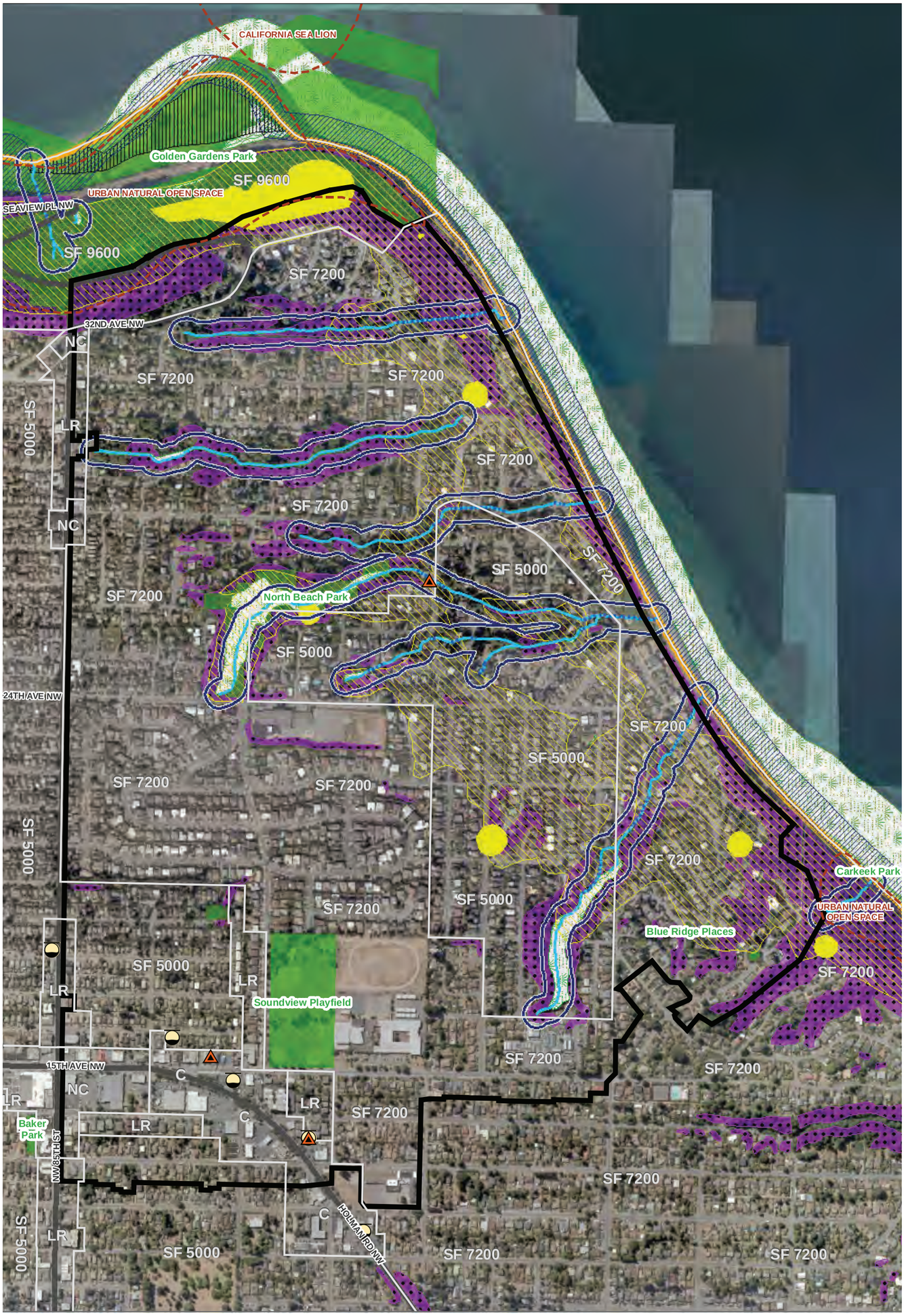
3.2.2 Surface Water

In the North Beach Basin there are several small streams which descend north from the upper ridges of the Basin to the Puget Sound shoreline. The North Beach Basin critical areas map (Figure 3.7) shows that most of the surface streams have been piped near the shoreline to accommodate residential land development. Two streams converge approximately 700 feet southwest of the North Beach Pump Station at the intersection of Marmount Drive and North Beach Drive, and are piped through the pump station site and Blue Ridge Park to an outfall on the shoreline.

Figure 3.6
NORTH BEACH BASIN TOPOGRAPHY

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Figure 3-6.ai



LEGEND

- Basin Boundary
- Streams
- Streams (Piped)
- Major Roads
- Riparian Corridors
- Wetland Areas
- Shoreline
- Flood Prone Areas
- Liquefaction Zones
- Potential Landslide Areas
- Known Landslide Areas
- Steep Slopes (>40% Slope)
- Public Parks
- Priority Habitat Species (PHS)
- Priority Fish Presence/Migration (Coho Salmon, Cutthroat Trout)
- Confirmed and Suspected Contaminated Sites
- Leaking Underground Storage Tanks (LUST)

Seattle Zoning Designations

C, Commercial
IB, Industrial Buffer
IG, Industrial General
LR, Lowrise
MR, Midrise
NC, Neighborhood Commercial
SF, Single Family

N

0 325 650
Feet

SOURCE: City of Seattle, 2009; WDFW, 2007; AEX, 2007 (Aerial)

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Figure 3-7.ai

Figure 3.7
NORTH BEACH BASIN
CRITICAL AREAS MAP

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Department of Natural Resources and Parks
Wastewater Treatment Division

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3.2.3 Rainfall

Seattle's average yearly rainfall is 36.2 inches. Heaviest rainfall occurs in the winter months, with November, December, and January averaging 5 to 6 inches per month. In June, July, and August rainfall drops sharply to an average of 1 inch per month.

3.2.4 Air

The Puget Sound region is a unique part of the country. No other region of the United States at this latitude has weather that is as moderate, with mild temperatures and few serious storms. The temperate climate is largely a result of maritime influences and a diverse topography. The jet stream typically supplies the area with a steady supply of cool, fresh air off the ocean. This marine flow not only contributes to the mild climate, but also mixes the air, which helps keep pollution from accumulating.

Air quality within King County and the City of Seattle is monitored and regulated by the Puget Sound Clean Air Agency. According to data published in 2007 by this agency (the most recent published data), the air quality in King County was "good" 78% of the time, and "moderate" 21% of the time.

3.2.5 Sensitive Areas

3.2.5.1 Wetlands and Streams

Figure 3.7 also shows wetlands and streams within the North Beach Basin. Several streams flow through ravines to Puget Sound. No surface channels or wetlands were observed in the bottom of the Basin near the North Beach Pump Station. There are mapped wetlands along the Sound to the north of the Basin boundary. GIS maps indicate a piped stream through the North Beach Pump Station property and Blue Ridge Park.

3.2.5.2 Shorelines

The Puget Sound shoreline lies at the bottom of the North Beach Basin. It is a mix of natural beach, riprap, and bulkhead. Land use along this area is primarily residential. A BNSF railroad line runs along the northern edge of the Basin adjacent to Puget Sound.

3.2.5.3 Floodplains

The City of Seattle has mapped flood prone areas within each basin, including the North Beach Basin. These areas generally correspond to the shoreline of Puget Sound, as shown in Figure 3.7.

3.3 ENDANGERED/THREATENED SPECIES AND HABITATS

Figure 3.7 depicts mapped priority habitat species areas and priority fish migration and/or presence areas. Golden Gardens Park, west of the Basin, and an urban natural open space along Puget Sound northwest of the Basin, are Priority Habitat Species (PHS) areas.

There are no designated critical areas within the vicinity of the North Beach Pump Station. Salmonscape and Priority Habitats and Species mapping by the Washington Department of

Fish and Wildlife (WDFW) indicates the existence of a stream flowing through Blue Ridge Park; however, no listed fish presence is indicated for this stream. The North Beach Basin critical areas map identifies this stream and a riparian corridor through Triton Drive NW and Blue Ridge Park. During the site investigation, no surface flow or riparian habitat was observed. The closest potential riparian habitat for this stream occurs approximately 700 feet to the southwest of the North Beach Pump Station. Although it is unlikely fish will use this piped stream, further investigation would be required to verify whether this assumption is true.

Puget Sound itself contains numerous threatened and endangered species, including Chinook salmon, bull trout, steelhead, canary rockfish, yelloweye rockfish, bocaccio rockfish, green sturgeon, orca whale, Stellar sea lion, and marbled murrelet.

BASIS OF PLANNING

King County is actively working on a number of projects to better manage, control, and reduce the number of overflow events within their system. This chapter describes the modeling efforts and control approaches considered in the development of the basis-of-planning requirements to manage CSOs from the North Beach Basin.

4.1 SYSTEM MODELING

The peak wet-weather flows and volumes in the North Beach Basin were modeled and calibrated based on historical flow monitoring data.

4.1.1 Background

The County provides wastewater treatment for a number of municipalities in western Washington. The County owns and operates an extensive regional collection system to convey wastewater from the municipalities to the County's treatment plants. Portions of the system are up to 100 years old. The older sewer basins in the City of Seattle use combined sewers that convey both sanitary and stormwater flows in a common pipe.

The stormwater flow component entering the sewer during and following a rain event can be significant and exceed the system's conveyance capacity. The County has permitted overflow points in the combined system to allow the excess, "combined sewer overflows", to be diverted to a receiving water body.

Figure 4.1 shows the extent of the North Beach Basin. As described in Chapter 3, the Basin is divided into five hydraulically separated sub-basins (NB01 through NB05). Sub-basin flows converge at the bottom of the Basin near the North Beach Pump Station.

4.1.2 Data

The North Beach Basin model was developed based on physical basin data, flow data, and rainfall records provided by the County.

4.1.2.1 <u>Physical Basin Data</u>

King County collected and provided all the necessary Geographical Information System (GIS) information for developing the models used in an electronic database format. The GIS data is from databases maintained by the County and the City of Seattle. Basin data falls into one of three general categories: geometric data, land use data, and population data.

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Figure 4-1.ai

Figure 4.1
NORTH BEACH BASIN OVERVIEW

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

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4.1.2.1.1 Geometric Data

The GIS database contains the majority of the physical data including the following layers:

- Basin boundary.
- Building footprints.
- Elevation contours with 2-foot intervals.
- Combined sewer piping, including pipe diameter, length, and the upstream and downstream manholes.
- Numbered sub-basins delineated by King County.
- Surface run-off channel.
- Known lateral sewer and drain line locations.
- Lateral sewer drain entrances.
- Tax parcels within each basin, impervious and pervious connections noted.
- Impervious areas within the Parcels_name layer.
- Rights-of-way within the basin divided into sub areas by run-off destination.
- Road labels, broken down by block.

4.1.2.1.2 Land Use Data

Land use data is contained in a separate GIS database. Data is coded by parcel identification number and contains all of the zoning information.

4.1.2.1.3 Population Data

The population data for the basin was provided by the County in spreadsheet format. The data is based on the 2000 United States census and was assumed to be accurate since the North Beach Basin is built-out with very little development that would significantly impact population data. The population is divided into residential, commercial, and industrial populations on a County-designated basin level.

4.1.2.2 Flow Data

Flow data for model setup and calibration came from several sources, including King County and ADS Environmental Services. King County monitors pump station flows, sewer flows, levels, and overflows at select points within the system. The flow data is sampled every 10 to 15 minutes and is measured with a portable flow meter.

The flow data used for model calibration came from a King County portable flow meter at the overflow manhole just upstream of the pump station and from five portable flow meters placed upstream in the basin.

ADS Environmental Services installed and monitored five flow meters to supplement county data and to provide data for the individual sub-basins. ADS monitored five flow meters in the North Beach Basin (see Figure 4.1) from December 2007 through June 2008. The details of the ADS flow monitoring program were summarized in the *Temporary Flow Monitoring Report* (ADS, July 2008).

4.1.2.3 Rainfall Records

The City of Seattle maintains rain gauges throughout the city. The rain data for the North Beach Basin was provided from Rain Gauge RG07 located at Whitman Middle School near the corner of 15th Avenue NW and NW 92nd Street (see Figure 4.1).

4.1.3 Model Description

The modeling software MIKE Urban was selected for developing the sub-basin models. The MIKE Urban software models and details can be found in the *MIKE Urban Collection Systems Users Guide* (Danish Hydraulic Institute, 2005), as well as the *MIKE Urban Model Manager Users Guide* (Danish Hydraulic Institute, 2007).

4.1.3.1 Hydrology

MIKE Urban has several modules to estimate wet-weather flow from a sub-basin. In consultation with King County, the catchment modules consisting of MOUSE Kinematic Wave-B (MOUSE-B) and RDI were chosen to model inflow and infiltration, respectively. MOUSE-B includes measurable parameters that can be extracted from GIS databases including catchment slope, length (analogous to time of concentration), and five parameters describing percent impervious/pervious area. MOUSE-B also includes 26 Kinematic Wave parameters, including values for Horton's and Manning's equations for estimating inflow. These parameters are not directly measurable; these must be estimated. RDI includes 19 parameters for infiltration (near surface and groundwater) that are also not directly measurable and so must be estimated.

4.1.3.2 Hydraulics

The collection system hydraulic module CS Pipeflow was used to model pipes and junctions. This module solves the complete St. Venant (dynamic wave) equations throughout the drainage network, which allows for modeling of backwater effects, flow reversal, surcharging in manholes, alternating free-surface and pressurized flow, tidal outfalls, storage basins, pumps, weirs, orifices, etc. The pipe flow model can also perform long-term simulation (LTS) and automatic dynamic pipe design.

4.1.4 Model Setup, Calibration, and Verification

The details of model construction for the basin are described in the *MIKE Urban Modeling Approach Technical Memorandum* (Carollo Engineers, October 2008) included in Appendix B. An initial test calibration was conducted for the North Beach Sub-basin NB05, which is also summarized in the *MIKE Urban Calibration Test Technical Memorandum* (Carollo Engineers, November 2008) included in Appendix B. The results are summarized here.

4.1.4.1 Calibration Standards

Proper calibration requires an assessment of the precision and accuracy of the modeled variables in predicting the measured variables. In this case, flows are the primary variables used for calibration. The goal of calibration depends on the specific use of the model. The model for this work needed to be accurately calibrated to flow volume, peaks, and hydrograph shape because both conveyance as well as equalization facilities were analyzed.

The wet-weather calibration focused on meeting the recommendations on model verification contained in the *Code of Practice for the Hydraulic Modeling of Sewer Systems*, Version 3.001 (Wastewater Planning Users Group (WWPUG), December 2002), a section of the Chartered Institution of Water and Environmental Management. By these conventions, the comparison period between observed and modeled events should last until flow has substantially returned to dry weather flows (DWF). Observed and modeled hydrographs should meet the criteria for two out of three events. The accuracy of the predicted peak flow should be within +25% to -10%. The accuracy of the predicted volume of flow should be in the range of +20% to -10%.

4.1.4.2 Initial North Beach Calibration

The North Beach model was calibrated to the ADS flow data. A statistical analysis of the data, including correlation (expressed as R^2 values), total volume, peak flows, and time to centroid was performed for each sub-basin. In general, the data correlation was average (R^2 = 0.60 to 0.79; Volume/Peak/Timing Error = 10 to 20%) to good ($R^2 \geq 0.80$; Volume/Peak/Timing Error ≤ 10%). Detailed results of this calibration are provided in the *North Beach Basin Calibration Round 1 Technical Memorandum* (Carollo Engineers, November 2008) in Appendix B.

4.1.4.3 Data Disaggregation

Following initial modeling, there were questions on the dry weather flow since the sum of the ADS meters was greater than the downstream county meters. A decision was made to adjust the ADS meter DWF to match the county meters, as this would result in the model predicting less DWF and a more conservative estimate of inflow/infiltration. Details of the data disaggregation procedure are summarized in the *South Magnolia and North Beach Basins Population/Land Use Analysis Technical Memorandum* (Carollo Engineers, January 2008) in Appendix B.

King County performed fill-and-draw pump tests at North Beach Pump Station and compared the volume of flow in the wet well as it filled and emptied with the flow measured at the upstream flowmeters. The downstream meters near the pump station measured closer to the pump test volumes than the sum of the upstream ADS meters. Therefore, the individual sub-basin ADS flows used in the model were disaggregated so that the sum of them matched a flowmeter near the pump station. The disaggregation procedure is summarized in the *North Beach Flow Adjustment Technical Memorandum* (Carollo Engineers, January 2009) in Appendix B.

To complete the disaggregation process, three factors were developed for each meter and applied to the county data: base infiltration (BI), sanitary flow (SF), and wet-weather flow (WWF). Base infiltration is calculated using the Stevens-Schutzbach equation and, along with the sanitary flow, makes up the average dry weather flow. Sanitary flow is flow generated only by customers. It is calculated as the average dry weather flow minus BI. Wet-weather flow is water that enters the system from rainfall events. It is calculated as total flow minus BI and SF. The process to revise the flows was as follows:

- Step 1: County and ADS data were converted to a common time step of 15 minutes. For the North Beach Basin, the county meter was NBEACHINLET.
- Step 2: County flow data was disaggregated for each sub-basin by applying the three component factors (BI, SF, and WWF). The BI and SF values are presented in the *South Magnolia and North Beach Basins Population/Land Use Analysis Technical Memorandum* (Carollo Engineers, January 2008). BI and SF were based on the dry weather flow period from May 4, 2008 to May 11, 2008. This period observed no rainfall with light to dry antecedent conditions. WWF for each meter (ADS and County) was calculated as total flow minus BI and SF. The WWF factor was based on the weighted-average WWF.
- Step 3: Each disaggregated county hydrograph was plotted against the observed ADS data. The three factors were adjusted until a good fit was found for peak flows and volumes.
- Step 4: All disaggregated county hydrographs were added together and checked against the total county basin hydrograph. When the individual disaggregated county hydrographs matched well to the observed ADS meter flow, and added up these equaled the downstream county hydrograph, the process was considered complete.

Based on this process, the factors in the *North Beach Flow Adjustment Technical Memorandum* (Carollo Engineers, January 2009) were generated to produce an adequate fit to each sub-basin. The sum of the disaggregated county hydrographs added up to the county downstream flows.

4.1.4.4 Wet-Weather Calibration and Verification

The details of the North Beach wet-weather calibration process are summarized in the *North Beach Round 3 Calibration Technical Memorandum* (Carollo Engineers, July 2009) included in Appendix B. The model calibrated well (see Section 4.1.4.1 for calibration standards) to all wet-weather storms, and was acceptable for conducting long-term simulations.

The final basis-of-planning requirements are presented in Section 4.3.

4.2 CSO CONTROL APPROACHES

During the planning process, four CSO control approaches were considered partially effective at controlling overflows to the required level. These approaches were:

- Storage.
- Convey-and-Treat.
- End-of-Pipe Treatment.
- Peak-Flow Reduction (Demand Management).

In addition, a combination of these approaches was considered wherever feasible.

The process of developing CSO control approaches was initiated in 2007 based on existing county documentation, modeling data, and basin-specific field work. Preliminary evaluations of potential approaches, including constraints and opportunities in each basin, were prepared.

During this effort, it was recognized that additional information relating to how peak flows were distributed within each sub-basin was needed to fully evaluate the range of potential approaches. Therefore, a flow monitoring and modeling program was used to obtain data for smaller areas within each basin. This information helped determine the feasibility of the distributed control approaches and/or approaches away from the bottom of the basin considered here.

4.2.1 Convey-and-Treat Approach

The convey-and-treat control approach involves transporting peak flows out of the basin to existing facilities for treatment prior to discharge. This approach requires an increase in pumping and/or conveyance capacity as well as an increase in treatment and/or outfall capacity at existing facilities.

In North Beach, the convey-and-treat approach involves increasing the capacity of the North Beach Pump Station and Force Main either by supplementing or replacing the existing infrastructure. In addition, treatment capacity at the Carkeek CSO Treatment Facility would need to be expanded.

4.2.2 Storage Approach

The storage control approach involves capturing peak flows in excess of the existing conveyance capacity during precipitation events for storage. Stored flow is pumped back to the existing combined system for conveyance/treatment at existing facilities following the event. This approach would require new storage facilities in the basin. Rectangular storage on private property and pipeline storage within the public right-of-way were considered.

4.2.3 End-of-Pipe Treatment Approach

The end-of-pipe treatment control approach involves capturing peak flows in excess of the existing conveyance capacity during precipitation events for treatment and discharge. This approach would require new treatment, including solids capture and disinfection, at or near the existing CSO location.

In North Beach, end-of-pipe treatment would involve construction of a high-rate clarification and disinfection treatment facility within the basin. Discharge is assumed to be through the existing CSO outfall as the peak rate of discharge would be identical to the existing system.

4.2.4 Peak-Flow Reduction Approach

Peak-flow reduction entails reducing the basin-wide flow to the combined system infrastructure during precipitation events to a level that provides adequate CSO control. This could be achieved through one or more of the following techniques.

4.2.4.1 Green Stormwater Infrastructure (GSI)

Stormwater is separated from the combined sewer system and re-routed to GSI (e.g., rain barrels, rain gardens, bioswales, etc.) facilities. Stormwater generated during precipitation events can also be reduced through implementing other GSI techniques (e.g., permeable pavement).

4.2.4.2 Inflow and Infiltration (I/I) Improvements

Inflow improvements involve taking stormwater from impervious areas (e.g., rooftops, roadways, driveways, etc.) that currently goes to the combined sewer system and re-routing the flow to new or existing storm sewer pipes and outfalls. Infiltration improvements involve rehabilitation of sewer laterals and mains to eliminate stormwater/groundwater infiltration to the sewer system.

4.2.5 Combined Approach

A combined approach involves using any of the above CSO control approaches together to minimize impacts and costs (e.g., I/I improvements to reduce the storage volume at the bottom of the basin).

4.3 BASIS OF PLANNING REQUIREMENTS

The following planning requirements were developed based on regulatory requirements for control of CSOs, system modeling, and viable control approaches.

This project was initiated to address the following:

- **Revised Code of Washington (RCW) 90.48.480:** This law requires “the greatest reasonable reduction of combined sewer overflows at the earliest possible date.”
- **Washington Administrative Code (WAC) 173-245-020 (22):** ‘The greatest reasonable reduction’ means control of each CSO in such a way that an average of one untreated discharge may occur per year.”

Therefore, according to these regulatory requirements, CSOs must be controlled to an average of no more than one untreated discharge per year per outfall based on a long-term average.

King County calibrated the North Beach Basin Model using the County's Runoff Model and approximately two years of data collected prior to 2007. Both the MIKE Urban and the Runoff/Transport calibrated models were used to simulate a 30-year record using the historical data from City of Seattle Rain Gauge RG07. A 30-year extended precipitation and evaporation time series (ETS) was input to the calibrated hydrologic models. The 30-year simulation produces a time series of flows at the basin outlet. The output from these model runs represent the base wastewater flow plus the rainfall-dependent inflow and infiltration that is conveyed to the pump station.

Both calibrated models were run for a 30-year long-term simulation for the period from January 1, 1978 to June 30, 2008. Based on the modeling data, the required storage volume and peak flow rate were determined for the following conditions:

1. The long-term average from the entire rainfall record.
2. The average of 20-year averages (e.g., the 1-year control volume is computed for each 20-year period in the 30-year record, then the 11 1-year control volumes are averaged).
3. The maximum 20-year rainfall period in the entire rainfall record (the rainfall record is not repeated for this calculation).

After the Runoff/Transport model had been calibrated, it was discovered via a pump test that the meters used to calibrate the model were grossly overestimating flow to the North Beach Pump Station. The flows were adjusted prior to calibrating the MIKE Urban model. The MIKE Urban model results were used to size the CSO facility at North Beach.

All peak flows above the North Beach Pump Station capacity during the 30-year simulation were marked for analysis. Volumes of the events that exceeded the North Beach Pump Station capacity were ranked by storm event. For the 30-year simulation, the 30th CSO volume was selected for sizing the CSO storage facilities in the North Beach Basin.

The results of the three conditions were nearly the same. Both the long-term average storage volume and the storage volume from the maximum 20-year period in the record were the same. The average of 20-year averages was 0.01 MG smaller. The long-term average from the entire 30-year record was used for sizing the storage facility. This storage volume would have achieved the 1-year CSO discharge criteria in any 20-year period in the 30-year record. This work is summarized in the technical memorandum *Updated CSO Control Volumes for Puget Sound Beach CSOs* (King County, June 2010) in Appendix B.

The resulting design storage volume for North Beach Basin was approximately 0.19 million gallons (MG) based on a North Beach Pump Station capacity of 3.4 mgd. Subsequent to this memorandum, the capacity of the North Beach Pump Station was revised to 3 mgd based on the results of pump testing. The design storage volume and peak flow conveyance for North Beach was adjusted accordingly. Appendix B contains the final summary table of 1-year CSO control volumes for the three conditions evaluated and 1-year peak flow rate. The supporting data files for this table (also in Appendix B) rank the storms by overflow volume and peak flow rate to yield the basis-of-planning requirements of 0.23 MG and 9.6 mgd.

Table 4.1 summarizes the basis-of-planning for the North Beach Basin.

Table 4.1 North Beach Basis-of-Planning Requirements

Control Approach	Required Volume or Capacity
Convey-and-Treat	**6.6 mgd[1]**
Required Peak Convey-and-Treat Capacity	**9.6** mgd
Existing Convey-and-Treat Capacity	3.0 mgd
Storage	**0.23 MG**
End-of-Pipe Treatment	**6.6 mgd[2]**
Peak Flow Reduction (Demand Management)	
Storage Volume for 25% Impervious Disconnection[3]	0.12 MG
Storage Volume for 50% Impervious Disconnection[3]	0.06 MG
Storage Volume for 75% Impervious Disconnection[3]	0.02 MG

Notes:

1. Convey-and-treat capacity is the difference between "required peak convey-and-treat capacity" and "existing convey-and-treat capacity".
2. End of pipe treatment capacity is the difference between "required peak convey-and-treat capacity" and "existing convey-and-treat capacity".
3. Represents the percentage of impervious surface currently connected to the combined sewer system that must be disconnected to reduce the required storage volume.

ALTERNATIVE DEVELOPMENT AND EVALUATION

This chapter describes the process used to develop and evaluate potential solutions for meeting the combined sewer overflow control objective for the North Beach Basin. Alternatives were developed for several broad CSO control approaches: storage, convey-and-treat, end-of-pipe treatment, peak-flow reduction, and a combination of these.

Each alternative was evaluated for technical merit, ability to be implemented, and cost. The number of alternatives was reduced from a preliminary set of nine to a shortlist of three and, finally, to a recommendation of one proposed alternative for further environmental review.

5.1 EVALUATION METHODOLOGY

Alternative development and evaluation was conducted in two phases. Phase 1, which began in January 2007, focused on reviewing flow projections, assessing the viability of broad CSO control approaches, and developing initial criteria for evaluating CSO control approaches. The work included the following:

- Define evaluation criteria.
- Identify potentially viable control approaches.
- Develop initial conceptual alternatives.
- Evaluate initial conceptual alternatives.

Existing flow data was reviewed during Phase 1, which indicated that fieldwork was needed to better define the origin of peak flows. Flow monitoring was conducted in several sub-basins between December 2007 and June 2008. The flow monitoring helped define peak flow contributions from discrete sub-basin areas and confirmed flow modeling previously performed by the County. As a result of this effort, CSO control volumes were developed for several sub-basins, and overall control volumes for the basin were refined.

Phase 2 built upon the results of Phase 1 and flow monitoring work. Phase 2 included the following:

- Refine and re-evaluate preliminary CSO control alternatives.
- Screen preliminary alternatives.
- Refine short-listed alternatives to select a proposed project.

5.1.1 Phase 1

Phase 1 included a review of projected flows, identification of viable control approaches, development of initial criteria to screen control approaches, and identification of initial alternatives that responded to the criteria. During this phase, the project boundaries were established, as depicted in Figure 5.1. The project boundary was based upon the local

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Figure 5-1.ai

Figure 5.1
NORTH BEACH BASIN OVERVIEW

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wastewater collection system, which is divided into five sub-basins that all flow to the North Beach Pump Station and outfalls. Phase 1 included the steps described below.

5.1.1.1 Step 1: Define Evaluation Criteria

This step began at project inception in January 2007. Criteria that were used to determine viability of CSO control approaches were defined by the project team. Seven criteria categories were selected, as illustrated in Table 5.1. The technical memorandum *CSO Control Approaches and Planning Boundaries* (Carollo Engineers, December 2007) describes the considerations for these categories in more detail.

5.1.1.2 Step 2: Identify Potentially Viable Control Approaches

The CSO control approaches evaluated in this project represent broad concepts for achieving CSO control. The following control approaches were considered:

- **Control Approach 1 – Peak-Flow Storage.** Store peak flows that exceed conveyance capacity in the basin during each storm event, and use existing pumping and piping facilities to convey stored flow downstream once the rainfall event has subsided.
- **Control Approach 2 – Convey-and-Treat Peak Flows.** Convey peak flows out of the basin by increasing pumping and force main capacity, or the capacity of the gravity sewer system. This approach may also require treatment upgrades at the point where the peak flows are discharged, as the capacity of existing treatment facilities may not be adequate for additional flows and loads.
- **Control Approach 3 – End-of-Pipe Treatment for Peak Flows.** Treat and discharge peak flows at or near the current CSO locations. The typical treatment process used for end-of-pipe treatment includes high-rate clarification (HRC) and ultraviolet (UV) disinfection.
- **Control Approach 4 – Peak-Flow Reduction.** Reduce the magnitude of the flow in the collection system through infiltration and inflow (I/I) reduction in separated systems, or by disconnecting impervious areas in combined systems.
- **Control Approach 5 – Combined Approach.** Reduce peak flows within the basin by implementing a combination of two or more of the previous four CSO approaches.

Table 5.1 Initial Evaluation Categories and Criteria

Cost Effectiveness	Operations and Maintenance Feasibility	Technical Feasibility	Public Health and Environmental Benefits	Flexibility	Community	Compatibility with Other Programs and Initiatives
– Capital cost – Life-cycle costs – Use of existing facilities – Grants/loan ranking	– Reliably meets CSO objectives – WTD automation – Ease of start-up/ shut-down – Ease of maintenance – No adverse impacts on County or City – Ease of regulatory reporting	– Compatible with existing system – Technically feasible – Can be permitted – Land is available – Minimizes federal & state permit constraints	– Meets CSO requirements – Minimizes public exposure – Minimal environmental footprint – Minimizes environmental risks – Minimizes or avoid contact with endangered species – Coordinates with Puget Sound goals	– Future regulations – Climate change – Implementation	– Neighborhood equity – Cost allocation – Minimal shoreline impacts – Minimal property disruption – Minimal implementation impacts – Minimal operations impacts – Minimal disturbance of archeological areas	– Coordinate with Seattle parks, SPU, and transportation – Sediment management plan – County-wide planning policies – Stormwater management responsibilities – Conveyance system improvement policies – WTD productivity initiative – WTD CSO Program

5.1.1.3 Step 3: Develop Initial Conceptual Alternatives

Initial alternatives were developed in order to assess each control approach, as described in the technical memorandum *CSO Control Approaches and Planning Boundaries*. Each initial alternative identified necessary infrastructure improvements and theoretical locations. The locations were chosen based on their proximity to the combined sewer overflow location and the feasibility of using gravity sewerage to convey flow into and out of the proposed infrastructure. Storage alternatives identified during this phase were limited to a single centralized storage location, either in the basin or out of the basin. Dispersed storage options were identified in Phase 2, after flow monitoring and modeling were completed.

5.1.1.4 Step 4: Evaluate Initial Conceptual Alternatives

Following the development of initial alternatives, an assessment of the viability of each control approach was completed considering the constraints of the North Beach Basin (topography, land use, downstream capacity, and peak-flow sources). The conclusions of the assessment were as follows:

- **Peak-Flow Storage Approach.** Peak-flow storage was determined to be technically feasible. The steep topography and built-out characteristics of the North Beach Basin results in very few suitable locations for storage except for sites near the North Beach Pump Station. Other storage-based alternatives would require pumping from the bottom of the basin to the CSO storage facility.
- **Convey-and-Treat Approach.** The convey-and-treat control approach was determined to be technically feasible, but would require increasing the capacity of the North Beach Pump Station, the North Beach Force Main, and the Carkeek CSO Treatment Facility (see Figure 2.1).
- **End-of-Pipe Treatment Approach.** End-of-pipe treatment was determined to be technically feasible. The steep topography and built-out characteristics of the North Beach Basin results in very few suitable locations for end-of-pipe treatment except for sites near the North Beach Pump Station. Other treatment-based alternatives would require pumping from the bottom of the basin to the CSO treatment facility.
- **Peak-Flow Reduction Approach.** Peak-flow reduction, including both inflow and infiltration reduction, appears to be technically feasible within the North Beach Basin. It would require an aggressive implementation plan to rehabilitate a significant portion of the infrastructure. It was recommended that the costs and feasibility (e.g., technical, inter-jurisdictional) associated with implementing peak-flow reduction within the North Beach Basin be more fully evaluated to determine the viability of this approach.

These were only initial assessments of the viability of the identified control approaches. Additional consideration of these control approaches was given in Phase 2.

These conceptual alternatives were reviewed with agency stakeholders at Agency Workshop No. 1 on May 7, 2009. Stakeholders included King County, Ecology, and Seattle Public Utilities. Input from the workshop was used to help refine the alternatives and criteria for Phase 2.

5.1.2 Phase 2

Phase 2 included refinement and re-evaluation of the feasible CSO control approaches and preliminary alternatives from Phase 1 following completion of flow monitoring. Community information meetings and briefings with citizens in the North Beach Basin in 2007, late 2009, and early 2010 elicited comments on community concerns about the approaches and alternatives under consideration. Community comments, such as the importance of Blue Ridge Park to maintaining open space and views, factored into refined criteria and ranking of alternatives. Phase 2 involved the following three steps.

5.1.2.1 Step 1: Refine and Re-evaluate Preliminary CSO Control Alternatives

The memoranda *Developing Criteria for Evaluating CSO Alternatives* (Carollo Engineers, August 2009) and *Selecting Candidate Sites for CSO Control Approaches* (Carollo Engineers, August 2009) describe the process used to refine and re-evaluate the preliminary alternatives. The process is summarized below.

5.1.2.1.1 Step 1A: Criteria Development

In order to develop criteria for evaluation of alternatives, the CSO Project Team appointed a “Category Lead,” team members designated as subject matter experts, for each of seven categories of selection criteria. The Category Leads developed selection criteria and applied them in three steps:

1. Select up to five criteria for each final category shown in Table 5.2. In the operations and maintenance (O&M) category, for example, one criterion might be “Reliability,” another might be “Site Access,” and so forth. As part of this process, the seven categories developed in Phase 1 were refined. During refinement, some categories were combined and renamed as shown in Table 5.2. Two initial categories, “Flexibility” and “Compatibility with other Programs and Initiatives,” were combined with other categories due to their interrelationship. The “Land Use/Acquisition/ Permitting” category was subdivided into two categories, “Land Use/Acquisition” and “Permitting,” in recognition of differences between land acquisition and project permitting.

2. Develop questions to be answered for each criterion. These questions were used to “test” the impact of a particular alternative on the criterion being considered. For example, one question for the “Reliability” criterion was, “Does the alternative rely on complex automation for successful operation?” Another question was “Has the alternative proven to be a reliable CSO control method in other installations?”

3. Develop a description of how the criterion will be measured using the rating scale (Low, Moderate, and High Impact). For the question, “Does the alternative rely on

Table 5.2 Initial and Final Evaluation Categories

Initial Category (June 2007)	Final Category (September 2009)
Cost Effectiveness	Cost
Ease of Operations and Maintenance	Operations and Maintenance (O&M)
Technical Feasibility and Compatibility	Technical
Public Health and Environmental	Environmental
Community Considerations	Community Impact
Flexibility[1]	Land Use/Acquisition[2]
Compatibility with Other Programs and Initiatives[1]	Permitting[2]

Notes:
1. Criteria combined with other categories in final criteria category list.
2. Category added following initial criteria category development.

complex automation for successful operation?" a "High" score would be described by, "The alternative requires substantial automation of mechanical equipment for performance." A "Low" score would be described by "The alternative is relatively simple and requires limited automation and equipment for performance."

A copy of the final criteria and evaluation questions are contained in the Alternative Evaluation Summary Documentation in Appendix C.

5.1.2.1.2 Step 1B: Alternatives Development

Site suitability criteria for the evaluation were developed and then used together with GIS data to identify potential preliminary sites.

Available land areas where new system components could be sited and constructed were identified based on the "technical feasibility" of the resulting alternative. "Technical feasibility" was defined as follows:

- Availability of Peak Flows. The resulting alternative must be sited in a location that allows sufficient peak flows to be captured and routed to the new facility.
- Constructability. The resulting alternative (and associated system components) must be constructible on site. In order for an alternative to be constructible, the site where components would be built must be sufficient size, with reasonable access provided for construction activities (e.g., staging, excavation, tank construction, etc.).
- Operational Performance. The resulting alternative (and system components) must be capable of meeting the intended performance within the existing hydraulic profile of the CSO outfall and (combined sewer system) CSS.

A hierarchy of technical considerations was used to judge "technical feasibility" and identify potential sites for the CSO control approaches; in the order of most to least favorable these were as follows:

1. Favor locations and facility configurations at the bottom of the basin near the existing CSO outfall.
   a. Provides ability to capture 100% of the flow in the basin and route it to the new facility.
   b. Reduces complexity of control system required to route flows to new facility; thereby, reducing risks of future overflows.
   c. Minimizes conveyance system construction requirements.
2. Favor locations along existing combined sewer trunk lines through which 50% or more of the total basin peak flow is conveyed.
   a. Helps ensure sufficient volumes are captured to adequately reduce peak flows and volumes at the bottom of the basin at the existing CSO outfall.
3. Favor locations and facility configurations that allow passive diversion of peak flows to the new facility (e.g., over a weir wall) over more complex control systems requiring telemetry or SCADA.
   a. Increases reliability by eliminating the need for a power and control system.
   b. Reduces the potential need to oversize the facility to limit overflows.
4. Favor locations and facility configurations where the bottom of new structures will not exceed a depth of 30 feet below the ground surface elevation.
   a. Minimizes shoring and dewatering requirements.
   b. Requires less area for construction and staging.
   c. Creates shallower facilities for easier access.
   d. Avoids excessive structural requirements for tanks and treatment facilities.
   e. Increases feasibility of cut-and-cover construction for storage pipes versus riskier and more expensive tunneled construction.

5.1.2.2 Step 2: Preliminary Alternative Screening

This step involved screening the full list of alternatives to develop a short-list of three for detailed evaluation. Step 2 was completed in a series of non-technical (community relations, land use and permitting, environmental) and technical (technical implementation, operations and maintenance, cost) meetings. The screening process for reducing the preliminary alternatives from nine to three is described in memoranda titled *CSO Control Alternative Review and Comment Procedure* (Carollo Engineers, September 2009) and *Alternative Narrowing Process* (Triangle Associates, November 2009). This process is summarized in Table 5.3.

During the development of a short-list of three alternatives, potential sites were further refined so the project team could focus on the characteristics of specific sites and how they would affect the implementation of each alternative.

Table 5.3 Screening Steps and Schedule for Short-listing of Alternatives

Workshop/ Meeting Date	August 2009	September 2009	October 2009	November 2009	December 2009
Meeting Purpose	Basin Leads present preliminary alternatives for initial comment.	Non-technical focus meetings to identify information needed to complete alternative review matrices.	Technical focus meetings to add detail for O&M issues (e.g., layouts, configurations).	Team workshop to complete review matrices for each alternative.	Team workshops to select top 3 alternatives.
Screening Results	Preliminary cut of least-attractive alternatives by Consultant.	Revisions to preliminary alternative evaluations based on comments received from CSO Team (non-technical focus).	Revisions to preliminary alternative evaluations based on comments received from CSO Team (technical focus).	Revisions to preliminary alternative evaluations based on comments received from CSO Team (technical and non-technical focus).	Select 3 alternatives for further evaluation.

5.1.2.3 Step 3: Refinement of Short-listed Alternatives and Selection of a Proposed Alternative

Between February 2010 and August 2010, the three short-listed alternatives were further developed. Detailed information is provided in the *North Beach Alternatives Update Information Technical Memorandum* (Carollo Engineers, October 2010) in Appendix C. Step 3 was completed in a series of non-technical and technical meetings to identify the range of information needed to complete the alternative review and prepare evaluation matrices for each alternative.

5.2 NO ACTION ALTERNATIVE

RCW 90.48.480 and WAC 173-245-020 (22) require CSOs to be limited to an average of no more than one untreated discharge per year per outfall on a long-term average. In the North Beach Basin, there were an average of 10 combined sewer overflows annually from 1991 to 2009, with an average annual total overflow of 2.2 million gallons.

The No Action Alternative entails no changes to the sewer system in the North Beach Basin. This alternative would result in CSOs in the North Beach Basin in excess of one per year on a long-term average based on historical data. The Basin would not comply with RCW 90.48.480 and WAC 173-245-020 (22) or the West Point Treatment Plant NPDES Permit.

The risk to Puget Sound water quality (e.g., bacteria, nutrients, and metals) would remain at present levels. Decreased water quality could adversely affect biological resources and potentially result in decreased availability of the beach and/or public exposure.

5.3 PRELIMINARY ALTERNATIVES

This section provides a detailed description of the alternatives developed under Step 1B of Phase 2 (as described in Section 5.1.2.1.2). Development of alternatives began with identification of preliminary sites suitable for CSO facilities. Based on this information and design criteria resulting from flow monitoring and modeling, preliminary alternatives were developed using the identified viable CSO control approaches.

5.3.1 Planning Level Basis of Design

5.3.1.1 Basis-of-Planning Requirements

Table 5.4 summarizes the basis-of-planning requirements for control of the North Beach Basin. This information was used to size facilities for each CSO control approach. Refer to Chapter 4 for details on the development of basis-of-planning requirements.

Table 5.4 North Beach Basin Basis-of-Planning Requirements

Required Storage Volume	0.23 MG
Required Conveyance Capacity	5.5 mgd[1]
Required End-of-Pipe Treatment Capacity	5.5 mgd[1]
Required Impervious Area Disconnection[2]	Varies

Notes:
1. Revised to 6.6 mgd following screening of preliminary alternatives to develop a short-list for further review. The increase in conveyance and end-of-pipe treatment capacity for final basis-of-planning requirements (see Section 4.3) would have had a negative impact on convey-and-treat and end-of-pipe treatment approaches. Since alternatives based on these approaches were not short-listed (see Section 5.4) the preliminary alternatives in this section were not revisited.
2. Impact of impervious area disconnection on the design criteria for each of the other approaches. For example, disconnection of 75% of the impervious area in the basin reduces the required storage volume to 0.02 MG.

5.3.1.2 Basis-of-Design Criteria

The basis-of-design criteria are key criteria established as a basis for sizing equipment and laying out facilities. Consistency of design criteria is important for evaluating alternatives. Documenting the design criteria also provides key input for final design of the improvements.

Figures 5.2 through 5.4 illustrate typical details for potential facilities common to many of the alternatives considered, including storage (rectangular and pipeline), conveyance (pump station), and end-of-pipe treatment. Table 5.5 highlights key design criteria used for preliminary screening.

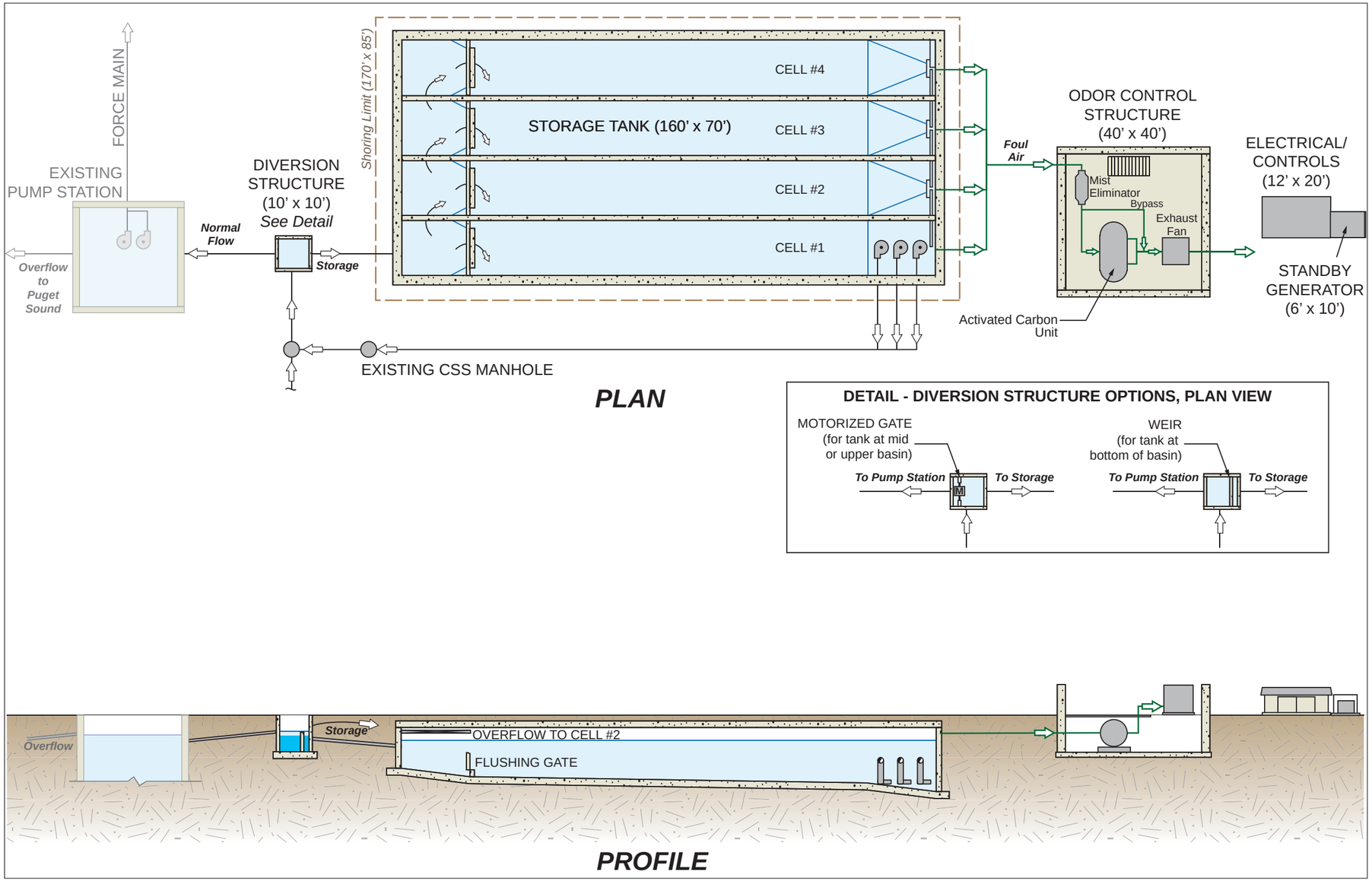

Figure 5.2
RECTANGULAR STORAGE
BASIS OF DESIGN TYPICAL DETAIL

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Figure 5-2.ai

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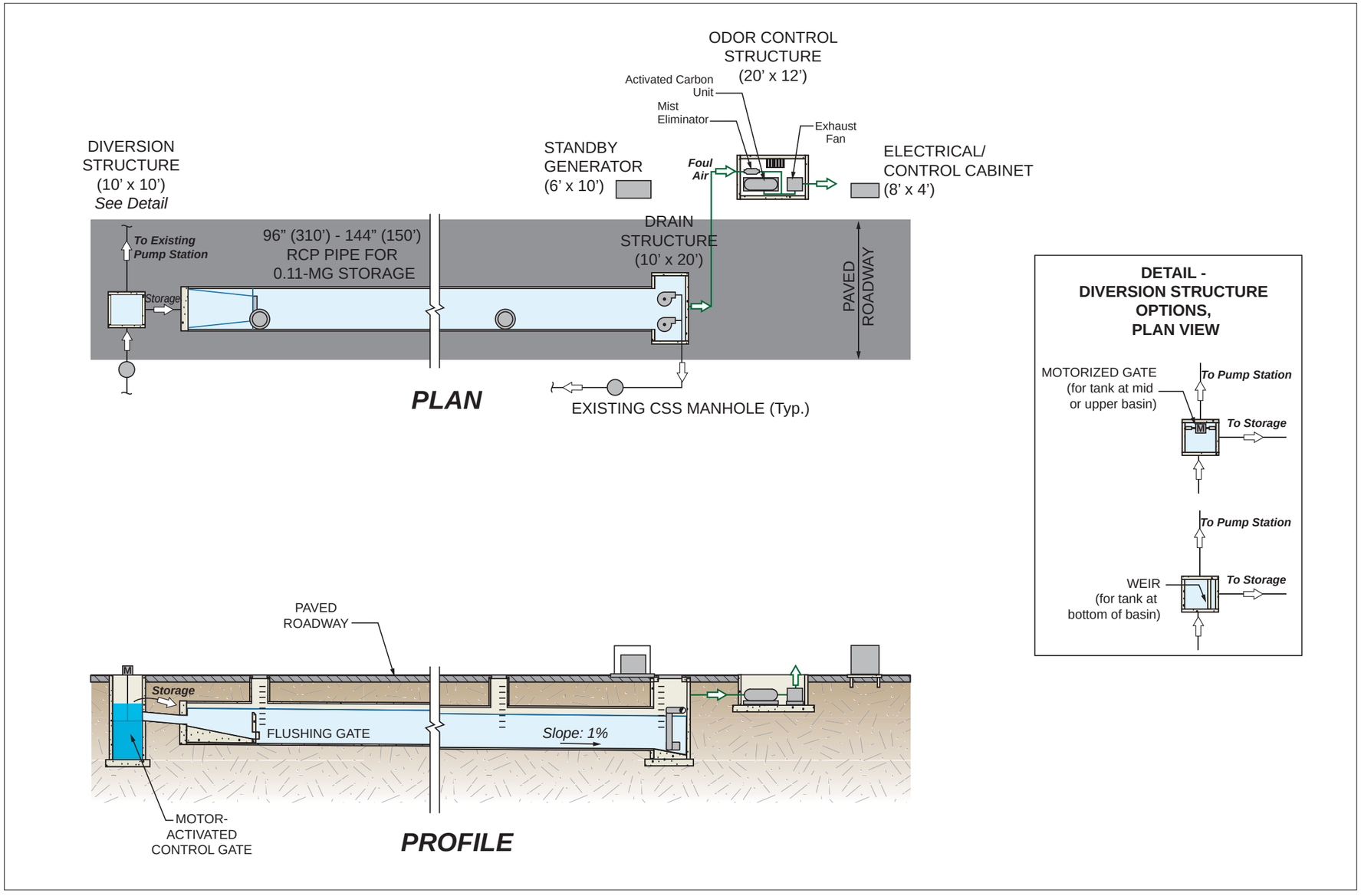

Figure 5.3
PIPELINE STORAGE
BASIS OF DESIGN TYPICAL DETAIL

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Figure 5-3.ai

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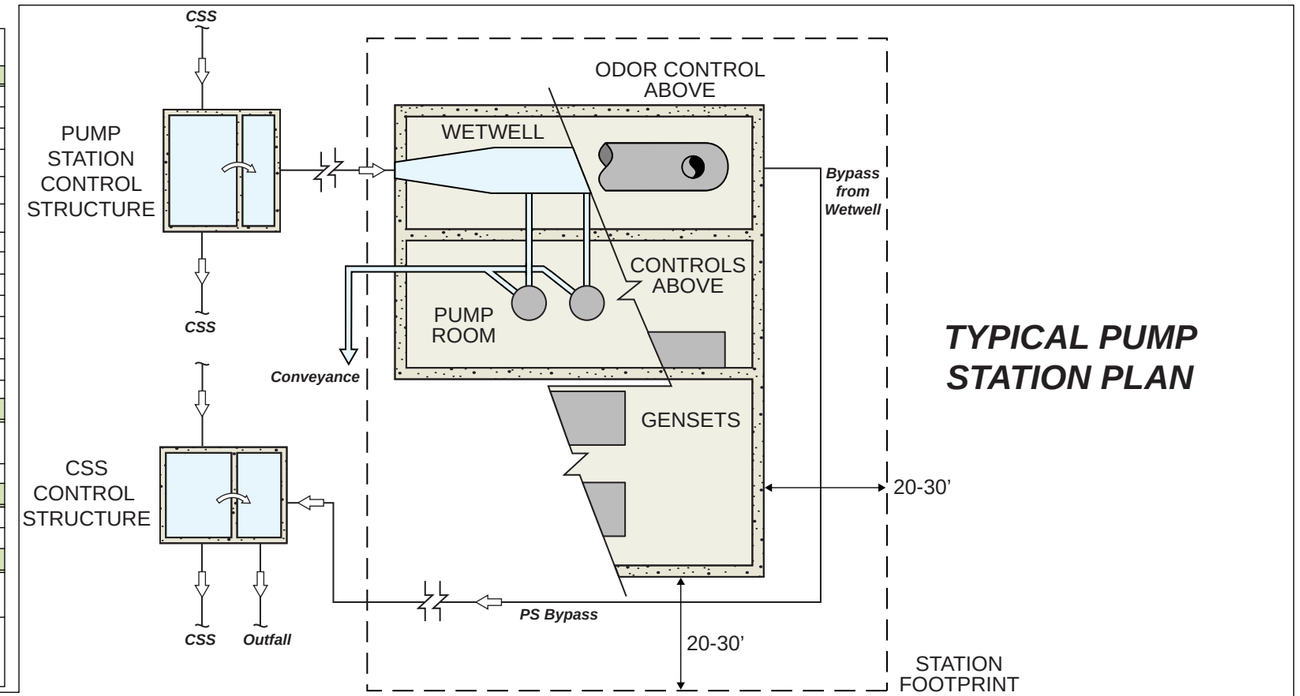
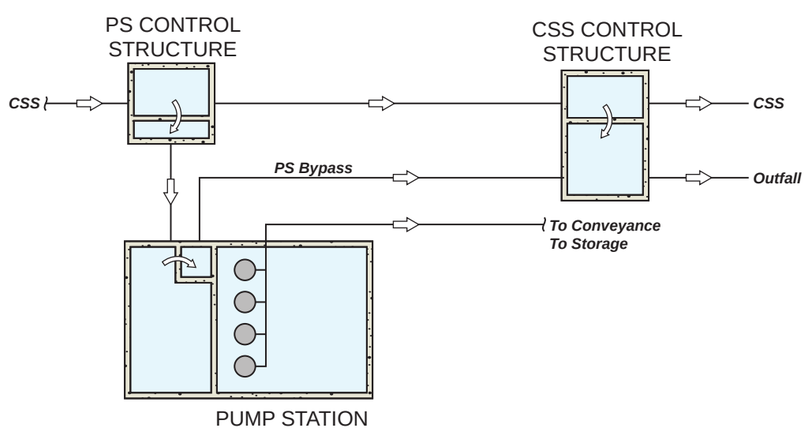
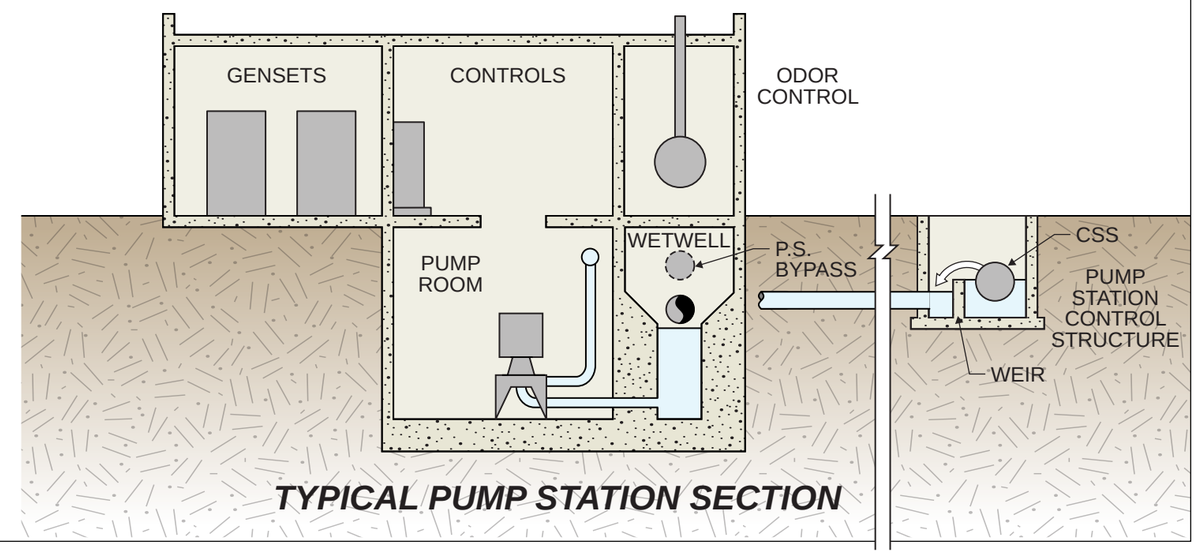
7 to 30 Mgd Pump Station Criteria and Assumptions				
General				
Firm Capacity mgd		7	20	30
Hydraullic Conditions		70 - 200 ft head	70 - 200 ft head	Over 200 ft Head
		single stage	single stage	series, two stage
Number pumps installed		4	4	8
Motor Size, Hp		50 - 125 at 7mgd	125 - 325 at 20mgd	200 - 700 at 30mgd
Standby power, kW		1@200 - 400	2@250 - 650	2@600-1250
		Station Footprint, with setbacks		
Wetwell		Circular, rectangular	Rectangular	Rectangular
Pump types, installation	Submersible wet pit	90 x 90	110 x 105	NA
	Centrifugal dry pit	110 x 90	110 x 90	115 x 100
	VTSH dry pit	90 x 90	NA	NA
Average depth, ft		25	25	25
Outer Walls, ft		2	2	2
Shoring		5ft beyond walls		
Mechanical				
Ventilation	12 air changes per hour in occupied space when operational.			
Odor Control	Carbon scrubber and fan, 2AC/hr for wetwell. Operates when pump station on line.			
Ancillary Eqpmt.	Typical service air, water, gates, valves for ww pump station			
Electrical				
Pump drives	Close coupled motors, VFD			
Emergency Power	Permanent generator(s), diesel, sound attenuated. 36-hour fuel capacity in buried tank			
Flow Control Strategy				
Diversion Structure	Divert peak flows using a weir and/or gate structure on the sewer upstream of the CSO control structure.			
Control Strategy	Peak flows are diverted over a weir when water elevation exceeds capacity of sewer or existing dry wet weather pump station. Flows exceeding pump station capacity overflow to outfall.			



TYPICAL PUMP STATION PLAN

GENERAL ARRANGEMENT PLAN





TYPICAL PUMP STATION SECTION

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Figure 5.4
PUMP STATION
BASIS OF DESIGN TYPICAL DETAIL

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Table 5.5 North Beach Basin Basis-of-Design Criteria

Facility	Design Criteria
Peak-Flow Storage (Rectangular or Pipeline)	
Number of Cells	Rectangular - 2 to 4; Pipeline - 1
Floor Slope	1%
Minimum Freeboard	2 feet
Number of Drain Pumps	3 duty
Type of Pumps	Submersible
Maximum Time to Drain Storage	24 hours
Odor Control	Peak air displacement rate (peak flow to storage) or 2 air changes per hour (whichever is greater)
Air Treatment	Activated carbon; 1 pass; 50 fpm; constant speed fan/blower
Occupied Space Ventilation	12 air changes per hour
Standby Generator	Total estimated load; diesel w/ 24 hour capacity
Access	Every 200 feet (maximum); outside right-of-way
Equipment Materials	Corrosion-resistant (304/316 SS or FRP)
Conveyance (Convey-and-Treat)	
Number of Pumps	3 duty + 1 standby (per stage[1])
Type of Pumps	Centrifugal, dry-pit
Firm Capacity	Required conveyance capacity[2]
Wet well	Self-cleaning
Odor Control	2 air changes per hour (wet well)
Air Treatment	Activated carbon; 1 pass; 50 fpm; constant speed fan/blower
Occupied Space Ventilation	12 air changes per hour
Standby Generator	Total estimated load; diesel w/ 36 hour capacity
Force Main	2 @ Firm Capacity; 8 feet per second (maximum)
Equipment Materials	Corrosion resistant (304/316 SS or FRP)
Treatment (End-of-Pipe or Convey-and-Treat)	
Influent Screening	
Type	Perforated plate
Number of Screens	2
Screen Spacing	6 mm
High-Rate Clarification	
Number of Trains	2
TSS Removal	85% or 10 mg/L (maximum)
BOD Removal	50% or 10 mg/L (maximum)
Chemical Feed Systems	Coagulant and Polymer

Table 5.5 North Beach Basin Basis-of-Design Criteria

Facility	Design Criteria
UV Disinfection	
Number of Channels	1
Transmittance @ 254 nm	70%
Minimum Dose	40 mJ/cm^2
Odor Control	2 air changes per hour (process basins)
Air Treatment	Activated carbon; 1 pass; 50 fpm; constant speed fan/blower
Occupied Space Ventilation	12 air changes per hour
Standby Generator	Total estimated load; diesel w/ 36 hour capacity
Equipment Materials	Corrosion-resistant (304/316 SS or FRP)

Notes:
1 Total head above 200 feet requires 2-stage pumping for solids pumps.
2 See Table 5.4.

5.3.2 Identification of Preliminary Sites

Potential facility sites were evaluated using the criteria provided in Table 5.6 and GIS data from King County and the City of Seattle. The initial screening identified several parcels meeting the criteria. A survey and review of the site characteristics resulted in nine candidate sites, excluding public right-of-way and occupied properties. Figure 5.5 illustrates parcels in the North Beach Basin that could be suitable for siting CSO alternatives.

The viable control approaches were matched with the preliminary sites based on the results of flow monitoring and modeling, and on basin reconnaissance. Potential areas were defined roughly by the ability to route flow to the CSO facility location, topography, and distance from the existing CSO control facility. An important project assumption is that existing CSO outfalls would not be modified due to environmental and permitting impacts on the required CSO implementation schedule. Therefore, it was important that no new control points were created by the alternatives.

Table 5.6 Site Suitability Analysis

CSO Control Approach	Configuration	Minimum Requirements for Potential Sites
1. Peak-Flow Storage		
Bottom of Basin	Rectangular.	• Flat (< 5%)area near existing CSO. • Outside public right-of-way. • Greater than 1 acre. • Less than Elevation 60.
Bottom of Basin / "Up-Basin"	Rectangular, conveyance to Carkeek Pump Station.	• Flat (< 5%) area for pump station and storage. • Outside public right-of-way. • Pump station sized for peak flow. • Approximately 1 acre for storage; greater than 1/4 acre for pump station. • Pump station less than Elevation 50.
	Rectangular, conveyance to 8th Ave. Interceptor.	• Flat (< 5%) area for pump station and storage. • Outside public right-of-way. • Sized for peak flow pump station. • Approximately 1 acre for storage; greater than 1/4 acre for pump station. • Storage greater than Elevation 350. • Pump station less than Elevation 50.
	Deep Tunnel.	• Flat (< 5%) area for tunnel access portals. • Outside public right-of-way. • Approximately 2,600 feet at 14-feet diameter • Greater than 1/4 acre for downstream access; less than Elevation 50. • Greater than 1/2 acre for upstream access.

Table 5.6 Site Suitability Analysis

CSO Control Approach	Configuration	Minimum Requirements for Potential Sites
2. Convey-and-Treat		
Bottom of Basin	Peak flow pump station, pipeline to Carkeek CSO TP through Beach Alignment.	• Flat (< 5%) area for pump station. • Outside public right-of-way. • Sized for peak flow pump station. • Greater than 1/4 Acre for pump station. • Pump Station less than Elevation 50. • Carkeek CSO TP modifications.
	Peak flow pump station, pipeline to Carkeek CSO TP through Neighborhood Alignment.	• Flat (< 5%) area for pump station. • Outside public right-of-way. • Sized for peak flow pump station. • Greater than 1/4 Acre for pump station. • Pump station less than Elevation 50. • Carkeek CSO TP modifications.
3. End-of-Pipe Treatment		
Bottom of Basin	New high-rate clarification and UV disinfection treatment facility.	• Flat (< 5%) area for treatment facility. • Outside public right-of-way. • Greater than 1 acre. • Less than Elevation 50.
Bottom of Basin / ”Up-Basin”	Peak flow pump station, pipeline to new high rate clarification and UV disinfection treatment facility.	• Flat (< 5%) area for pump station and treatment facility. • Both sites outside public right-of-way. • Greater than 1/4 Acre for pump station. • Pump station less than Elevation 50. • Greater than 1 acre for treatment facility.

Table 5.6 Site Suitability Analysis

CSO Control Approach	Configuration	Minimum Requirements for Potential Sites
4. Peak-Flow Reduction		
Rooftop Separation	Disconnection of impervious areas (roof drains and catch basins) with stormwater re-routed to new or existing MS4.	• Available impervious area for disconnection. • Inside or outside public right-of-way.
Green Stormwater Infrastructure (GSI)	Implementation of GSI techniques to limit stormwater response to rainfall.	• See GSI findings for constraints.
MS4 Construction	Disconnection of impervious areas in the right-of-way (catch basins) with stormwater re-routed to new or existing MS4.	• Combined system inside public right-of-way. • See GSI findings for constraints.
5. Combined Approach		
I/I Control	Rehabilitation of sewers and laterals and disconnection of impervious areas (roof drains and catch basins). May require MS4 construction to prevent localized flooding.	• I/I assessment of sewers. • Available impervious area for disconnection. • Inside and outside public right-of-way.

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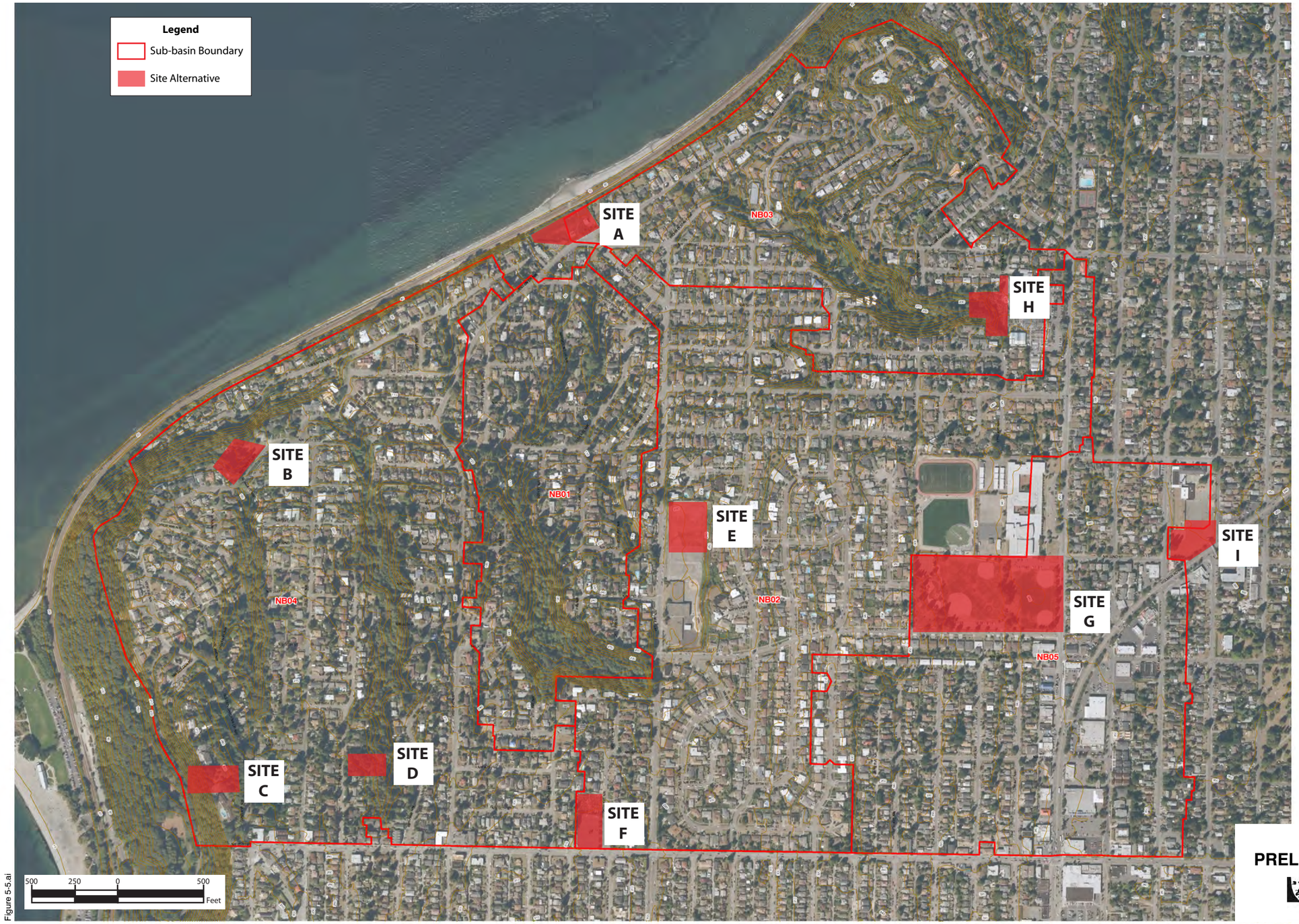

Figure 5.5
NORTH BEACH BASIN
PRELIMINARY SITE ALTERNATIVES

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5.3.3 Preliminary Alternatives Overview

Development of preliminary alternatives is described in detail in the memoranda *Planning Confirmation* (Carollo Engineers, March 2010) and *Siting Report* (Carollo Engineers, June 2010). The following alternatives were developed for the North Beach Basin:

Control Approach 1 - Peak-Flow Storage:

- Alternative 1A - Rectangular Bottom-of-Basin Storage
- Alternative 1B - Pipeline Bottom-of-Basin Storage
- Alternative 1C - Rectangular Storage Up in the Basin with Conveyance to 8th Avenue Interceptor
- Alternative 1D - Rectangular Bottom-of-Basin Storage with Conveyance to 8th Avenue Interceptor

Control Approach 2 - Convey-and-Treat:

- Alternative 2A - Conveyance to Carkeek CSO Treatment Plant through Beach Alignment
- Alternative 2B - Conveyance to Carkeek CSO Treatment Plant through Neighborhood Alignment

Control Approach 3 - End-of-Pipe Treatment:

- Alternative 3A - End-of-Pipe Treatment at the Bottom of the Basin
- Alternative 3B - End-of-Pipe Treatment Up in the Basin

Control Approach 5 - Combined Approach:

- Alternative 5A - Inflow Improvements with Storage, Infiltration Improvements or Green Stormwater Infrastructure (GSI)

Control Approach 4, Peak-Flow Reduction by separation, was not adequate as a standalone option and therefore was included in a combined approach (see Section 5.3.7).

The preliminary alternatives are described below and summarized in Table 5.7. Conceptual layouts for improvement facilities were developed and drawn at representative sites within the feasible areas, as shown in Figures 5.6 through 5.13.

Table 5.7 Summary of North Beach Basin Preliminary Alternatives

Approach	Alternative	Description	Potential Site(s)[1]
Peak-Flow Storage	1A	0.23 MG rectangular storage at bottom of basin	A
	1B	0.23 MG pipeline storage at bottom of basin in public right-of-way	Right-of-Way
	1C	8.5 mgd pump station with 0.15 MG storage at top of basin and conveyance to 8th Avenue Interceptor	A, I
	1D	3.5 mgd pump station with 0.15 MG storage at bottom of basin and conveyance to 8th Avenue Interceptor	A, I
Convey-and-Treat	2A	8.5 mgd pump station and force main through beach alignment to Carkeek; 5.5 mgd additional treatment at Carkeek	A
	2B	8.5 mgd pump station and force main through neighborhood alignment to Carkeek; 5.5 mgd additional treatment at Carkeek	A
End-of-Pipe Treatment	3A	5.5 mgd treatment plant at bottom of basin	A
	3B	5.5 mgd pump station at bottom of basin and 5.5-mgd treatment plant at top of basin	A, B, C, D, E, F, G, H, and I
Combined	5A	Inflow Improvements with storage, infiltration improvements or GSI	N/A

Notes:

1. See Figure 5.5 - North Beach Basin Preliminary Site Alternatives.

Figure 5.6
NORTH BEACH BASIN
ALTERNATIVE 1A

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Figure 5.7
NORTH BEACH BASIN
ALTERNATIVE 1B

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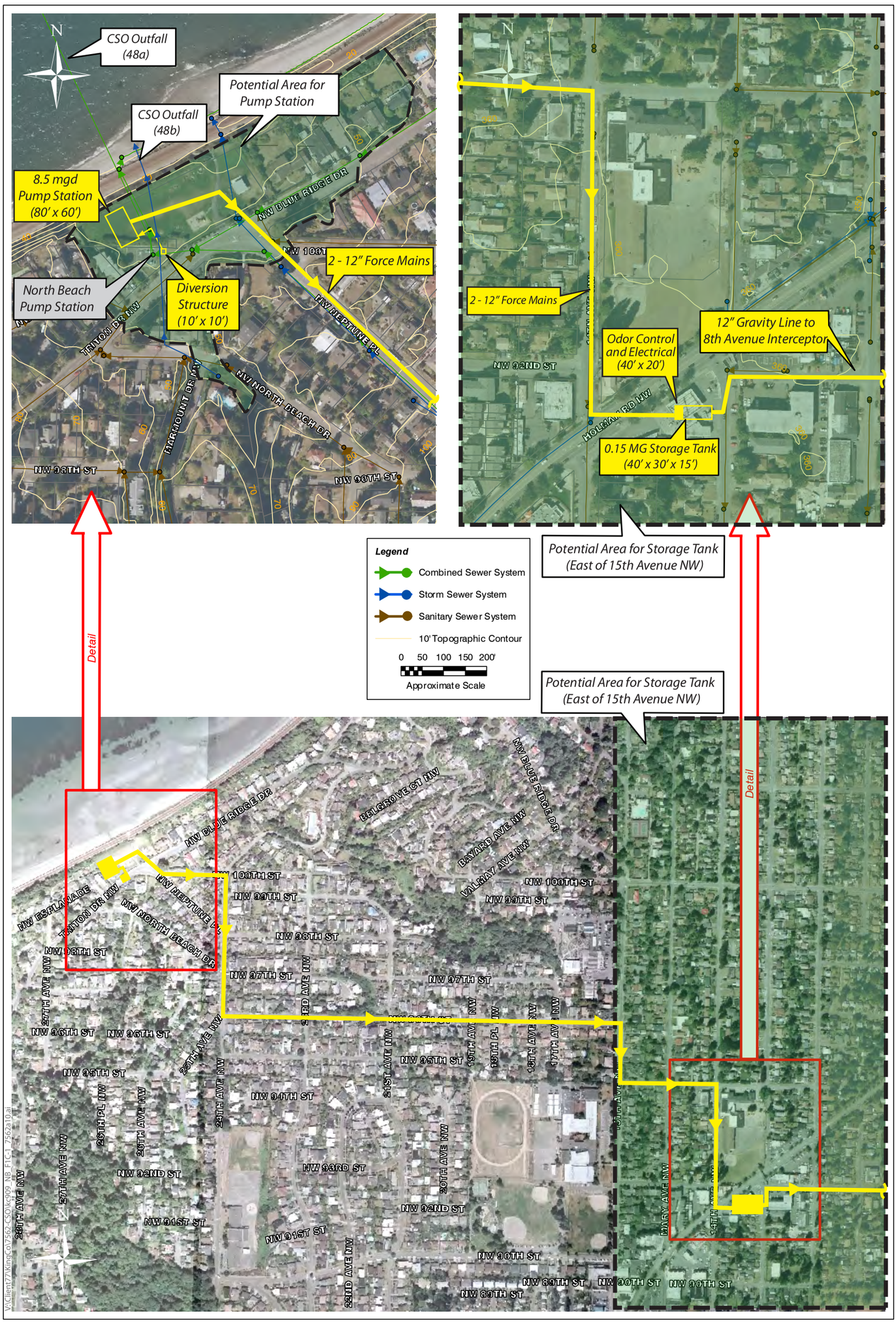

Figure 5.8
NORTH BEACH BASIN
ALTERNATIVE 1C

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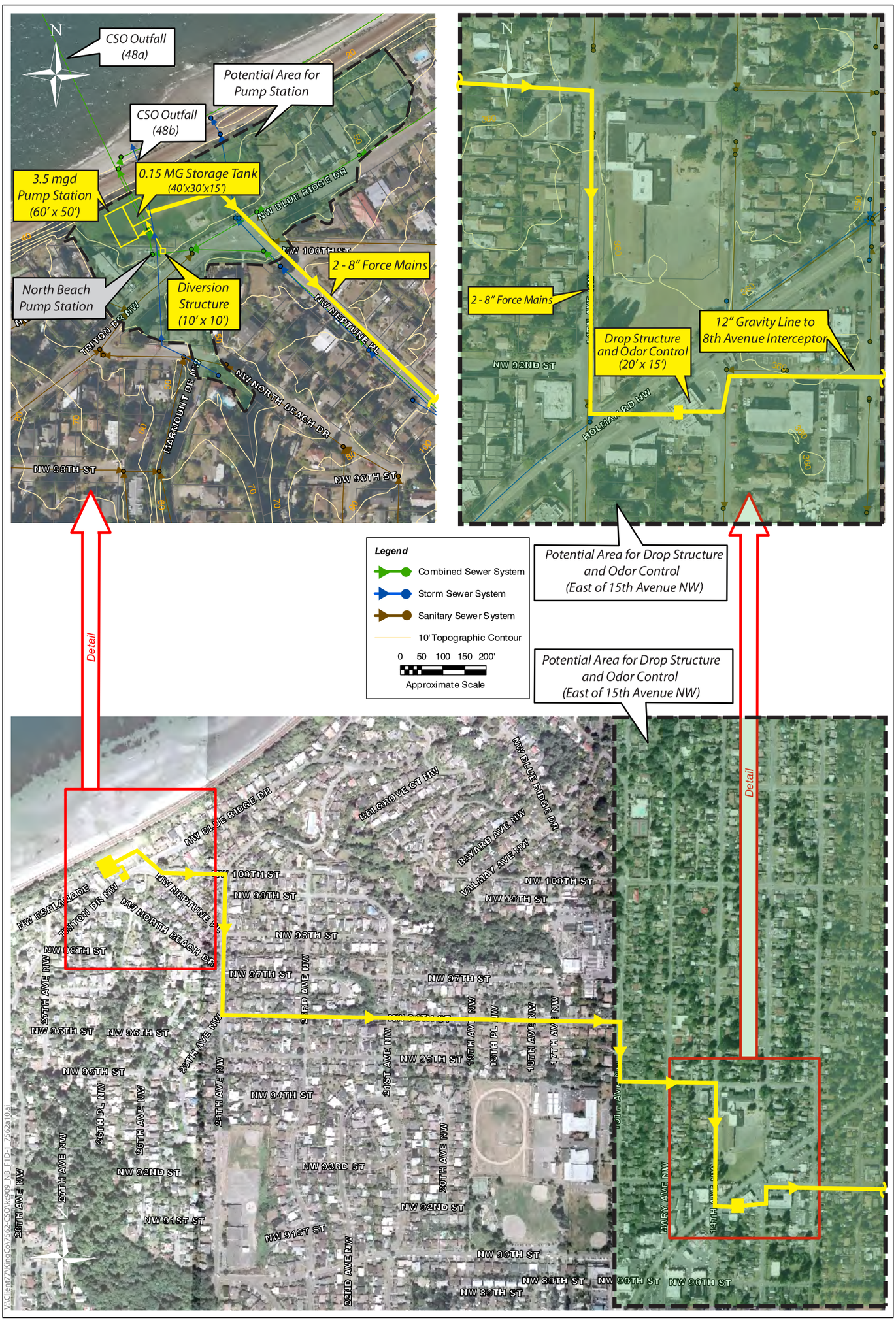

Figure 5.9
NORTH BEACH BASIN
ALTERNATIVE 1D

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Figure 5.10
NORTH BEACH BASIN
ALTERNATIVE 2A

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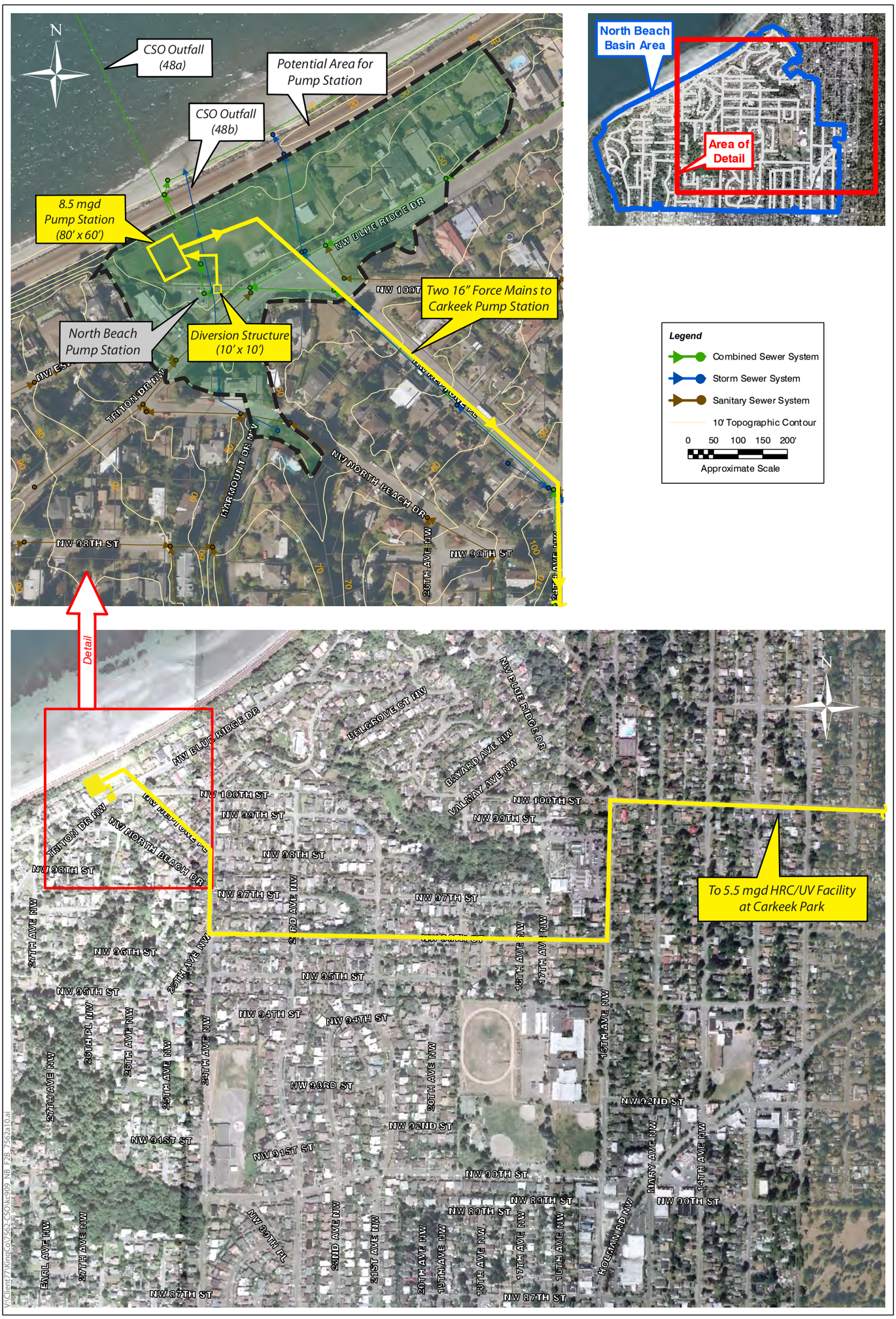

Figure 5.11
NORTH BEACH BASIN
ALTERNATIVE 2B

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Figure 5-11.ai

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Figure 5-12.ai

Figure 5.12
NORTH BEACH BASIN
ALTERNATIVE 3A

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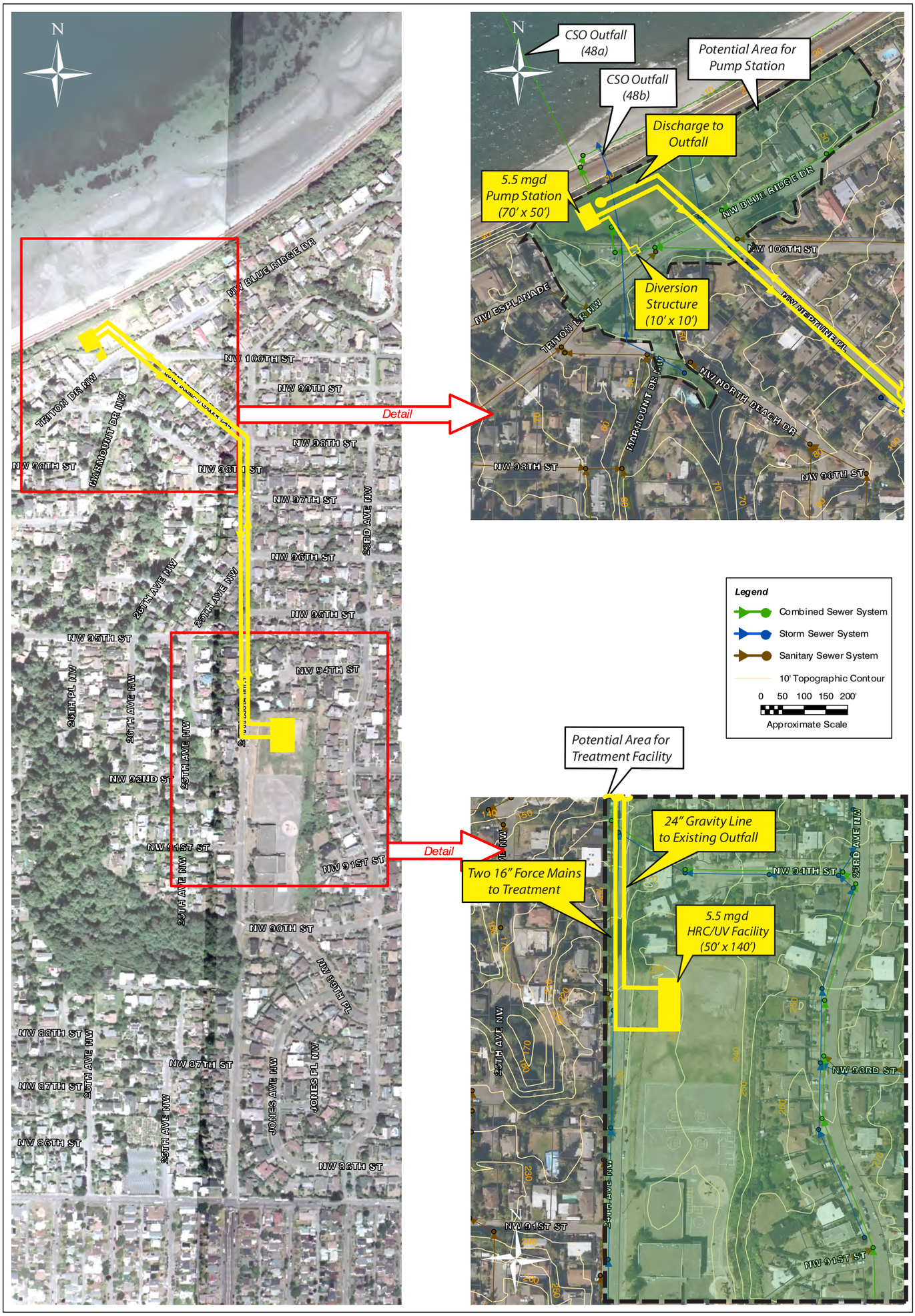

Figure 5.13
NORTH BEACH BASIN
ALTERNATIVE 3B

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Figure 5-13.ai

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5.3.4 Alternatives Using Control Approach 1 – Peak-Flow Storage

This control approach requires rectangular or pipeline storage tanks large enough to achieve the control objective. Alternatives with one tank, tunnel, or pipe are termed "centralized storage" and alternatives with more than one location for storage are termed "distributed storage."

Figure 5.14 shows the approximate flow from each sub-basin in North Beach. The maximum flow ranges from 17- to 30-percent of the total flow. Approximately 65 percent of the flow during a peak event (5.5 mgd out of the total 8.5 mgd) needs to be captured to provide adequate control. Therefore, distributed storage requires a minimum of three storage tanks. In addition, due to the branching of the collection system immediately upstream of the North Beach Pump Station, these storage tanks need to be near the bottom of the basin. Based on this information, distributed storage was deemed impractical in the North Beach Basin.

Storage could be located anywhere in the basin or out of the basin. However, the pump station required to convey the flows would be larger than a storage tank at the bottom of the basin. Therefore, centralized storage up in the basin was deemed to be impractical in the North Beach Basin.

Alternative 1A - Rectangular Bottom-of-Basin Storage (see Figure 5.6). This alternative includes a rectangular storage tank at the bottom of the basin adjacent to the North Beach Pump Station on private property. It includes the following elements:

- A 0.23 MG buried storage tank with dimensions of 55 x 40 x 15 feet deep.
- The tank includes a pump station to empty the tank contents over a 24-hour period after a storm.
- A new diversion structure to divert flows from the sewer to storage during a peak event.
- Ancillary facilities including:
  - Standby power.
  - Odor control.
  - Electrical room.
- The site includes surface access, fencing, and off-street parking.

Alternative 1B - Pipeline Bottom-of-Basin Storage (see Figure 5.7). This alternative includes pipeline storage located at the bottom of the basin adjacent to the North Beach Pump Station within the public right-of-way (NW Blue Ridge Drive and Triton Drive NW). Ancillary facilities would be located on the North Beach Pump Station site. It includes the following elements:

- A 0.23 MG buried storage pipeline with dimensions of approximately 250 feet (subsequently revised to 325 feet to allow for additional freeboard and one percent slope) by 12 feet diameter.

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Figure 5.14
NORTH BEACH BASIN
SUB-BASIN FLOW PERCENTAGES

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Figure 5-14.ai

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- The tank includes a pump station to empty the tank contents over a 24-hour period after a storm.
- A new diversion structure to divert flows from the sewer to storage during a peak event.
- Ancillary facilities including:
  - Standby power.
  - Odor control.
  - Electrical room.
- The site includes surface access, fencing, and off-street parking.

Alternative 1C - Centralized Storage Up in the Basin with Conveyance to 8th Avenue Interceptor (see Figure 5.8). This alternative includes a pump station at the bottom of the basin, a force main to the top of the basin, and a gravity line from the top of the basin to the 8th Avenue Interceptor. In addition, it includes a storage tank located at the top of the basin. Ancillary facilities would also be located at the top of the basin. This alternative replaces the existing North Beach Pump Station and Force Main to the Carkeek Pump Station. It includes the following elements:

- An 8.5 mgd pump station with approximate dimensions of 80 x 60 feet.
- Two 12-inch diameter force mains of approximately 5,000 linear-feet.
- One 12-inch diameter gravity sewer of approximately 3,000 linear-feet.
- A new diversion structure to divert flows from the sewer to the new pump station.
- A 0.15 MG buried storage tank with dimensions of 40 x 30 x 15 feet deep.
  - The tank includes a pump station to empty the tank contents over a 24-hour period after a storm.
- Ancillary facilities including:
  - Standby power.
  - Odor control.
  - Electrical room.
- The sites include surface access, fencing, and off-street parking.

Alternative 1D - Rectangular Bottom-of-Basin Storage with Conveyance to 8th Avenue Interceptor (see Figure 5.9). This alternative includes a pump station at the bottom of the basin, a force main to the top of the basin, and a gravity line from the top of the basin to the 8th Avenue Interceptor. In addition, it includes a storage tank located at the bottom of the basin. Ancillary facilities would be located both at the top of the basin (drop structure, odor control, and electrical) and at the bottom of the basin (standby power and electrical). This alternative replaces the existing North Beach Pump Station and force main to the Carkeek Pump Station. It includes the following elements:

- A 3.5 mgd pump station with approximate dimensions of 60 x 50 feet.
- Two 8-inch diameter force mains of approximately 5,000 linear-feet.
- One 12-inch diameter gravity sewer of approximately 3,000 linear-feet.
- A new diversion structure to divert flows from the sewer to the new pump station.
- A 0.15 MG buried storage tank with dimensions of 40 x 30 x 15 feet deep.
- The tank includes a pump station to empty the tank contents over a 24-hour period after a storm.
- Ancillary facilities including:
  - Standby power.
  - Odor control.
  - Electrical room.
- The sites include surface access, fencing, and off-street parking.

5.3.5 Alternatives Using Control Approach 2 - Convey-and-Treat

This control approach includes conveyance capacity increases to convey peak flows out of the basin to downstream facilities. A constraint of this approach is that the treatment capacity at the Carkeek CSO Treatment Plant would need to be increased by 5.5 mgd.

Alternative 2A - Conveyance to Carkeek CSO Treatment Plant through Beach Alignment (see Figure 5.10). This alternative includes a pump station and force main to Carkeek Pump Station. In addition, it includes a high-rate clarification treatment facility adjacent to the Carkeek Pump Station and CSO Treatment Facility. This alternative replaces the existing North Beach Pump Station and Force Main to the Carkeek Pump Station. It includes the following elements:

- An 8.5 mgd pump station with approximate dimensions of 80 x 60 feet.
- A 16-inch diameter force main of approximately 3,000 linear feet within the Puget Sound tidelands and Carkeek Park.
- A new diversion structure to redirect flows from the sewer to the new pump station.
- A 5.5 mgd high-rate clarification treatment facility adjacent to the Carkeek Pump Station.
- Ancillary facilities including:
  - Standby power.
  - Odor control.
  - Electrical room.
- The sites include surface access, fencing, and off-street parking.

Alternative 2B - Conveyance to Carkeek CSO Treatment Plant through Neighborhood Alignment (see Figure 5.11). This alternative includes a pump station and force main to the Carkeek Pump Station. In addition, it includes a high-rate clarification treatment facility adjacent to the Carkeek Pump Station and CSO Treatment Facility. This alternative replaces the existing North Beach Pump Station and Force Main to the Carkeek Pump Station. It includes the following elements:

- An 8.5 mgd pump station with approximate dimensions of 80 x 60 feet.
- A 24-inch diameter force main of approximately 7,000 linear-feet within the public right-of-way.
- A new diversion structure to redirect flows from the sewer to the new pump station.
- A 5.5 mgd high-rate clarification treatment facility adjacent to the Carkeek Pump Station.
- Ancillary facilities including:
  - Standby power.
  - Odor control.
  - Electrical room.
- The sites include surface access, fencing, and off-street parking.

5.3.6 Alternatives Using Control Approach 3 – End-of-Pipe Treatment

This control approach includes treatment of peak flows through a high-rate clarification facility within the North Beach Basin. The treated effluent would be discharged through the existing North Beach outfall.

Alternative 3A - Bottom-of-Basin Treatment Facility (see Figure 5.12). This alternative requires a high-rate clarification wet-weather treatment plant located at the bottom of the basin near the North Beach Pump Station. It includes the following elements.

- A new diversion structure to redirect flows from the sewer to the new treatment plant.
- A 5.5-mgd high-rate clarification plant with approximate dimensions of 50 x 140 feet.
- A 20-inch discharge pipe to connect the plant to the existing outfall.

Alternative 3B - Treatment Facility Up in the Basin (see Figure 5.13). This alternative requires a high-rate clarification wet-weather treatment plant located up in the basin. This alternative also requires a pump station near the North Beach Pump Station and conveyance piping to and from the treatment facility. It includes the following elements:

- A new diversion structure to redirect flows from the sewer to the new pump station.
- A new 5.5 mgd pump station of approximately 70 x 50 feet to convey flows from the bottom of the basin to the treatment plant.
- A 16-inch force main to convey flows to the treatment plant.

- A 5.5 mgd high-rate clarification plant with approximate dimensions of 50 x 140 feet.
- A 24-inch discharge pipe to connect to the existing outfall.

5.3.7 Alternatives Using Control Approach 5 - Combined Approach

This approach combines peak-flow reduction by disconnecting rooftops that are currently connected to the CSS with peak-flow reduction through infiltration improvements or peak-flow storage. A detailed analysis of this approach is provided in the *North Beach Inflow and Infiltration Alternative Analysis Project Memorandum* (Carollo Engineers, May 2010).

Alternative 5A - Inflow and Infiltration (I/I) Control. Table 5.8 summarizes the assumptions used in the North Beach I/I analysis. More detailed investigations (sewer system evaluation survey (SSES)) would be conducted to refine these assumptions and gain pre-design level information if this alternative is pursued. However, these assumptions are consistent with the County's I/I Program.

Table 5.8 I/I Analysis Assumptions

Number of Homes in Sub-basin	NB01-274; NB02-676; NB03-310; NB04-667; NB05-461	
	Inflow	**Infiltration**
Percent of Homes Repaired	10%[2]	63%[1]
Repair Effectiveness	100%	75%
I/I Reduction Cost	$3,300/home[3]	Easy - $10,000/home[4] Medium - $12,000/home[4] Hard - $17,000/home[4]
Percent of Homes per Repair Category	N/A	Easy - 33% Medium - 33% Hard - 33%

Notes:
1. Based on 95% of "easy" and "medium" homes consistent with the *Initial Infiltration and Inflow Reduction Project Alternative Analysis Report* (King County, April 2009).
2. Based on 13% of homes connected as cited in the *CSO Beach Project GIS Analysis* (King County, September 2008) and disconnection of 75% of these homes.
3. Based on *North Beach I/I Reduction Benefit/Cost Analysis* (King County, July 2007).
4. From *Initial Infiltration and Inflow Reduction Project Alternatives Analysis Report* (King County, April 2009).

The *North Beach I/I Reduction Benefit/Cost Analysis* (King County, July 2007) report estimated 4% of the homes had roof drains connected to the sewer system. The *CSO Beach Project GIS Analysis* (King County, September 2008) indicated 13% of the homes had roof drains connected. The I/I analysis for North Beach assumed 13% of houses are connected. Disconnecting a maximum of 75% of those connected homes is assumed to account for

potential issues associated with disconnection such as technical feasibility and homeowner willingness.

The cost to disconnect roof drains was $3,000 per roof in 2003 dollars (*North Beach I/I Reduction Benefit/Cost Analysis;* King County, July 2007). Using the Engineering New Record Construction Cost Indices (ENR CCI) the cost has been escalated to $3,300 per roof in 2010 dollars. These costs do not include contingency, project costs, or other miscellaneous expenses associated with construction. This estimate does not include conveyance or treatment of roof runoff, which would increase the costs substantially.

It was assumed that 63 percent of side sewers are repaired for infiltration. In the *Initial Infiltration and Inflow Reduction Project Alternative Analysis Report* (King County, April 2009) the County estimated they could repair side sewers on the “easy” and “medium” homes (67 percent). The “hard” homes would have significant landscaping, challenging topography, or other issues that would make side sewer repair infeasible or cost prohibitive. Of the “easy” and -“medium” homes, it was assumed the County could obtain right-of entry agreements with 95 percent of the homeowners.

Any repairs made to the side sewers/laterals would not completely eliminate infiltration in that location. The *I/I Reduction Feasibility Evaluation for Alternatives Analysis* (King County, November 2009) estimated a range for side sewer/lateral repair effectiveness; it was assumed that between 60 and 75 percent of the infiltration would be eliminated in that particular location by the repair efforts. The I/I analysis for North Beach assumed 75 percent repair effectiveness.

The cost to repair a side sewer/lateral varies depending upon how easy or difficult it is to access the pipe. The *Initial Infiltration and Inflow Reduction Project Alternative Analysis Report* (King County, April 2009) for Eastgate, Issaquah, and Skyway divided the ease-of-access and construction into three categories: “Easy”, “Medium”, and “Hard.” The I/I analysis for North Beach assumed an equal split between these categories, similar to Eastgate.

Inflow Improvements

To eliminate development of infrastructure such as storage or end-of-pipe treatment for North Beach CSOs, inflow and infiltration need to be reduced by 5.5 mgd. This is the flow rate over and above the capacity of the North Beach Pump Station (3.0 mgd).

The North Beach hydraulic model was used to determine the amount of infiltration and inflow in each sub-basin. A 1-year storm from October 2007, identified by King County as a design storm, was used to generate the storm flow volumes. The total peak storm inflow rate was estimated to be 5.9 mgd.

The calculations averaged the inflow rate over the 310 connected homes and assumed disconnection of 233 of these homes (10 percent of the total homes). Based on the number of homes repaired and the repair effectiveness, inflow reduction for the entire basin is estimated to be 4.42 mgd. This is 80 percent of the required peak-flow reduction (4.42 mgd divided by 5.50 mgd). Therefore, even with inflow reduction throughout the basin, approximately 45,000 gallons of storage (20 percent of the total volume required), green stormwater infrastructure, or infiltration improvements would be required.

The average unit cost (not including project costs and contingencies) for inflow reduction is $4.16 per gallon removed from the peak flow. This is lower than the unit cost (not including project costs and contingency) of $10.00 per gallon of storage. However, the unit costs for inflow reduction do not include potential requirements for stormwater collection and treatment.

Considering the steep slopes and high groundwater table in certain areas, additional water percolating into the ground may exacerbate landslide issues and localized flooding within the basin. Stormwater collection and treatment impacts the costs significantly and adds to the risk and cost variability of inflow improvements.

Inflow Improvements with Bottom-of-Basin Storage

A 45,000 gallon storage tank would be required to supplement inflow improvements. The construction cost for inflow improvements and storage facilities is approximately $5.7 million not including stormwater collection infrastructure. If stormwater collection were required, the total construction costs could be as high as $46.6 million to include storm sewers and street upgrades throughout the basin. While the scope of stormwater collection requirements may be reduced during detailed design, the range of costs indicates a high degree of variability and risk associated with this option.

Inflow Improvements with Infiltration Improvements

The total peak storm inflow rate is estimated to be 3.2 mgd. Assuming 63 percent of homes in the basin/sub-basin can be repaired and 75 percent of the infiltration from those homes is eliminated, the infiltration reduction for the entire basin (1,504 homes) is estimated to be 1.51 mgd. This is approximately 27 percent of the required peak-flow reduction (1.51 mgd divided by 5.50 mgd). Only 1.1 mgd of the total potential infiltration reduction would be required to eliminate storage since inflow would be the first priority. Therefore, approximately 1,100 homes (out of 2,388 total within the North Beach Basin) would need to be repaired to supplement inflow improvements.

Infiltration reduction project costs are based on the unit costs in Table 5.8 with an average cost of $12,000 per home repaired. The average unit cost (not including project costs and contingency) for infiltration repairs is $315 per gallon removed from the peak flow. This is significantly higher than the unit cost (not including project costs and contingency) of $10.00 per gallon of storage. In addition, the unit costs for infiltration reduction do not include potential requirements for stormwater collection and treatment.

The construction cost for the inflow and infiltration improvements is approximately $32.4 million, not including stormwater collection infrastructure. If stormwater collection were required, the total construction costs could be as high as $73.3 million to include storm sewers and street upgrades throughout the basin. While the scope of stormwater collection requirements may be reduced during detailed design, the range of costs indicates a high degree of variability and risk associated with this option.

Inflow Improvements with Green Stormwater Infrastructure (GSI)

Green Stormwater Infrastructure (GSI) was evaluated in the memorandum *CSO Beach Projects Demand Management Analysis* (King County, May 2010) to determine whether GSI, either alone or in combination with other methods, can achieve CSO control. GSI was not recommended for the North Beach Basin. The following is a summary of the analysis and findings.

King County performed a GIS analysis in 2008. The analysis identified sources of stormwater to the CSS and the separate municipal storm sewer system (MS4) and the characteristics of the basin as they relate to these sources. Impervious, pervious, and rooftop areas were identified, along with the destination of any flows originating from these locations, on both assessed property and the street ROW. The analysis built on flow monitoring and modeling in the CSS conducted in 2006. The results of this analysis indicated that less than 10 percent of the impervious area in the basin is connected to the sewer system.

Results of the GIS analyses were used to conduct a GIS spatial analysis to assess the feasibility of GSI implementation in the study area. King County based its feasibility analysis of the potential for GSI on a white paper titled *Low Impact Development: San Francisco's Green Approach to Stormwater Management* (Carollo Engineers, October 2007). The steps in King County's analysis were as follows:

- Develop criteria to identify types of areas suitable for application of the GSI techniques, starting with the San Francisco criteria and modifying them to accommodate data available for Seattle.
- For each GSI technique, identify the number of acres connected to the CSS in each sub-basin where stormwater could potentially be diverted or attenuated.

Final criteria used to identify suitable areas for each of the GSI techniques are shown in Table 5.9.

All of the criteria for a given scenario and source of flow - rooftop, impervious, or pervious - had to be met for that area to be considered for a GSI technique. Acreages identified for one GSI technique could also be included for another technique. For example, the acres under green roofs for a sub-basin are also included in acres under roof disconnection for the same sub-basin.

The results of the GSI feasibility analysis indicates that the North Beach Basin has little potential for GSI implementation. Depending on the GSI technique, only 4 to 13 acres connected to the CSS shows potential for GSI. In addition, the steep slopes, inflow/infiltration issues, and lack of public-right-of-way connections to the sewer system make this basin less favorable for GSI. See Figure 5.15.

Table 5.9 Used to Identify Areas Suitable for GSI Techniques

GSI Technique	Criteria
Green Roofs	• Roofs connected to CSS. • Roofs over 5,000 ft^2. • Roofs with slopes between 5 and 20 degrees. • Buildings and garages selected from City of Seattle building footprint dataset (does not include decks, patios, etc.).
Roof Disconnection	• Roofs connected to the CSS
Street Trees	• Areas identified in LIDAR as less than 5 ft higher than ground elevation. • Areas in the right-of-way. • Areas connected to the CSS. • Pervious areas.
Bioretention	• Non-rooftop areas in the right-of-way or on private property. • Impervious areas. • Areas connected to the CSS. • Ground slope less than 5%.
Permeable Pavement	• Impervious areas of low-traffic streets, alleys, and parking lots greater than 10,000 ft^2. • Areas connected to the CSS. • Ground slope less than 5%.

5.4 SCREENING OF PRELIMINARY ALTERNATIVES

This section describes the alternatives screening performed under Step 2 of Phase 2 (as described in Section 5.1.2.2). The screening process is described in detail in memoranda titled *CSO Control Alternative Review and Comment Procedure* (Carollo Engineers, September 2009) and *Alternative Narrowing Process* (Triangle Associates, November 2009).

5.4.1 Refined Preliminary Alternatives

The preliminary alternatives were refined and evaluated between August 2009 and February 2010. Team workshops held each month focused on technical and non-technical aspects of the alternatives. Engineering schematics of each of the CSO control approaches were developed in order to estimate site-specific costs as a result of county operations and maintenance input. The schematics were used to develop a basis of costs for the alternatives. A planning-level cost estimate for each of the alternatives was developed and included in this evaluation.

5.4.2 Short-List Development

The refined preliminary alternatives were reviewed in a team workshop on February 11, 2010, at which they were reduced to the following three alternatives for further evaluation:

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Shaun O'Neil 20100611

Figure 5.15
RESULTS OF GSI FEASIBILITY ANALYSIS

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- Alternative 1A – A buried, rectangular 0.23 MG concrete storage tank within Blue Ridge Park adjacent to the existing North Beach Pump Station. A below-grade odor control and electrical support facility would be required.
- Alternative 1B – A buried, 0.23 MG storage pipeline located adjacent to the North Beach Pump Station within the public right-of-way (Triton Drive NW and NW Blue Ridge Drive). An above-grade odor control and electrical support facility would be required and is assumed to be on county property.
- Alternative 1D – A buried, rectangular 0.15 MG concrete storage tank within Blue Ridge Park adjacent to the North Beach Pump Station. In addition, this alternative includes a 3.5-mgd high-head pump station and above-grade odor control and electrical support facility adjacent to the storage tank. This pump station would replace the existing North Beach Pump Station and convey base flows through two small-diameter (~8-inch) force mains, drop structure, and gravity sewer (~12-inch) to the 8th Avenue Interceptor.

Meeting notes for this workshop (Alternative Screening Workshop for North Beach Basin, February 11 and 17, 2010) are included as Appendix C.

5.4.3 Refinement of Short-Listed Alternatives

Between February 2010 and August 2010, the three short-listed alternatives were further developed by the Category Leaders, Basin Leads, and project team at large.

Appendix C includes a detailed description of the short-listed alternatives (*North Beach Alternatives Update Information Technical Memorandum*, Carollo Engineers, September 2010). It includes detailed operational descriptions and control narratives. Summaries of the short-listed alternatives are given below. Table 5.10 summarizes pertinent data for the alternatives. These options are illustrated in Figures 5.16 through 5.18.

5.4.3.1 Alternative 1A – Rectangular Bottom of Basin Storage

This alternative includes a buried, rectangular concrete storage tank, located adjacent to the North Beach Pump Station on Triton Drive NW. The tank provides 0.23 MG of combined sewage storage volume. Below-grade odor control and electrical facilities are included.

The existing 15-inch outfall line would be re-routed from the North Beach Pump Station to the upstream end of the storage tank. Any flows during a peak wet-weather event that exceed the capacity of the pump station (approximately 3 mgd) would overtop the weir at the North Beach Pump Station and flow to the storage tank via the outfall line. Once the capacity of the storage tank had been reached, flow would overtop the outfall weir (approximate elevation 123.00) in the storage tank and flow to the existing 15-inch outfall line. A schematic of this flow pattern is shown in Figure 5.19.

Table 5.10 North Beach Basin Short-Listed Alternative Data

	Alternative 1A	Alternative 1B	Alternative 1D
Type of Vessel, Dims., ft.	Buried, Rectangular Tank, 85 x 40 x 15	Buried, Pipeline Storage, 12 (diameter) x 325	Buried, Rectangular Tank 55 x 40 x 15 High Head PS 85 x 35 x 35 (15 above grade)
# Internal Channels	2	1	2
Sewer, Dia, in./length, ft/ construction	N/A	N/A	2@8/ 5,000 LF / Cut-and-Cover 12/ 3,000 LF/Cut-and-Cover
Excavation Limits to Shoring, L x W x H (depth), ft	90 x 50 x 35	335 x 25 x 25	65 x 50 x 40 High Head PS 60 x 40 x 30
Diversion Control Structure Dims L x W x H (depth), ft	N/A	10 x 10 x 10	N/A
Odor Control / Electrical Footprint, L x W x H (height),ft	40 x 20 x 15	40 x 20 x 15	35 x 35 x 15 Attached to High Head Pump Station
Drop Structure DimsL x W x H (depth), ft	N/A	N/A	20 x 15 x 5
Land Acquisition, SF	10,000	N/A	18,000
Construction Limits, Staging, SF	20,000	20,000 (in addition to 60-ft temporary construction easement along storage pipeline)	20,000

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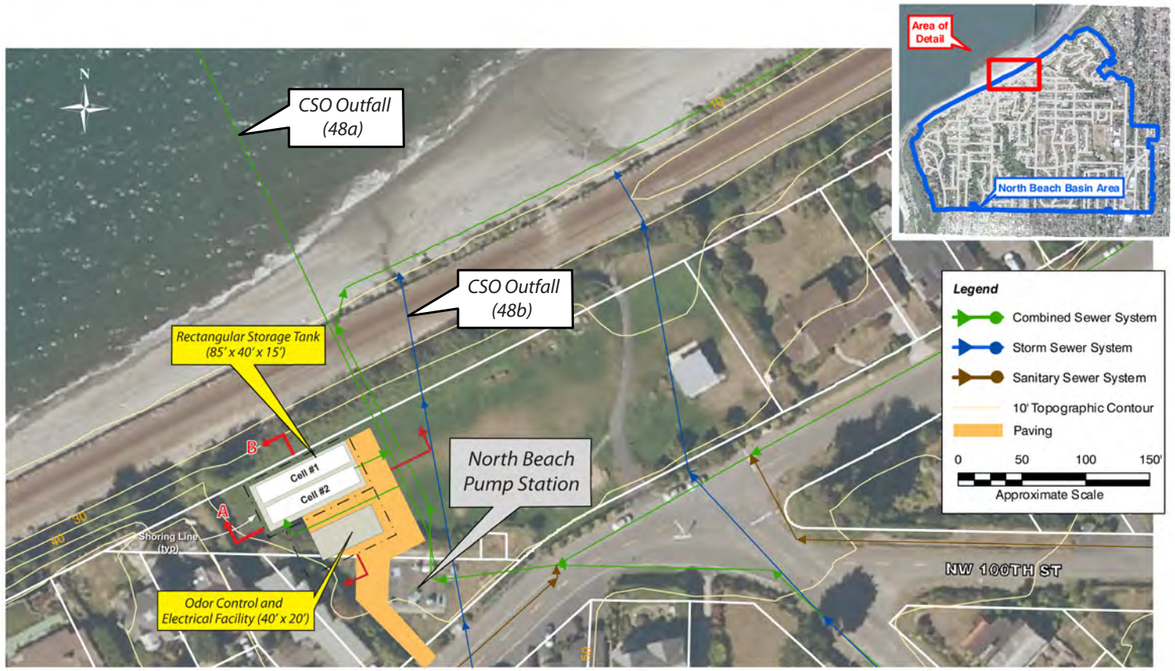


North Beach Alternative 1A: Rectangular Bottom of the Basin Storage

Project Elements:

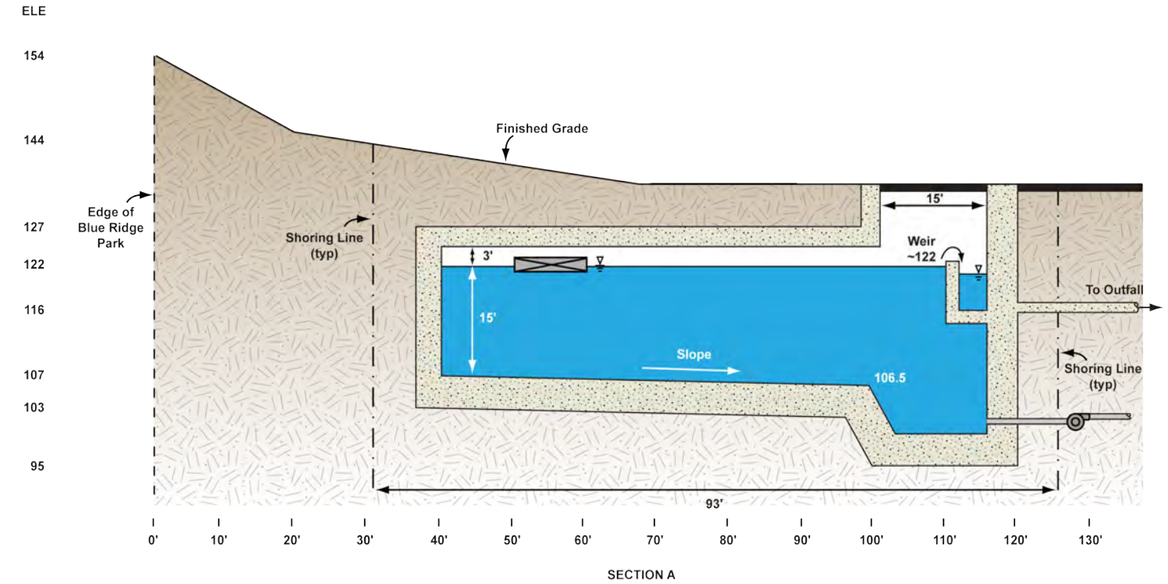
- 0.23 MG underground storage tank
- Underground pumping equipment to drain stored flows
- Underground odor control and electrical facilities

Benefits:

- Facility located where peak flows can be captured passively
- Similar to other King County operating facilities
- Efficient, safe access for operations and maintenance staff

Challenges:

- Easement or acquisition of private park required
- Requires shoreline permit
- Access to Blue Ridge Park restricted during construction
- Shoreline zone is Conservancy Recreation



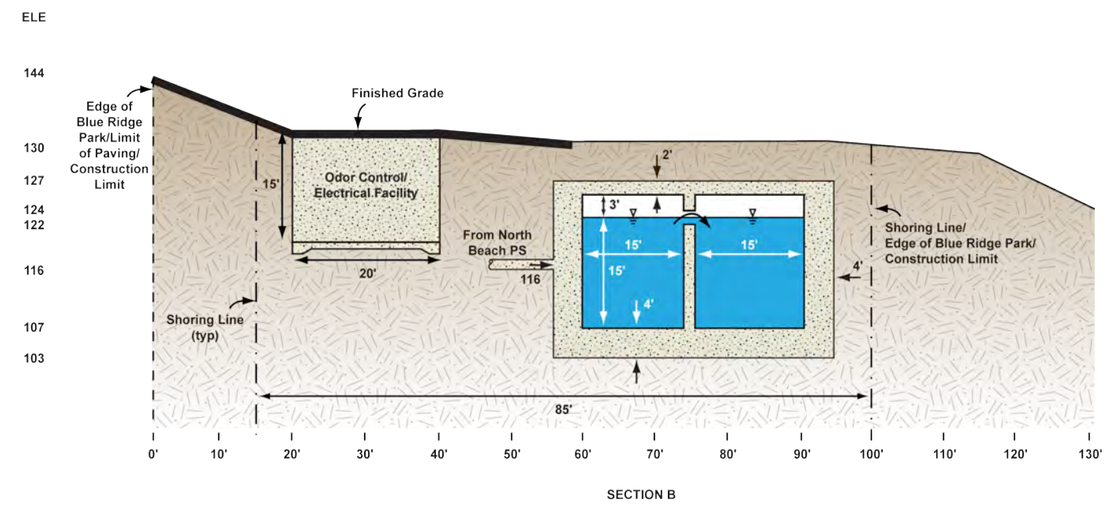


Figure 5.16
NORTH BEACH BASIN ALTERNATIVE 1A - RECTANGULAR BOTTOM OF BASIN STORAGE SITE PLAN AND SECTIONS

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Figure 5-16.ai

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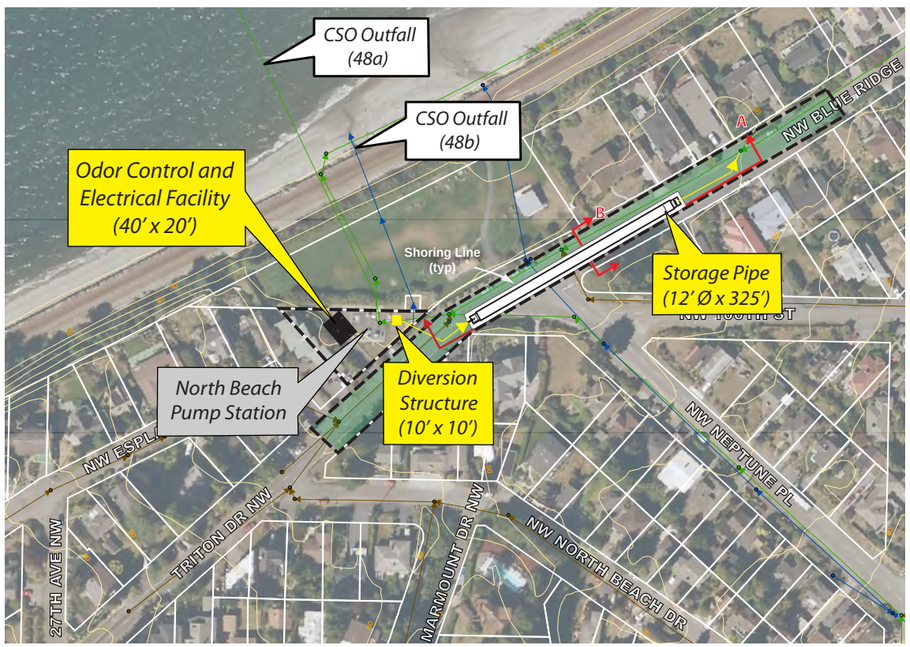
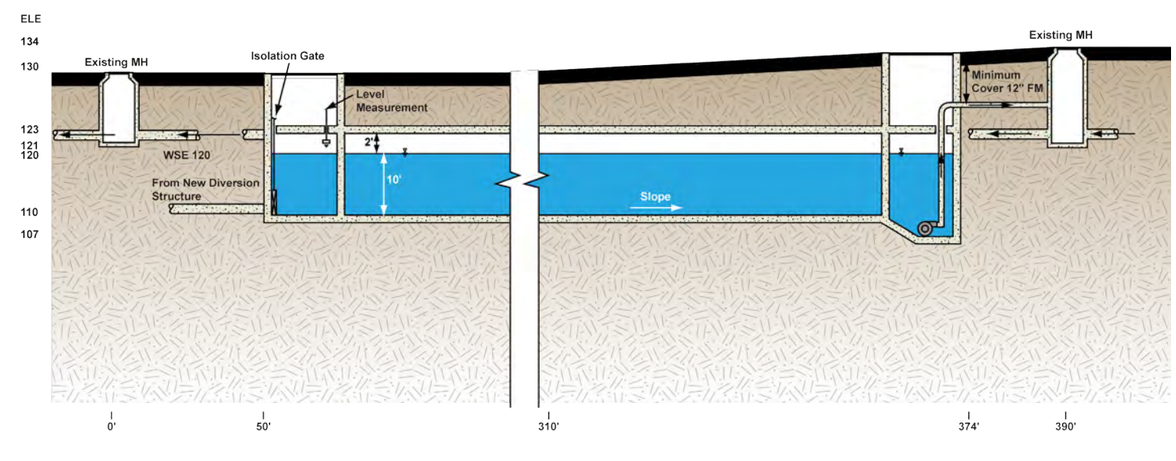


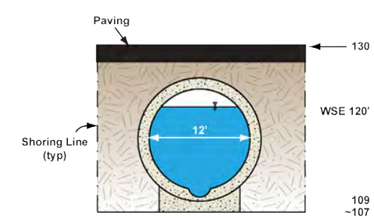
N

0 50 100 150'
Approximate Scale

Legend

- Combined Sewer System
- Storm Sewer System
- Sanitary Sewer System
- 10' Topographic Contour





North Beach Alternative 1B: Pipeline Bottom of the Basin Storage

Project Elements:

- Underground diversion structure to direct flows to storage
- 0.23 MG underground storage pipeline in right-of-way
- Underground pumping equipment to drain stored flows in the in-line storage pipe
- Odor control and electrical facilities located on King County property

Benefits:

- Facility located where peak flows can be captured passively
- Similar to other King County operating facilities
- No apparent need to use or acquire private property

Challenges:

- Location in narrow street will result in access limitations to residences during extended construction period
- Periodic long-term street access is needed for operations & maintenance activities

Figure 5.17
NORTH BEACH BASIN ALTERNATIVE 1B - PIPELINE BOTTOM OF BASIN STORAGE SITE PLAN AND SECTIONS

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Figure 5-17.ai

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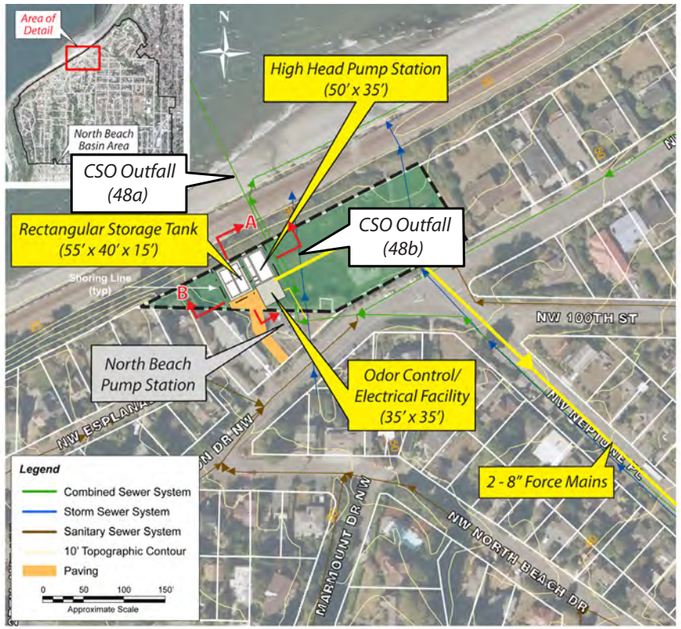

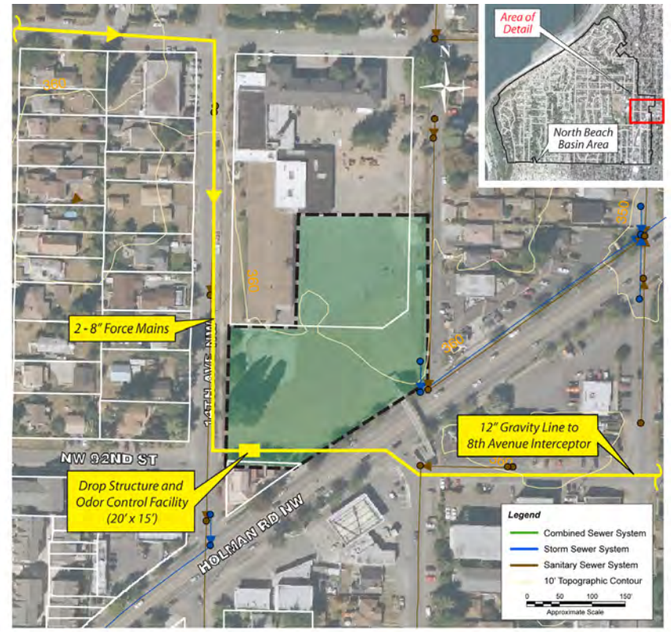

North Beach Alternative 1D: Centralized Storage at Bottom of Basin with Conveyance to 8th Avenue Interceptor

Project Elements:

- 3.5 mgd Pump Station at bottom of basin (300+ feet of head)
- 0.15 MG underground storage tank at bottom of basin
- Above ground odor control and electrical facilities adjacent to pump station
- 2 - 8" Force Mains from bottom of basin to Holman Rd NW (~5000 linear feet)
- Drop structure and odor control in utility easement
- 12" gravity sewer to 8th Avenue Interceptor (~3000 linear feet)

Benefits:

- Replaces existing force main in tidelands
- Facility located where peak flows can be captured passively
- Similar to other King County operating facilities
- Efficient, safe access for operations and maintenance staff

Challenges:

- Private property acquisition required for this alternative
- Increased O&M costs
- Requires shoreline permit
- Access to Blue Ridge Park restricted during construction
- Shoreline zone is Conservancy Recreation

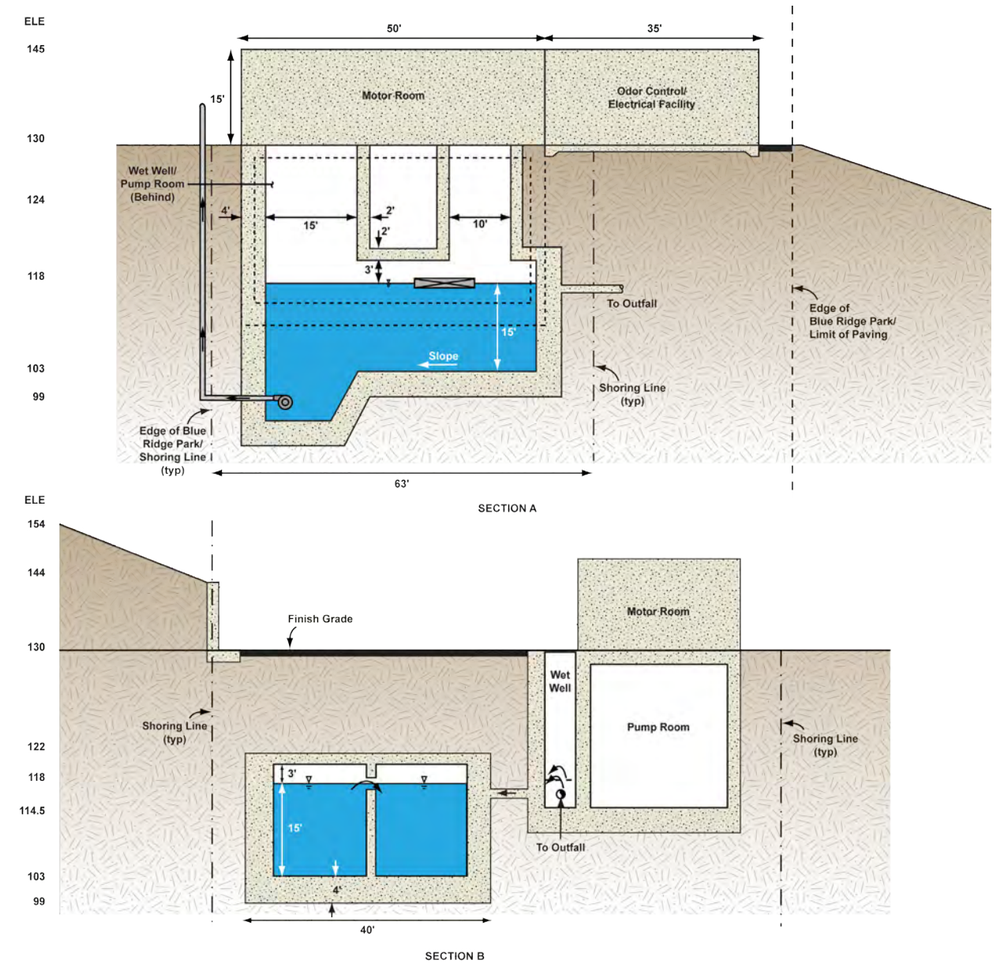

Figure 5.18
NORTH BEACH BASIN ALTERNATIVE 1D - RECTANGULAR BOTTOM OF BASIN STORAGE WITH CONVEYANCE TO 8TH AVENUE INTERCEPTOR SITE PLAN AND SECTIONS

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Figure 5-18.ai

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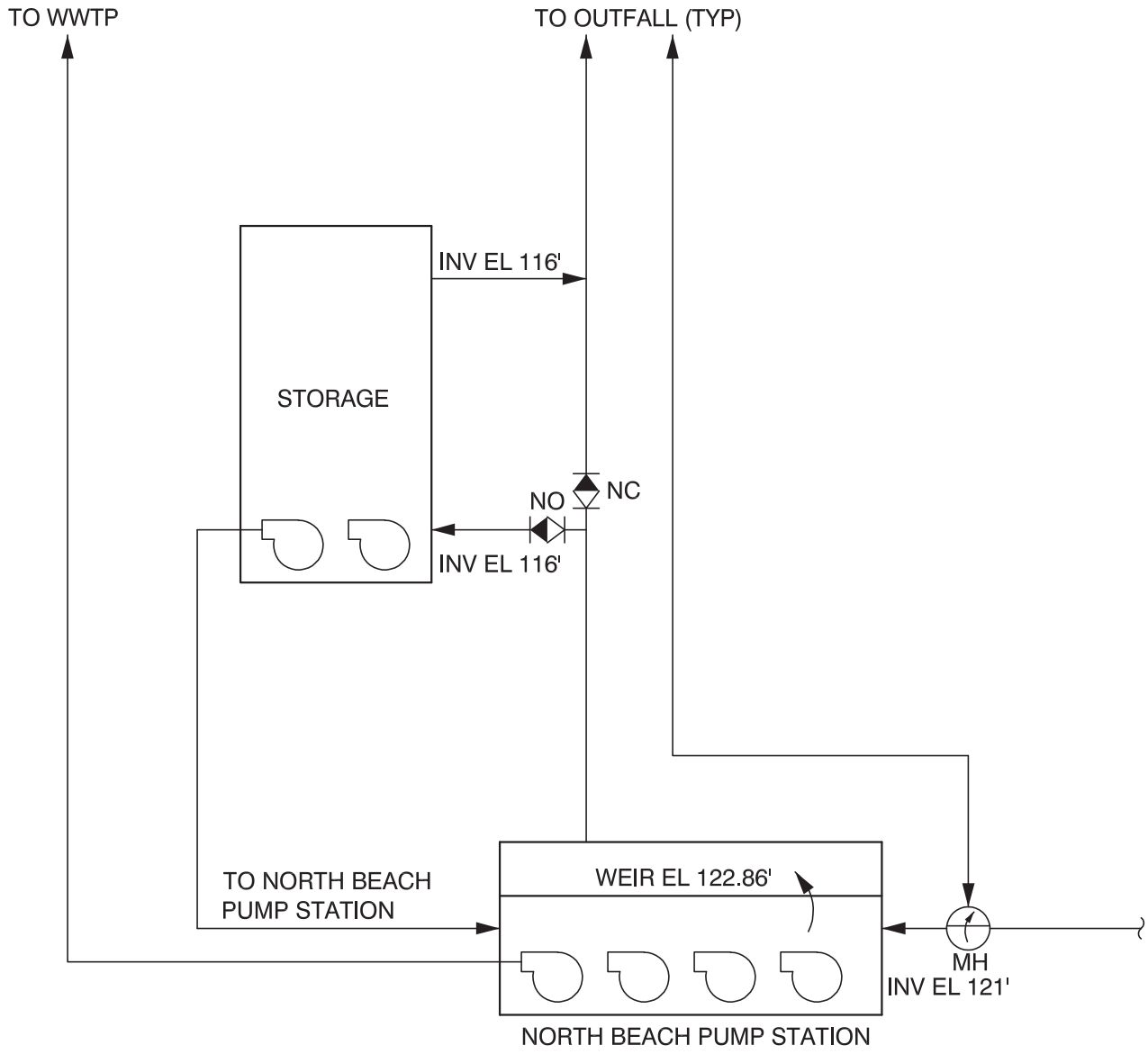

Figure 5.19
NORTH BEACH BASIN ALTERNATIVE 1A - RECTANGULAR BOTTOM-OF-BASIN STORAGE FLOW SCHEMATIC

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Figure 5-19.ai

The tank would retain the required volume until rainfall had ceased and a preset time had elapsed. Automatic cleaning cycles would empty each of the tank channels in turn, and the contents would be pumped back into the North Beach Pump Station over a 24-hour period using submersible pumps in the tank.

The tank would be equipped with carbon scrubber odor control, electrical equipment, and a backup generator, all housed in a separate below-grade structure. The tank would be accessed from the top at either end for maintenance. Cleaning equipment would consist of either flushing gates or tipping buckets as determined during detailed design.

The County evaluated this alternative using the evaluation criteria listed in Appendix C. Detailed results of this evaluation are also provided in Appendix C. The sections below summarize evaluation considerations for this alternative.

5.4.3.1.1 Land Use and Permitting

The site for Alternative 1A is located in residentially zoned open space owned by the Blue Ridge Homeowners Association. The site is known as “Blue Ridge Park.” Partial acquisition or an easement would be required. The park is designated "Conservancy Recreation" (CR) in Seattle's Shoreline Master Program. Storage is considered a "Utility Service Use" and is prohibited. This would require a code amendment or rezone. This alternative would also require a Shoreline Permit.

5.4.3.1.2 Environmental

The site is a relatively flat, clear space. There are no known environmental issues of concern associated with the site.

5.4.3.1.3 Technical

Alternative 1A is the simplest to operate of the three alternatives because it would allow for passive inflow during peak events and the tank’s rectangular geometry would facilitate cleaning. Because of the site’s location and size extensive shoring would be required during construction and would limit the ability to expand the tank in the future.

5.4.3.1.4 Operations and Maintenance

The storage tank concept is familiar to county operations staff. The concept is simple to operate and maintain. There is safe access to the site.

5.4.3.1.5 Costs

This alternative is the second least costly of the short-listed alternatives. At this level of estimating, the cost is essentially equal to that of Alternative 1B. However, since the parcel is privately owned, the schedule and cost risk for this alternative is significant.

5.4.3.1.6 Community

Construction at this site would have short-term and long-term impacts on the community. Construction would create noise, dust, and construction traffic impacts on local traffic and neighboring residences. Blue Ridge Park would be inaccessible during construction and

would be impacted by periodic maintenance activities. The community has a strong opposition to use of any portion of Blue Ridge Park.

5.4.3.2 Alternative 1B – Pipeline Bottom of Basin Storage

This alternative includes buried pipeline storage located in Triton Drive NW and NW Blue Ridge Drive public right-of-way. The tank provides 0.23 MG of combined sewage storage volume. Odor control and electrical facilities would be included on the existing North Beach Pump Station property.

Flow to the North Beach Pump Station would be routed through a new diversion structure. During wet-weather events, the water level in the wet-well of the pump station would back-up and overflow the weir (approximate elevation 123.00) at the diversion structure. A new 15-inch overflow pipeline would run from the diversion structure to the head of the 12-foot diameter storage pipeline. When the maximum water surface elevation (approximately 121.00) was reached in the storage pipe, the rising water level would overtop the existing outfall weir(s) and peak flows would be conveyed through the existing outfall(s) to Puget Sound. A schematic of this flow pattern is shown in Figure 5.20. The tank would retain the required volume until rainfall had ceased and not occurred for a preset time. Automatic cleaning cycles would empty the tank and the contents would be pumped back into the North Beach Pump Station over a 24-hour period using submersible pumps in the tank.

The facility would include carbon scrubber odor control, electrical equipment, and a backup generator on the North Beach Pump Station site. The storage pipeline would be accessed from the top at either end for maintenance. Cleaning equipment would include either flushing gates or tipping buckets as determined during detailed design.

The County evaluated this alternative using the evaluation criteria listed in Appendix C. Detailed results of this evaluation are also provided in Appendix C. The sections below summarize the evaluation considerations for this alternative.

5.4.3.2.1 Land Use and Permitting

The site for Alternative 1B is in a public right-of-way and is on county-owned property. Site acquisition would not be required. Zoning for the North Beach Pump Station site is Single Family Residential. Utility service use is permitted as a City Council conditional use. This alternative would not require a Shoreline Permit. This alternative would require either a Street Improvement Permit or Major Utility Permit

5.4.3.2.2 Environmental

The site is a relatively flat, clear space. There are no known environmental issues of concern associated with the site.

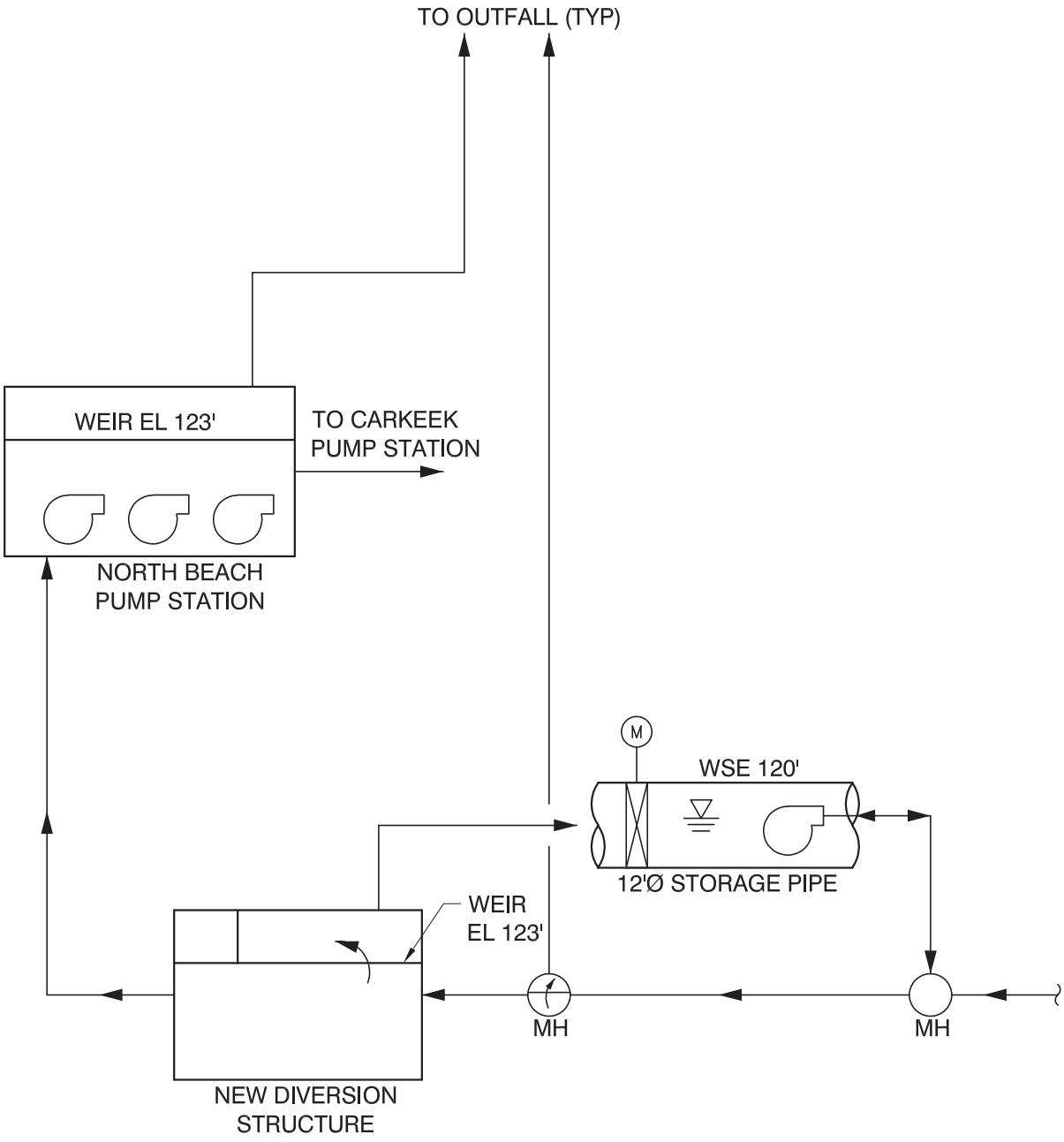

Figure 5.20
NORTH BEACH ALTERNATIVE 1B - PIPELINE BOTTOM-OF-BASIN STORAGE FLOW SCHEMATIC

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Department of Natural Resources and Parks
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Figure 5-20.ai

5.4.3.2.3 Technical

Alternative 1B would be relatively simple to operate because it would allow for passive inflow during peak events and only has one cell. However, pipeline storage may be more difficult to clean than rectangular storage due to the shape and length. Site location and size would require extensive shoring during construction and limit the ability to expand the tank in the future.

5.4.3.2.4 Operations and Maintenance

The storage tank concept is familiar to county operations staff. The concept is simple to operate and maintain. However, access is a concern and additional staffing (relative to Alternative 1A) is likely needed due to the location within the public right-of-way. Infrequent maintenance issues would require traffic control procedures and a street use/closure permit.

5.4.3.2.5 Costs

This alternative is the least costly of the short-listed alternatives. Furthermore, the schedule and cost risk is estimated to be significantly lower than the other alternatives since private property is not required and the facilities would not be within the Conservancy Recreation zone. Street use costs might be substantial if the work took longer than anticipated.

5.4.3.2.6 Community

Construction at this site has short-term and long-term impacts on the community. It would create noise, dust, and construction traffic impacts on local traffic and neighboring residences. Maintenance activities might require street closures. The community has indicated strong support for this alternative since it does not use any portion of Blue Ridge Park.

5.4.3.3 Alternative 1D – Rectangular Bottom-of-Basin with Conveyance to 8th Avenue Interceptor

This alternative includes a buried, rectangular concrete storage tank located adjacent to a new county pump station on Triton Drive NW. The tank would provide 0.15-MG of combined sewage storage. The new 3.5 mgd pump station would replace the existing North Beach Pump Station and convey base wastewater flows through two 8-inch diameter force mains to a drop structure at the top of the basin. The drop structure would provide a transition from the force mains to a 12-inch gravity sewer that conveys the flows to the 8th Avenue Interceptor. The drop structure includes odor control equipment. Odor control and electrical facilities would also be included within the new pump station at the bottom of the basin.

Alternative 1D would include construction of a new 3.5 mgd high-head pump station. Flow would be routed directly from the collection system via the existing 18-inch line to the wet-well of the new pump station. Flows exceeding 3.5 mgd would overtop the first weir (approximate elevation 120.00) in the wet well. From there flows would be conveyed via a short pipeline to the underground storage tank. When the level in the tank reached its maximum water surface elevation, flow in the wet-well would overtop the overflow weir

(approximate elevation 118.00). The overflow would flow by gravity to the existing outfall and Puget Sound. A schematic of this flow pattern is shown in Figure 5.21.

The tank would retain the required volume until rainfall had ceased and a preset time had elapsed. Automatic cleaning cycles would empty each tank and the contents would be pumped back into the North Beach Pump Station over a 24-hour period using submersible pumps in the tank.

The pump station and tank would be equipped with carbon scrubber odor control, electrical equipment, and a backup generator. The tank would be accessed from the top at either end for maintenance. Cleaning equipment would consist of either flushing gates or tipping buckets as determined during detailed design.

The County evaluated this alternative using the evaluation criteria listed in Appendix C. Detailed results of this evaluation are also provided in Appendix C. The sections below summarize the evaluation considerations for this alternative. Land Use and Permitting

The site for Alternative 1D is located in a residentially zoned open-space owned by the Blue Ridge Homeowners Association. The site is known as “Blue Ridge Park.” Partial acquisition would be required. The park is designated "Conservancy Recreation" (CR) in Seattle's Shoreline Master Program. Storage is considered a "Utility Service Use" and is prohibited. This would require a code amendment or rezone. This alternative would also require a Shoreline Permit. This alternative requires a Street Utility Permit, but construction of the drop structure near Crown Hill Park would be within an existing 30-foot wide utility easement.

5.4.3.3.1 Environmental

The site is a relatively flat, clear space. There are no known environmental issues of concern associated with this site. There are known contaminated sites and there is potential that contaminated soils could be encountered in the vicinity of the drop structure and odor control facility site and pipeline alignment.

5.4.3.3.2 Technical

The pump station would require two-stage pumping, which is more costly and requires more maintenance than the existing North Beach Pump Station design. Flows from the Carkeek Pump Station would need to be limited so that the capacity of the 8th Avenue Interceptor would not be exceeded. Site location and size would require extensive shoring during construction and limit the ability to expand the tank in the future. In addition, gravity lines that connect to the North Beach Force Main upstream of the Carkeek Pump Station would need to be modified since the force main would no longer carry flows from North Beach.

5.4.3.3.3 Operations and Maintenance

The pump station and storage tank concept is familiar to county operations staff. The alternative would require more maintenance relative to Alternatives 1A and 1B due to the need for a two-stage pump station. There is safe access to the site.

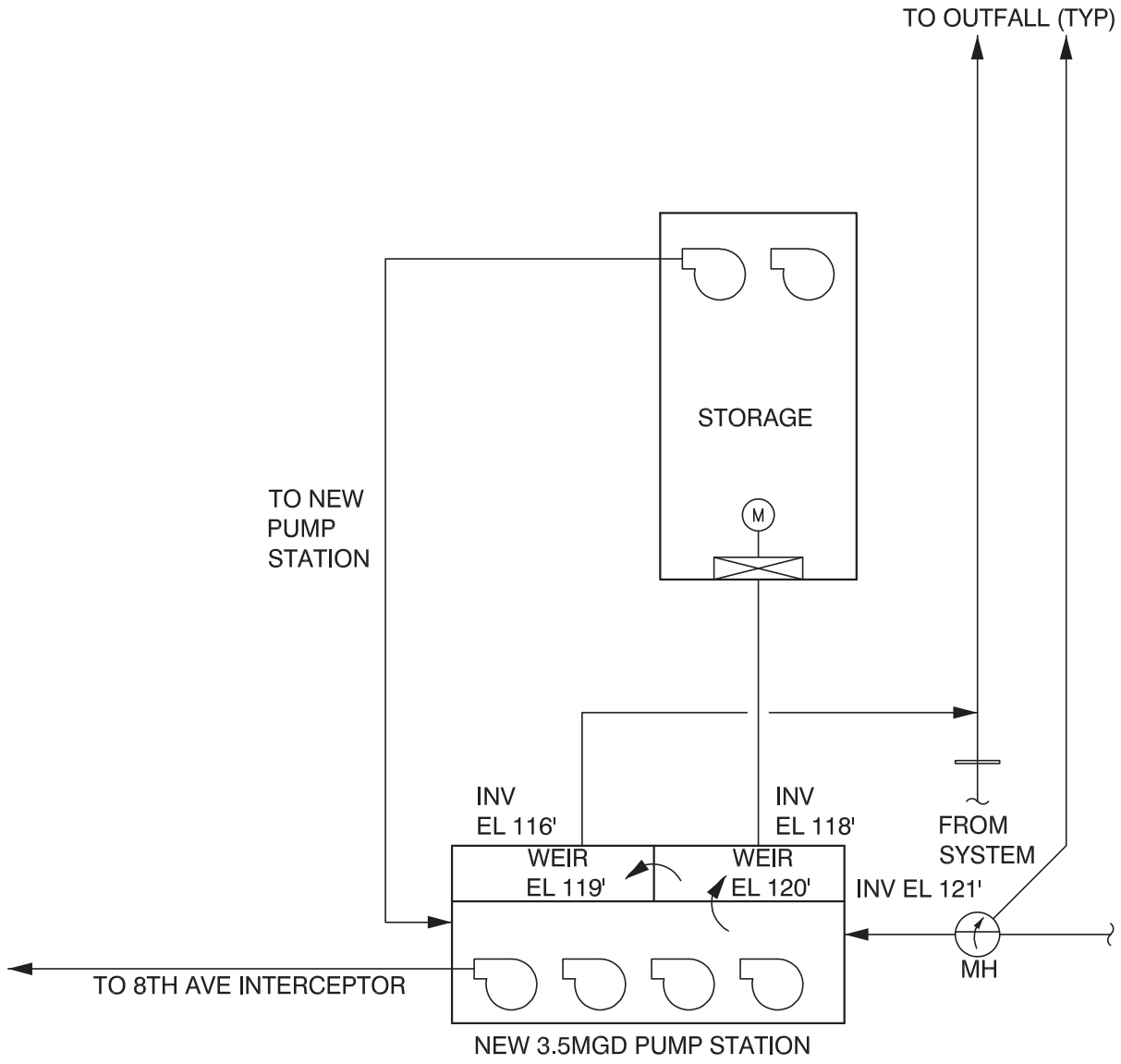

Figure 5.21
NORTH BEACH ALTERNATIVE 1D - RECTANGULAR BOTTOM-OF-BASIN STORAGE WITH CONVEYANCE TO 8TH AVENUE INTERCEPTOR FLOW SCHEMATIC

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Figure 5-21.ai

5.4.3.3.4 Costs

This alternative would be three to four times more costly than Alternative 1A or 1B and would significantly change the operating characteristics of the North Beach infrastructure by bypassing the Carkeek Pump Station. Since the wastewater would need to be pumped over a ridge to 8th Avenue, the operating costs would also be significantly higher than the existing system.

5.4.3.3.5 Community

Construction at this site would have short-term and long-term impacts on the community. Construction would create noise, dust, and construction traffic impacts on local traffic and neighboring residences. Because pipeline and facility construction would occur at two sites, this work would impact multiple areas of the basin. Blue Ridge Park would be inaccessible during construction and would be impacted by periodic maintenance activities. The community has a strong opposition to use of any portion of Blue Ridge Park. Construction of the Drop Structure might impact Crown Hill Park.

The alternative would eliminate the need for a future potential project to upgrade the existing force main and/or pump station.

5.5 SELECTION OF A PROPOSED ALTERNATIVE

This section describes the selection of a proposed project approach from among the three short-listed alternative under Step 3 of Phase 2 (as described in Section 5.1.3.3). Detailed information is provided in the *North Beach Alternatives Update Information Technical Memorandum* (Carollo Engineers, June 2010) in Appendix C.

5.5.1 Refinement of the Evaluation Criteria

The evaluation template used by the project team to evaluate these alternatives is included in Appendix C. It describes the team's comments on the various factors affecting review and recommendation of a proposed alternative.

5.5.2 Evaluation Process

5.5.2.1 <u>Screening Analysis</u>

The project team convened several focus group meetings between March 2010 and August 2010. The team reviewed updated and new information about the alternatives . The team refined the criteria questions and evaluation ratings using the results of each of these meetings.

The team compiled evaluation results from the focus group meetings and convened a workshop in August 2010 to make a recommendation for a proposed alternative to carry forward for further environmental review. Meeting notes from this workshop are in Appendix C. Table 5.11 summarizes the project team's analysis of the three shortlisted alternatives.

Table 5.11 Evaluation Summary of Short-Listed Alternative Data

	Alternative 1A: Rectangular Bottom-of-Basin Storage	**Alternative 1B: Pipeline Bottom-of-Basin Storage**	**Alternative 1D: Centralized Storage at Bottom of Basin with Conveyance to 8th Avenue Interceptor.**
Overall Evaluation Ratings	This alternative was in the middle for low-impact scores and tied with Alternative 1D for the most high-impact ratings.	This alternative had the most low-impact ratings and had the fewest high-impact ratings.	This alternative had the fewest low-impact scores and tied with Alternative 1A for the most high-impact ratings.
Technical Considerations	Passive diversion of flows and infrastructure similar to other county facilities. Shoring, groundwater, and physical space concerns for constructability. No street access required. Minimum staffing and maintenance requirements.	Passive diversion of flows and infrastructure similar to other county facilities. Shoring, groundwater, and physical space concerns for constructability. Street access may be required - concern about staff safety and street closure requirements. Increased staffing and maintenance requirements due to facilities in the right-of-way.	Passive diversion of flows and infrastructure similar to other county facilities. Shoring, groundwater and physical space concerns for constructability. Increased maintenance due to two-stage pumping. No street access required and minimum staffing and maintenance requirements.
Preliminary Cost Estimates[1]			
Construction	$5,850,000	$5,100,000	$18,800,000
Land/Easements	$600,000	$400,000	$785,000
Street Use Fees	$0	$350,000	$480,000
Additional Costs	$4,500,000	$4,000,000	$14,800,000
Total	**$10,950,000**	**$9,850,000**	**$34,865,000**
Community Input	Not as much support as Alternative 1B.	Support for this alternative.	Not as much support as Alternative 1B.
Real Estate	Opposition to acquisition of portion of Blue Ridge Park (private park owned by the Blue Ridge community).	No property acquisition required. Facilities within right-of-way or county property.	Opposition to acquisition of portion of Blue Ridge Park (private park owned by the Blue Ridge community).
Land Use Permits (in addition to the typical construction permits)	Shoreline Permit Council Conditional Use Permit – The storage tank would be located in a privately-owned park designated "Conservancy Recreation" (CR) in Seattle's Shoreline Master Program. Storage is considered a "Utility Service Use." Utility Service Uses are prohibited.	Council Conditional Use Permit - Would be straight forward because Seattle Municipal code says this is permitted and there is community support for this alternative.	Shoreline Permit Council Conditional Use Permit – The storage tank would be located in a privately-owned park designated "Conservancy Recreation" (CR) in Seattle's Shoreline Master Program. Storage is considered a "Utility Service Use." Utility Service Uses are prohibited.
Environmental Considerations	No known environmental issues of concern.	No known environmental issues of concern.	Known contaminated sites and potential to encounter contaminated soils in the vicinity of the drop structure and odor control facility site and pipeline alignment near Holman Road.
Risk Analysis High Impact and High Probability Risks	• Challenge to Shoreline Permit application; appeal successful. Cost: $900,000; Schedule: 11 months. • City would not issue permit for storage in "Conservancy Recreation" Shoreline Designation; rezone or code amendment required. Cost: $N/A; schedule: 9 months. • County procured construction permits delayed. Cost: $N/A; schedule: 9 months. • Significant portion of park closed for intermittent maintenance. Cost: $3,000,000; schedule: N/A. • Stakeholders request additional meetings to discuss the project. Cost: $N/A; schedule: 5 months. • Small Contractor Supplies (SCS) requirements change. Cost: $N/A; schedule: 4 months. • Blue Ridge Board agrees to grant an easement then changes mind. Cost: $2,400,000; schedule: 14 months. • Blue Ridge Board sued; all negotiations stopped with KC. Cost: $N/A; schedule: 16 months.	• Small Contractor Supplies (SCS) requirements change. Cost: $N/A; schedule: 4 months.	• Challenge to Shoreline Permit application; appeal successful. Cost: $900,000; schedule: 11 months. • City would not issue permit for storage in "Conservancy Recreation" Shoreline Designation; rezone or code amendment required. Cost: $N/A; schedule: 9 months. • County procured construction permits delayed. Cost: $N/A; schedule: 9 months. • Stakeholders request additional meetings to discuss the project. Cost: $N/A; schedule: 5 months. • Small Contractor Supplies (SCS) requirements change. Cost: $N/A; schedule: 4 months. • Existing building encroaches on easement in Crown Hill Park. Cost: $50,000; schedule: 11 months. • Blue Ridge Board agrees to grant an easement then changes mind. Cost: $2,400,000; schedule: 14 months. • Blue Ridge Board sued; all negotiations stopped with KC. Cost: $N/A; schedule: 16 months.

Notes:
1. Additional costs include non-construction capital costs except for specific itemized costs noted in the table.

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5.5.2.2 Project Risk Analysis

In July 2010, the project team conducted project implementation risk assessment workshops for the short-listed alternatives. The resulting risk assessment matrices are in Appendix C. Alternatives 1A and 1D had a number of potential high-impact and high-probability risks, as shown in Table 5.11. This resulted in higher cost and schedule risk for these alternatives which could impact meeting the compliance schedule and final project costs. Alternative 1B had only one potential high-probability and high-impact risk, resulting in much lower cost and schedule risk.

5.5.3 Proposed Alternative for Further Environmental Review

Pipeline Bottom-of-Basin Storage (Alternative 1B) is the alternative proposed for further environmental review for the following reasons:

- Straightforward approach, similar to other county facilities, with minimal technical complexity.
- Minimal permitting/zoning issues.
- Private property acquisition not required.
- Preferred by the community.
- No known environmental issues of concern.
- Lowest capital and life-cycle costs.
- Lowest schedule and cost risk.

Chapter 6 describes the proposed alternative in detail.

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PROPOSED ALTERNATIVE

This chapter provides engineering, cost, and environmental information for the proposed alternative (Alternative 1B - Pipeline Bottom-of-Basin Storage). The preliminary information for this alternative, presented in Chapter 5, is also included in this chapter, along with additional design details and environmental information in order to provide a complete description of the proposed alternative.

6.1 ALTERNATIVE OVERVIEW

6.1.1 Overflow Frequency and Volume

Table 6.1 shows CSO frequency and volume from the North Beach Basin both prior to project implementation and anticipated after implementation.

Table 6.1 CSO Frequency and Volume from the North Beach Basin

CSO Frequency and Volume	Prior To Project Implementation	Anticipated After Project Implementation[2]
Annual Frequency	10 Overflows/year	1 Overflow/year
Annual Volume	2.2 MG	0.5 MG
30-year Simulation Total Volume	34.9 MG[1]	15.5 MG

Notes:
1. Based on MIKE Urban Model and a North Beach PS capacity of 3 MGD.
2. Based on MIKE Urban Model, North Beach PS capacity of 3 MGD, and 0.23 MG of storage at bottom of basin.

6.1.2 General Layout

Alternative 1B includes a buried storage pipeline located in Triton Drive NW and NW Blue Ridge Drive public right-of-way. The pipeline would provide 0.23 MG of storage volume for combined sewage. Ancillary facilities would be located on the North Beach Pump Station site. Figure 6.1 illustrates this scenario. It includes the following elements:

- A new diversion structure to redirect peak flows from the sewer to storage.
- A 325-foot-long, and 12-foot in diameter buried storage pipe. The storage pipeline includes:
  - A 20-inch influent sewer-and-isolation gate.
  - A pump station to empty the pipeline contents over a 24-hour period following a wet-weather event.
  - A 6-inch effluent line to the local CSS.
  - A flushing system, including a flap gate and utility water equipment, to facilitate pipeline cleaning.

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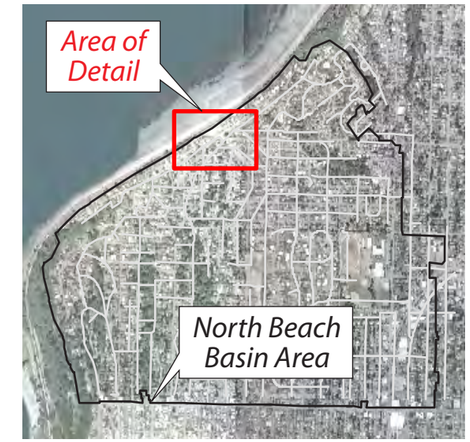

N

0 50 100 150'
Approximate Scale

Legend

- Combined Sewer System
- Storm Sewer System
- Sanitary Sewer System
- 10' Topographic Contour
- Feasible Area for Pipe Location

Figure 6.1
SITE LAYOUT PLAN

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Department of Natural Resources and Parks
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Figure 6-1_new.ai

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  - Access features for routine and long-term operations and maintenance.
- An ancillary equipment facility for odor control, mechanical, and electrical equipment including:
  - Control panels and MCCs.
  - Standby power generator, including fuel storage tank.
  - Odor control system including mist eliminator, carbon scrubbers, and fans.
  - Ventilation system.
  - Utility water system including backflow preventer, air gap tank, pumps, and hydropneumatic tank.
- Site improvements including:
  - Improvements as required by SDOT along Triton Drive NW and NW Blue Ridge Drive.
  - North Beach Pump Station surface access, fencing, and landscaping modifications and restoration.

6.1.2.1 Diversion Structure

In this scenario, flow to the North Beach Pump Station will be routed through a new diversion structure. Figure 6.2 shows a conceptual plan and section view of this arrangement.

During wet-weather conditions, the water level in the North Beach Pump Station wet well and combined sewer system will rise. The rising water level in the diversion structure will overtop the weir (at Elevation 123.00 feet (Metro Datum)) and peak flows will be diverted to the storage pipeline. A new 20-inch pipeline will run from the diversion structure to the head of the storage pipeline. When the maximum water surface elevation in the storage pipe (Elevation 121.00 (Metro Datum)) is reached, the isolation gate will close and any additional peak flows will flow through one of the existing outfalls to Puget Sound.

The diversion structure will be below grade and include access hatches for visual inspection and maintenance. Utility water will be provided near the structure for washdown of the weir and flushing of the pipeline to storage. The structure will also house a level sensor for remote monitoring of water levels.

6.1.2.2 Pipeline Storage

The proposed CSO storage facility is a buried pipeline 325 feet long and 12-feet in diameter. Figure 6.3 shows a conceptual plan and Figure 6.4 shows section views of this storage pipeline. The pipeline is equipped with carbon scrubber odor control, electrical equipment, and a backup generator, housed in a separate structure on the North Beach Pump Station site. The pipeline is accessed from the top at portals for maintenance. Equipment at the portals includes level sensors, flushing gate, and utility water valving for cleaning, and submersible effluent pumps and valving to drain the pipeline.

In this design, the pipeline will begin to fill once CSOs overtop the weir at the diversion structure and are conveyed through the 20-inch influent pipe. Pipeline storage will be sloped to a sump at

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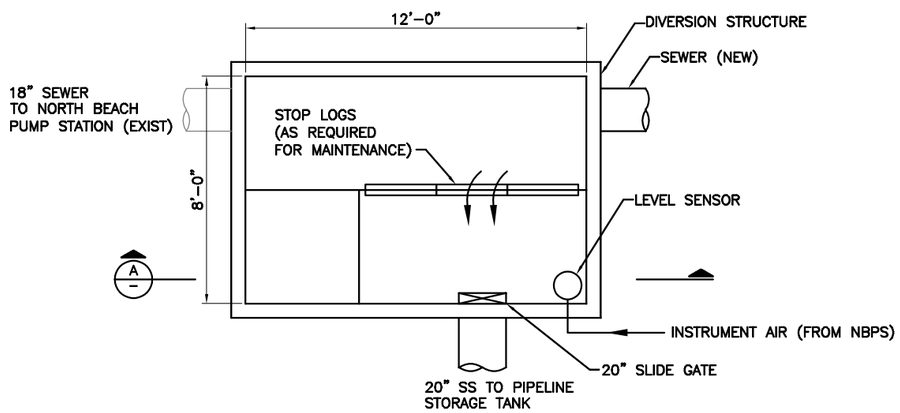
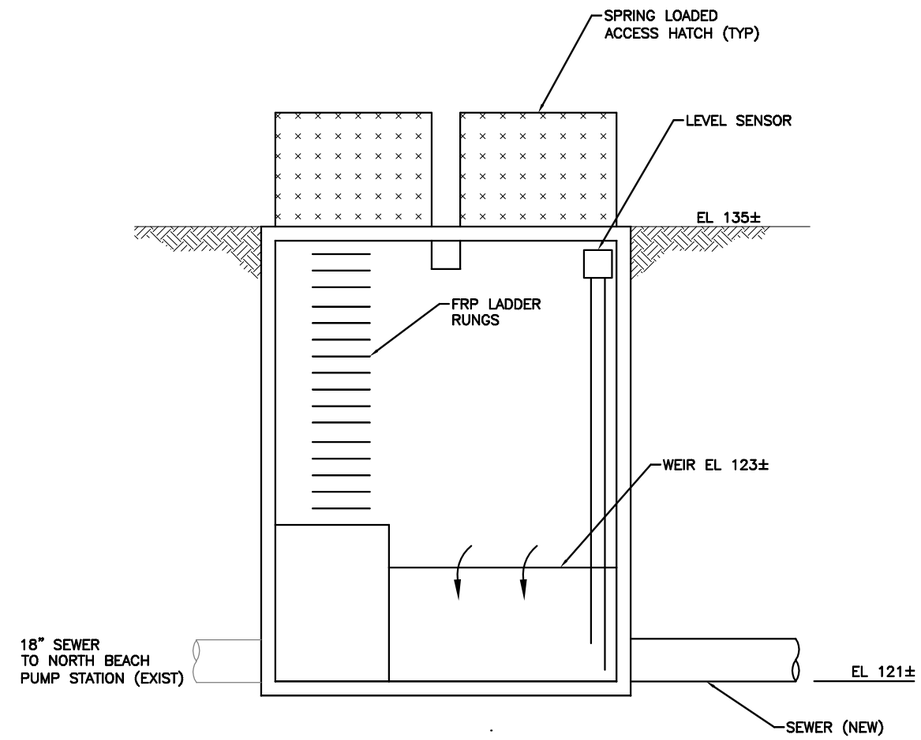
NOTES:

1. ELEVATIONS AND PIPE DIMENSIONS ARE APPROXIMATE AND SHOULD BE VERIFIED DURING FINAL DESIGN.



DIVERSION STRUCTURE PLAN
SCALE: 3/8" = 1'-0"



SECTION A
SCALE: 3/8" = 1'-0"

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AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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DRAWN: JLS
RECOMMENDED:
APPROVED:
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SCALE: AS NOTED
CONTRACT NO:

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FIGURE 6.2
DIVERSION STRUCTURE
PLAN AND SECTION

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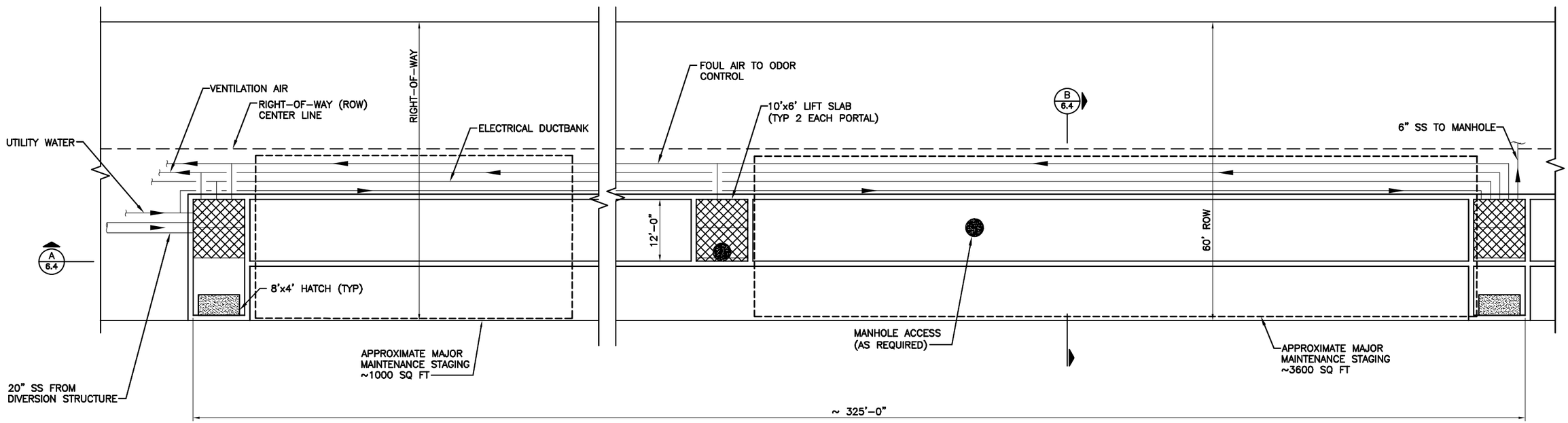

STORAGE PIPELINE PLAN
SCALE: 1" = 20'

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NORTH BEACH BASIN

FIGURE 6.3
STORAGE PIPELINE PLAN

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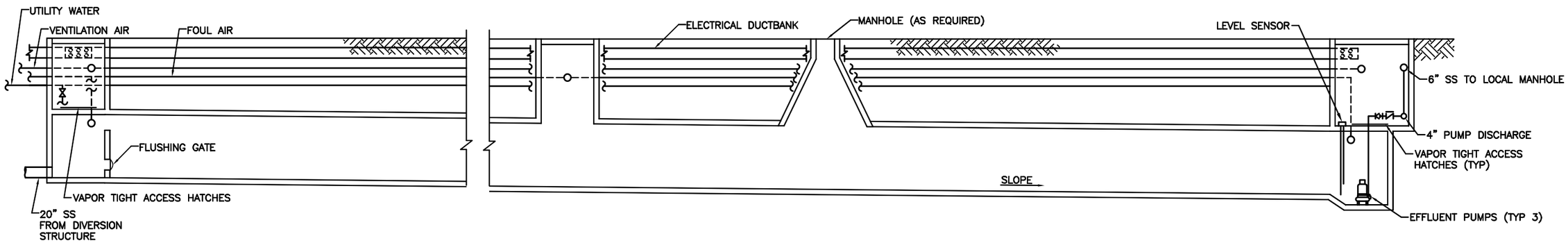
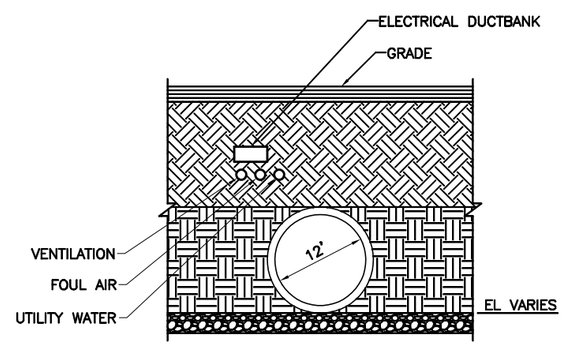


SECTION A 6.3
SCALE: 1" = 10'



SECTION B 6.3
SCALE: 1" = 10'

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NORTH BEACH BASIN

FIGURE 6.4
STORAGE PIPELINE SECTIONS

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the effluent end of the facility so that water will begin to collect around the effluent pumps. When the storage pipeline reaches the maximum water level, the influent gate will close.

When flows drop below the capacity of the North Beach Pump Station, the storage pipeline effluent pumps will be activated and the influent gate opened. Three submersible pumps located in the sump will lift stored flows back into the sewer system via a 6-inch force main to a local manhole. The minimum pumping rate will be 160 gpm to drain the pipeline in a maximum of 24 hours. If the combined sewer flow rate and pumped storage flow rate exceed the capacity of the North Beach Pump Station, flows will overtop the weir in the diversion structure and be recirculated to the storage pipeline.

After the storage pipeline empties, an automated flushing system will be used to remove solids. The flushing gate will be closed and utility water will fill a portion of the pipeline upstream of the gate. Once the water level reaches a certain level, the gate will open and discharge the flushing water. The flushing water will be sent through the pipeline, scouring the solids on the pipeline floor. After each flush, the water will be collected in the sump of the pipeline and pumped by the submersible pumps. The same force main used to pump stored flows will convey the flush water from the pipeline to the sewer system.

Access to the portals and storage pipeline will be through lift slabs and hatches. The upstream and downstream portals will have ladders or additional access equipment for routine maintenance. The portals will be isolated from the storage pipeline and ventilated as required to allow for routine operations and maintenance, such as level sensor calibration and pump exercising.

The access hatches would be embedded into large, concrete removable panels that could be lifted by boom truck or crane to allow for infrequent repairs or manual cleaning. Intermediate access points would also be provided for life safety equipment access to support long-term maintenance activities.

6.1.2.3 Ancillary Equipment Facility

The ancillary equipment facility for this approach, shown in Figure 6.5, contains the odor control system, mechanical equipment, and electrical equipment to support the storage pipeline. The exterior dimensions of the ancillary equipment facility are approximately 40 feet long by 20 feet wide. The facility is one-story maximum as allowed by Seattle Municipal Code. The facility is located to provide adequate access to facilities on the North Beach Pump Station site and minimize its visual presence.

The odor control system consists primarily of a carbon adsorption scrubber vessel, mist eliminator, and fan. Additional instruments and smaller components would also be required, but are not considered major equipment. The ventilation rate would be two air changes per hour (ac/hr) or maximum fill rate (5.5 mgd), whichever is greater, to control odors. There are also provisions, including a variable speed drive for the odor control fan and bypass ductwork, for six ac/hr to bypass the carbon scrubber and to facilitate manned entry into the storage facility. The odor control system is directly connected to the storage facility with buried corrosion-resistant ductwork or piping (PVC or fiberglass ductwork). Treated-air discharge ductwork would be routed to a location and height on the North Beach Pump Station site as determined during final design.

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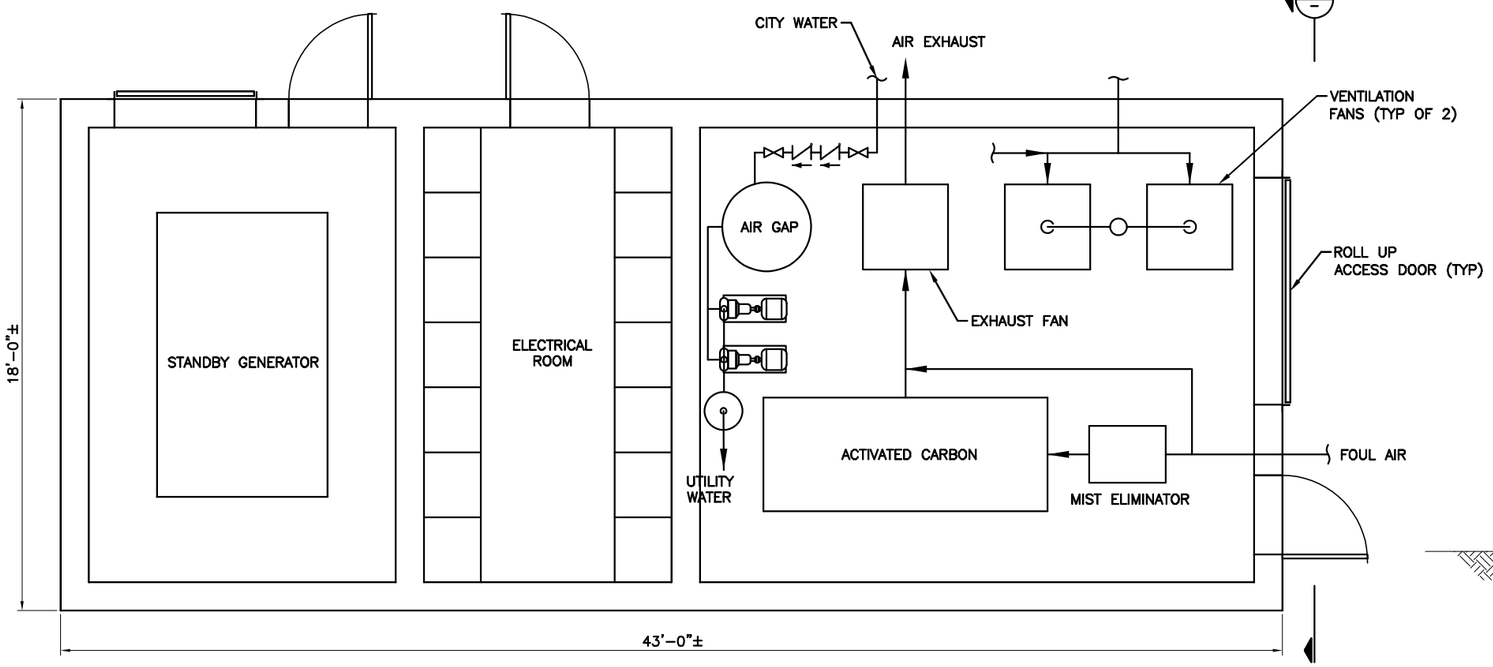

ANCILLARY EQUIPMENT FACILITY
SCALE: 3/8" = 1'-0"

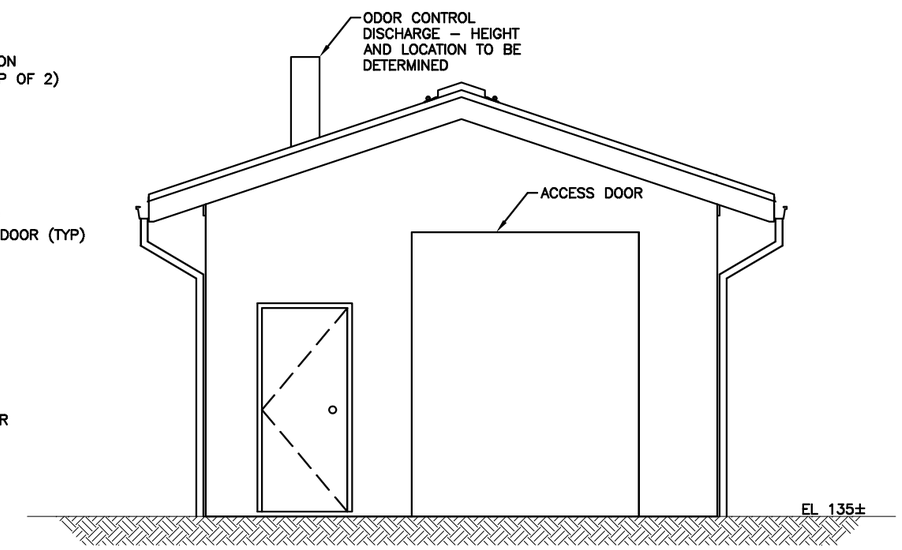

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FIGURE 6.5
ANCILLARY EQUIPMENT FACILITY
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The building also houses HVAC equipment for the ancillary equipment facility and the storage pipeline portals. The ventilation rate for the occupied spaces would be 12 air changes per hour (ac/hr) continuously.

To provide water for the flushing system and other facility needs, water drawn from a new service water line is be routed through an above-grade backflow preventer and air break tank as required by health codes. The air break tank is a 500-gallon reservoir inside the ancillary equipment facility. Utility water pumps would draw from the reservoir and pump the water into a hydropneumatic tank to pressurize the utility water system.

6.1.2.4 Site Improvements

6.1.2.4.1 Access to Proposed Facilities

Access to the storage pipeline is from the right-of-way on Triton Drive NW and NW Blue Ridge Drive. Access hatches for routine maintenance are located as far to the edge of the right-of-way as possible. Moving as far from the traveled roadway lanes as possible will facilitate safe access and minimize street closures. All access hatches would be rated for HS20 loading. Removable lifting slabs are configured in other areas of the right-of-way for less frequent maintenance activities. Depending on the final location of the lifting slabs, these maintenance activities would require partial or full closure of the roadway.

The road alignment and configuration should provide the space required and safe setbacks for maintenance access to the storage pipeline. The hatches and surrounding space would be marked for King County vehicles only.

The North Beach Pump Station site has an existing access road on the west side of the site. This alternative uses a portion of this area for the ancillary equipment facility, cutting off access to the north side of the pump station. A new access road would be constructed on the east side of the North Beach Pump Station to allow access to the diversion structure and north side of the ancillary equipment facility and North Beach Pump Station.

6.1.2.4.2 Revisions to the Existing Site

The entire North Beach Pump Station site would be fenced with restricted access both during construction and after project completion. The site is currently fenced on all sides; this existing fence would be replaced or restored after construction.

Stormwater control and treatment is required per the Seattle Municipal Code. Stormwater bioretention is to be placed around the site adjacent to paved surfaces and runoff will be directed to these locations for treatment prior to discharge to the existing storm drain system in the right-of-way. Irrigation controllers and irrigation lines to stormwater bioretention areas and perimeter planting areas would be established to facilitate plant establishment. Stormwater requirements are discussed in more detail below.

The existing rockery retaining wall along the eastern property boundary may be revised to facilitate site grading and construction. The retaining wall would likely be replaced. The replacement could be constructed of concrete or rock and would range in height between 3 and 5 feet similar to the existing.

6.1.2.4.3 Right-of-Way Improvements

The right-of-way in the project area will be repaved following construction to meet current SDOT pavement and street restoration requirements. Applicability of the following codes would be verified during final design:

- Development projects must provide full street improvements (Ordinance 122615 Sidewalks Improvement Initiative).
- Pavement removal and restoration in the right-of-way must conform to SDOT Director's Rule 5-2009.
- Any new landscaping must be in accordance with City of Seattle standards.
- Stormwater requirements must conform to Seattle Department of Planning and Development Director's Rule 17-2009 (SMC Chapters 22.800 – 22.808).

Protection of existing utilities is addressed in Section 6.2.

6.1.2.4.4 Stormwater Requirements

Due to improvements both within the right-of-way and on a parcel, if implemented this alternative will be classified as a "Joint Project" under Seattle Municipal Code, requiring that both parcel-based and roadway stormwater requirements be met (SMC 22.805.070). The area of impact for the proposed alternative includes more than 7,000 square feet of new or replaced impervious surface. Therefore, for site stormwater control, according to the November 2009 Directors' Rules for the Seattle Stormwater Code (SMC Chapters 22.800-22.808), runoff from the site will require water quality treatment. The design water quality treatment volume is to be equal to 91 percent of the total volume of the simulation period using an approved continuous model (SMC 22.805.090.B1.a).

The site discharges to a storm drainage system that drains to Puget Sound, which is classified as a designated receiving water and will not require the project to implement flow control.

This location is not designated as "capacity-constrained," which would require peak flow control (SMC 22.805.080.B4). However, as a "large" project (replacing 5,000 square feet or more of impervious surface), this project would require an analysis of the downstream system within 1/4-mile of the site to ensure sufficient capacity of the drainage system (SMC 22.805.020.I). Should the downstream system be determined to have insufficient capacity for the peak flow with a 4-percent annual probability (a 25-year recurrence interval), peak flow control or improvements to the drainage system may be necessary.

This alternative will implement green stormwater infrastructure BMPs to the maximum extent feasible (SMC 22.805.020.F), including, but not limited to, the use of permeable surfacing and bioretention for water quality treatment. Under the City's current standards for design of low impact development (LID) concepts, the size of the treatment facility will be based on the percentage of existing impervious surface and on the technology used.

6.1.2.4.5 Landscaping

Existing shrubs and grass would be removed due to construction. There are no large trees in the construction area.

Areas disturbed by construction would be replanted with drought-tolerant or native planting, or both, as developed during final design. Landscaping will be in accordance with City of Seattle standards and the County will work with the community to develop the landscaping plan, as this area is a viewshed for the residences. Temporary irrigation systems would be employed during the plant establishment period (typically 1 to 2 years) to reduce plant mortality.

6.1.3 Process Flow

This section describes how the North Beach CSO control facilities will operate during normal flow and peak wet-weather events after the proposed changes.

6.1.3.1 Normal Flow Description

Figure 6.6 is a schematic of normal flow operation. Normal flow is defined as flow up to 3 mgd, which is the capacity of the North Beach Pump Station. Normal flows from the North Beach Basin will pass through the diversion structure to the North Beach Pump Station. All flow will be conveyed to the Carkeek Pump Station and, ultimately, the West Point Treatment Plant.

6.1.3.2 Peak Wet-Weather Flow Description

Figure 6.7 is a schematic of peak wet-weather flow operation. Peak wet-weather flow is defined as flow greater than 3 mgd, which exceeds the capacity of the North Beach Pump Station. Peak wet-weather flows from the North Beach Basin will enter the diversion structure, which will send 3 mgd through to the North Beach Pump Station for conveyance to the Carkeek Pump Station.

All flow greater than 3 mgd will overflow a weir in the diversion structure and flow by gravity to pipeline storage. If the capacity of the influent pipe (approximately 6.6 mgd) or pipeline storage (230,000 gallons) is exceeded during the peak wet-weather event, overflows will occur at the existing outfalls. When the capacity of pipeline storage is exceeded, an isolation gate at the inlet will be closed to prevent flooding through the pipeline storage access portals.

At the conclusion of the peak wet-weather event, when flows in the CSS subside to less than 3 mgd, effluent pumps will drain the pipeline. The pumps will be sized to drain the storage pipeline in less than 24 hours (firm capacity). Should wastewater flows in the CSS combined with storage effluent exceed the capacity of the North Beach Pump Station, the excess flow will overflow the weir at the diversion structure and recirculate through storage.

6.1.3.3 Process Flow Diagram

Figure 6.8 shows a process flow schematic of the North Beach CSO control system.

Instrumentation and controls strategies will be developed during final design of this project. The SCADA system will provide the operator with applicable control set points and will generate level alarms when the storage facility approaches and reaches its fill level and when flows overtop weirs. Appropriate control actions will be implemented for the following situations:

- Power failure and restore.
- Communications failure and restore.
- PLC self-diagnostics alarms and restore.

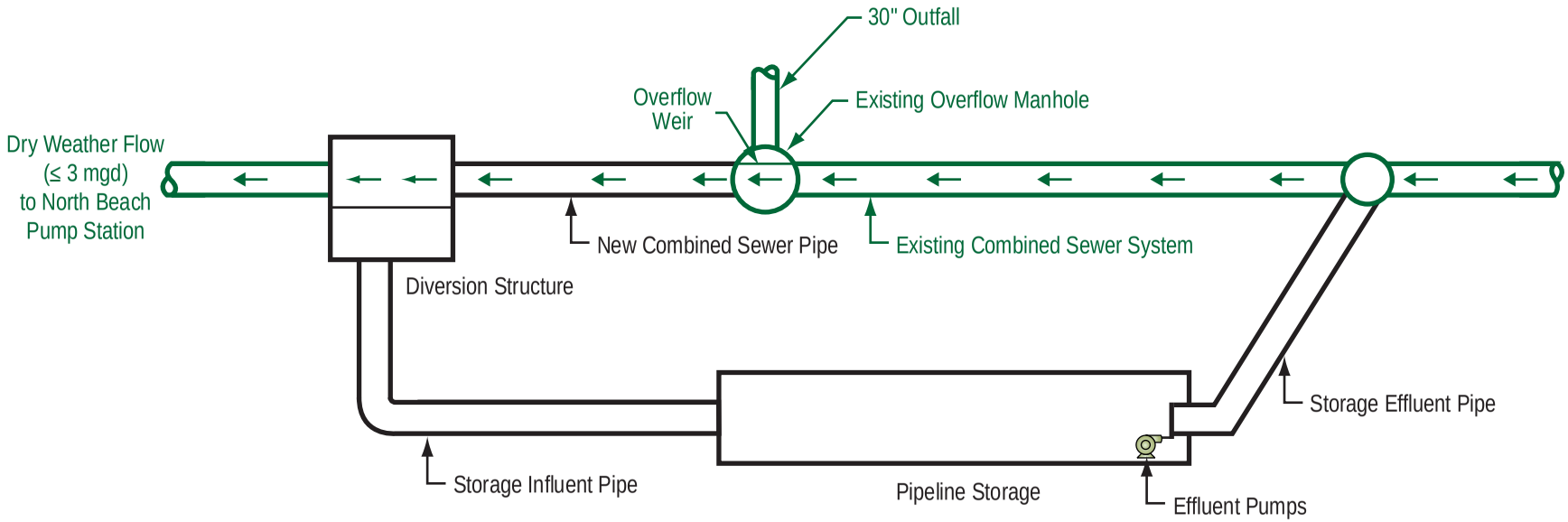

Figure 6.6
AVERAGE DRY-WEATHER FLOW SCHEMATIC

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Figure 6-6.ai

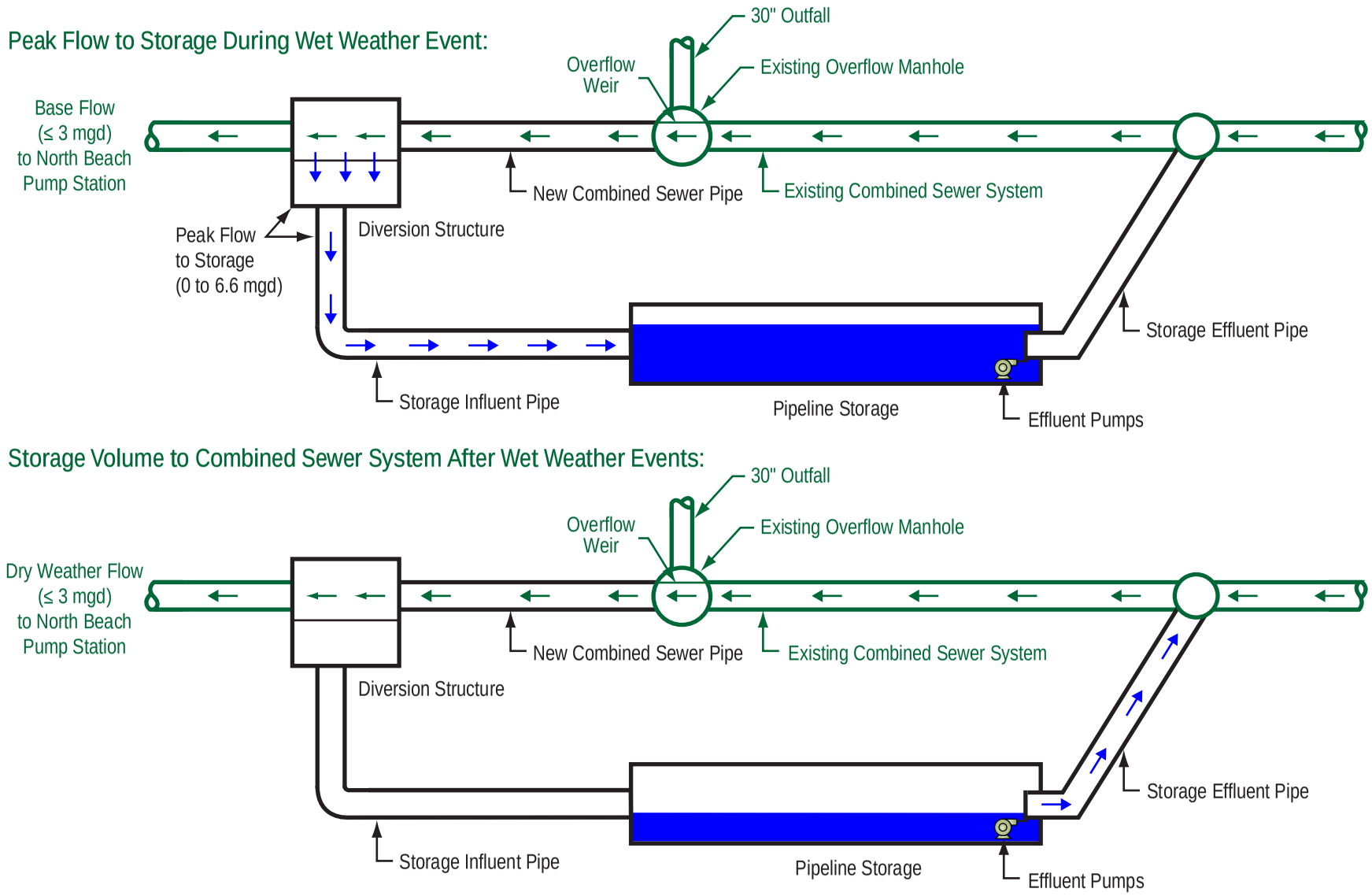

Figure 6.7
PEAK WET-WEATHER FLOW SCHEMATIC

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Figure 6-7.ai

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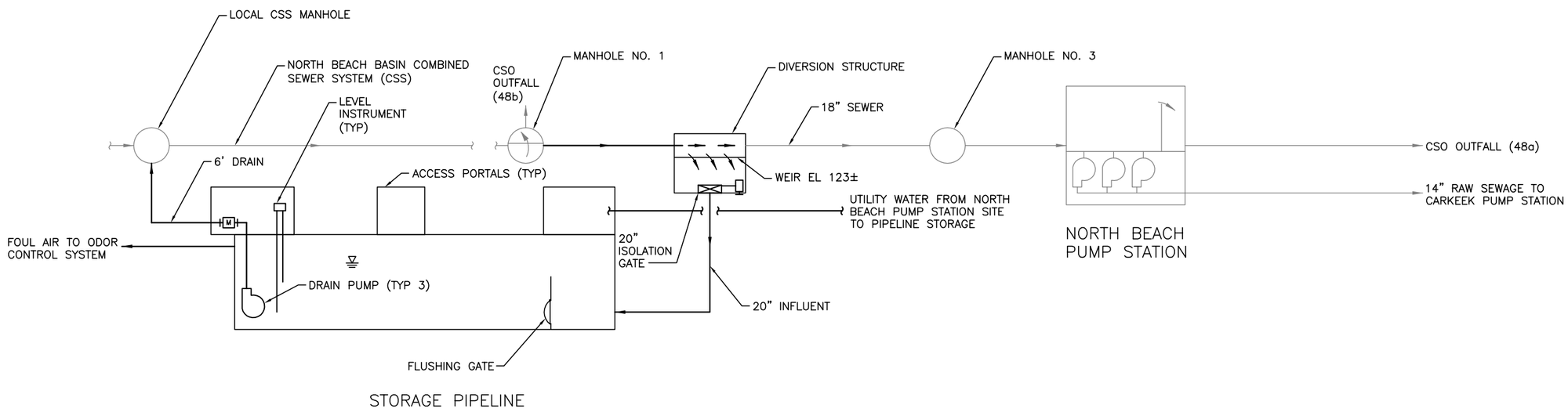

PROCESS FLOW DIAGRAM
SCALE: NTS

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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DRAWN: JLS
RECOMMENDED:
APPROVED:
CHECKED:
SCALE: NONE
CONTRACT NO:

King County

DEPARTMENT OF NATURAL RESOURCES & PARKS
NORTH BEACH BASIN

FIGURE 6.8
PROCESS FLOW DIAGRAM

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- Level measure calibration, out of range (high and low), and restore.
- Set point entry range checking.

6.1.3.4 Hydraulic Profile

The hydraulic profile of the North Beach CSO control system is shown in Figure 6.9.

6.1.4 Facility Sizing

Major project dimensions and sizes are provided in Table 6.2. Additional details of the proposed facilities can be found in Figures 6.2 through 6.5.

Table 6.2 North Beach Basin CSO Facility Sizing

Facility Component	Design Criteria[1]
Diversion Structure	
Structure Dimensions	12 ft x 8 ft
Structure Depth	17 ft
Weir Length	8 ft
Pipeline Storage	
Diameter of Influent Pipe	20 in
Pipeline Volume	0.23 MG
Pipeline Length	325 ft
Pipeline Diameter	12 ft
Number of Cells	1
Floor Slope	1%
Minimum Freeboard	2 ft
Number of Drain Pumps	2 duty + 1 standby
Drain Pump Type	Submersible
Drain Pump Capacity	80 gpm each
Diameter of Effluent Pipe	6 in
Maximum Time to Drain Storage	24 hrs
Access	Every 200 ft (minimum); outside right-of-way
Equipment Materials	Corrosion resistant (304/316 SS or FRP)

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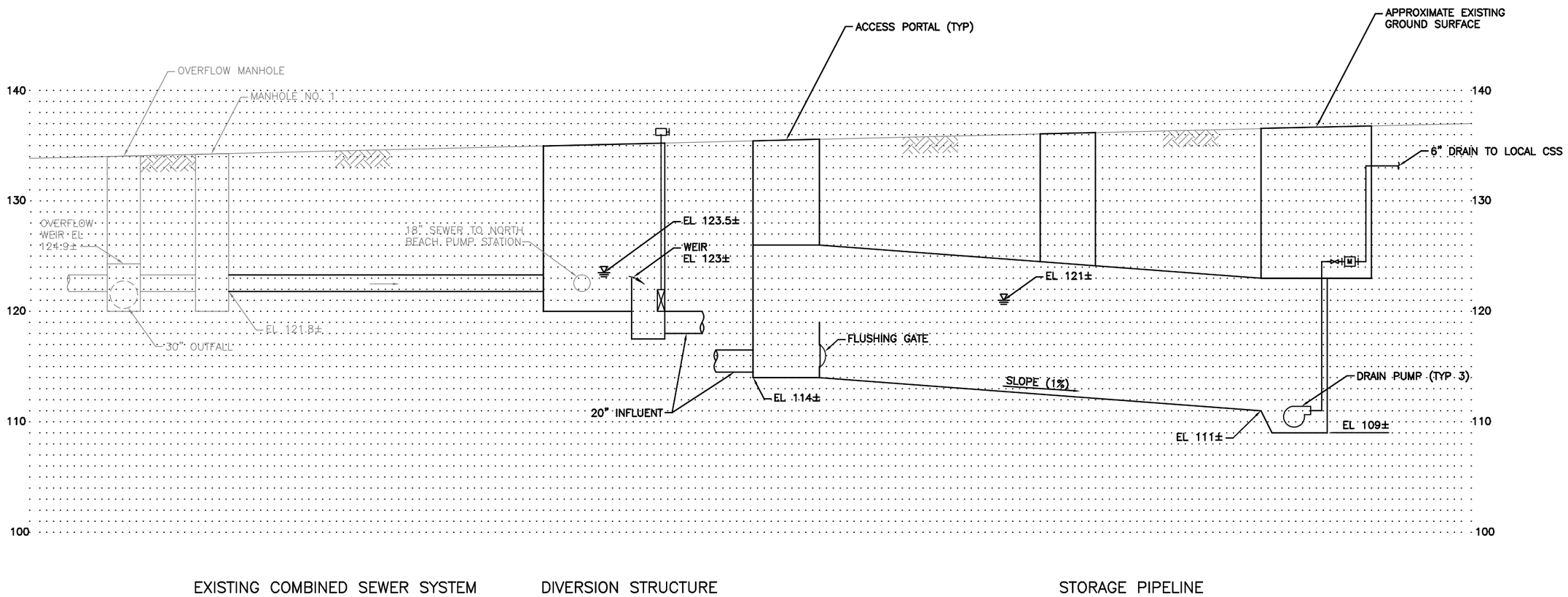
GENERAL NOTES:

1. ALL EVELVATIONS BASED ON METRO DATUM.
2. WATER SURFACE ELEVATIONS BASED ON MAXIMUM CSO FLOW (6.6 MGD) OR VOLUME (230,000 GALLONS).



HYDRAULIC PROFILE
SCALE: H = NTS
V = 1" = 10'

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

No.	REVISION	BY	APP'D	DATE

DRAFT

DESIGNED: KWH
DRAWN: JLS
RECOMMENDED:
APPROVED:
CHECKED:
SCALE: AS NOTED
CONTRACT NO:

King County

DEPARTMENT OF NATURAL RESOURCES & PARKS
NORTH BEACH BASIN

FIGURE 6.9
HYDRAULIC PROFILE

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Table 6.2 North Beach Basin CSO Facility Sizing (continued)

Facility Component	Design Criteria[1]
Ancillary Equipment Facility	
Odor Control	Peak air displacement rate (5.5-mgd peak-flow to storage) or 2 ac/hr (whichever is greater)
Air Treatment	Activated carbon; 1 pass; 50 fpm; constant speed fan/blower
Occupied Space Ventilation	12 ac/hr
Standby Generator	Total estimated load; 80% of nameplate rating at full load; diesel w/ 24 hr capacity
Backflow Preventer	4 in
Air Gap Tank	500 gal
Number of Utility Water Pumps	2 duty
Utility Water Pump Type	End-suction centrifugal
Utility Water Pump Capacity	80 -100 gpm
Facility Footprint	40 ft x 20 ft

Notes:
1. Design criteria are preliminary and may be revised during final design.

6.2 ENVIRONMENTAL IMPACTS

The project would reduce the volume and frequency of untreated overflows to Puget Sound, enhancing water quality and wildlife habitat. Elements evaluated during initial environmental analyses included: groundwater and surface water, earth resources, land use, recreational resources, utilities, transportation, odor and air quality, noise, vibration, cultural resources, endangered/ threatened species and habitats, and prime or unique farmland. The County prepared a SEPA environmental checklist and issued a Determination of Nonsignificance (DNS) consistent with WAC 197-11 on April 28, 2011. The SEPA DNS and environmental checklist are provided in Appendix D as an appendix to the SERP report.

6.2.1 Existing Ecosystems

The primary project area consists of a parcel on Triton Drive NW and right-of-way along Triton Drive NW and NW Blue Ridge Drive. The parcel, owned by King County, includes the North Beach Pump Station and ancillary support facilities.

Documentation provided in Appendix D describes existing environmental conditions in the project area.

6.2.1.1 Wetlands

According to the City of Seattle Critical Areas Map (Figure 3.7) there are no wetlands on or immediately adjacent to the project sites.

6.2.1.2 Streams and Ditches

The City of Seattle Critical Areas Map (Figure 3.7) indicates a piped stream crossing though the project area near the western edge of the North Beach Pump Station parcel. This is the pipe that the existing overflow manhole discharges into. It is anticipated that there would be no need to relocate or modify this piped stream due to construction of the proposed facilities.

There is a ditch along the southeast side of the NW Blue Ridge Drive right-of-way. The ditch carries stormwater from residential development and other surface water runoff to existing storm drainage features.

Street frontage improvements required for this project could permanently impact the surface water ditch. The ditch would be reconfigured or replaced to convey stormwater runoff.

6.2.1.3 Fish Resources

There are no fish bearing streams in the vicinity of the project. This project would limit combined sewer overflows to Puget Sound, which should enhance water quality and wildlife habitat. Therefore, no negative impact on fish resources is expected.

6.2.2 Groundwater and Surface Water

A preliminary geologic/geotechnical evaluation (Shannon & Wilson, Inc., August 2010) of the North Beach alternatives is provided in Appendix A. As described in Chapter 3, the evaluation included an assessment of the geologic conditions in the project area and information on the geotechnical limitations. A detailed geotechnical evaluation will be conducted during final design.

The depth to groundwater is unknown but it is probably perched close to the ground surface since the surface water in this basin is focused toward the project area.

Since the proposed storage pipeline will be approximately 25 feet below ground surface, it is assumed that groundwater will be encountered during excavation for the pipeline. Dewatering flow will most likely be discharged through the existing sewer or storm drain systems. An NPDES or Industrial Waste Discharge Permit would be obtained, as required.

Puget Sound lies to the north of the project area. However, no impact on the Sound is expected. The project will have a long-term beneficial impact on water resources since it will achieve the CSO control objective of allowing no more than one untreated event per year on average.

6.2.3 Earth Resources

6.2.3.1 Soils

Impacts on soils during construction of the CSO facilities will include erosion from excavation activities. A majority of the soils excavated for the storage pipeline would be hauled off-site to approved locations.

6.2.3.2 Geologic Hazards

The City of Seattle Critical Areas Map (Figure 3.7) shows no geologic hazards on or near the site.

6.2.3.3 Soil and Groundwater Contamination

According to the City of Seattle Critical Areas Map (Figure 3.7) there are no known contaminated areas in the vicinity of the project.

6.2.4 Land Use

The right-of-way within the proposed construction area will be temporarily impacted during construction activities. No permanent impacts on land use are anticipated.

6.2.5 Recreational Resources

The project site is immediately south of Blue Ridge Park. Currently, the site is used by the Blue Ridge neighborhood as a private park.

Construction of the facilities would impact access to the park by recreational users. Parking immediately adjacent to the park will not be available. Pedestrian access would likely be routed along the north edge of the NW Blue Ridge Drive right-of-way.

There would be no long-term impact on recreational resources.

6.2.6 Utilities

Existing utilities at the North Beach Pump Station site and in the Triton Drive NW and NW Blue Ridge Drive right-of-way may need to be relocated as part of facility construction and improvements to the property. Existing sewer, drainage, power, gas, and telecommunications services would be maintained through temporary and/or permanent relocation of utilities as required by the final design.

6.2.7 Transportation

There will be temporary impacts on traffic and access during construction within Triton Drive NW and NW Blue Ridge Drive. Potential delays and detours during construction could have temporary, indirect impacts. Longer traffic queuing times are not anticipated.

Temporary road closures would occur on Triton Drive NW and NW Blue Ridge Drive within the construction area for construction of the influent pipe, storage pipeline, effluent pipe and utilities

required for the storage pipeline. There are nearby alternate routes available to Triton Drive NW from the west and NW Blue Ridge Drive from the east. The length of closure is anticipated to be 12 to 18 months. The closure would also require temporary relocation of the Metro bus stop adjacent to the North Beach Pump Station site and re-routing of the bus. In addition to road closures and detours during construction, there will be increased construction traffic to and from the project site. The peak number of daily construction trips would occur during excavation and backfilling of the storage pipeline and asphalt paving and are estimated at approximately 30 trips per day. During other phases of construction, the number of daily construction trips is likely to be less than 30 trips per day. It is likely that the general construction traffic would have little impact on the level of service in the area.

During construction, the contractor would be required to submit a traffic control plan detailing the haul route for construction traffic. Additional traffic control measures, such as warning signs and flaggers, may be a requirement of the haul route approval.

Measures to reduce or control transportation impacts by the completed project would not be required.

6.2.8 Odor and Air Quality

Air quality impacts from earth-moving activities during construction are typical for large construction projects. BMPs would be implemented for dust control, including street sweeping, watering exposed soil surfaces, and covering soil stockpiles to help minimize the amount of fugitive dust and particulate pollution to the surrounding areas. Other similar BMPs might be employed by the contractor to minimize dust. Construction activities often concentrate heavy equipment powered by gas or diesel engines in a particular location. Air pollution from engines could increase during certain activities, such as queuing trucks for loading and offloading of materials, or during heavy excavation. Provisions to limit idling of mechanical equipment typically are included in King County projects and would be employed during construction to minimize the amount of air pollution generated from gas- and diesel-engine-driven machinery, as well as to limit greenhouse gas effects.

Long-term impacts (continuous emissions) from odors associated with operation of the facilities would be minimized and mitigated through several design features. Odor generation in the new diversion structure would be minimized by limiting turbulence and keeping the hatches to the structure closed. Odors generated at the storage pipeline would be minimized through the automated flushing system installed to clean settled solids from the pipeline after each storage event. Periodic manual wash-down of the accessible portions of the pipeline walls could be used to minimize odorous gas formation in the pipeline further; however, the current design prioritizes the automated flushing system. Any odors generated within the pipeline from stored wastewater or solids not removed from the wash-down system would be mitigated through operation of the planned odor control facility.

Instrumentation to measure inlet and outlet gas concentrations at the odor control facility would help determine the functional performance and life remaining on the carbon filter media to more accurately schedule carbon replacement. Active monitoring ensures that foul odors are controlled to the extent possible by the installed system.

6.2.9 Noise

Noise impacts during construction would be mitigated by contract documents requiring compliance with noise regulations and the local jurisdictional codes. Variances may be obtained if the schedule requires working additional hours beyond current ordinance allowances.

Equipment operation after the facility is in operation would produce little if any noticeable noise. Pumps in the storage pipeline are submersible and would not produce noticeable noise. All functional noise controls, such as insulation under access hatches, would be implemented so that noise levels at the property line would not exceed limits established for the site's current zoning.

In this alternative odor control equipment, pump motor starters and a standby generator are housed in a facility on the North Beach Pump Station site. Additional noise mitigation measures such as louver baffles, acoustical shrouds, and exhaust stack silencers would be included as necessary to provide minimum noise conditions at the site's property line. Additional measures such as cabinet acoustical insulation or noise-suppressing insulation inside the structure may be required if noise levels at the site became unacceptable to the adjacent residents.

6.2.10 Vibration

Vibration during construction of the facilities would be monitored at nearby residences. Standards of care would be applied and specified in the contract documents.

During normal operation of the storage pipeline and completed facility equipment, vibrations would be localized to the degree that only those persons standing near the equipment enclosure or on hatches directly adjacent to equipment would notice vibrations. Pumps currently sized for this facility are not large enough to create vibration issues, particularly given the mass of the new storage facility. Odor control equipment and standby generator would be fitted with anti-vibration components in the equipment anchoring systems specified for the project.

6.2.11 Cultural Resources

A review of known and potential cultural, archaeological, and historic resources within the North Beach Basin has been conducted. There are no known archaeological sites or historic structures on or near the proposed project site. Based on site characteristics and location, the project area has a low probability of containing archaeological resources.

6.2.12 Endangered/Threatened Species or Habitats

There are no threatened or endangered species known to be on or immediately adjacent to the project site. Project construction would be approximately 200 to 300 feet south of Puget Sound. Long-term effects of the project would be beneficial to listed species in Puget Sound, as water quality would be improved with a reduction in combined sewer overflow events.

6.2.13 Prime or Unique Farmland

There is no farmland within the project area, so there would be no impacts on prime or unique farmland.

6.3 DESIGN LIFE

The design life of the storage facility is based on a 50-year life cycle, and the primary equipment design life is based on a 20-year life cycle. Routine maintenance of the facility and replacement of equipment would occur as needed to obtain the design life.

6.4 RESIDUALS MANAGEMENT

The proposed storage pipeline is designed with a flushing gate so that solids will be cleaned out of the pipe following a CSO event and do not accumulate in the storage pipe. Utility water would also be provided at the diversion structure to flush the influent pipeline to storage. Therefore, sludge management should not be a concern here. The storage pipeline will be designed to allow for access and cleaning by O&M staff, should additional cleaning be needed.

6.5 ABILITY TO EXPAND

It is not anticipated the North Beach Basin will experience any significant demographic or land use changes in the future. The area is considered built-out and population levels are anticipated to remain relatively constant. The need for this project is not due to anticipated population growth or increase in sewered areas (connecting on-site systems to sewer system); therefore, it is not anticipated that future demographics, land use, or population growth will increase the storage volume required to meet current Ecology requirements.

In the event that the facility is undersized, the primary option to provide additional CSO reduction is inflow and infiltration reduction measures, including a focus on the City of Seattle's Residential RainWise Program.

Due to the age of the collection system in the North Beach Basin, it is likely that many locations experience inflow and infiltration; the majority of the inflow and infiltration is likely occurring on private property.

The City's Residential RainWise Program aims at reducing the amount of stormwater runoff (inflow) from private properties into the sewer collection system. By removing residential stormwater connections from the combined system, the volume and flow rate of wet-weather peak flows are reduced. This reduction increases the capacity of the existing facilities within the basin.

For the City-owned collection sewers, additional investigation would be required to identify and locate points of infiltration in the system. It is difficult to predict the level of reduction that will be achieved with infiltration reduction projects, and the projects are unreliable in achieving the reductions of flow required for CSO control. Other combined sewer agencies across the nation, including many in the Northwest, consider infiltration reduction a good asset management practice but do not rely upon it to achieve compliance with CSO reduction requirements. Infiltration reduction is usually a secondary benefit of rehabilitating the pipe.

6.6 O&M AND STAFFING NEEDS

The recommended alternative would need regular maintenance to ensure that the design life of the facility is met and proper operation occurs. Table 6.3 shows the types of O&M activities that could occur, the frequency of each activity, and staffing requirements to perform those activities.

Key issues for O&M include the following:

- Monitor the system remotely during a wet-weather event and for equipment condition during dry weather.
- Design the system for ease-of-operations and maintenance, including post-wet weather event cleaning.
- Design so that maintenance staff will not need to routinely enter the storage pipeline.
- Provide provisions for entry to storage pipeline and maintenance, if needed.
- Visually integrate the ancillary facility with the surrounding neighborhood.

6.7 DESIGN GUIDELINES

This section summarizes the guiding principles that will be used for final design of the proposed alternative.

6.7.1 Site Design

The finished design of the site must provide for adequate traffic movement and safety while providing adequate access, working space, and parking for maintenance of the facilities. Minimizing impact on existing land uses is an important design parameter in the final design of the alternative.

6.7.2 Traffic

It is important to minimize lane and road closures and impacts on traffic during construction.

Once the facility is completed, King County O&M staff will periodically be required to visit the site. Disruption to traffic should be minimized without compromising King County's ability to effectively operate and maintain the facility.

6.7.3 Structural/Geotechnical

Shoring for earthwork should be of a type appropriate for the available space and other site conditions. Shoring for earthwork must adequately support the sides of the excavation and protect adjacent areas and structures.

Anticipated groundwater levels would require dewatering during construction of the pipeline, piping and diversion structure. The structural design of the storage pipeline would also need to counteract buoyancy due to groundwater while avoiding or minimizing the need for piles or other foundation supports.

Table 6.3 Operations and Maintenance Activities

Component	Activity	Frequency	Staff Needed	Special Equipment Needed
Diversion Structure				
Access Hatches	Inspect hatches for wear and tear from surface by opening access hatches and visually assess conditions; replace worn or damaged components.	Annually	2	Repair components from manufacturer/ supplier
Gates	Grease riser stems, adjust seats, etc. depending on type of gate.	Annually or per Manufacturer recommendations	2	None
Gates	Replace gates.	As needed	6	Confined space entry equipment
Operators/Actuators	Grease riser stems, packing, seats, etc., depending on type of operator/actuator.	Annually or per manufacturer recommendations	2	None
Level Gauges	Inspect and take readings.	Weekly	1	None
Level Gauges	Calibrate.	Annually	1	None
Level Gauges	Repair/Replace gauges.	As needed	2	None
Pipeline Storage				
Access Hatches	Inspect hatches for wear and tear from surface by opening access hatches and visually assess conditions; replace worn or damaged components.	Annually	2	Repair components from manufacturer/ supplier
Flushing Gate	Inspect flushing gate for wear and tear from surface by opening access hatches to view and visually assess conditions.	Monthly	2	None
Flushing Filling System	Inspect for damage to filling system; replace worn or damaged components.	Monthly	2	Repair components from manufacturer/ supplier
Storage Pipeline	Supplemental manual cleaning.	Every 3 to 5 years	10	Boom truck, Vactor™ truck, confined space entry equipment
Storage Pipeline	Flushing after CSO event.	~10 times per year	2	None

Table 6.3 Operations and Maintenance Activities

Component	Activity	Frequency	Staff Needed	Special Equipment Needed
Storage Pipeline	Surface inspection – open hatches and inspect visible areas with surface-supplied lighting to monitor for debris accumulation.	After each event for first year. Thereafter, annually at a minimum.	2	Surface direction lighting
Storage Pipeline	Manned structural inspection – perform manned entry into pipeline area to inspect concrete structure.	10-year cycle/post-seismic event	5	Confined space entry equipment, fire department standby
Storage Pipeline	Survey of existing structure for settlement.	10-year cycle/post-seismic event	4	Survey crew and equipment
Pumps	Routine maintenance – bearings, sensors – can be done at surface.	Semi-annually	3	None
Pumps	Pump Start/Stop cycling; operate pumps manually to ensure start/stop.	Monthly	2	None
Pumps	Clearing rags, blockages; can be done at surface.	As needed	3	None
Pumps	Slide rail – inspect for wear and tear.	Every 10 years/when manned structural inspection is performed	5	Confined space entry equipment, fire department standby
Valves	Grease riser stems, packing, seats, etc., depending on type of valves.	Annually or per manufacturer recommendations	3	None
Valves	Replace valves.	As needed	3	None
Gates	Grease riser stems, adjust seats, etc., depending on type of gate.	Annually or per manufacturer recommendations	3/5	None/confined space entry equipment
Gates	Replace gates.	As needed	6	Confined space entry equipment
Operators/Actuators	Grease riser stems, packing, seats, etc., depending on type of operator/actuator.	Semi-annually or per manufacturer recommendations	3	None

Table 6.3 Operations and Maintenance Activities

Component	Activity	Frequency	Staff Needed	Special Equipment Needed
Flow Meter	Inspect and take readings.	Weekly	1	None
Flow Meter	Calibrate.	Annually	1	None
Flow Meter	Repair/Replace gauges.	As needed	2	None
Level Gauges	Inspect and take readings.	Monthly	1	None
Level Gauges	Calibrate.	Annually	1	None
Level Gauges	Repair/Replace gauges.	As needed	2	None
Electrical Room				
Panels	Routine inspection and maintenance.	Semi-annually or per manufacturer	1	None
VFDs	Routine inspection and maintenance.	Semi-annually or per manufacturer	1	None
PLC	Routine inspection and maintenance.	Semi-annually or per manufacturer	1	None
MCC	Routine inspection and maintenance.	Semi-annually or per manufacturer	1	None
Motor Starters	Routine inspection and maintenance.	Semi-annually or per manufacturer	1	None
Standby Generator	Routine inspection and maintenance.	Semi-annually or per manufacturer	2	None
Standby Generator	Routine testing	Monthly	2	None
Mechanical Room				
Air Gap Tank	Visually inspect for leaks, corrosion and fouled contacts on instruments/floats.	Monthly	1	None
Air Gap Tank Filling System	Visually inspect for leaks, manually operate valves or system by hand-adjusting floats/level controllers.	Annually	1	None
HVAC	Belts and Bearings – Inspect and replace as needed.	Semi-annually or per manufacturer	1	None
Carbon Filter Media	Sample carbon for saturation; collect analytical sample for analysis by vendor/laboratory.	Semi-annually	1	None

Table 6.3 Operations and Maintenance Activities

Component	Activity	Frequency	Staff Needed	Special Equipment Needed
Carbon Filter Media	Inspect filter bed for crusting/fouling – use rake/hand tools to break up fouled surface (horizontal bed only).	Semi-annually or as indicated by pressure gauges across filter bed	1	None
Carbon Filter Media	Replace carbon media.	On 5-year intervals or as indicated by carbon testing results	3	Vactor™ truck, boom truck or lifting equipment if facility not equipped
Fan – Odor Control Fan	Belts and Bearings - Inspect and replace as needed.	Semi-annually or per manufacturer	1	None
Fan – HVAC	Belts and Bearings - Inspect and replace as needed.	Semi-annually or per manufacturer	1	None
Grease/Mist Eliminator	Remove fouled media filters and replace with clean filters; clean fouled filters off-site and store.	Semi-annually or as indicated by pressure gauges across filter bed	2	Flatbed truck to haul filters, lifting equipment if facility is not equipped
Pressure Gauges	Inspect all gauges and record readings.	Monthly based on visits to facility	1	None
Pressure Gauges	Repair/Replace gauges.	As needed	1	None
Fiberglass Ductwork	Visually inspect all ductwork for cracking or leaks.	Annually and after seismic events	1	None
Dampers	Visually inspect all dampers and actuators for damage or wear and tear.	Annually	1	None
Silencer	Visually inspect silencer for damage or wear and tear.	Annually	1	None

6.7.4 Stormwater Management

Stormwater design will follow the City of Seattle Stormwater Code for water quality treatment for runoff. The design water quality treatment volume will be equal to 91 percent of the total volume of the simulation period using an approved continuous model (SMC 22.805.090.B1.a). The stormwater design also will incorporate LID concepts to the extent feasible including, but not limited to, the use of permeable surfacing and bioretention.

6.7.5 Architecture/Landscaping

The ancillary equipment facility will be architecturally designed to be visually integrated with the surrounding neighborhood. Architectural consideration will be given to retaining walls, exhaust stacks, intake and exhaust plenum vaults, and other exposed above-grade features to ensure compatibility with the existing site's aesthetic characteristics.

Landscape design will be compatible with the surrounding neighborhood and park, will utilize native or drought-tolerant plants, and will minimize irrigation and maintenance requirements.

6.7.6 O&M and Facility Inspections

An important objective in the design of the project is for simple, reliable and safe operations and maintenance. This includes avoiding the need to routinely enter the storage pipeline to perform O&M activities by including a post-event flushing system and other design features.

The storage pipeline would be maintainable from access portals or the ground surface whenever possible, including the post-event solids removal activities. Access portals would be located so that O&M crews can access the equipment and storage pipeline, if needed.

Provisions for personnel and equipment to enter the portals and pipeline storage would be provided. For example, removable concrete panels would be incorporated into the design to allow large equipment to be placed inside or removed. Smaller access hatches would also be provided to allow access for routine operations and maintenance. Furthermore, the overall facility would be remotely monitored during operation to verify that mechanical systems are working properly.

Pumps would be used to drain the storage facility rather than draining it by gravity. When downstream capacity is available, the storage facility would drain at the maximum flow rate possible without overloading the downstream conveyance system. The pumps would be rail-guided submersible pumps to minimize the need for entry for maintenance.

The odor control system can assist in ventilation for maintenance activities as well as odor control. in this design the ventilation rate is 2 ac/hr to control odors, with provisions for 6 ac/hr with a bypass around the carbon scrubber prior to entry into the storage facility. Auxiliary portable ventilation equipment could be employed for infrequent entrance into the pipeline.

6.7.7 Reliability

The location of the site allows for filling of storage by gravity. Existing outfalls provide a relief point in the event that flow rates or volumes exceed the capacity of the storage pipeline and influent piping.

The odor control equipment, drain pumps, and other items requiring power are not considered critical to storing flows to prevent CSOs, since the storage pipeline would fill by gravity. Loss of power would prevent the storage facility from being drained by the pumps after an event; however, this would not prevent the sewer collection system from continuing to operate. Furthermore, it is anticipated that the CSO facility will only be used a few times a year and that the likelihood of back-to-back uses of the facility is very low. Although not considered critical, the design includes on-site standby power for reliability of some facility equipment such as the tank drain pumps, odor control systems, inlet control gates, and telemetry systems.

6.7.8 Effects of Sea Level Rise

In March of 2006, the King County Executive issued an executive order on Global Warming Preparedness directing all agencies to prepare for the affects of climate change including adaptation, mitigation and sequestration. The Wastewater Treatment Division is evaluating the effects of rising sea levels associated with climate change. Sea level rise (SLR) scenarios were developed by combining prediction of future SLR and storm surge from statistical analysis. The three main sources for the scenarios came from the University of Washington's Climate Impacts Group, Department of Ecology Report *Sea Level Rise in the Coastal Waters of Washington State* (2008) and *Response of Extreme Storm Tide Levels to Long-Term Sea Level Change* (C.E. Zervas, 2005).

To give a broad array of possibilities 1, 2, 10, and 100 year storm events were considered for each of the SLR scenarios. Table 6.4 shows the values used for possible future sea-level conditions with storm events.

Table 6.4 Puget Sound Sea-Level Rise Scenarios with Storm Surge

Sea-Level Rise Scenarios (Metro datum in ft.)	Storm Surge				
	No Storm	1 yr (1.48')	2 yr (2.27')	10 yr (2.79')	100 yr (3.19')
Current Conditions (Mean High High-Water)	105.36	106.84	107.63	108.15	108.55
Medium SLR 2050 (6")	105.86	107.34	108.13	108.65	109.05
Medium SLR 2100 (13")	106.44	107.92	108.71	109.23	109.63
Very High SLR 2050 (22")	107.19	108.67	109.46	109.98	110.38
Very High SLR 2100 (50")	109.53	111.01	111.8	112.32	112.72

No facilities associated with the CSO project are vulnerable to sea level rise scenarios. The lowest point vulnerable to SLR is the bottom of the storage pipeline at (Elevation 109.0 Metro) which will be designed for high groundwater conditions.

The outfall flow rate could be diminished under future SLR scenarios. This is being evaluated for the entire combined sewer system and adaptation plans will be evaluated under a separate project.

6.8 FEASIBILITY OF IMPLEMENTATION

Based on an evaluation of land use/permitting, environmental impacts, engineering, operations and maintenance, and community impacts, implementation of the proposed alternative appears to be feasible, with no identification of fatal flaws.

FINANCIAL ANALYSIS

This chapter includes financial information for the proposed CSO control alternative in the North Beach Basin - Alternative 1B – Pipeline Bottom-of-Basin Storage. The various components of the project costs are provided including: construction, engineering, property acquisition, and O&M. This chapter also provides life-cycle costs and project financing information.

7.1 CAPITAL COSTS

This section includes planning-level construction, engineering, property acquisition, and O&M costs for the proposed alternative in 2010 dollars. Estimated quantities are based on the conceptual design presented in Chapter 6.

7.1.1 Construction Cost Estimate

The planning-level cost estimate is based on cost curve data supplemented by quantity takeoffs. Cost curves were developed using data from the design and construction of similar facilities and/or using Tabula 2.0, the County's cost-estimating database. General contractor overhead and profit, estimating contingency, and allied costs (including engineering, legal, and administrative costs) were added to the construction cost estimate to develop total project costs.

The estimating contingency of 30 percent is derived from the cost estimate classification system defined by the Association for Advancement of Cost Engineering (AACE) International. Class 4 estimate accuracy ranges from minus 30 percent to plus 50 percent due to the preliminary nature of project data and engineering. The estimating contingency of 30 percent reflects the recommended standard contingency for the preliminary stage of the project.

Key cost factors include:

- Year: 2010.
- ENR CCI: 8645.
- AACE Cost Estimate Classification: 4.

Table 7.1 summarizes the construction cost estimate for the proposed alternative. A more detailed estimate is provided in Appendix E.

Table 7.1 Construction Cost Summary

Item	Description	Amount
Base Cost	Construction costs including contractor's overhead, profit, and general conditions.	$3,900,000
Construction Contingency	30%	$1,200,000
Total		**$5,100,000**

7.1.2 Project Cost Estimate

Table 7.2 summarizes the total project cost estimate including engineering, construction management, and County administrative costs.

Table 7.2 Project Cost Summary

Item	Description	Amount
Construction	See Table 7.1.	$5,100,000
Land/Easement	Temporary construction easement for staging.	$400,000
Street Use Fee		$350,000
Additional Costs	Tax, allied costs, permit fees and project contingency.	$4,000,000
Total		**$9,850,000**

7.2 OPERATION AND MAINTENANCE COSTS

The basis of O&M costs for the purpose of developing planning-level estimates and calculating life-cycle costs was developed using information supplied by the County (*South Sammamish Basin Conveyance Facility O&M Assumptions*, Brown and Caldwell, March 2002). Relevant information and assumptions in the memorandum include:

- ENR Construction Cost Index: 7341.
- Labor: $32/hr.
- Storage Pipeline, $/MG:
  - Cleaning: $6,600/yr.
  - Inspection: $6,600/yr.
  - Maintenance: $4,300/yr.
- Gravity Sewers: $1/LF/yr.
- Force Mains: $0.02/LF/yr.

- Ancillary Facilities:
  - One inspection time per week or 4 hours per week based on half the general maintenance and inspection required for regulator stations.

Based on the assumptions above and the conceptual design, approximately 650 hours per year is required for O&M. This estimate includes supplemental manual cleaning of the storage pipeline (assumed every 3 years) with O&M hours normalized over the life of the facility. The initial labor rate in 2014 is estimated to be $53 per hour. Table 7.3 summarizes O&M costs for the first year of operation. Subsequent years are escalated at approximately 3 percent per annum for the life-cycle cost calculations.

Table 7.3 O&M Cost Summary

Item	Annual Cost 2014 ($/yr)
Operations and Maintenance Labor (Tank, diversion structure, ancillary facilities)	$34,900
Electricity (ventilation, power)	$ 4,700
Chemicals (activated carbon replacement once per two years)	$ 5,000
Standby Generator (fuel)	$ 1,200
Total	**$45,800**

7.3 LIFE-CYCLE COST ESTIMATE

Life-cycle costs are based on the Wastewater Treatment Division Business Case Evaluation calculation method (King County, 2009). Life-cycle costs assume a 35-year capital cost repayment period and project life (2014-2049). The nominal discount rate is 5.5 percent and the real discount rate is 2.7 percent. The net life-cycle cost for the project is estimated to be $11,500,000. The average annual project cost is estimated to be $512,000.

7.4 PROJECT FINANCING

This section describes King County's financial capability, capital financing plan, and customer charges.

7.4.1 Financial Capability

The County's Wastewater Treatment Division (WTD) capital improvement program (CIP) is funded primarily through proceeds from sewer revenue bond sales, variable-rate short-term borrowing, capacity charge revenues, and transfers from the operating fund. Additionally, some low-interest loan programs such as the State Revolving Fund (SRF) and the Public Works Trust Fund (PWTF) are available to fund all or part of the project. However, loan applications must go through a competitive ranking process and rank high enough to receive available loan funds. Approximately 84 percent of WTD's total operating revenues are from monthly sewer charges collected from WTD's component agencies. Transfers of operating funds to the capital program are the result of the additional cash generated to meet the

financial policy requirement of maintaining a debt service coverage ratio of no less than 1.15 times all debt service requirements. WTD uses these transfers to reduce the amount of borrowing necessary to finance the capital program.

Standard & Poor's and Moody's Investor Services are leading global financial firms that rate corporate stocks and municipal bonds according to risk profiles. In 2009, the firms confirmed the ratings to the Wastewater Treatment Division's bonds, citing:

- Strong management practices.
- Continued positive financial performance.
- Solid rate base and large service area.
- Commitment to a capital improvement plan.

The Moody's rating for WTD's sewer revenue bonds, as well as similar bonds issued in the past, remained at Aa3 while the Standard and Poor's rating remained at AA+. These favorable credit ratings lower the cost of borrowing by reducing the amount of debt service, which, in turn, reduces impacts to the rate.

7.4.2 Capital Financing Plan

The capital costs associated with the North Beach CSO Project will be financed through the resources available for capital improvements in accordance with the financial policies of the County and the WTD. The actual financing mix and cost of these instruments will reflect economic and financial conditions, WTD's financial position, and the appropriateness of the project for securing below-market-rate resources.

7.4.3 Customer Charges

The costs associated with construction plus operation and maintenance of the facility will be reimbursed or supported through a combination of user charges. These include the regular monthly sewer rate and the capacity charge which is levied on customers establishing new connections to the system. The monthly rate is a uniform amount levied on all system customers or customer equivalents. The capacity charge is levied on new connections to the system for a period of 15 years, with the option of payoff at a discount.

Annually, the County Executive proposes a sewer rate and capacity charge reflecting the current forecast of monetary requirements. In accordance with long-term contracts with the component sewer agencies, the monthly sewer rate must be adopted by the Council by June 30 of each year. In June 2010, the County Council adopted a monthly wholesale sewer rate of $36.10 and a capacity charge of $50.45 commencing January 1, 2011. In accordance with the financial plan associated with the 2011 adopted sewer rate and the proposed 2011 capital budget covering the period of 2011 to 2016, the revenues generated by this rate, capacity charge and subsequent planned increases in each will provide the funding for the construction of the North Beach CSO Project.

IMPLEMENTATION PLAN

8.1 IMPLEMENTATION PLAN

This chapter describes the implementation plan for the proposed alternative - Pipeline Bottom-of-Basin Storage (Alternative 1B). It includes the preliminary project schedule and lists the permits required for project implementation.

8.1.1 Project Schedule

The preliminary project schedule is summarized in Table 8.1.

Table 8.1 Preliminary Project Schedule

Activity	Anticipated Dates
Facility Plan Development	June 2010 – December 2010
SEPA/SERP	November 2010 – May 2011
Facility Plan Approval	September 2011
Permitting and Property Acquisition	June 2011 – September 2012
Final Design Consultant Selection	December 2010 – July 2011
Final Design	August 2011 – December 2012
Construction	March 2013 – March 2015
Start-up	March 2014 – June 2015
Project Commissioning	October 2014 – May 2016 (2 wet seasons)[1]

Notes:

1. While it may not take a full 2 years for commissioning, North Beach facilities must be controlled in a way that does not impact the Carkeek CSO Treatment Plant. Therefore, some commissioning period will be required.

8.1.2 Required Permits

The following permits will be obtained prior to construction of the new facility:

- Washington Department of Ecology:
  - NPDES Permit (construction dewatering).
  - Underground Storage Tank Permit (required for generator).
- Seattle Department of Planning and Development:
  - Master Use Permit:

    - Council Conditional Use (for ancillary facilities).
    - Building Permit.
    - Clear and Grade (will include any critical areas review).

- Seattle Department of Transportation:
  - Street Use Permit.
  - Utility Permit.
- King County:
  - Industrial Waste Stormwater Discharge Permit.

Other permits that may apply to the facility:

- Puget Sound Clean Air Agency:
  - Air Quality Permit (for odor control).

MISCELLANEOUS REQUIREMENTS

The State of Washington *Criteria for Sewage Works Design* (Ecology, August 2008) has a number of miscellaneous requirements for a complete facility plan. The following sections provide documentation of these miscellaneous requirements including information on SEPA/SERP compliance, and public involvement.

9.1 STATE ENVIRONMENTAL POLICY ACT COMPLIANCE

Compliance with the State Environmental Policy Act is a prerequisite for obtaining any permits/approvals for a CSO project. SEPA allows agencies to both consider and mitigate for environmental impacts of proposals as well as to provide opportunities for public participation prior to any final decision.

King County, as SEPA lead agency, prepared a SEPA environmental checklist and issued a DNS consistent with WAC 197-11 on April 28, 2011. The SEPA DNS and environmental checklist are provided in Appendix D as an appendix to the SERP report.

9.2 STATE ENVIRONMENTAL REVIEW PROCESS COMPLIANCE

All projects that receive financial assistance from the State Water Pollution Control Revolving Loan Fund (SRF) must meet the provisions of the State Environmental Review Process (SERP) (WAC 173-98-100). SERP compliance helps ensure that environmentally sound alternatives are selected and that these satisfy the state's responsibility to ensure recipients comply with the National Environmental Policy Act (NEPA). The following sections summarize compliance with the applicable federal regulations under SERP. King County prepared a SERP Environmental Issues Checklist that was distributed to the appropriate Federal cross-cutting agencies and tribes. The SERP document is provided in Appendix D as an appendix to the SERP report.

9.2.1 National Historic Preservation Act/Archaeological and Historic Preservation Act

The National Historic Preservation Act (NHPA) requires federal agencies to evaluate the effects of federal undertakings on historical, archaeological, and cultural resources, and to consult with the State Historic Preservation Officer (SHPO) regarding possible adverse cultural resources impacts. A review of historic, archaeological, and cultural resources that could be impacted by the proposed alternative is summarized in Section 6.2.

9.2.2 Clean Air Act

The Clean Air Act establishes a comprehensive program for improving and maintaining air quality throughout the United States. A review of air quality issues for the proposed alternative is summarized in Section 6.2.

9.2.3 Coastal Zone Management Act

The project is not within designated shorelines. Therefore, the Coastal Zone Management Act regulations and requirements are not applicable.

9.2.4 Endangered Species Act

Section 7 of the Endangered Species Act prohibits federal agency actions from jeopardizing listed species or adversely modifying designated critical habitat. A review of endangered/threatened species and habitats in the project area is summarized in Section 6.2.

9.2.5 Farmland Protection Policy Act

The proposed alternative area is not located on the inventory of prime or unique farmlands and will not impact or convert any existing farmlands to non-agricultural uses. Therefore, the Farmland Protection Policy Act regulations and requirements are not applicable.

9.2.6 Fish and Wildlife Coordination Act

There are no fish-bearing streams or water bodies within the project area. Therefore, the Fish and Wildlife Coordination Act regulations and requirements are not applicable.

9.2.7 Executive Order 11988, Floodplain Management

The proposed alternative project area is not located within a mapped Federal Emergency Management Agency (FEMA) floodplain. Therefore, the regulations and requirements of Executive Order 11988 are not applicable.

9.2.8 Executive Order 11990, Protection of Wetlands

The proposed alternative project area does not include any wetlands. Therefore, the regulations and requirements of Executive Order 11990 are not applicable.

9.2.9 Wild and Scenic Rivers Act

The purpose of the Wild and Scenic Rivers Act is to preserve the scenic, cultural, historic, recreational, and geologic values of selected rivers. No federally recognized wild and scenic rivers are in the project area. Therefore, the regulations and requirements of this act are not applicable.

9.3 PUBLIC INVOLVEMENT AND OUTREACH

The goal of public involvement and outreach was to inform interested citizens about the Combined Sewer Overflow (CSO) Beach Project in the North Beach Basin and to provide opportunities for meaningful involvement in the CSO control planning process.

The public process objectives were to:

- Provide timely and clear information to stakeholders and the public about the purpose of the project and their opportunities to participate.
- Conduct a clear, systematic, and objective process for identifying and evaluating alternatives for CSO control and associated wastewater infrastructure (pump station, pipeline, etc.), and selecting preferred alternative(s) and site(s).
- Obtain input from stakeholders and the public on the alternatives and criteria before preferred alternative(s) and site(s) are selected by King County.

9.3.1 Agency Stakeholder Engagement Process

To facilitate stakeholder input, a workshop for local and state agency staff and tribal entities was held on May 7, 2009 to advise the development of the CSO control alternatives and their evaluation criteria. This workshop covered the four basins associated with the CSO Beaches project: North Beach, South Magnolia, Murray, and Barton. Agencies and Tribes were sent a letter of invitation and a reminder email. A meeting summary was sent to all attendees.

The workshop participants reviewed the CSO program, the range of approaches the County considered to address CSOs in the four basins, and its public outreach approach. Participants provided input on the approaches, existing conditions, current and future projects, plans and opportunities for coordination and methods for public outreach. The project team used this input to guide development of the range of alternatives that would be considered as well as to modify the existing public involvement plan where appropriate.

A technical memo was sent in the winter of 2010 to agency stakeholders as the alternatives were narrowed from nine to three. The memo explained how the short list of alternatives was determined and solicited written comments to inform the identification of an alternative for environmental review. Stakeholders will receive a letter explaining how their input was used to inform the process, as well as provide information about the upcoming SEPA process. Agencies were also notified via email of all public meetings.

Elected officials (King County Executive, Councilmember Larry Phillips, Seattle City Councilmember, Rasmussen), agencies (Department of Ecology, Seattle Public Utilities and Seattle Public Utilities and Neighborhoods Committee, Suquamish, Muckelshoot and Tulalip Tribes) and regional committees (Metropolitan Water Pollution Abatement Advisory Committee and Regional Water Quality Committee) were briefed at key milestones for each basin.

9.3.2 Public Meetings and Briefings

King County hosted public meetings, community group meetings and briefings, and one tribal briefing between 2007 and 2010 to provide information about the development of CSO control alternatives and to facilitate active public participation in the planning process. In advance of the public meetings, postcards or newsletters were mailed to property owners in the basin area, people who had joined the mailing list, and representatives of community

organizations who had expressed interest in the planning process. Email notifications were sent to the County's contact lists and community organizations with listservs for additional distribution. Notices of public meetings were available on the project and King County website and were provided to local and regional media through press releases. During the alternatives selection process, over 250 people attended a public meeting, community meeting or briefing, or tribal briefing.

9.3.2.1 Public Meetings

- October 19, 2009: A public open house was held to provide residents with broad background on the CSO control problem in North Beach, explain approaches identified to control CSOs, provide information on how to stay up to date on progress, and solicit input.
- March 30, 2010: A public meeting was held to present the three preferred CSO control alternatives and solicit public input.
- June 26, 2010: A technical information session was held to respond to citizens' requests for technical information and to answer questions about the process to identify and screen CSO control alternatives.
- October 19, 2010: A public meeting was held to review the county's decision process for selecting the recommended alternative, convey how community input influenced the decision process, share detailed information about the selection, and present next steps in the process.

9.3.2.2 Community Group Meetings and Briefings

September 24, 2009: Olympic Manor Club hosted a community meeting to inform local residents about the CSO control problem in North Beach and solicit public input.

November 16, 2009: Blue Ridge Community Club hosted a community meeting with the same intent as the Olympic Manor Club.

February 29, 2008: A meeting was held at Crown Hill Elementary to explore the use of the site for CSO control.

Between February, 2007 and July, 2010, nine community briefings were held for neighborhood groups, including Piper's Creek Watershed Council, Blue Ridge Community Club, North Beach Club, and the Broadview Task Force. The community briefings were held at the request of the community to address concerns specific to each community group.

9.3.2.3 Tribal Briefings

In June 2010, King County briefed the Suquamish Tribe on the three preferred alternatives and solicited their input.

Public input from all meetings and briefings was used to identify an alternative for further review. Almost all of the respondents recognized the need to address the CSO problem in North Beach. Most respondents from both Blue Ridge and North Beach encouraged construction of the storage pipeline in the street to avoid any impacts on Blue Ridge Park. Many encouraged purchase of private property for construction use and any present or future need, avoiding use of Blue Ridge Park for these activities. The Suquamish Tribe have expressed concerns about potential health and environmental impacts related to CSO outfalls at North Beach.

A very small number of residents responded that addressing the CSO problem outweighed concerns about impacts to Blue Ridge Park

9.3.3 Public Information

9.3.3.1 Project Website

In 2009 a project website, www.kingcounty.gov/CSObeachprojects, was established to make information on the development of the CSO control approaches available to the public. A link to the project website was made available on the Wastewater Treatment Division's homepage and provided to the public in meeting notices, press releases, newsletters, emails and at meetings.

Notice of all public meetings and stakeholder workshops were posted on the website. After public meetings, written summaries, presentations, and handouts were made available on the website. Interested parties were able to sign up for the project mailing list and were provided a phone and email contact for King County staff.

Technical information was made available on the website as a separate link (http://www.kingcounty.gov/environment/wtd/Construction/Seattle/BeachCSO/Library/TechInfo.aspx) to allow interested citizens opportunities to better understand the decision process. Individuals could request CD copies of the technical information as needed.

9.3.3.2 Project Mailings

A newsletter was mailed to about 5,000 basin residents in fall 2009 with information about the upcoming decision process for CSO control projects and options for community involvement and participation. The newsletter included a mail-in form to sign up for email updates and/or hard copies of web materials. A second newsletter was sent in spring 2010 to announce the three selected alternatives for CSO control and provide information about a public meeting to discuss the alternatives. Newsletters were also provided as a PDF by email and mailed to local and state agencies and tribes.

In fall 2010, a postcard was sent to basin residents to announce the recommended alternative and invite community members to a public meeting. The postcard referred residents to the website for further details and provided contact information for King County staff.

In addition to targeted mailings, news releases were sent to local and regional media at key milestones, including blogs, and to city and state agencies for distribution.

9.3.4 Comment Tracking and Response Process

Over 200 members of the public submitted feedback or input in a variety of ways. Stakeholders and members of the public were invited to ask questions and provide comments at all of the stakeholder workshops and public meetings. The consultant team and representatives of King County responded to comments and questions during those meetings. A summary of public comment and response from each meeting was posted in the meeting summary available on the project website, and a 'frequently asked questions' page was included on the website.

King County community relations planning staff received the comments that were submitted via the website, an online survey, email and phone. The comments were saved by County staff for their records. Some comments were intended to inform the CSO control decision process and did not require a response. For questions and comments that did require a response, King County staff responded via email or phone.

Public input from all meetings, briefings, and comments was incorporated into the alternative selection process and facility plan, and was used for planning public meetings and briefings. Based on the strong level of public input during the decision-making process, specific requests from stakeholders, and King County's commitment to public involvement, the County is planning continued public outreach throughout the design and construction phases. An updated public involvement plan will be developed for design and construction to keep the community and stakeholders engaged and informed, and to respond to concerns during design, environmental review, and construction.

APPENDICES

APPENDIX A	Preliminary Geologic/Geotechnical Evaluation
APPENDIX B-1	Executive Summary
APPENDIX B-2	Comparing Modeled Flow Events against Observed Events: Determining Preferred Model for Estimating CSO Storage Volumes
APPENDIX B-3	Updated CSO Control Volumes for Puget Sound Beach CSOs
APPENDIX B-4	Mike Urban Modeling Approach
APPENDIX B-5	Mike Urban Calibration Test
APPENDIX B-6	North Beach Basin Calibration, Round 1
APPENDIX B-7	South Magnolia and North Beach Basins Population/Land Use Analysis
APPENDIX B-8	North Beach Flow Adjustment
APPENDIX B-9	North Beach Basin Calibration, Round 3
APPENDIX C	Alternative Evaluation Summary Documentation
APPENDIX D-1	State Environmental Review Process (SERP) Documentation
APPENDIX D-2	Public Meeting Agendas and Summaries
APPENDIX D-3	SEPA Affidavits of Publication
APPENDIX D-4	SEPA Comments and Responses
APPENDIX E	Cost Data

Appendix A

PRELIMINARY GEOLOGIC/GEOTECHNICAL EVALUATION

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

ALASKA
CALIFORNIA
COLORADO
FLORIDA
MISSOURI
OREGON
WASHINGTON

August 24, 2010

Mr. Allen de Steiguer
Carollo Engineers
1218 Third Avenue, Suite 1600
Seattle, WA 98101

RE: PRELIMINARY GEOLOGIC/GEOTECHNICAL EVALUATION OF NORTH BEACH ALTERNATIVES, SEATTLE, WASHINGTON

Dear Mr. de Steiguer:

At your request, we have performed a preliminary evaluation of three potential alternatives for a proposed Combined Sewer Overflow (CSO) project in the North Beach neighborhood of Seattle; the project is called the North Beach CSO. The purposes of our preliminary study are to understand the geologic conditions in this area and to determine the geotechnical limitations and opportunities for the three potential sites for the CSO project.

The scope of our preliminary study included a literature review consisting of Shannon & Wilson and City of Seattle files, review of the GeoMap Northwest website, a site reconnaissance, a meeting with you to discuss our preliminary findings, and preparation of this report.

SITE AND PROJECT DESCRIPTIONS

The North Beach CSO project is primarily focused on the area at and adjacent to an existing sewer pump station at North Beach, as shown in Figure 1. The site is located at the confluence of five streets as they all converge on the lowest point of elevation in a large, semi-circular basin in the Blue Ridge neighborhood. The top of the basin is at about elevation 340 feet (440 feet Metro Datum) and the elevation of the existing pump station is about elevation 35 feet (135 feet Metro Datum). Slope inclinations in the basin range from about 20 to 50 percent and the entire area is covered with residential development. All of the streets are paved and drainage consists of a combination of open ditches and buried culverts.

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From the existing pump station and adjacent Blue Ridge Park to its north, the ground surface drops down steeply (about 70 percent) to the west about 10 feet to the BNSF Railway (BNSF) drainage ditch and double-track alignment. At the western edge of the railroad bench, the rock seawall drops near vertically down about 8 to 10 feet to the Puget Sound beach. Water flows through culverts in the seawall at two locations; one from the stormwater collection system in the Olympia Terrace neighborhood and the other from the creeks that flows through the North Beach neighborhood.

Alternative 1A includes a 60-foot- by 40-foot- by 35-foot-deep storage tank in Blue Ridge Park and a one-story aboveground odor control and electrical facility in the park (40-foot by 20-foot). Alternative 1B includes a 12-foot-diameter storage pipeline in the NW Blue Ridge Drive right-of-way (ROW), a buried Diversion Structure (10-foot- by 10-foot- by 15-foot-deep) and a one-story above grade odor control and electrical facility in the pump station site (40-foot by 20-foot). The proposed storage pipe is approximately 250 feet long and 25 feet deep. Alternative 1D includes a 40-foot- by 30-foot- by 35-foot-deep storage tank and a 60-foot by 50-foot- by 20-foot-deep pump station in Blue Ridge Park, twin 8-inch force mains, about 5 feet deep, from the pump station to a one-story at-grade odor control facility and drop structure (20-foot by 15-foot) near the intersection of Holman Road NW and 14th Avenue NW, and a 12-inch gravity main to the 8th Avenue Interceptor.

GEOLOGIC CONDITIONS

The geologic map for Seattle indicates that the surface deposits in the area of the proposed storage tank would be Vashon recessional outwash, typically consisting of a medium dense, slightly silty to silty, gravelly sand or sandy gravel. This deposit appears to be underlain by glaciolacustrine silt and clay, commonly called the Lawton Clay. Typically, the Lawton Clay is 50 feet or more thick and contains interbeds of fine sand. The depth to groundwater is unknown, but it is probably perched close to the ground surface because of the likelihood that the shallow surface water in this basin is focused toward the park/pump station site. There is no site-specific subsurface information for this site. Borings performed nearby for residential purposes are very shallow and are unlikely to represent conditions at the proposed structure locations.

The slope between the western edge of Blue Ridge Park and the BNSF tracks did not appear to contain in situ soil. Because this slope was uneven and contained construction debris and other deleterious materials, it is probably artificial fill placed to make a level park surface. This fill of unknown thickness may overlie the recessional outwash.

Street grade profiles obtained from the City of Seattle's records indicate that the streets leading into the convergence just east of the park have minor cuts and fills, mostly plus or minus 2 feet, but with a maximum of 4 feet. Therefore, it is likely that the original ground surface sloped down from the street to the railroad property at a gentle gradient. Moving northward and southward from the street intersection, cuts or fills were less than 2 feet.

As discussed above, the slope between the park and the railroad tracks is only about 10 feet high. To the north and south of the site, the height of that slope increases quickly to 30 to 40 feet high. These slopes have suffered shallow instability many times. There are no records of slope instability at the park or pump station.

No records of subsurface exploration were found in Shannon & Wilson files or on the GeoMap Northwest website for the Holman Road NW/14th Avenue NW site. The Geologic Map of Seattle indicates that the site is underlain by Vashon till; however, exposures of soil in a nearby drainage ditch indicate that a thin layer of recessional outwash may overlie the till.

GEOTECHNICAL APPLICATIONS

As discussed previously, only very limited subsurface and groundwater data are available. Explorations would be required to determine the subsurface conditions, including the depth to groundwater, relative densities of the soils, and soil types.

Storage Tanks, Pump Station, and Diversion Structure Excavation

The excavations in Blue Ridge Park for a storage tank (Alternatives 1A and 1D) and pump station (Alternative 1D) and at the North Beach Pump Station for the diversion structure (Alternative 1B) will require temporary shoring to reduce the overall impact to the sites. The proposed depths of the storage tanks and the pump station, about 35 and 25 feet for Alternatives 1A/D and 1B, respectively, will likely require a tieback or internally braced shoring system. The

excavation for the proposed diversion structure, about 15 feet deep, could likely be constructed with stacked trench boxes or cantilevered shoring.

The groundwater conditions at the Blue Ridge Park and North Beach Pump Station sites are not currently known. The need for relatively impermeable or watertight shoring will depend on possible permit limitations on groundwater disposal volumes, the ability to perform groundwater recharge, and whether settlement-sensitive structures, utilities or other improvements are identified during design. The groundwater disposal volumes will be a function of the depth to groundwater and the thickness and hydraulic conductivity of the overlying recessional outwash. The relatively impermeable shoring could consist of pre-drilled sheet piles, a secant pile, and soil-mixed or slurry wall system. If very loose soils are identified in the explorations, and depending on the proximity of existing structures, utilities, and other improvements, driven or vibrated sheet pile shoring systems could result in unacceptable vibrations and settlements. A variable moment or vibration damping hammer could reduce, but would not eliminate, the potential for unacceptable vibrations and settlement.

Depending on the groundwater conditions and thickness and extent of the fill and recessional outwash at the site, liquefaction may be a concern for some of the structures. Liquefaction could result in undesirable settlement of the proposed structures. If liquefaction is an issue, ground improvement or deep foundation elements may be required.

The buried structures will also need to be checked for uplift. Uplift piles, tiedown anchors, and/or an extended perimeter slab could be used to resist uplift. In addition, if relatively impermeable shoring is required and secant piles are the selected shoring system, the secant piles could be incorporated into the final design of the uplift resistance system.

Storage Pipe

The storage pipe alternative in the NW Blue Ridge Drive ROW (Alternative 1B) could likely be constructed as an open trench. The proposed 25-foot-deep excavation could likely be supported by a braced, soldier pile and lagging shoring system in conjunction with dewatering and possible groundwater recharge. However, if drawdown-induced settlement sensitive soils are present and

groundwater recharge is not feasible, then relatively impermeable or watertight shoring systems similar to those discussed earlier may be required.

Depending on the groundwater conditions and thickness and extent of the fill and recessional outwash at the site, liquefaction may be a concern. Liquefaction could result in undesirable settlement of the proposed structures. Depending on the allowable limits on settlement, ground improvement or deep foundation elements may be required to mitigate potential liquefaction.

The buried storage pipeline will also need to be checked for uplift. A pipe sled could be used to resist uplift.

Force Mains and Gravity Line

We do not anticipate any significant geotechnical challenges for the open trenching of the force mains or gravity line (Alternative 1D). Trench boxes in combination with sumps and pumps would likely be sufficient for supporting the excavation and controlling groundwater.

Above-grade Structures

The one-story above-grade structures at the Blue Ridge Park and North Beach Pump Station sites (Alternatives 1A and 1B) and the one-story at-grade odor control facility and drop structure near the intersection of Holman Road NW and 14th Avenue NW (Alternative 1D), could likely be supported on spread footings or mat foundations. Minor overexcavation may be required if soft or loose soils are present at or below the foundation grade elevation. The potential for liquefaction at the North Beach Pump Station site would need to be evaluated after explorations are completed to determine if ground improvement or deep foundations would be required.

LIMITATIONS

This preliminary evaluation is intended for use in comparing alternatives for the North Beach CSO project. No subsurface explorations were performed for this project. After selection of the

preferred alternative, explorations will be completed for preliminary design of the chosen facilities.

Sincerely,

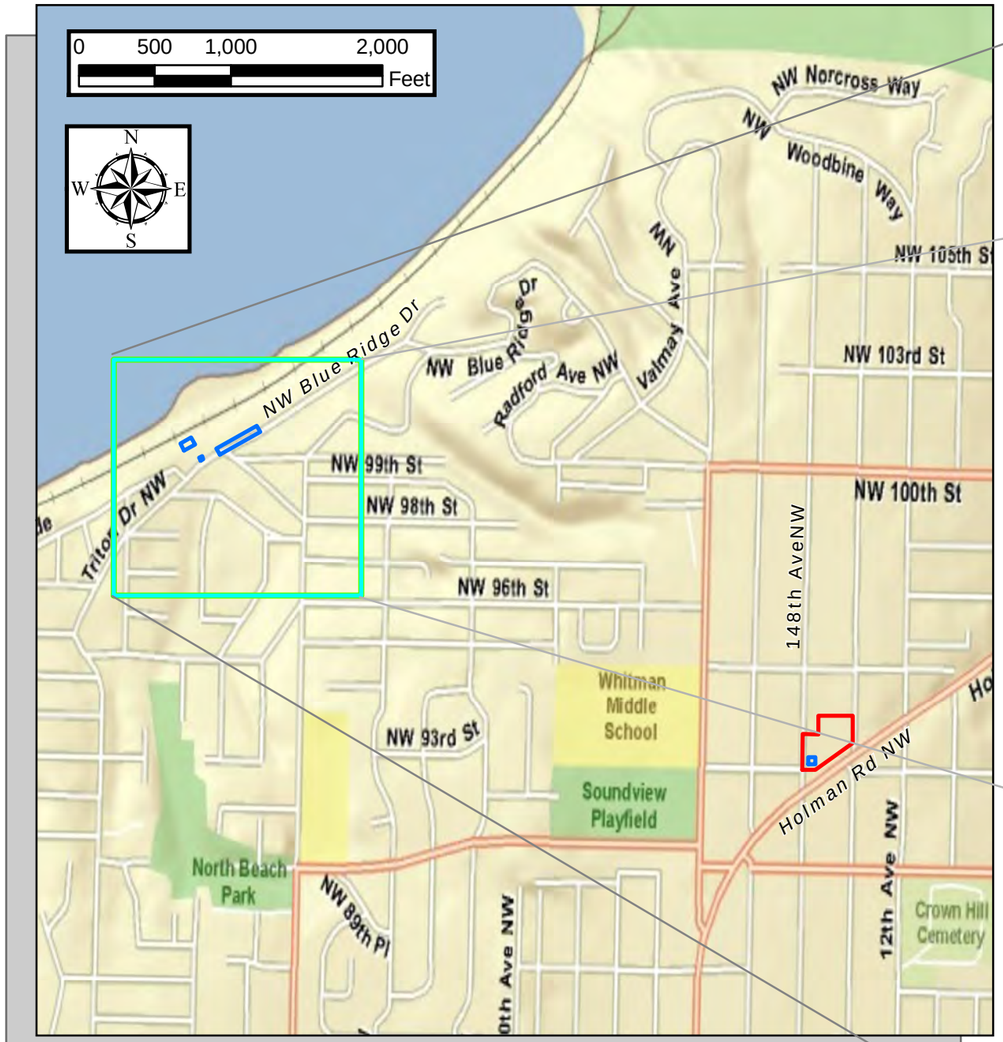
SHANNON & WILSON, INC.

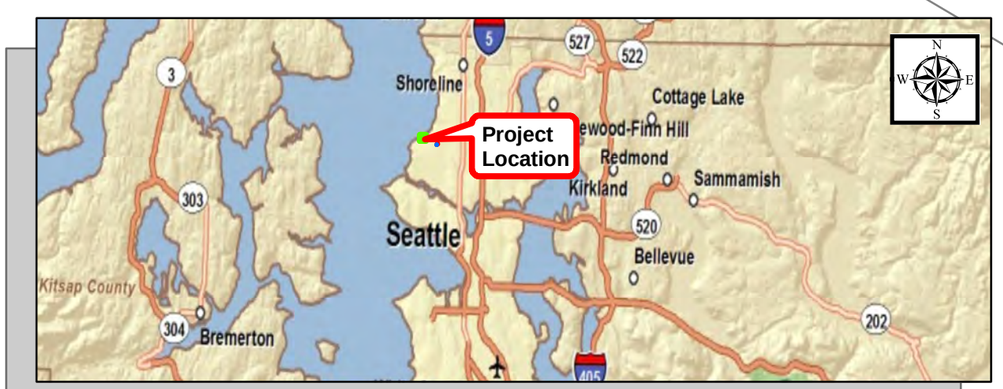
David C. Ward, P.E., L.E.G.
Senior Principal Engineer

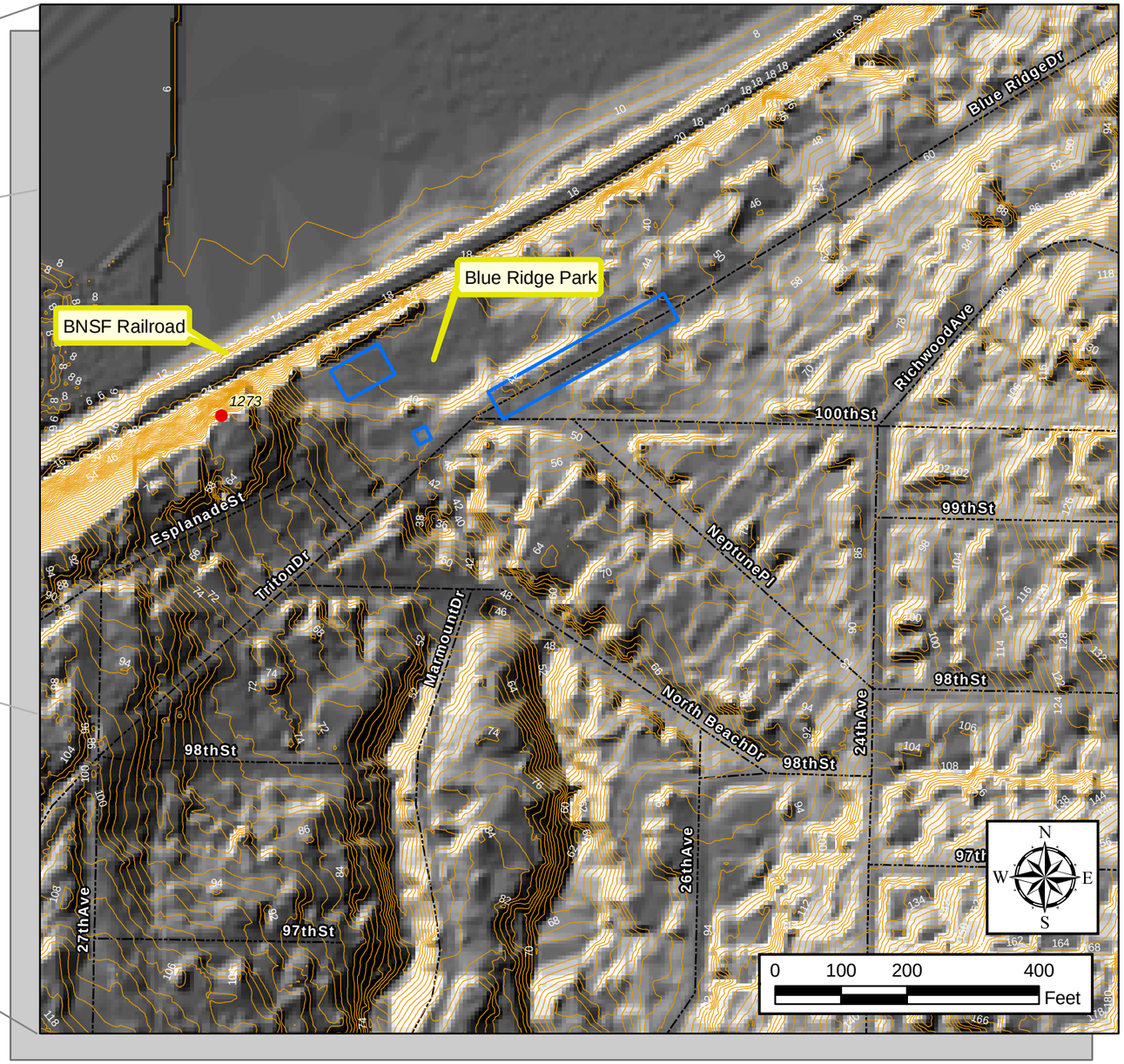
William T. Laprade, L.E.G.
Senior Vice President

DC:MSK:WTL/dcw

Enc: Figure 1 – North Beach CSO Site Plan







Legend

- Project Location
- Drop Structure Site
- Potential Structure Excavations
- Streets
- Contours (2 ft)
- Shallow Colluvial Landslide

Carollo Engineers
North Beach CSO

SITE PLAN

August 2010 | 21-1-20698-050

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 1

Filename: T:\Project\21-1\20698_Beach_CSOs\AV_mxd\North_Beach_Vicinity Date: 4/29/2010 (RWR)

Appendix B-1

EXECUTIVE SUMMARY

PROJECT MEMORANDUM

Project Name:	Barton, Murray, North Beach, South Magnolia CSO Facilities	**Date:**	September, 12, 2011
Client:	King County DNRP, Wastewater Treatment Division	**Project Number:**	7562A10
Prepared By:	Brian Matson		
Reviewed By:	Susanna Leung		
Subject:	Introduction to Appendix B		

INTRODUCTION

Several modeling efforts were used part of the King County Barton, Murray, Magnolia, and North Beach CSO Projects. This appendix includes a series of documents that describe the modeling efforts and how they were used. The documents are listed in Table 1 below.

Table 1 Appendix B documents

Document	Applicable Basin
Comparing Modeled Flow Events against Observed Events: Determining Preferred Model for Estimating CSO Storage Volumes	North Beach & South Magnolia
Updated CSO Control Volumes for Puget Sound Beach CSOs	North Beach & South Magnolia
Mike Urban Modeling Approach	North Beach & South Magnolia
Mike Urban Calibration Test	North Beach & South Magnolia
North Beach Basin Calibration, Round 1	North Beach
South Magnolia Basin Calibration, Round 2	South Magnolia
South Magnolia and North Beach Basins Population/Land Use Analysis	North Beach & South Magnolia
North Beach Flow Adjustment	North Beach & South Magnolia
North Beach Basin Calibration, Round 3	North Beach
South Magnolia Basin Calibration, Round 3	South Magnolia

SUMMARY

Models for all four basins were initially calibrated by King County using the Runoff hydrologic model. Data for these calibration efforts largely describe flows at the bottom of each basin. Therefore, it was difficult to assess the feasibility and magnitude of various “up-basin” CSO control alternatives (such as peak flow reduction and/or distributed storage) using the County’s Runoff model. Portable flow meters were selectively placed in the four basins to delineate how much basin flow came from each sub-basin and provide data for more refined basin model calibrations. As King County is gradually replacing the Runoff model with Mouse/RDII, the Mouse/RDII (within the Mike Urban platform) was selected for sub-basin flow simulations.

After the flow monitoring period was over, the County found the portable metered data disagreed with measured pump station flows. This finding resulted in a decision to omit direct use of the portable flow meters for calibrating model sub-basins; however, sub-basin calibration was accomplished by disaggregating a single downstream hydrograph into sub-basin hydrographs based on the portable flow data. This disaggregating approach was used for calibrating sub-basins in all four basins.

Following the disaggregation and calibration process, it was determined that the Mouse/RDII model produced significantly different storage volumes relative to the Runoff model. Because calibrations were acceptable for both models, King County performed an assessment to determine which model better matched observed data. The results of the assessment are documented in this appendix, along with a recommendation to use the Runoff model for determining CSO control requirements in the South Magnolia, Barton, and Murray basins. The RDII/Mouse model was selected for the North Beach basin. Tables of flows and volumes (produced by the selected mode) are included at the end of this appendix. These data were used to determine the required CSO storage and peak flow conveyance capacity.

Appendix B-2

COMPARING MODELED FLOW EVENTS AGAINST OBSERVED EVENTS: DETERMINING PREFERRED MODEL FOR ESTIMATING CSO STORAGE VOLUMES

2006 CSO Control Project

Comparing Modeled Flow Events against Observed Events: Determining Preferred Model for Estimating CSO Storage Volumes.

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June 15, 2010

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1.1 Introduction

In 2007 as part of the King County Barton, Murray, Magnolia, and North Beach CSO Projects, a short term flow monitoring program was implemented. Portable flow meters were selectively placed in the four basins to delineate how much basin flow came from each sub-basin and provide data for more refined basin model calibrations. After the flow monitoring period was over, the County found the portable metered data disagreed with measured pump station flows (Schock, 2009). This finding resulted in a decision to omit direct use of the portable flow meters for calibrating model sub-basins; however, sub-basin calibration was accomplished by disaggregating a single downstream hydrograph into sub-basin hydrographs based on the portable flow data (Carollo, 2009). This disaggregating approach was used for calibrating sub-basins in the Barton, Murray, and North Beach basins. The Mouse/RDII model was used for all four sub-basin calibrations, which was accomplished by Carollo Consultants. Prior to the Mouse/RDII calibration effort, the County calibrated its Runoff model for the four basins. The models were used for estimating CSO storage volumes to control CSO discharges. This report discusses the differences between the two modeling efforts.

1.2 Calibration Overview

Before discussing basin CSO control requirements, a brief discussion is presented on potential differences between the County model results and the consultant model results; potential differences are outlined in Table 1. The four basins were initially calibrated by the County using the Runoff hydrologic model; however, the County is gradually replacing the Runoff model with Mouse/RDII, Mouse/RDII (within the Mike Urban platform) was selected for sub-basin flow simulations. The two models are structurally different and are likely to produce different hydrograph responses; however, even the same model will reproduce some storm events better than others. This difference in reproducibility is an inherent limitation of all models; a model will perform best to those storms it was calibrated against. The Runoff and Mouse/RDII models were calibrated to different storm conditions or time series. The Mouse/RDII model was calibrated to flow data obtained between December 2007 and June 2008 and the Runoff model was calibrated to flow data obtained between 2001 and 2005. Because the models were calibrated to different time series, the calibrated models represent potentially different basin conditions and temporal changes in flow meter and rain gage response. The models were calibrated to different time periods and by different people. Because model calibration is considered partly art, results are subjective to the individual. People will interpret calibration results differently as an individual and as a group, even the County found three viable calibration results for the Barton and Murray basins (Schock, 2009a and 2009b). While these differences can produce significantly different model results, they are acceptable and should be considered part of the variability or uncertainty inherent in computer modeling. Had either modeling study been viewed in isolation, their results would have been considered acceptable. Viewed together, these modeling differences present a nice case study into the potential variability or range CSO control size for a single facility. However, current design practices require a single CSO control size and this report presents a method for assessing which model appears to match the existing data set better.

Table 1. Calibration procedures that could result in different design requirements for CSO storage volumes.

Different Models
Calibrating to different storm series and number of storms
Inconsistent calibration protocols for assessing an acceptable calibration
Variability of flow meter and between flow meters
Different people doing the calibration
Variability of rain gauge

1.3 Modeled CSO Volume Requirements

Based on long term simulation from the two models, simulated basin CSO storage requirements are very different between models; the Carollo Mouse/RDII model predicts smaller storage requirements for three of the four basins (Table 2). For the Barton and Murray basins, Carollo storage requirement are statistically different from the County requirements at the 95th confidence intervals (CI). For Magnolia and North Beach, the CI cannot be computed because it requires knowing portable meter uncertainty. Because the storage volumes are substantially different, the County wants direction on which model should be used for estimating CSO storage volumes. The model selection is based on which model appears to match the existing data set better.

Table 2. Expected CSO storage requirements for the four Puget Sound Beaches CSO Projects; storage is based on the one-year recurrence interval. Upper and lower 95th confidence intervals were calculated using the group bias; total uncertainty propagates group bias and flow meter error.

Basin	Carollo	King County		
	Expected	Expected	Lower 95th	Upper 95th
Barton [1]	0.0	0.11	0.06	0.16
Murray [2]	1.2	1.0	0.83	1.13
Magnolia	0.95	1.78	NA	
North Beach	0.18	2.15	NA	

1. 95th CI based on a model bias of 4.7 and 5 observations.
2. 95th CI based on a model bias of 3.1 and 8 observations.

1.3.1 Methods

The two models were calibrated to observed basin flows and assessed using several measures of fit (Schock, 2007, 2007a, 2009a, 2009b; and Carollo, 2009a). Because these measures of fit indicated acceptable calibrations, additional measures of fit were required for assessing which model most correctly mimics basin response. The only other comparison method was reviewing overflow durations and frequencies, which are based on observed water level data near an overflow structure (weir); water level was the only other independent data set available. Overflow events are observed when the water level exceeds a defined weir elevation; these events were compared to simulated overflow events. A simulated overflow is realized when the simulated flows exceed pump station capacity or system flow capacity. While this method is based on observed data, it still has potential problems.

Accurate identification or verification of overflow events is subject to accurate water level measurements, accurate weir elevations, and accurate pump capacity or system flow capacity information. Water level time series better identify or verify overflow events when water levels plateau between a steep incline and decline (Figure 1). Overflow events based on modeled flow and estimated pump capacity or system flow capacity are much more difficult to verify (Figure 2); they are usually verified with water level time series information. At best, accurate pump capacity is assessed using fill and draw methods and system capacity is assessed using general flow equations or portable flow meters, which can have significant bias (Schock, 2009). This flow capacity uncertainty is presented in the section assessing model results for the North Beach Basin. Given these caveats, overflow duration and frequency will be used for assessing which model is the most correct. Duration differences are expressed as the average of the absolute difference.

$$\Delta d = \frac{1}{N}\sum_{i=1}^{N}\left|d_{mdl} - d_{wl}\right|_i \tag{1.1}$$

Where Δd is the absolute duration error (ADE), d_{mdl} is the storm duration predicted by the model, d_{wl} is the storm duration estimated from water levels, and N is the number of observations. The absolute duration error is a more robust measure than the average duration error because the absolute error retains the bias for each observation while the average error allows observed biases to cancel. For example, the two hydrographs in Figure 3 have equal but opposite duration errors. The absolute duration error is b_1, but the average duration error is zero. For this example model, considering the hydrographs as a group the model has zero duration error, but for any specific hydrograph the model has an expected duration error of $\pm b_1$. The absolute duration error contains the average duration error plus a correction term for negative durations; the absolute duration equals zero only when the model perfectly represents observed durations. Because CSO control volumes are based on a single hydrograph, one would be more interested in how well a model represents a single hydrograph rather than an average of an ensemble of hydrographs, the smallest absolute duration error is desirable.

Overflow duration and frequency will be the primary parameters of interest; however, data consistency was considered in some cases.

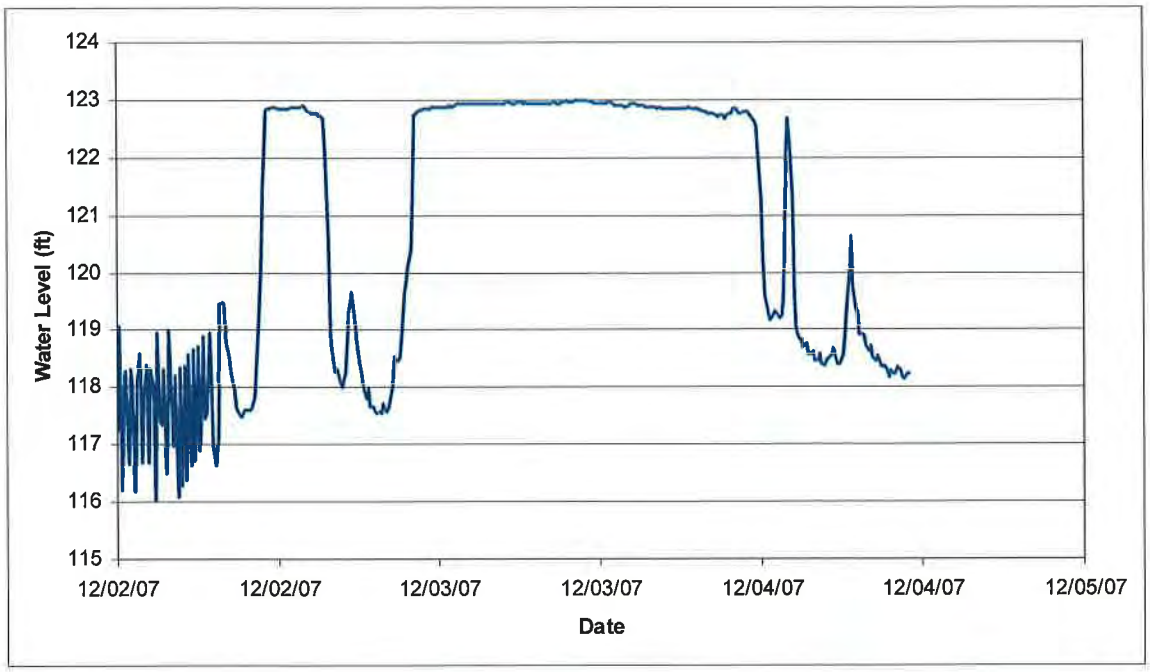

Figure 1. Water level time series when flow is dissipated over a control structure. The overflow event occurred where the water level plateaus. Data is for the North Beach pump station.

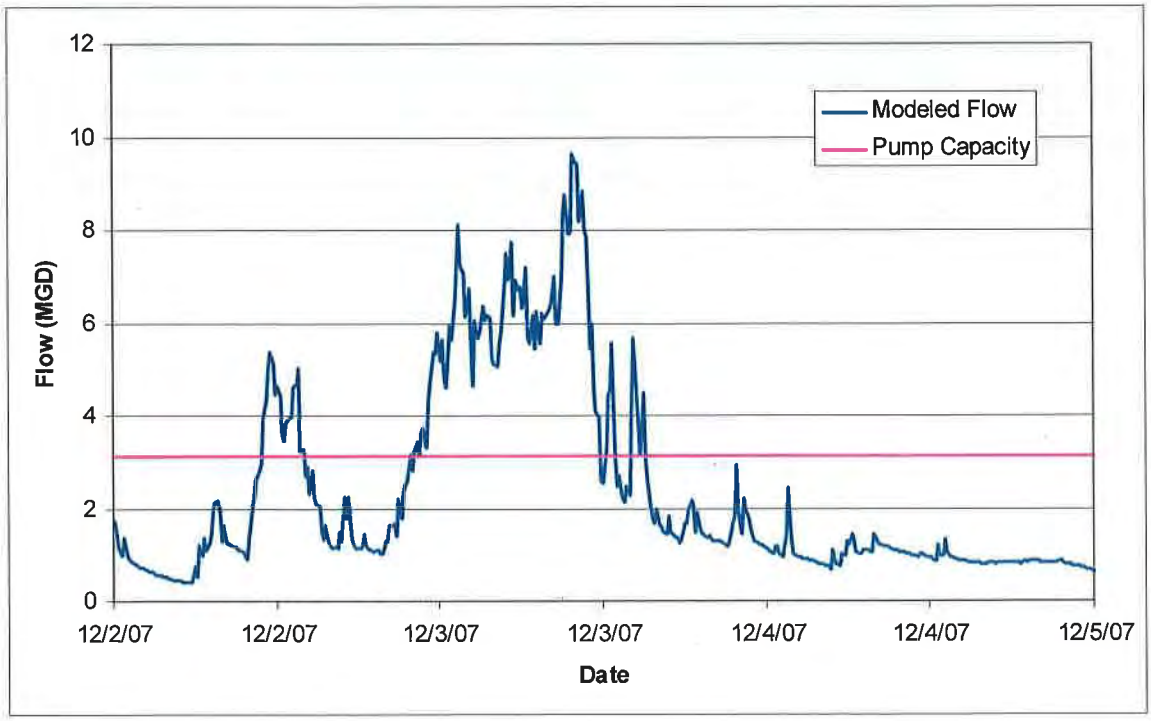

Figure 2. Modeled flow time series and estimated pump capacity. The overflow event occurs when modeled flow exceeds pump capacity. Data is for the North Beach pump station for the same time period shown in Figure 1.

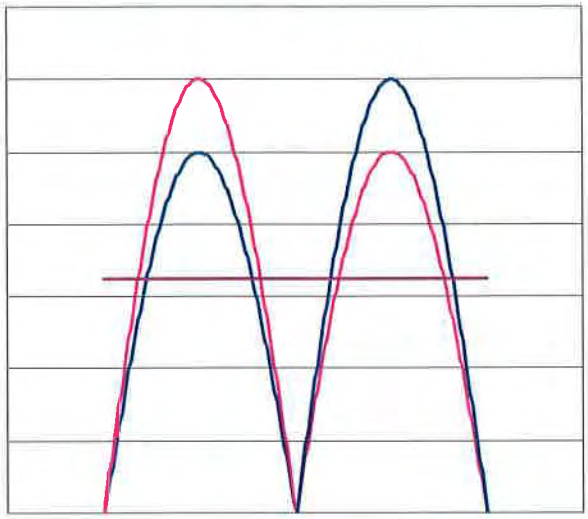

Figure 3. Two hydrographs with equal duration errors, but of opposite sign. The first hydrograph has duration error b_1 and the second has duration error b_2=-b_1.

Because both model calibration results were considered acceptable, data consistency may show conditions changed between calibration periods i.e., basin characteristics or data collection conditions may have changed between periods. Consistency was checked using the double mass balance method; however, double mass balance allows assessing only data consistency.

1.3.2 Results

1.3.2.1 Barton and Murray Basins

For the Barton and Murray pump stations, wet well water level data was obtained from the PI Historian data base, which retains data back to September 2005. Overflow events were initially identified when water levels were greater than weir elevations and verified when the data showed a plateau. These events were checked against simulated overflow events, which were identified when modeled flows exceeded estimated pump station capacities.

Based on Barton pump station wet well data and a weir elevation of 107.75 ft, about 27 overflow events were initially identified from December 2005 through June 2008; however, only 13 could be verified as true overflow events (Table 3). Between January 10, 2006 and February 14, 2006 the Barton force main broke and was under repair, this condition resulted in omitting 14 events. Of the 13 verified events, the Runoff model matched 6 and the Mouse/RDII model matched 3. Based on the 13 verified events, about 5 overflow events per year occurred for the water level events, 6 overflow events per year occurred for the Runoff model, and 2 overflow events per year occurred for the Mouse/RDII model. The two models concurrently matched only three events where storm durations could be compared; the Runoff model consistently over predicted durations and Mouse/RDII consistently under predicted, but the Runoff model had a smaller absolute error (Table 4). The Mouse/RDII performed poorly at matching actual events (23%) and event frequency and it has a higher absolute duration error (60 min).

While the Runoff model matched 46% of the actual overflow events, it does much better at matching event frequency and storm duration (37 min absolute duration error); the Runoff model is recommended because the model appears to match the existing data set better.

Table 3. Barton pump station overflow events based on wet well water levels and modeled flows assuming a 22 MGD pump capacity (Schock, 2009). The shaded area identifies 14 instances when the Barton force main was possibly impaired.

Wet Well	Runoff	Mouse/RDII		Wet Well	Runoff	Mouse/RDII
24-Dec-05	**24-Dec-05**			4-Nov-06		
10-Jan-06	10-Jan-06	16-Jan-06		**6-Nov-06**	**6-Nov-06**	
17-Jan-06	16-Jan-06			11-Dec-06		
18-Jan-06	4-Feb-06				13-Nov-06	
19-Jan-06				**14-Dec-06**	**14-Dec-06**	**14-Dec-06**
20-Jan-06				15-Dec-06		
21-Jan-06				26-Dec-06		
4-Feb-06				2-Jan-07		
5-Feb-06				**7-Jan-07**	**7-Jan-07**	
6-Feb-06					8-Jan-07	8-Jan-07
7-Feb-06					21-May-07	21-May-07
8-Feb-06					20-Aug-07	
10-Feb-06					26-Aug-07	
11-Feb-06					4-Sep-07	
14-Feb-06				**3-Dec-07**	**2-Dec-07**	**3-Dec-07**
8-Mar-06					8-Apr-08	
18-Mar-06				**6-Jun-08**	**6-Jun-08**	**6-Jun-08**
	14-Sep-06					
	2-Nov-06					

Table 4. Estimated overflow durations (hh:mm) for the three concurrent events identified in Table 3. The absolute error was 37 min for Runoff and 1:24 for Mouse/RDII. A complete list of durations is given in appendix A, Table A. 1.

Overflow Event	Water Level	Runoff	Mouse/RDII
14-Dec-06	2:30	2:43	1:12
3-Dec-07	12:10	13:30	9:35
6-Jun-08	0:40	1:00	0:21
ADS		00:37	1:24
Avg. Bias		00:37	1:24

Based on Murray pump station wet well water level data and a weir elevation of 108.5 ft, about 46 overflow events were initially identified from December 2005 through June 2008; however, only 16 could be verified as true overflow events but two were corroborated by the models (Table 5). Of the 18 events, the Runoff model matched 9 and the Mouse/RDII model matched 12. Based on the 16 verified events about 6.5 overflow events per year occurred, the Runoff model predicted about 7.7 overflow events per year and the Mouse/RDII model predicted about 11 overflow events per year.

Where the models matched observed overflow events, the Runoff model matched 50% of the observed events and the Mouse/RDII model matched 69%. The two models concurrently matched nine events, but the 24-Dec-05 event was omitted because of suspicious water level and pump data and the 02-Dec-07 and 03-Dec-07 events were considered the same event. The absolute duration errors differ slightly, Runoff was 1:20 (hh:mm) and Mouse/RDII was 1:34, and Runoff model over estimates duration by 1:10 and Mouse/RDII over estimates duration by 1:11 (Table 6). For overall storm frequency, percent of matched storms, and absolute duration error, the Runoff model performs slightly better than the Mouse/RDII model. The Runoff model is recommended because it appears to match the existing data set better.

Table 5. Murray pump station overflow events based on wet well water levels and events estimated from modeled flows using a 31.5 MGD pump capacity (Schock, 2009). The shaded area identifies seven instances when the Barton force main was possibly impaired.

Wet Well	Runoff	Mouse/RDII		Wet Well	Runoff	Mouse/RDII
22-Dec-05				12-Dec-06		
24-Dec-05	**24-Dec-05**	**24-Dec-05**			14-Dec-06	14-Dec-06
	24-Dec-05	24-Dec-05			14-Dec-06	
25-Dec-05						24-Dec-06
31-Dec-05					26-Dec-06	26-Dec-06
		5-Jan-06			26-Dec-06	
10-Jan-06	10-Jan-06	10-Jan-06				27-Dec-06
	16-Jan-06	16-Jan-06		**7-Jan-07**	**7-Jan-07**	**7-Jan-07**
		28-Jan-06			8-Jan-07	8-Jan-07
29-Jan-06		29-Jan-06		9-Jan-07		9-Jan-07
30-Jan-06	30-Jan-06	30-Jan-06			21-May-07	21-May-07
		1-Feb-06		19-Aug-07		
4-Feb-06	4-Feb-06	4-Feb-06			20-Aug-07	20-Aug-07
4-Jun-06		4-Jun-06			26-Aug-07	26-Aug-07
		14-Sep-06		**4-Sep-07**	**4-Sep-07**	**4-Sep-07**
	2-Nov-06	2-Nov-06			16-Nov-07	16-Nov-07
4-Nov-06	**4-Nov-06**	**4-Nov-06**			17-Nov-07	17-Nov-07
	4-Nov-06	4-Nov-06		**2-Dec-07**	**2-Dec-07**	**2-Dec-07**
		5-Nov-06				2-Dec-07
6-Nov-06	**6-Nov-06**	**6-Nov-06**		**3-Dec-07**	**3-Dec-07**	**3-Dec-07**
	12-Nov-06	12-Nov-06			8-Apr-08	8-Apr-08
	13-Nov-06	13-Nov-06		**6-Jun-08**	**6-Jun-08**	**6-Jun-08**
11-Dec-06		11-Dec-06				
14-Dec-06	**14-Dec-06**	**14-Dec-06**				

Table 6. Estimated overflow durations for the three concurrent events identified in Table 5. The absolute error is 1:20 (hh:mm) for Runoff and 1:34 for Mouse/RDII. A complete list of durations is given in appendix A, Table A. 2 .

Overflow Event	Water Level	Runoff	Mouse/RDII
24-Dec-05	sd[a]	--	--
4-Nov-06	1:00	0:10	0:10
6-Nov-06	5:10	2:20	2:30
14-Dec-06	4:40	4:00	5:00
7-Jan-07	2:00	0:40	0:30
4-Sep-07	0:20	1:00	1:00
2-Dec-07	17:20	14:20	12:30
6-Jun-08	1:00	1:00	1:10
ADS		1:20	1:34
Avg Bias		-1:08	-1:14

a. sd is suspicious data and duration error not computed.

1.3.2.2 Magnolia Basin

For the Magnolia diversion structure, water level and flow data was obtained from the WTD Flow Monitoring Group; water level data since September 2006 was obtained because prior to September 2006 the data was deemed unreliable (personal communication Araya, 2009). Overflow events were identified when water levels exceeded about 39 inches (personal communication Johnson, 2010). Water level overflow events were compared against simulated overflow events, which were identified when modeled flows exceeded estimated diversion structure capacity of 4.3 MGD. In addition to the water level data, basin flow data was available from January 2007 and allowed assessing CSO storage differences between observed and modeled flows using the same 4.3 MGD diversion capacity. Water level overflow events and CSO storages were determined for the period January 2007 through June 2008.

1.3.2.2.1 Water Level Based Storm Durations

Based on the diversion structure water level data, 60 overflow events were identified and the smallest storm duration was five minutes. Because Seattle Pump Station 77 discharges into the diversion structure, these two short events could be an artifact of the pump station rather than a true storm event. Based on analyses provided by Seattle, PS 77 discharge events had durations less than 6 minutes 95 percent of the time and a corresponding discharge of 1.9 MGD or less (email, Beedle, 2006). These events could be an artifact of the City of Seattle Pump Station 77; however, both models predicted events concurrent to the two and so they were retained. Where applicable, multiple inter-day events were combined into a single day (Table 7). This process resulted in 34 water level overflow events, the Runoff model predicted 33 events per year, and the Mouse/RDII model predicted 32 events per year. The Runoff model matched 97% of the observed water level overflows and Mouse/RDII matched 94%. For the absolute duration error, the Runoff model did worse because of the large error in the 02-Dec-07 storm; the Runoff absolute duration error was 3:02 (hh:mm) and the Mouse/RDII absolute duration error was 0:41 (Table 8). Eliminating the worst duration error in each model series profoundly affected the absolute duration error for Runoff, Runoff had an absolute duration error of 0:59 (hh:mm) and Mouse/RDII had an absolute duration error

of 0:36. Runoff over predicted duration by 0:53 and Mouse/RDII over predicted duration by 0:15.

Table 7. Magnolia diversion structure overflow events based on water levels modeled flow using a 4.3 MGD diversion capacity.

Diversion Water Level	Runoff	Mouse/RDII	Diversion Water Level	Runoff	Mouse/RDII
1-Jan-07	**1-Jan-07**		**15-Nov-07**	**15-Nov-07**	**15-Nov-07**
2-Jan-07	**2-Jan-07**	**2-Jan-07**		16-Nov-07	
3-Jan-07	**3-Jan-07**		**17-Nov-07**	**17-Nov-07**	**17-Nov-07**
5-Jan-07	**5-Jan-07**	**5-Jan-07**	**26-Nov-07**	**26-Nov-07**	**26-Nov-07**
7-Jan-07	**7-Jan-07**	**7-Jan-07**		1-Dec-07	1-Dec-07
	16-Jan-07		**2-Dec-07**	**2-Dec-07**	**2-Dec-07**
	10-Feb-07		**4-Dec-07**		**4-Dec-07**
8-Mar-07	**8-Mar-07**	**8-Mar-07**		16-Dec-07	
11-Mar-07	**11-Mar-07**	**11-Mar-07**	**18-Dec-07**	**18-Dec-07**	**18-Dec-07**
19-Mar-07	**19-Mar-07**	**19-Mar-07**		19-Dec-07	
20-Mar-07	**20-May-07**	**20-May-07**	**22-Dec-07**	**22-Dec-07**	**22-Dec-07**
21-May-07	**21-May-07**	**21-May-07**	**27-Dec-07**	**27-Dec-07**	**27-Dec-07**
	21-May-07			2-Jan-08	
	20-Jul-07		**9-Jan-08**	**9-Jan-08**	**9-Jan-08**
	3-Sep-07	3-Sep-07		10-Jan-08	10-Jan-08
4-Sep-07	**4-Sep-07**		**12-Jan-08**	**12-Jan-08**	
	27-Sep-07		**14-Jan-08**	**14-Jan-08**	**14-Jan-08**
	27-Sep-07		**19-Jan-08**	**19-Jan-08**	**19-Jan-08**
	28-Sep-07			6-Feb-08	
30-Sep-07	**30-Sep-07**	**30-Sep-07**	**15-Mar-08**	**15-Mar-08**	**15-Mar-08**
30-Sep-07	30-Sep-07	30-Sep-07	**16-Mar-08**	**16-Mar-08**	**16-Mar-08**
	3-Oct-07	3-Oct-07	**23-Mar-08**	**23-Mar-08**	**23-Mar-08**
	7-Oct-07		**26-Mar-08**	**26-Mar-08**	**26-Mar-08**
17-Oct-07	**17-Oct-07**	**17-Oct-07**		28-Mar-08	28-Mar-08
	18-Oct-07			29-Mar-08	29-Mar-08
19-Oct-07	**19-Oct-07**	**19-Oct-07**		14-Apr-08	
24-Oct-07	**24-Oct-07**	**24-Oct-07**	**3-Jun-08**	**3-Jun-08**	**3-Jun-08**
12-Nov-07	**12-Nov-07**	**12-Nov-07**	**9-Jun-08**	**9-Jun-08**	**9-Jun-08**

Table 8. Estimated overflow durations for the concurrent events identified in Table 7. The absolute error is 3:02 (hh:mm) for Runoff and 0:41 for Mouse/RDII. Shaded areas identify worst absolute duration error in each model series. A complete list of durations is given in appendix A, Table A. 3.

Date	Water Level	Runoff	Mouse/RDII
1-Jan-07	00:10	0:20	
2-Jan-07	04:30	4:20	3:45
3-Jan-07	00:25		
5-Jan-07	03:05	3:20	3:03
7-Jan-07	01:40	1:30	1:23
8-Mar-07	00:40	0:40	0:20
11-Mar-07	00:45	1:20	0:20
19-Mar-07	00:50	1:10	0:30
20-Mar-07	02:20	1:50	0:41
21-May-07	01:40	1:50	2:02
4-Sep-07	00:10	0:20	
30-Sep-07	00:20	4:50	3:14
17-Oct-07	00:15	1:00	0:31
19-Oct-07	00:35	2:30	1:42
24-Oct-07	00:15	0:40	0:21
12-Nov-07	01:05	5:10	4:56
15-Nov-07	01:10	4:40	3:56
17-Nov-07	01:15	1:40	1:21
26-Nov-07	00:05	1:30	1:11
2-Dec-07	25:55	96:40	26:45
4-Dec-07	00:15		
18-Dec-07	00:40	0:50	0:51
22-Dec-07	00:35	1:50	0:31
27-Dec-07	00:15	0:30	0:11
9-Jan-08	00:40	0:40	0:41
12-Jan-08	00:10	0:30	
14-Jan-08	01:55	2:10	1:52
19-Jan-08	00:50	1:00	0:41
15-Mar-08	00:50	0:50	0:52
16-Mar-08	00:15	0:40	
23-Mar-08	01:15	4:10	2:44
26-Mar-08	00:30	1:40	0:40
3-Jun-08	03:25	8:30	6:17
9-Jun-08	00:10	0:30	0:10
ADS		3:02	00:41
Avg Bias		2:56	00:22

1.3.2.2.2 Flow Based CSO Storage Volumes

CSO storage volumes were calculated for flow exceeding the capacity of the diversion structure. Observed flows were obtained by adding portable meter data in manholes MH026-104, MH026-006, and MH026-008. For a diversion capacity of 4.3 MGD and calculating storage volumes using a 24 hr separation, the predicted overflow events per year were 19 for the observed flow, 28 for the Runoff model, and 21 for the Mouse/RDII model (Table 9). The flow based overflow events differ from the water level overflow

events, 19 events/yr compared to 26 events/yr. The Runoff model matched 92% of the observed flow based overflow events and Mouse/RDII matched 81%. Total volume weighted relative CSO volume error for Runoff it was 102% and for Mouse/RDII it was 36% (Table 10). When the 2-Dec-07 storm event was omitted, the errors were 18% for Runoff and 12% for Mouse/RDII and Runoff over predicted volumes by 55% and Mouse/RDII under predicted volumes by 10%. The volume weighted relative CSO volume error was computed as,

$$\Delta V_i = \frac{1}{\sum_N V_{obs}} V_{obs} \frac{\left|V_{mdl} - V_{obs}\right|_i}{V_{obs}}$$
$$\Delta V_i = \frac{\left|V_{mdl} - V_{obs}\right|_i}{\sum_N V_{obs}} \tag{1.2}$$

Where ΔV_i us the ith observed volume weighted relative CSO volume error, V_{mdl} is the modeled CSO volume, V_{obs} is the observed CSO volume, and N is the number of events. The cumulative volume weighted relative error is sum of all ΔV_i.

For the water level and flow based analyses, the Runoff model had better event frequency and number of matched events, but the Mouse/RDII model had better (lower) duration and volumetric errors. Runoff duration and volumetric errors improved substantially when the 2-Dec-07 storm was removed, but the duration and volumetric errors were still higher. This condition could be because Runoff was calibrated to flow data in 2005 and 2006 and Mouse/RDII was calibrated to flow data in 2007 and 2008. Between these time periods basin conditions, flow meters, and rain gauges may have changed and any changes would be apparent in a double mass analyses.

Table 9. Magnolia diversion structure overflow events based on metered flow and modeled flow using a 4.3 MGD diversion capacity. The 1-Dec-07 and 2-Dec-07 events are considered the same event.

Diversion Flow	Runoff	Mouse/RDII		Diversion Flow	Runoff	Mouse/RDII
1-Jan-07	**1-Jan-07**			**17-Nov-07**	**17-Nov-07**	**17-Nov-07**
		2-Jan-07		**26-Nov-07**	**26-Nov-07**	**26-Nov-07**
5-Jan-07	**5-Jan-07**	**5-Jan-07**			1-Dec-07	1-Dec-07
7-Jan-07	**7-Jan-07**	**7-Jan-07**		2-Dec-07		
	16-Jan-07			**16-Dec-07**	**16-Dec-07**	
	10-Feb-07			**18-Dec-07**	**18-Dec-07**	**18-Dec-07**
8-Mar-07	**8-Mar-07**	**8-Mar-07**		**22-Dec-07**	**22-Dec-07**	**22-Dec-07**
11-Mar-07	**11-Mar-07**	**11-Mar-07**		**27-Dec-07**	**27-Dec-07**	**27-Dec-07**
19-Mar-07	**19-Mar-07**	**19-Mar-07**			2-Jan-08	
20-May-07	**20-May-07**	**20-May-07**		**9-Jan-08**	**9-Jan-08**	**9-Jan-08**
	20-Jul-07			**12-Jan-08**	**12-Jan-08**	
	3-Sep-07	3-Sep-07		**14-Jan-08**	**14-Jan-08**	**14-Jan-08**
4-Sep-07				**19-Jan-08**	**19-Jan-08**	**19-Jan-08**
	27-Sep-07				6-Feb-08	
30-Sep-07	**30-Sep-07**	**30-Sep-07**		**15-Mar-08**	**15-Mar-08**	**15-Mar-08**
	3-Oct-07	3-Oct-07		**23-Mar-08**	**23-Mar-08**	**23-Mar-08**
	7-Oct-07	17-Oct-07		25-Mar-08		
	17-Oct-07	19-Oct-07			26-Mar-08	26-Mar-08
	19-Oct-07				28-Mar-08	28-Mar-08
24-Oct-07	**24-Oct-07**	**24-Oct-07**			29-Mar-08	29-Mar-08
12-Nov-07	**12-Nov-07**	**12-Nov-07**			14-Apr-08	
15-Nov-07	**15-Nov-07**	**15-Nov-07**		**3-Jun-08**	**3-Jun-08**	**3-Jun-08**

Table 10. Estimated volume weighted relative CSO volume error for concurrent events identified in Table 9. The cumulative volume weight relative error is 102% for Runoff and 36% for Mouse/RDII.

Overflow Event	Runoff	Mouse/RDII
5-Jan-07	1.36%	1.74%
7-Jan-07	1.22%	1.48%
8-Mar-07	0.11%	0.29%
11-Mar-07	0.18%	0.59%
19-Mar-07	0.09%	0.55%
20-May-07	0.10%	1.01%
30-Sep-07	0.82%	0.10%
24-Oct-07	0.80%	0.30%
12-Nov-07	1.34%	0.17%
15-Nov-07	2.00%	1.04%
17-Nov-07	0.81%	0.03%
26-Nov-07	0.68%	0.10%
2-Dec-07	84%	24%
18-Dec-07	0.11%	0.14%
22-Dec-07	0.20%	0.32%
27-Dec-07	0.08%	0.05%
9-Jan-08	0.58%	0.10%
14-Jan-08	0.41%	0.36%
19-Jan-08	0.00%	0.51%
15-Mar-08	0.68%	0.11%
23-Mar-08	1.02%	0.23%
3-Jun-08	4.91%	2.81%

1.3.2.2.3 Magnolia Double Mass Analysis

The double mass analysis compared modeled flows to observed portable metered flow. Because model parameters are consistent over time, an inconsistent response would derive from the flow meters, rain gauges, or basin changes. Metered flow from MH026-104 was used in the double mass analysis because it contained flow information over both calibration periods (2005 through 2008). The double mass method was also used to assess flow proportions between flow at MH026-104 and flow for MH026-006 and MH026-008; flows from MH026-006 and MH026-008 were about 20% of the flow from MH026-104 (Figure 4). Based on this ratio, modeled flows should be about 20% higher than MH026-104 flows. The Mouse/RDII model had the same average slope as MH026-104 and the Runoff model had average slope of 1.27 (Figure 5). For both models, three flow regimes are apparent in the double mass diagram. The first is from 3-Oct-05 to 4-Nov-06, the second is from 4-Nov-06 to 18-Jan-07, the third is from 18-Jan-07 onward (Figure 5). After around 18-Jan-07, the Runoff model predicts larger flows (slope is 1.58) compared to earlier flows (slope is 1.16). Because model parameters are consistent over time, this result suggests the flow regime changed between the two periods. This shift maybe from changes in rain gauges or basin characteristics because the flow meter double mass balance indicates the meters were fairly consistent between the two periods (Figure 4). While a flow regime shift is apparent, the double mass balance nor other available basin information allows assessing which flow regime is

correct, or if the shift is a natural variation. The double mass balance does indicate that on average the Runoff model flows better resemble total basin flow, but probably over predicts flows after 18-Jan-07. And that on average the Mouse/RDII model under represents total basin flow, but could better resembles flows after 18-Jan-07.

Because the Runoff model produces better storm frequency, matched storm events, and average total flow representation, the Runoff model is recommended because the model appears to match the existing data set better.

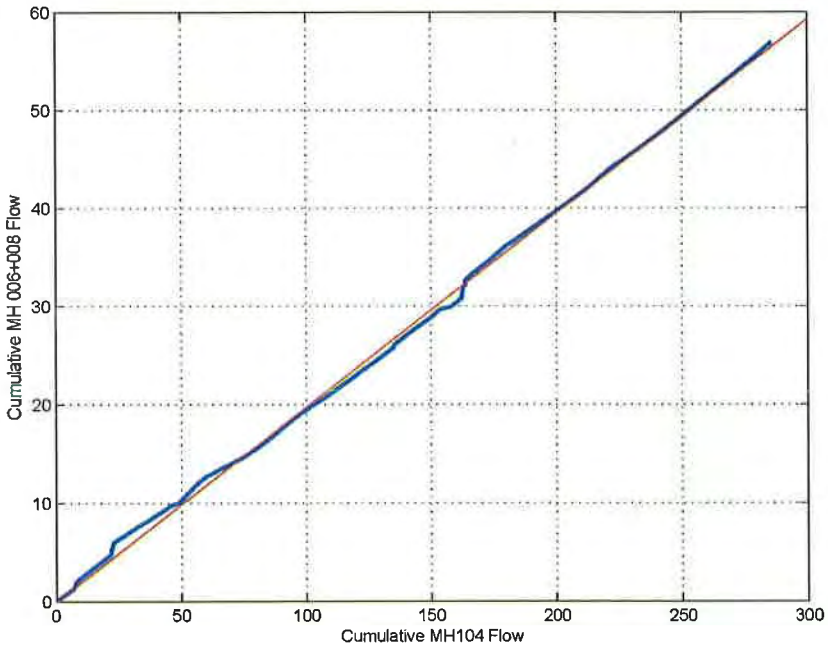

Figure 4. Double mass diagram for flows at MH026-104 and combined flows in MH026-006 plus MH026-008 (blue line); the average slope is 0.197 (red line). Flow data series spans 25-Aug-06 through 31-Oct-08.

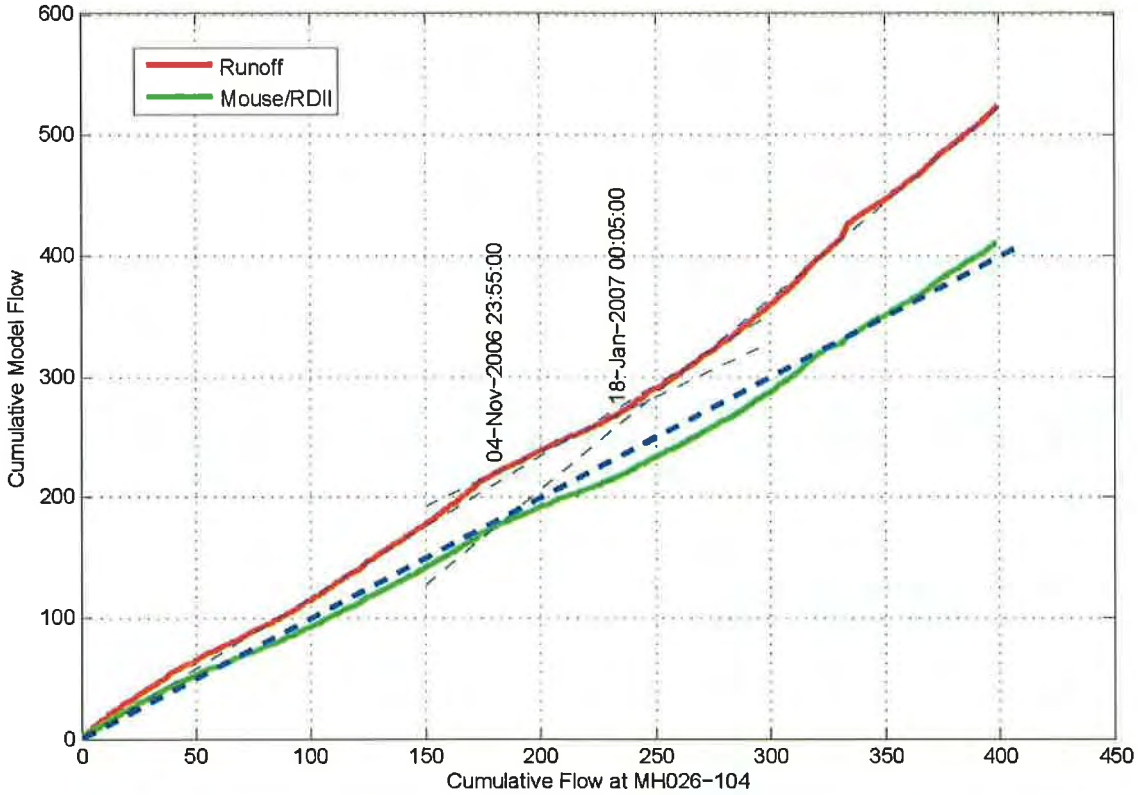

Figure 5. Double mass diagram for flows at MH026-104 and the Runoff model (red line) and the Mouse/RDII model (green line). The heavy dashed line has a 1:1 slope; the Mouse/RDII model has average slope 1.00; and Runoff model has average slope 1.27.

1.3.3 North Beach Basin

For the North Beach basin, CSO storage volume differences were more easily assessed because of observed bias in flow meters used for calibrating the models. The Runoff model was calibrated to three meters (one for each sub-basin) that were potentially biased high about 75% (NBCSO123); whereas the Mouse model was calibrated to a single meter biased high about 28% (NBCSO, Table 11). Therefore, the Mouse/RDII is recommended.

1.3.3.1 Water Level Based Overflow Frequencies

The North Beach data set provides an opportunity to present potential uncertainty in the applied methods when assumed or estimated but unverified pump capacity or system capacity are used. In the North Beach basin, the station pumps were tested for peak flow rates when all portable meters and wet well bubblers were operating, meter locations are shown in Figure 6. The pump test provided information about potential portable meter errors and differences between assumed pump capacity and verified pump capacities. Previously, the pump capacity was thought to be 3.4 MGD; however, recent pump tests indicate pump capacity is about 2.7 MGD with a maximum of 2.9 MGD depending on the wet well level (Table 12 and Kaplan, 2010).

Table 11. Average inflow during the North Beach pump test (data reproduced from Table 12, in Schock, 2009).

Meter or Station	Flow (MGD)	Relative error from the pump test inflow.
NBCSO	0.63	28%
NBCSO123[a]	0.86	75%
NBCHWETWELL	0.55	12%
12/17/08 Pump Test	0.49	NA
a. Sum of meters N.BeachCSO1, N.BeachCSO2, N.BeachCSO3.		

Table 12. Estimated North Beach pump station flow capacity based on pump test. Pumps were run at maximum speed for each test. The two large pumps were run concurrently for number combinations 1 & 2 (data reproduced from Table 11, in Schock, 2009).

Pump(s)	Calculated Peak (MGD)	Average Influent flow (MGD)
1	2.6	0.55
1 & 2	2.6	0.49
2	2.4	0.45
1 & 2	2.7	0.47
1 & 2	2.9	0.56
Kaplan (2010)	3.0	
Average	2.71	0.49
std dev	0.21	0.05
Rel. Error	8%	10%

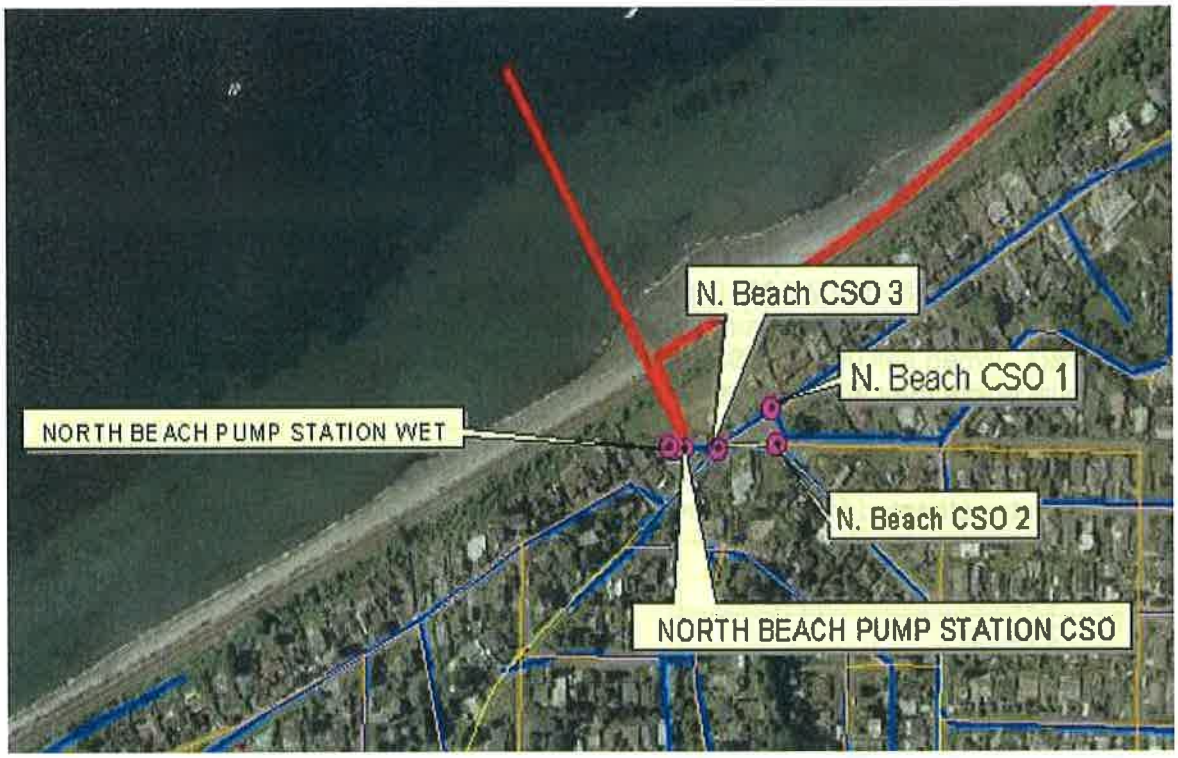

Figure 6. Portable flows meters near the North Beach pump station.

Table 13. North Beach pump station portable meter equivalent nomenclature used between Figure 6 and text.

Figure 6 Nomenclature	Abbreviated name
North Beach pump station CSO	NBCSO
N. Beach CSO1 + CSO2 + CSO3	NBCSO123
North Beach pump station wet	NBCHWETWELL

Wet well water levels were obtained from the PI Historian and flow data was obtained from WTD Flow Monitoring Group. Overflow events were identified when water levels exceeded 122.73 ft and verified when water levels showed a plateau. For the wet well water level data, 17 possible events were identified and 15 were verified and between 2-Jan-07 through 3-Jun-08 (Table 14). Over the same period and for a 3.4 MGD pump capacity, the Mouse/RDII model predicted 15 events and matched 11 events; modeled event counts compare well for a threshold flow of 3.4 MGD.

The Mouse/RDII model and the NBHWETWELL flow meter had similar overflow event frequencies using a slightly shorter period and a 3.4 MGD capacity; the wet well flow meter predicted 11 events, the Mouse/RDII predicted 12 events for a threshold flow of 3.4 MGD, and the wet well water level indicated 11 events.

1.3.3.2 Accounting for Flow Meter Bias

The simulated North Beach overflow statistics may have compared well with wet well level sensor overflow statistics because the 3.4 MGD pump capacity compensated for the NBCSO meter bias; however, a lower pump capacity would be required when

accounting for the NBCSO meter bias in the modeled hydrograph. The NBCSO portable meter was biased high about 28% based on a single pump test (Table 11), and the average pump capacity was about 2.7 MGD (Table 12). If the model was calibrated to biased data, the simulated hydrograph couldould be adjusted downward by 28%. Using the adjusted model hydrograph and a 2.7 MGD pump capacity, the calculated overflow events match the durations and number for the unadjusted hydrograph with a 3.4 MGD pump capacity (Table 16). This example illustrates the need for a complete accounting of data errors (or uncertainty) when estimating CSO controls. If one calculated CSO storage volumes for the 2.7 MGD pump capacity but did not adjust the hydrograph accordingly, the calculated event frequency and CSO storage requirements would be incorrect. When calculating CSO controls, an effort should be made to assess how potential errors may affect results.

Table 14. North Beach pump station overflow events based on wet well water levels and events estimated from modeled flows using a 3.4 MGD pump capacity.

Wet Well Water Level	Mouse/RDII
2-Jan-07	**2-Jan-07**
3-Jan-07	
5-Jan-07	**5-Jan-07**
7-Jan-07	
	8-Jan-07
19-Mar-07	**19-Mar-07**
	20-May-07
	19-Aug-07
20-Aug-07	**20-Aug-07**
19-Oct-07	**19-Oct-07**
17-Nov-07	**17-Nov-07**
2-Dec-07	**2-Dec-07**
3-Dec-07	**3-Dec-07**
4-Dec-07	
9-Jan-08	**9-Jan-08**
15-Mar-08	**15-Mar-08**
4-Apr-08	
	7-Apr-08
3-Jun-08	**3-Jun-08**

Table 15. Estimated overflow durations between the Wet well water level and MOUSE/RDII model for the concurrent events identified in Table 14. The absolute error is 1:23 (hh:mm) for the Mouse/RDII mode. A complete list of durations is given in appendix A, Table A. 4.

Event	Wet Well Water Level	MOUSE/RDII
2-Jan-07	2:36	1:11
5-Jan-07	1:39	0:41
19-Mar-07	0:22	0:21
20-Aug-07	0:20	0:11
19-Oct-07	0:23	1:23
17-Nov-07	0:18	0:11
2-Dec-07	4:03	2:45
3-Dec-07	24:12	14:16
9-Jan-08	0:11	0:10
15-Mar-08	0:01	0:10
3-Jun-08	1:03	1:12
ADS		1:23
Avg Bias		-1:08

Table 16. Simulated overflow events for an unadjusted hydrograph and 3.4 MGD pump capacity and a hydrograph adjusted downward 28% and 2.7 MGD pump capacity. Between the two results, the absolute error is 51 seconds.

Event	Durations (hh:mm)	
	Hydrograph unadjusted and 3.4 MGD	Hydrograph adjusted down and 2.7 MGD
2-Jan-07	1:27	1:24
5-Jan-07	0:53	0:52
8-Jan-07	0:34	0:34
19-Mar-07	0:31	0:30
20-May-07	0:18	0:18
28-Jun-07	0:02	0:01
19-Aug-07	0:11	0:11
20-Aug-07	0:12	0:12
19-Oct-07	2:13	2:08
17-Nov-07	0:16	0:16
2-Dec-07	17:24	17:23
3-Dec-07	1:04	1:04
18-Dec-07	0:02	0:02
9-Jan-08	0:10	0:10
15-Mar-08	0:09	0:09
4-Apr-08	0:14	0:13
7-Apr-08	0:22	0:21
18-Apr-08	0:04	0:04
3-Jun-08	2:47	2:45

1.4 Summary and Conclusions

King County and Carollo CSO storage modeling results produced significantly different storage volumes but both models had acceptable calibration results. Because calibrations were acceptable, a different assessment method was employed to determine which model better matched observed data. The method reviewed overflow frequencies and durations based on water level measurement near overflow structures; the method was different or independent from the calibration methods employed. Based on the water level method, CSO storage volumes should be estimated using the preferred models given in Table 17.

The North Beach basin was the easiest basin to assess because field investigation revealed the Mouse/RDII basin calibration meter had a smaller relative error compared to the Runoff basin calibration meters; therefore the Mouse/RDII model is the preferred model. In the Barton basin, overflow frequency and storm durations was better simulated with the County's Runoff model and was picked for its better match to observed data. In the Murray basin results were a little less straight forward. Runoff predicted better overflow frequency and storm durations; Mouse/RDII better matched the number of observed overflow events. The Runoff model was selected because it was better at two out of three measures. The Magnolia basin was the most difficult basin to assess.

In Magnolia, the Runoff model predicted better overflow frequency and better matched number of observed storm events; however, the Runoff model had a much higher absolute duration error that was most affected by a single storm event (2-Dec-07). Removing the worst duration errors for both models significantly reduced the Runoff duration error but had a smaller effect on the Mouse/RDII duration error. Analyses indicated the Runoff model over predicted both storm duration and overflow volumes. This condition possibly resulted from a change in the basin flow regime, which occurred after the Runoff model was calibrated and during the period of the Mouse/RDII calibration. The regime change indicated the Runoff model should be predicting larger flows compared to the Mouse/RDII model after the change, but Mouse/RDII would under predict flows before the change. The flow regime change was determined using the double mass balance method, which also indicated the Runoff model predicted better average flow conditions compared to the Mouse/RDII model. Because Runoff better resembles total basin flow, it had better overflow frequency, and it better matched number of observed storm events it was selected as the preferred model.

Supplemental to the primary intent of this report, analyses for the North Beach basin indicated that some of the assumptions or system capacity estimates may produce the appropriate results but for inappropriate reasons. Analyses indicate that incomplete accounting of flow meter errors could produce inaccurate results pertaining to estimated CSO storage volumes for what are thought to be corrected system capacities. The results suggest all variable errors should be thoroughly considered before making final design recommendations.

Table 17. Preferred models for estimating CSO storage volumes in the four basins.

Basin	Model

Barton	Runoff, County
Murray	Runoff, County
Magnolia	Runoff, County
North Beach	Mouse/RDII, Carollo

References:

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This appendix provides the complete wet well and model storm durations used for comparing simulated storm duration to observed durations.

Table A. 1. Barton pump station overflow events based on wet well water levels and modeled flows assuming a 22 MGD pump capacity (Schock, 2009); durations have unit's hh:mm. The shaded area identifies when the Barton force main was possibly impaired.

Wet Well		Runoff		Mouse/RDII	
Date	Duration	Date	Duration	Date	Duration
24-Dec-05	0:40	24-Dec-05	1:30		
10-Jan-06		10-Jan-06		16-Jan-06	
17-Jan-06		16-Jan-06			
18-Jan-06		4-Feb-06			
19-Jan-06					
20-Jan-06					
21-Jan-06					
4-Feb-06					
5-Feb-06					
6-Feb-06					
7-Feb-06					
8-Feb-06					
10-Feb-06					
11-Feb-06					
14-Feb-06					
8-Mar-06	1:50				
18-Mar-06	2:00				
		14-Sep-06	0:00		
		2-Nov-06	0:20		
4-Nov-06	0:30				
6-Nov-06		6-Nov-06	2:10		
		13-Nov-06	0:10		
11-Dec-06	0:10				
14-Dec-06[a]	2:30	14-Dec-06	2:43	14-Dec-06	1:12
15-Dec-06[a]	21:10				
26-Dec-06	2:30				
2-Jan-07	1:00				
7-Jan-07	0:50	7-Jan-07	0:30		
		8-Jan-07	0:50	8-Jan-07	0:21
		21-May-07	0:40	21-May-07	0:21
		20-Aug-07	0:10		
		26-Aug-07	0:10		
		4-Sep-07	0:50		
3-Dec-07	12:10	2-Dec-07	13:30	3-Dec-07	9:35
		8-Apr-08	0:10		
6-Jun-08	0:40	6-Jun-08	1:00	6-Jun-08	0:21

a. Water level data looks suspicious.

Table A. 2. Murray pump station overflow events based on wet well water levels and events estimated from modeled flows using a 31.5 MGD pump capacity (Schock, 2009);

durations have unit's hh:mm. The shaded area identifies seven instances when the Barton force main was possibly impaired.

Wet Well		Runoff		Mouse/RDII	
Date	Duration	Date	Duration	Date	Duration
22-Dec-05	0:20				
24-Dec-05[a]	6:10	24-Dec-05	0:20	24-Dec-05	0:20
		24-Dec-05	0:20	24-Dec-05	0:30
25-Dec-05	0:50				
31-Dec-05	1:10				
				5-Jan-06	
10-Jan-06	1:00	10-Jan-06	0:10	10-Jan-06	0:20
		16-Jan-06	0:30	16-Jan-06	0:30
				28-Jan-06	
29-Jan-06	11:20			29-Jan-06	0:00
30-Jan-06		30-Jan-06	0:30	30-Jan-06	0:20
				1-Feb-06	
4-Feb-06	1:10	4-Feb-06	0:10	4-Feb-06	0:20
				4-Jun-06	0:10
				14-Sep-06	
		2-Nov-06		2-Nov-06	1:00
4-Nov-06	1:00	4-Nov-06	0:00	4-Nov-06	0:10
		4-Nov-06	0:10	4-Nov-06	0:10
				5-Nov-06	
6-Nov-06	5:10	6-Nov-06	2:20	6-Nov-06	2:30
		12-Nov-06	0:00	12-Nov-06	0:20
		13-Nov-06	0:00	13-Nov-06	0:20
11-Dec-06	0:50			11-Dec-06	0:10
12-Dec-06	0:20				
14-Dec-06	4:40	14-Dec-06	1:30	14-Dec-06	1:30
		14-Dec-06	1:00	14-Dec-06	3:30
		14-Dec-06	1:30		
				24-Dec-06	
		26-Dec-06	0:40	26-Dec-06	3:00
		26-Dec-06	0:40		
				27-Dec-06	
7-Jan-07	2:00	7-Jan-07	0:40	7-Jan-07	0:30
		8-Jan-07	0:50	8-Jan-07	0:50
9-Jan-07[a]				9-Jan-07	0:10
		21-May-07	0:40	21-May-07	0:40
19-Aug-07	0:10				
		20-Aug-07	0:00	20-Aug-07	0:20
		26-Aug-07	0:10	26-Aug-07	0:20
4-Sep-07	0:20	4-Sep-07	1:00	4-Sep-07	1:00
		16-Nov-07	0:00	16-Nov-07	0:20
		17-Nov-07	0:10	17-Nov-07	0:10
2-Dec-07[b]		2-Dec-07	14:20	2-Dec-07	0:10
				2-Dec-07	12:30
3-Dec-07[b]	17:20	3-Dec-07	0:00	3-Dec-07	0:20
4-Dec-07	0:30				
		8-Apr-08		8-Apr-08	0:20
6-Jun-08	1:10	6-Jun-08	1:00	6-Jun-08	1:10

a. Water level data looks suspicious.
b. Dec. 2 and Dec, 3, 2007 durations were added together.

Table A. 3. Magnolia diversion structure overflow events based on water levels modeled flow using a 4.3 MGD diversion capacity); durations have unit's hh:mm. For the models, events having a single observation are denoted with a blank duration.

Diversion Water Level		Runoff		Mouse/RDII	
Date	Duration	Date	Duration	Date	Duration
1-Jan-07	00:10	1-Jan-07	0:20		
2-Jan-07	01:05	2-Jan-07	1:00	2-Jan-07	0:51
2-Jan-07	03:25	2-Jan-07	3:20	2-Jan-07	2:54
				2-Jan-07	
3-Jan-07	00:25	3-Jan-07			
5-Jan-07	00:35	5-Jan-07	3:20	5-Jan-07	3:03
5-Jan-07	02:30				
7-Jan-07	00:15	7-Jan-07	0:10	7-Jan-07	1:23
7-Jan-07	01:25	7-Jan-07	1:20		
		16-Jan-07			
		10-Feb-07	0:10		
8-Mar-07	00:40	8-Mar-07	0:40	8-Mar-07	0:20
11-Mar-07	00:30	11-Mar-07	1:20	11-Mar-07	0:10
11-Mar-07	00:15			11-Mar-07	0:10
19-Mar-07	00:15	19-Mar-07	1:10	19-Mar-07	0:30
19-Mar-07	00:35				
20-Mar-07	00:15	20-May-07	1:20	20-May-07	0:10
20-May-07	00:40	20-May-07	0:30	20-May-07	0:10
20-May-07	01:00			20-May-07	0:21
20-May-07	00:25				
21-May-07	01:40	21-May-07		21-May-07	2:02
		21-May-07	1:50		
		20-Jul-07			
		3-Sep-07	0:30	3-Sep-07	0:21
4-Sep-07	00:10	4-Sep-07	0:20		
		27-Sep-07			
		27-Sep-07	0:20		
		28-Sep-07			
30-Sep-07	00:05	30-Sep-07	4:40	30-Sep-07	0:10
30-Sep-07	00:15	30-Sep-07	0:10	30-Sep-07	3:04
		3-Oct-07	0:30	3-Oct-07	
		7-Oct-07	0:10		
17-Oct-07	00:15	17-Oct-07	0:30	17-Oct-07	0:10
		17-Oct-07	0:30	17-Oct-07	0:21
		18-Oct-07			
19-Oct-07	00:35	19-Oct-07	1:40	19-Oct-07	1:31
		19-Oct-07	0:20	19-Oct-07	0:11
		19-Oct-07	0:30	19-Oct-07	
24-Oct-07	00:15	24-Oct-07	0:30	24-Oct-07	0:21
		24-Oct-07	0:10	24-Oct-07	
12-Nov-07	00:45	12-Nov-07	5:10	12-Nov-07	4:56
12-Nov-07	00:20				
15-Nov-07	00:25	15-Nov-07	0:40	15-Nov-07	0:41

15-Nov-07	00:45	15-Nov-07	0:20	15-Nov-07	0:11
		15-Nov-07	2:30	15-Nov-07	0:10
				15-Nov-07	1:22
				15-Nov-07	1:32
		16-Nov-07	1:10		
17-Nov-07	01:15	17-Nov-07	1:40	17-Nov-07	1:21
26-Nov-07	00:05	26-Nov-07	1:30	26-Nov-07	1:11
		1-Dec-07	0:30	1-Dec-07	
		1-Dec-07	0:40	1-Dec-07	0:11
2-Dec-07	04:40	2-Dec-07	5:50	2-Dec-07	5:26
2-Dec-07	19:30	2-Dec-07	0:10	2-Dec-07	19:59
3-Dec-07	01:00	2-Dec-07	18:40	3-Dec-07	0:40
3-Dec-07	00:45			3-Dec-07	0:40
4-Dec-07	00:15			4-Dec-07	
		16-Dec-07	0:30		
18-Dec-07	00:40	18-Dec-07	0:50	18-Dec-07	0:51
		19-Dec-07			
		19-Dec-07			
22-Dec-07	00:35	22-Dec-07	1:50	22-Dec-07	0:21
				22-Dec-07	0:10
27-Dec-07	00:15	27-Dec-07	0:30	27-Dec-07	0:11
		2-Jan-08			
9-Jan-08	00:40	9-Jan-08	0:40	9-Jan-08	0:41
		10-Jan-08		10-Jan-08	0:10
12-Jan-08	00:10	12-Jan-08	0:30		
14-Jan-08	00:45	14-Jan-08	0:40	14-Jan-08	0:41
14-Jan-08	01:10	14-Jan-08	1:30	14-Jan-08	1:11
19-Jan-08	00:50	19-Jan-08	1:00	19-Jan-08	0:41
		6-Feb-08			
15-Mar-08	00:50	15-Mar-08	0:50	15-Mar-08	0:52
16-Mar-08	00:15	16-Mar-08	0:40	16-Mar-08	
23-Mar-08	00:10	23-Mar-08	0:50	23-Mar-08	
23-Mar-08	01:05	23-Mar-08	1:00	23-Mar-08	0:31
		23-Mar-08	2:20	23-Mar-08	2:13
26-Mar-08	00:30	26-Mar-08	0:40	26-Mar-08	0:10
		26-Mar-08	1:00	26-Mar-08	0:30
		28-Mar-08	0:20	28-Mar-08	
		29-Mar-08	1:00	29-Mar-08	0:11
		14-Apr-08	0:10		
3-Jun-08	00:40	3-Jun-08	3:10	3-Jun-08	2:23
3-Jun-08	02:45	3-Jun-08	1:00	3-Jun-08	3:54
		3-Jun-08	4:20		
9-Jun-08	00:10	9-Jun-08	0:30	9-Jun-08	0:10

Table A. 4. North Beach pump station overflow events based on wet well water levels and events estimated from modeled flows using a 3.4 MGD pump capacity. Portable meter data was available for a shorter observation period.

Wet Well Water Level		NBCHWetwell		Mouse/RDII	
Date	Duration	Date	Duration	Date	Duration
2-Jan-07	2:36	NA		**2-Jan-07**	1:11
3-Jan-07	0:14				
5-Jan-07	1:39			**5-Jan-07**	0:41
7-Jan-07	0:22				
				8-Jan-07	0:21
19-Mar-07	0:22	**19-Mar-07**	1:00	**19-Mar-07**	0:21
		20-May-07	0:30	20-May-07	0:00
				19-Aug-07	0:10
20-Aug-07	0:20	**20-Aug-07**	0:15	**20-Aug-07**	0:11
19-Oct-07	0:23	**19-Oct-07**	0:15	**19-Oct-07**	1:43
17-Nov-07	0:18	**17-Nov-07**	0:15	**17-Nov-07**	0:11
2-Dec-07	4:03	**2-Dec-07**	4:15	**2-Dec-07**	15:38
3-Dec-07	4:48	**2-Dec-07**	1:45	**3-Dec-07**	1:23
		4-Dec-07	0:15		
9-Jan-08	0:11	**9-Jan-08**	0:00	**9-Jan-08**	0:10
15-Mar-08	0:01			**15-Mar-08**	0:10
4-Apr-08	0:09	**4-Apr-08**	0:00		
				7-Apr-08	0:10
3-Jun-08	1:03	**3-Jun-08**	1:15	**3-Jun-08**	1:32

Appendix B-3

UPDATED CSO CONTROL VOLUMES FOR PUGET SOUND BEACH CSOs

Technical Memorandum

ROBERT E. SWARNER
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23800
REGISTERED
PROFESSIONAL ENGINEER

EXPIRES 1/15/2012

Date: December 9, 2010

To: Shahrzad Namini

From: Bob Swarner (revised by Kevin Schock)

Cc: Bob Swarner

Subject: Updated CSO Control Volumes for Puget Sound Beach CSOs

This is a summary technical memorandum presenting the updated CSO control volumes for use in the Puget Sound Beach CSO Projects. A detailed technical memo is being written to provide more information and documentation comparing the results from two models and recent flow and overflow data.

King County calibrated each of the Puget Sound Beach CSO project areas using the County's Runoff Model and approximately 2 years of data collected prior to 2007. Subsequently Carollo Engineers calibrated the MOUSE model for sub-basins in each of the project basins using flowmeters that were placed in the sewers for 6 months from December 2007 through June 6, 2008. Both calibrated models were run for a 30-year long-term simulation to obtain the 1-year storage volume for each project basin. The resulting 1-year control volumes from each model differed from the other model's estimates, which is to be expected when to using a different model and a different calibration period.

A comparison of each model to the data gathered from early 2007 through June 2008 for each project area was performed (Schock, 2010). Flow data near the downstream portions of the basins were used to compare with the model output. For the Barton, Murray, and South Magnolia basins, it was concluded that we should continue to use the storage volume estimates I sent to you on October 8, 2009. The MOUSE model tends to underestimate flow more often than the Runoff model in the Barton and S. Magnolia basins and may be underestimating the required storage volume in those basins. In the Murray basin, the MOUSE model tends to overestimate flow when compared to the magnetic flowmeters at the pump stations and overestimates the number of overflow events.

For the North Beach basin, the MOUSE model matches the flow data near the pump station and the number of overflow events much better than the Runoff model, so I am recommending using the storage volume that is estimated using the MOUSE model. This volume is significantly lower than the previous volume estimate. The main reason for the difference is that, subsequent to the Runoff model calibration, a pump test revealed that the upstream meters used for the calibration were reading much higher flows than indicated by the pump test. Meters near the pump station were reading much closer to pump test flow results. This finding was used when providing Carollo with direction in

calibrating the MOUSE model. The meters near the pump station were used to adjust upstream meter data so that the total flow matched the "good" downstream meters. It was expected that the resulting storage volume from the MOUSE model would be lower than the original County 1-year CSO volume estimate for this basin. At North Beach Pump Station, the MOUSE model matches well with the flow data collected in 2007 and 2008.

The following is a table containing the updated CSO control volumes associated with the 3 conditions that WTD management has requested. The 3 conditions are:

1. The long-term average from the entire rainfall record;
2. The average of 20-year averages (e.g., the 1-year control volume is computed for each 20-year period in the 30 year record; then the eleven 1-year control volumes are averaged); and
3. The maximum 20 year rainfall period in the entire rainfall record. (The rainfall record is not repeated for this calculation.)

CSO storage Volumes for the 3 Conditions Specified by WTD Management and Peak flows.

Condition	Barton	Murray	South Magnolia	North Beach
	Design Vol. (MG)	Design Vol. (MG)	Design Vol. (MG)	Design Vol. (MG)
Long term Average [1]	0.11 [2]	0.99	1.8	0.23 [3]
Avg. of 20-year averages	0.05	0.81	1.8	0.21
Maximum 20-year Average [4]	0.16	0.97	1.9	0.23
Peak Flow for Long term Average (MGD)	40	59	12	24
Max Flow From Events smaller than Long term (MGD)	42	68	39	24

1 – Rainfall record in simulation: July 1, 1978 – June 30, 2008
2 – Assumes Barton Pump Station will be upgraded to 33 mgd capacity.
3 – Pump station capacity of 3 mgd.
4 – Without repeating the rainfall record.

The Barton CSO control volume in the table is based on the assumption that the Barton Pump Station will be upgraded from about 22 mgd to 33 mgd.

Appendix B-4

MIKE URBAN MODELING APPROACH

TECHNICAL MEMORANDUM

Project Name:	Barton, Murray, North Beach, South Magnolia CSO Facilities	**Date:**	10/17/2008
Client:	King County DNRP, Wastewater Treatment Division	**Project Number:**	7562A10
Prepared By:	Shawn Dent		
Reviewed By:	Brian Matson, Allen de Steiger, Karl Hadler, Jason Nikaido, Ed Wicklein		
Subject:	Mike Urban Modeling Approach		
Distribution:	Bob Swarner, King County Bruce Crawford, King County Kevin Schock, King County Shahrzad Namini, King County		

Purpose

The purpose of this Technical Memorandum (TM) is describe the approach for applying the MIKE URBAN software to model the hydrology of the subbasins and the hydraulics of the sewers in the Barton, Murray, North Beach and South Magnolia basins. The sewers to be modeled include a selection of the Combined Sewer System (CSS), Sanitary Sewer System (SSS), and the Municipal Separate Storm Sewer System (MS4) within the basins. The purpose of modeling these basins and sewers is to accurately estimate the flow generated by each type of sewers and if demand management alternatives will be effective in reducing or eliminating end-of-basin Combined Sewer Overflows (CSOs).

Model Construction Approach

Every model is a simplification of the actual system. The models for the four basins need to be constructed as a tool that represents the hydrology and hydraulics of the basins at a level that allows for analysis of demand management solutions. This study will utilize the hydrologic (surface and subsurface) and hydraulic modules of MIKE URBAN. It is assumed that only select pipes within each of the four basins will be modeled.

Hydrologic Modules

MIKE URBAN has several modules to estimate the wet weather flow from a subbasin. In consultation with King County, the catchment modules consisting of MOUSE Kinematic Wave - B (MOUSE-B) and RDI were chosen to model inflow and infiltration respectively. These catchment modules are the most complex modules available in MIKE URBAN. All catchment modules require a value for subbasin area. Other parameters necessary for MOUSE-B and RDI are summarized below:

- *MOUSE-B module* - This module includes measurable parameters that can be extracted from the GIS including catchment slope, length (analogous to time of concentration), and five parameters describing percent impervious/pervious area. This module also includes 26 Kinematic Wave parameters (including values for Horton's and Manning's equation) for

estimating inflow. These 26 parameters are not directly measurable and must be estimated.

- *RDI module* - This module includes 19 parameters for infiltration (near surface and groundwater) that are not directly measurable and must be estimated.

Therefore, the application of MOUSE-B and RDI modules requires a total of 53 parameters, eight that are directly measurable from GIS data, and 45 parameters that must be estimated as part of the calibration effort. Estimating these 45 parameters for each subbasin will present a challenge, but default values will be used as much as possible for parameters that don't contribute significantly to calibration.

It is envisioned that MOUSE-B and RDI will be used to simulate rainfall dependent infiltration and inflow (I/I) in the CSS and SSS subbasins, while only MOUSE-B will be used to simulate inflow and overland flow in the MS4 subbasins.

Hydraulic Module

The collection system hydraulic module (CS Pipeflow) will be used to model pipes and junctions. This module solves the complete St. Venants (dynamic wave) equations throughout the drainage network both looped and branched, which allows for modeling backwater water effects, flow reversal, surcharging in manholes, alternating free-surface and pressurized flow, tidal outfalls, storage basins, pumps, weirs, orifices etc. The pipe flow model can also perform Long Term Simulation (LTS) and automatic dynamic pipe design.

Model Structure

This modeling effort needs to accurately represent the CSS, SSS, and MS4 systems within each basin. The flow monitoring effort measured flows in the CSS and SSS in each of the four basins, but no MS4 sewers were monitored. However, the MS4 system needs to be modeled in order to examine potential demand management alternatives. The modeled MS4 pipelines will have different subbasins tributary to those sewers than the CSS, and therefore, a second set of subbasins will need to be defined.

CSS/SSS System. Subbasins (or catchments) for the CSS and SSS are defined by each meter location within each basin. Therefore, there will be 7 subbasins in Barton, 6 in Murray, 5 in North Beach and 7 in South Magnolia. An estimate of sanitary flow and I/I will be made for each of these subbasins based on the characteristics of the tributary area upstream of each meter location. Only CSS and SSS pipes downstream of these meter locations will be modeled. *Attachment No.1* illustrates the subbasins that are tributary to each meter location and highlights the pipelines that will be modeled in each of the four basins.

The MS4 was not monitored in any of the basins. Therefore, defining MS4 subbasins will be more subjective than the method described for the CSS/SSS. The MS4 basins will be defined based on the either Scenario A or B defined by King County (CSO Beach Project GIS Analysis, Draft Technical Memorandum, King County, August 2008). Discussion of which scenario is appropriate for each basin will be discussed below (section on calibration).

MS4 System. Inclusion of MS4 pipes in the model will also be subjective since only pipes downstream of the defined MS4 subbasins will be modeled. It is the intent of this modeling effort to include MS4 pipelines that have a similar extent or slightly larger extent than the CSS/SSS. The extent of modeled MS4 pipelines will also define how detailed the demand management alternatives can be investigated.

The initial criteria for including MS4 pipelines in the model will be generally based on the extent of the modeled CSS/SSS along with a generalized guideline of modeling only pipes that are equal to or greater than 18-inches in diameter. Therefore, defining MS4 pipelines in the model will be somewhat basin-specific. Only MS4 pipes (downstream of the MS4 subbasins) will be included in the model and analyzed for capacity deficiencies for the demand management alternatives. *Attachment No.2* illustrates the MS4 subbasins and highlights the pipelines that will be modeled in each of the four basins.

The pipe networks included in the models will be based on the data available in the GIS layers provided to by King County. If data is not available in the GIS for necessary pipes or junctions, King County will be contacted to provide this information. If this information is not easily available, then assumptions will be made to fill in this data based on available upstream and downstream data. Any data that is interpolated in this fashion will be noted for future verification by King County.

Since this modeling effort is not meant to be an all inclusive pipe model, demand management alternatives will only be able to identify capacity limitation in the downstream MS4 pipelines that will be modeled. MS4 pipes upstream in the subbasin need to be further analyzed in more detailed modeling efforts if demand management projects are to be designed.

Rainfall. Rainfall was monitored by one to two rain gages in each basin during the flow monitoring study. The Murray Basin had two gages. One rain gage for each basin has been assigned to each of the subbasins within that basin. This method assumes that the rainfall measured at each gage fell uniformly across each subbasin.

Model Calibration Approach

Once the four models are constructed, the CSS/SSS portions of the models will be calibrated to measured flows using monitored rainfall. The calibrated models will then be used to investigate the feasibility of demand management alternatives within the basins.

Calibration is the process of adjusting parameters in a model to accurately and precisely represent measured variables (e.g., flow, depths, velocity, volume, etc.). Calibration is necessary because collection system models are mathematical representations of a physical system that incorporate some level of simplification. These necessary simplifications introduce error and uncertainty into the analysis. Adjustments of model parameters are necessary to reduce error and better meet the expectations of model application. Both dry weather flow and I/I will be calibrated for the CSS/SSS models.

Dry and Wet Weather Flows

The sanitary flow, or Dry Weather Flow (DWF), will be calibrated by applying a unit diurnal pattern and an Average Dry Weather Flow (ADWF). The unit diurnal pattern for each subbasin will be approximated from the flows that are least affected by rainfall (flows in the late May to June monitoring period). The ADWF will be estimated based on unit flow factors applied to the parcel level land use data in the GIS for residential, commercial and industrial contributions. The unit flow factors will be adjusted to best match the measured ADWF's. The unit flow factors may vary between basins, but due to similar land use patterns, it is not envisioned that these differences will be substantial.

Wet weather flows, or I/I, will be calibrated by inputting measured parameters from the GIS (e.g. area, slope, length, and percent imperviousness) and adjusting other parameters that cannot be directly measured. Although length (analogous to time of concentration) can be measured, this parameter is usually considered a “calibration parameter” that can be adjusted to best represent measured data. Other calibration parameters are usually a subset of unmeasured parameters that have the most dramatic affect in adjusting modeled flow to match measured flow. Several of the unmeasured parameters are included in the model but may not have much affect on calibration. The calibration parameters used in each subbasin will be defined in a later TM.

Precision and Accuracy

Proper calibration requires an assessment of the precision and accuracy of modeled variables compared to measured variables. In this case, flows are the primary variable used for calibration. The goal of calibration depends on the specific use of the model. This model will need to be accurately calibrated to flow volume, peaks, and hydrograph shape because both conveyance as well as equalization facilities will be analyzed. MIKE URBAN provides several calibration tools that will be used and reported (e.g. scatter graphs, residuals, statistics, etc.). King County and Carollo will mutually decide upon what constitutes an adequate calibration by discussing the quality of the monitoring data and the results of the calibration effort.

Time Intervals

The monitoring effort completed by ADS provides the rainfall, flow, depth and velocity measurements that will be used for this study. It was the initial intent of this monitoring effort to record data at 5-minute intervals. However, due to various issues, not all the flow/depth/velocity data could be provided at this interval. Some of the data was provided at a 15-minute interval. When measured flows in a basin consist of both 5-minute and 15-minute data, the best accuracy for the overall basin defaults to 15-minute data. However, the rainfall data was provided at 5-minute intervals for each basin and will be used in the calibration effort. Therefore, 5-minute rain data will be used to run the models, but modeled flows will be aggregated to 15-minute intervals, and reported at this interval, for calibration of the subbasin flows.

GIS Analysis Scenarios

Scenario A, generated by King County’s GIS analysis, will first be chosen to represent the basins, since this scenario appears to represent the most conservative flow estimate for the MS4 (i.e. the largest amount of flow directed to the MS4). This assumption is necessary due to the demand management objectives. Calibration to the CSS/SSS flows will then be used as a second check to verify that total wet weather flows generated by the rainfall over the basins balances. For example, if Scenario A is chosen, but the CSS/SSS within that basin can not be calibrated using reasonable parameters, then the Scenario B will be selected for calibration (assuming that Scenario B provides for a better calibration of the CSS/SSS monitored system).

Flow Balance

Rainfall that is intercepted by each basin must either enter the CSS or SSS (as I/I), enter the MS4 (as inflow), flow overland out of the basin, or be stored within the basin (at either the surface or subsurface). Since the models will only be calibrated to the flows in the CSS/SSS, the other flows (entering the MS4, overland flow, and storage) will need to be estimated. The flows entering the MS4 or flowing overland can readily be estimated using the area and percent impervious estimates generated using the GIS data. However, as stated above, the length (or time of concentration) can be measured, but is usually manipulated as a calibration parameter. Based on the results of the CSS calibrations, a best estimate will be made for each MS4’s and

overland subbasins length. The flow remaining in the subbasins as surface or subsurface storage will be that rainfall that hasn't been conveyed by the other systems.

Design Event and LTS Analysis

The hydrologic modules described above will be used to perform both the design event analysis and the Long Term Simulation (LTS) analysis. The LTS analysis will only utilize the hydrologic portion of the model to project hourly long-term flows based on hourly long-term measured rainfall.

Appendix B-5

MIKE URBAN CALIBRATION TEST

TECHNICAL MEMORANDUM

Project Name:	Barton, Murray, North Beach, South Magnolia CSO Facilities	**Date:**	11/05/2008
Client:	King County DNRP, Wastewater Treatment Division	**Project Number:**	7562A10
Prepared By:	Jason Nikaido, Ed Wicklein, Shawn Dent		
Reviewed By:	Brian Matson, Allen de Steiger, Karl Hadler		
Subject:	MIKE URBAN Calibration Test		
Distribution:	Bob Swarner, King County Bruce Crawford, King County Kevin Schock, King County Shahrzad Namini, King County		

Purpose

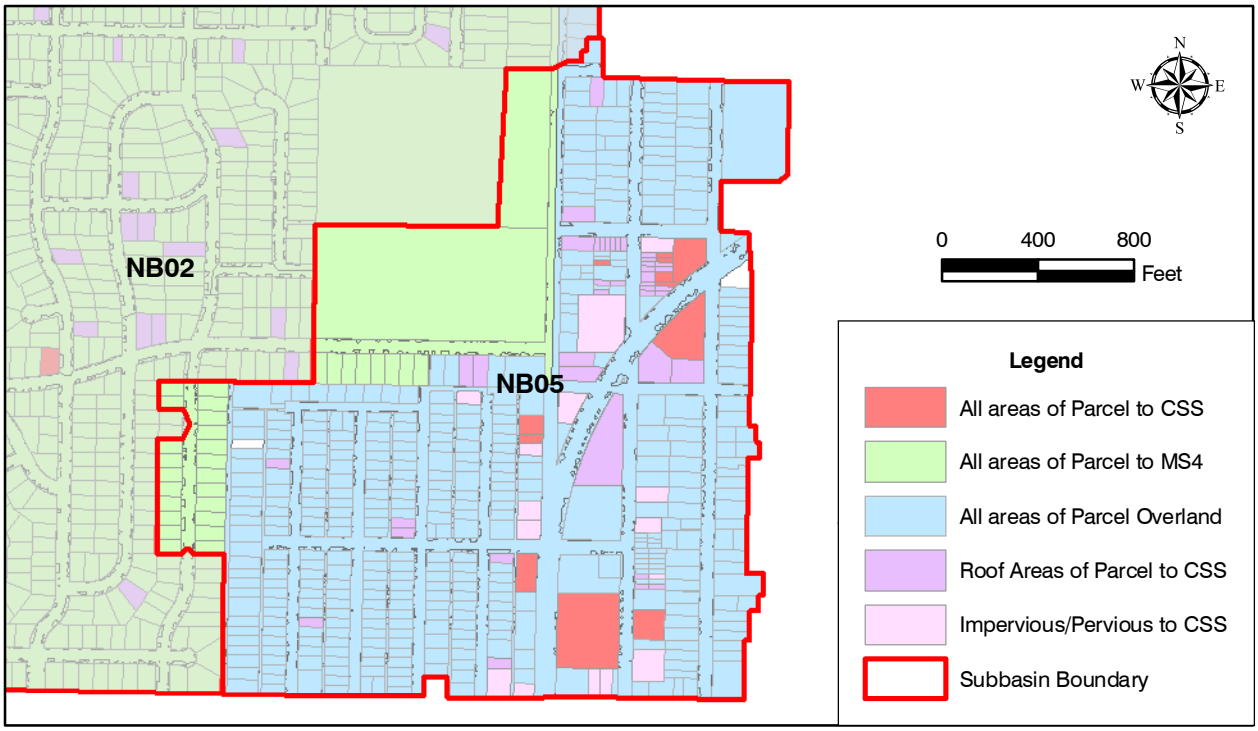
The purpose of this Technical Memorandum (TM) is describe the results of a calibration test using MIKE URBAN software to model the hydrology of subbasin NB05 in the North Beach basin. The purpose of this model calibration effort is to demonstrate how the model was calibrated, what parameters were used, and summarize the results obtained. Statistical tools available in MIKE URBAN are used to report on the accuracy and precision of the calibration. This TM provides a structured protocol for calibrating the models and a basis for judging the efficacy of MIKE URBAN to model the hydrology of the subbasins in the North Beach, South Magnolia, Barton and Murray basins. The TM, *MIKE URBAN Modeling Approach, Carollo Engineers, October 17, 2008*, should be reference for further detail on the overall modeling approach.

Subbasin NB05 Description

The North Beach basin consists of five subbasins designated by five metering locations. Subbasin NB05, the most upstream subbasin, was chosen for the test calibration. This subbasin was chosen because it is the most upstream subbasin in the North Beach basin (no upstream flow influence). The subbasin is primarily overland flow but also contains a mix of Combined Sewer System (CSS), Sanitary Sewer System (SSS) and Municipal Separate Storm Sewer System (MS4). The average slope of this subbasin is 0.014 feet/feet. The average length of this subbasin is 328 feet (length is a surrogate parameter used for time of concentration).

Table 1 summarizes the characteristics of this subbasin. Figure 1 illustrates the features of this subbasin.

Scenario A



Scenario B

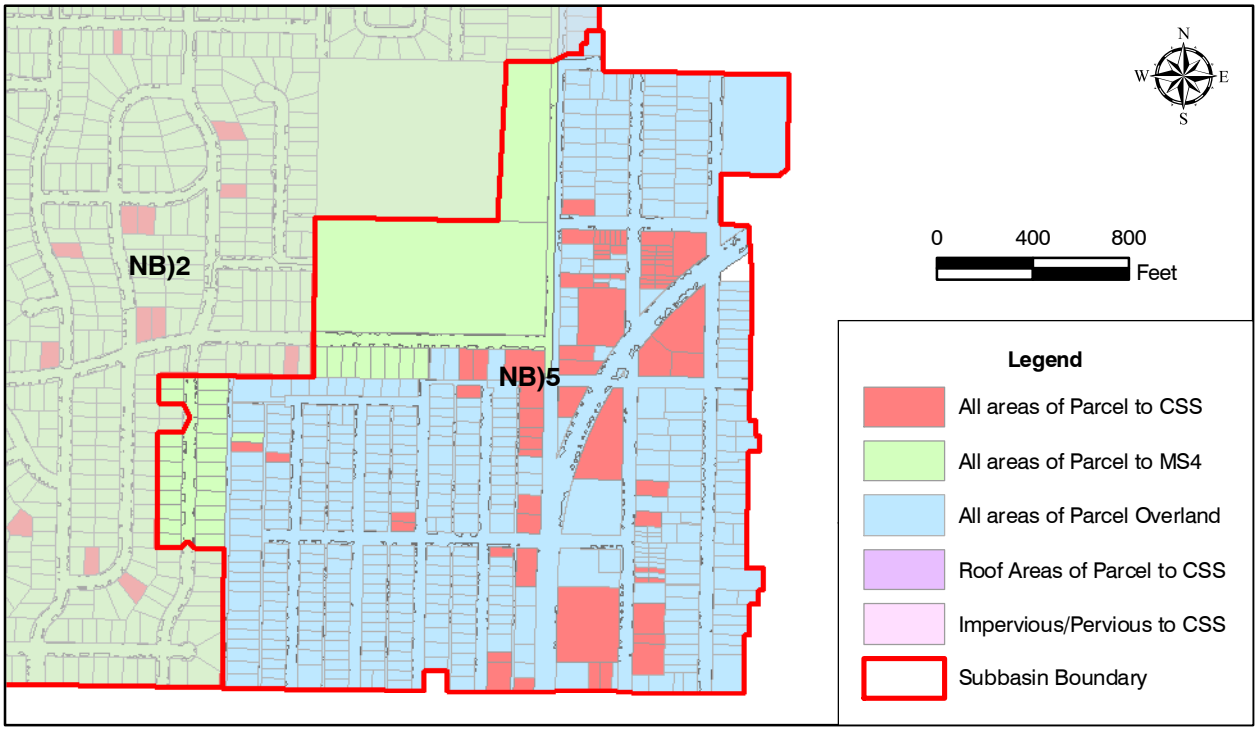


Figure 1
SUBBASIN NB05 FEATURES
BARTON, MURRAY, NORTH BEACH,
SOUTH MAGNOLIA CSO FACILITIES
KING COUNTY DNRP,
WASTEWATER TREATMENT DIVISION

King County

carollo
Engineers...Working Wonders With Water™

E:\Carollo\King_Co\7562A10\Model\North_Beach\nb_scnA_scnB.mxd
Friday, November 07, 2008

Table 1	Subbasin NB05 Characteristics Barton, Murray, North Beach, and South Magnolia CSO Basins King County DNRP, Wastewater Treatment Division												
		Acreage						Percentage					
	Feature Class	Scenario A			Scenario B			Scenario A			Scenario B		
Feature		CSS	MS4	O[1]	CSS	MS4	O	CSS	MS4	O	CSS	MS4	O
ROW	Impervious	0.0	2.9	21.9	0.0	2.9	21.9	0.0	2.6	19.9	0.0	2.6	19.9
	Pervious	0.0	0.3	2.8	0.0	0.3	2.8	0.0	0.3	2.6	0.0	0.3	2.6
Parcels	Roof	4.6	1.8	17.1	5.3	1.9	16.3	4.1	1.7	15.6	4.8	1.7	14.8
	Impervious	5.9	5.6	24.1	7.5	5.5	22.5	5.4	5.0	21.9	6.8	5.0	20.4
	Pervious	0.8	8.1	14.2	1.0	8.1	14.1	0.7	7.4	12.9	0.9	7.4	12.8
Total Area	---	11.3	18.7	80.3	13.7	18.7	77.7	10.2	17.0	72.8	12.5	16.9	70.5

Notes:
(1) O = Overland flow

Monitored data

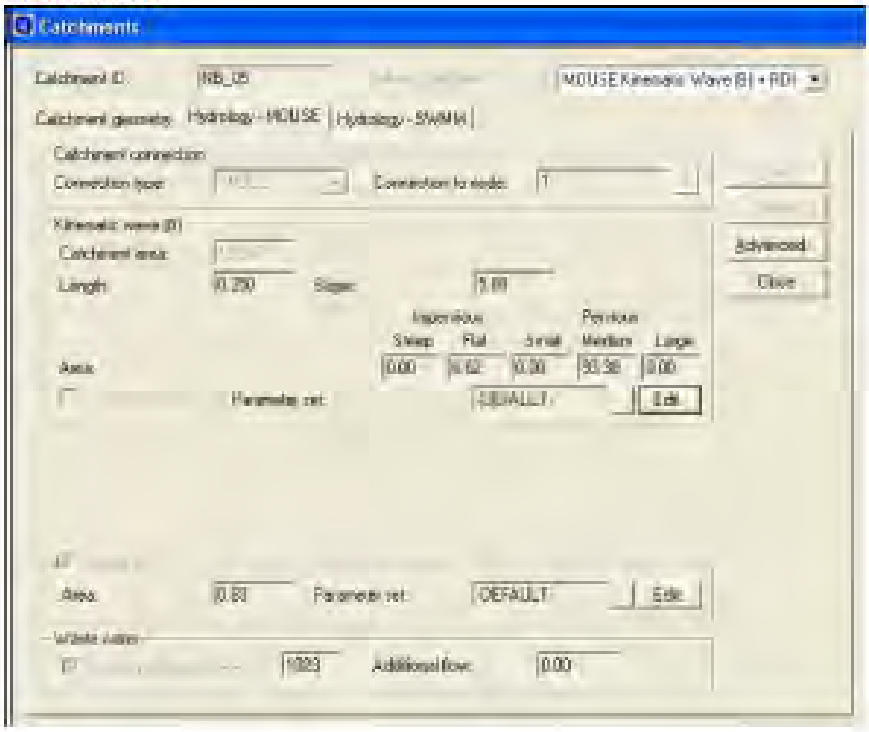
The monitoring effort completed by ADS provides the rainfall, flow, depth and velocity measurements that will be used for this study. It was the initial intent of this monitoring effort to record data at 5-minute intervals. However, due to various issues, not all the flow/depth/velocity data could be provided at this interval. Some of the data was provided at a 15-minute interval. When measured flows in a basin consist of both 5-minute and 15-minute data, the best accuracy for the overall basin defaults to 15-minute data. However, the rainfall data was provided at 5-minute intervals for each basin and will be used in the calibration effort. Therefore, 5-minute rain data will be used to run the models, but modeled flows will be aggregated to 15-minute intervals, and reported at this interval, for calibration of the subbasin flows.

Calibration Parameters

The subbasin model was calibrated to both Dry Weather Flow (DWF) and Infiltration and Inflow (I/I). DWF was calibrated by applying a unit diurnal pattern and an Average Dry Weather Flow (ADWF). The unit diurnal pattern for each subbasin was approximated from the flows that are least affected by rainfall, which included weekend and weekday flows from May 4 - 11, 2008. No rainfall was observed during this period with minimal preceding it. The ADWF was estimated as person equivalents (PE) based on unit flow factors applied to population estimates and parcel level land use data in the GIS for residential, commercial and industrial contributions. The unit flow factors were adjusted to best match the measured ADWF's. Based on the period from May 4 - 11, 2008, a dry weather flow of 0.1023 mgd was estimated. Using an average of 100 gallons per capita per day, a PE of 1,023 was used.

The MOUSE Kinematic Wave - B (MOUSE-B) and RDI were chosen to model inflow and infiltration respectively. I/I was calibrated by inputting measured parameters from the GIS (e.g. area, slope, length, and percent imperviousness) and adjusting other parameters that cannot be directly measured. Although length (analogous to time of concentration) can be measured, this parameter is usually considered a "calibration parameter" that can be adjusted to best represent measured data. Other calibration parameters are usually a subset of unmeasured parameters that have the most dramatic affect in adjusting modeled flow to match measured flow. Table 2 summarizes the calibration parameter set and the values used to calibrate the subbasins response. Figure 2 presents the Kinematic Wave and RDI parameters.

Kinematic Wave Parameters



RDI Parameters

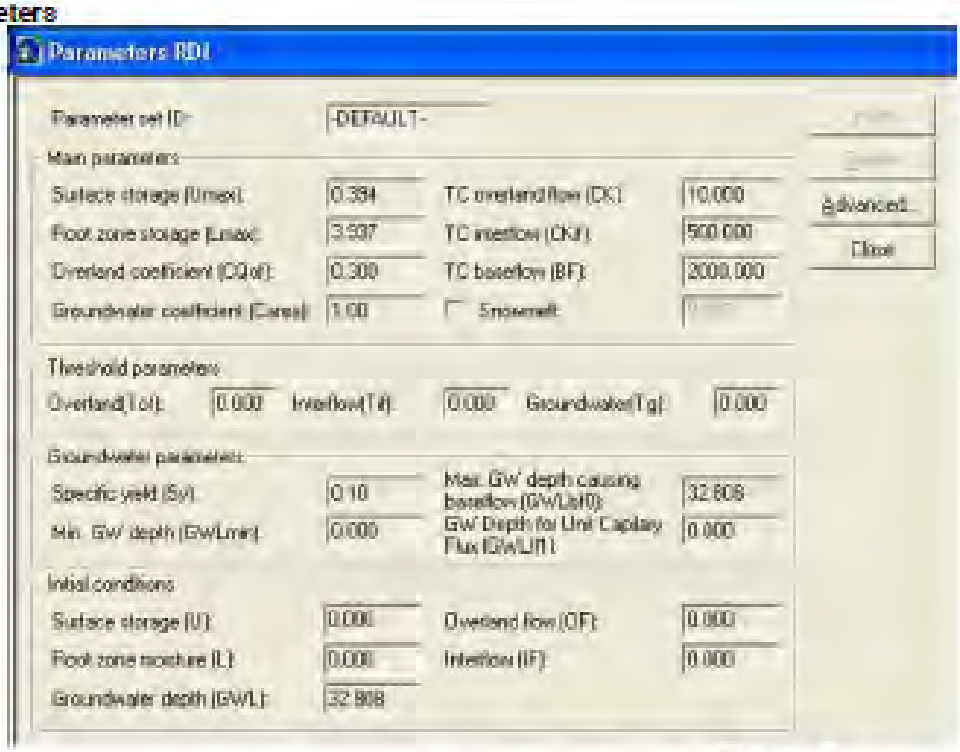


Figure 2
KINEMATIC WAVE AND RDI PARAMETERS
BARTON, MURRAY, NORTH BEACH,
SOUTH MAGNOLIA CSO FACILITIES
KING COUNTY DNRP,
WASTEWATER TREATMENT DIVISION

King County carollo

Table 2	Subbasin NB05 Hydrologic Calibration Parameters Barton, Murray, North Beach, and South Magnolia CSO Basins King County DNRP, Wastewater Treatment Division		
Parameter (units)	**Typical Range**	**Value Used**	**Comments**
Area (acres)	Varies	11.3	Physical measurement - total area tributary to CSS
Length (feet)	Varies	0.25	Physical measurement - adjusted during calibration
Slope (ft/ft)	Varies	5.00	Physical Measurement - adjusted during calibration
Steep Impervious (%)	Varies	0.00	Physical Measurement
Flat Impervious (%)	Varies	7.08	Physical Measurement - total impervious area
Small Pervious (%)	Varies	0.00	Physical Measurement
Medium Pervious (%)	Varies	92.92	Physical Measurement - total pervious area
Large Pervious (%)	Varies	0.00	Physical Measurement
RDI Area (acres)	Varies	0.83	Physical Measurement - pervious area tributary to CSS
Kinematic Wave	Varies	See Fig 2	Default
RDI	Varies	See Fig 2	Default

Results

Proper calibration requires an assessment of the precision and accuracy of modeled variables compared to measured variables. In this case, flows are the primary variable used for calibration. The goal of calibration depends on the specific use of the model. This model will need to be accurately calibrated to flow volume, peaks, and hydrograph shape because both conveyance as well as equalization facilities will be analyzed. MIKE URBAN provides several calibration tools that will be used and reported (e.g. scatter graphs, residuals, statistics, etc.). King County and Carollo will mutually decide upon what constitutes an adequate calibration by discussing the quality of the monitoring data and the results of the calibration effort.

Figures 3-9 present hydrographs of the calibration for each month. In general, the response to rainfall is good. Peak flows, hydrograph shape, and dry weather flows for the measured and modeled data match well. In addition, wet weather flows return to dry weather flows as expected.

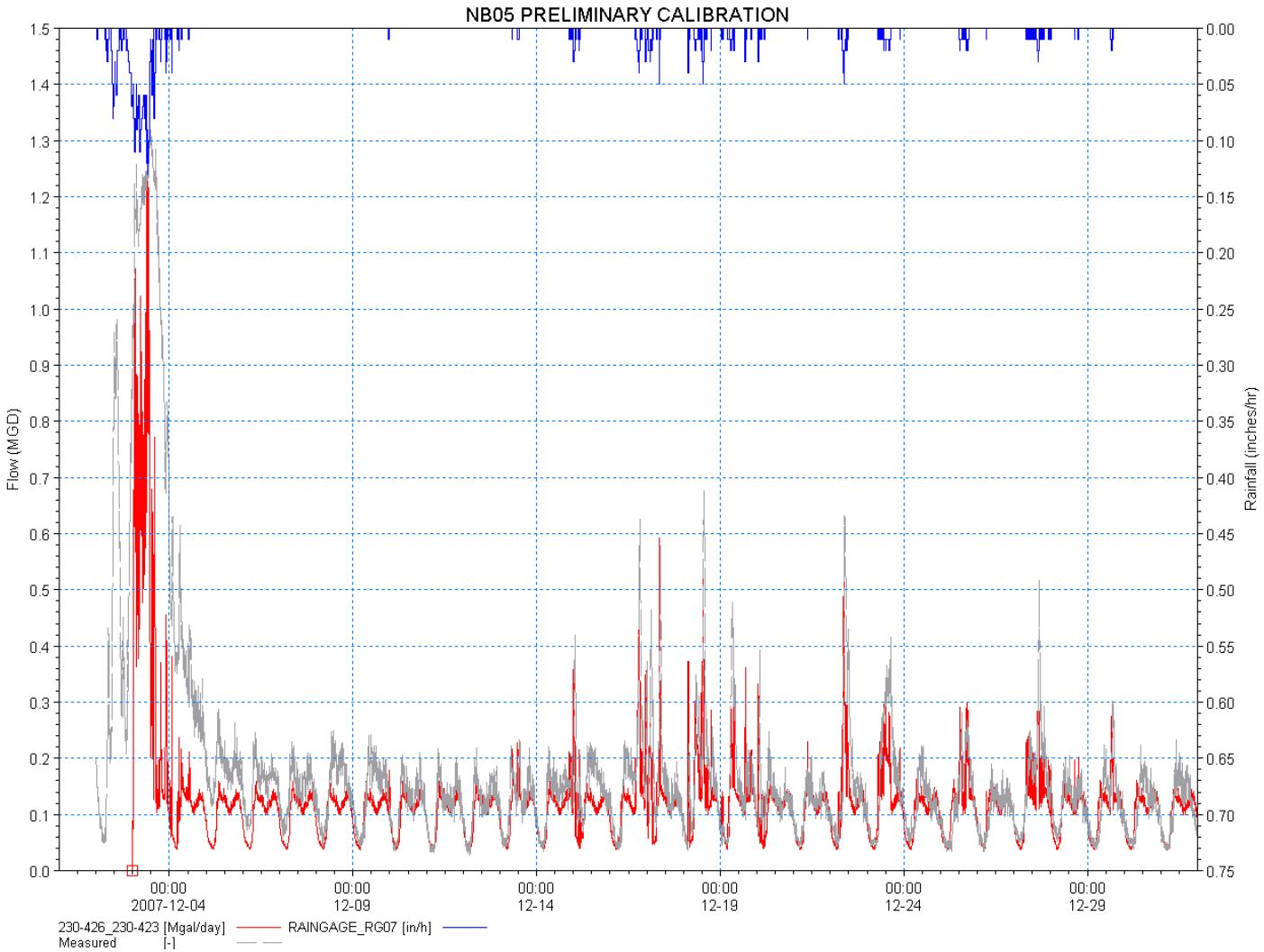


Figure 3
SUBBASIN NB05 TEST CALIBRATION - DECEMBER 2007
BARTON, MURRAY, NORTH BEACH, SOUTH MAGNOLIA CSO FACILITIES
KING COUNTY DNRP, WASTEWATER TREATMENT DIVISION

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Friday, November 07, 2008

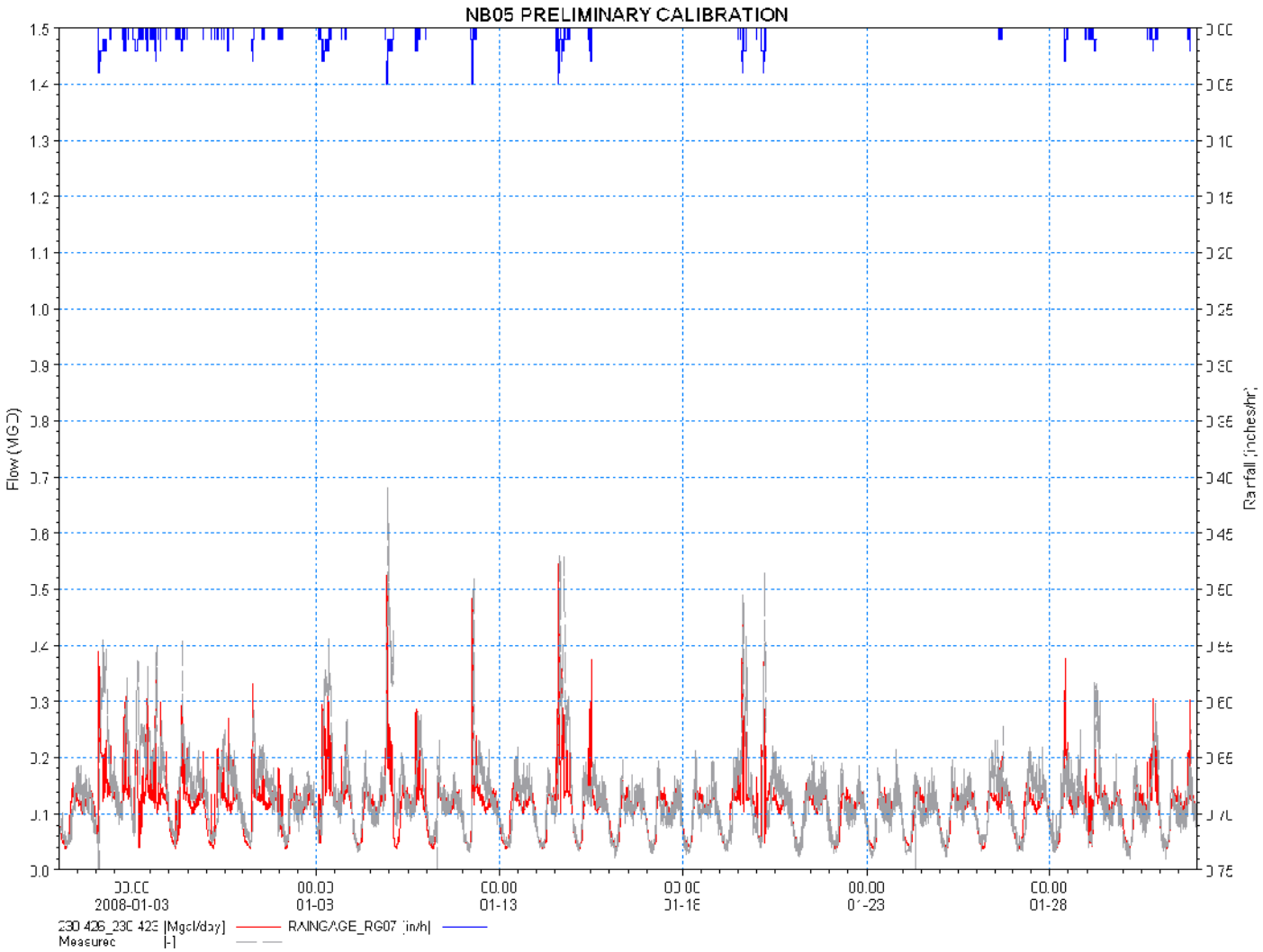

Figure 4
SUBBASIN NB05 TEST CALIBRATION - JANUARY 2008
BARTON, MURRAY, NORTH BEACH, SOUTH MAGNOLIA CSO FACILITIES
KING COUNTY DNRP, WASTEWATER TREATMENT DIVISION

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Friday, November 07, 2008

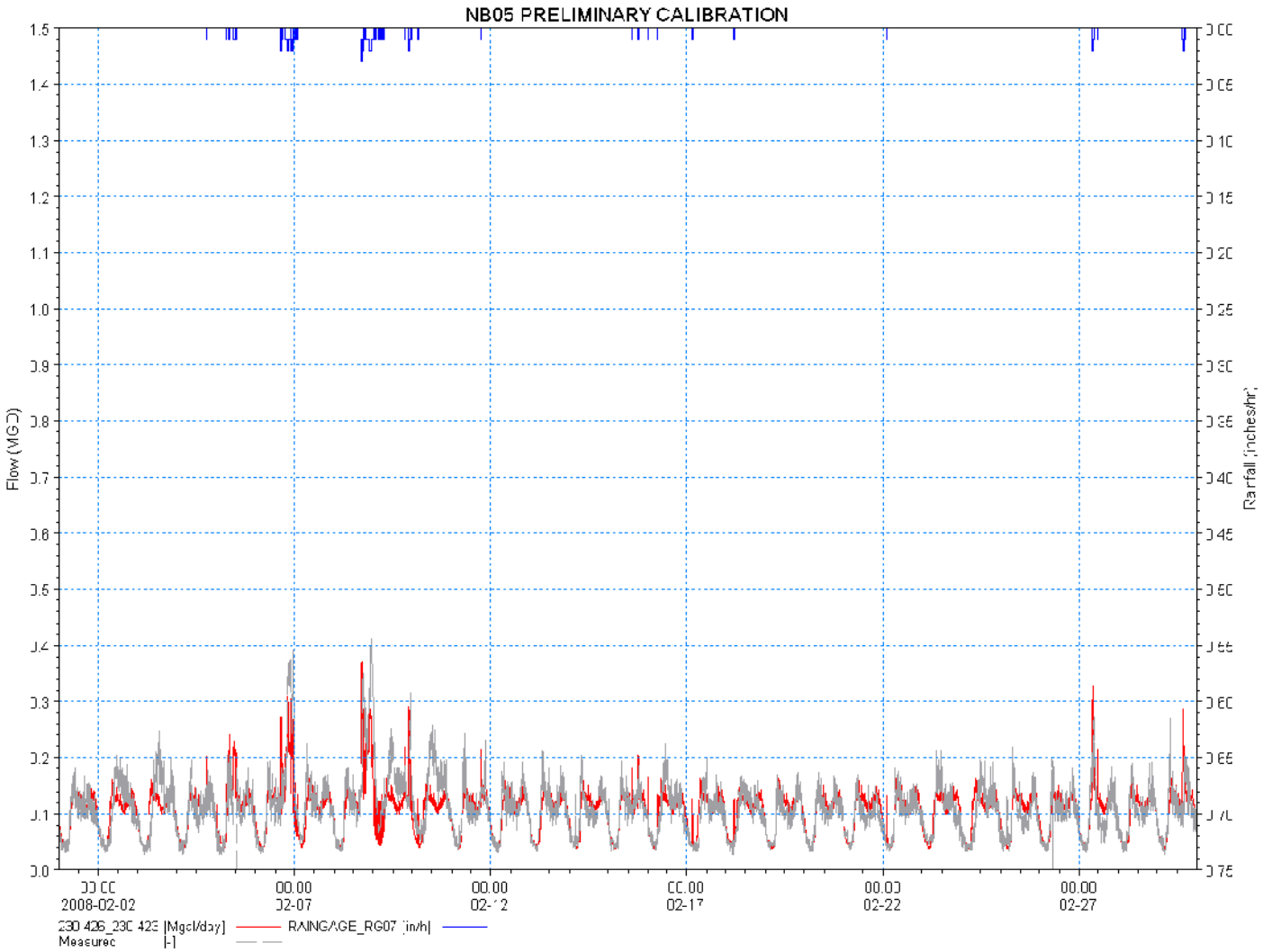

Figure 5

SUBBASIN NB05 TEST CALIBRATION - FEBRUARY 2008

BARTON, MURRAY, NORTH BEACH, SOUTH MAGNOLIA CSO FACILITIES

KING COUNTY DNRP, WASTEWATER TREATMENT DIVISION

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Friday, November 07, 2008

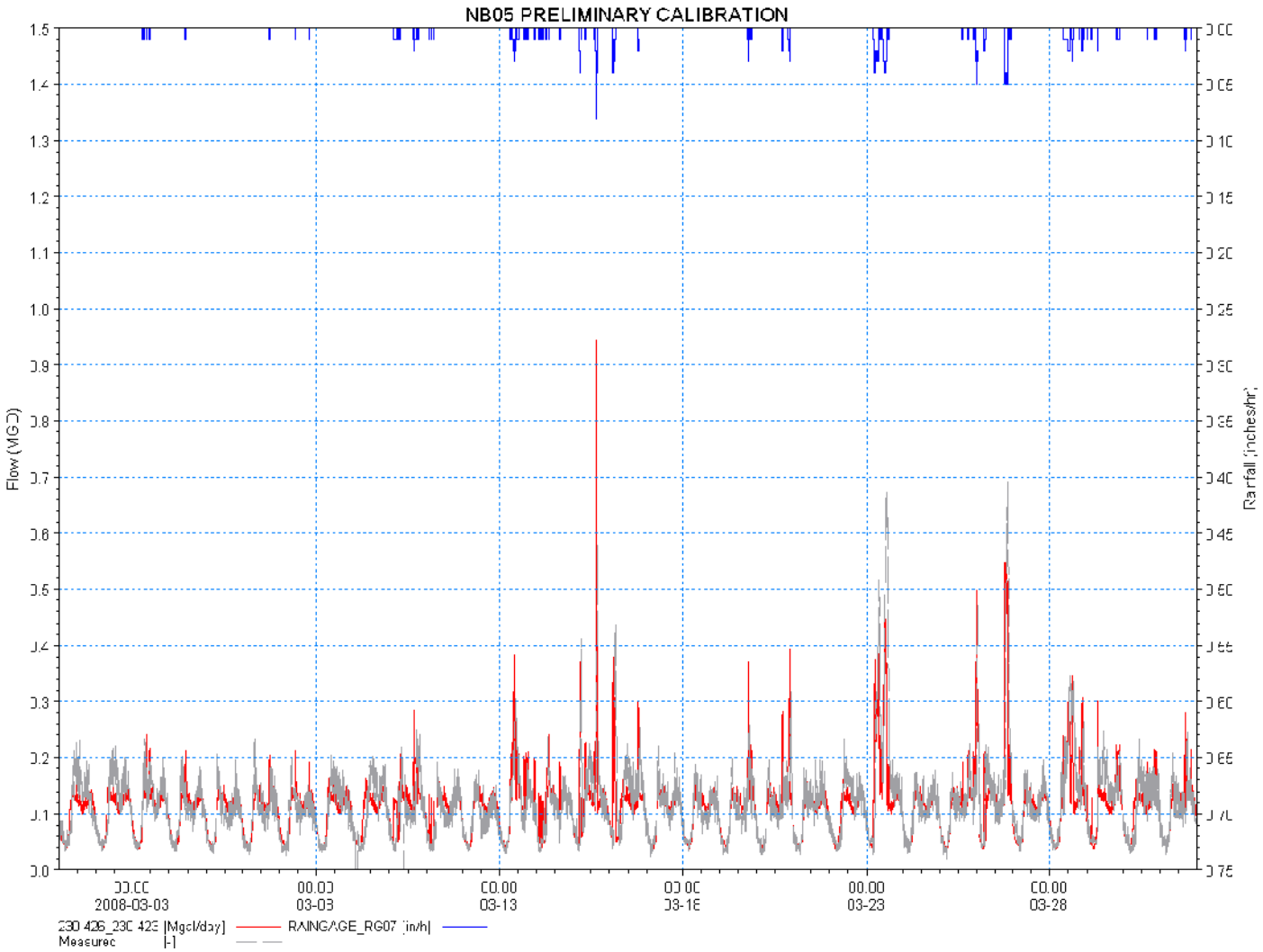

Figure 6
SUBBASIN NB05 TEST CALIBRATION - MARCH 2008
BARTON, MURRAY, NORTH BEACH, SOUTH MAGNOLIA CSO FACILITIES
KING COUNTY DNRP, WASTEWATER TREATMENT DIVISION

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Friday, November 07, 2008

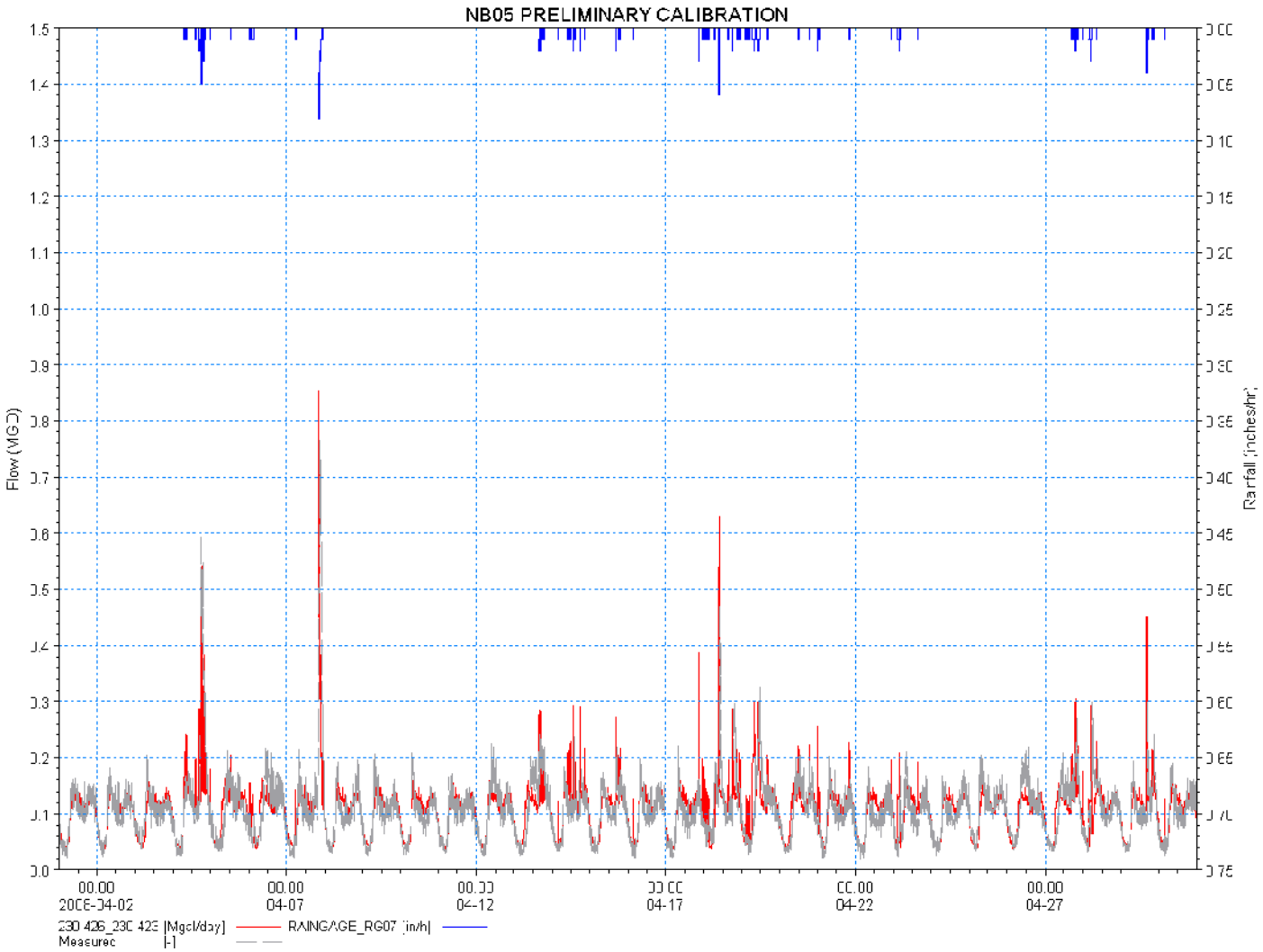

Figure 7
SUBBASIN NB05 TEST CALIBRATION - APRIL 2008
BARTON, MURRAY, NORTH BEACH, SOUTH MAGNOLIA CSO FACILITIES
KING COUNTY DNRP, WASTEWATER TREATMENT DIVISION

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Friday, November 07, 2008

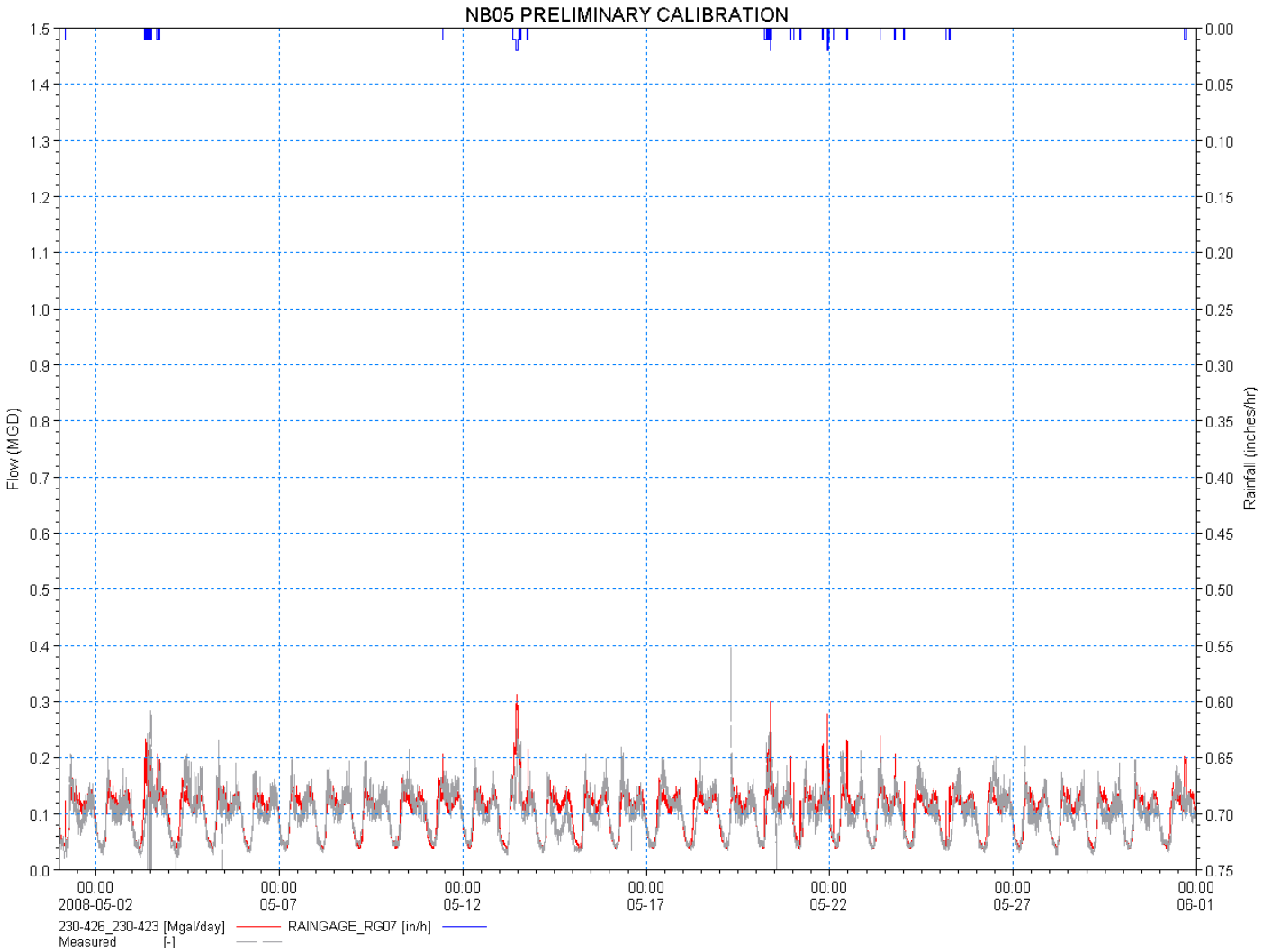

Figure 8
SUBBASIN NB05 TEST CALIBRATION - MAY 2008
BARTON, MURRAY, NORTH BEACH, SOUTH MAGNOLIA CSO FACILITIES
KING COUNTY DNRP, WASTEWATER TREATMENT DIVISION

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Friday, November 07, 2008

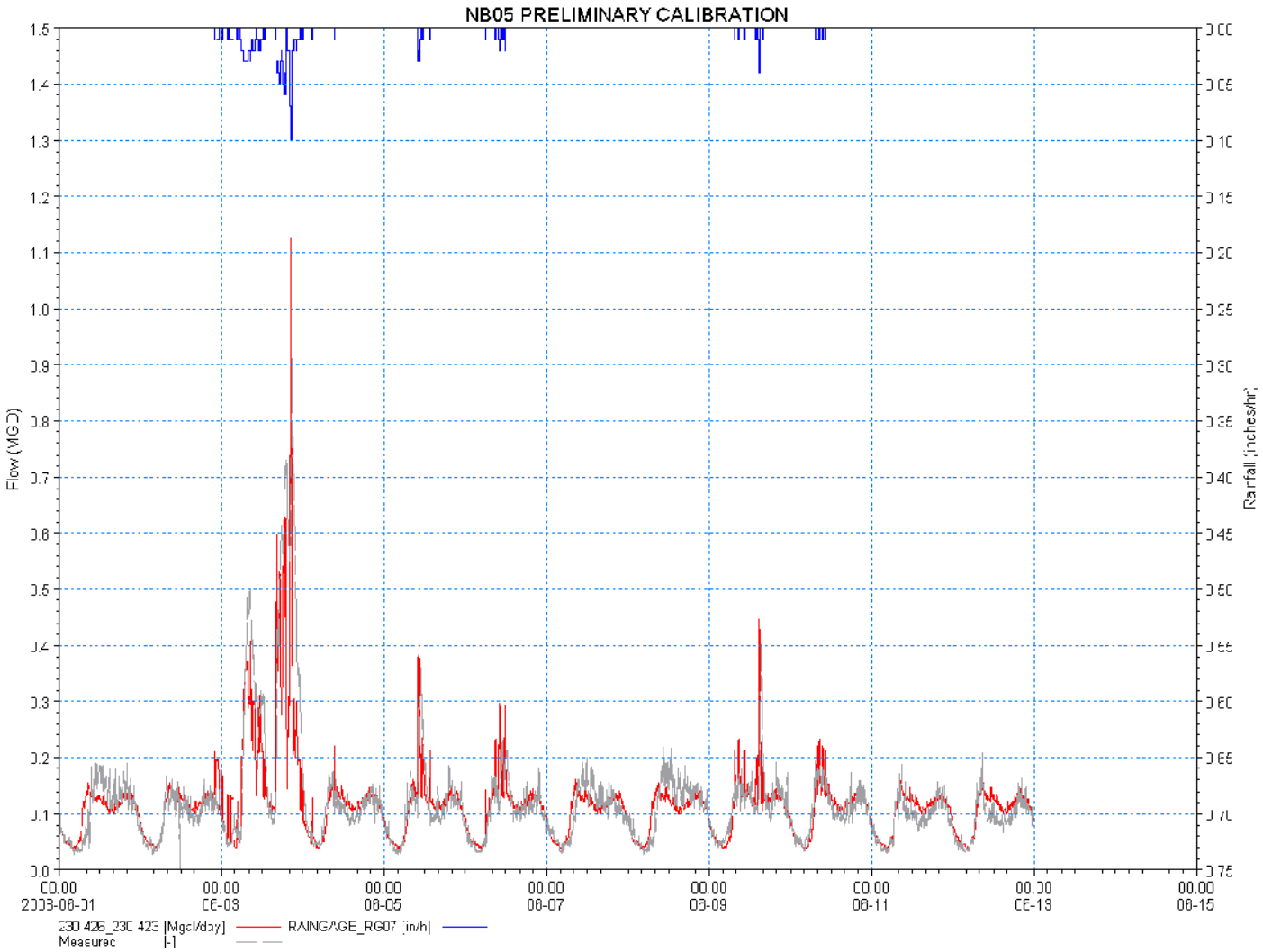

Figure 9
SUBBASIN NB05 TEST CALIBRATION - JUNE 2008
BARTON, MURRAY, NORTH BEACH, SOUTH MAGNOLIA CSO FACILITIES
KING COUNTY DNRP, WASTEWATER TREATMENT DIVISION

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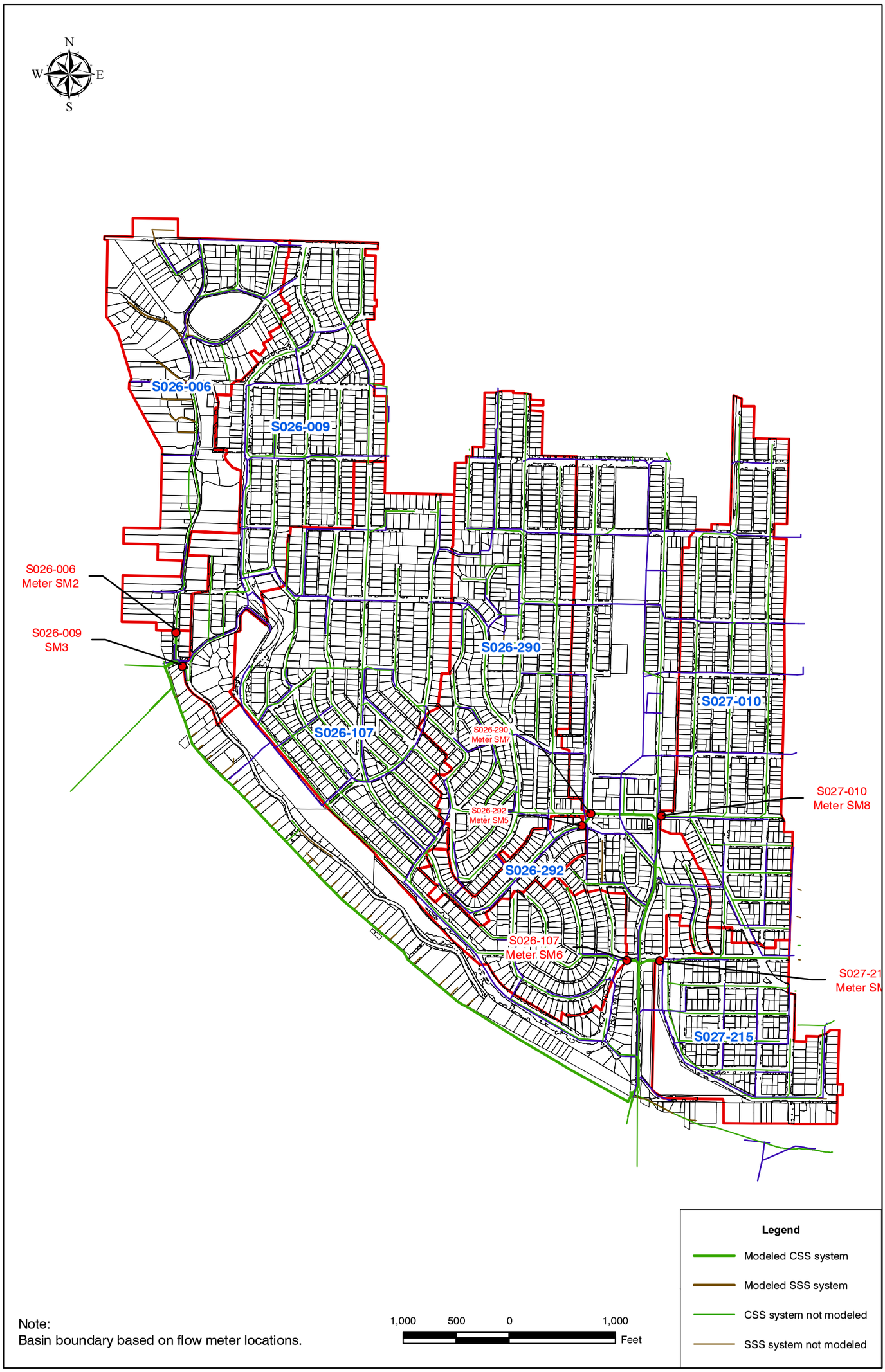
Friday, November 07, 2008



Note:
Basin boundary based on flow meter locations.

Figure A-4
PRELIMINARY SANITARY BASINS AND PIPES
SOUTH MAGNOLIA
BARTON, MURRAY, NORTH BEACH, SOUTH MAGNOLIA CSO FACILITIES
KING COUNTY DNRP, WASTEWATER TREATMENT DIVISION

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Wednesday, November 5, 2008

Appendix B-6

NORTH BEACH BASIN CALIBRATION, ROUND 1

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SEATTLE, WASHINGTON 98101-3032
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PHONE: (206) 684-6532

TECHNICAL MEMORANDUM

Project Name:	CSO Planning/Predesign Services	**Date:**	11/17/2008
Client:	King County DNRP, Wastewater Treatment Division	**Project Number:**	7562A.10
Prepared By:	Shawn Dent, Jason Nikaido, Ed Wicklein		
Reviewed By:	Allen deSteiguer		
Subject:	North Beach Basin Calibration, Round 1		
Distribution:	King County, Project Team		

This memo contains the calibration for the North Beach Basin. The following are included:

MikeUrban Layout (Figure 1)
Calibration Parameter Table (Table 1)

NB01

- NB01 Calibration Plot (Figure 2)
- NB01 Statistical Analysis Plot (Figure 3)
- NB01 Statistical Analysis Table (Table 2)

NB02

- NB02 Calibration Plot (Figure 4)
- NB02 Statistical Analysis Plot (Figure 5)
- NB02 Statistical Analysis Table (Table 3)

NB03

- NB03 Calibration Plot (Figure 6)
- NB03 Statistical Analysis Plot (Figure 7)
- NB03 Statistical Analysis Table (Table 4)

NB04

- NB04 Calibration Plot (Figure 8)
- NB04 Statistical Analysis Plot (Figure 9)
- NB04 Statistical Analysis Table (Table 5)

NB05

- NB05 Calibration Plot (Figure 10)
- NB05 Statistical Analysis Plot (Figure 11)
- NB05 Statistical Analysis Table (Table 6)

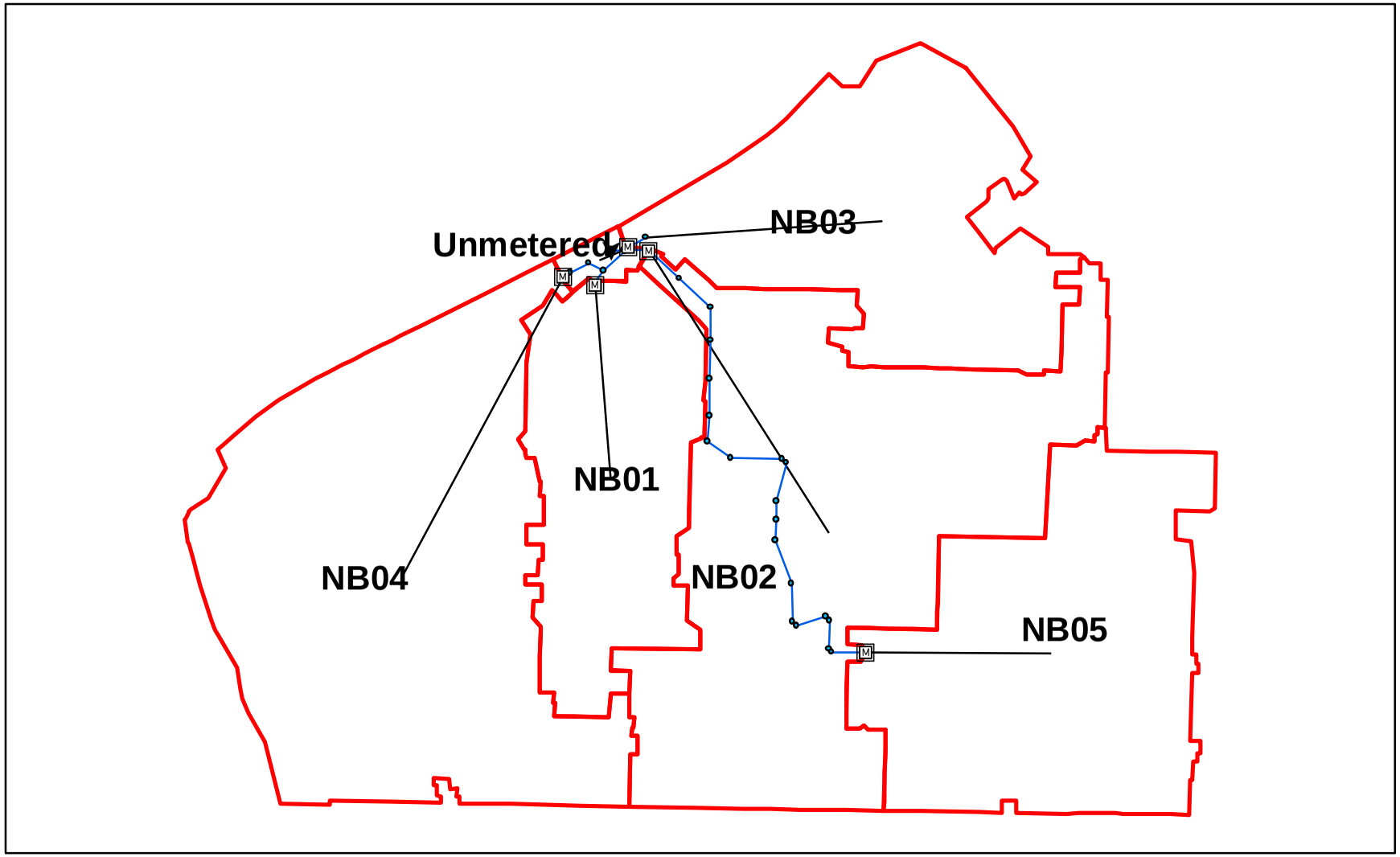


Figure 1
MIKE URBAN LAYOUT- NORTH BEACH
CSO PLANNING/PREDESIGN SERVICES
KING COUNTY DNRP, WASTEWATER TREATMENT DIVISION

E:\Carollo\King_Co\7562A10\Model\North_Beach\MIKE URBAN Layout.mxd
Monday, November 17, 2008

Table 1 - Calibration Parameters
CSO Planning/Predesign Services
King County DNRP, Wastewater Treatment Division

Parameter	MU name	Units	Meter NB01	NB02	NB03	NB04	NB05
Catchment Geometry							
Drainage Area	Area	Acres	73.400	76.000	128.500	94.500	48.050
Kinematic Wave (B)							
Length	Length	Feet	1250.00	100.00	200.00	100.00	50.00
Slope	Slope	0/00	7.72	8.26	9.2	5.65	1.73
Steep Impervious Area	AISteep	%	0.00	0.00	0.00	0.00	0.00
Flat Impervious Area	AIFlat	%	53.69%	71.31%	60.72%	56.25%	74.72%
Small Pervious Area	APSmall	%	0.00	0.00	0.00	0.00	0.00
Medium Pervious Area	APMedium	%	0.00	0.00	0.00	0.00	0.00
Large Pervious Area	APLarge	%	46.31%	28.69%	39.28%	43.75%	25.28%
Wetting initial losses, steep impervious area	WetSteep	Inches	1.969E-03	1.969E-03	1.969E-03	1.969E-03	1.969E-03
Wetting initial losses, flat impervious area	WetFlat	Inches	1.969E-03	1.969E-03	1.969E-03	1.969E-03	1.969E-03
Wetting initial losses, small pervious area	WetSmall	Inches	1.969E-03	1.969E-03	1.969E-03	1.969E-03	1.969E-03
Wetting initial losses, medium pervious area	WetMedium	Inches	1.969E-03	1.969E-03	1.969E-03	1.969E-03	1.969E-03
Wetting initial losses, large pervious area	WetLarge	Inches	1.969E-03	1.969E-03	1.969E-03	1.969E-03	1.969E-03
Storage initial losses, flat impervious area	StorageFlat	Inches	2.362E-02	2.362E-02	2.362E-02	2.362E-02	2.362E-02
Storage initial losses, small pervious area	StorageSmall	Inches	3.937E-02	3.937E-02	3.937E-02	3.937E-02	3.937E-02
Storage initial losses, medium pervious area	StorageMedium	Inches	3.937E-02	3.937E-02	3.937E-02	3.937E-02	3.937E-02
Storage initial losses, large pervious area	StorageLarge	Inches	7.874E-02	7.874E-02	7.874E-02	7.874E-02	7.874E-02
Horton's infiltration capacity, maximum, small pervious area	InfMaxSmall	Inches/hour	0.142	0.142	0.142	0.142	0.142
Horton's infiltration capacity, maximum, medium pervious area	InfMaxMedium	Inches/hour	1.417	1.417	1.417	1.417	1.417
Horton's infiltration capacity, maximum, large pervious area	InfMaxLarge	Inches/hour	2.835	2.835	2.835	2.835	2.835
Horton's infiltration capacity, minimum, small pervious area	InfMinSmall	Inches/hour	0.071	0.071	0.071	0.071	0.071
Horton's infiltration capacity, minimum, medium pervious area	InfMinMedium	Inches/hour	0.142	0.142	0.142	0.142	0.142
Horton's infiltration capacity, minimum, large pervious area	InfMinLarge	Inches/hour	0.709	0.709	0.709	0.709	0.709
Horton's exponent, wet condition, small pervious area	InfExpWetSmall	sec^{-1}	1.500E-03	1.500E-03	1.500E-03	1.500E-03	1.500E-03
Horton's exponent, wet condition, medium pervious area	InfExpWetMedium	sec^{-1}	1.500E-03	1.500E-03	1.500E-03	1.500E-03	1.500E-03
Horton's exponent, wet condition, large pervious area	InfExpWetLarge	sec^{-1}	1.500E-03	1.500E-03	1.500E-03	1.500E-03	1.500E-03
Horton's exponent, dry condition, small pervious area	InfExpDrySmall	sec^{-1}	5.000E-05	5.000E-05	5.000E-05	5.000E-05	5.000E-05
Horton's exponent, dry condition, medium pervious area	InfExpDryMedium	sec^{-1}	1.000E-05	1.000E-05	1.000E-05	1.000E-05	1.000E-05
Horton's exponent, dry condition, large pervious area	InfExpDryLarge	sec^{-1}	5.000E-05	5.000E-05	5.000E-05	5.000E-05	5.000E-05
Manning number, steep impervious area	ManningSteep	---	0.0125	0.0125	0.0125	0.0125	0.0125
Manning number, flat impervious area	ManningFlat	---	0.0143	0.0143	0.0143	0.0143	0.0143
Manning number, small pervious area	ManningSmall	---	0.0333	0.0333	0.0333	0.0333	0.0333
Manning number, medium pervious area	ManningMedium	---	0.0333	0.0333	0.0333	0.0333	0.0333
Manning number, large pervious area	ManningLarge	---	0.0833	0.0833	0.0833	0.0833	0.0833
RDI							
Area	RdiiArea	%	100.000	100.000	100.000	100.000	100.000
Surface storage (Umax)	Umax	Inches	0.394	0.394	0.394	0.394	0.394
Root zone storage (Lmax)	Lmax	Inches	3.937	3.937	3.937	3.937	3.937
Overland coefficient (CQof)	Cqof	---	0.300	0.300	0.300	0.300	0.300
Groundwater coefficient (Carea)	GwCarea	---	1.00	1.00	1.00	1.00	1.00
TC overland flow (CK)	Ck	Hours	10.000	10.000	10.000	10.000	10.000
TC interflow (CKif)	Ckif	Hours	500.000	500.000	500.000	500.000	500.000
TC baseflow (BF)	Ckof	Hours	2000.000	2000.000	2000.000	2000.000	2000.000
Overland flow threshold (Tof)	Tof	%	0.000	0.000	0.000	0.000	0.000
Interflow threshold (Tif)	Tif	%	0.000	0.000	0.000	0.000	0.000
Groundwater threshold (Tg)	Tg	%	0.000	0.000	0.000	0.000	0.000
Specific yield (Sy)	GwSy	---	0.10	0.10	0.10	0.10	0.10
Minimum groundwater depth (GWLmin)	GwLmin	Feet	32.808	32.808	32.808	32.808	32.808
Maximum groundwater depth causing baseflow (GWLbf0)	GWLbf0	Feet	0.000	0.000	0.000	0.000	0.000
Groundwater depth for unit capilary flux (GWLfl1)	GWLfl1	Feet	0.000	0.000	0.000	0.000	0.000
Initial surface storage (U)	InitU	Inches	0.000	0.000	0.000	0.000	0.000
Initial root zone moisture (L)	InitL	Inches	0.000	0.000	0.000	0.000	0.000
Initial groundwater depth (GWL)	InitGwl	Feet	32.808	32.808	32.808	32.808	32.808
Initial overland flow (OF)	InitOf	Inches/hour	0.000	0.000	0.000	0.000	0.000
Initial interflow (IF)	InitIf	Inches/hour	0.000	0.000	0.000	0.000	0.000

Figure 2

NB01 Calibration - June Storm Event

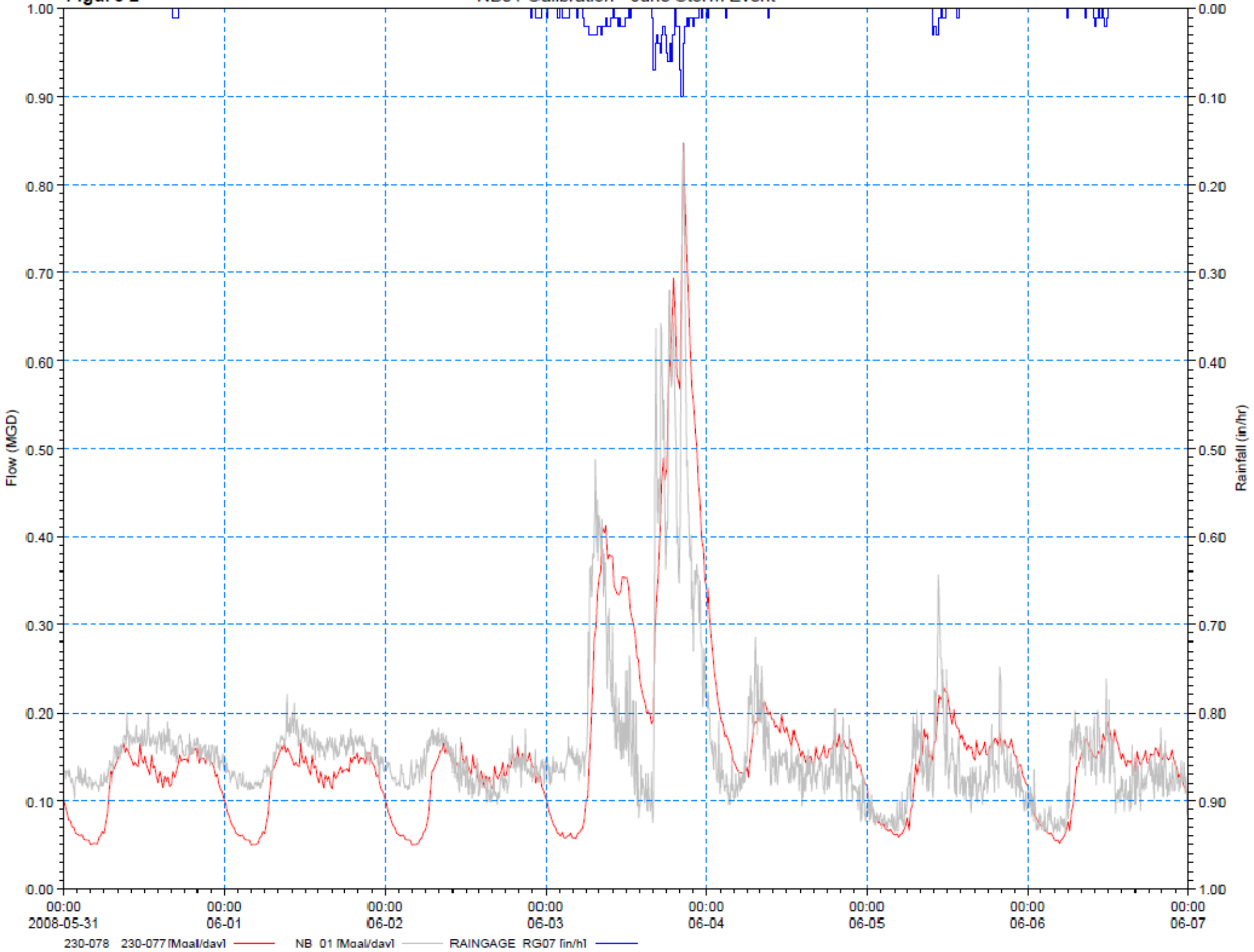
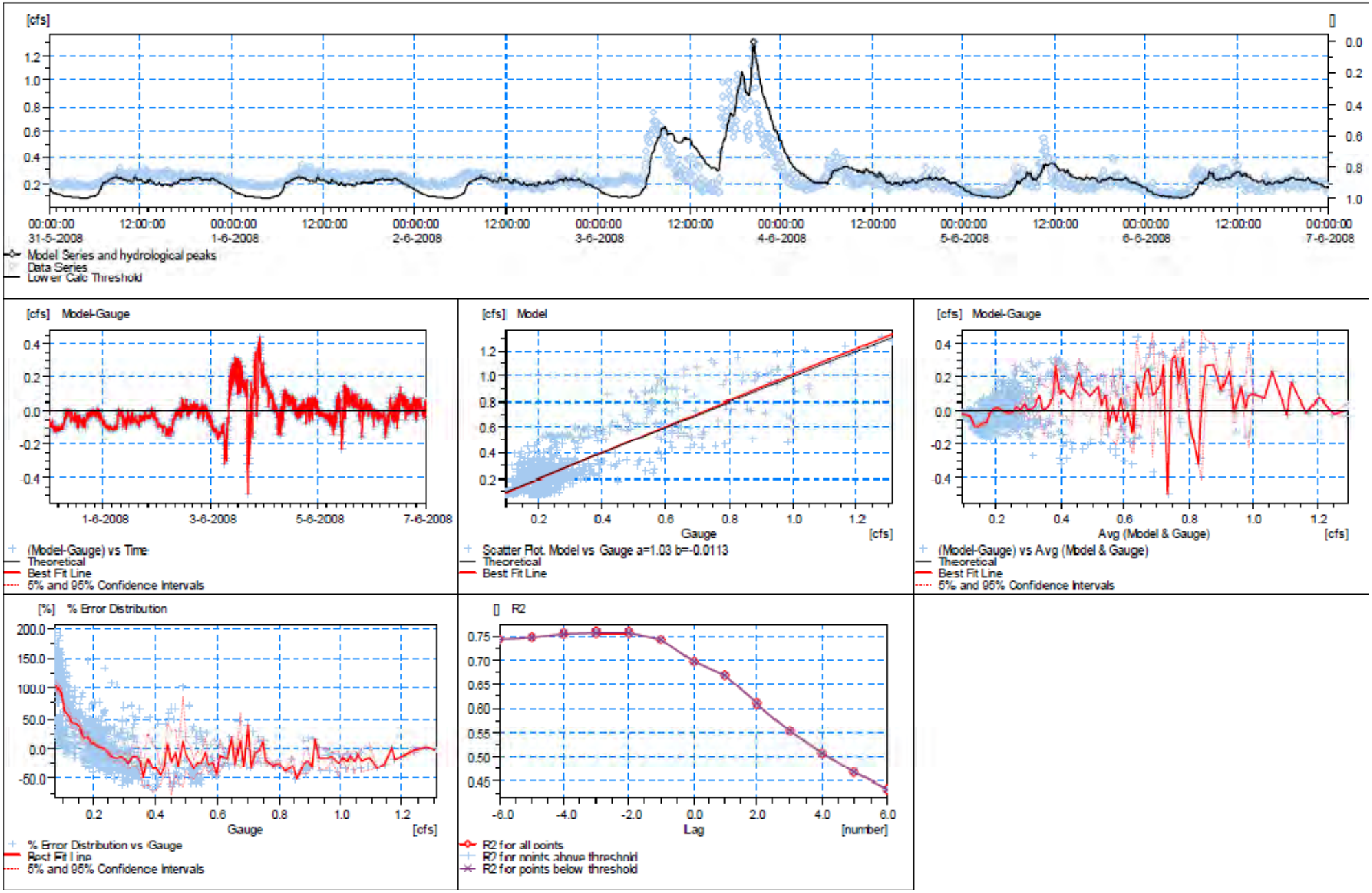


Figure 3

230-078 230-077 (230-078 -> 230-077) 16.40



R2 = 0.696

Table 2 - NB01 Statistical Analysis
CSO Planning/Predesign Services
King County DNRP, Wastewater Treatment Division

Result	Value	
Correlation coeficient R2	0.696	
Max. positive difference	0.44	cfs
Max. negative difference	-0.496	cfs
Volume observed	148742.594	CF
Volume modelled	146028.02	CF
Volume error	-1.825	%
Peak observed value	1.309	cfs
Peak modelled value	1.309	cfs
Peak error	0.041	%
Rising Limb Slope 1 (Simulated TS)	0.11293	
Rising Limb Slope 1 (Observed TS)	0.09742	
Rising Limb Slope 2 (Simulated TS)	2.67053	
Rising Limb Slope 2 (Observed TS)	33.245	
Falling Limb Slope 1 (Simulated TS)	-4.28127	
Falling Limb Slope 1 (Observed TS)	-10.81881	
Falling Limb Slope 2 (Simulated TS)	-0.12683	
Falling Limb Slope 2 (Observed TS)	-0.12781	
Goodness for Time to centroid	-10.887	%
Coefficient of Efficiency	0.538	
Observed TS. Peak 1	1.309	cfs
Simulated TS. Peak 1	1.309	cfs
Magnitude Error. Peak 1	-0.041	%
Observed TS. Time to Peak 1	92.48	hours
Simulated TS. Time to Peak 1	92.397	hours
Timing Error. Peak 1	0.09	%

Figure 4

NB02 Calibration - June Storm Event

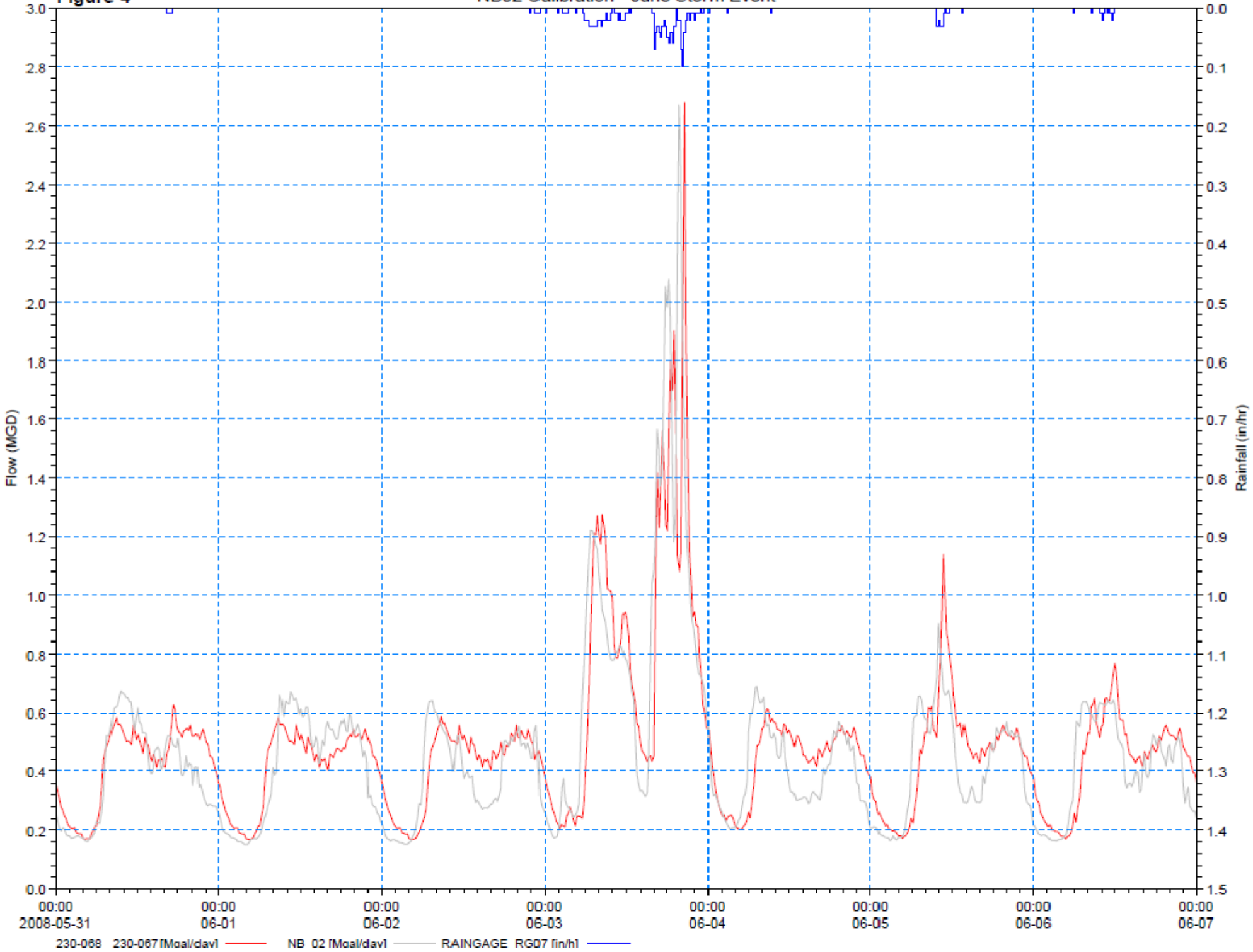
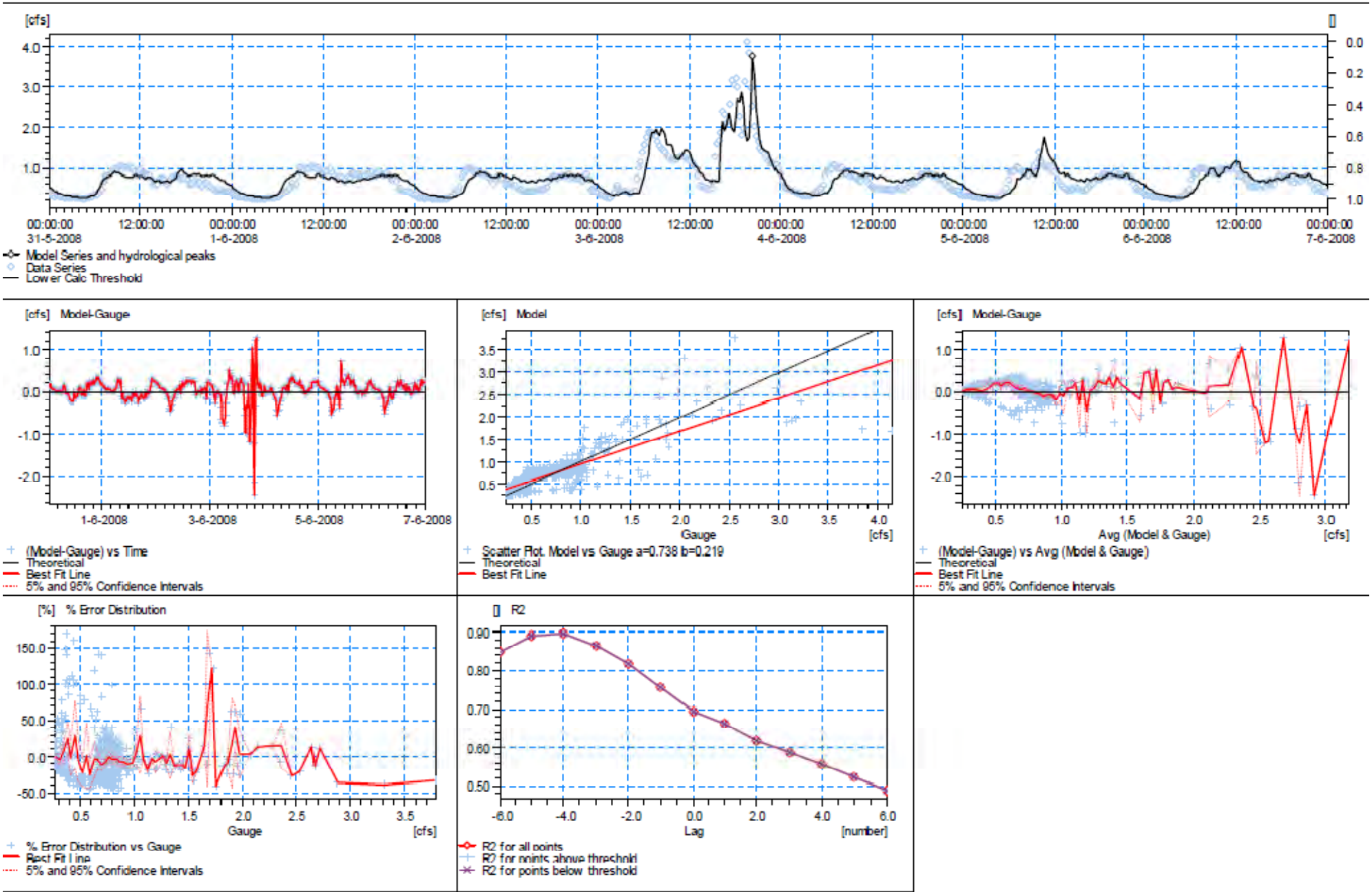


Figure 5

230-068 230-067 (230-068 -> 230-067) 84.89



R2 = 0.694

Table 3 - NB02 Statistical Analysis
CSO Planning/Predesign Services
King County DNRP, Wastewater Treatment Division

Result	Value	
Correlation coeficient R2	0.694	
Max. positive difference	1.286	cfs
Max. negative difference	-2.437	cfs
Volume observed	436685.638	CF
Volume modelled	454658.884	CF
Volume error	4.116	%
Peak observed value	4.134	cfs
Peak modelled value	3.783	cfs
Peak error	-8.483	%
Rising Limb Slope 1 (Simulated TS)	0.32359	
Rising Limb Slope 1 (Observed TS)	0.35237	
Rising Limb Slope 2 (Simulated TS)	6.92761	
Rising Limb Slope 2 (Observed TS)	8.24704	
Falling Limb Slope 1 (Simulated TS)	-41.92986	
Falling Limb Slope 1 (Observed TS)	-29.94725	
Falling Limb Slope 2 (Simulated TS)	-0.3414	
Falling Limb Slope 2 (Observed TS)	-0.40286	
Goodness for Time to centroid	-1.195	%
Coefficient of Efficiency	0.687	
Observed TS. Peak 1	4.134	cfs
Simulated TS. Peak 1	3.783	cfs
Magnitude Error. Peak 1	8.483	%
Observed TS. Time to Peak 1	91.564	hours
Simulated TS. Time to Peak 1	92.314	hours
Timing Error. Peak 1	-0.817	%

Figure 6

NB03 Calibration - June Storm Event

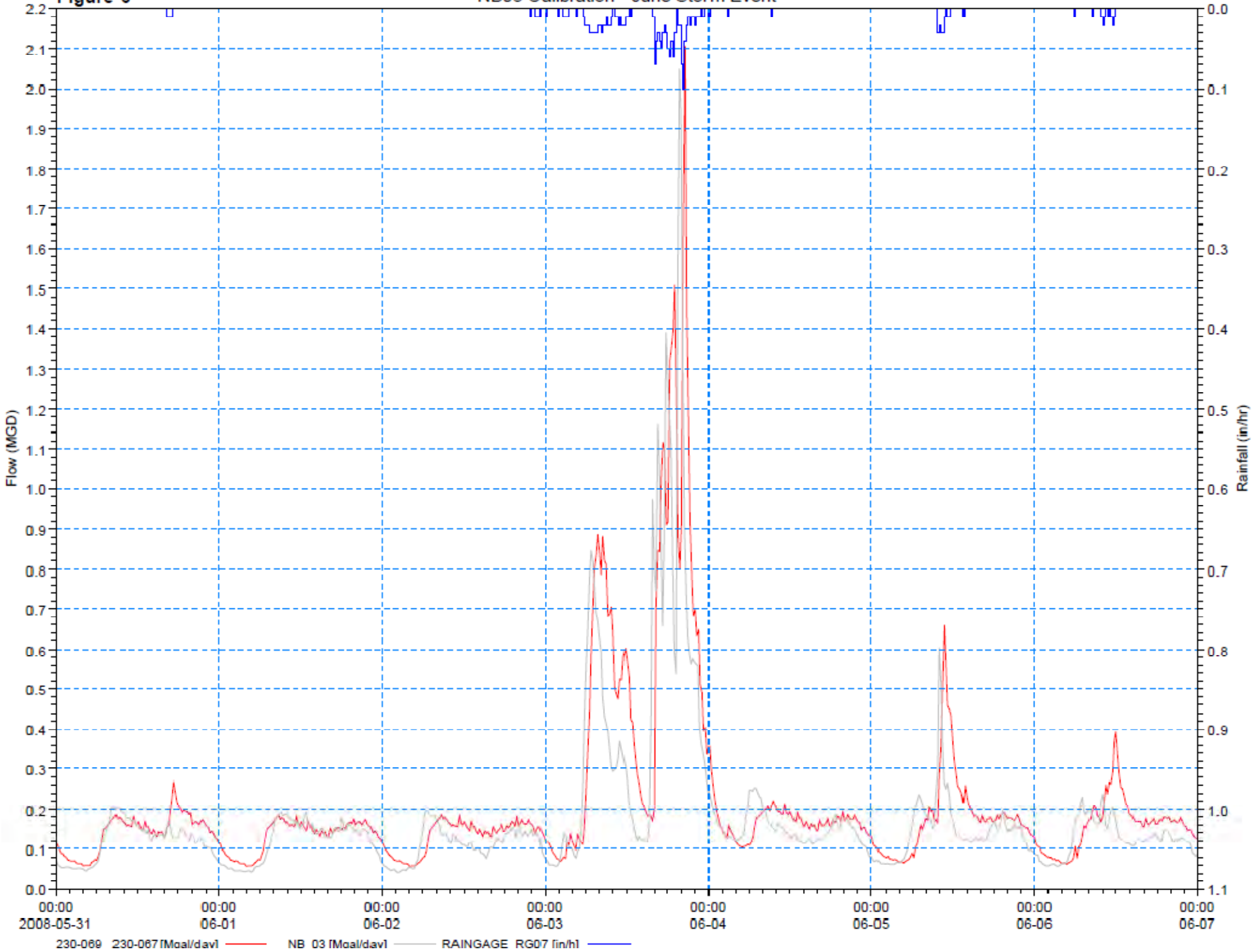
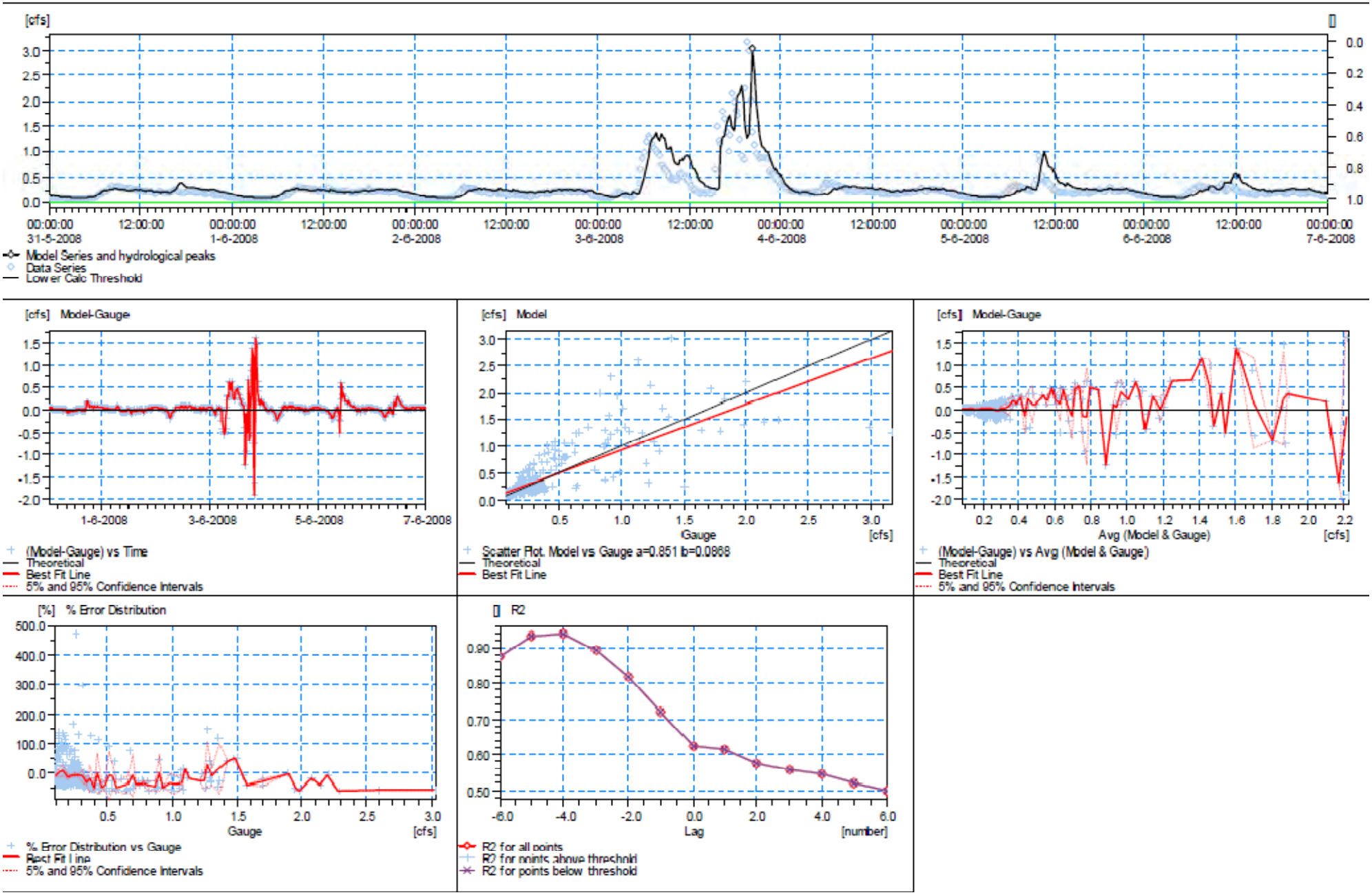


Figure 7

230-069 230-067 (230-069 -> 230-067) 87.87



R2 = 0.624

Table 4 - NB03 Statistical Analysis
CSO Planning/Predesign Services
King County DNRP, Wastewater Treatment Division

Result	Value	
Correlation coeficient R2	0.624	
Max. positive difference	1.625	cfs
Max. negative difference	-1.897	cfs
Volume observed	167260.136	CF
Volume modelled	194891.771	CF
Volume error	16.52	%
Peak observed value	3.169	cfs
Peak modelled value	3.028	cfs
Peak error	-4.436	%
Rising Limb Slope 1 (Simulated TS)	0.27154	
Rising Limb Slope 1 (Observed TS)	0.27333	
Rising Limb Slope 2 (Simulated TS)	5.92496	
Rising Limb Slope 2 (Observed TS)	136.20565	
Falling Limb Slope 1 (Simulated TS)	-29.42356	
Falling Limb Slope 1 (Observed TS)	-45.8687	
Falling Limb Slope 2 (Simulated TS)	-0.30679	
Falling Limb Slope 2 (Observed TS)	-0.32443	
Goodness for Time to centroid	-1.567	%
Coefficient of Efficiency	0.52	
Observed TS. Peak 1	3.169	cfs
Simulated TS. Peak 1	3.028	cfs
Magnitude Error. Peak 1	4.436	%
Observed TS. Time to Peak 1	91.564	hours
Simulated TS. Time to Peak 1	92.314	hours
Timing Error. Peak 1	-0.817	%

Figure 8

NB04 Calibration - June Storm Event

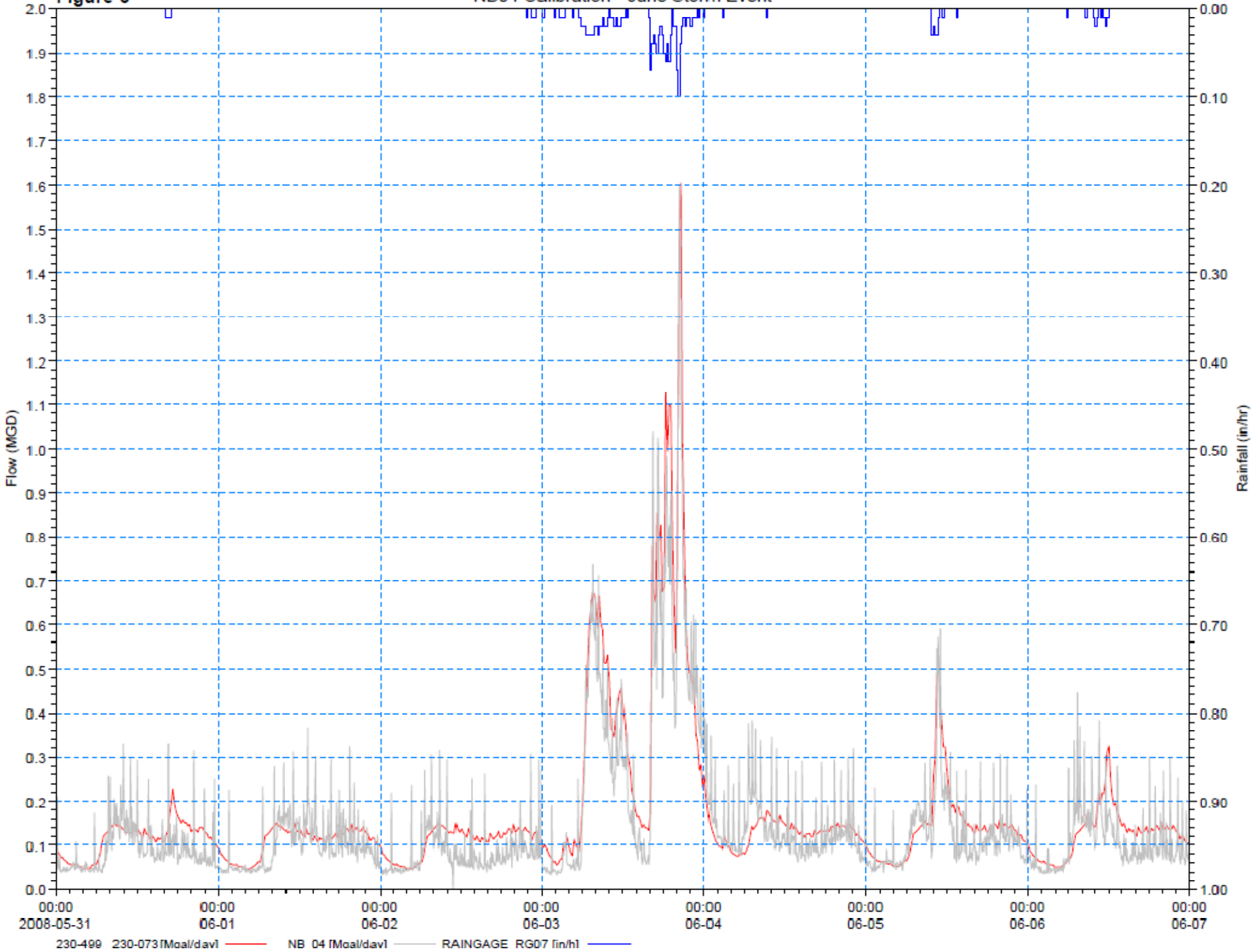
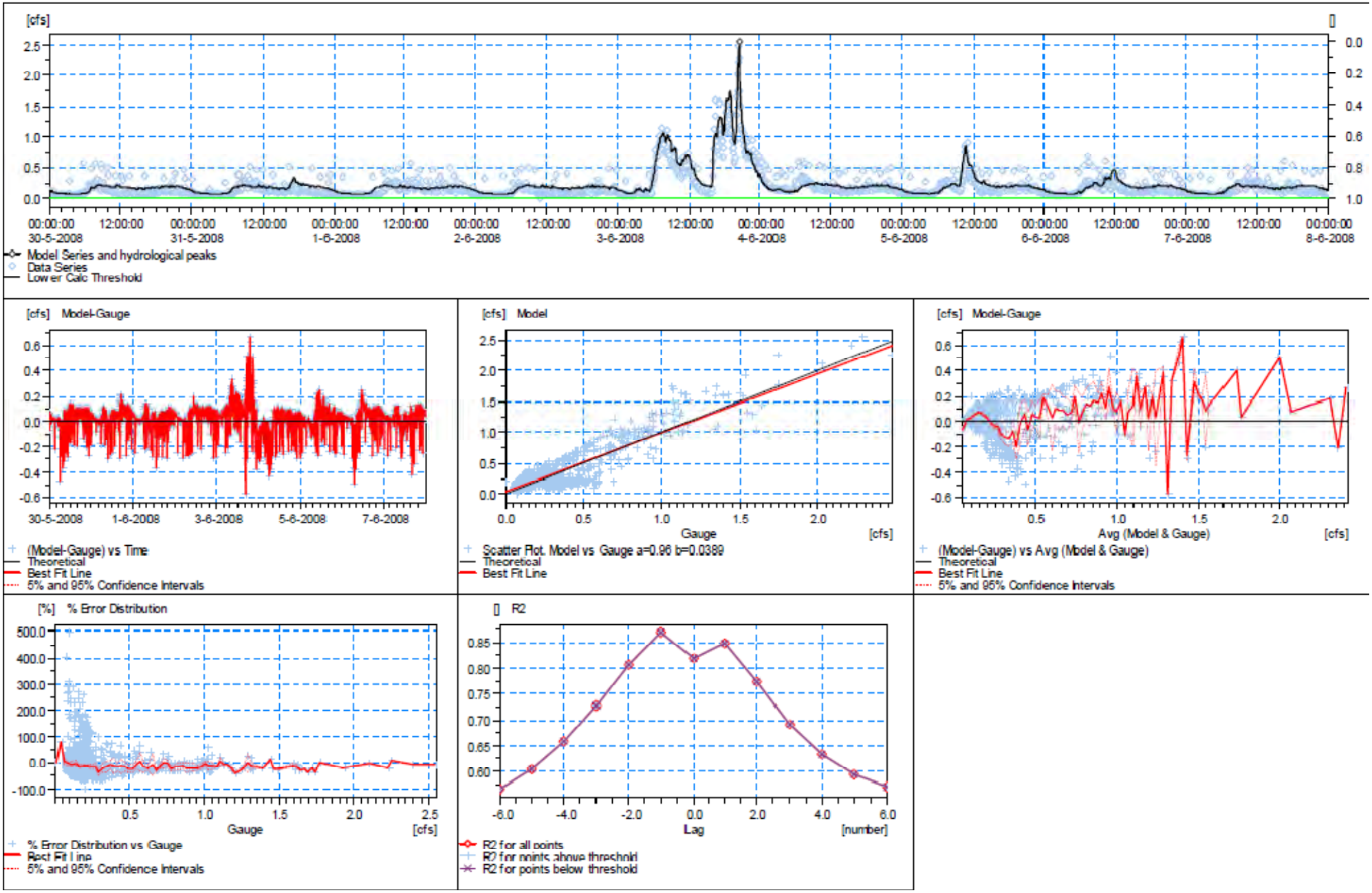


Figure 9

230-499 230-073 (230-499 -> 230-073) 28.11



R2 = 0.818

Table 5 - NB04 Statistical Analysis
CSO Planning/Predesign Services
King County DNRP, Wastewater Treatment Division

Result	Value	
Correlation coeficient R2	0.818	
Max. positive difference	0.669	cfs
Max. negative difference	-0.575	cfs
Volume observed	158007.399	CF
Volume modelled	181869.57	CF
Volume error	15.102	%
Peak observed value	2.469	cfs
Peak modelled value	2.549	cfs
Peak error	3.239	%
Rising Limb Slope 1 (Simulated TS)	0.18176	
Rising Limb Slope 1 (Observed TS)	0	
Rising Limb Slope 2 (Simulated TS)	5.07118	
Rising Limb Slope 2 (Observed TS)	0	
Falling Limb Slope 1 (Simulated TS)	-30.42048	
Falling Limb Slope 1 (Observed TS)	0	
Falling Limb Slope 2 (Simulated TS)	-0.19486	
Falling Limb Slope 2 (Observed TS)	0	
Goodness for Time to centroid	0.77	%
Coefficient of Efficiency	0.773	
Simulated TS. Peak 1	2.549	cfs
Simulated TS. Time to Peak 1	116.583	hours

Figure 10

NB05 Calibration - June Storm Event

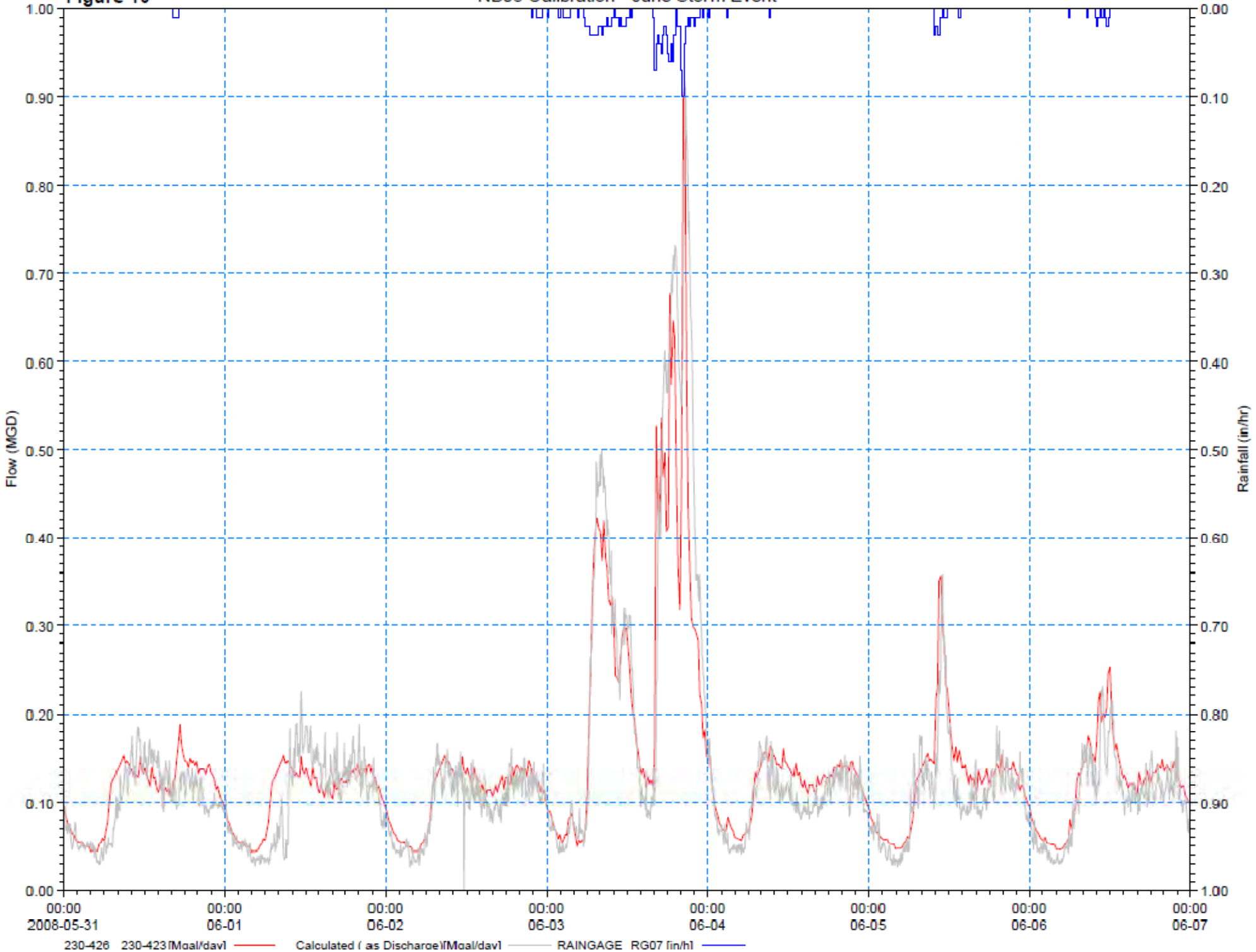
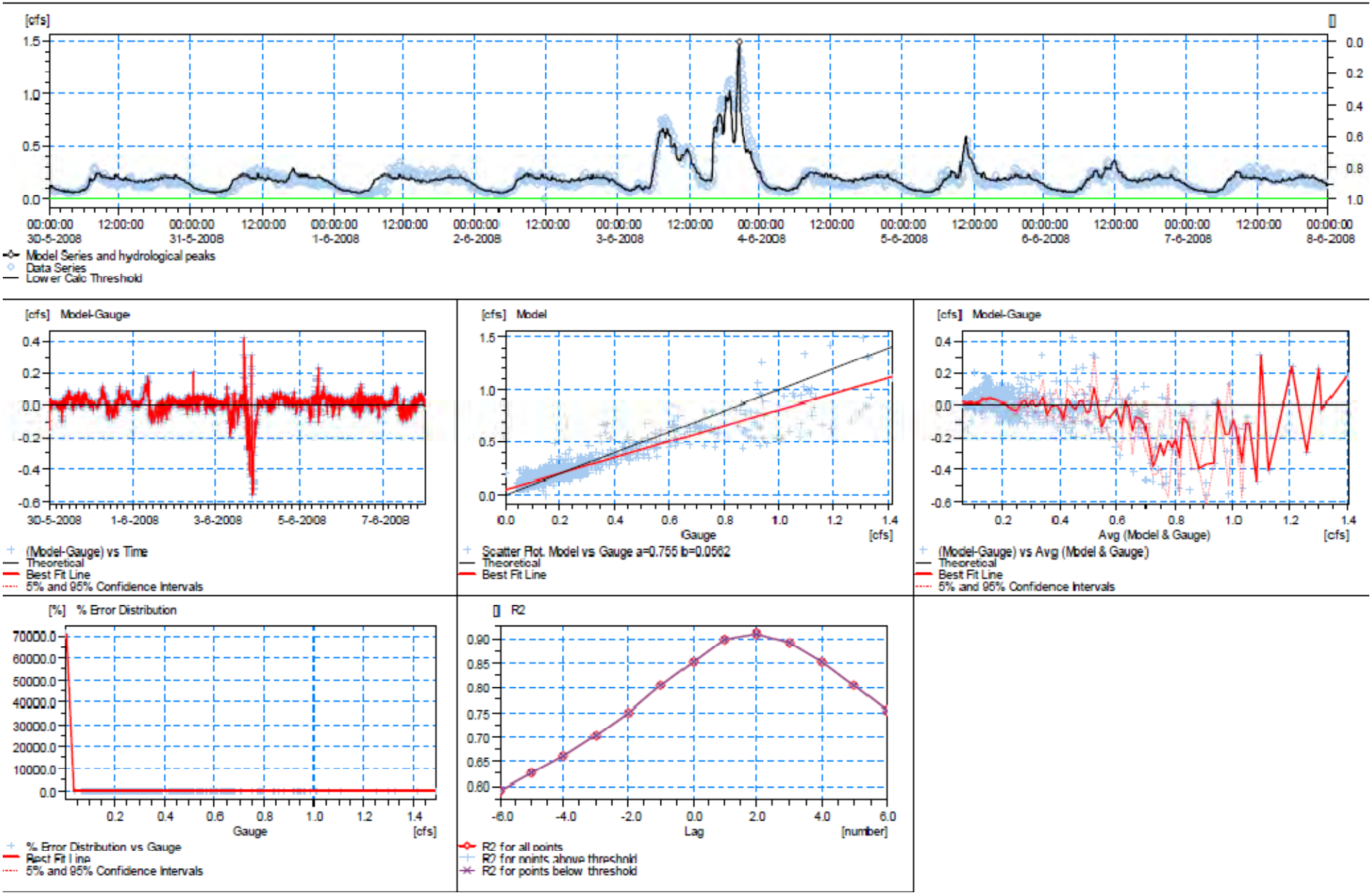


Figure 11

230-426 230-423 (230-426 -> 230-423) 60.53



R2 = 0.853

Table 6 - NB05 Statistical Analysis
CSO Planning/Predesign Services
King County DNRP, Wastewater Treatment Division

Result	Value	
Correlation coeficient R2	0.853	
Max. positive difference	0.423	cfs
Max. negative difference	-0.563	cfs
Volume observed	149026.898	CF
Volume modelled	156173.067	CF
Volume error	4.795	%
Peak observed value	1.41	cfs
Peak modelled value	1.49	cfs
Peak error	5.677	%
Rising Limb Slope 1 (Simulated TS)	0.10622	
Rising Limb Slope 1 (Observed TS)	0	
Rising Limb Slope 2 (Simulated TS)	2.93677	
Rising Limb Slope 2 (Observed TS)	0	
Falling Limb Slope 1 (Simulated TS)	-20.01494	
Falling Limb Slope 1 (Observed TS)	0	
Falling Limb Slope 2 (Simulated TS)	-0.10897	
Falling Limb Slope 2 (Observed TS)	0	
Goodness for Time to centroid	0.226	%
Coefficient of Efficiency	0.839	
Simulated TS. Peak 1	1.49	cfs
Simulated TS. Time to Peak 1	116.583	hours

Appendix B-7

SOUTH MAGNOLIA AND NORTH BEACH BASINS POPULATION/LAND USE ANALYSIS

TECHNICAL MEMORANDUM

Project Name:	CSO Planning/Predesign Services	**Date:**	01/06/2009
Client:	King County DNRP, Wastewater Treatment Division	**Project Number:**	7562A.10
Prepared By:	Jason Nikaido, Ed Wicklein		
Reviewed By:	Shawn Dent		
Subject:	South Magnolia and North Beach Basins Population/Land Use Analysis		
Distribution:	King County, Carollo Project Team		

Purpose

Based on comments from the Round 1 Magnolia/North Beach Calibration meeting, a detailed analysis was performed on the dry weather flow (DWF). Dry weather flow for the sum of the ADS meters was greater than the downstream County meters in both basins. A decision was made to adjust the ADS meter DWF to match the County DWF because this would result in the model predicting less DWF but more inflow/infiltration (I/I) at the meter locations (i.e. a more conservative estimate of I/I). As before, peak flows for the sum of the ADS meters and downstream meters would remain equal.

Methodology

Using GIS and spreadsheet calculations, the population (provided by the County for County CSO basins) was distributed to the metered basins.

Step 1: Compare County CSO Basin populations with ADS metered basin present use.

Step 2: Distribute population to ADS metered basins by weighted area of County CSO basins.

Step 3: Estimate base infiltration using flow meter data and Stevens-Schutzbach equation.

$$BI = \frac{0.4 \times MDWF}{1 - 0.6(MDWF/ADWF)^{ADWF^{0.7}}}$$

Where,

BI = Base infiltration
MDWF = Minimum average day flow
ADWF = Average dry weather flow

Step 4. Re-apportion dry weather flow in metered subbasins (ADS) to match downstream meters (County) (i.e. ADS subbasin flows proportionally adjusted down).

South Magnolia Basin

Figure 1 illustrates the Round 1 calibration for the MAGCSO meter. As discussed in the Round 1 calibration meeting, the ADS metered DWF is greater than the MAGCSO meter. This may be due to the low depths and high velocities (pipelines are on steep slopes) which could underestimate flows. However, the high wet weather flows (with greater depths) most likely produced more accurate results as shown by the peak flows corresponding well to each other.

Figure 1 - Sum of ADS meters vs. County meter

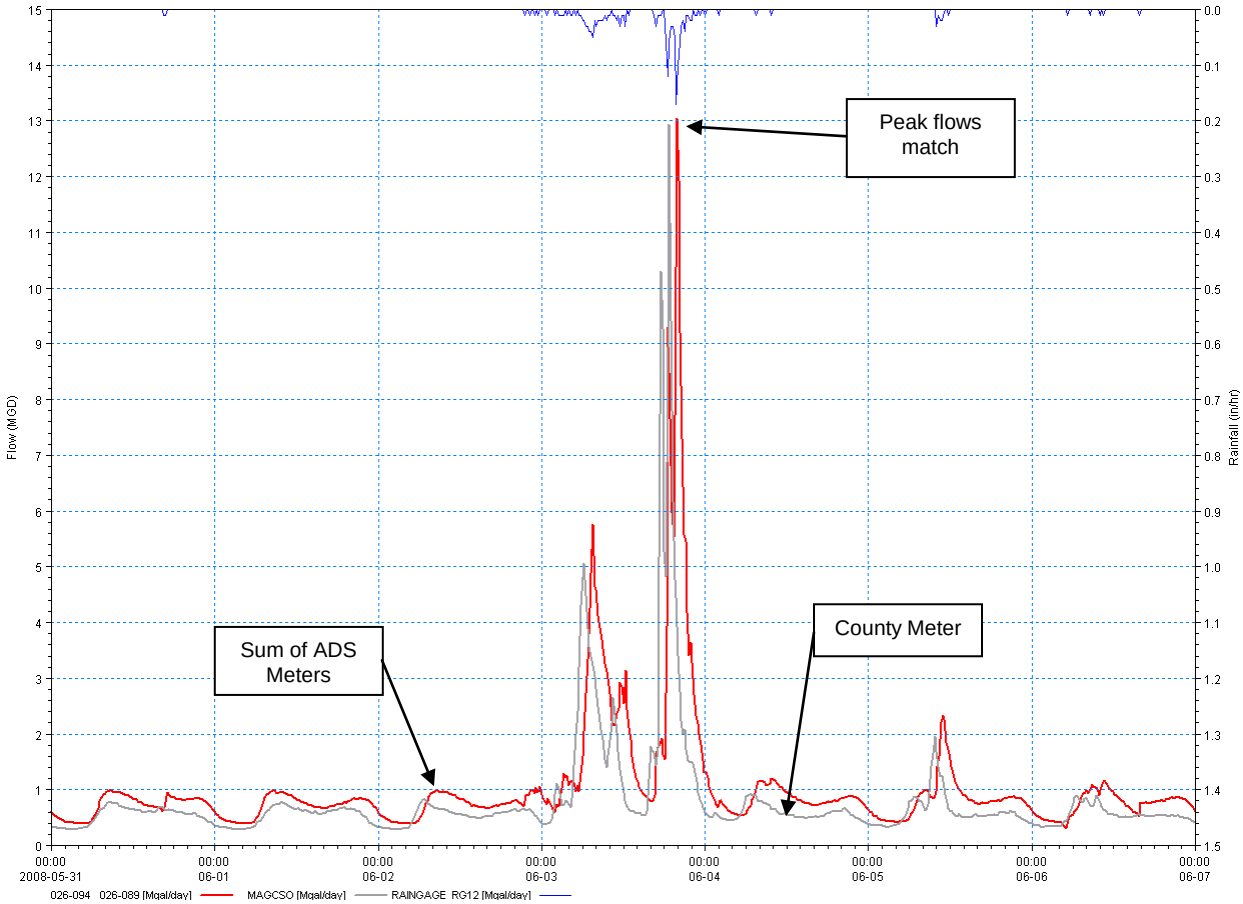


Table 1 presents a comparison for the total basin flow between the sum of the upstream meters and the basin meters. The sum of the meters unit factor of 141.5 gallons per capita per day (gpcd) is 2.6 times greater than the City of Seattle average of ~55 gpcd[1]. The basin meter unit factor of 90.8 is also higher than the City average by a factor of 1.7 but may be reasonable when considering basin to basin differences in wastewater generation.

[1] Per County Staff, 12/16/2008 teleconference.

Table 1 Magnolia basin comparison (ADS vs. County meter)				
Description	**Units**	**Sum of Meters(1)**	**Basin Meter(2)**	**Difference(3)**
Sanitary Flow	MGD(4)	0.626	0.401	+0.225
Base Infiltration	MGD	0.286	0.266	+0.020
ADWF(5)	MGD	0.861	0.668	+0.193
Population	Persons	4,422	4,422	0
Unit Factor	Gal/capita/day	141.5	90.8	+50.7

Notes:
1. Sum of Meters = SM02 + SM03 + SM05 + SM06 + SM07 + SM08 + SM09 + Unmetered area
2. Basin Meter = MAGCSO meter + SM02 + SM03
3. Difference = Sum of Meters - Basin Meter
4. MGD = million gallons per day
5. ADWF = Average dry weather flow

The ADS meter DWF was reduced to match the County's MAGCSO meter. In this process, several anomalies arose and are described below. Figure 2 and Tables 2-4 illustrate the population and present use in the basin and present the revised DWF values. Meters SM02 and SM03 are not tributary to the MAGCSO meter and were thus calibrated to the ADS meters. This explains the greatly varying unit factor for SM02 and SM03 when compared with the other meters.

<u>Anomalies</u>

- CSO Basin 151 contains no commercial area. The commercial population of 378 was not distributed to the model since it there was no corresponding present use.

- CSO Basin 153 has 545 residential parcels but only a population of 172.

- Large unmetered area (~14% of population).

TABLE 2
SOUTH MAGNOLIA CSO BASIN POPULATION

Meter	RES	COM	IND	Total
151[1]	1947	378	0	2325
152	856	264	9	1129
153	172	41	0	212
154	961	172	0	1133
Total	**3936**	**854**	**9**	**4799**

Notes:
(1) Present Use shows no COM area in CSO Basin 151.The 378 persons were NOT distributed to metered subbasins SM02 and SM03.

TABLE 4
SOUTH MAGNOLIA DRY WEATHER FLOW

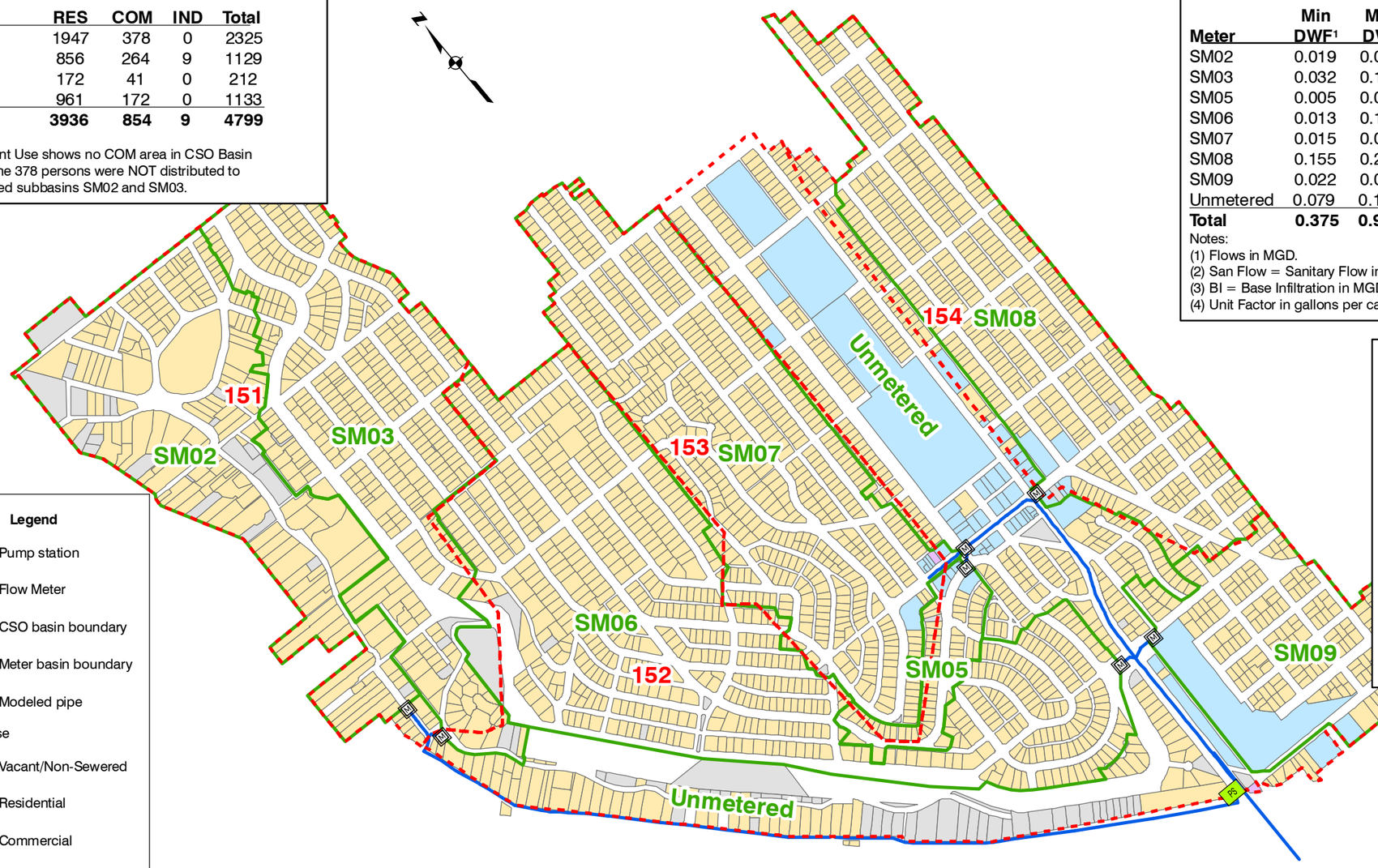
Meter	Min DWF[1]	Max DWF[1]	Avg DWF[1]	San Flow[2]	BI[3]	BI% of Min	Unit Factor[4]
SM02	0.019	0.055	0.036	0.019	0.017	91.4%	32.8
SM03	0.032	0.110	0.071	0.043	0.028	85.2%	32.4
SM05	0.005	0.019	0.010	0.006	0.004	75.6%	135.4
SM06	0.013	0.192	0.102	0.062	0.040	64.4%	135.4
SM07	0.015	0.076	0.045	0.027	0.018	64.4%	135.4
SM08	0.155	0.288	0.215	0.131	0.084	54.5%	135.4
SM09	0.022	0.078	0.050	0.030	0.020	87.9%	135.4
Unmetered	0.079	0.197	0.138	0.082	0.056	68.5%	135.4
Total	**0.375**	**0.968**	**0.668**	**0.401**	**0.266**	**71.1%**	**90.8**

Notes:
(1) Flows in MGD.
(2) San Flow = Sanitary Flow in MGD
(3) BI = Base Infiltration in MGD. Calculated using Stevens-Schutzbach equation.
(4) Unit Factor in gallons per capita per day..

TABLE 3
SOUTH MAGNOLIA MODELED POPULATION

Meter	RES	COM	IND	Total
SM02[1]	586	0	0	586
SM03[1]	1333	0	0	1333
SM05	34	13	0	47
SM06	458	0	0	458
SM07	170	32	0	202
SM08	893	77	0	970
SM09	150	75	0	225
Unmetered	312	280	9	601
Total	**3936**	**476**	**9**	**4422**

Notes:
(1) Present Use shows no COM area in CSO Basin 151.The 378 persons were NOT distributed to metered subbasins SM02 and SM03.



Legend
- Pump station
- Flow Meter
- CSO basin boundary
- Meter basin boundary
- Modeled pipe

Present Use
- Vacant/Non-Sewered
- Residential
- Commercial
- Industrial

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Figure 2
SOUTH MAGNOLIA POPULATION AND PRESENT USE
CSO PLANNING/PREDESIGN SERVICES
KING COUNTY DNRP, WASTEWATER TREATMENT DIVISION

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Wednesday, December 03, 2008

North Beach

Figure 3 illustrates the Round 1 calibration for the NBEACHINLET meter. Like in the Magnolia basin, the ADS metered DWF in North Beach is also higher than the County's NBEACHINLET metered DWF. ADS meter locations in steep areas are likely contributing to low depths and underestimating of flow. However, wet weather flows with higher depths result in equivalent peak flows between ADS and NBEACHINLET meters.

Figure 3 - Sum of ADS meters vs. County meter

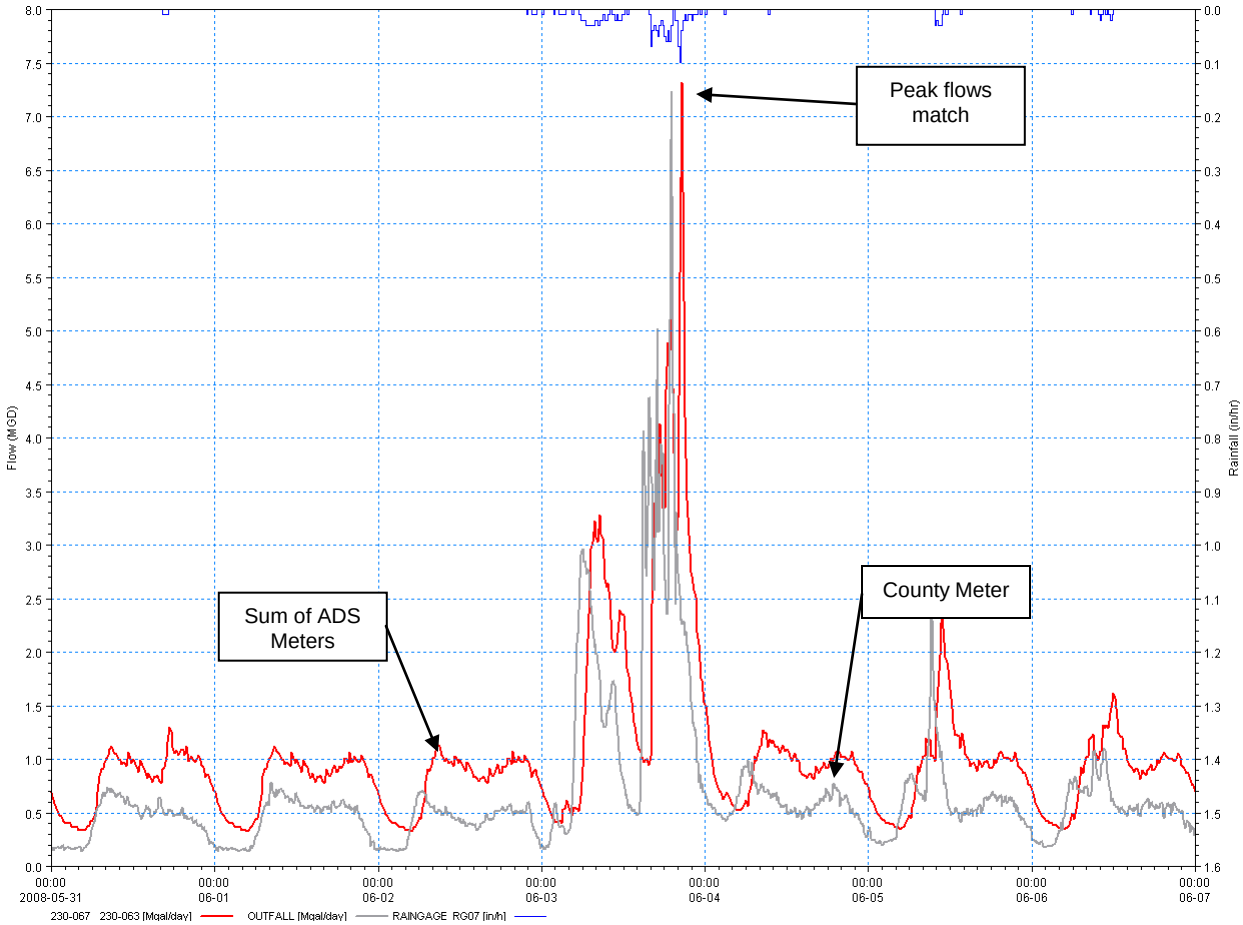


Table 1 presents a comparison for the total basin flow between the sum of the upstream meters and the basin meters. The sum of the meters unit factor of 118.6 gallons per capita per day (gpcd) is high when compared to the City of Seattle average of ~55 gpcd. The basin meter unit factor of 50.7 gpcd is close to the Seattle per capita average.

Table 5 North Beach basin comparison (ADS vs. County meter)				
Description	**Units**	**Sum of Meters(1)**	**Basin Meter(2)**	**Difference(3)**
Sanitary Flow	MGD(4)	0.484	0.309	+0.175
Base Infiltration	MGD	0.240	0.121	+0.119
ADWF(5)	MGD	0.724	0.430	+0.294
Population	Persons	6,101	6,101	0
Unit Factor	Gal/capita/day	118.6	50.7	+67.9

Notes:
1. Sum of Meters = NB01 + NB02 + NB03 + NB04 + NB05 + Unmetered area
2. Basin Meter = NBEACHINLET meter
3. Difference = Sum of Meters - Basin Meter
4. MGD = million gallons per day
5. ADWF = Average dry weather flow

Like the Magnolia basin, the ADS meter DWF in North Beach was also reduced to match the County's NBEACHINLET meter. In this process, several anomalies arose and are described below. Figure 4 and Tables 6-8 illustrate the population and present use in the basin and present the revised DWF values.

Anomalies

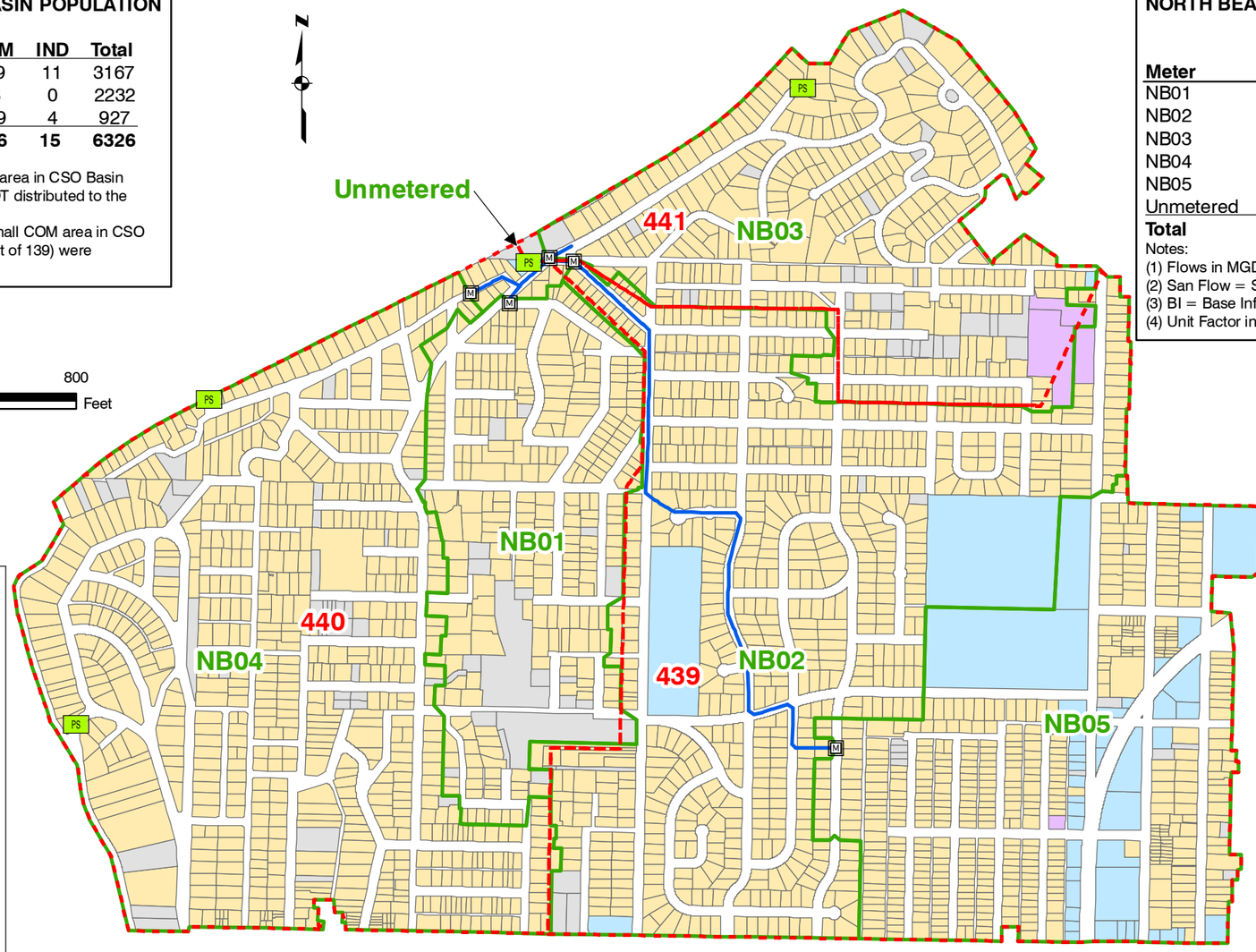
- CSO Basin 440 contains no commercial area. The commercial population of 88 was not distributed to the model since there was no corresponding present use.

- CSO Basin 441 has only one small commercial parcel. Only 2 of the 139 commercial population was distributed.

TABLE 6
NORTH BEACH CSO BASIN POPULATION

Meter	RES	COM	IND	Total
439	2697	459	11	3167
440[1]	2143	88	0	2232
441[2]	785	139	4	927
Total	**5625**	**686**	**15**	**6326**

Notes:
(1) Present Use shows no COM area in CSO Basin 440.The 88 persons were NOT distributed to the metered subbasins.
(2) Present Use shows only a small COM area in CSO Basin 441. Only 2 person (out of 139) were distributed to NB03.



Legend
- Pump station
- Flow Meter
- CSO basin boundary
- Meter basin boundary
- Modeled pipe

PresentUse
- Residential
- Commercial
- Industrial
- Vacant/Non-Sewered

TABLE 8
NORTH BEACH DRY WEATHER FLOW

Meter	Min DWF[1]	Max DWF[1]	Avg DWF[1]	San Flow[2]	BI[3]	BI% of Min	Unit Factor[4]
NB01	0.062	0.161	0.109	0.033	0.013	21.1%	53.8
NB02	0.121	0.477	0.295	0.095	0.037	30.4%	53.8
NB03	0.053	0.189	0.119	0.043	0.017	31.8%	43.1
NB04	0.040	0.223	0.097	0.064	0.033	80.9%	43.1
NB05	0.038	0.161	0.102	0.073	0.030	78.5%	51.6
Unmetered	0.001	0.002	0.001	0.001	0.000	0.0%	50.7
Total	**0.188**	**0.643**	**0.430**	**0.309**	**0.121**	**64.4%**	**50.7**

Notes:
(1) Flows in MGD.
(2) San Flow = Sanitary Flow in MGD
(3) BI = Base Infiltration in MGD. Calculated using Stevens-Schutzbach equation.
(4) Unit Factor in gallons per capita per day..

TABLE 7
NORTH BEACH MODELED POPULATION

Meter	RES	COM	IND	Total
NB01	622	0	0	622
NB02	1575	182	0	1758
NB03[1]	789	2	4	795
NB04	1491	0	0	1491
NB05	1120	276	11	1407
Unmetered[2]	28	0	0	28
Total	**5625**	**461**	**15**	**6101**

Notes:
(1) Present Use shows only a small COM area in CSO Basin 441. Only 2 person (out of 139) were distributed to NB03.
(2) Present Use shows no COM area in CSO Basin 440.The 88 persons were NOT distributed to the metered subbasins.
(3) Total population in model reduced from 6326 to 6101 due to conflicts with Present Use.

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Figure 4
NORTH BEACH POPULATION AND PRESENT USE
CSO PLANNING/PREDESIGN SERVICES
KING COUNTY DNRP, WASTEWATER TREATMENT DIVISION

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Thursday, December 04, 2008

Recommendation

Carollo recommends using the DWF's measured by the County's basin meter (and the adjustment of the subbasin ADS DWFs presented in Tables 4 and 8) rather than the higher ADS metered flows for the following reasons:

- Overall basin unit factors are reasonable,
- ADS and County meter peak flows correspond well to each other,
- Using the lower County DWF results in peak flows that are more conservative.

Action Items

County to decide whether to proceed with model calibration using methodology presented in this memo or revised population/land use values.

Appendix B-8

NORTH BEACH FLOW ADJUSTMENT

TECHNICAL MEMORANDUM

Project Name:	CSO Planning/Predesign Services	**Date:**	01/12/2009 (Orig) 01/21/2009 (Revised)
Client:	King County DNRP, Wastewater Treatment Division	**Project Number:**	7562A.10
Prepared By:	Jason Nikaido		
Reviewed By:	Shawn Dent, Allen deSteiguer		
Subject:	North Beach Flow Adjustment		
Distribution:	Carollo Project Team		

Objective

This Technical Memorandum (TM) is to document the process by which downstream County flow hydrographs will be disaggregated to produce upstream subbasin hydrographs using observed ADS flow data. These disaggregated County hydrographs will then be the basis for calibration. This TM specifically documents the North Beach basin flow adjustments, but the same process will be used for the other three basins.

Methodology

It was decided after two meetings with King County that the downstream meters for each basin, owned by the County, represent more accurate flows for the basin in total than the sum of the observed ADS meters. Therefore, the individual subbasin flows will be disaggregated County flows based on observed ADS meters. The ADS meters will be used to determine factors to aid the disaggregation process. The disaggregated County hydrographs will generally match the observed ADS data. However, it is known that dry weather flow errors exist. These errors were corrected previously and also assumed that the downstream County meter was correct.

The disaggregation process includes applying factors to the total County metered flow, for each ADS meter, so that a new “adjusted” hydrograph can be developed for each ADS meter location. This process will also help the County to disaggregate downstream County flow meter data in the future by application of these factors.

Three factors are developed for each meter and applied to the County data. These include base infiltration (BI), sanitary flow (SF), and wet weather flow (WWF). Base infiltration (BI) is calculated using the Stevens-Schutzbach equation and along with sanitary flow make up average dry weather flow. Sanitary flow (SF) is flow generated only by customers and calculated as the average dry weather flow minus BI. Wet weather flow (WWF) is water that enters the system from rainfall events and is calculated as total flow minus BI minus SF. The process is as follows:

Step 1: County data and ADS data converted to common time step of 15 minutes. For the North Beach basin, the County meter is NBEACHINLET.

Step 2: County flow data disaggregated for each subbasin by applying the three component factors (BI, SF, WWF). The BI and SF values were presented previously in the South Magnolia and North

Beach Basins Population/Land Use Analysis Memo[1]. BI and SF are based on the dry weather flow period from 5/4/2008 to 5/11/2008. This period observed no rainfall with light to dry antecedent conditions. WWF for each meter, ADS and County, is calculated (Total flow - BI - SF). WWF factor based on weighted-average WWF.

Step 3: Each disaggregated County hydrograph is plotted against the observed ADS data. The three factors are adjusted until a good fit is accomplished for peak flows and volumes. The DWF's will obviously be different, since these are were the main adjustments need to be made. The peak WWF's should be very close for each measured data set.

Step 4: All disaggregated County hydrographs are added together and checked against the total County basin hydrograph. When the individual disaggregated County hydrographs match well to the observed ADS meter flow, and they add up to equal the downstream County hydrograph, the process is complete.

Based on this process, the factors in Table 1 were generated to produce an adequate fit to each subbasin. The sum of the disaggregated County hydrographs add up the County downstream flows.

Figures 1 through 5 represent the disaggregated County and observed ADS hydrographs for March 2008[2]. Figure 6 represents the County downstream metered flows and the sum of the disaggregated County hydrographs for March 2008. As expected, the two hydrographs are identical. It is assumed that little to no travel time for flows is apparent between the subbasin outlets and the basin outlet. Therefore, the four meters (NB05 is upstream of NB02) can be summed directly to equal the downstream County meter flows.

Figures 7 and 8 represent the County downstream metered flows and the sum of the observed ADS hydrographs for the December and June events, respectively. Figures 9 through 11 represent the statistical analysis for the County data and the sum of the observed ADS hydrographs.

Observations and Discussion

The following observations were noted based on this analysis.

1. For meters NB01 through NB04, ADS meters measured higher DWF than the adjusted flows.

2. The sum of the observed ADS meters measured more WWF than County meter for the large December wet weather event. Therefore, the sum of the ADS meters (during wet weather flows) will be used instead of the downstream County meter flows. However, the adjusted DWF's will still be applied during this wet weather period.

3. Generally, the WWF patterns between the disaggregated County and observed ADS flows match well, even when accounting for differences in DWF.

The disaggregated County hydrographs will be the basis for the calibration of the MIKE URBAN model. This same process will be applied to the other three basins.

1 South Magnolia and North Beach Basins Population/Land Use Analysis, January 6, 2009.
2 In the 1/12/2009 version of the memo, the entire flow monitoring period was shown. For the 1/21/2009 version, the period shown has been changed to March 2008 to better illustrate the correlation between the two data sets.

Table 1 BI, SF, and WWF Factors

Component	NB01	NB02[1]	NB03	NB04	NB05	Unmetered	Sum of ADS
BI[2]	10.14%	28.63%	12.94%	25.27%	23.02%	0.00%	100%
SF[3]	10.83%	30.59%	13.83%	20.79%	23.49%	0.46%	100%
WWF[4]	17.54%	16.22%	29.89%	24.02%	9.33%	3.00%	100%

Notes:

1. Factors for NB02 only. Upstream meter NB05 was subtracted out prior to analysis.
2. BI = Base Infiltration = $\dfrac{0.4 \times MDWF}{1 - 0.6(MDWF/ADWF)^{ADWF^{0.7}}}$

   Where,

   MDWF = Minimum average day flow (i.e. minimum of diurnal pattern average from 5/4/2008 through 5/11/2008)

   ADWF = Average dry weather flow

   BI% = $BI_i \times \dfrac{BI_i}{\sum_{i=NB01}^{NB05} BI_i}$

3. SF% = Sanitary Flow% = Average dry weather flow - BI = $\dfrac{SF_i}{SF_{County}}$

4. WWF = Wet Weather Flow = WWF - BI - SF

   WWF Factor = $\dfrac{\sum_{t=1}^{n} \dfrac{WWF_{ADS\,i}}{WWF_{County}}}{n}$

   Where,

   WWF_{ADS} = Wet weather flow of each ADS meter

   WWF_{County} = Wet weather flow of each downstream County meter

   WWF% = $WWF_i \times \dfrac{WWF_i}{\sum_{i=NB01}^{NB05} WWF_i}$

Figure 1

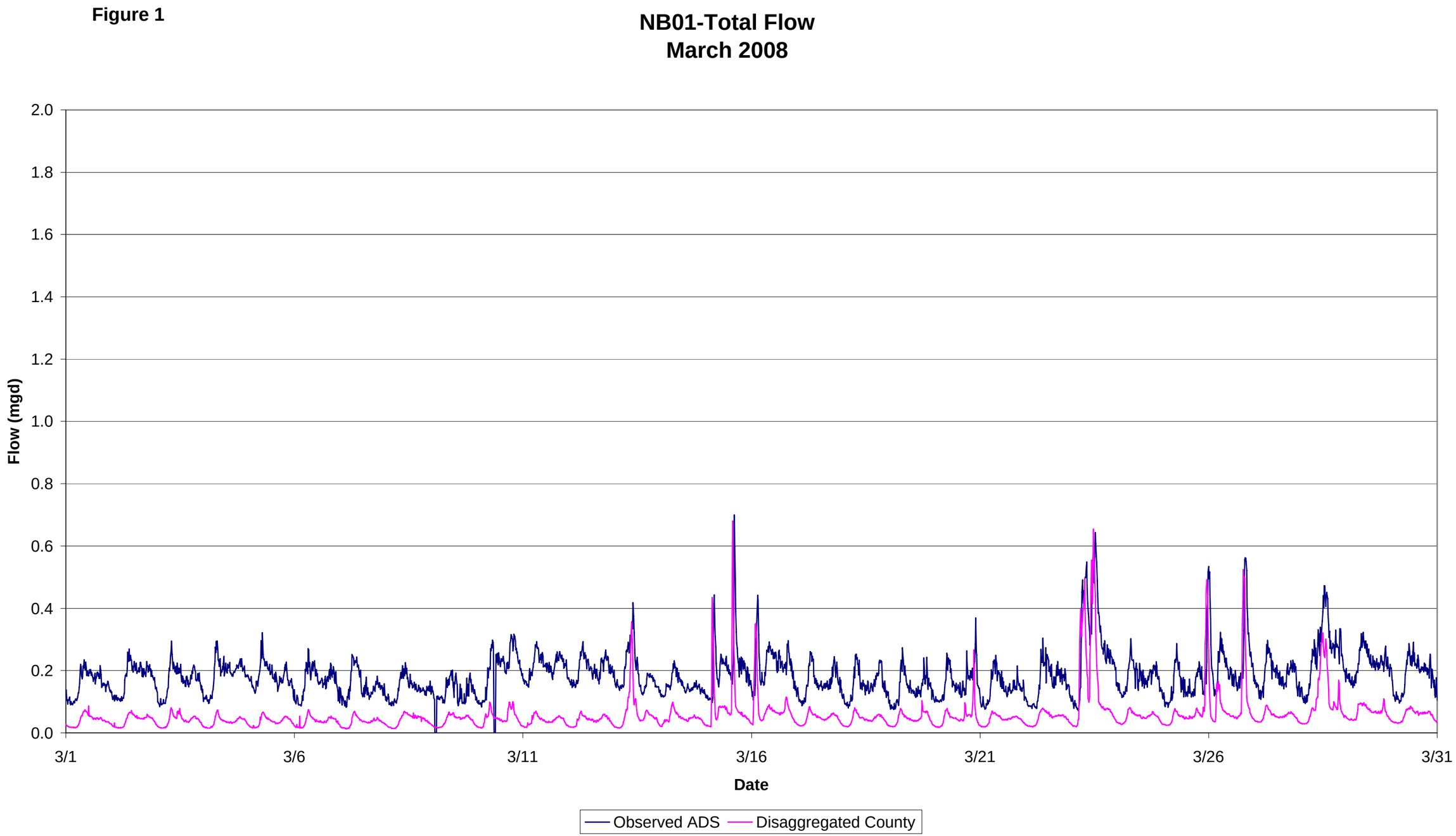

NB01-Total Flow
March 2008
Flow (mgd)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
3/1
3/6
3/11
3/16
3/21
3/26
3/31
Date
Observed ADS
Disaggregated County

Figure 2

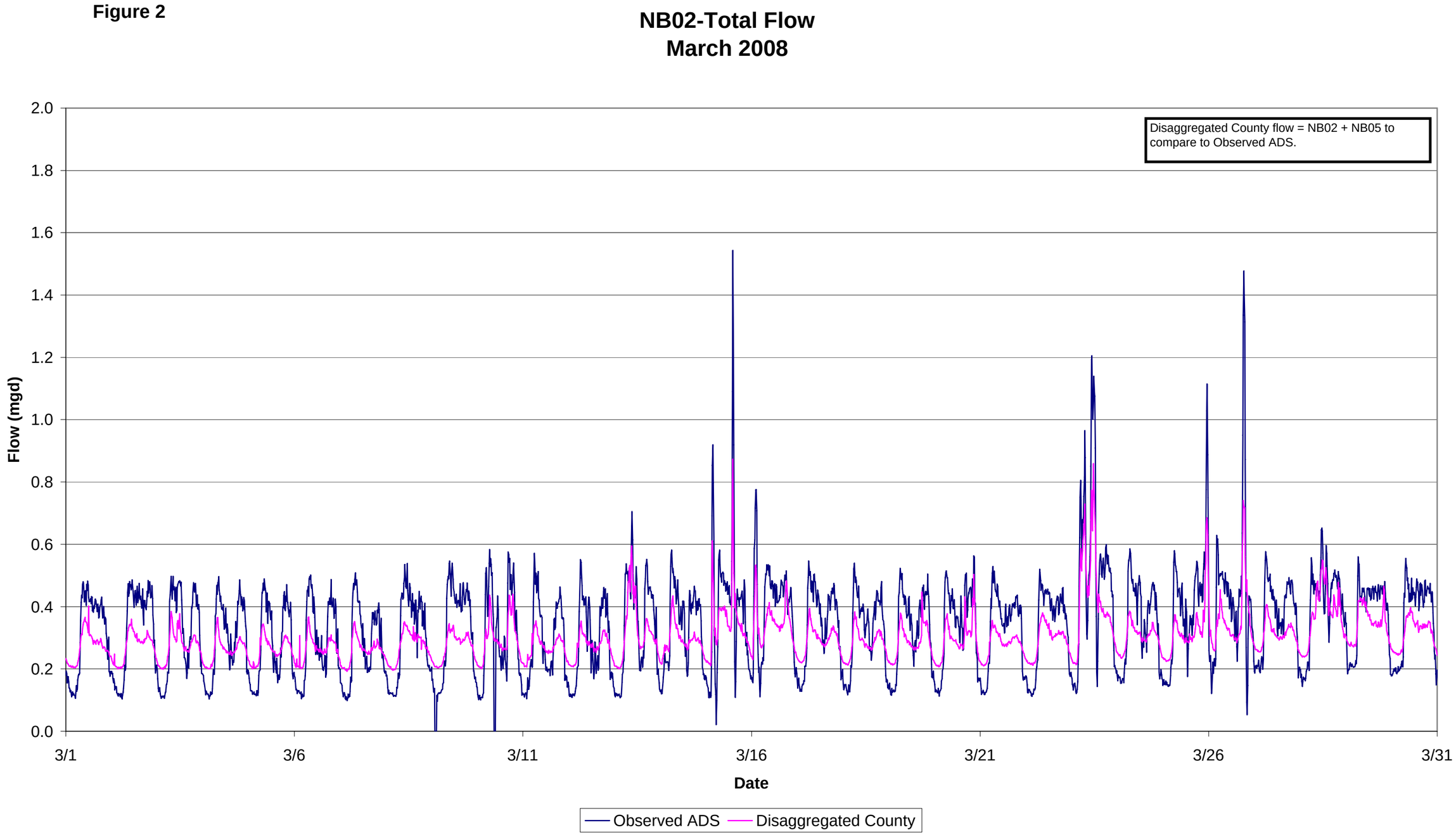

NB02-Total Flow
March 2008
Disaggregated County flow = NB02 + NB05 to compare to Observed ADS.
Flow (mgd)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
3/1
3/6
3/11
3/16
3/21
3/26
3/31
Date
Observed ADS
Disaggregated County

Figure 3

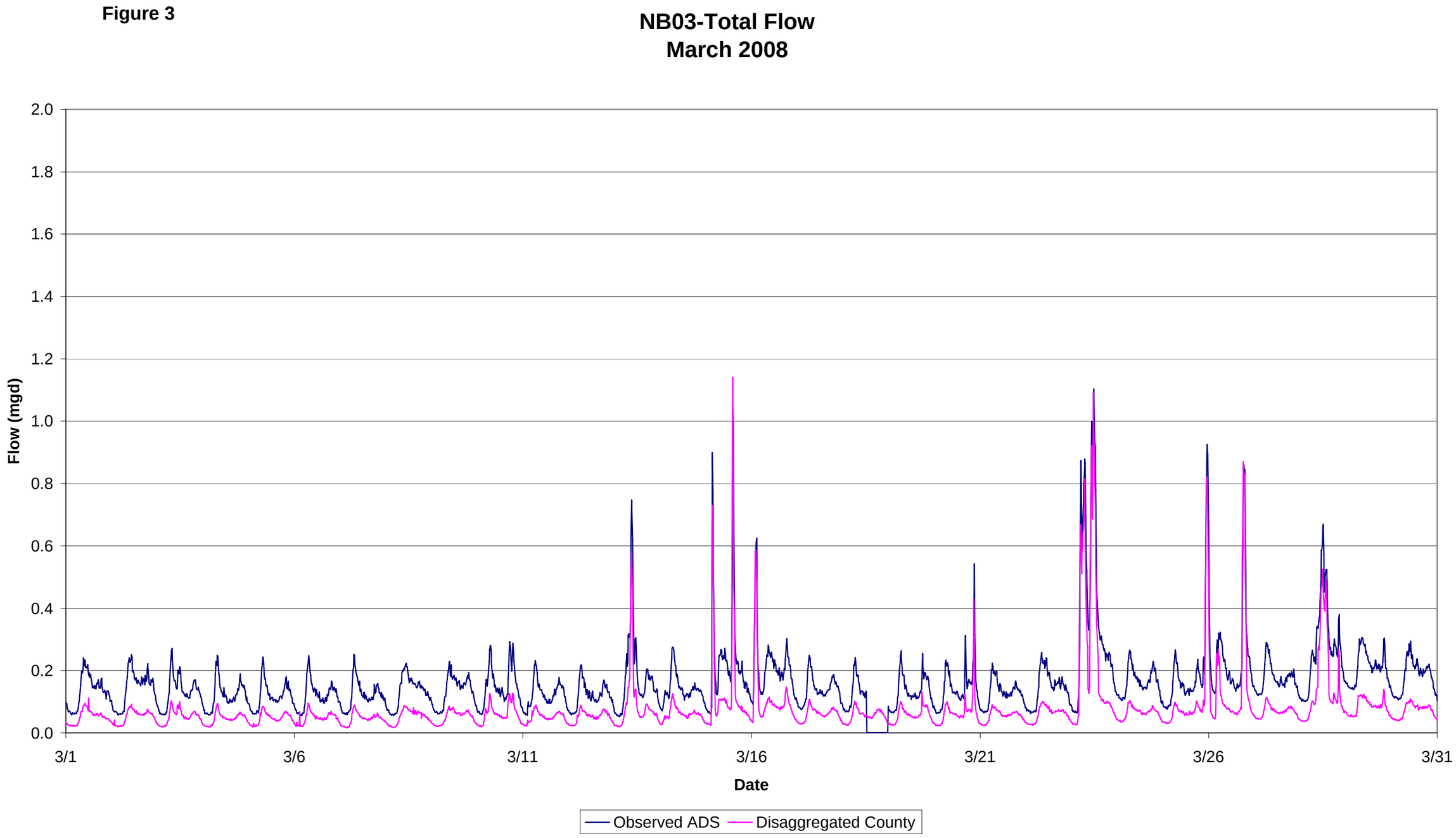

NB03-Total Flow
March 2008
Flow (mgd)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
3/1
3/6
3/11
3/16
3/21
3/26
3/31
Date
Observed ADS
Disaggregated County

Figure 4

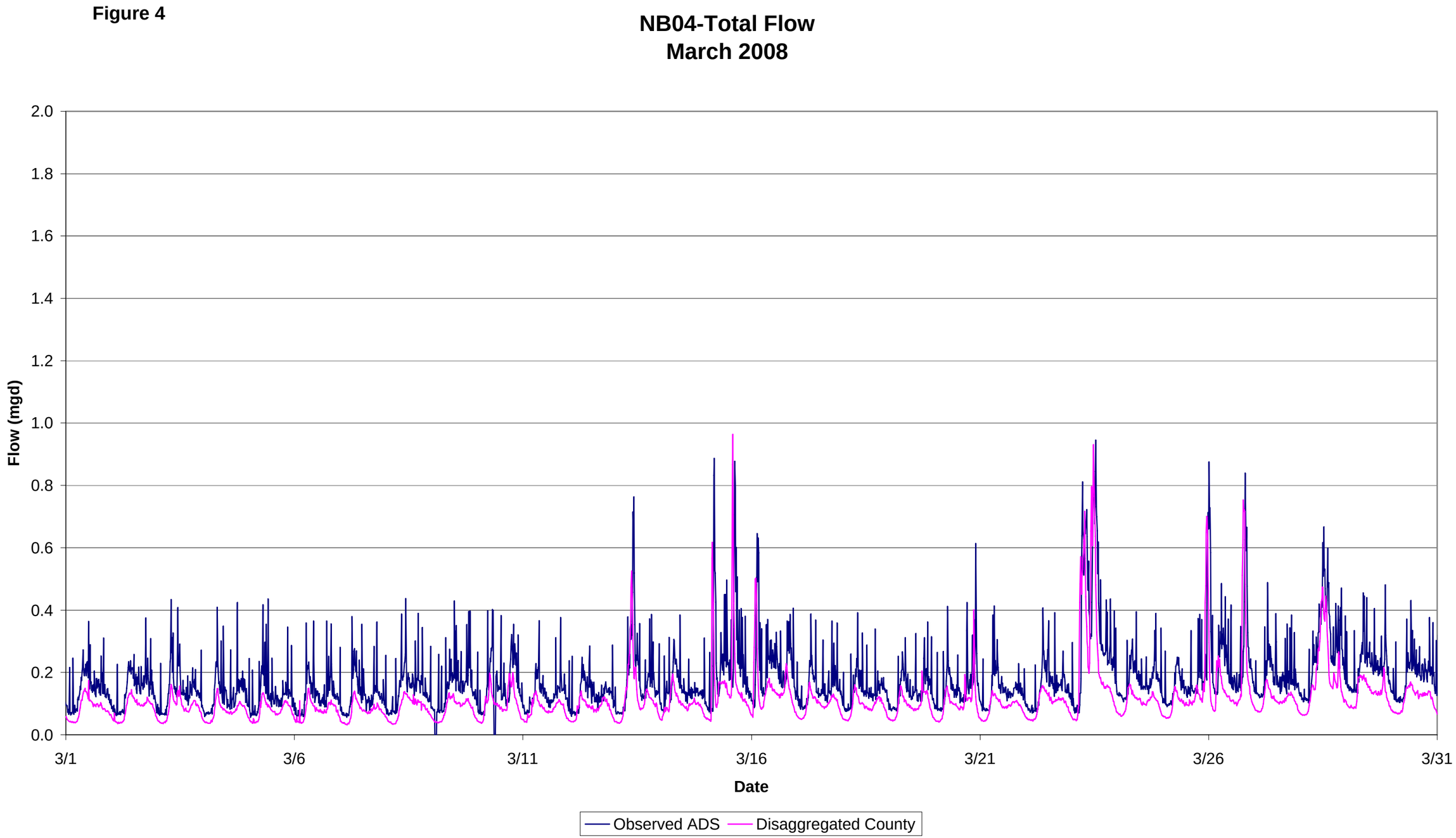

NB04-Total Flow
March 2008
Flow (mgd)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
3/1
3/6
3/11
3/16
3/21
3/26
3/31
Date
Observed ADS
Disaggregated County

Figure 5

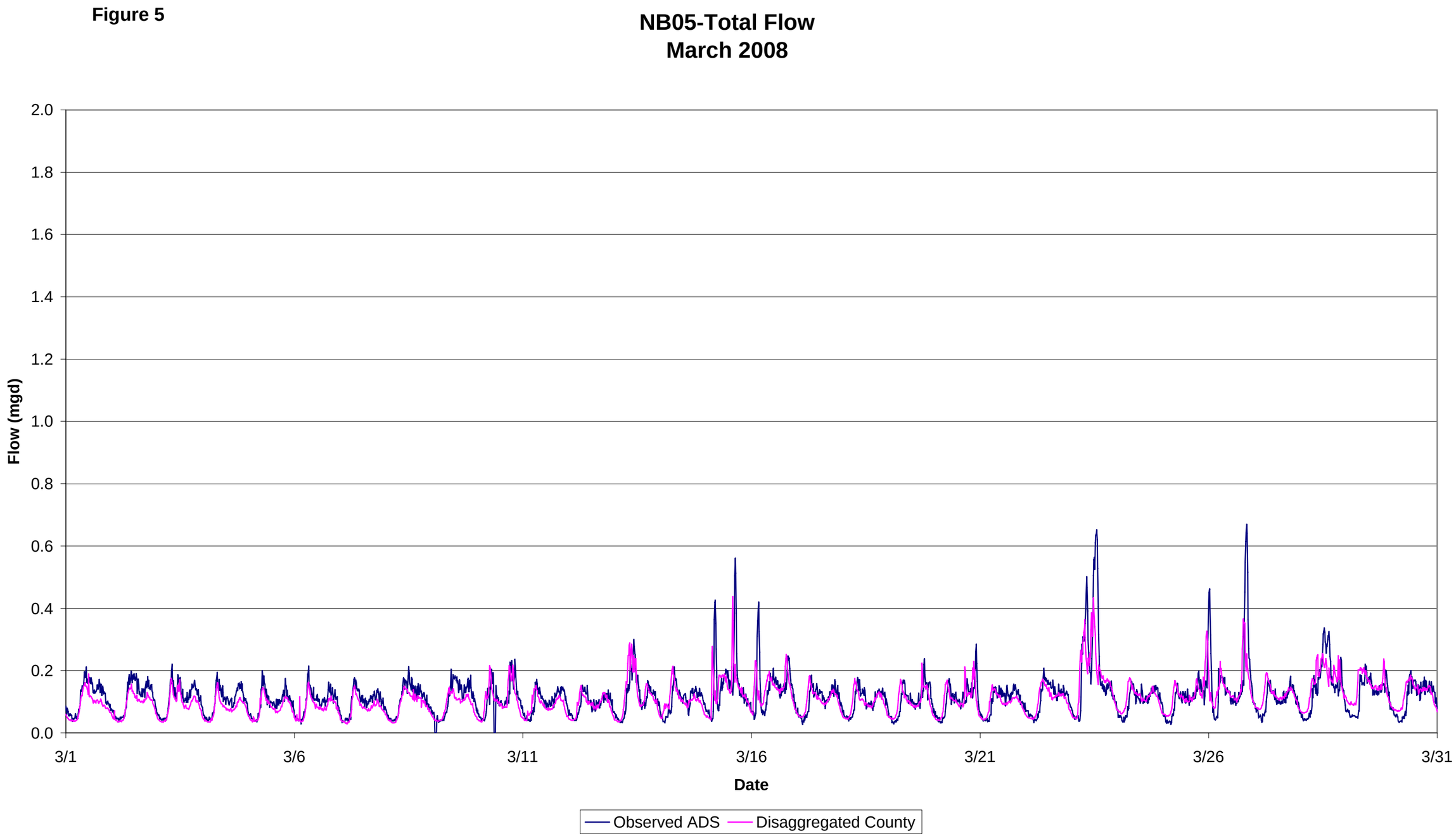

NB05-Total Flow
March 2008
Flow (mgd)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
3/1
3/6
3/11
3/16
3/21
3/26
3/31
Date
Observed ADS
Disaggregated County

Figure 6

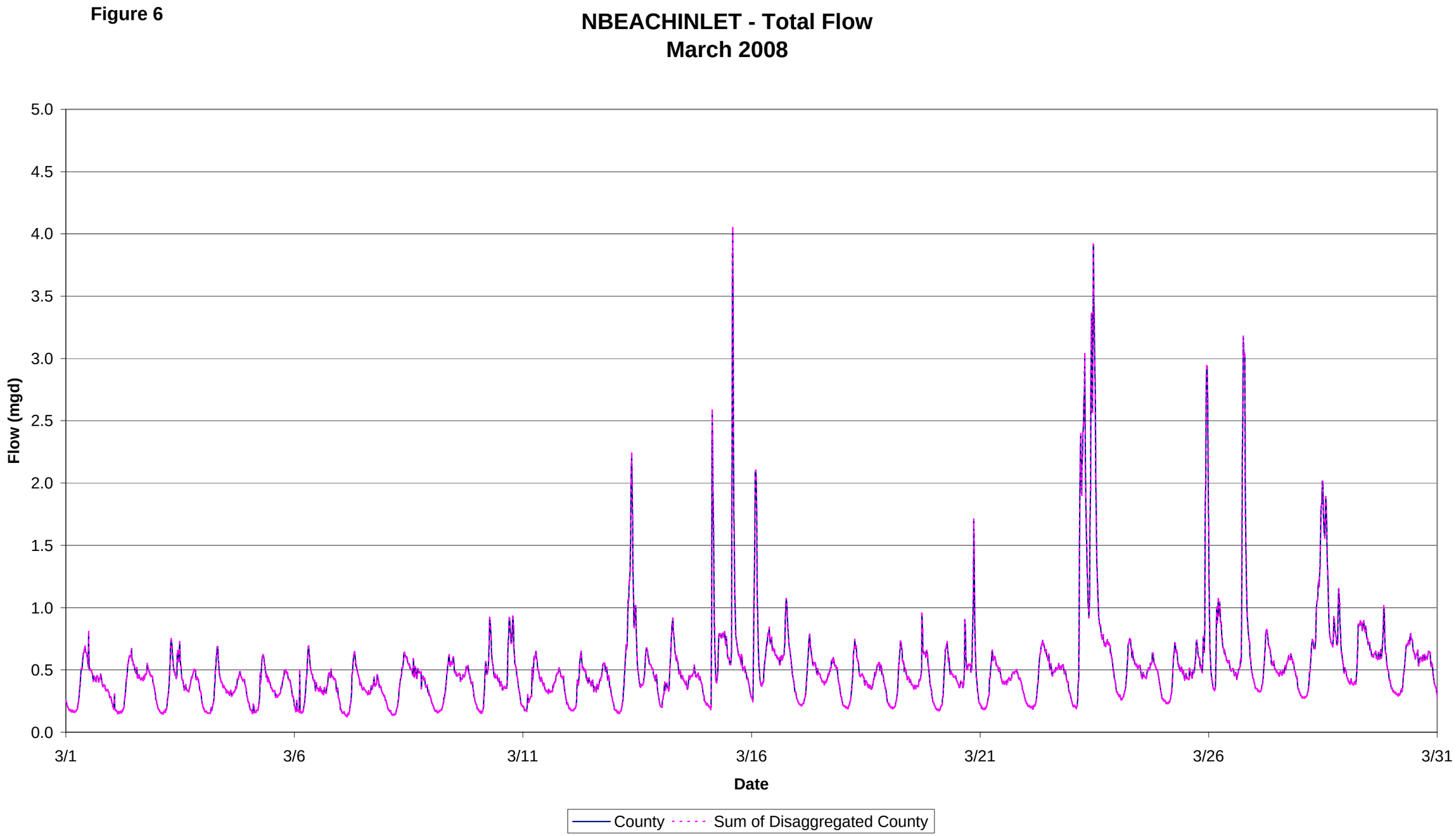

NBEACHINLET - Total Flow
March 2008
Flow (mgd)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
3/1
3/6
3/11
3/16
3/21
3/26
3/31
Date
County
Sum of Disaggregated County

Figure 7

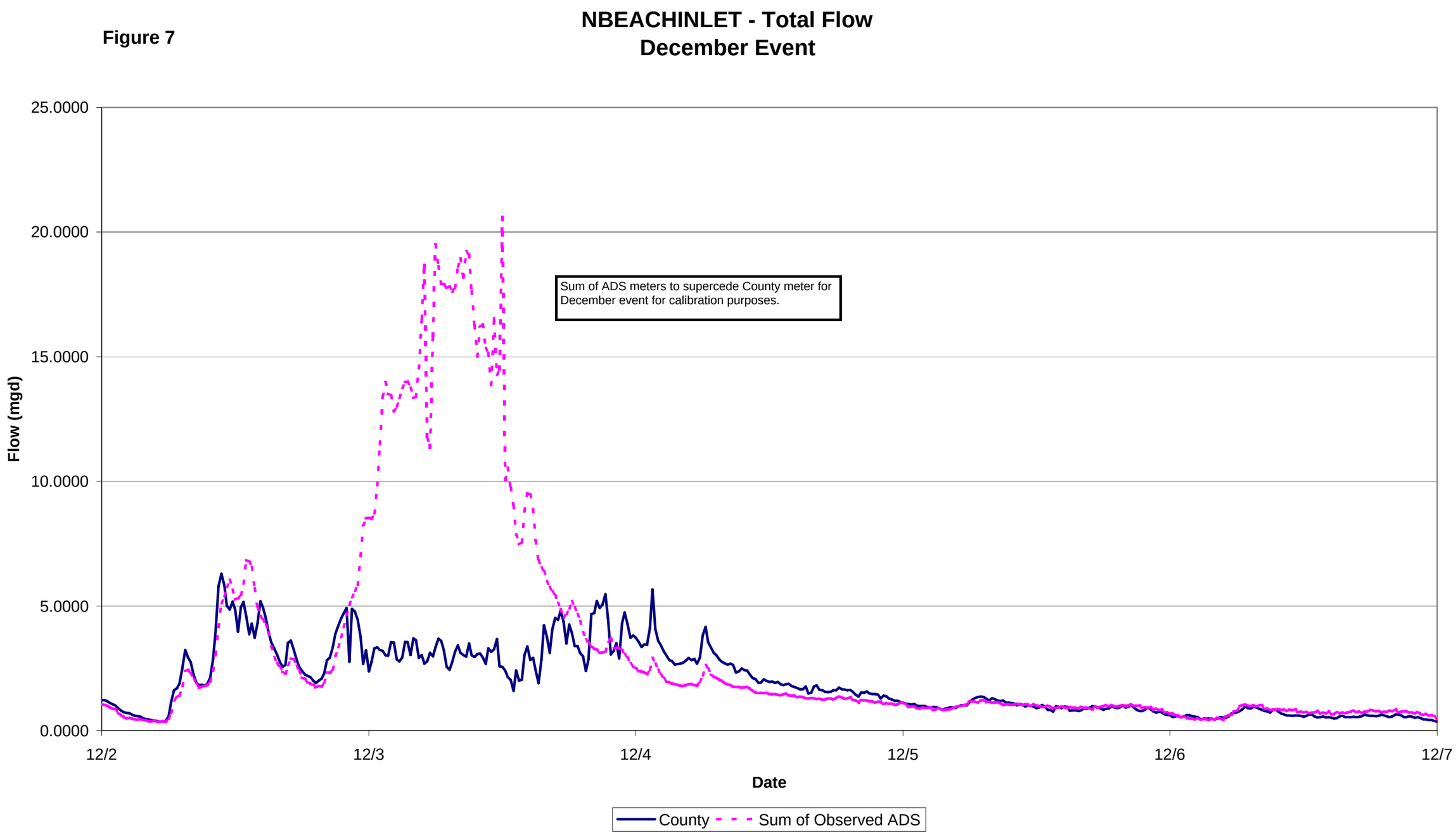

NBEACHINLET - Total Flow
December Event
25.0000
20.0000
15.0000
10.0000
5.0000
0.0000
Flow (mgd)
Sum of ADS meters to supercede County meter for December event for calibration purposes.
12/2
12/3
12/4
12/5
12/6
12/7
Date
County
Sum of Observed ADS

Figure 8

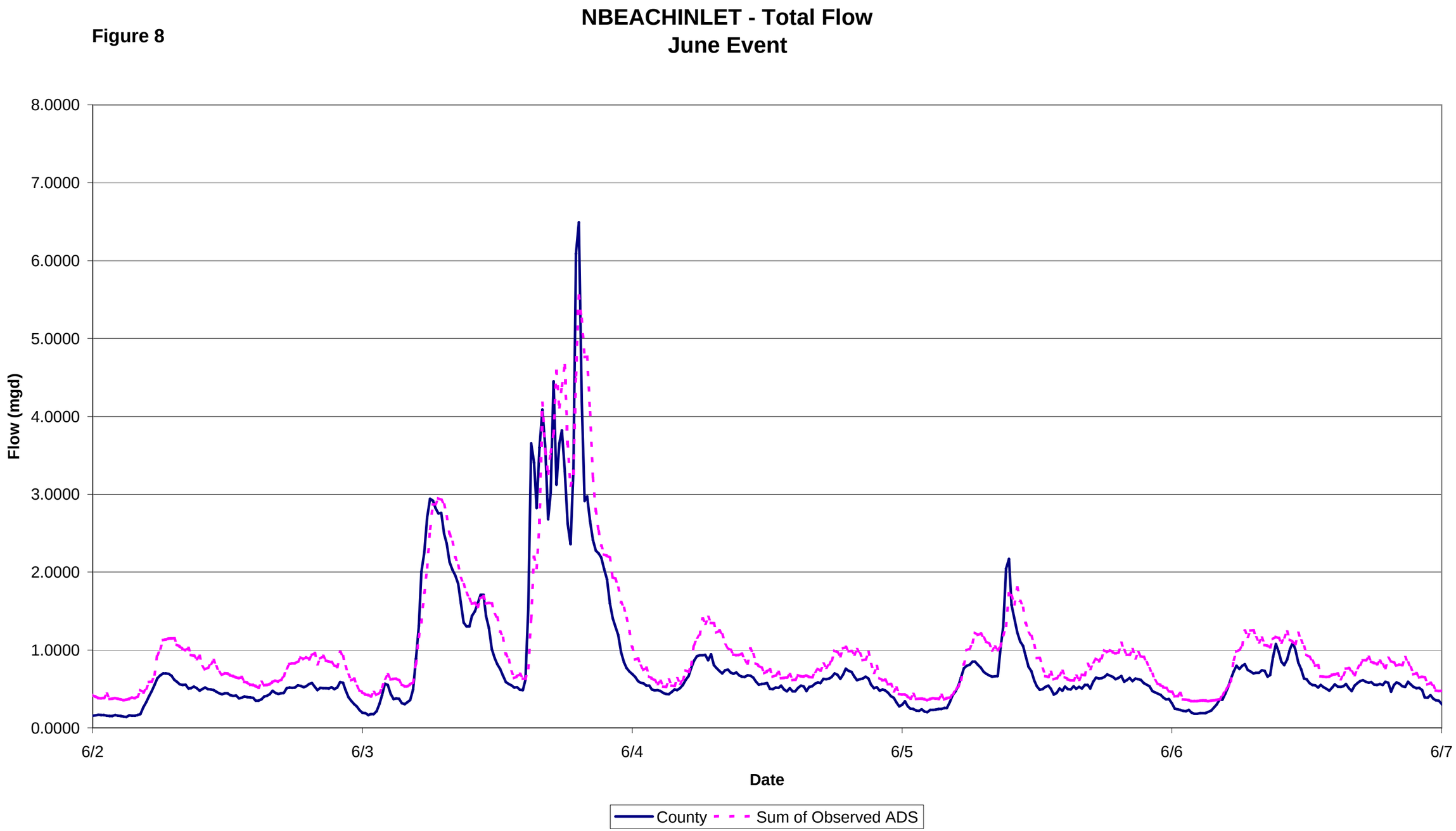
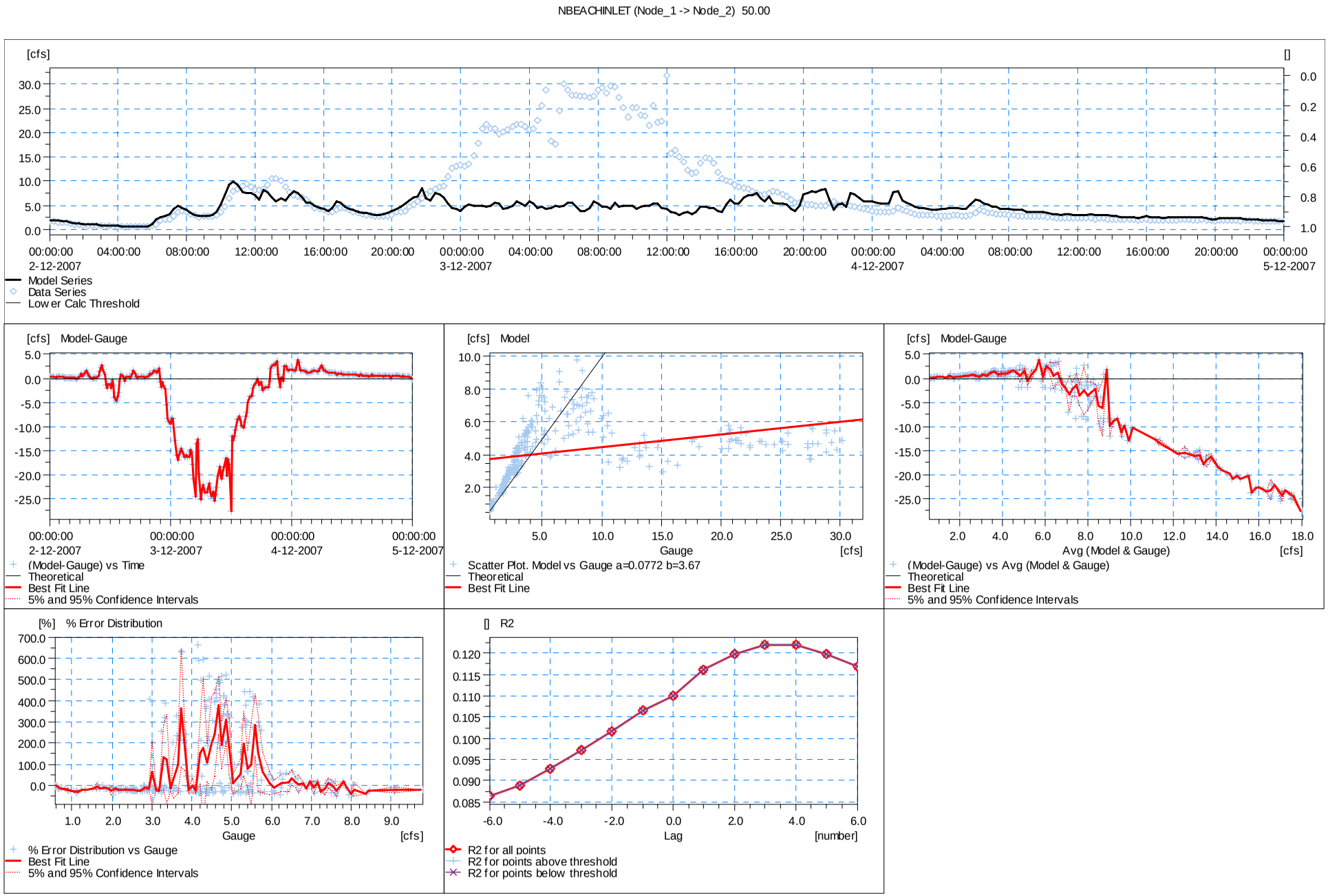
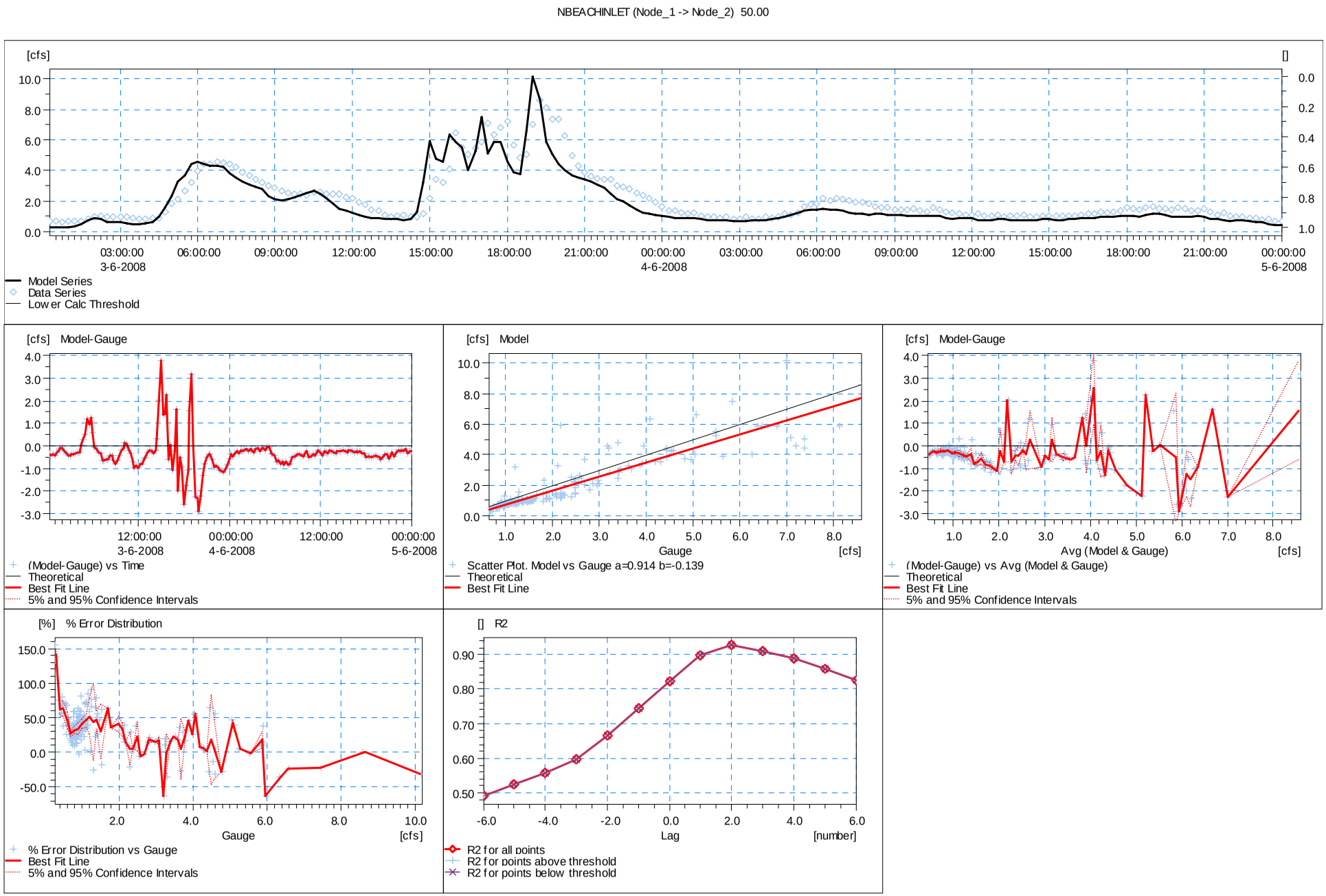

NBEACHINLET - Total Flow
June Event
8.0000
7.0000
6.0000
5.0000
4.0000
3.0000
2.0000
1.0000
0.0000
Flow (mgd)
6/2
6/3
6/4
6/5
6/6
6/7
Date
County
Sum of Observed ADS

Figure 9



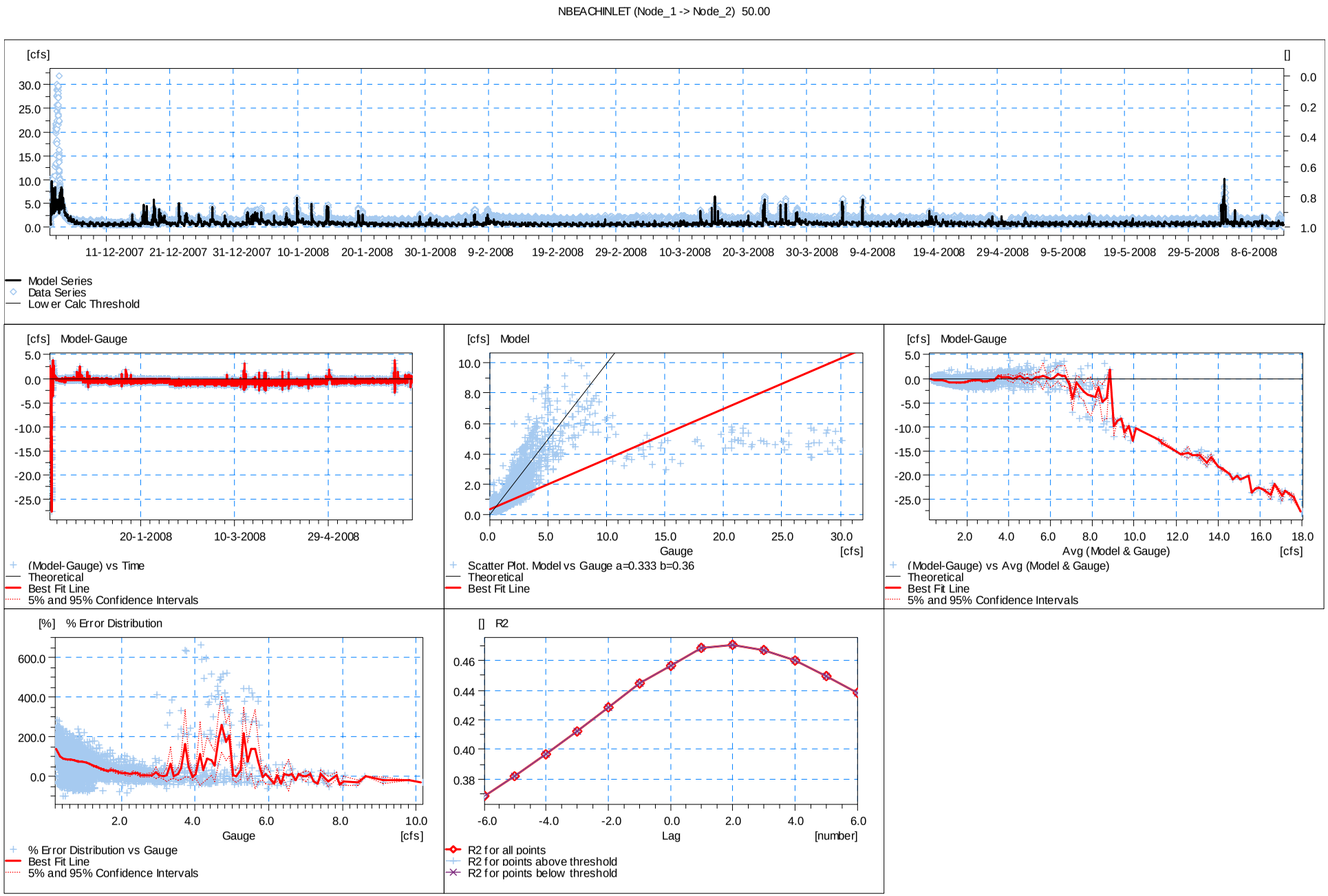
R2 = 0.110

Figure 10

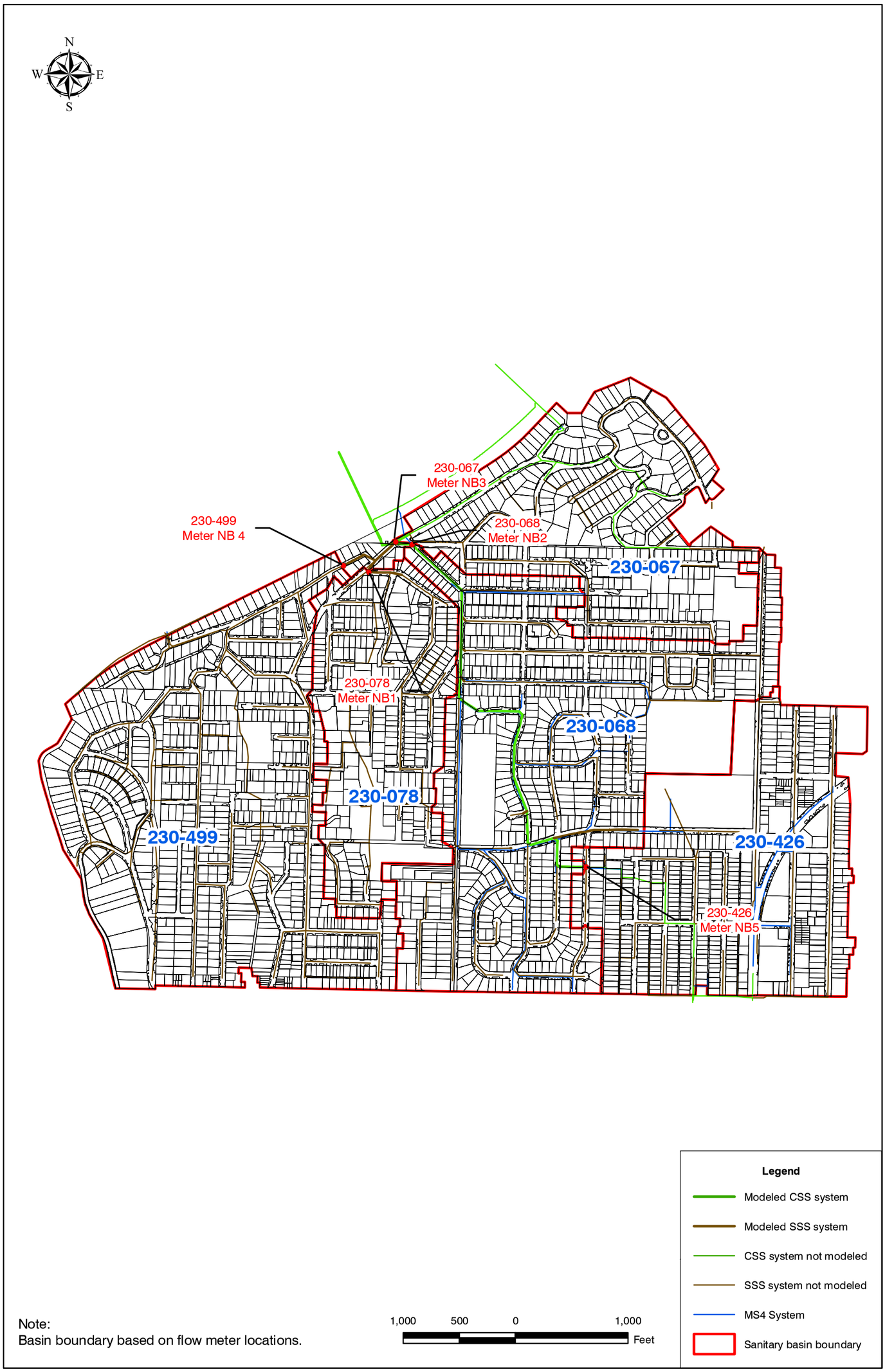


R2 = 0.823

Figure 11



R2 = 0.457



Note:
Basin boundary based on flow meter locations.

Figure A-3
PRELIMINARY SANITARY BASINS AND PIPES
NORTH BEACH
BARTON, MURRAY, NORTH BEACH, SOUTH MAGNOLIA CSO FACILITIES
KING COUNTY DNRP, WASTEWATER TREATMENT DIVISION

King County
carollo
Engineers...Working Wonders With Water™

E:\Carollo\King_Co\7562A10\GIS\082508_from_shaun\Barton\barton_san_basins.mxd
Wednesday, November 5, 2008

Appendix B-9

NORTH BEACH BASIN CALIBRATION, ROUND 3

Engineers...Working Wonders With Water™

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PHONE: (206) 684-6532

TECHNICAL MEMORANDUM

Project Name:	CSO Planning/Predesign Services	**Date:**	July 13, 2009 (Revised July 23, 2009)
Client:	King County DNRP, Wastewater Treatment Division	**Project Number:**	7562A.10
Prepared By:	Ed Wicklein		
Reviewed By:	Allen deSteiguer, Brian Matson		
Subject:	North Beach, Round 3		
Distribution:	King County, Project Team		

1.0 INTRODUCTION AND BACKGROUND

This technical memorandum (TM) summarize the results of the round 3 wet weather calibration for the North Beach basin. The sub basins were calibrated to disaggregated County flow data from the North Beach CSO meter. Model calibration followed guidelines in the "Code of Practice for the Hydraulic Modeling of Sewer Systems", version 3.001 published by the Water Planning Group, a section of the Chartered Institution of Water and Environmental Management. The document is available at:

http://www.ciwem.org/groups/wapug/code_of_practice.asp. The recommendations summarized below are a portion of section 6.5.4 Storm Flow Verification, from the aforementioned document and are the basis of our model calibration.

- The comparison period between observed and modeled events should last until flow has substantially returned to DWF.
- Observed and modeled hydrographs should meet the criteria for two out of three events.
- The peak flow should be in the range +25% to -10%.
- The volume of flow should be in the range +20% to -10%.

2.0 BASIS OF MODEL

Table 1 summarizes the ten largest rainfall events that occurred during the flow-monitoring period. A storm is defined as having no rainfall at least 24 hours before and after the event. The ADS flow data showed that flow generally returned to DWF conditions within 24 hours of the end of the rain event. Thus most of the wet weather flow contribution is attributed to direct connections and impervious areas (i.e. fast response). Some of these storms could not be used

for calibration due to lack of data. The ADS meters recorded data for the period from mid-December 2007, through mid-June 2008. Calibration focused on matching flows from the second, third and fifth largest storms, storms that began on June 2, 2008, December 16, 2007 and March 13, 2008, respectively.

Table 1 Storm Statistics Based on Period of Rain Record[1]
CSO Planning/Predesign Services
King County DNRP, Wastewater Treatment Division

Ranking	Start Date	Duration (Hours)	Event Total (Inches)
1	12/1/2007	66	6.57
2	6/2/2008	25.8	1.44
3	12/16/2007	84.5	1.41
4	1/2/2008	118.8	1.26
5	3/13/2008	82.5	1.05

Notes:

1. Rain gauge RG7

Wet weather flow was generated in the model using the MOUSE Kinematic Wave (B) + RDI routines. Model B was used to generate the fast response curve (FRC) while the RDI routine generated the slow response curve (SRC). The wet weather parameters are summarized in Table 2.

The model calibrated well to all three storms. The peak flow and volume were within criteria for the three storms except for the volume of NB03 for the March 13th storm. Table 3 summarizes the calibration for each meter for each calibration storm and the January 2nd storm. A basin schematic is located following Table 3. Plots of the calibration for each of the three calibration events and the large December 1 storm following the basin schematic. December 1 graphs are shown for illustrative purposes only. Note that for meter NB02 the FRC and SRC curves are for that meter's contribution only. The total observed and modeled flows are cumulative, including flow from upstream subbasins.

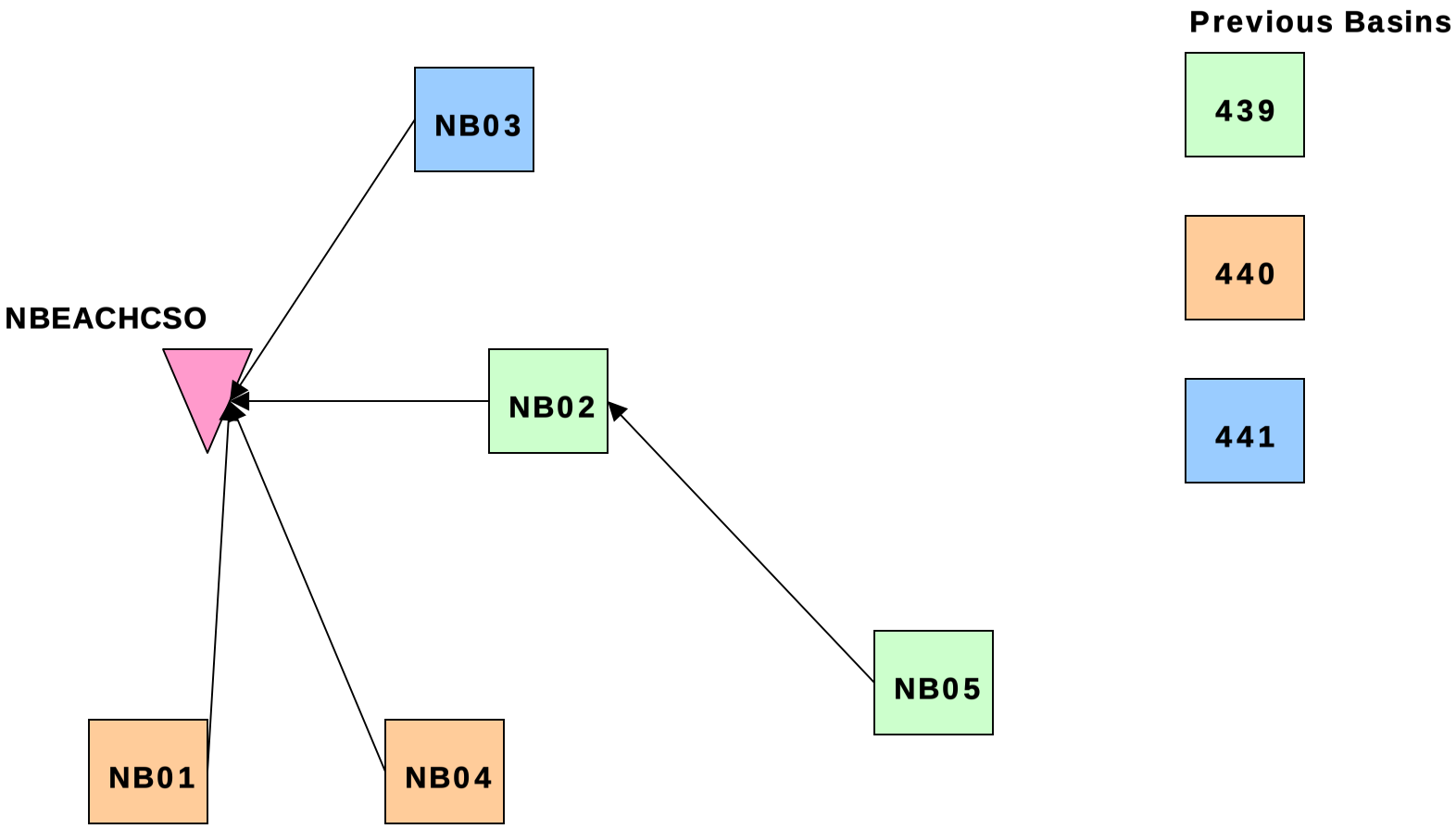
Table 2 North Beach Calibration Parameters
CSO Planning/Pre-Design Services
King County DNRP, Wastewater Treatment Division

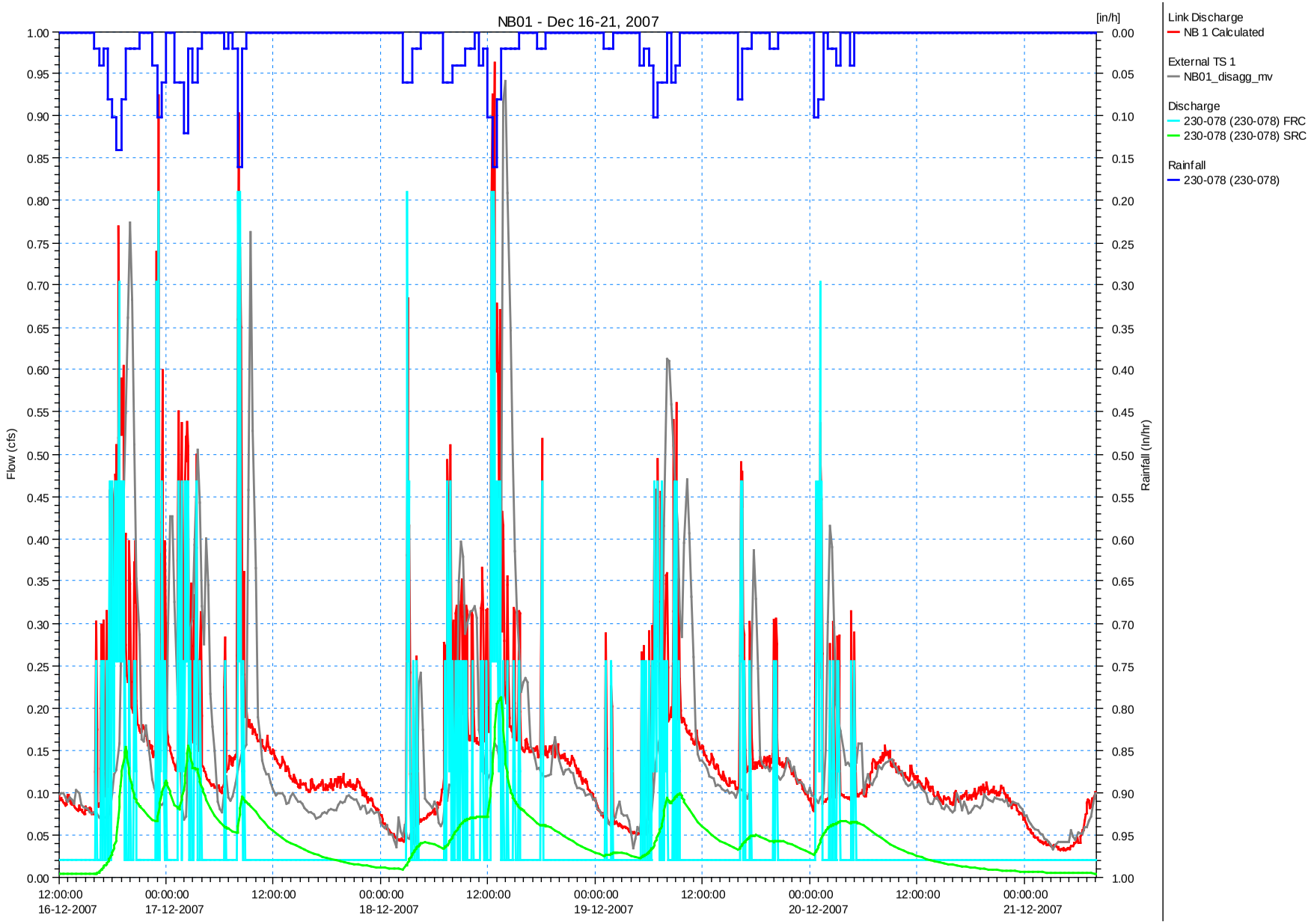
Parameter	MU Table	MU Name	Units	Subbasin					
				NB01	NB02	NB03	NB04	NB05	Unmetered
Catchment Geometry									
Drainage Area	ms_Catchment	Area	(Acres)	73.415	170.802	97.125	97.125	113.563	1
MOUSE Kinematic Wave (B)									
Length	msm_HModB	Length	(Feet)	150.000	250.000	500.000	250.000	250.000	250.000
Slope	msm_HModB	Slope	(0/00)	60.00	20.00	30.00	60.40	30.00	60.40
Steep Impervious Area	msm_HModB	AISteep	(%)	0.00	0.00	0.00	0.00	0.00	0.00
Flat Impervious Area	msm_HModB	AIFlat	(%)	3.85	1.50	4.65	2.10	1.00	10.00
Small Pervious Area	msm_HModB	APSmall	(%)	0.00	0.00	0.00	0.00	0.00	0.00
Medium Pervious Area	msm_HModB	APMedium	(%)	0.00	0.00	0.00	0.00	0.00	0.00
Large Pervious Area	msm_HModB	APLarge	(%)	0.00	0.00	0.00	0.00	0.00	0.00
Manning Number, steep impervious area	msm_HParB	ManningSteep	---	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
Manning Number, flat impervious area	msm_HParB	ManningFlat	---	0.0150	0.0300	0.0300	0.0143	0.0300	0.0143
Manning Number, small pervious area	msm_HParB	ManningSmall	---	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Manning Number, medium pervious area	msm_HParB	ManningMedium	---	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Manning Number, large pervious area	msm_HParB	ManningLarge	---	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
RDI									
Area	msm_HModCRC	RdiiArea	(%)	4.50	4.80	6.75	3.00	2.90	10.00
Surface storage (Umax)	msm_HParRDII	Umax	(Inches)	0.120	0.150	0.080	0.150	0.200	0.120
Root zone storage (Lmax)	msm_HParRDII	Lmax	(Inches)	4.507	10.374	10.000	4.507	10.000	4.507
Overland coefficient(CQof)	msm_HParRDII	Cqof	---	0.480	0.300	0.550	0.480	0.500	0.480
Groundwater coefficient (Carea)	msm_HParRDII	GwCarea	---	1.000	1.000	1.000	1.000	1.000	1.000
TC overland flow (CKof)	msm_HParRDII	Ck	(Hours)	0.500	0.500	0.500	0.500	0.500	0.500
TC interflow (CKif)	msm_HParRDII	Ckif	(Hours)	6.000	4.000	4.000	4.000	6.000	6.000
TC baseflow (CKbf)	msm_HParRDII	Ckbf	(Hours)	100.000	100.000	100.000	500.000	500.000	100.000
Overland flow threshold (Tof)	msm_HParRDII	Tof	(%)	0.000	0.000	0.000	0.000	0.000	0.000
Interflow treshold (Tif)	msm_HParRDII	Tif	(%)	0.000	0.000	0.000	0.000	0.000	0.000
Groundwater threshold (Tg)	msm_HParRDII	Tg	(%)	0.000	0.000	0.000	0.000	0.000	0.000
Specific yield (Sy)	msm_HParRDII	GwSy	---	0.200	0.200	0.200	0.200	0.200	0.200
Minimum groundwater depth (GWLmin)	msm_HParRDII	GWLmin	(Feet)	0.000	0.000	0.000	0.000	0.000	0.000
Max GW depth causing baseflow (GWLbf0)	msm_HParRDII	GwLbf0	(Feet)	18.000	18.000	18.000	18.000	18.000	18.000
GW depth for unit capilary flux (GWLfl1)	msm_HParRDII	GWLfl1	(Feet)	1.000	1.000	1.000	1.000	1.000	1.000
Initial surface storage (U)	msm_HParRDII	InitU	(Inches)	0.000	0.000	0.000	0.000	0.000	0.000
Initial root zone moisture (L)	msm_HParRDII	InitL	(Inches)	4.507	10.374	10.000	4.507	10.000	4.507
Initial groundwater depth (GWL)	msm_HParRDII	InitGwl	(Feet)	0.000	0.000	0.000	0.000	0.000	0.000
Initial overland flow (OF)	msm_HParRDII	InitOf	(In/hr)	0.000	0.000	0.000	0.000	0.000	0.000
Initial interlow (IF)	msm_HParRDII	InitIf	(In/hr)	0.000	0.000	0.000	0.000	0.000	0.000

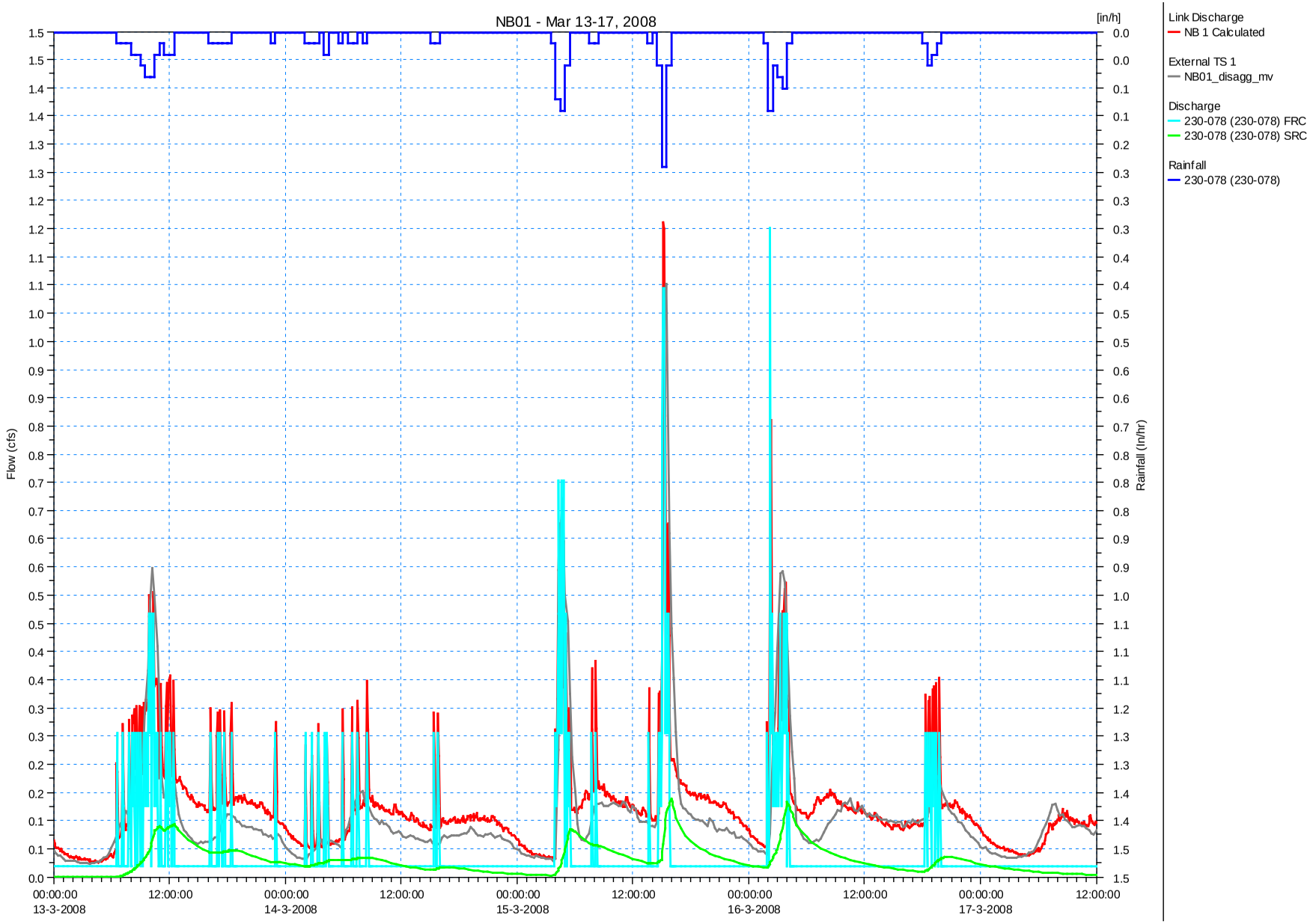
Table 3 North Beach Calibration Statistics
CSO Planning/Pre-Design Services
King County DNRP, Wastewater Treatment Division

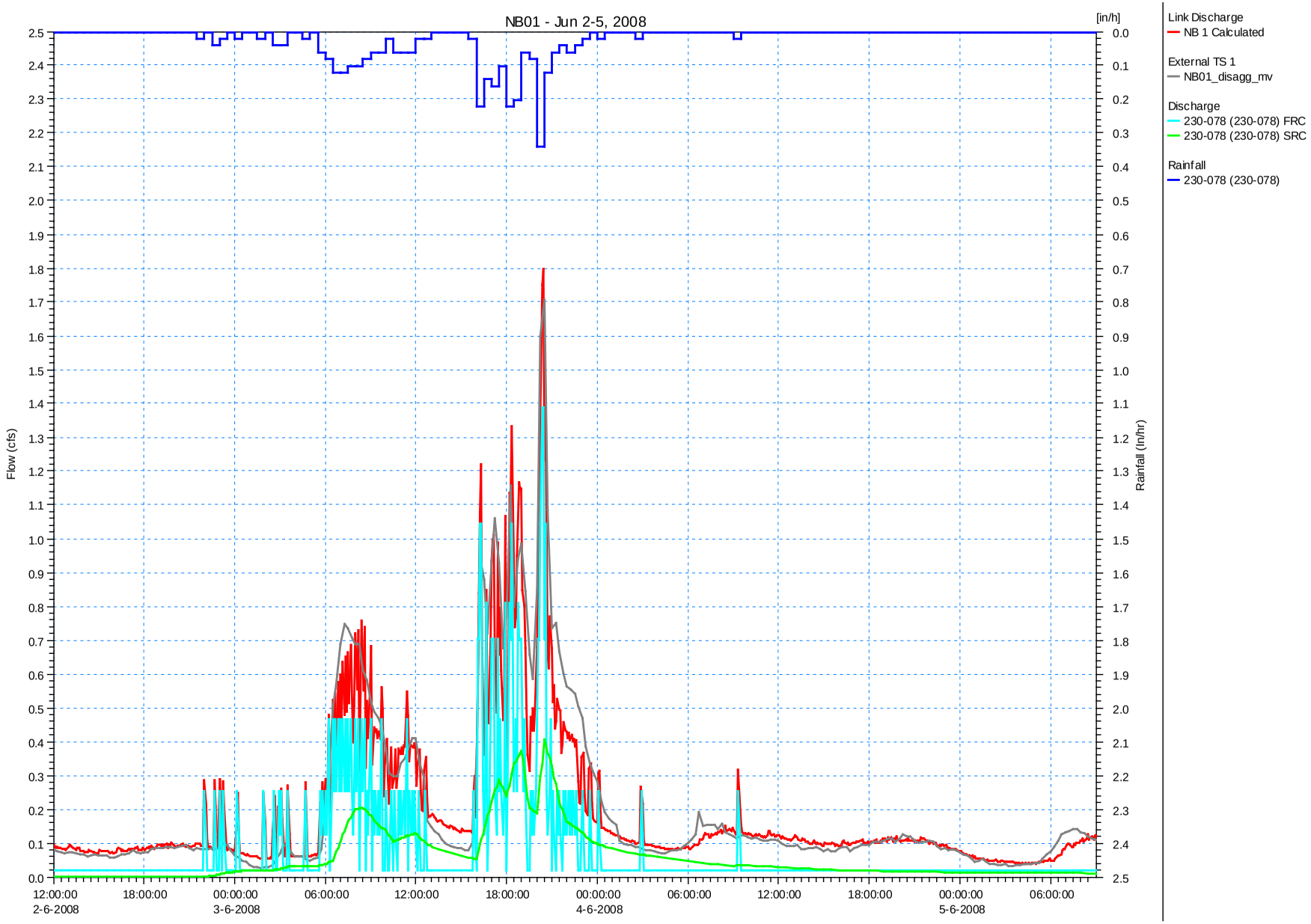
Description	Units	Subbasin NB01	NB02	NB03	NB04	NB05	Basin
Calibration Storm 1 (Storm No. 2)[1]							
Correlation coefficient (R2)	---	0.90	0.89	0.95	0.91	0.88	0.94
Maximum positive difference	(MGD)	0.14	0.48	0.34	0.21	0.13	1.01
Maximum negative difference	(MGD)	-0.35	-0.21	-0.41	-0.45	-0.16	-1.28
Volume observed	(Mgal)	0.38	1.11	0.59	0.63	0.46	2.75
Volume modeled	(Mgal)	0.36	1.21	0.59	0.61	0.45	2.78
Volume error	(%)	-6.10	8.69	0.19	-3.88	-2.32	1.07
Peak observed flow	(MGD)	1.10	1.80	1.86	1.55	0.68	6.49
Peak modeled flow	(MGD)	1.18	1.95	2.03	1.65	0.74	6.84
Peak flow error	(%)	7.14	8.26	9.43	6.47	9.84	5.37
Peak flow criterion met?[5]	(Yes/No)	Yes	Yes	Yes	Yes	Yes	Yes
- See note below		---	---	---	---	---	---
Volume criterion met?[6]	(Yes/No)	Yes	Yes	Yes	Yes	Yes	Yes
- See note below		---	---	---	---	---	---
Calibration Storm 2 (Storm No. 3)[2]							
Correlation coefficient (R2)	---	0.11	0.54	0.18	0.20	0.54	0.28
Maximum positive difference	(MGD)	0.47	0.51	0.79	0.56	0.13	2.44
Maximum negative difference	(MGD)	-0.47	-0.44	-0.72	-0.60	-0.20	-2.31
Volume observed	(Mgal)	0.46	1.68	0.67	0.82	0.72	3.68
Volume modeled	(Mgal)	0.48	1.81	0.76	0.89	0.70	3.97
Volume error	(%)	4.66	7.69	13.21	7.63	-1.55	7.96
Peak observed flow	(MGD)	0.61	1.06	1.02	0.87	0.40	3.65
Peak modeled flow	(MGD)	0.63	1.03	0.92	0.84	0.37	3.46
Peak flow error	(%)	3.08	-2.20	-9.73	-3.43	-8.17	-5.18
Peak flow criterion met?[5]	(Yes/No)	Yes	Yes	Yes	Yes	Yes	Yes
- See note below		---	---	---	---	---	---
Volume criterion met?[6]	(Yes/No)	Yes	Yes	Yes	Yes	Yes	Yes
- See note below		---	---	---	---	---	---
Calibration Storm 3 (Storm No. 5)[3]							
Correlation coefficient (R2)	---	0.64	0.69	0.81	0.62	0.64	0.72
Maximum positive difference	(MGD)	0.39	0.27	0.35	0.50	0.12	1.41
Maximum negative difference	(MGD)	-0.30	-0.36	-0.45	-0.47	-0.21	-1.68
Volume observed	(Mgal)	0.32	1.30	0.44	0.59	0.56	2.67
Volume modeled	(Mgal)	0.38	1.48	0.57	0.69	0.58	3.12
Volume error	(%)	19.80	13.62	29.64	16.49	4.12	17.09
Peak observed flow	(MGD)	0.68	1.15	1.14	0.96	0.44	4.05
Peak modeled flow	(MGD)	0.75	1.05	1.22	1.01	0.41	4.04
Peak flow error	(%)	10.36	-8.58	6.64	4.49	-5.91	-0.24
Peak flow criterion met?[5]	(Yes/No)	Yes	Yes	Yes	Yes	Yes	Yes
- See note below		---	---	---	---	---	---
Volume criterion met?[6]	(Yes/No)	Yes	Yes	No	Yes	Yes	Yes
- See note below		---	---	7	---	---	---
Storm No. 4[4]							
Correlation coefficient (R2)	---	0.29	0.64	0.41	0.40	0.61	0.50
Maximum positive difference	(MGD)	0.29	0.30	0.39	0.38	0.11	1.45
Maximum negative difference	(MGD)	-0.22	-0.22	-0.34	-0.28	-0.10	-1.11
Volume observed	(Mgal)	0.51	1.99	0.73	0.93	0.85	4.20
Volume modeled	(Mgal)	0.49	1.87	0.75	0.89	0.74	4.03
Volume error	(%)	-5.33	-5.63	2.71	-4.15	-12.82	-4.05
Peak observed flow	(MGD)	0.32	0.68	0.53	0.48	0.29	2.05
Peak modeled flow	(MGD)	0.47	0.75	0.56	0.62	0.30	2.22
Peak flow error	(%)	44.69	10.71	6.52	28.26	3.15	8.14
Peak flow criterion met?[5]	(Yes/No)	No	Yes	Yes	No	Yes	Yes
- See note below		---	---	---	---	---	---
Volume criterion met?[6]	(Yes/No)	Yes	Yes	Yes	Yes	No	Yes
- See note below		---	---	---	---	---	---

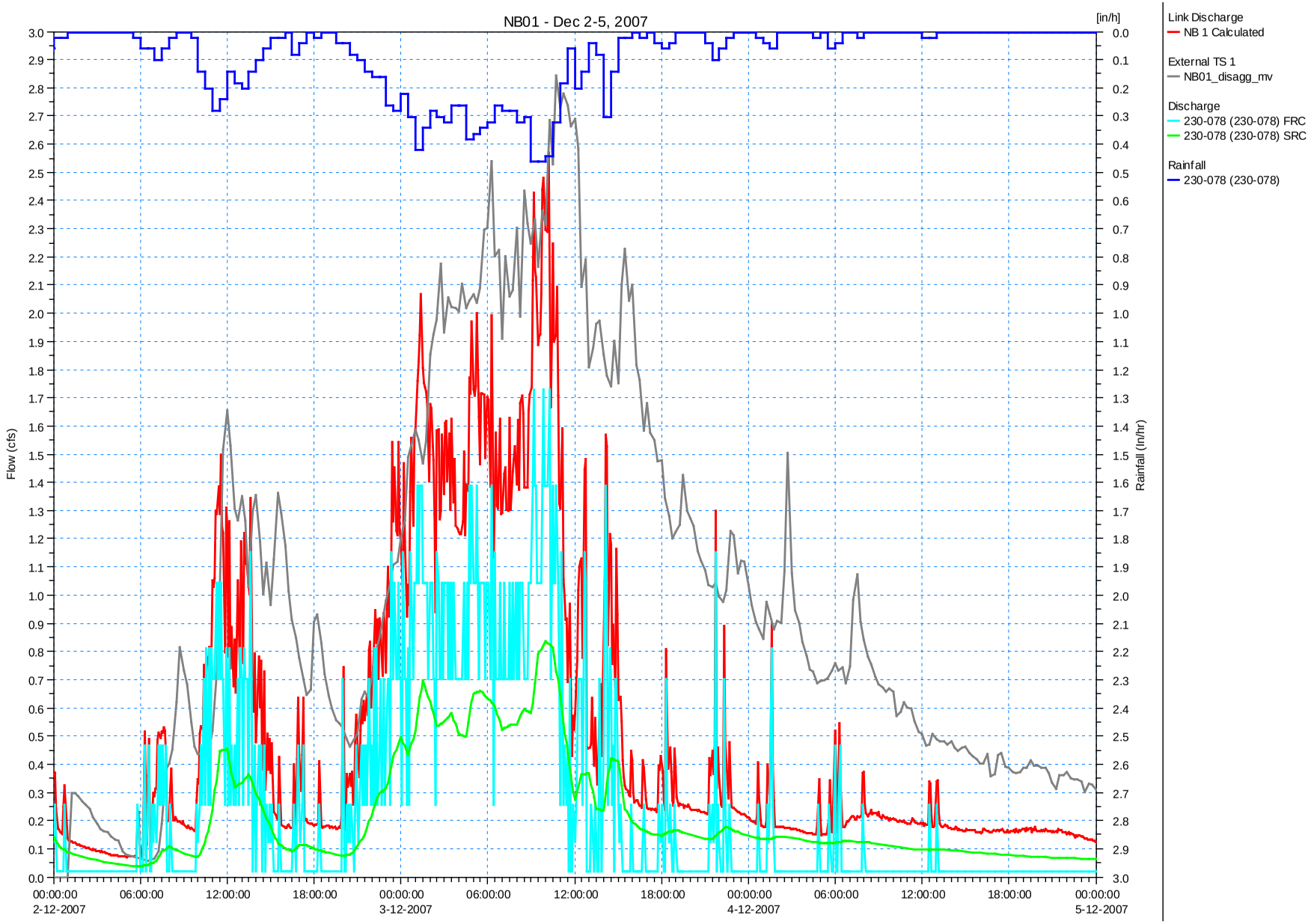
Notes:
(1) Calibration Storm 1: June 2, 2008 12:00 to June 5, 2008 9:00
(2) Calibration Storm 2: December 16, 2007 12:00 to December 21, 2007 8:00
(3) Calibration Storm 3: March 13, 2008 0:00 to March 17, 2008 12:00
(4) Storm No. 4: January 2, 2008 0:00 to January 7, 2008 12:00
(5) Peak flow error should be between +25% and -10% per the "Code of Practice for the Hydraulic Modeling of Sewer Systems."
(6) Volume error should be between +20% and -10% per the "Code of Practice for the Hydraulic Modeling of Sewer Systems."
(7) Inflow and infiltration over predicted.

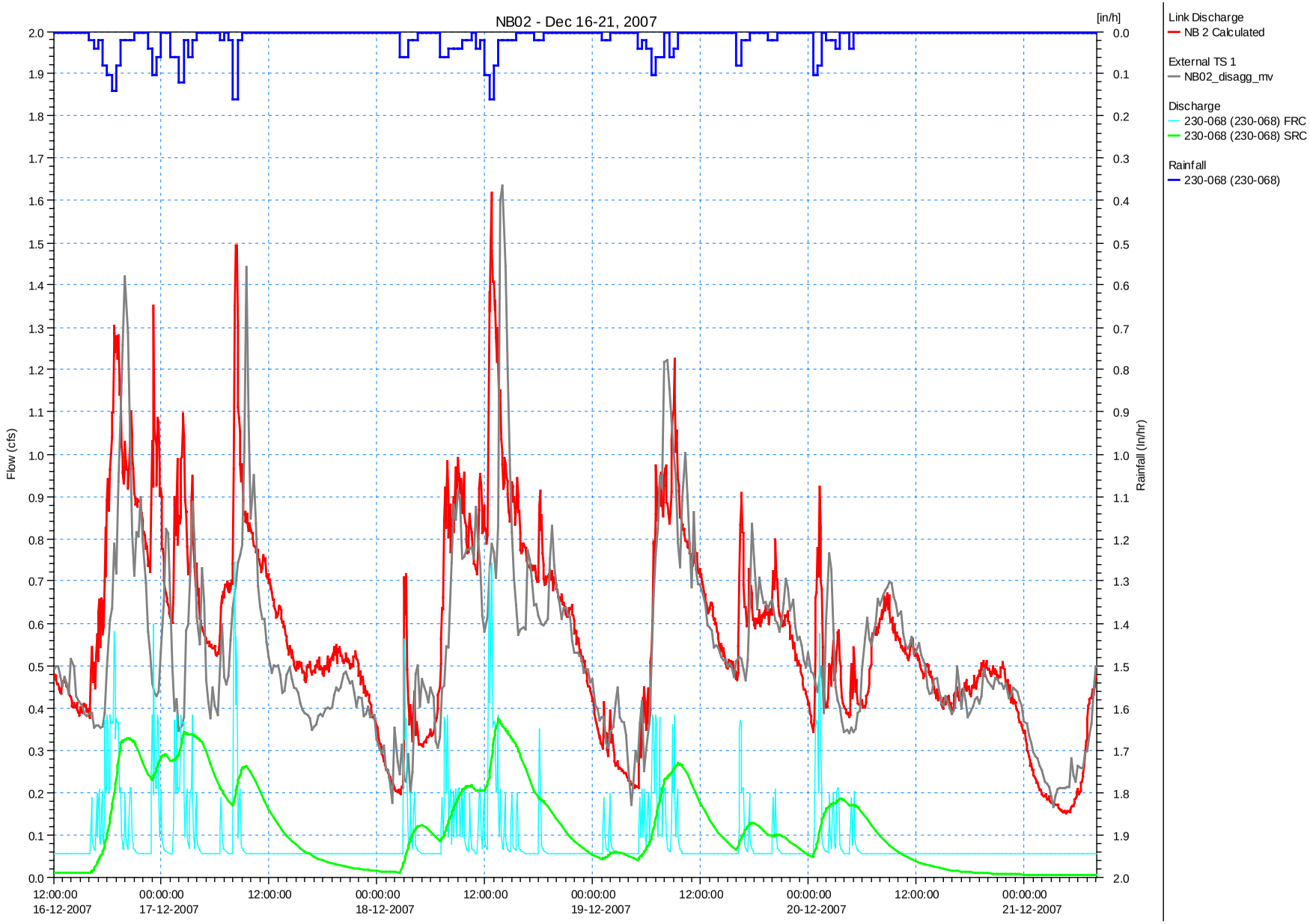

Previous Basins
439
440
441
NB03
NBEACHCSO
NB02
NB05
NB01
NB04

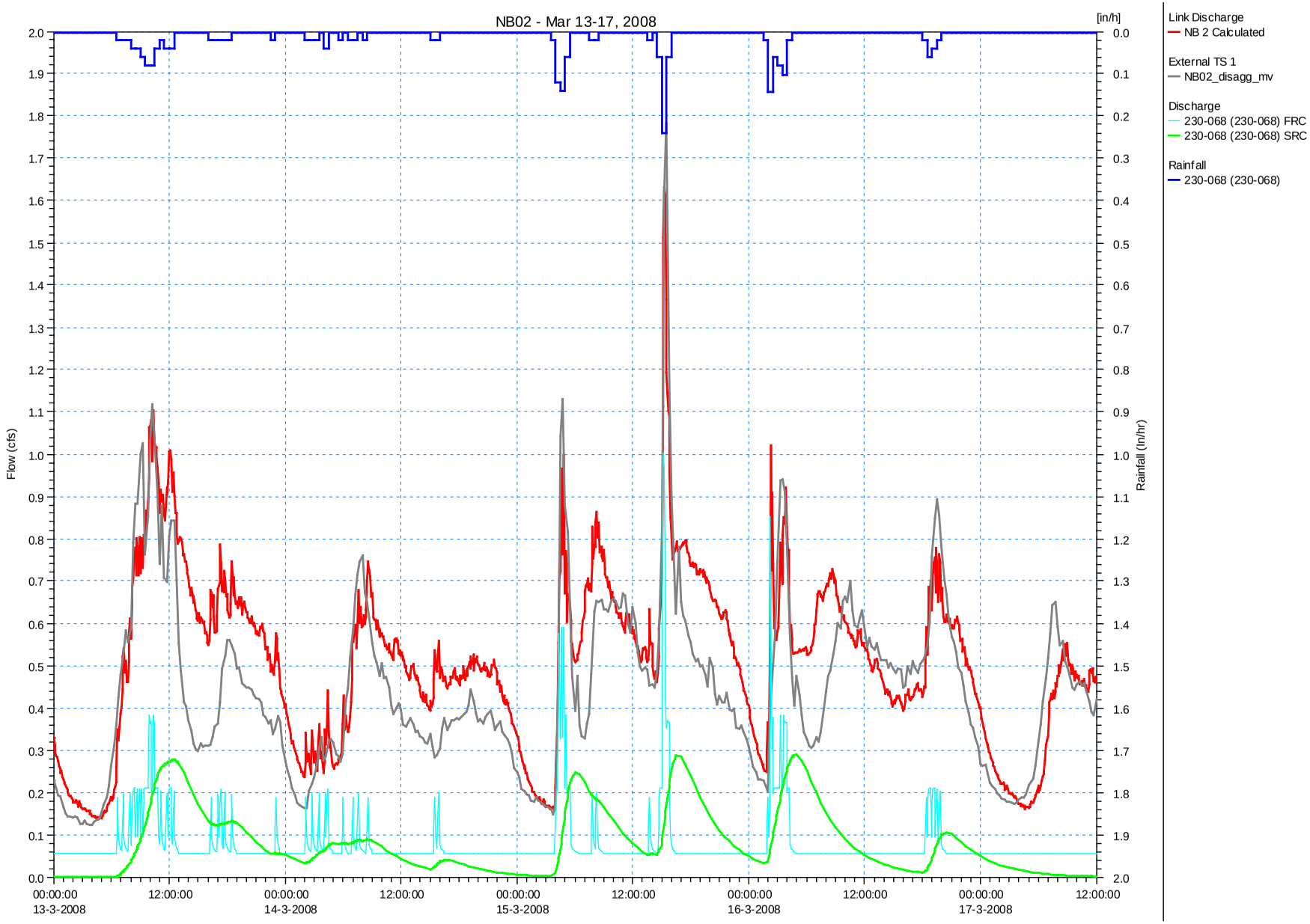

NB01 - Dec 16-21, 2007
[in/h]
Flow (cfs)
Rainfall (in/hr)
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
12:00:00 16-12-2007
00:00:00 17-12-2007
12:00:00
00:00:00 18-12-2007
12:00:00
00:00:00 19-12-2007
12:00:00
00:00:00 20-12-2007
12:00:00
00:00:00 21-12-2007
Link Discharge
NB 1 Calculated
External TS 1
NB01_disagg_mv
Discharge
230-078 (230-078) FRC
230-078 (230-078) SRC
Rainfall
230-078 (230-078)

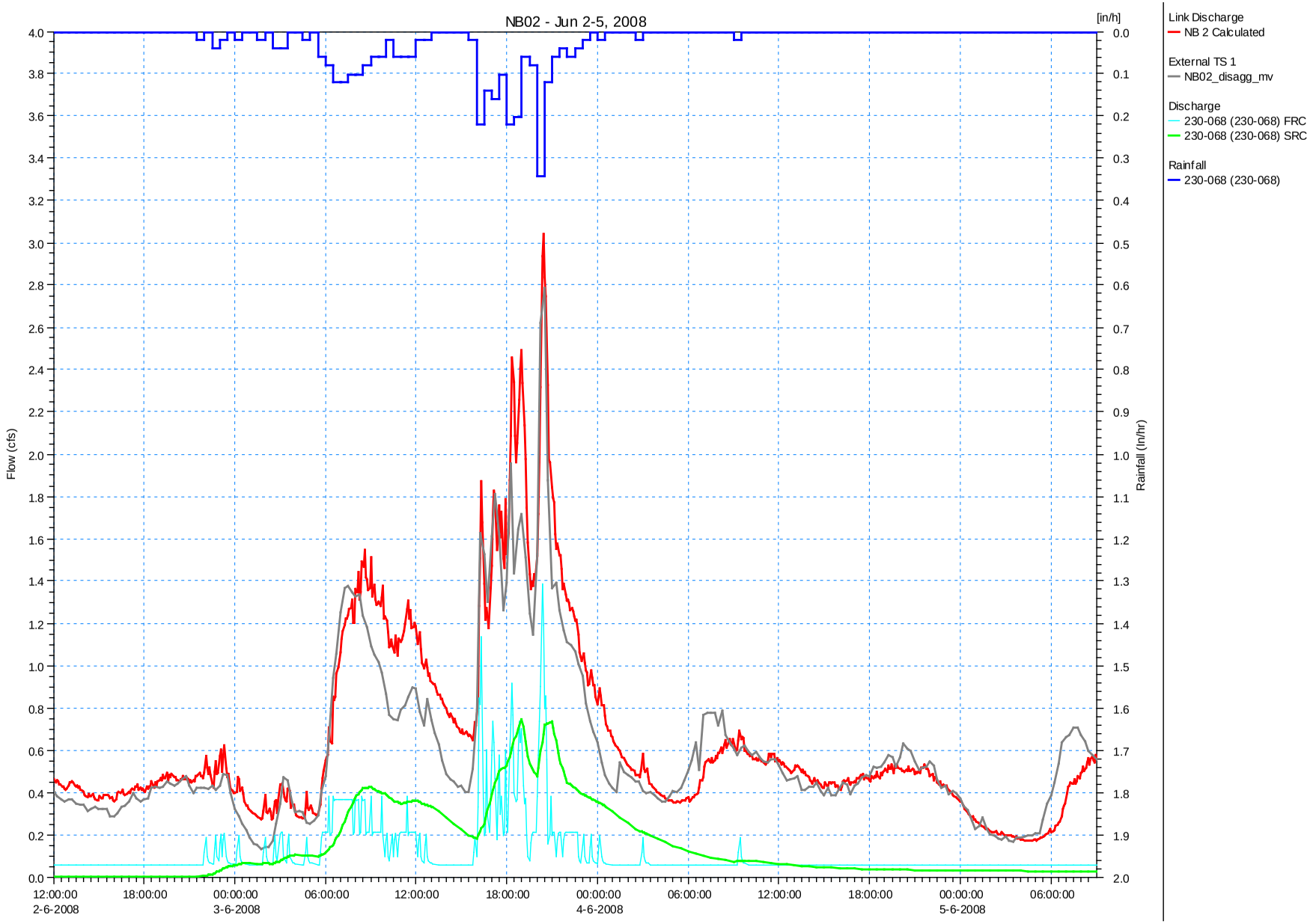

NB01 - Mar 13-17, 2008
[in/h]
Flow (cfs)
Rainfall (in/hr)
00:00:00 13-3-2008
12:00:00
00:00:00 14-3-2008
12:00:00
00:00:00 15-3-2008
12:00:00
00:00:00 16-3-2008
12:00:00
00:00:00 17-3-2008
12:00:00
Link Discharge
NB 1 Calculated
External TS 1
NB01_disagg_mv
Discharge
230-078 (230-078) FRC
230-078 (230-078) SRC
Rainfall
230-078 (230-078)

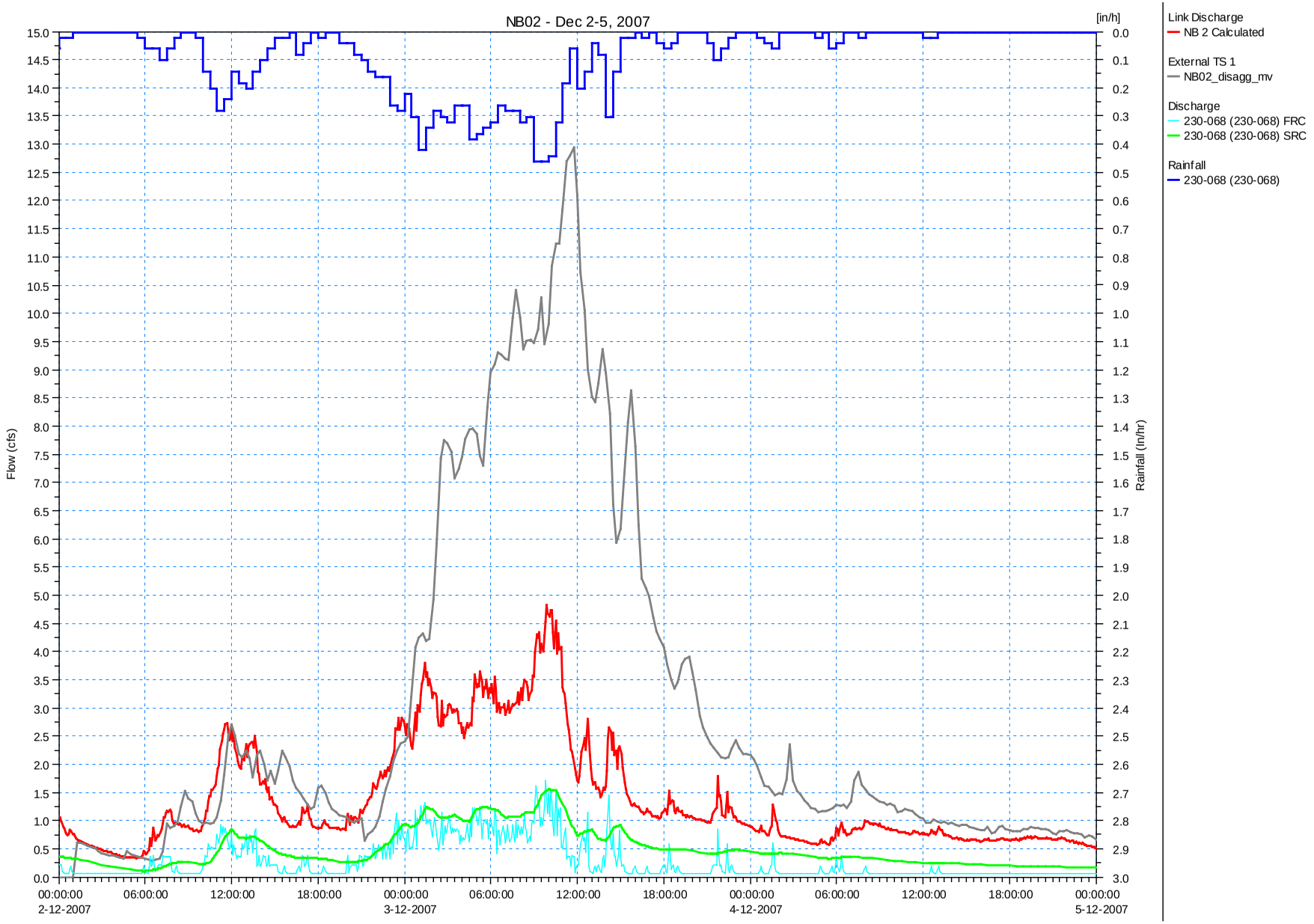

NB01 - Jun 2-5, 2008
[in/h]
Flow (cfs)
Rainfall (in/hr)
12:00:00 2-6-2008
18:00:00
00:00:00 3-6-2008
06:00:00
12:00:00
18:00:00
00:00:00 4-6-2008
06:00:00
12:00:00
18:00:00
00:00:00 5-6-2008
06:00:00
Link Discharge
NB 1 Calculated
External TS 1
NB01_disagg_mv
Discharge
230-078 (230-078) FRC
230-078 (230-078) SRC
Rainfall
230-078 (230-078)

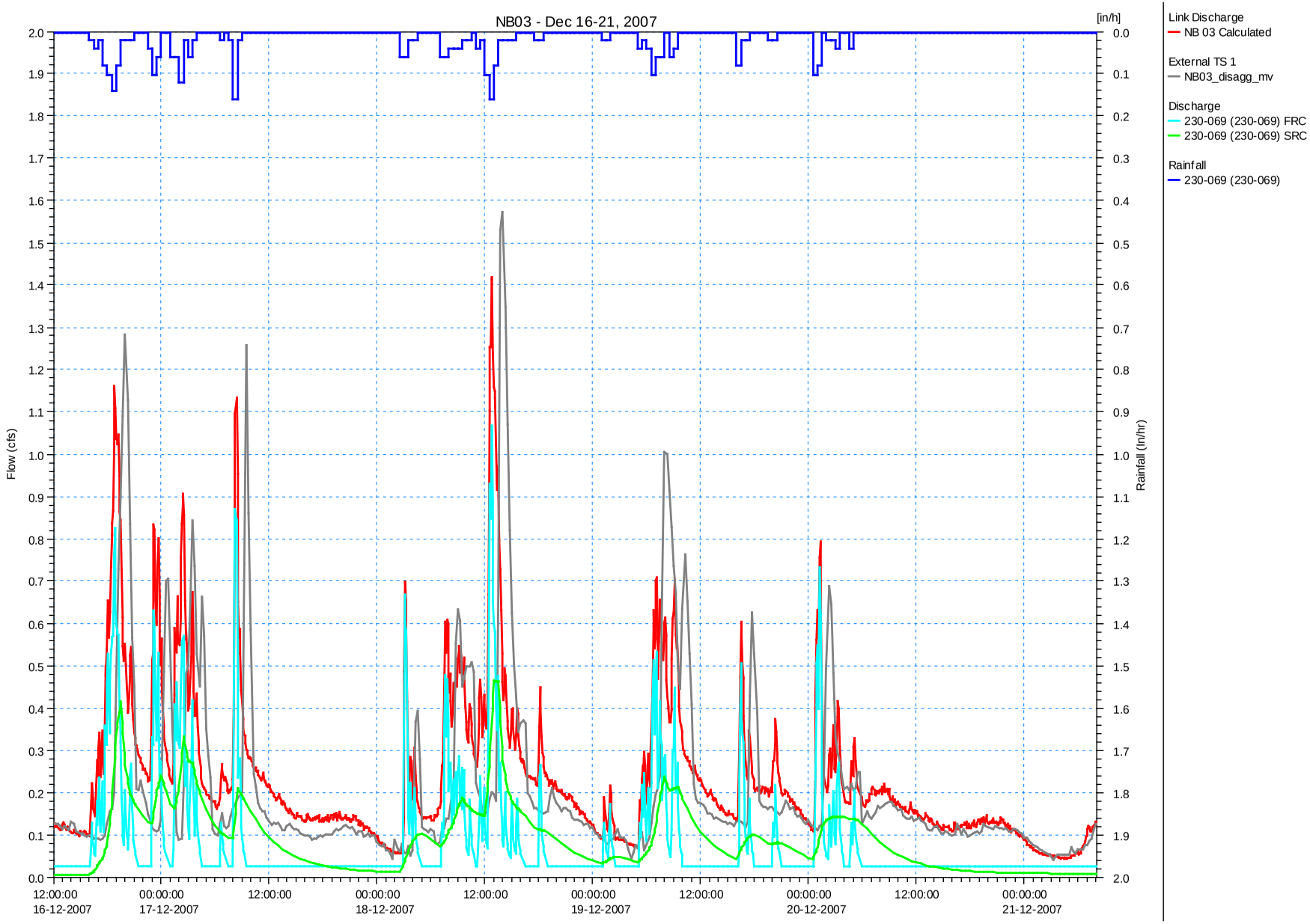

NB01 - Dec 2-5, 2007
[in/h]
Flow (cfs)
Rainfall (in/hr)
00:00:00 2-12-2007
06:00:00
12:00:00
18:00:00
00:00:00 3-12-2007
06:00:00
12:00:00
18:00:00
00:00:00 4-12-2007
06:00:00
12:00:00
18:00:00
00:00:00 5-12-2007
Link Discharge
NB 1 Calculated
External TS 1
NB01_disagg_mv
Discharge
230-078 (230-078) FRC
230-078 (230-078) SRC
Rainfall
230-078 (230-078)

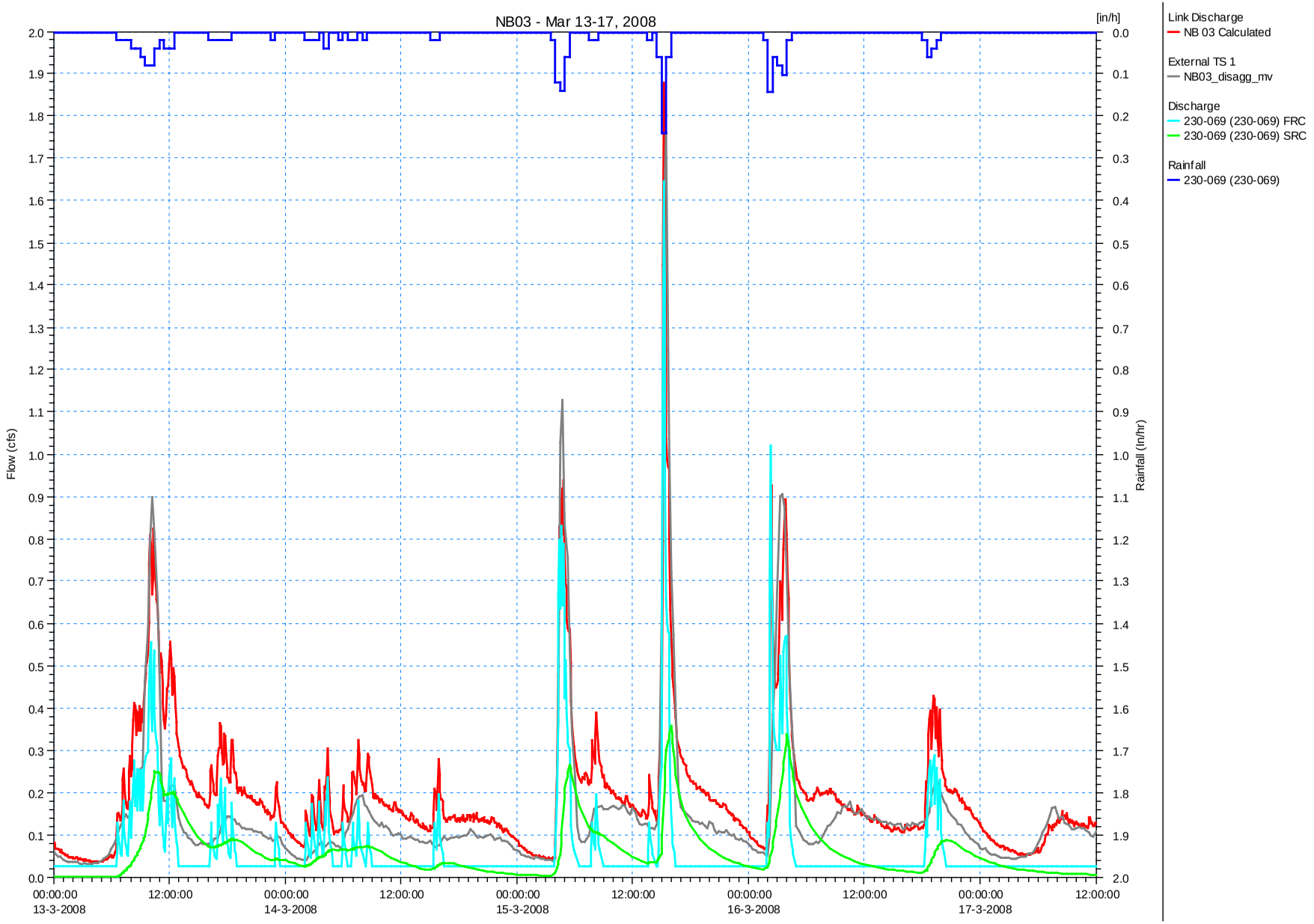

NB02 - Dec 16-21, 2007
[in/h]
Flow (cfs)
Rainfall (in/hr)
Link Discharge
NB 2 Calculated
External TS 1
NB02_disagg_mv
Discharge
230-068 (230-068) FRC
230-068 (230-068) SRC
Rainfall
230-068 (230-068)
12:00:00 16-12-2007
00:00:00 17-12-2007
12:00:00
00:00:00 18-12-2007
12:00:00
00:00:00 19-12-2007
12:00:00
00:00:00 20-12-2007
12:00:00
00:00:00 21-12-2007

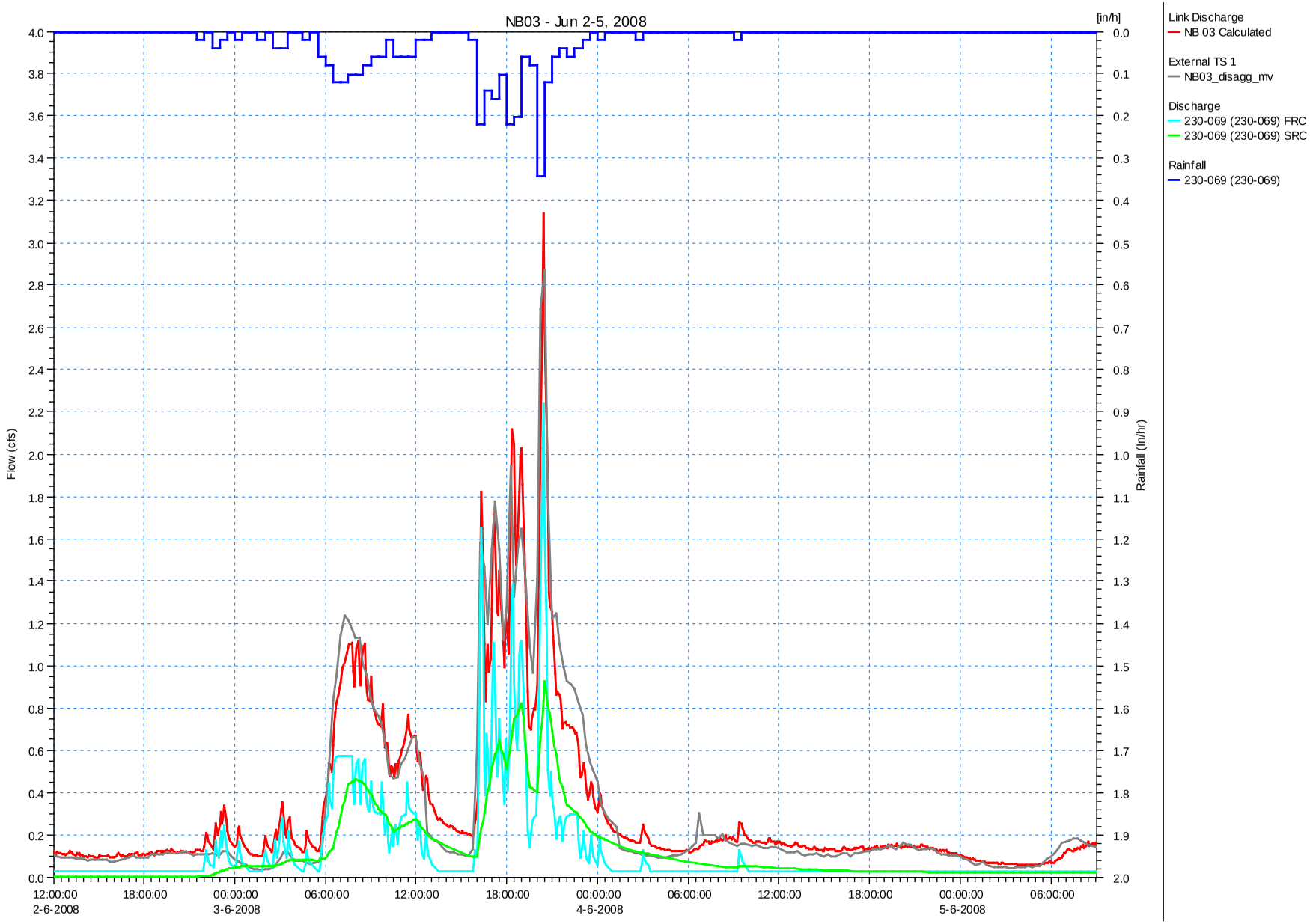

NB02 - Mar 13-17, 2008
[in/h]
Flow (cfs)
Rainfall (in/hr)
Link Discharge
NB 2 Calculated
External TS 1
NB02_disagg_mv
Discharge
230-068 (230-068) FRC
230-068 (230-068) SRC
Rainfall
230-068 (230-068)
00:00:00 13-3-2008
12:00:00
00:00:00 14-3-2008
12:00:00
00:00:00 15-3-2008
12:00:00
00:00:00 16-3-2008
12:00:00
00:00:00 17-3-2008
12:00:00

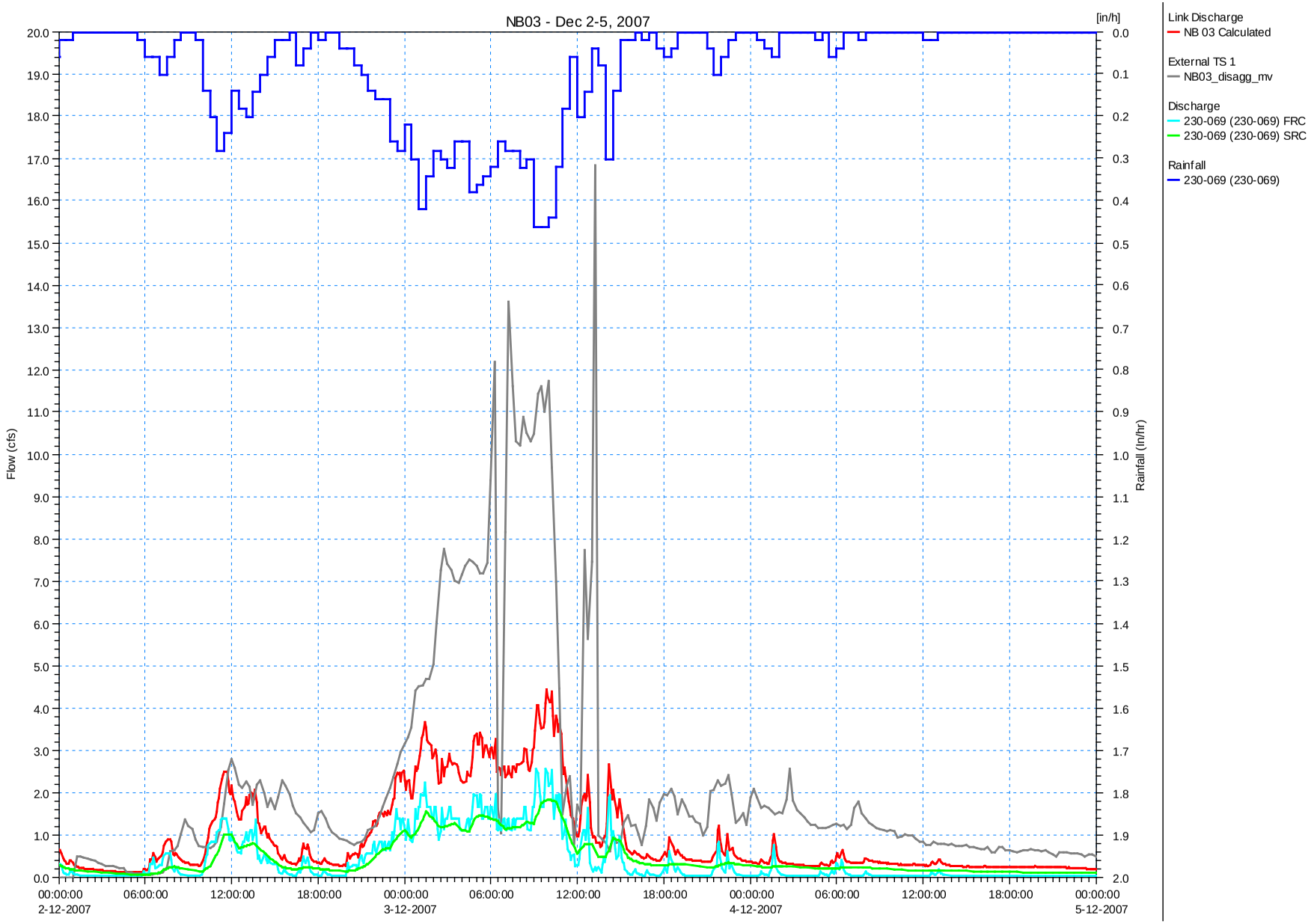

NB02 - Jun 2-5, 2008
[in/h]
Flow (cfs)
Rainfall (in/hr)
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
12:00:00 2-6-2008
18:00:00
00:00:00 3-6-2008
06:00:00
12:00:00
18:00:00
00:00:00 4-6-2008
06:00:00
12:00:00
18:00:00
00:00:00 5-6-2008
06:00:00
Link Discharge
NB 2 Calculated
External TS 1
NB02_disagg_mv
Discharge
230-068 (230-068) FRC
230-068 (230-068) SRC
Rainfall
230-068 (230-068)

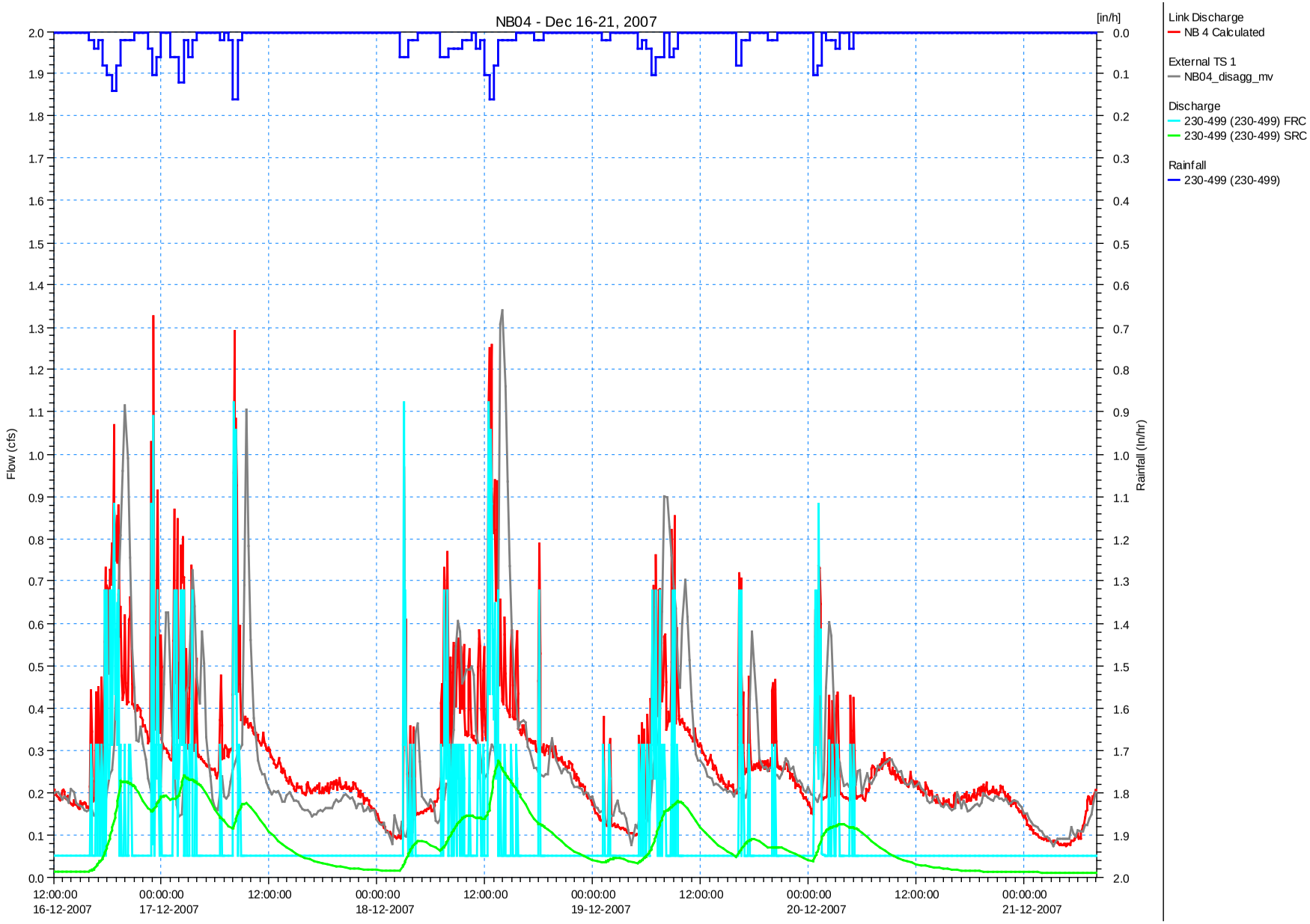

NB02 - Dec 2-5, 2007
[in/h]
Flow (cfs)
Rainfall (in/hr)
Link Discharge
NB 2 Calculated
External TS 1
NB02_disagg_mv
Discharge
230-068 (230-068) FRC
230-068 (230-068) SRC
Rainfall
230-068 (230-068)
00:00:00 2-12-2007
06:00:00
12:00:00
18:00:00
00:00:00 3-12-2007
06:00:00
12:00:00
18:00:00
00:00:00 4-12-2007
06:00:00
12:00:00
18:00:00
00:00:00 5-12-2007

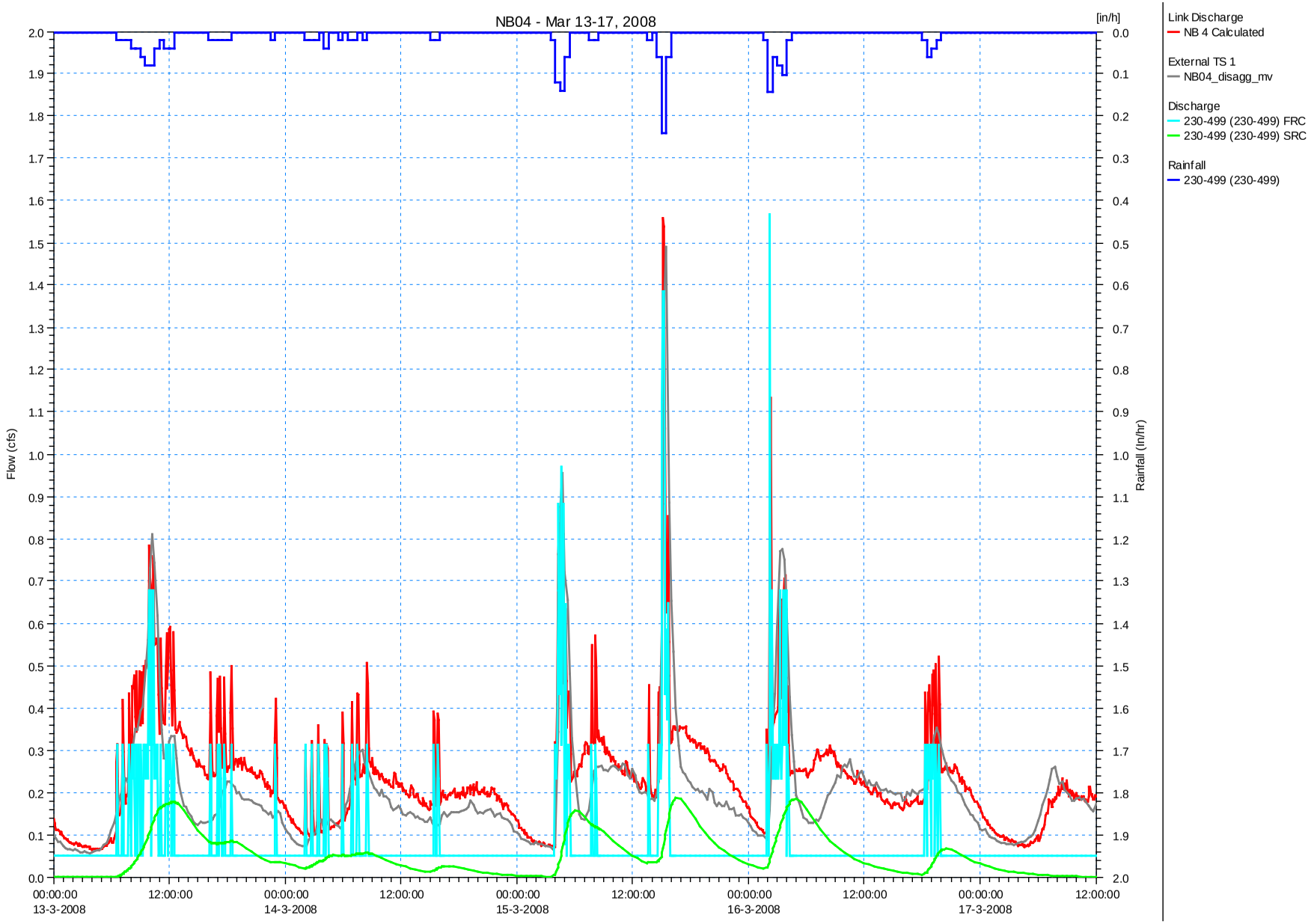

NB03 - Dec 16-21, 2007
[in/h]
Flow (cfs)
Rainfall (in/hr)
Link Discharge
NB 03 Calculated
External TS 1
NB03_disagg_mv
Discharge
230-069 (230-069) FRC
230-069 (230-069) SRC
Rainfall
230-069 (230-069)
12:00:00 16-12-2007
00:00:00 17-12-2007
12:00:00
00:00:00 18-12-2007
12:00:00
00:00:00 19-12-2007
12:00:00
00:00:00 20-12-2007
12:00:00
00:00:00 21-12-2007


NB03 - Mar 13-17, 2008
[in/h]
Flow (cfs)
Rainfall (in/hr)
Link Discharge
NB 03 Calculated
External TS 1
NB03_disagg_mv
Discharge
230-069 (230-069) FRC
230-069 (230-069) SRC
Rainfall
230-069 (230-069)
00:00:00 13-3-2008
12:00:00
00:00:00 14-3-2008
12:00:00
00:00:00 15-3-2008
12:00:00
00:00:00 16-3-2008
12:00:00
00:00:00 17-3-2008
12:00:00


NB03 - Jun 2-5, 2008
[in/h]
Flow (cfs)
Rainfall (in/hr)
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
12:00:00 2-6-2008
18:00:00
00:00:00 3-6-2008
06:00:00
12:00:00
18:00:00
00:00:00 4-6-2008
06:00:00
12:00:00
18:00:00
00:00:00 5-6-2008
06:00:00
Link Discharge
NB 03 Calculated
External TS 1
NB03_disagg_mv
Discharge
230-069 (230-069) FRC
230-069 (230-069) SRC
Rainfall
230-069 (230-069)


NB03 - Dec 2-5, 2007
[in/h]
Flow (cfs)
Rainfall (in/hr)
20.0
19.0
18.0
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
00:00:00
2-12-2007
06:00:00
12:00:00
18:00:00
00:00:00
3-12-2007
06:00:00
12:00:00
18:00:00
00:00:00
4-12-2007
06:00:00
12:00:00
18:00:00
00:00:00
5-12-2007
Link Discharge
NB 03 Calculated
External TS 1
NB03_disagg_mv
Discharge
230-069 (230-069) FRC
230-069 (230-069) SRC
Rainfall
230-069 (230-069)


NB04 - Dec 16-21, 2007
[in/h]
Flow (cfs)
Rainfall (in/hr)
Link Discharge
NB 4 Calculated
External TS 1
NB04_disagg_mv
Discharge
230-499 (230-499) FRC
230-499 (230-499) SRC
Rainfall
230-499 (230-499)
12:00:00 16-12-2007
00:00:00 17-12-2007
12:00:00
00:00:00 18-12-2007
12:00:00
00:00:00 19-12-2007
12:00:00
00:00:00 20-12-2007
12:00:00
00:00:00 21-12-2007


NB04 - Mar 13-17, 2008
[in/h]
Flow (cfs)
Rainfall (in/hr)
Link Discharge
NB 4 Calculated
External TS 1
NB04_disagg_mv
Discharge
230-499 (230-499) FRC
230-499 (230-499) SRC
Rainfall
230-499 (230-499)
00:00:00 13-3-2008
12:00:00
00:00:00 14-3-2008
12:00:00
00:00:00 15-3-2008
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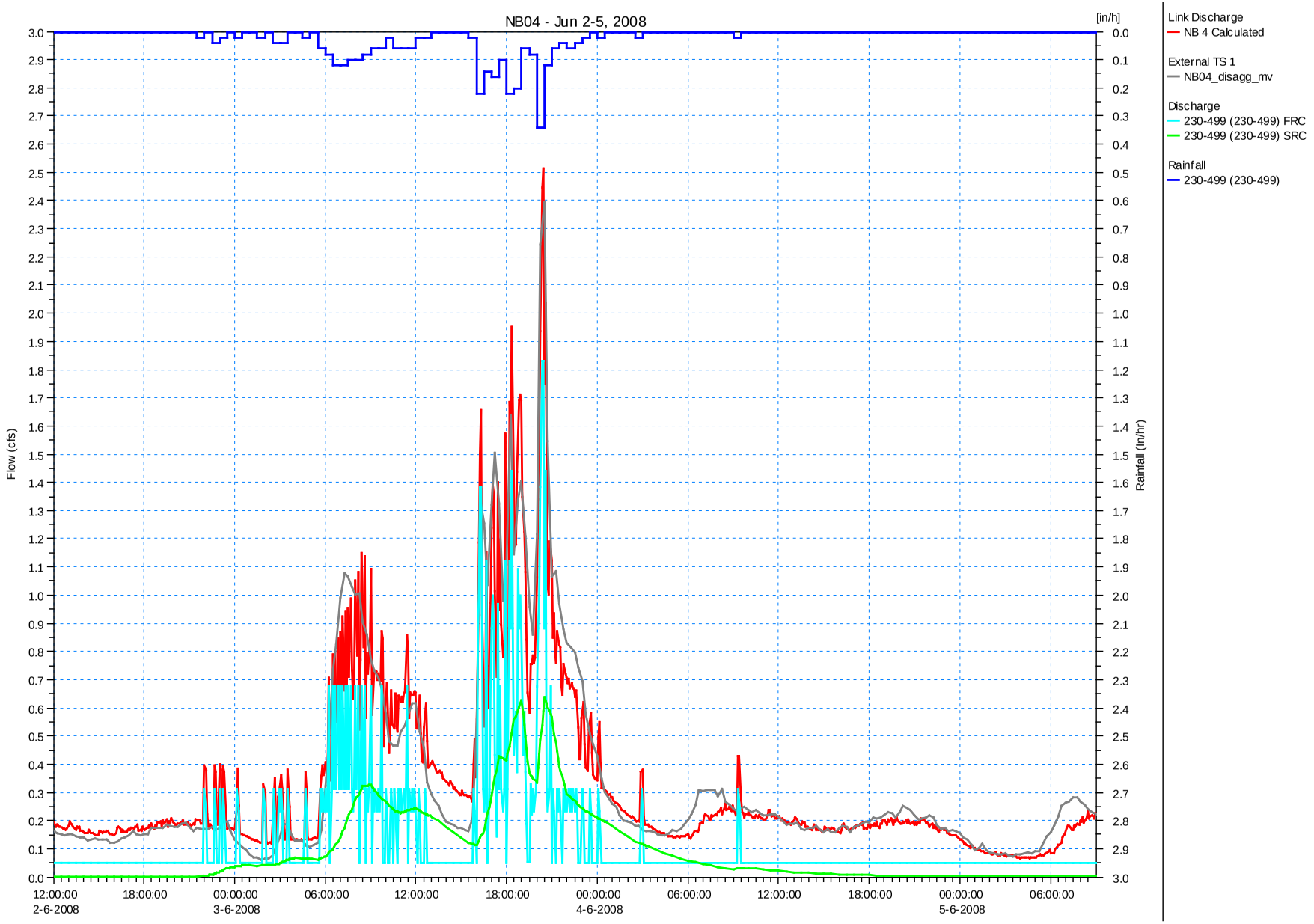
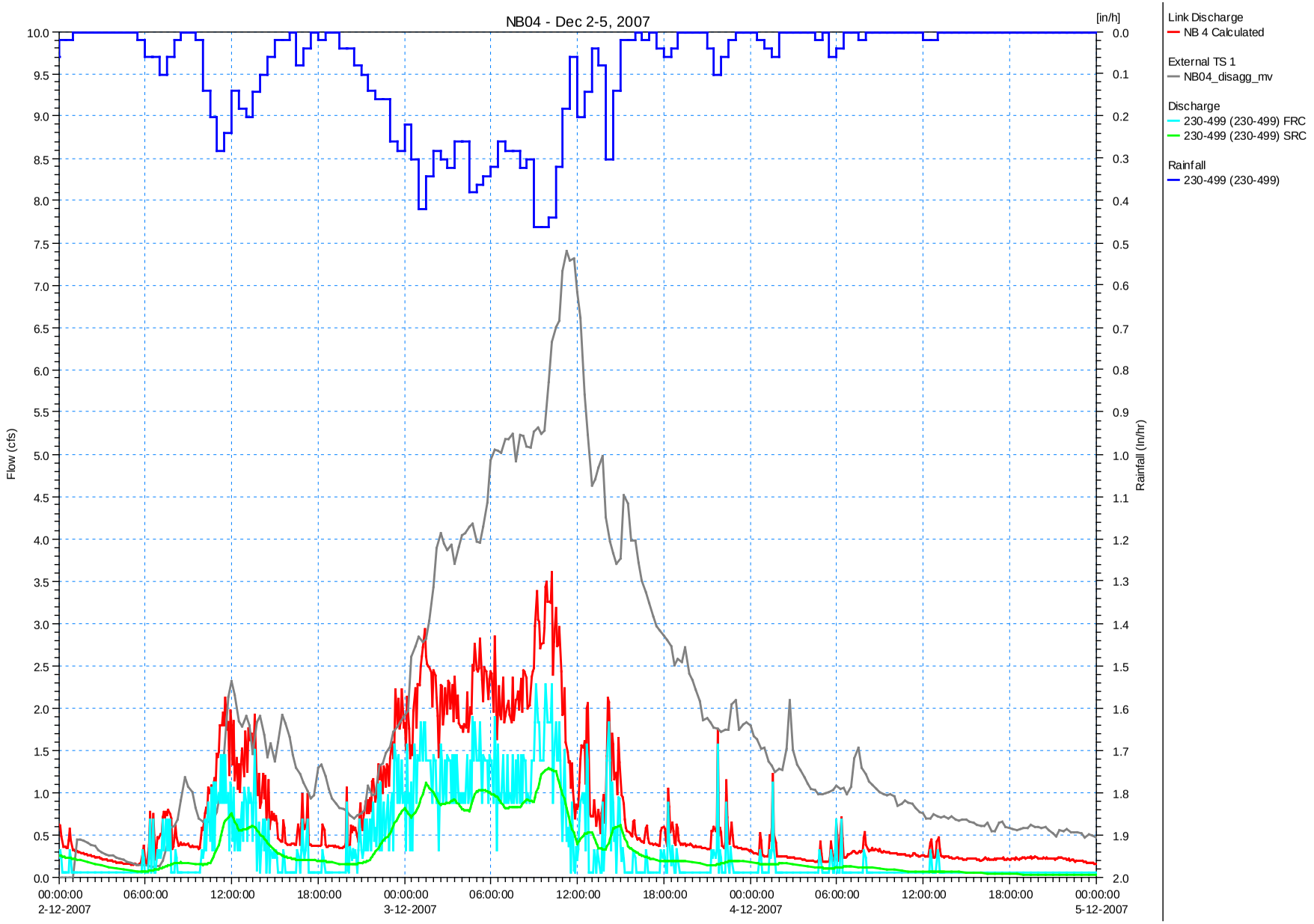
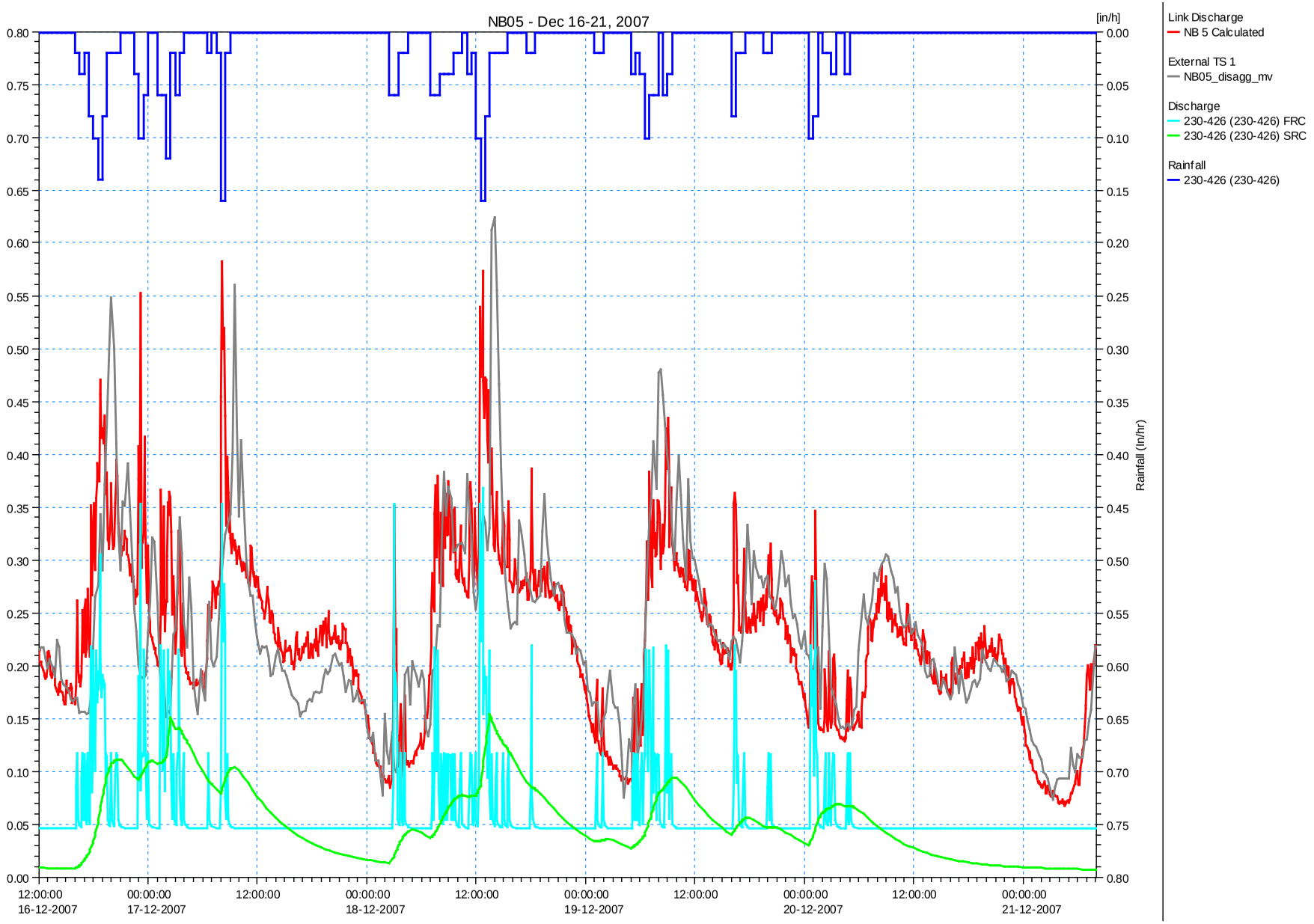
00:00:00 17-3-2008
12:00:00


NB04 - Jun 2-5, 2008
[in/h]
Flow (cfs)
Rainfall (in/hr)
12:00:00 2-6-2008
18:00:00
00:00:00 3-6-2008
06:00:00
12:00:00
18:00:00
00:00:00 4-6-2008
06:00:00
12:00:00
18:00:00
00:00:00 5-6-2008
06:00:00
Link Discharge
NB 4 Calculated
External TS 1
NB04_disagg_mv
Discharge
230-499 (230-499) FRC
230-499 (230-499) SRC
Rainfall
230-499 (230-499)


NB04 - Dec 2-5, 2007
[in/h]
Flow (cfs)
Rainfall (in/hr)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
00:00:00 2-12-2007
06:00:00
12:00:00
18:00:00
00:00:00 3-12-2007
06:00:00
12:00:00
18:00:00
00:00:00 4-12-2007
06:00:00
12:00:00
18:00:00
00:00:00 5-12-2007
Link Discharge
NB 4 Calculated
External TS 1
NB04_disagg_mv
Discharge
230-499 (230-499) FRC
230-499 (230-499) SRC
Rainfall
230-499 (230-499)


NB05 - Dec 16-21, 2007
[in/h]
Rainfall (in/hr)
Link Discharge
NB 5 Calculated
External TS 1
NB05_disagg_mv
Discharge
230-426 (230-426) FRC
230-426 (230-426) SRC
Rainfall
230-426 (230-426)
12:00:00 16-12-2007
00:00:00 17-12-2007
12:00:00
00:00:00 18-12-2007
12:00:00
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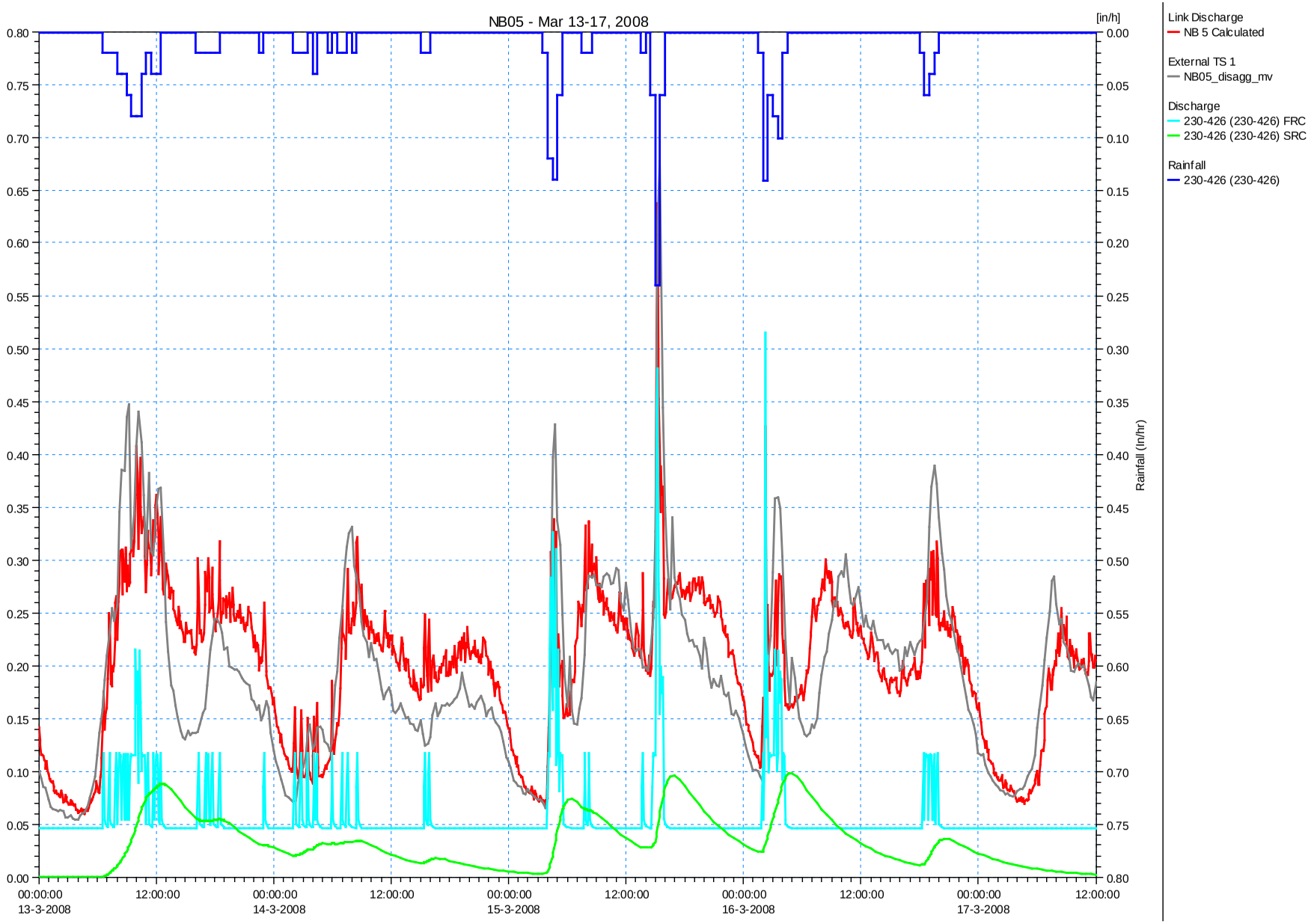
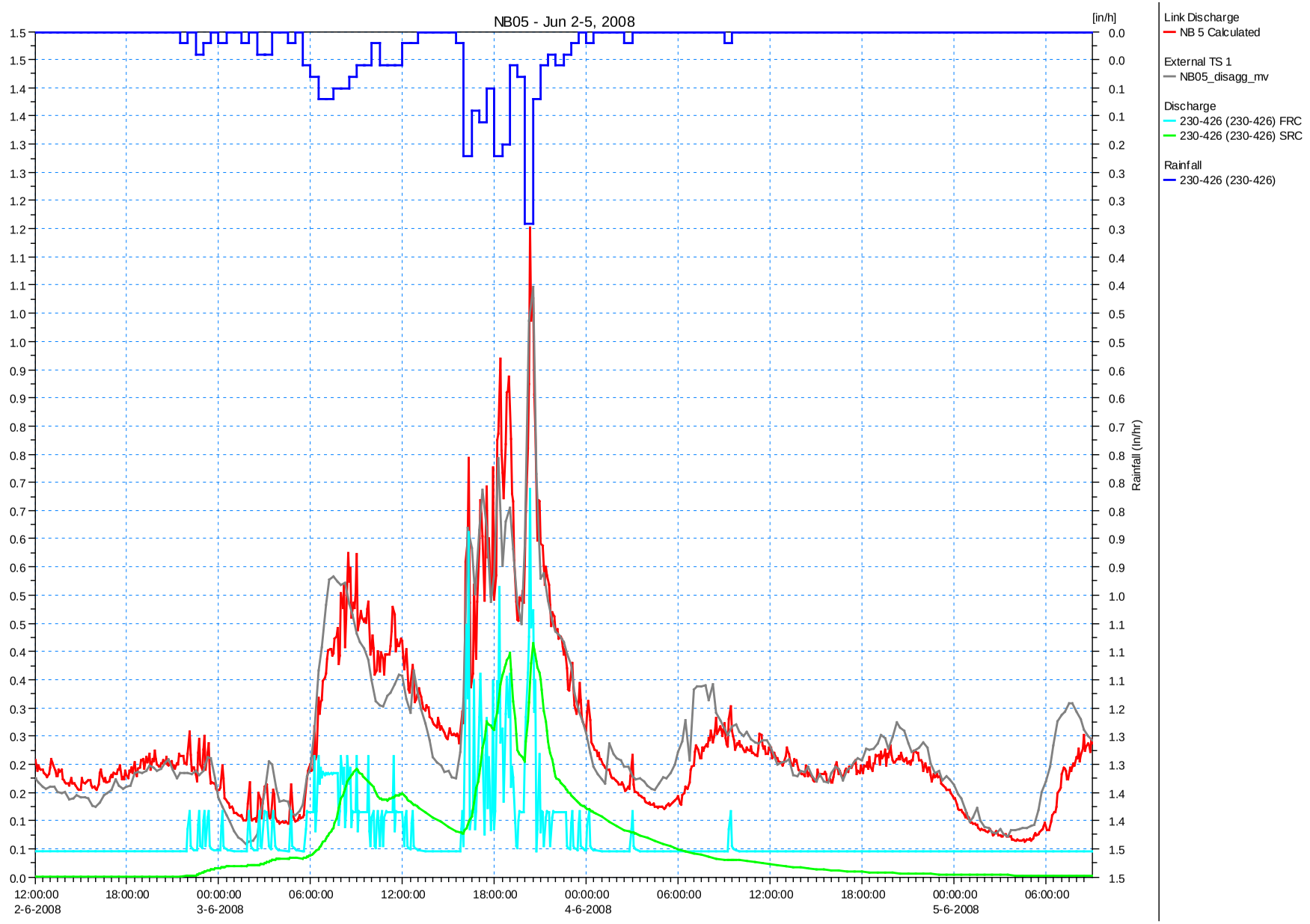
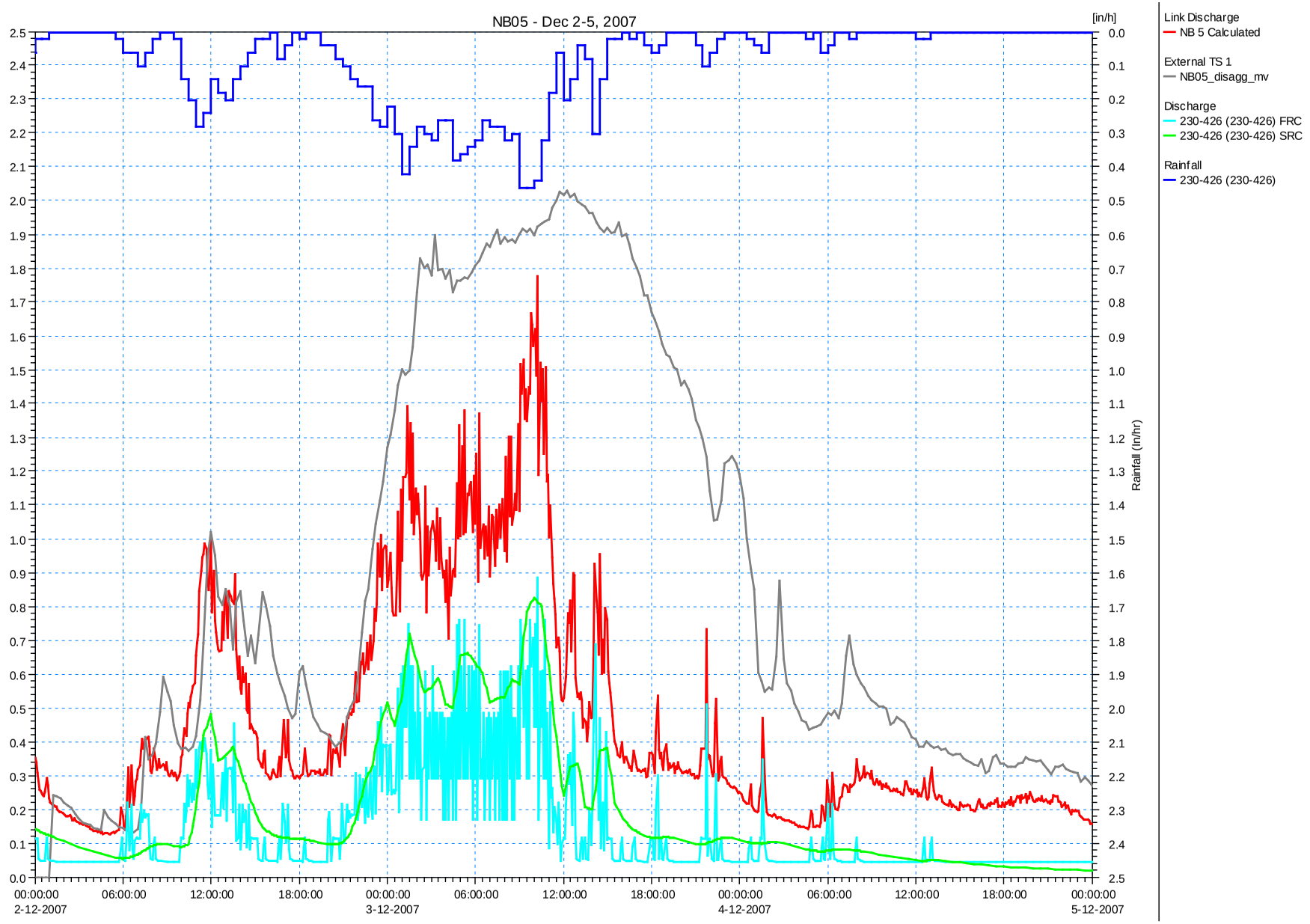
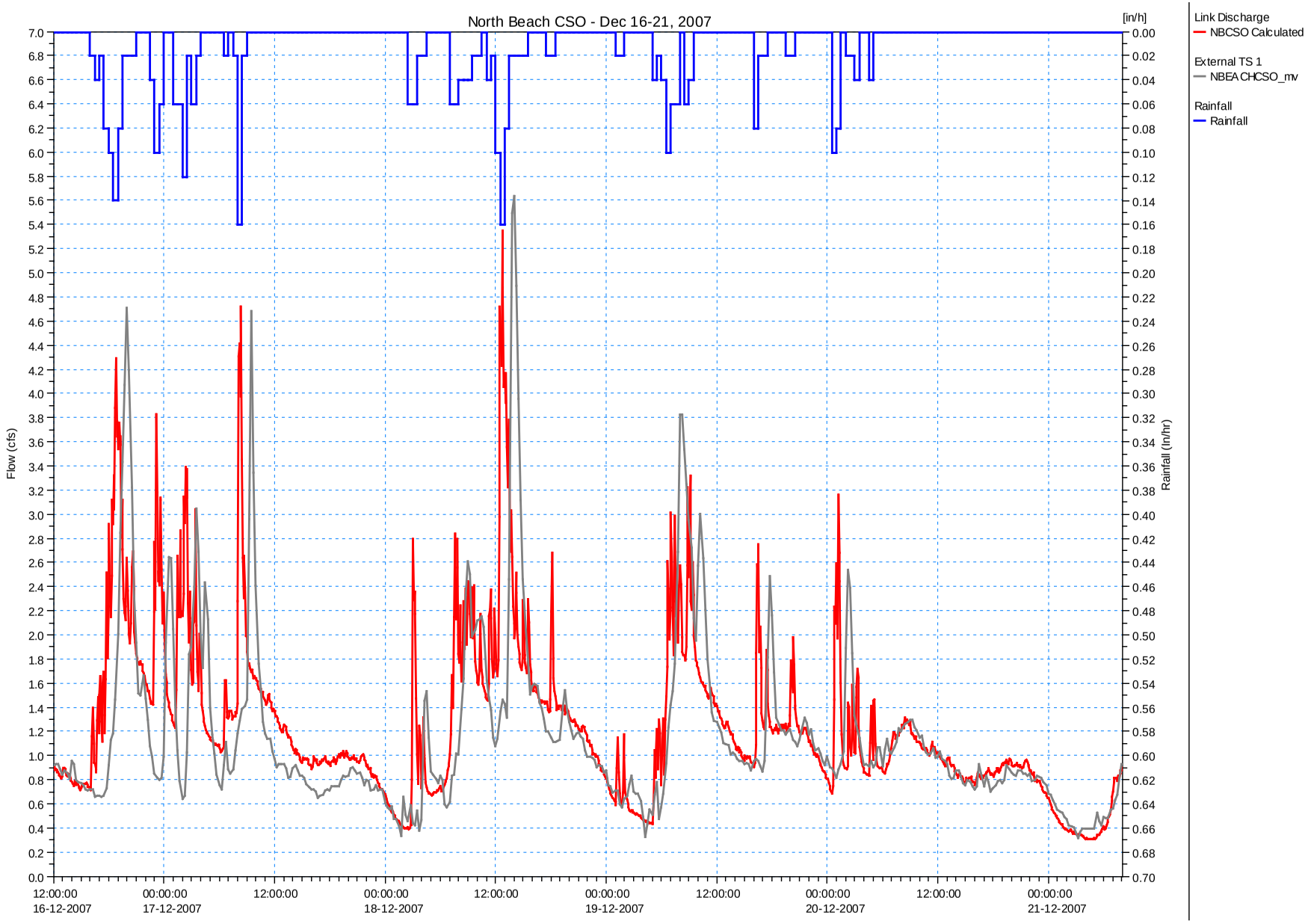
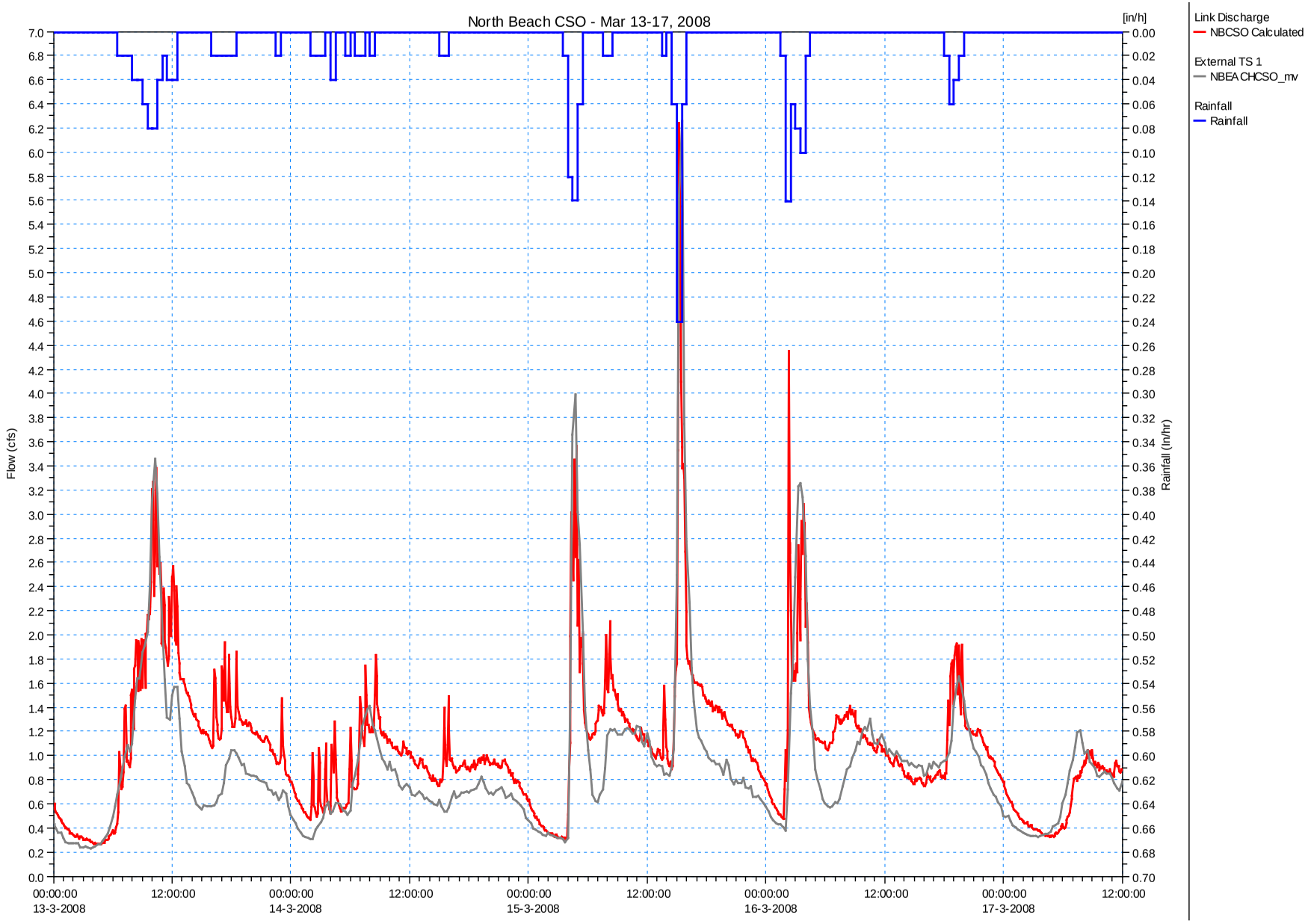
12:00:00
00:00:00 21-12-2007

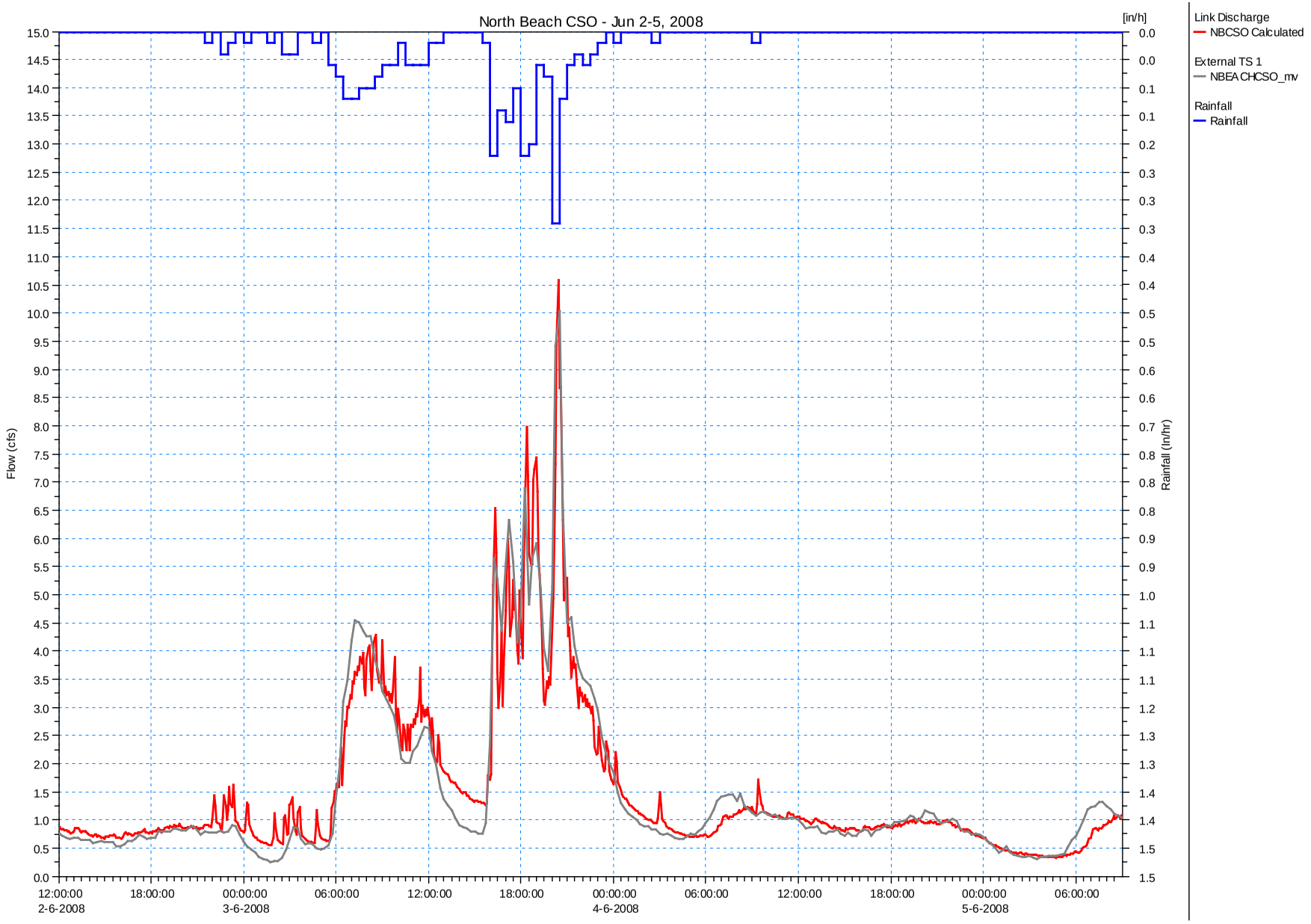

NB05 - Mar 13-17, 2008
[in/h]
Rainfall (in/hr)
Link Discharge
NB 5 Calculated
External TS 1
NB05_disagg_mv
Discharge
230-426 (230-426) FRC
230-426 (230-426) SRC
Rainfall
230-426 (230-426)
00:00:00 13-3-2008
12:00:00
00:00:00 14-3-2008
12:00:00
00:00:00 15-3-2008
12:00:00
00:00:00 16-3-2008
12:00:00
00:00:00 17-3-2008
12:00:00

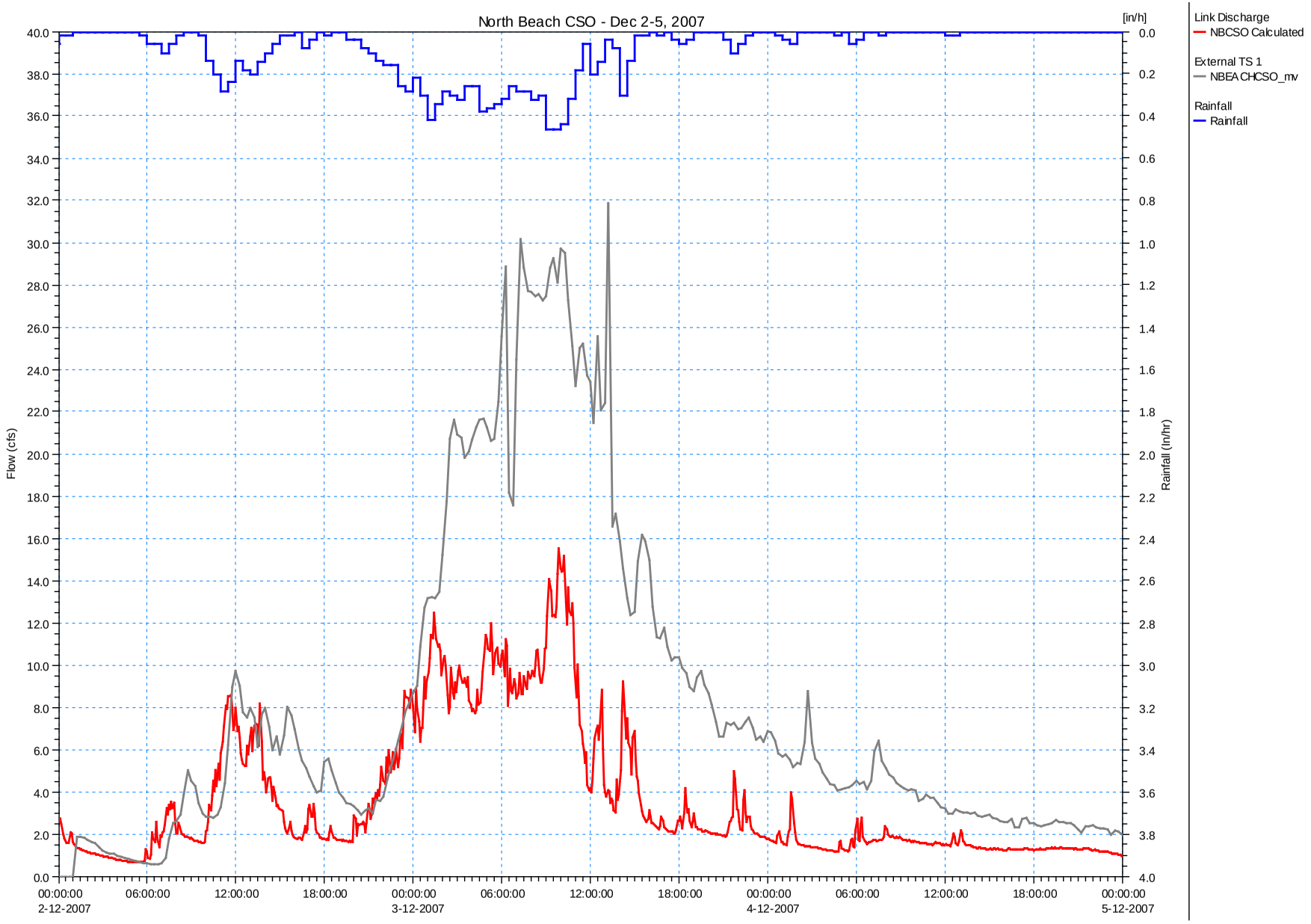

NB05 - Jun 2-5, 2008
[in/h]
Rainfall (in/hr)
Link Discharge
NB 5 Calculated
External TS 1
NB05_disagg_mv
Discharge
230-426 (230-426) FRC
230-426 (230-426) SRC
Rainfall
230-426 (230-426)
12:00:00 2-6-2008
18:00:00
00:00:00 3-6-2008
06:00:00
12:00:00
18:00:00
00:00:00 4-6-2008
06:00:00
12:00:00
18:00:00
00:00:00 5-6-2008
06:00:00


NB05 - Dec 2-5, 2007
[in/h]
Rainfall (in/hr)
Link Discharge
NB 5 Calculated
External TS 1
NB05_disagg_mv
Discharge
230-426 (230-426) FRC
230-426 (230-426) SRC
Rainfall
230-426 (230-426)
00:00:00 2-12-2007
06:00:00
12:00:00
18:00:00
00:00:00 3-12-2007
06:00:00
12:00:00
18:00:00
00:00:00 4-12-2007
06:00:00
12:00:00
18:00:00
00:00:00 5-12-2007


North Beach CSO - Dec 16-21, 2007
Flow (cfs)
Rainfall (in/hr)
[in/h]
Link Discharge
NBCSO Calculated
External TS 1
NBEACHCSO_mv
Rainfall
Rainfall
12:00:00 16-12-2007
00:00:00 17-12-2007
12:00:00
00:00:00 18-12-2007
12:00:00
00:00:00 19-12-2007
12:00:00
00:00:00 20-12-2007
12:00:00
00:00:00 21-12-2007


North Beach CSO - Mar 13-17, 2008
Flow (cfs)
Rainfall (in/hr)
[in/h]
Link Discharge
NBCSO Calculated
External TS 1
NBEACHCSO_mv
Rainfall
Rainfall
00:00:00 13-3-2008
12:00:00
00:00:00 14-3-2008
12:00:00
00:00:00 15-3-2008
12:00:00
00:00:00 16-3-2008
12:00:00
00:00:00 17-3-2008
12:00:00


North Beach CSO - Jun 2-5, 2008
[in/h]
Flow (cfs)
Rainfall (in/hr)
Link Discharge
NBCSO Calculated
External TS 1
NBEACHCSO_mv
Rainfall
Rainfall
12:00:00 2-6-2008
18:00:00
00:00:00 3-6-2008
06:00:00
12:00:00
18:00:00
00:00:00 4-6-2008
06:00:00
12:00:00
18:00:00
00:00:00 5-6-2008
06:00:00


North Beach CSO - Dec 2-5, 2007
[in/h]
Flow (cfs)
Rainfall (In/hr)
Link Discharge
NBCSO Calculated
External TS 1
NBEACHCSO_mv
Rainfall
Rainfall
00:00:00 2-12-2007
06:00:00
12:00:00
18:00:00
00:00:00 3-12-2007
00:00:00 4-12-2007
00:00:00 5-12-2007

Appendix B-10

FINAL CSO STORAGE VOLUMES FOR THE 3 CONDITIONS SPECIFIED BY WTD MANAGEMENT, AND PEAK FLOW RATE

Final CSO Storage Volumes for the 3 Conditions Specified by WTD Management and Peak Flow Rate (December 2010)

Condition	North Beach
	Design Criteria[2]
Long term Average [1]	0.23 MG
Avg. of 20-year averages	0.21 MG
Maximum 20-year Average [3]	0.23 MG
1-yr Recurrence Peak Flow	9.6 mgd

1 – Rainfall record in simulation: July 1, 1978 – June 30, 2008
2 – Pump station capacity of 3 mgd.
3 – Without repeating the rainfall record.

North Beach Storm Rank by Overflow Volume

Input File: Y:\NorthBeachPS\FacilityDesign\Carollo\nb_initial_lts.csv

Rank	Start Time	End Time	Volume Net (MG)	
1	12/2/07 10:51	12/3/07 15:10	2.06	
2	12/28/96 13:52	12/29/96 19:46	1.37	
3	10/20/03 2:34	10/20/03 17:56	0.99	
4	10/5/81 16:28	10/6/81 20:32	0.86	
5	12/3/82 5:14	12/3/82 15:47	0.83	
6	11/3/78 12:06	11/4/78 0:20	0.81	
7	1/17/86 22:36	1/18/86 21:15	0.80	
8	11/18/03 6:13	11/19/03 9:04	0.70	
9	10/25/86 1:46	10/26/86 14:19	0.52	
10	12/30/96 21:08	1/2/97 10:09	0.46	
11	4/22/96 21:52	4/23/96 16:27	0.45	
12	11/20/80 23:02	11/21/80 11:44	0.43	
13	2/8/96 1:47	2/9/96 0:29	0.42	
14	3/18/97 11:46	3/19/97 20:28	0.38	
15	12/16/79 22:33	12/19/79 12:48	0.36	
16	9/5/84 7:14	9/5/84 15:17	0.35	
17	4/3/91 18:52	4/5/91 4:44	0.35	
18	8/22/01 15:33	8/22/01 17:25	0.33	
19	1/9/90 4:42	1/9/90 16:12	0.32	
20	12/9/95 20:42	12/11/95 2:13	0.29	
21	5/30/97 17:25	5/31/97 10:27	0.29	
22	1/14/88 0:39	1/14/88 21:32	0.29	
23	10/4/90 11:55	10/4/90 16:50	0.28	
24	1/11/80 17:14	1/12/80 9:04	0.28	
25	8/22/04 2:19	8/22/04 20:58	0.28	
26	9/26/81 19:24	9/29/81 0:48	0.26	
27	12/14/06 11:20	12/14/06 19:58	0.26	
28	4/19/97 16:56	4/20/97 21:01	0.26	
29	9/22/78 16:04	9/22/78 19:53	0.23	
30	**2/17/81 21:29**	**2/19/81 7:00**	**0.23**	Maximum 20-Yr average and approximate long-term average
31	6/24/99 2:13	6/24/99 7:42	0.23	
32	11/1/84 12:42	11/2/84 12:28	0.23	
33	9/16/03 3:48	9/16/03 6:30	0.23	
34	5/4/03 16:43	5/4/03 18:14	0.22	
35	1/7/78 12:28	1/8/78 5:36	0.22	
36	11/2/04 2:47	11/2/04 8:18	0.21	
37	12/1/87 1:39	12/3/87 2:57	0.21	
38	**11/24/90 1:51**	**11/24/90 14:59**	**0.20**	Average of 20-Yr averages
39	12/28/86 12:33	12/29/86 3:55	0.20	
40	11/10/95 21:40	11/11/95 2:19	0.19	
41	1/27/92 7:53	1/29/92 8:32	0.19	
42	3/2/87 18:44	3/3/87 20:40	0.19	
43	1/4/83 18:14	1/5/83 9:44	0.18	
44	12/24/05 1:32	12/25/05 4:15	0.18	

45	9/23/92 11:47	9/23/92 19:21	0.18
46	12/4/96 9:08	12/4/96 14:14	0.18
47	6/22/05 7:06	6/22/05 11:18	0.17
48	12/2/89 12:14	12/4/89 2:13	0.16
49	10/26/85 16:21	10/27/85 19:09	0.16
50	11/3/83 14:39	11/3/83 19:47	0.16
51	12/14/79 13:19	12/14/79 20:33	0.16
52	1/31/87 3:14	2/1/87 1:13	0.16
53	8/2/96 7:46	8/2/96 18:10	0.15
54	4/12/79 13:06	4/12/79 20:10	0.15
55	12/13/01 11:41	12/13/01 20:20	0.15
56	12/14/02 7:12	12/14/02 22:03	0.14
57	10/19/07 4:49	10/19/07 19:07	0.14
58	11/22/88 7:47	11/22/88 9:40	0.14
59	10/24/85 6:36	10/24/85 21:48	0.14
60	11/6/80 20:43	11/6/80 23:34	0.14
61	10/19/00 21:25	10/20/00 18:06	0.13
62	9/14/96 19:15	9/15/96 2:12	0.13
63	9/15/97 17:28	9/17/97 16:40	0.13
64	4/8/79 16:13	4/9/79 16:44	0.13
65	10/25/90 10:45	10/25/90 11:11	0.13
66	10/1/97 12:40	10/2/97 9:07	0.13
67	11/11/81 7:47	11/11/81 19:26	0.13
68	10/4/97 0:25	10/4/97 8:39	0.13
69	6/3/08 16:11	6/3/08 21:04	0.13
70	12/25/80 17:51	12/26/80 5:46	0.13
71	2/5/96 8:44	2/6/96 9:00	0.12
72	11/27/96 15:08	11/27/96 17:34	0.12
73	10/1/81 18:12	10/1/81 20:34	0.12
74	1/29/06 16:10	1/30/06 3:42	0.12
75	5/20/97 8:52	5/20/97 11:47	0.11
76	11/30/94 2:11	11/30/94 4:48	0.11
77	12/12/95 21:33	12/14/95 20:17	0.11
78	5/4/99 18:11	5/4/99 18:40	0.10
79	5/21/86 5:06	5/21/86 21:42	0.10
80	11/28/01 6:35	11/29/01 2:05	0.10
81	12/15/82 17:50	12/16/82 20:47	0.10
82	11/21/93 9:39	11/21/93 12:05	0.10
83	9/30/95 14:10	9/30/95 14:57	0.10
84	11/13/01 18:04	11/15/01 11:48	0.10
85	7/9/97 12:14	7/9/97 13:25	0.10
86	12/4/90 3:45	12/4/90 6:34	0.10
87	4/16/05 4:42	4/16/05 6:22	0.10
88	11/7/97 7:40	11/7/97 9:16	0.10
89	3/31/96 16:41	4/1/96 8:05	0.10
90	6/20/84 11:42	6/20/84 19:14	0.10
91	12/22/78 6:56	12/22/78 8:07	0.09
92	12/15/81 4:38	12/15/81 11:49	0.09
93	12/26/06 18:14	12/27/06 0:29	0.09
94	1/23/81 19:14	1/24/81 18:09	0.09
95	10/26/94 11:15	10/27/94 2:37	0.09
96	11/17/82 1:59	11/17/82 7:08	0.09

97	12/4/81 22:47	12/5/81 11:16	0.09
98	6/27/01 10:34	6/27/01 12:10	0.08
99	11/19/83 12:22	11/20/83 1:15	0.08
100	4/7/87 20:29	4/7/87 22:07	0.08
101	9/3/92 20:38	9/4/92 2:50	0.08
102	6/6/85 22:40	6/7/85 15:53	0.08
103	6/1/99 13:11	6/1/99 14:51	0.08
104	2/13/81 21:41	2/14/81 1:50	0.08
105	11/20/98 6:45	11/20/98 19:42	0.07
106	1/27/97 19:08	1/27/97 22:06	0.07
107	10/17/96 17:05	10/17/96 20:55	0.07
108	11/5/88 7:55	11/5/88 15:09	0.07
109	11/24/83 0:13	11/24/83 5:58	0.07
110	11/25/98 5:14	11/25/98 16:42	0.07
111	5/15/05 3:48	5/15/05 7:37	0.07
112	11/4/06 14:03	11/6/06 12:45	0.07
113	12/5/87 11:25	12/6/87 18:06	0.07
114	9/25/82 18:56	9/25/82 19:16	0.07
115	9/7/79 22:49	9/8/79 13:52	0.07
116	1/8/07 11:23	1/8/07 12:00	0.07
117	3/17/80 16:40	3/17/80 19:16	0.07
118	7/26/95 1:08	7/26/95 3:29	0.07
119	5/12/88 19:20	5/12/88 20:41	0.07
120	11/2/88 8:37	11/3/88 19:57	0.07
121	10/13/88 15:53	10/13/88 17:26	0.07
122	6/17/86 20:20	6/18/86 15:52	0.07
123	11/5/05 19:08	11/5/05 20:35	0.07
124	4/16/01 22:51	4/16/01 23:16	0.07
125	8/9/91 3:11	8/9/91 7:13	0.07
126	5/12/96 20:21	5/13/96 16:47	0.06
127	11/12/06 18:23	11/13/06 0:26	0.06
128	2/24/99 14:27	2/24/99 16:05	0.06
129	7/16/99 0:56	7/16/99 5:43	0.06
130	3/15/97 10:04	3/15/97 16:21	0.06
131	12/11/06 10:07	12/11/06 23:51	0.06
132	8/29/83 20:12	8/29/83 23:58	0.06
133	11/23/84 7:13	11/23/84 9:51	0.06
134	1/27/87 16:57	1/27/87 17:39	0.06
135	12/19/94 11:15	12/19/94 18:16	0.06
136	11/16/02 9:15	11/16/02 14:26	0.06
137	6/3/97 15:13	6/4/97 15:52	0.06
138	4/12/95 22:43	4/13/95 18:38	0.06
139	4/6/88 3:08	4/6/88 5:35	0.06
140	3/22/98 6:24	3/22/98 7:25	0.06
141	12/11/93 18:05	12/11/93 19:27	0.06
142	6/22/93 15:04	6/22/93 15:22	0.06
143	1/5/06 20:06	1/5/06 21:25	0.06
144	6/24/80 22:56	6/25/80 2:04	0.06
145	8/28/05 18:30	8/28/05 19:33	0.06
146	1/16/86 13:35	1/16/86 22:17	0.06
147	2/22/96 19:48	2/22/96 20:54	0.06
148	11/23/86 5:14	11/24/86 5:17	0.06

149	10/2/95 3:39	10/2/95 4:31	0.06
150	4/26/97 19:37	4/26/97 22:41	0.06
151	5/13/85 19:32	5/13/85 20:16	0.06
152	1/6/90 22:17	1/6/90 23:46	0.05
153	10/12/96 23:59	10/13/96 5:09	0.05
154	9/3/79 10:19	9/3/79 11:20	0.05
155	12/15/99 11:12	12/15/99 13:14	0.05
156	11/28/80 22:56	11/29/80 2:38	0.05
157	5/11/00 20:18	5/11/00 21:09	0.05
158	10/23/78 20:08	10/23/78 21:10	0.05
159	11/22/81 19:35	11/23/81 10:49	0.05
160	4/15/78 16:07	4/15/78 23:26	0.05
161	2/26/80 3:08	2/26/80 15:57	0.05
162	1/4/03 6:05	1/4/03 12:02	0.05
163	10/21/82 21:45	10/22/82 12:33	0.05
164	12/21/79 14:04	12/21/79 17:19	0.04
165	10/28/89 2:48	10/28/89 3:18	0.04
166	11/5/80 18:06	11/5/80 20:31	0.04
167	10/30/83 19:12	10/30/83 19:34	0.04
168	10/11/03 17:04	10/11/03 18:08	0.04
169	12/2/96 8:40	12/2/96 9:53	0.04
170	4/14/80 13:37	4/14/80 17:02	0.04
171	1/6/02 19:05	1/8/02 6:05	0.04
172	12/9/91 4:47	12/9/91 5:21	0.04
173	12/2/80 11:13	12/2/80 16:39	0.04
174	6/26/82 8:18	6/26/82 8:57	0.04
175	6/3/90 0:07	6/3/90 4:12	0.04
176	1/17/05 8:29	1/17/05 13:19	0.04
177	1/2/07 5:20	1/3/07 8:04	0.04
178	12/9/87 12:04	12/9/87 16:36	0.04
179	3/19/07 19:32	3/19/07 20:07	0.04
180	4/3/94 14:09	4/3/94 15:14	0.04
181	6/2/88 16:04	6/2/88 20:05	0.04
182	10/29/97 5:35	10/30/97 7:02	0.04
183	1/1/03 18:23	1/2/03 22:07	0.04
184	2/20/84 11:06	2/20/84 12:21	0.04
185	11/9/99 21:06	11/9/99 23:07	0.04
186	6/11/01 4:20	6/11/01 21:11	0.04
187	4/16/92 10:37	4/16/92 23:19	0.04
188	9/25/97 20:47	9/26/97 18:31	0.04
189	1/5/07 19:53	1/5/07 21:11	0.04
190	9/9/78 6:02	9/9/78 16:43	0.04
191	10/22/85 9:17	10/22/85 9:46	0.04
192	1/18/97 8:44	1/18/97 10:35	0.03
193	10/8/97 15:21	10/8/97 17:46	0.03
194	6/16/81 12:04	6/16/81 12:28	0.03
195	2/24/79 18:06	2/25/79 17:51	0.03
196	12/18/81 23:08	12/19/81 12:23	0.03
197	2/21/02 2:11	2/22/02 0:39	0.03
198	9/3/94 8:42	9/3/94 10:37	0.03
199	3/5/89 15:21	3/6/89 9:51	0.03
200	6/6/90 8:03	6/6/90 9:40	0.03

201	11/28/95 16:23	11/29/95 9:34	0.03
202	11/16/03 11:21	11/16/03 12:30	0.03
203	12/20/80 10:17	12/21/80 9:59	0.03
204	3/11/89 3:35	3/11/89 7:10	0.03
205	2/1/00 8:02	2/1/00 11:02	0.03
206	1/17/98 0:58	1/17/98 6:48	0.03
207	5/15/01 17:43	5/15/01 18:22	0.03
208	8/7/85 17:31	8/7/85 18:10	0.03
209	8/3/99 18:16	8/3/99 18:37	0.03
210	12/12/99 7:19	12/12/99 11:11	0.03
211	7/26/78 12:36	7/26/78 17:35	0.03
212	9/12/97 1:43	9/12/97 14:13	0.03
213	11/21/06 13:37	11/21/06 14:04	0.03
214	1/25/82 23:10	1/25/82 23:44	0.03
215	9/1/78 8:53	9/1/78 19:07	0.03
216	3/5/87 16:48	3/5/87 17:14	0.03
217	3/1/91 16:06	3/2/91 22:14	0.03
218	1/9/06 23:30	1/10/06 2:07	0.03
219	10/15/85 23:53	10/16/85 3:35	0.03
220	4/13/02 18:43	4/13/02 22:20	0.03
221	11/8/06 19:44	11/8/06 21:42	0.03
222	9/22/84 4:24	9/22/84 4:56	0.03
223	12/22/86 8:22	12/22/86 19:27	0.03
224	11/30/96 16:29	11/30/96 16:49	0.03
225	8/23/93 16:04	8/23/93 16:27	0.03
226	11/1/83 11:25	11/1/83 12:58	0.03
227	2/1/06 17:39	2/1/06 17:57	0.03
228	8/24/97 14:49	8/24/97 17:38	0.03
229	8/30/85 15:38	8/30/85 17:03	0.03
230	7/6/81 22:14	7/7/81 1:53	0.03
231	7/3/98 8:32	7/3/98 9:09	0.03
232	1/25/02 4:53	1/25/02 5:44	0.03
233	7/2/99 0:32	7/2/99 17:02	0.03
234	1/14/96 16:47	1/15/96 11:35	0.03
235	4/29/97 12:56	4/29/97 13:16	0.03
236	2/1/78 17:06	2/2/78 17:00	0.03
237	10/28/82 13:30	10/28/82 17:26	0.03
238	2/21/92 6:43	2/21/92 21:37	0.03
239	4/19/80 14:35	4/19/80 18:43	0.03
240	6/16/80 14:28	6/16/80 18:54	0.03
241	1/29/04 14:29	1/30/04 1:36	0.03
242	10/16/01 11:06	10/16/01 18:19	0.03
243	11/19/86 22:05	11/20/86 14:24	0.03
244	6/10/83 2:03	6/10/83 2:45	0.03
245	4/30/87 20:47	4/30/87 22:06	0.03
246	2/2/91 13:29	2/3/91 10:43	0.03
247	6/1/88 12:29	6/1/88 12:48	0.03
248	1/11/88 2:08	1/11/88 2:30	0.02
249	1/3/01 16:35	1/4/01 19:01	0.02
250	11/22/79 13:23	11/22/79 14:36	0.02
251	11/22/01 8:13	11/22/01 11:22	0.02
252	10/15/03 10:21	10/15/03 17:59	0.02

253	10/27/98 16:43	10/27/98 18:48	0.02
254	10/10/84 8:24	10/10/84 22:02	0.02
255	3/13/00 20:50	3/14/00 17:43	0.02
256	11/24/95 15:09	11/24/95 17:46	0.02
257	12/9/04 23:23	12/10/04 23:17	0.02
258	10/15/96 14:40	10/15/96 15:07	0.02
259	11/1/92 16:42	11/1/92 17:48	0.02
260	4/28/92 20:47	4/28/92 21:07	0.02
261	1/18/05 15:57	1/18/05 21:41	0.02
262	12/12/98 10:05	12/13/98 19:12	0.02
263	12/30/05 15:35	12/30/05 20:46	0.02
264	5/18/88 16:29	5/18/88 16:54	0.02
265	9/16/05 8:24	9/16/05 8:46	0.02
266	10/22/89 5:57	10/22/89 8:47	0.02
267	9/4/05 16:24	9/4/05 16:46	0.02
268	1/21/78 2:30	1/21/78 6:42	0.02
269	3/10/82 23:23	3/11/82 0:59	0.02
270	1/25/90 10:55	1/25/90 11:11	0.02
271	9/1/83 1:28	9/1/83 2:21	0.02
272	10/26/79 23:13	10/27/79 14:52	0.02
273	11/10/89 10:06	11/10/89 13:24	0.02
274	1/17/99 20:49	1/18/99 0:34	0.02
275	3/15/81 19:58	3/15/81 21:31	0.02
276	4/25/90 10:47	4/25/90 11:16	0.02
277	3/23/86 17:10	3/23/86 17:55	0.02
278	5/28/02 20:20	5/28/02 20:44	0.02
279	1/19/96 12:08	1/21/96 4:30	0.02
280	12/3/79 15:40	12/3/79 23:35	0.02
281	7/16/78 7:07	7/16/78 8:13	0.02
282	11/30/93 23:22	12/1/93 17:26	0.02
283	12/20/06 22:43	12/21/06 0:17	0.02
284	2/7/00 16:24	2/8/00 16:44	0.02
285	5/15/78 11:55	5/15/78 12:17	0.02
286	8/19/78 1:22	8/19/78 1:41	0.02
287	1/23/82 17:47	1/23/82 18:23	0.02
288	5/30/87 1:29	5/30/87 4:37	0.02
289	5/13/78 23:44	5/14/78 0:14	0.02
290	8/17/80 19:21	8/17/80 23:45	0.02
291	9/19/81 5:18	9/19/81 6:21	0.02
292	10/3/96 11:22	10/4/96 17:09	0.02
293	6/16/06 11:34	6/16/06 11:50	0.02
294	10/31/80 6:32	10/31/80 7:40	0.02
295	6/3/01 1:06	6/3/01 2:37	0.02
296	2/4/91 20:16	2/4/91 20:40	0.02
297	2/17/83 12:12	2/17/83 13:48	0.02
298	9/24/88 18:20	9/25/88 4:38	0.02
299	1/27/90 7:18	1/27/90 7:59	0.02
300	10/30/01 21:59	10/30/01 22:21	0.02
301	11/8/92 12:28	11/8/92 15:03	0.02
302	10/24/79 8:59	10/25/79 4:31	0.02
303	3/20/84 14:55	3/20/84 15:29	0.02
304	11/26/86 17:26	11/26/86 21:49	0.02

305	3/22/03 5:44	3/22/03 6:04	0.02
306	1/19/02 7:21	1/19/02 7:37	0.02
307	11/13/87 8:42	11/13/87 10:42	0.02
308	3/12/91 17:48	3/12/91 18:08	0.02
309	12/24/06 18:03	12/24/06 19:08	0.02
310	11/19/80 0:27	11/19/80 0:42	0.02
311	3/26/88 6:50	3/26/88 9:28	0.02
312	9/18/83 7:45	9/18/83 9:37	0.02
313	10/23/89 10:16	10/23/89 11:00	0.02
314	7/4/92 15:56	7/4/92 16:28	0.01
315	12/13/81 15:21	12/13/81 17:22	0.01
316	11/17/81 9:53	11/17/81 10:47	0.01
317	3/12/02 7:31	3/12/02 9:52	0.01
318	9/29/05 21:50	9/30/05 22:14	0.01
319	3/15/92 3:49	3/15/92 8:43	0.01
320	7/1/93 23:53	7/2/93 0:13	0.01
321	1/3/84 0:58	1/3/84 1:41	0.01
322	1/28/88 10:08	1/28/88 21:47	0.01
323	3/2/94 15:01	3/2/94 15:16	0.01
324	9/10/04 22:02	9/11/04 0:25	0.01
325	12/28/95 19:39	12/29/95 16:59	0.01
326	6/23/83 16:16	6/23/83 16:33	0.01
327	12/12/02 11:54	12/12/02 16:22	0.01
328	6/10/90 0:32	6/10/90 1:03	0.01
329	5/31/93 6:57	5/31/93 9:43	0.01
330	5/26/82 7:38	5/26/82 9:20	0.01
331	12/16/97 13:10	12/17/97 12:17	0.01
332	2/1/80 5:34	2/2/80 12:42	0.01
333	2/3/06 23:53	2/4/06 0:12	0.01
334	11/17/07 12:35	11/17/07 12:55	0.01
335	11/17/91 14:05	11/17/91 14:28	0.01
336	12/2/81 2:31	12/2/81 3:08	0.01
337	8/12/78 16:19	8/12/78 16:33	0.01
338	12/5/99 23:58	12/6/99 0:31	0.01
339	11/15/06 14:50	11/15/06 17:35	0.01
340	1/5/90 16:30	1/5/90 17:00	0.01
341	3/5/92 21:45	3/5/92 22:09	0.01
342	1/10/97 5:31	1/10/97 5:43	0.01
343	11/10/84 5:37	11/10/84 15:50	0.01
344	2/16/03 15:46	2/16/03 17:25	0.01
345	11/14/83 20:00	11/14/83 21:01	0.01
346	7/2/90 3:27	7/2/90 4:17	0.01
347	4/15/97 16:11	4/15/97 16:37	0.01
348	10/9/00 8:58	10/9/00 9:36	0.01
349	4/7/08 20:11	4/7/08 21:06	0.01
350	3/26/97 21:48	3/27/97 0:05	0.01
351	5/4/85 14:30	5/4/85 14:49	0.01
352	9/14/06 1:14	9/14/06 1:28	0.01
353	1/31/92 1:44	2/1/92 18:33	0.01
354	10/8/04 9:00	10/8/04 9:15	0.01
355	1/11/91 12:25	1/11/91 15:08	0.01
356	8/6/95 15:17	8/6/95 15:55	0.01

357	12/3/95 19:31	12/3/95 20:48	0.01
358	5/3/97 11:50	5/3/97 12:23	0.01
359	6/10/78 16:37	6/10/78 16:54	0.01
360	1/30/95 6:52	1/31/95 11:37	0.01
361	2/11/79 17:41	2/13/79 1:27	0.01
362	2/1/86 6:18	2/1/86 6:32	0.01
363	4/9/80 2:34	4/9/80 16:06	0.01
364	12/8/93 11:52	12/8/93 12:14	0.01
365	12/1/79 14:58	12/1/79 22:16	0.01
366	1/9/00 6:45	1/9/00 7:05	0.01
367	4/22/97 19:00	4/23/97 14:57	0.01
368	3/15/87 20:05	3/15/87 20:27	0.01
369	9/19/06 5:08	9/19/06 5:23	0.01
370	4/13/82 18:05	4/13/82 18:19	0.01
371	11/27/84 1:12	11/27/84 8:31	0.01
372	6/6/93 13:03	6/6/93 22:31	0.01
373	7/24/91 13:53	7/24/91 14:28	0.01
374	1/14/00 9:09	1/14/00 10:17	0.01
375	7/9/79 22:18	7/9/79 23:54	0.01
376	3/22/00 7:30	3/22/00 7:48	0.01
377	8/9/85 21:36	8/9/85 22:35	0.01
378	10/6/90 2:32	10/6/90 2:44	0.01
379	3/26/05 7:02	3/27/05 1:50	0.01
380	1/7/06 11:53	1/7/06 12:10	0.01
381	3/11/97 15:24	3/11/97 18:34	0.01
382	1/14/98 8:10	1/14/98 12:26	0.01
383	11/4/90 18:10	11/4/90 18:25	0.01
384	10/16/82 15:20	10/16/82 15:41	0.01
385	3/25/87 19:17	3/25/87 19:37	0.01
386	11/3/96 15:37	11/3/96 15:51	0.01
387	2/18/82 9:45	2/19/82 6:46	0.01
388	8/19/07 6:01	8/19/07 6:14	0.01
389	12/6/96 10:29	12/7/96 15:23	0.01
390	3/14/95 11:04	3/14/95 11:18	0.01
391	5/23/06 9:21	5/23/06 9:47	0.01
392	12/3/81 15:24	12/3/81 15:44	0.01
393	1/5/86 10:46	1/5/86 13:21	0.01
394	5/20/07 15:29	5/20/07 17:23	0.01
395	2/16/01 12:39	2/16/01 14:21	0.01
396	4/5/80 10:31	4/5/80 22:51	0.01
397	2/9/83 0:07	2/9/83 5:13	0.01
398	12/8/84 2:50	12/8/84 4:48	0.01
399	10/10/95 21:34	10/11/95 2:36	0.01
400	10/28/00 1:09	10/28/00 1:35	0.01
401	5/11/84 6:10	5/11/84 6:40	0.01
402	10/31/90 17:25	10/31/90 17:41	0.01
403	9/25/98 11:49	9/25/98 12:12	0.01
404	8/20/07 10:11	8/20/07 10:27	0.01
405	3/1/82 5:56	3/1/82 6:12	0.01
406	2/17/91 5:09	2/17/91 5:24	0.01
407	6/12/91 14:45	6/12/91 19:36	0.01
408	7/9/78 9:25	7/9/78 23:28	0.01

409	11/4/05 11:43	11/4/05 12:05	0.01
410	2/10/83 23:41	2/11/83 2:07	0.01
411	2/17/94 18:19	2/17/94 20:12	0.01
412	1/26/03 4:02	1/26/03 4:21	0.01
413	9/26/92 10:32	9/26/92 10:46	0.01
414	4/30/97 17:39	4/30/97 19:24	0.01
415	12/25/86 20:32	12/25/86 21:22	0.01
416	12/21/05 20:50	12/22/05 16:26	0.01
417	12/9/93 16:28	12/10/93 7:32	0.01
418	12/25/98 14:27	12/25/98 15:42	0.01
419	6/1/80 5:52	6/2/80 5:46	0.01
420	9/10/83 12:22	9/10/83 12:41	0.01
421	12/9/79 20:36	12/9/79 20:54	0.01
422	10/12/90 12:17	10/12/90 12:35	0.01
423	2/18/96 17:54	2/18/96 18:08	0.01
424	6/17/96 18:11	6/17/96 18:22	0.01
425	4/4/08 17:31	4/4/08 19:52	0.01
426	11/13/81 23:56	11/14/81 12:55	0.01
427	10/7/82 13:14	10/7/82 13:41	0.01
428	3/12/03 11:14	3/12/03 22:58	0.01
429	11/19/97 14:19	11/19/97 15:40	0.01
430	7/13/81 7:26	7/13/81 11:26	0.01
431	2/15/82 22:56	2/15/82 23:23	0.01
432	5/14/83 19:55	5/14/83 22:10	0.01
433	7/25/83 16:18	7/25/83 16:31	0.01
434	12/13/99 18:09	12/13/99 18:21	0.01
435	11/5/86 19:14	11/5/86 19:31	0.01
436	4/7/91 13:39	4/7/91 13:57	0.01
437	3/23/00 18:49	3/23/00 19:02	0.01
438	4/19/78 17:33	4/19/78 18:06	0.01
439	5/16/88 12:00	5/16/88 12:21	0.01
440	6/17/95 18:29	6/17/95 18:41	0.01
441	11/22/98 16:24	11/22/98 16:37	0.01
442	10/21/90 10:46	10/21/90 11:09	0.01
443	12/10/96 15:23	12/10/96 15:37	0.01
444	3/29/88 21:43	3/29/88 21:53	0.00
445	6/19/89 21:05	6/19/89 22:30	0.00
446	2/17/79 19:27	2/17/79 19:42	0.00
447	10/25/84 8:28	10/25/84 8:44	0.00
448	12/14/00 16:08	12/14/00 18:38	0.00
449	11/26/00 7:22	11/26/00 21:13	0.00
450	3/7/78 4:39	3/7/78 5:41	0.00
451	7/15/87 20:32	7/15/87 20:44	0.00
452	12/1/95 23:47	12/2/95 0:02	0.00
453	10/20/85 1:01	10/20/85 6:38	0.00
454	9/2/79 4:17	9/2/79 4:27	0.00
455	4/29/06 14:20	4/29/06 16:38	0.00
456	3/11/80 14:49	3/11/80 15:14	0.00
457	3/30/83 16:08	3/30/83 16:18	0.00
458	1/2/87 20:20	1/2/87 21:47	0.00
459	11/15/96 9:08	11/15/96 9:21	0.00
460	11/6/89 21:08	11/6/89 21:19	0.00

461	5/2/88 10:16	5/2/88 12:15	0.00
462	1/9/08 22:39	1/9/08 22:59	0.00
463	5/23/84 15:29	5/23/84 15:40	0.00
464	11/28/84 19:19	11/29/84 11:46	0.00
465	10/8/01 20:26	10/8/01 20:35	0.00
466	1/26/98 0:00	1/26/98 0:16	0.00
467	7/1/79 8:58	7/1/79 20:46	0.00
468	1/31/90 19:08	1/31/90 21:35	0.00
469	1/23/98 9:19	1/23/98 22:15	0.00
470	10/8/98 20:06	10/8/98 20:16	0.00
471	2/22/83 19:45	2/22/83 20:24	0.00
472	4/25/96 12:22	4/25/96 15:18	0.00
473	8/27/84 7:19	8/27/84 7:30	0.00
474	3/3/99 13:13	3/3/99 13:24	0.00
475	3/15/08 15:09	3/15/08 15:24	0.00
476	4/28/80 0:04	4/28/80 0:15	0.00
477	10/28/81 14:24	10/28/81 14:33	0.00
478	11/19/01 8:39	11/19/01 19:53	0.00
479	1/5/98 3:51	1/5/98 5:51	0.00
480	2/6/05 12:53	2/6/05 13:28	0.00
481	3/10/84 16:28	3/10/84 17:10	0.00
482	7/31/84 21:31	7/31/84 21:46	0.00
483	2/4/86 17:06	2/4/86 18:23	0.00
484	4/12/01 17:20	4/12/01 17:37	0.00
485	2/14/78 21:05	2/14/78 21:30	0.00
486	11/18/86 7:01	11/18/86 10:50	0.00
487	11/8/00 1:19	11/8/00 4:27	0.00
488	1/27/83 6:57	1/27/83 8:29	0.00
489	11/7/85 20:30	11/7/85 20:53	0.00
490	12/15/01 14:18	12/16/01 14:41	0.00
491	5/5/84 23:43	5/5/84 23:53	0.00
492	2/17/96 5:39	2/17/96 13:53	0.00
493	10/28/96 15:04	10/28/96 15:17	0.00
494	1/20/79 16:44	1/20/79 16:55	0.00
495	10/25/82 20:34	10/25/82 21:01	0.00
496	5/18/96 10:24	5/18/96 10:41	0.00
497	1/7/04 19:18	1/8/04 4:18	0.00
498	10/10/89 8:28	10/10/89 8:55	0.00
499	4/15/96 21:42	4/15/96 21:56	0.00
500	2/10/02 17:33	2/10/02 17:57	0.00
501	10/19/79 14:08	10/19/79 15:34	0.00
502	3/23/85 10:17	3/23/85 10:30	0.00
503	1/1/98 12:05	1/1/98 13:09	0.00
504	11/13/84 11:59	11/13/84 12:35	0.00
505	11/2/06 15:46	11/2/06 18:25	0.00
506	11/1/80 13:45	11/1/80 13:56	0.00
507	11/7/95 23:58	11/8/95 0:17	0.00
508	1/23/04 9:12	1/24/04 6:06	0.00
509	11/25/05 7:57	11/25/05 8:18	0.00
510	9/21/96 13:46	9/21/96 13:54	0.00
511	10/22/79 18:03	10/23/79 2:47	0.00
512	9/9/82 4:03	9/9/82 4:15	0.00

513	9/3/96 9:59	9/3/96 10:09	0.00
514	12/1/98 15:32	12/1/98 16:16	0.00
515	3/28/02 8:20	3/28/02 8:45	0.00
516	5/16/79 6:24	5/16/79 6:33	0.00
517	11/15/81 14:26	11/15/81 14:40	0.00
518	2/12/98 4:47	2/12/98 18:48	0.00
519	1/4/00 0:02	1/4/00 1:30	0.00
520	10/17/03 5:45	10/17/03 6:28	0.00
521	6/9/84 8:06	6/9/84 8:22	0.00
522	12/14/84 13:56	12/14/84 15:04	0.00
523	5/19/86 20:42	5/19/86 21:32	0.00
524	8/6/92 7:50	8/6/92 11:57	0.00
525	3/4/94 2:09	3/4/94 2:17	0.00
526	2/27/99 20:19	2/27/99 20:38	0.00
527	9/29/80 14:14	9/29/80 15:45	0.00
528	5/2/95 1:26	5/2/95 6:55	0.00
529	10/22/04 20:15	10/22/04 20:23	0.00
530	4/12/96 17:12	4/12/96 17:21	0.00
531	7/11/79 12:31	7/11/79 12:38	0.00
532	4/1/83 14:21	4/1/83 15:28	0.00
533	2/11/85 3:31	2/11/85 8:22	0.00
534	1/16/06 20:51	1/16/06 21:12	0.00
535	10/6/82 7:36	10/6/82 7:51	0.00
536	8/27/97 16:47	8/27/97 16:55	0.00
537	12/31/98 4:37	12/31/98 4:47	0.00
538	9/6/99 5:42	9/6/99 5:51	0.00
539	3/23/08 11:38	3/23/08 13:00	0.00
540	4/18/08 9:46	4/18/08 9:57	0.00
541	11/29/78 16:43	11/29/78 19:07	0.00
542	8/18/03 2:53	8/18/03 2:59	0.00
543	10/24/06 6:08	10/24/06 6:18	0.00
544	10/11/85 14:25	10/11/85 14:36	0.00
545	11/16/86 16:17	11/16/86 16:30	0.00
546	10/14/96 11:56	10/14/96 12:04	0.00
547	3/7/97 16:24	3/7/97 16:33	0.00
548	3/26/80 18:43	3/26/80 18:53	0.00
549	8/1/85 3:19	8/1/85 3:27	0.00
550	9/9/88 19:30	9/9/88 19:37	0.00
551	10/16/95 11:22	10/16/95 11:47	0.00
552	1/13/98 3:29	1/13/98 3:53	0.00
553	11/12/99 8:24	11/12/99 9:07	0.00
554	12/18/07 12:38	12/18/07 12:51	0.00
555	5/1/84 12:10	5/1/84 12:36	0.00
556	5/30/90 20:05	5/30/90 22:44	0.00
557	8/17/95 1:34	8/17/95 1:42	0.00
558	11/4/00 7:54	11/4/00 8:04	0.00
559	7/8/02 0:02	7/8/02 0:09	0.00
560	10/21/96 21:09	10/21/96 21:24	0.00
561	3/25/98 21:22	3/25/98 21:29	0.00
562	3/5/04 0:48	3/5/04 0:54	0.00
563	2/6/79 16:38	2/6/79 16:50	0.00
564	1/17/82 13:39	1/17/82 13:53	0.00

565	11/26/91 18:29	11/26/91 18:56	0.00
566	11/23/95 3:51	11/23/95 5:17	0.00
567	2/8/99 15:37	2/8/99 15:49	0.00
568	6/8/80 9:36	6/8/80 9:45	0.00
569	12/9/81 22:38	12/10/81 13:45	0.00
570	11/7/92 4:52	11/7/92 6:24	0.00
571	11/23/97 19:03	11/24/97 12:15	0.00
572	12/17/99 15:32	12/17/99 15:40	0.00
573	2/19/91 4:56	2/19/91 5:11	0.00
574	6/30/93 23:19	6/30/93 23:27	0.00
575	3/23/95 3:03	3/23/95 3:17	0.00
576	2/3/96 21:36	2/3/96 22:12	0.00
577	3/24/98 17:19	3/24/98 17:28	0.00
578	2/5/99 20:56	2/5/99 21:04	0.00
579	10/16/00 14:59	10/16/00 16:15	0.00
580	5/15/03 16:08	5/15/03 16:17	0.00
581	8/28/04 20:51	8/28/04 20:58	0.00
582	11/26/06 13:49	11/26/06 14:03	0.00
583	10/9/78 16:02	10/9/78 16:11	0.00
584	11/17/79 15:18	11/17/79 15:26	0.00
585	4/24/85 18:19	4/24/85 18:33	0.00
586	8/29/06 19:39	8/29/06 19:47	0.00
587	2/20/96 3:27	2/20/96 3:34	0.00
588	5/2/85 19:06	5/2/85 19:14	0.00
589	1/1/87 4:08	1/1/87 4:19	0.00
590	10/14/89 2:44	10/14/89 2:54	0.00
591	11/8/94 19:49	11/8/94 20:02	0.00
592	12/26/94 2:49	12/26/94 3:02	0.00
593	1/6/96 13:10	1/7/96 3:44	0.00
594	1/30/97 4:26	1/30/97 5:01	0.00
595	3/1/97 8:39	3/1/97 14:04	0.00
596	5/5/97 16:42	5/5/97 17:07	0.00
597	12/31/79 23:43	12/31/79 23:49	0.00
598	2/25/83 19:01	2/25/83 19:09	0.00
599	5/28/88 0:00	5/28/88 0:07	0.00
600	10/21/89 0:33	10/21/89 0:40	0.00
601	4/23/90 21:54	4/23/90 22:06	0.00

North Beach Storm Rank by Peak Flow

Input File: Y:\NorthBeachPS\FacilityDesign\Carollo\nb_initial_lts.csv
Cutoff Flow: 3.0000
Peak Flow = Peak Flow Net + 3 MGD

Rank	Start Time	End Time	Peak Flow Net (mgd)	Peak Flow (mgd)	
1	12/28/96 13:52	12/29/96 19:46	47.5698	50.57	
2	2/17/81 21:29	2/19/81 7:00	21.4248	24.42	
3	10/25/90 10:45	10/25/90 11:11	18.742	21.74	
4	11/3/78 12:06	11/4/78 0:20	17.1388	20.14	
5	5/4/03 16:43	5/4/03 18:14	14.1241	17.12	
6	4/12/79 13:06	4/12/79 20:10	13.1934	16.19	
7	5/4/99 18:11	5/4/99 18:40	12.3388	15.34	
8	9/25/82 18:56	9/25/82 19:16	11.4035	14.40	
9	10/4/97 0:25	10/4/97 8:39	10.4031	13.40	
10	10/5/81 16:28	10/6/81 20:32	9.9343	12.93	
11	9/26/81 19:24	9/29/81 0:48	9.8723	12.87	
12	6/22/93 15:04	6/22/93 15:22	9.775	12.78	
13	4/8/79 16:13	4/9/79 16:44	9.6613	12.66	
14	3/31/96 16:41	4/1/96 8:05	9.5678	12.57	
15	8/22/01 15:33	8/22/01 17:25	9.3604	12.36	
16	11/1/84 12:42	11/2/84 12:28	9.2754	12.28	
17	4/16/01 22:51	4/16/01 23:16	9.0782	12.08	
18	9/7/79 22:49	9/8/79 13:52	8.8405	11.84	
19	9/23/92 11:47	9/23/92 19:21	8.7122	11.71	
20	9/5/84 7:14	9/5/84 15:17	8.4087	11.41	
21	5/11/00 20:18	5/11/00 21:09	8.1977	11.20	
22	6/3/97 15:13	6/4/97 15:52	8.1498	11.15	
23	12/14/02 7:12	12/14/02 22:03	8.0356	11.04	
24	7/9/97 12:14	7/9/97 13:25	7.5699	10.57	
25	11/18/03 6:13	11/19/03 9:04	7.4141	10.41	
26	12/22/78 6:56	12/22/78 8:07	6.9485	9.95	
27	9/22/78 16:04	9/22/78 19:53	6.8459	9.85	
28	10/20/03 2:34	10/20/03 17:56	6.791	9.79	
29	10/19/07 4:49	10/19/07 19:07	6.6961	9.70	
30	**12/2/07 10:51**	**12/3/07 15:10**	**6.6399**	**9.64**	1-yr recurrence peak flow
31	8/9/91 3:11	8/9/91 7:13	6.6067	9.61	
32	12/1/87 1:39	12/3/87 2:57	6.5967	9.60	
33	10/24/85 6:36	10/24/85 21:48	6.5081	9.51	
34	6/17/86 20:20	6/18/86 15:52	6.321	9.32	
35	8/22/04 2:19	8/22/04 20:58	6.3058	9.31	
36	9/30/95 14:10	9/30/95 14:57	6.2929	9.29	
37	1/4/03 6:05	1/4/03 12:02	6.2813	9.28	
38	6/27/01 10:34	6/27/01 12:10	6.2369	9.24	
39	4/14/80 13:37	4/14/80 17:02	6.2164	9.22	
40	12/14/06 11:20	12/14/06 19:58	5.987	8.99	
41	10/30/83 19:12	10/30/83 19:34	5.9608	8.96	
42	8/2/96 7:46	8/2/96 18:10	5.8337	8.83	
43	10/26/94 11:15	10/27/94 2:37	5.6625	8.66	
44	5/21/86 5:06	5/21/86 21:42	5.656	8.66	
45	9/14/96 19:15	9/15/96 2:12	5.6493	8.65	
46	1/27/92 7:53	1/29/92 8:32	5.6347	8.63	
47	5/20/97 8:52	5/20/97 11:47	5.6186	8.62	

48	4/19/97 16:56	4/20/97 21:01	5.5057	8.51
49	11/20/80 23:02	11/21/80 11:44	5.4761	8.48
50	9/12/97 1:43	9/12/97 14:13	5.4114	8.41
51	10/25/86 1:46	10/26/86 14:19	5.2881	8.29
52	11/3/83 14:39	11/3/83 19:47	5.1069	8.11
53	11/6/80 20:43	11/6/80 23:34	5.0812	8.08
54	10/21/82 21:45	10/22/82 12:33	5.0649	8.06
55	8/28/05 18:30	8/28/05 19:33	5.0459	8.05
56	1/23/81 19:14	1/24/81 18:09	5.0261	8.03
57	2/8/96 1:47	2/9/96 0:29	4.9426	7.94
58	12/9/91 4:47	12/9/91 5:21	4.9314	7.93
59	9/3/79 10:19	9/3/79 11:20	4.8699	7.87
60	4/6/88 3:08	4/6/88 5:35	4.8458	7.85
61	2/1/06 17:39	2/1/06 17:57	4.8341	7.83
62	11/22/88 7:47	11/22/88 9:40	4.8305	7.83
63	12/30/96 21:08	1/2/97 10:09	4.8094	7.81
64	1/4/83 18:14	1/5/83 9:44	4.7562	7.76
65	12/3/82 5:14	12/3/82 15:47	4.7346	7.73
66	9/15/97 17:28	9/17/97 16:40	4.7032	7.70
67	8/3/99 18:16	8/3/99 18:37	4.59	7.59
68	2/13/81 21:41	2/14/81 1:50	4.5054	7.51
69	3/22/98 6:24	3/22/98 7:25	4.4997	7.50
70	11/10/95 21:40	11/11/95 2:19	4.4886	7.49
71	10/1/97 12:40	10/2/97 9:07	4.4605	7.46
72	10/2/95 3:39	10/2/95 4:31	4.4054	7.41
73	1/25/90 10:55	1/25/90 11:11	4.3929	7.39
74	4/15/78 16:07	4/15/78 23:26	4.3745	7.37
75	8/30/85 15:38	8/30/85 17:03	4.3602	7.36
76	12/24/05 1:32	12/25/05 4:15	4.3283	7.33
77	10/28/89 2:48	10/28/89 3:18	4.3277	7.33
78	11/21/93 9:39	11/21/93 12:05	4.3206	7.32
79	10/1/81 18:12	10/1/81 20:34	4.3198	7.32
80	6/22/05 7:06	6/22/05 11:18	4.3129	7.31
81	10/15/85 23:53	10/16/85 3:35	4.2983	7.30
82	8/7/85 17:31	8/7/85 18:10	4.2836	7.28
83	9/16/03 3:48	9/16/03 6:30	4.279	7.28
84	1/8/07 11:23	1/8/07 12:00	4.2695	7.27
85	4/29/97 12:56	4/29/97 13:16	4.2614	7.26
86	11/2/04 2:47	11/2/04 8:18	4.2311	7.23
87	11/30/96 16:29	11/30/96 16:49	4.2084	7.21
88	12/11/93 18:05	12/11/93 19:27	4.1993	7.20
89	6/24/99 2:13	6/24/99 7:42	4.175	7.18
90	6/1/88 12:29	6/1/88 12:48	4.0641	7.06
91	7/16/99 0:56	7/16/99 5:43	4.0592	7.06
92	4/3/91 18:52	4/5/91 4:44	4.0102	7.01
93	12/16/79 22:33	12/19/79 12:48	3.9369	6.94
94	10/13/88 15:53	10/13/88 17:26	3.8601	6.86
95	11/11/81 7:47	11/11/81 19:26	3.8311	6.83
96	11/21/06 13:37	11/21/06 14:04	3.8116	6.81
97	6/16/06 11:34	6/16/06 11:50	3.7421	6.74
98	4/28/92 20:47	4/28/92 21:07	3.7202	6.72
99	12/9/95 20:42	12/11/95 2:13	3.6984	6.70
100	1/27/87 16:57	1/27/87 17:39	3.6817	6.68
101	1/11/88 2:08	1/11/88 2:30	3.6654	6.67
102	1/25/82 23:10	1/25/82 23:44	3.6593	6.66

103	11/24/95 15:09	11/24/95 17:46	3.6339	6.63
104	10/19/00 21:25	10/20/00 18:06	3.5751	6.58
105	5/15/05 3:48	5/15/05 7:37	3.5682	6.57
106	6/26/82 8:18	6/26/82 8:57	3.5653	6.57
107	8/23/93 16:04	8/23/93 16:27	3.5571	6.56
108	1/9/90 4:42	1/9/90 16:12	3.5147	6.51
109	4/16/05 4:42	4/16/05 6:22	3.4823	6.48
110	5/12/96 20:21	5/13/96 16:47	3.4769	6.48
111	2/5/96 8:44	2/6/96 9:00	3.4539	6.45
112	6/3/08 16:11	6/3/08 21:04	3.4509	6.45
113	6/1/99 13:11	6/1/99 14:51	3.4379	6.44
114	1/17/86 22:36	1/18/86 21:15	3.4218	6.42
115	5/28/02 20:20	5/28/02 20:44	3.4159	6.42
116	8/19/78 1:22	8/19/78 1:41	3.3743	6.37
117	5/13/85 19:32	5/13/85 20:16	3.3736	6.37
118	11/7/97 7:40	11/7/97 9:16	3.3651	6.37
119	4/12/95 22:43	4/13/95 18:38	3.3638	6.36
120	4/22/96 21:52	4/23/96 16:27	3.3539	6.35
121	1/14/88 0:39	1/14/88 21:32	3.3514	6.35
122	1/14/96 16:47	1/15/96 11:35	3.3207	6.32
123	1/10/97 5:31	1/10/97 5:43	3.3186	6.32
124	10/12/96 23:59	10/13/96 5:09	3.3178	6.32
125	1/11/80 17:14	1/12/80 9:04	3.3064	6.31
126	10/22/85 9:17	10/22/85 9:46	3.2421	6.24
127	11/19/80 0:27	11/19/80 0:42	3.2316	6.23
128	6/16/81 12:04	6/16/81 12:28	3.2181	6.22
129	10/4/90 11:55	10/4/90 16:50	3.1814	6.18
130	11/16/02 9:15	11/16/02 14:26	3.1545	6.15
131	5/30/97 17:25	5/31/97 10:27	3.1417	6.14
132	1/16/86 13:35	1/16/86 22:17	3.1412	6.14
133	3/2/94 15:01	3/2/94 15:16	3.1377	6.14
134	1/19/02 7:21	1/19/02 7:37	3.1259	6.13
135	11/30/93 23:22	12/1/93 17:26	3.0764	6.08
136	6/6/85 22:40	6/7/85 15:53	3.0733	6.07
137	11/30/94 2:11	11/30/94 4:48	3.0642	6.06
138	1/18/05 15:57	1/18/05 21:41	3.0625	6.06
139	9/25/97 20:47	9/26/97 18:31	3.0417	6.04
140	10/15/96 14:40	10/15/96 15:07	3.0136	6.01
141	12/4/90 3:45	12/4/90 6:34	2.9744	5.97
142	12/4/96 9:08	12/4/96 14:14	2.9397	5.94
143	11/28/80 22:56	11/29/80 2:38	2.8944	5.89
144	12/13/01 11:41	12/13/01 20:20	2.8829	5.88
145	8/12/78 16:19	8/12/78 16:33	2.8737	5.87
146	9/4/05 16:24	9/4/05 16:46	2.8733	5.87
147	12/14/79 13:19	12/14/79 20:33	2.853	5.85
148	3/5/87 16:48	3/5/87 17:14	2.8512	5.85
149	11/5/05 19:08	11/5/05 20:35	2.8367	5.84
150	1/1/03 18:23	1/2/03 22:07	2.8192	5.82
151	9/9/78 6:02	9/9/78 16:43	2.814	5.81
152	2/2/91 13:29	2/3/91 10:43	2.8121	5.81
153	3/18/97 11:46	3/19/97 20:28	2.8103	5.81
154	1/25/02 4:53	1/25/02 5:44	2.7821	5.78
155	6/2/88 16:04	6/2/88 20:05	2.7708	5.77
156	3/19/07 19:32	3/19/07 20:07	2.7406	5.74
157	12/5/87 11:25	12/6/87 18:06	2.7326	5.73

158	4/26/97 19:37	4/26/97 22:41	2.7188	5.72
159	3/20/84 14:55	3/20/84 15:29	2.7087	5.71
160	7/3/98 8:32	7/3/98 9:09	2.7067	5.71
161	6/23/83 16:16	6/23/83 16:33	2.6888	5.69
162	3/2/87 18:44	3/3/87 20:40	2.6839	5.68
163	3/22/03 5:44	3/22/03 6:04	2.6748	5.67
164	10/3/96 11:22	10/4/96 17:09	2.6647	5.66
165	11/9/99 21:06	11/9/99 23:07	2.6548	5.65
166	3/5/89 15:21	3/6/89 9:51	2.647	5.65
167	10/6/90 2:32	10/6/90 2:44	2.645	5.65
168	9/16/05 8:24	9/16/05 8:46	2.6447	5.64
169	9/14/06 1:14	9/14/06 1:28	2.6244	5.62
170	10/26/85 16:21	10/27/85 19:09	2.6004	5.60
171	1/9/06 23:30	1/10/06 2:07	2.5778	5.58
172	6/16/80 14:28	6/16/80 18:54	2.5758	5.58
173	11/20/98 6:45	11/20/98 19:42	2.569	5.57
174	2/1/00 8:02	2/1/00 11:02	2.544	5.54
175	5/15/78 11:55	5/15/78 12:17	2.5409	5.54
176	2/1/86 6:18	2/1/86 6:32	2.5254	5.53
177	8/24/97 14:49	8/24/97 17:38	2.5024	5.50
178	10/8/04 9:00	10/8/04 9:15	2.4908	5.49
179	6/6/90 8:03	6/6/90 9:40	2.4737	5.47
180	3/12/91 17:48	3/12/91 18:08	2.4692	5.47
181	12/2/96 8:40	12/2/96 9:53	2.4511	5.45
182	8/17/80 19:21	8/17/80 23:45	2.4494	5.45
183	10/17/96 17:05	10/17/96 20:55	2.4375	5.44
184	7/26/78 12:36	7/26/78 17:35	2.4039	5.40
185	5/18/88 16:29	5/18/88 16:54	2.4038	5.40
186	11/27/96 15:08	11/27/96 17:34	2.3888	5.39
187	1/5/06 20:06	1/5/06 21:25	2.3483	5.35
188	5/15/01 17:43	5/15/01 18:22	2.3445	5.34
189	12/11/06 10:07	12/11/06 23:51	2.3083	5.31
190	4/13/82 18:05	4/13/82 18:19	2.308	5.31
191	2/3/06 23:53	2/4/06 0:12	2.2873	5.29
192	9/3/92 20:38	9/4/92 2:50	2.2711	5.27
193	12/15/82 17:50	12/16/82 20:47	2.263	5.26
194	12/15/81 4:38	12/15/81 11:49	2.2623	5.26
195	7/6/81 22:14	7/7/81 1:53	2.2508	5.25
196	11/28/01 6:35	11/29/01 2:05	2.2487	5.25
197	11/3/96 15:37	11/3/96 15:51	2.2486	5.25
198	12/2/89 12:14	12/4/89 2:13	2.2384	5.24
199	1/7/78 12:28	1/8/78 5:36	2.2263	5.23
200	11/24/90 1:51	11/24/90 14:59	2.2242	5.22
201	12/28/86 12:33	12/29/86 3:55	2.2116	5.21
202	9/29/05 21:50	9/30/05 22:14	2.2089	5.21
203	9/19/06 5:08	9/19/06 5:23	2.1996	5.20
204	11/17/82 1:59	11/17/82 7:08	2.199	5.20
205	7/1/93 23:53	7/2/93 0:13	2.1974	5.20
206	8/19/07 6:01	8/19/07 6:14	2.1974	5.20
207	11/5/80 18:06	11/5/80 20:31	2.1794	5.18
208	9/22/84 4:24	9/22/84 4:56	2.1763	5.18
209	10/23/78 20:08	10/23/78 21:10	2.1716	5.17
210	2/4/91 20:16	2/4/91 20:40	2.1579	5.16
211	4/7/87 20:29	4/7/87 22:07	2.1444	5.14
212	11/10/89 10:06	11/10/89 13:24	2.1429	5.14

213	6/10/83 2:03	6/10/83 2:45	2.1394	5.14
214	11/17/07 12:35	11/17/07 12:55	2.1372	5.14
215	12/15/99 11:12	12/15/99 13:14	2.1259	5.13
216	12/2/80 11:13	12/2/80 16:39	2.1126	5.11
217	1/17/98 0:58	1/17/98 6:48	2.1116	5.11
218	6/17/96 18:11	6/17/96 18:22	2.0884	5.09
219	1/6/90 22:17	1/6/90 23:46	2.0824	5.08
220	3/22/00 7:30	3/22/00 7:48	2.0706	5.07
221	12/21/79 14:04	12/21/79 17:19	2.0652	5.07
222	10/30/01 21:59	10/30/01 22:21	2.0621	5.06
223	4/19/80 14:35	4/19/80 18:43	2.0608	5.06
224	9/1/78 8:53	9/1/78 19:07	2.0581	5.06
225	2/7/00 16:24	2/8/00 16:44	2.0552	5.06
226	2/22/96 19:48	2/22/96 20:54	2.044	5.04
227	10/11/03 17:04	10/11/03 18:08	2.0382	5.04
228	1/5/90 16:30	1/5/90 17:00	2.0355	5.04
229	4/25/90 10:47	4/25/90 11:16	2.0349	5.03
230	5/4/85 14:30	5/4/85 14:49	2.0296	5.03
231	12/12/95 21:33	12/14/95 20:17	2.0211	5.02
232	4/5/80 10:31	4/5/80 22:51	2.0155	5.02
233	11/4/90 18:10	11/4/90 18:25	1.9946	4.99
234	12/16/97 13:10	12/17/97 12:17	1.9825	4.98
235	12/30/05 15:35	12/30/05 20:46	1.9684	4.97
236	3/14/95 11:04	3/14/95 11:18	1.9675	4.97
237	6/3/90 0:07	6/3/90 4:12	1.9509	4.95
238	3/11/89 3:35	3/11/89 7:10	1.95	4.95
239	6/10/78 16:37	6/10/78 16:54	1.9477	4.95
240	5/12/88 19:20	5/12/88 20:41	1.9468	4.95
241	3/17/80 16:40	3/17/80 19:16	1.9335	4.93
242	3/23/86 17:10	3/23/86 17:55	1.9062	4.91
243	1/7/06 11:53	1/7/06 12:10	1.895	4.90
244	11/8/92 12:28	11/8/92 15:03	1.8879	4.89
245	11/4/06 14:03	11/6/06 12:45	1.8868	4.89
246	11/26/86 17:26	11/26/86 21:49	1.8628	4.86
247	12/20/80 10:17	12/21/80 9:59	1.8605	4.86
248	12/12/99 7:19	12/12/99 11:11	1.8542	4.85
249	11/22/81 19:35	11/23/81 10:49	1.8413	4.84
250	1/29/06 16:10	1/30/06 3:42	1.8387	4.84
251	11/5/88 7:55	11/5/88 15:09	1.8384	4.84
252	1/18/97 8:44	1/18/97 10:35	1.8274	4.83
253	11/1/83 11:25	11/1/83 12:58	1.8262	4.83
254	7/9/78 9:25	7/9/78 23:28	1.8035	4.80
255	11/8/06 19:44	11/8/06 21:42	1.7965	4.80
256	11/13/01 18:04	11/15/01 11:48	1.7963	4.80
257	12/4/81 22:47	12/5/81 11:16	1.7868	4.79
258	2/24/99 14:27	2/24/99 16:05	1.778	4.78
259	12/22/86 8:22	12/22/86 19:27	1.7755	4.78
260	3/29/88 21:43	3/29/88 21:53	1.7621	4.76
261	12/12/02 11:54	12/12/02 16:22	1.7489	4.75
262	9/2/79 4:17	9/2/79 4:27	1.7356	4.74
263	3/30/83 16:08	3/30/83 16:18	1.7189	4.72
264	12/25/80 17:51	12/26/80 5:46	1.7113	4.71
265	3/15/97 10:04	3/15/97 16:21	1.7073	4.71
266	9/26/92 10:32	9/26/92 10:46	1.7015	4.70
267	2/11/79 17:41	2/13/79 1:27	1.6975	4.70

268	10/31/90 17:25	10/31/90 17:41	1.6921	4.69
269	11/28/95 16:23	11/29/95 9:34	1.6797	4.68
270	11/2/88 8:37	11/3/88 19:57	1.6729	4.67
271	7/25/83 16:18	7/25/83 16:31	1.6575	4.66
272	12/12/98 10:05	12/13/98 19:12	1.6526	4.65
273	6/17/95 18:29	6/17/95 18:41	1.6488	4.65
274	2/17/91 5:09	2/17/91 5:24	1.6435	4.64
275	3/23/00 18:49	3/23/00 19:02	1.6435	4.64
276	2/21/92 6:43	2/21/92 21:37	1.638	4.64
277	11/12/06 18:23	11/13/06 0:26	1.6333	4.63
278	3/1/82 5:56	3/1/82 6:12	1.6306	4.63
279	12/21/05 20:50	12/22/05 16:26	1.6288	4.63
280	8/20/07 10:11	8/20/07 10:27	1.6245	4.62
281	1/23/82 17:47	1/23/82 18:23	1.621	4.62
282	7/26/95 1:08	7/26/95 3:29	1.6084	4.61
283	5/13/78 23:44	5/14/78 0:14	1.6084	4.61
284	12/13/99 18:09	12/13/99 18:21	1.6029	4.60
285	10/26/79 23:13	10/27/79 14:52	1.601	4.60
286	7/16/78 7:07	7/16/78 8:13	1.5971	4.60
287	1/27/97 19:08	1/27/97 22:06	1.5951	4.60
288	10/27/98 16:43	10/27/98 18:48	1.5925	4.59
289	11/19/83 12:22	11/20/83 1:15	1.5801	4.58
290	10/8/01 20:26	10/8/01 20:35	1.5756	4.58
291	5/3/97 11:50	5/3/97 12:23	1.573	4.57
292	4/3/94 14:09	4/3/94 15:14	1.57	4.57
293	10/28/81 14:24	10/28/81 14:33	1.5643	4.56
294	3/26/97 21:48	3/27/97 0:05	1.5631	4.56
295	6/20/84 11:42	6/20/84 19:14	1.5629	4.56
296	2/18/96 17:54	2/18/96 18:08	1.5593	4.56
297	11/6/89 21:08	11/6/89 21:19	1.5422	4.54
298	11/22/98 16:24	11/22/98 16:37	1.5307	4.53
299	1/28/88 10:08	1/28/88 21:47	1.5208	4.52
300	9/1/83 1:28	9/1/83 2:21	1.5202	4.52
301	12/9/87 12:04	12/9/87 16:36	1.5195	4.52
302	10/8/98 20:06	10/8/98 20:16	1.511	4.51
303	7/15/87 20:32	7/15/87 20:44	1.5033	4.50
304	2/17/83 12:12	2/17/83 13:48	1.5021	4.50
305	3/25/87 19:17	3/25/87 19:37	1.4998	4.50
306	4/22/97 19:00	4/23/97 14:57	1.4988	4.50
307	11/19/86 22:05	11/20/86 14:24	1.4987	4.50
308	9/19/81 5:18	9/19/81 6:21	1.4926	4.49
309	1/6/02 19:05	1/8/02 6:05	1.4911	4.49
310	9/3/94 8:42	9/3/94 10:37	1.4842	4.48
311	1/26/03 4:02	1/26/03 4:21	1.4796	4.48
312	12/9/04 23:23	12/10/04 23:17	1.4756	4.48
313	1/31/87 3:14	2/1/87 1:13	1.4585	4.46
314	10/28/00 1:09	10/28/00 1:35	1.4584	4.46
315	12/3/81 15:24	12/3/81 15:44	1.4552	4.46
316	2/24/79 18:06	2/25/79 17:51	1.4539	4.45
317	5/23/84 15:29	5/23/84 15:40	1.4466	4.45
318	3/12/02 7:31	3/12/02 9:52	1.4371	4.44
319	10/10/84 8:24	10/10/84 22:02	1.4361	4.44
320	12/19/94 11:15	12/19/94 18:16	1.4341	4.43
321	7/2/99 0:32	7/2/99 17:02	1.4327	4.43
322	11/24/83 0:13	11/24/83 5:58	1.4324	4.43

323	10/16/82 15:20	10/16/82 15:41	1.427	4.43
324	3/1/91 16:06	3/2/91 22:14	1.4251	4.43
325	8/9/85 21:36	8/9/85 22:35	1.4185	4.42
326	3/12/03 11:14	3/12/03 22:58	1.4182	4.42
327	11/16/03 11:21	11/16/03 12:30	1.4177	4.42
328	4/9/80 2:34	4/9/80 16:06	1.4056	4.41
329	12/8/93 11:52	12/8/93 12:14	1.383	4.38
330	10/8/97 15:21	10/8/97 17:46	1.374	4.37
331	3/10/82 23:23	3/11/82 0:59	1.3737	4.37
332	11/1/92 16:42	11/1/92 17:48	1.3652	4.37
333	4/15/97 16:11	4/15/97 16:37	1.3556	4.36
334	1/2/07 5:20	1/3/07 8:04	1.3548	4.35
335	3/3/99 13:13	3/3/99 13:24	1.3324	4.33
336	11/15/96 9:08	11/15/96 9:21	1.3312	4.33
337	12/18/81 23:08	12/19/81 12:23	1.3212	4.32
338	12/10/96 15:23	12/10/96 15:37	1.3127	4.31
339	1/5/07 19:53	1/5/07 21:11	1.3107	4.31
340	2/1/78 17:06	2/2/78 17:00	1.3039	4.30
341	8/27/84 7:19	8/27/84 7:30	1.3034	4.30
342	7/2/90 3:27	7/2/90 4:17	1.2967	4.30
343	10/12/90 12:17	10/12/90 12:35	1.2942	4.29
344	5/5/84 23:43	5/5/84 23:53	1.2938	4.29
345	10/16/01 11:06	10/16/01 18:19	1.2868	4.29
346	7/24/91 13:53	7/24/91 14:28	1.2818	4.28
347	11/17/91 14:05	11/17/91 14:28	1.2808	4.28
348	6/12/91 14:45	6/12/91 19:36	1.28	4.28
349	1/9/00 6:45	1/9/00 7:05	1.2753	4.28
350	2/17/79 19:27	2/17/79 19:42	1.2717	4.27
351	8/29/83 20:12	8/29/83 23:58	1.2691	4.27
352	1/31/92 1:44	2/1/92 18:33	1.2659	4.27
353	12/20/06 22:43	12/21/06 0:17	1.2584	4.26
354	11/22/79 13:23	11/22/79 14:36	1.2549	4.25
355	3/5/92 21:45	3/5/92 22:09	1.2508	4.25
356	10/15/03 10:21	10/15/03 17:59	1.2499	4.25
357	12/9/79 20:36	12/9/79 20:54	1.2497	4.25
358	4/28/80 0:04	4/28/80 0:15	1.2497	4.25
359	4/16/92 10:37	4/16/92 23:19	1.2475	4.25
360	10/24/79 8:59	10/25/79 4:31	1.2454	4.25
361	10/7/82 13:14	10/7/82 13:41	1.245	4.25
362	3/15/92 3:49	3/15/92 8:43	1.243	4.24
363	3/15/87 20:05	3/15/87 20:27	1.2346	4.23
364	9/10/04 22:02	9/11/04 0:25	1.2309	4.23
365	12/1/95 23:47	12/2/95 0:02	1.2242	4.22
366	10/9/00 8:58	10/9/00 9:36	1.2117	4.21
367	11/23/86 5:14	11/24/86 5:17	1.2046	4.20
368	12/28/95 19:39	12/29/95 16:59	1.2041	4.20
369	9/25/98 11:49	9/25/98 12:12	1.185	4.19
370	4/13/02 18:43	4/13/02 22:20	1.1819	4.18
371	10/10/95 21:34	10/11/95 2:36	1.1817	4.18
372	9/21/96 13:46	9/21/96 13:54	1.1784	4.18
373	12/26/06 18:14	12/27/06 0:29	1.1755	4.18
374	12/14/00 16:08	12/14/00 18:38	1.1689	4.17
375	10/25/84 8:28	10/25/84 8:44	1.1605	4.16
376	1/21/78 2:30	1/21/78 6:42	1.1603	4.16
377	11/25/98 5:14	11/25/98 16:42	1.1602	4.16

378	6/10/90 0:32	6/10/90 1:03	1.1479	4.15
379	4/7/08 20:11	4/7/08 21:06	1.145	4.15
380	7/4/92 15:56	7/4/92 16:28	1.1446	4.14
381	2/20/84 11:06	2/20/84 12:21	1.143	4.14
382	11/28/84 19:19	11/29/84 11:46	1.1301	4.13
383	1/17/05 8:29	1/17/05 13:19	1.1248	4.12
384	4/19/78 17:33	4/19/78 18:06	1.1239	4.12
385	11/14/83 20:00	11/14/83 21:01	1.1198	4.12
386	10/22/04 20:15	10/22/04 20:23	1.1164	4.12
387	11/23/84 7:13	11/23/84 9:51	1.1145	4.11
388	1/11/91 12:25	1/11/91 15:08	1.1115	4.11
389	12/3/95 19:31	12/3/95 20:48	1.1114	4.11
390	10/28/82 13:30	10/28/82 17:26	1.1082	4.11
391	7/11/79 12:31	7/11/79 12:38	1.1081	4.11
392	12/2/81 2:31	12/2/81 3:08	1.1063	4.11
393	3/11/97 15:24	3/11/97 18:34	1.1056	4.11
394	3/4/94 2:09	3/4/94 2:17	1.1032	4.10
395	9/18/83 7:45	9/18/83 9:37	1.0996	4.10
396	1/20/79 16:44	1/20/79 16:55	1.0972	4.10
397	6/3/01 1:06	6/3/01 2:37	1.092	4.09
398	1/3/01 16:35	1/4/01 19:01	1.0865	4.09
399	6/24/80 22:56	6/25/80 2:04	1.0651	4.07
400	6/11/01 4:20	6/11/01 21:11	1.0587	4.06
401	2/9/83 0:07	2/9/83 5:13	1.0542	4.05
402	2/26/80 3:08	2/26/80 15:57	1.05	4.05
403	11/13/87 8:42	11/13/87 10:42	1.0482	4.05
404	8/18/03 2:53	8/18/03 2:59	1.0431	4.04
405	9/10/83 12:22	9/10/83 12:41	1.0319	4.03
406	3/28/02 8:20	3/28/02 8:45	1.0313	4.03
407	9/24/88 18:20	9/25/88 4:38	1.0251	4.03
408	10/20/85 1:01	10/20/85 6:38	1.0203	4.02
409	12/5/99 23:58	12/6/99 0:31	1.0007	4.00
410	11/18/86 7:01	11/18/86 10:50	0.9974	4.00
411	9/3/96 9:59	9/3/96 10:09	0.9838	3.98
412	3/15/08 15:09	3/15/08 15:24	0.981	3.98
413	10/29/97 5:35	10/30/97 7:02	0.9789	3.98
414	11/4/05 11:43	11/4/05 12:05	0.9741	3.97
415	5/26/82 7:38	5/26/82 9:20	0.9695	3.97
416	2/17/94 18:19	2/17/94 20:12	0.967	3.97
417	5/16/79 6:24	5/16/79 6:33	0.9659	3.97
418	9/9/88 19:30	9/9/88 19:37	0.9609	3.96
419	11/1/80 13:45	11/1/80 13:56	0.9599	3.96
420	3/5/04 0:48	3/5/04 0:54	0.9597	3.96
421	1/19/96 12:08	1/21/96 4:30	0.9584	3.96
422	1/29/04 14:29	1/30/04 1:36	0.9572	3.96
423	2/16/03 15:46	2/16/03 17:25	0.9419	3.94
424	5/16/88 12:00	5/16/88 12:21	0.9399	3.94
425	7/31/84 21:31	7/31/84 21:46	0.9378	3.94
426	12/24/06 18:03	12/24/06 19:08	0.9375	3.94
427	1/17/99 20:49	1/18/99 0:34	0.9307	3.93
428	10/23/89 10:16	10/23/89 11:00	0.9296	3.93
429	10/31/80 6:32	10/31/80 7:40	0.9202	3.92
430	11/10/84 5:37	11/10/84 15:50	0.9125	3.91
431	4/12/96 17:12	4/12/96 17:21	0.9103	3.91
432	2/17/96 5:39	2/17/96 13:53	0.9095	3.91

433	10/28/96 15:04	10/28/96 15:17	0.9034	3.90
434	4/30/87 20:47	4/30/87 22:06	0.8993	3.90
435	3/13/00 20:50	3/14/00 17:43	0.893	3.89
436	4/7/91 13:39	4/7/91 13:57	0.892	3.89
437	11/13/81 23:56	11/14/81 12:55	0.8781	3.88
438	1/27/90 7:18	1/27/90 7:59	0.8752	3.88
439	1/5/98 3:51	1/5/98 5:51	0.8732	3.87
440	5/23/06 9:21	5/23/06 9:47	0.8717	3.87
441	8/6/95 15:17	8/6/95 15:55	0.8708	3.87
442	11/5/86 19:14	11/5/86 19:31	0.8692	3.87
443	3/23/85 10:17	3/23/85 10:30	0.8664	3.87
444	10/14/96 11:56	10/14/96 12:04	0.8656	3.87
445	8/27/97 16:47	8/27/97 16:55	0.8607	3.86
446	1/9/08 22:39	1/9/08 22:59	0.8537	3.85
447	12/6/96 10:29	12/7/96 15:23	0.8525	3.85
448	4/15/96 21:42	4/15/96 21:56	0.8467	3.85
449	1/3/84 0:58	1/3/84 1:41	0.8461	3.85
450	1/26/98 0:00	1/26/98 0:16	0.842	3.84
451	2/10/83 23:41	2/11/83 2:07	0.8377	3.84
452	5/14/83 19:55	5/14/83 22:10	0.828	3.83
453	6/1/80 5:52	6/2/80 5:46	0.825	3.83
454	3/26/88 6:50	3/26/88 9:28	0.8138	3.81
455	7/8/02 0:02	7/8/02 0:09	0.8137	3.81
456	2/1/80 5:34	2/2/80 12:42	0.8098	3.81
457	3/15/81 19:58	3/15/81 21:31	0.805	3.81
458	5/20/07 15:29	5/20/07 17:23	0.8034	3.80
459	11/15/06 14:50	11/15/06 17:35	0.7991	3.80
460	4/29/06 14:20	4/29/06 16:38	0.7991	3.80
461	2/15/82 22:56	2/15/82 23:23	0.7977	3.80
462	3/25/98 21:22	3/25/98 21:29	0.7889	3.79
463	8/1/85 3:19	8/1/85 3:27	0.7819	3.78
464	9/9/82 4:03	9/9/82 4:15	0.7775	3.78
465	11/2/06 15:46	11/2/06 18:25	0.7765	3.78
466	9/6/99 5:42	9/6/99 5:51	0.7738	3.77
467	2/22/83 19:45	2/22/83 20:24	0.7719	3.77
468	10/22/89 5:57	10/22/89 8:47	0.768	3.77
469	2/21/02 2:11	2/22/02 0:39	0.763	3.76
470	8/17/95 1:34	8/17/95 1:42	0.7605	3.76
471	3/10/84 16:28	3/10/84 17:10	0.7531	3.75
472	12/31/98 4:37	12/31/98 4:47	0.7488	3.75
473	8/28/04 20:51	8/28/04 20:58	0.7414	3.74
474	4/4/08 17:31	4/4/08 19:52	0.7377	3.74
475	10/22/79 18:03	10/23/79 2:47	0.7289	3.73
476	6/6/93 13:03	6/6/93 22:31	0.728	3.73
477	10/10/89 8:28	10/10/89 8:55	0.7227	3.72
478	12/3/79 15:40	12/3/79 23:35	0.7206	3.72
479	7/13/81 7:26	7/13/81 11:26	0.7104	3.71
480	10/24/06 6:08	10/24/06 6:18	0.7078	3.71
481	1/14/00 9:09	1/14/00 10:17	0.703	3.70
482	3/7/97 16:24	3/7/97 16:33	0.7024	3.70
483	5/18/96 10:24	5/18/96 10:41	0.6951	3.70
484	12/17/99 15:32	12/17/99 15:40	0.6917	3.69
485	11/27/84 1:12	11/27/84 8:31	0.6811	3.68
486	11/17/81 9:53	11/17/81 10:47	0.6807	3.68
487	10/16/95 11:22	10/16/95 11:47	0.6801	3.68

488	11/15/81 14:26	11/15/81 14:40	0.6776	3.68
489	4/18/08 9:46	4/18/08 9:57	0.6774	3.68
490	12/25/98 14:27	12/25/98 15:42	0.6739	3.67
491	11/19/97 14:19	11/19/97 15:40	0.6651	3.67
492	5/5/97 16:42	5/5/97 17:07	0.6633	3.66
493	10/11/85 14:25	10/11/85 14:36	0.6622	3.66
494	5/11/84 6:10	5/11/84 6:40	0.662	3.66
495	3/26/80 18:43	3/26/80 18:53	0.6608	3.66
496	7/9/79 22:18	7/9/79 23:54	0.6598	3.66
497	10/21/90 10:46	10/21/90 11:09	0.6575	3.66
498	3/11/80 14:49	3/11/80 15:14	0.656	3.66
499	12/25/86 20:32	12/25/86 21:22	0.6488	3.65
500	3/7/78 4:39	3/7/78 5:41	0.6485	3.65
501	12/13/81 15:21	12/13/81 17:22	0.6344	3.63
502	2/5/99 20:56	2/5/99 21:04	0.6322	3.63
503	1/5/86 10:46	1/5/86 13:21	0.6309	3.63
504	5/31/93 6:57	5/31/93 9:43	0.6274	3.63
505	5/30/87 1:29	5/30/87 4:37	0.6262	3.63
506	11/4/00 7:54	11/4/00 8:04	0.6256	3.63
507	6/30/93 23:19	6/30/93 23:27	0.6208	3.62
508	1/23/04 9:12	1/24/04 6:06	0.6202	3.62
509	11/17/79 15:18	11/17/79 15:26	0.6162	3.62
510	5/15/03 16:08	5/15/03 16:17	0.6119	3.61
511	8/29/06 19:39	8/29/06 19:47	0.6086	3.61
512	12/31/79 23:43	12/31/79 23:49	0.6076	3.61
513	4/30/97 17:39	4/30/97 19:24	0.6039	3.60
514	1/14/98 8:10	1/14/98 12:26	0.6031	3.60
515	4/12/01 17:20	4/12/01 17:37	0.5955	3.60
516	11/7/95 23:58	11/8/95 0:17	0.594	3.59
517	11/22/01 8:13	11/22/01 11:22	0.5938	3.59
518	8/6/92 7:50	8/6/92 11:57	0.5909	3.59
519	2/20/96 3:27	2/20/96 3:34	0.5847	3.58
520	12/14/84 13:56	12/14/84 15:04	0.5822	3.58
521	1/4/00 0:02	1/4/00 1:30	0.5818	3.58
522	2/6/05 12:53	2/6/05 13:28	0.5734	3.57
523	2/18/82 9:45	2/19/82 6:46	0.5723	3.57
524	2/14/78 21:05	2/14/78 21:30	0.5721	3.57
525	5/28/88 0:00	5/28/88 0:07	0.5713	3.57
526	5/19/86 20:42	5/19/86 21:32	0.569	3.57
527	6/19/89 21:05	6/19/89 22:30	0.5672	3.57
528	1/2/87 20:20	1/2/87 21:47	0.5633	3.56
529	4/25/96 12:22	4/25/96 15:18	0.548	3.55
530	6/8/80 9:36	6/8/80 9:45	0.5479	3.55
531	10/9/78 16:02	10/9/78 16:11	0.5429	3.54
532	10/21/89 0:33	10/21/89 0:40	0.5424	3.54
533	11/26/00 7:22	11/26/00 21:13	0.542	3.54
534	1/1/98 12:05	1/1/98 13:09	0.5417	3.54
535	1/23/98 9:19	1/23/98 22:15	0.5412	3.54
536	3/26/05 7:02	3/27/05 1:50	0.5406	3.54
537	11/23/97 19:03	11/24/97 12:15	0.5395	3.54
538	11/23/95 3:51	11/23/95 5:17	0.531	3.53
539	5/2/88 10:16	5/2/88 12:15	0.5222	3.52
540	10/19/79 14:08	10/19/79 15:34	0.5177	3.52
541	2/10/02 17:33	2/10/02 17:57	0.5166	3.52
542	3/24/98 17:19	3/24/98 17:28	0.5162	3.52

543	5/2/85 19:06	5/2/85 19:14	0.5146	3.51
544	1/30/95 6:52	1/31/95 11:37	0.5131	3.51
545	12/8/84 2:50	12/8/84 4:48	0.5127	3.51
546	9/29/80 14:14	9/29/80 15:45	0.5094	3.51
547	12/18/07 12:38	12/18/07 12:51	0.504	3.50
548	2/16/01 12:39	2/16/01 14:21	0.5011	3.50
549	12/9/93 16:28	12/10/93 7:32	0.4966	3.50
550	2/25/83 19:01	2/25/83 19:09	0.4909	3.49
551	3/1/97 8:39	3/1/97 14:04	0.4876	3.49
552	10/6/82 7:36	10/6/82 7:51	0.4836	3.48
553	12/15/01 14:18	12/16/01 14:41	0.4783	3.48
554	7/1/79 8:58	7/1/79 20:46	0.4768	3.48
555	12/9/81 22:38	12/10/81 13:45	0.4723	3.47
556	2/6/79 16:38	2/6/79 16:50	0.4707	3.47
557	11/7/85 20:30	11/7/85 20:53	0.4648	3.46
558	2/8/99 15:37	2/8/99 15:49	0.4477	3.45
559	1/7/04 19:18	1/8/04 4:18	0.4362	3.44
560	10/16/00 14:59	10/16/00 16:15	0.4306	3.43
561	11/13/84 11:59	11/13/84 12:35	0.4264	3.43
562	11/25/05 7:57	11/25/05 8:18	0.4235	3.42
563	10/25/82 20:34	10/25/82 21:01	0.4198	3.42
564	11/16/86 16:17	11/16/86 16:30	0.4147	3.41
565	6/9/84 8:06	6/9/84 8:22	0.4134	3.41
566	2/12/98 4:47	2/12/98 18:48	0.4024	3.40
567	2/27/99 20:19	2/27/99 20:38	0.402	3.40
568	1/31/90 19:08	1/31/90 21:35	0.3944	3.39
569	10/14/89 2:44	10/14/89 2:54	0.3861	3.39
570	12/1/98 15:32	12/1/98 16:16	0.3792	3.38
571	11/19/01 8:39	11/19/01 19:53	0.377	3.38
572	11/29/78 16:43	11/29/78 19:07	0.374	3.37
573	2/3/96 21:36	2/3/96 22:12	0.3689	3.37
574	1/1/87 4:08	1/1/87 4:19	0.362	3.36
575	10/17/03 5:45	10/17/03 6:28	0.355	3.36
576	2/4/86 17:06	2/4/86 18:23	0.3528	3.35
577	10/21/96 21:09	10/21/96 21:24	0.3402	3.34
578	12/1/79 14:58	12/1/79 22:16	0.3368	3.34
579	5/2/95 1:26	5/2/95 6:55	0.334	3.33
580	11/8/94 19:49	11/8/94 20:02	0.3281	3.33
581	1/16/06 20:51	1/16/06 21:12	0.3205	3.32
582	5/30/90 20:05	5/30/90 22:44	0.3182	3.32
583	1/27/83 6:57	1/27/83 8:29	0.3172	3.32
584	4/23/90 21:54	4/23/90 22:06	0.3144	3.31
585	4/24/85 18:19	4/24/85 18:33	0.3104	3.31
586	1/17/82 13:39	1/17/82 13:53	0.3098	3.31
587	12/26/94 2:49	12/26/94 3:02	0.3033	3.30
588	11/26/06 13:49	11/26/06 14:03	0.2975	3.30
589	11/7/92 4:52	11/7/92 6:24	0.2949	3.29
590	1/6/96 13:10	1/7/96 3:44	0.2811	3.28
591	2/11/85 3:31	2/11/85 8:22	0.2799	3.28
592	5/1/84 12:10	5/1/84 12:36	0.2754	3.28
593	2/19/91 4:56	2/19/91 5:11	0.2573	3.26
594	11/8/00 1:19	11/8/00 4:27	0.2554	3.26
595	3/23/08 11:38	3/23/08 13:00	0.2539	3.25
596	1/13/98 3:29	1/13/98 3:53	0.2462	3.25
597	3/23/95 3:03	3/23/95 3:17	0.2253	3.23

598	4/1/83 14:21	4/1/83 15:28	0.2023	3.20
599	11/26/91 18:29	11/26/91 18:56	0.19	3.19
600	1/30/97 4:26	1/30/97 5:01	0.1778	3.18
601	11/12/99 8:24	11/12/99 9:07	0.1129	3.11

Appendix C

ALTERNATIVE EVALUATION SUMMARY DOCUMENTATION

Alternative Screening Workshop for North Beach Basin

Feb. 11, 2010 and Feb. 17, 2010
King Street Center

Summary of Discussion

Attendance

King County		*Consultant*	*SPU*
Betsy Cooper	John Phillips	Ellen Blair	Sahba Mohandessi
Hien Dung	Kevin Schock	Karl Hadler	
Pam Erstad	Bob Swarner	Jeff Lykken	
Ron Kohler	Martha Tuttle	Kristine Maristela	
Kathy Mathena	Jim Weber	Brian Matson	
Sue Meyer	Mary Wohleb	Lloyd Skinner	
Lee Miller	Monica Van der Vieren	Bob Wheeler	
Shahrzad Namini	Karl Zimmer		
Chris Okuda			
Ukwenga Oleru			
Sekhar Palepu			

Purpose of this Summary:
This document provides a summary of the workshop process and captures the discussion themes that supported recommendations for CSO control project alternatives to be forwarded for review by internal management and further development by the project team.

Workshop Process
Team members used a collaborative approach to screen alternative means for CSO control using a range of factors. The work was accomplished through a workshop on Feb. 11, 2010 and is part of the team evaluation process to identify three CSO control alternatives for further evaluation. Documenting the workshop process is a critical piece of the project.

Workshop Goals and Objectives:
1. Recommend three alternative means for CSO control for the North Beach Basin to present the public for input and to develop in more detail, with the remaining alternatives to be tabled at this time.
2. Where possible, recommend a set of alternative means that represents the range of complexity and constraints in the basin.
3. Discuss and document the reasons and rationale for recommendations.

<u>Materials Available for Workshop</u>
1. Final revised North Beach Basin Alternatives summary sheets (1 for each alternative)
2. Final revised table of selection factors ratings and descriptions of Low, Moderate, and High impact

3. Final revised Alternative Rating Sheets for North Beach Basin (summary & expanded to include description of ratings)
4. Summary of major changes to Barton, Murray, and South Magnolia Basin Alternatives and overall evaluation criteria
5. Inventory of Available Property and Property Profiles
6. Preliminary planning level cost information for comparison purposes for North Beach Basin

Workshop Approach/Agenda

1. Overview & Summary of North Beach Alternatives (Karl Hadler, Carollo Engineers)

- Presentation
- Clarifying questions

2. Initial "Straw Poll" by King County Staff

- A "Straw Poll" was conducted to generate discussion and help inform the team's recommendations. An enlarged chart of the screening factors and draft ratings for all alternatives for the North Beach basin was posted on the wall. King County staff used dot stickers to indicate the alternatives they thought should be recommended for further evaluation and those they thought should not be recommended. Most importantly, staff also wrote their thoughts on the wall charts as to why certain alternatives should or should not be recommended as well as any questions they might have.

3. Initial North Beach Alternatives Narrowing - Discussion (facilitated by Bob Wheeler, Triangle Associates)

- Identify alternatives that clearly do not merit further consideration at this time
- Identify alternatives that clearly merit further consideration at this time
- Discussion of remaining alternatives to reduce the recommended number to three
- Discussion of basis for recommendations on all alternatives

3. Presentation of Preliminary Planning Level Cost Information for Comparison Purposes ()

- Methodology for determining costs
- Review of methodology for creating comparative cost ratings
- Discussion of whether cost information changes any of the three alternatives currently identified for further evaluation

4. Team Agreement on 3 Alternative means for CSO control for Further Development (facilitated by Bob Wheeler, Triangle Associates)

- Survey of team for confidence in recommended alternatives
- Final thoughts on recommendations

Workshop Outcome

King County staff recommended the following alternative means for CSO control to be considered for further development:

- Rectangular Storage, Bottom of Basin (Alternative 1A)
- Pipe Storage in Right of Way, Bottom of Basin (Alternative 1B)
- Conveyance to 8th Ave Interceptor, Storage in Upper Basin (Alternative 1C)

Additionally, King County staff recommended investigation of the infiltration and inflow (I/I) reduction approaches included in Alternative 5A) as an adaptive management strategy for the future.

The engineering basin lead, Karl Hadler, for the North Beach Basin supported these choices.

February 17, 2010 - *Follow up Meeting*

Meeting Approach/Agenda
Several good comments on Alternative 1C (Centralized Storage Up in Basin with Conveyance to 8th Avenue Interceptor) that were made at the February 11 workshop led to the development of a variation of this alternative – Alternative 1D, Centralized Storage at the Bottom of the Basin with Conveyance to 8th Avenue Interceptor. This configuration requires a smaller pump station. It also simplifies control in the event of a peak flow event. It would cost less due to the smaller pump station and smaller force mains.

Alternative 1D was presented at the February 17 project team meeting.

Meeting Outcome
King County staff agreed that Alternative 1D should be recommended for further development in place of Alternative 1C.

Summary of Workshop Process Discussion for North Beach Basin

Considerations for all CSO Project Basins

- All new force mains must have twin force mains instead of single.

Considerations for North Beach Basin

- The project team will not consider whether an alternative would eliminate the need to upgrade existing facilities while screening the CSO control alternatives. The project team may note that certain alternatives would eliminate the need to upgrade existing facilities and that information will be provided to WTD management. Alternative 1C, 2A, and 2B would eliminate the need to upgrade existing facilities.
- Building Alternative 1A or Alternative 1B would not preclude the County from building a project to pump and convey flows directly to the 8th Ave Interceptor in the future.
- It will be important to determine how the storage facilities would be cleaned.
- Remnants of older wastewater facilities may be discovered underground at Blue Ridge Park during construction. These may need to be removed.

Considerations for North Beach Basin CSO Control Alternatives

Alternative 1A: Rectangular Storage, Bottom of Basin (Recommended for further development)

Design Engineering
No discussion. Comments related to design engineering were captured in the evaluation document for the North Beach basin CSO control alternatives.

Cost
No discussion. Comments related to cost were captured in the evaluation document.

Land Use/Permitting
No discussion. Comments related to land use/permitting were captured in the evaluation document.

Environmental
No discussion. Comments related to environmental issues were captured in the evaluation document.

Community Impact
- Construction would be required in or near Blue Ridge Park.
- Construction would be required on private property.

O&M
No discussion. Comments related to O&M were captured in the evaluation document.

Alternative 1B: Pipe Storage in Right of Way, Bottom of Basin (Recommended for further development)

Design Engineering
- This is large diameter pipe in a narrow Right of Way.

Cost
No discussion. Comments related to cost were captured in the evaluation document.

Land Use/Permitting
No discussion. Comments related to land use/permitting were captured in the evaluation document.

Environmental
No discussion. Comments related to environmental issues were captured in the evaluation document.

Community Impact
- Construction would impact traffic on NW Blue Ridge Dr. and access to about a dozen homes.

O&M
No discussion. Comments related to O&M were captured in the evaluation document.

Alternative 1C: Conveyance to 8th Ave Interceptor, Storage in Upper Basin (Recommended for further development as variation Alternative 1D)

Design Engineering

- There is a regulatory limit on the volume of flow pumped based on the average wet weather flow.
- There are two gravity lines that connect directly to the North Beach force main. The flow in those lines would have to be re-routed.

Cost

- The cost of operating a high head pump station like this would be very high compared to most pump stations.

Land Use/Permitting

No discussion. Comments related to land use/permitting were captured in the evaluation document.

Environmental

No discussion. Comments related to environmental issues were captured in the evaluation document.

Community Impact

- Construction would be required in or near Blue Ridge Park. Construction would be required on private property.
- Construction would impact traffic along the conveyance line alignment.
- Construction would occur and a permanent facility would be built in the upper basin.
- The new pump station would be a little higher above ground than the existing pump station in Blue Ridge Park.

O&M

- Two-stage pumping is challenging to operate and consumes a lot of energy.
- It would be an advantage to take flow away from Carkeek facilities.

Alternative 2A: Conveyance along Beach Alignment to Carkeek CSO Treatment Plan (Not recommended for further development)

Design Engineering

- There may not be sufficient space to site an additional treatment facility within the existing footprint at Carkeek. It may be necessary to replace the whole Carkeek treatment facility with a higher capacity treatment facility.

Cost
No discussion. Comments related to cost were captured in the evaluation document.

Land Use/Permitting
- If this alternative requires the replacement of the entire Carkeek treatment facility, the Carkeek treatment facility would be out of service for 24 – 30 months during construction. The project team would need to consult with the Department of Ecology about the feasibility of doing this.

Environmental
- Force main alignment requires construction on the beach and it crosses creek.

Community Impact
No discussion. Comments related to community impacts were captured in the evaluation document.

O&M
No discussion. Comments related to O&M were captured in the evaluation document.

Alternative 2B: Conveyance with Neighborhood Alignment to Carkeek CSO Treatment Plant
(Not recommended for further development)

Design Engineering
- There may not be sufficient space to site an additional treatment facility within the existing footprint at Carkeek. It may be necessary to replace the whole Carkeek treatment facility with a higher capacity treatment facility.
- Topography would make siting the conveyance pipeline challenging.

Cost
No discussion. Comments related to cost were captured in the evaluation document.

Land Use/Permitting
- If this alternative requires the replacement of the entire Carkeek treatment facility, the Carkeek treatment facility would be out of service for 24 – 30 months during construction. The project team would need to consult with the Department of Ecology about the feasibility of doing this.

Environmental
No discussion. Environmental comments were captured in evaluation document.

Community Impact
- Requires construction of over 1000 feet of force main through residential neighborhood.

O&M
No discussion. Comments related to O&M were captured in the evaluation document.

Alternative 3A: Bottom of Basin Treatment Facility (Not recommended for further development)

Design Engineering

- There is a cross-connection between the sewer system and a stormwater outfall in one of the subbasins. The design of this alternative needs to account for closing the stormwater outfall so it does not receive overflows from the sewer system.

Cost

No discussion. Comments related to cost were captured in the evaluation document.

Land Use/Permitting

- Treatment facility in shoreline is currently prohibited by code.

Environmental

No discussion. Comments related to environmental issues were captured in the evaluation document.

Community Impact

- Community members may object to treatment facility in residential neighborhood.
- The treatment facility is larger than the storage tank proposed in Alternative 1A for the same location. Since a storage tank is more attractive for other reasons, there does not appear to be a good reason to pursue the treatment facility.

O&M

- O&M more complicated and time-consuming for staff than storage.

Alternative 3B: Upper Basin Treatment Facility (Not recommended for further development)

Design Engineering

No discussion. Comments related to design engineering were captured in the evaluation document.

Cost

- High cost compared to other North Beach CSO control alternatives.

Land Use/Permitting

No discussion. Comments related to land use/permitting were captured in the evaluation document.

Environmental

No discussion. Comments related to environmental issues were captured in the evaluation document.

Community Impact

- Location near a school may result in community opposition, which could delay the project schedule.

O&M

- O&M more complicated and time-consuming for staff than storage.

Alternative 5A – Infiltration and Inflow (I/I) Control (Not recommended for further development)

Design Engineering

- Further investigation will be needed to determine if it would be required to build a stormwater collection system in subbasin NB03.
- Further investigation will be needed to determine where improper stormwater connections are located.
- Further investigation is needed to determine if the stormwater collection system in subbasin NB02 has sufficient capacity to take flow discussed for this alternative.
- The topography of subbasin NB03 would make it challenging to construct a stormwater collection system.
- I/I reduction removes flow and therefore reduces stress on the entire wastewater system.
- Participation by property owners would have to be sufficient to meet the CSO control requirement.

Cost

- Low cost compared to other North Beach CSO control alternatives if no stormwater collection system is required in subbasin NB03. Cost would be the high end of what was estimated for this alternative if a stormwater collection system is required in subbasin NB03.
- Cost estimates assume no cost-sharing with the City of Seattle.

Land Use/Permitting

No discussion. Comments related to land use/permitting were captured in the evaluation document.

Environmental

No discussion. Comments related to environmental issues were captured in the evaluation document.

Community Impact

- A landslide was recently repaired near subbasin NB03. Community members may prefer not to remove stormwater from the sewer system.
- Ratepayers may expect King County to minimize capital outlay. This alternative would focus instead on fixing existing infrastructure. Ratepayers might find that attractive.

- Infiltration reduction would require construction on many private properties.
- I/I reduction can lead to localized flooding and drainage problems.
- Project schedule could be considerably delayed because of need to coordinate with City of Seattle and work required on hundreds of private properties.

<u>O&M</u>
No discussion. Comments related to O&M were captured in the evaluation document.

NORTH BEACH BASIN ALTERNATIVES

CATEGORY / CRITERIA	ALTERNATIVE 1A: RECTANGULAR BOTTOM OF BASIN STORAGE WITH CONVEYANCE TO CARKEEK PUMP STATION		ALTERNATIVE 1B: PIPELINE BOTTOM OF BASIN STORAGE WITH CONVEYANCE TO CARKEEK PUMP STATION		ALTERNATIVE 1C: CENTRALIZED STORAGE UP IN BASIN WITH CONVEYANCE TO 8TH AVENUE INTERCEPTOR	
	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION
LAND USE AND PERMITTING						
1. City of Seattle Comprehensive Plan	2	Section 6.5 of the Seattle Comprehensive Plan (Utilities Element of the Planning Policies, U16) states that the City should work cooperatively with King County to identify and expeditiously address combined sewer overflows. Elsewhere in the Comp Plan (Land Use Element, Section 2.1, LU 61 & 62), uses in Single Family Residential neighborhoods should affirm and encourage residential use by one household as the principal use or should only encourage uses that are permitted outright.	3	Section 6.5 of the Seattle Comprehensive Plan (Utilities Element of the Planning Policies, U16) states that the City should work cooperatively with King County to identify and expeditiously address combined sewer overflows. Elsewhere in the Comp Plan (Land Use Element, Section 2.1, LU 61 & 62), uses in Single Family Residential neighborhoods should affirm and encourage residential use by one household as the principal use or should only encourage uses that are permitted outright. Because of the small size of the facilities, the alterantive may be consistent with the comprehensive plan.	2	Section 6.5 of the Seattle Comprehensive Plan (Utilities Element of the Planning Policies, U16) states that the City should work cooperatively with King County to identify and expeditiously address combined sewer overflows. Elsewhere in the Comp Plan (Land Use Element, Section 2.1, LU 61 & 62), uses in Single Family Residential neighborhoods should affirm and encourage residential use by one household as the principal use or should only encourage uses that are permitted outright.
2. Seattle Municipal Code (SMC/Zoning Code)	2	Located on or adjacent to existing pump station. Zoning is Single Family Residential. Utility Service Use is permitted as a City Council conditional use.	2	Located on or adjacent to existing pump station. Zoning is Single Family Residential. Utility Service Use is permitted as a City Council conditional use.	3	**Bottom of Basin Site:** Zoning is Single Family Residential. **Holman Road Site:** Zoning is Commercial. Utility Service Uses are permitted in C1-40 zones.
3. Shoreline Master Program Compatibility	2	Storage is most likely considered a "Utility Service Use". A Utility Service Use is allowed outright within the Shoreline District only if it can be demonstrated that it requires a shoreline location, although water-related uses (pump stations will likely be considered a water-related use) are preferred next in line to water-dependent uses within the Shoreline District. It may be possible to locate the storage facility outside the Shoreline District (i.e., more than 200 feet from the Puget Sound shoreline).	3	Storage is most likely outside of the shoreline zone.	2	The pump station may be within the shoreline district. Utilities would be buried underground which would only temporarily disrupt public access. Storage tank would not be within the shoreline.
4. Permitting Complexity	2	This alternative may require a Shoreline Permit. Affected roadways in residential area with regional transportation (railway) adjacent to site. Will require careful traffic planning to maintain access. Work hours likely to be restricted.	3	This alternative likely does not require a Shoreline Permit. Affected roadways in residential area with regional transportation (railway) adjacent to site. Will require careful traffic planning to maintain access. Work hours likely to be restricted.	2	This alternative may require a Shoreline Permit. Affected roadways in residential area with regional transportation (railway) adjacent to site. Will require careful traffic planning to maintain access. Work hours likely to be restricted.
5. Property Acquisition Complexity	2	Single family residential acquisition required. Concerns regarding acquisition from homeowners association. Approximately 1/2 Ac.	3	Assumes street use of 250 lineal feet for pipeline storage.	2	**Bottom of Basin Site:** Single family residential. Possible concerns regarding acquisition from homeowners association. Approximately 1/4 Ac. **Holman Road Site:** Assume purchase from City of Seattle Parks **not** required. If purchase from City of Seattle Parks Dept. required would change to 1. Approximately 1/2 Ac. **Pipeline:** Extensive street right of way required.

NORTH BEACH BASIN ALTERNATIVES

CATEGORY / CRITERIA	ALTERNATIVE 1A: RECTANGULAR BOTTOM OF BASIN STORAGE WITH CONVEYANCE TO CARKEEK PUMP STATION		ALTERNATIVE 1B: PIPELINE BOTTOM OF BASIN STORAGE WITH CONVEYANCE TO CARKEEK PUMP STATION		ALTERNATIVE 1C: CENTRALIZED STORAGE UP IN BASIN WITH CONVEYANCE TO 8TH AVENUE INTERCEPTOR	
	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION
ENVIRONMENT						
1. Cultural Resources	3	No known archaeological sites or historic resources. Based on site characteristics, the project area has a low probability of containing archaeological resources.	3	No known archaeological sites or historic resources. Based on site characteristics, the project area has a low probability of containing archaeological resources.	3	No known archaeological sites or historic resources. Based on site characteristics, the project area has a low probability of containing archaeological resources.
2. Fish and Wildlife	3	Construction and operation of this alternative would not adversely affect fish and wildlife, or their habitat.	3	Construction and operation of this alternative would not adversely affect fish and wildlife, or their habitat.	3	Construction and operation of this alternative would not affect fish and wildlife, or their habitat.
3. Wetlands, Streams and Shoreline	3	GIS maps show a piped stream crossing through the project area. This rating assumes that construction would not impact the stream or any wetlands or shoreline area.	3	GIS maps show a piped stream crossing through the project area. This rating assumes that construction would not impact the stream or any wetlands or shoreline area.	3	**Bottom of Basin Site:** GIS maps show a piped stream crossing through this project area. This rating assumes that construction would not impact the stream or any wetlands or shoreline area. **Holman Road Site:** No wetlands, streams or shoreline in this project area.
4. Soils and Sediments	3	No known contaminated sites. Project area is not within liquifaction zone. No steep slopes and/or known landslide areas. Potential landslide areas are located within project area, but it is assumed that construction of this alternative would not increase the likelihood of landslides.	3	No known contaminated sites. Project area is not within liquifaction zone. No steep slopes and/or known landslide areas. Potential landslide areas are located within project area, but it is assumed that construction of this alternative would not increase the likelihood of landslides.	2	No known contaminated sites in the vicinity of the Blue Ridge Park Site. There are known contaminated sites and potential to encounter contaminated soils in the vicinity of the storage basin site and pipeline alignment near Holman Road. Project area is not within liquifaction zone. No steep slopes and/or known landslide areas. Potential landslide areas are located within project area, but it is assumed that construction of this alternative would not increase the likelihood of landslides.
5. Water Quality	3	No new untreated discharges to surface waters.	3	No new untreated discharges to surface waters.	3	No new untreated discharges to surface waters.
TECHNICAL						
1. Technical Complexity	3	Single site. Simple approach. Gravity overflow at new control structure to gravity fill tank. Automatic cleaning and emptying after event will require telemetry and local controls. Flows exceeding tank capacity overflow at diversion structure to existing outfall.	3	Single site. Simple approach. Gravity overflow at new control structure to gravity fill tank. Automatic cleaning and emptying after event will require telemetry and local controls. Flows exceeding tank capacity overflow at diversion structure to existing outfall.	2	Two sites. More complex approach including pump station sized for baseline and peaking. Gravity overflow at new control structure pumped to fill tank. Automatic cleaning and emptying after event will require telemetry and local controls. Flows exceeding tank capacity overflow at diversion structure to existing outfall.
2. Compatibility with Existing WW system	3	Stand alone alternative. Diversion structure to tank built in collection system upstream of existing CSO control. Does not affect downstream capacity in county system.	3	Stand alone alternative. Diversion structure to tank built in collection system upstream of existing CSO control. Does not affect downstream capacity in county system.	3	Stand alone alternative. Diversion structure to pump station built in collection system upstream of existing CSO control. Re-directs flow now going to Carkeek Pump Station. Potential impact at 3rd Street NW CSO and other downstream facilities needs to be evaluated.
3. Flexibility/Adaptive Management	2	Storage tank not easily modified for enlargement.	2	Storage tank not easily modified for enlargement.	1	Storage tank and pump station not easily modified for enlargement.
4. Constructability/ Implementation Schedule	2	Risks associated with shoring, groundwater and limited space. Very limited staging and access area due to residential area. Alternative can likely meet the construction schedule.	2	Risks associated with shoring, groundwater and limited space. Very limited staging and access area due to residential area. Alternative can likely meet the construction schedule.	2	Risks associated with shoring, groundwater and limited space for pump station. Limited staging and access area due to residential area. Storage site provides more flexibility but still provides challenges. Alternative can likely meet the construction schedule.

NORTH BEACH BASIN ALTERNATIVES

CATEGORY / CRITERIA	ALTERNATIVE 1A: RECTANGULAR BOTTOM OF BASIN STORAGE WITH CONVEYANCE TO CARKEEK PUMP STATION		ALTERNATIVE 1B: PIPELINE BOTTOM OF BASIN STORAGE WITH CONVEYANCE TO CARKEEK PUMP STATION		ALTERNATIVE 1C: CENTRALIZED STORAGE UP IN BASIN WITH CONVEYANCE TO 8TH AVENUE INTERCEPTOR	
	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION
O&M						
1. Staffing	3	Facility can be automatically started (gravity overflow) and run autonomously under design conditions. Minimal staffing required for operation and shut down. Some staffing/supervision may needed for cleaning. Facility should not impact downstream facilities.	3	Facility can be automatically started (gravity overflow) and run autonomously under design conditions. Minimal staffing required for operation and shut down. Some staffing/supervision may needed for cleaning. Facility should not impact downstream facilities.	2	Facility can be automatically started and run autonomously under design conditions. However, facility will be started using monitoring and telemetry. This may require operator response to ensure proper startup and operation of the facility. Some staffing/supervision may needed for cleaning. Facility should not impact downstream facilities.
2. Training	3	Staff familiar with storage facilities. Similar control approaches to other facilities within the system can be specified for consistency.	3	Staff familiar with storage facilities. Similar control approaches to other facilities within the system can be specified for consistency.	3	Staff familiar with pump stations and storage facilities. Similar control approaches to other facilities within the system can be specified for consistency.
3. Reliability	3	System is not complex. Gravity diversion over a weir. Power not critical for ability to store peak flows. Storage is a proven technology for controlling peak flow events.	3	System is not complex. Gravity diversion over a weir. Power not critical for ability to store peak flows. Storage is a proven technology for controlling peak flow events.	2	A pump station is required to actively divert flows to a storage tank during a peak event. Power is critical for operation of telemetry & monitoring equipment. Storage is a proven technology for controlling peak flow events.
4. Maintenance	3	Alternative requires little maintenances. Minimal telemetry/controls to maintain (typical level sensing and pump system controls). Assumes no entry to storage.	3	Alternative requires little maintenances. Minimal telemetry/controls to maintain (typical level sensing and pump system controls). Assumes no entry to storage.	2	Alternative requires more maintenance due to need for a two-stage pump station. More complex telemetry/controls than bottom of the basin alternatives. Assumes no entry to storage.
5. Safety	3	No street access required. No traffic control procedures required. No street use/closure permit required.	2	No street access required typical operations. Infrequent maintenance issues will require traffic control procedures and street use/closure permit.	3	No street access required. No traffic control procedures required. No street use/closure permit required.
COST EFFECTIVENESS						
1. Project Capital Costs	3	Relative Cost = 1.0	3	Relative Cost = 1.0	1	Relative Cost = 4.4 Potential benefit of avoided future costs since this eliminates the need for the existing North Beach Pump Station and Force Main.
2. Life Cycle Costs						
3. Cost Variability/Risk	3	Variability Ratio = 1.13	3	Variability Ratio = 1.01	3	Variability Ratio = 1.37
Note: Project Capital Costs for North Beach Alternatives range from a low $7.3M to a high of $63.3M						
COMMUNITY IMPACT						
1. Location	1	Alternative requires acquisition of private property. Facility can be designed to be consistent with community's vision of itself; however permanent above ground facilities will be visible to numerous homes. Some permanent loss of park use area may occur.	3	Pipeline in street is not visible. Ancillary facilites located within existing North Beach Pump Station site. Design will need to address concerns about light, noise, or odor control. Acquisition of private property is not required for this alternative. Does not address PS/FM upgrade project.	1	**Bottom of Basin Site:** Siting will require acquisition of private property. Facility will be visible from numerous properties uphill of the site. Design will need to address concerns about light, noise, or odor control. **Holman Road Site:** Site is currently privately owned. Site is visible but can be designed to be compatible with the surrounding commercial area.
2. Potential Community Impacts	2	Use will require frequent visits by O&M and potential heavy equipment access, primarily following a peak flow event. Assuming portion of Blue Ridge Park can be restored to park activities, some O&M activites may conflict with site uses and adjacent facilities requiring close coordination between O&M and the community.	2	Use will require frequent visits by O&M and potential heavy equipment access, primarily following a peak flow event. Pipeline storage in the right of way may require street closures.	3	Use will require frequent visits by O&M and potential heavy equipment access, primarily following a peak flow event. However, this will be at the Holman Road Site which is a commercial area. Operations at the bottom of the basin would be comparable to existing. Project eliminates need for a second project to upgrade existing infrastructure.
3. Construction Impacts	1	Siting will affect adjacent properties during construction Construction staging may require acquisition of additional single family residential property. Construction will create noise, dust and construction traffic impacts on local traffic and neighboring residences. Work hour and noise restrictions may impact the construction duration. It may be difficult to mitigate impacts through standard construction methods. Blue Ridge Park will be inaccessible during construction.	1	Siting will affect adjacent properties during construction. Construction staging may require acquisition of additional single family residential property. Construction will create noise, dust and construction traffic impacts on local traffic and neighboring residences. Work hour and noise restrictions may impact the construction duration. It may be difficult to mitigate impacts through standard construction methods. Blue Ridge Park will have limited access during construction.	1	Construction will create noise, dust and construction traffic impacts on local traffic and neighboring residences. Work hour and noise restrictions may impact the construction duration. It may be difficult to mitigate impacts through standard construction methods. Limited private property required at the bottom of the basin. Siting will affect adjacent properties during construction. Construction impacts various areas of the basin due to pipeline construction and facilities at two sites.

NORTH BEACH BASIN ALTERNATIVES

CATEGORY / CRITERIA	ALTERNATIVE 1D: CENTRALIZED STORAGE AT BOTTOM OF BASIN WITH CONVEYANCE TO 8TH AVENUE INTERCEPTOR		ALTERNATIVE 2A: CONVEYANCE TO CARKEEK CSO TREATMENT PLANT WITH BEACH ALIGNMENT		ALTERNATIVE 2B: CONVEYANCE TO CARKEEK CSO TREATMENT PLANT WITH NEIGHBORHOOD ALIGNMENT	
	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION
LAND USE AND PERMITTING						
1. City of Seattle Comprehensive Plan	2	Section 6.5 of the Seattle Comprehensive Plan (Utilities Element of the Planning Policies, U16) states that the City should work cooperatively with King County to identify and expeditiously address combined sewer overflows. Elsewhere in the Comp Plan (Land Use Element, Section 2.1, LU 61 & 62), uses in Single Family Residential neighborhoods should affirm and encourage residential use by one household as the principal use or should only encourage uses that are permitted outright.	2	Section 6.5 of the Seattle Comprehensive Plan (Utilities Element of the Planning Policies, U16) states that the City should work cooperatively with King County to identify and expeditiously address combined sewer overflows. Elsewhere in the Comp Plan (Land Use Element, Section 2.1, LU 61 & 62), uses in Single Family Residential neighborhoods should affirm and encourage residential use by one household as the principal use or should only encourage uses that are permitted outright. Location will require review for consistency with City parks policies.	2	Section 6.5 of the Seattle Comprehensive Plan (Utilities Element of the Planning Policies, U16) states that the City should work cooperatively with King County to identify and expeditiously address combined sewer overflows. Elsewhere in the Comp Plan (Land Use Element, Section 2.1, LU 61 & 62), uses in Single Family Residential neighborhoods should affirm and encourage residential use by one household as the principal use or should only encourage uses that are permitted outright. Location will require review for consistency with City parks policies.
2. Seattle Municipal Code (SMC/Zoning Code)	2	**Bottom of Basin Site:** Located on or adjacent to existing pump station. Zoning is Single Family Residential. Utility Service Use is permitted as a City Council conditional use. **Holman Road Site:** Zoning is Commercial. Utility Service Uses are permitted in C1-40 zones.	1	**Bottom of Basin Site:** Zoning is Single Family Residential. **Carkeek Park Site:** Zoning is Single Family. Expansion of an existing sewage treatment plant is permitted under strict provisions in the Land Use Code, requiring a City Council finding of no feasible alternative locations. **Pipeline:** On a Puget Sound Beach. Rating of 1 (red) is for permitting a pipeline on the beach, plus expanding STP in Carkeek Park.	2	**Bottom of Basin Site:** Zoning is Single Family Residential. **Carkeek Park Site:** Zoning is Single Family Residential. Expansion of an existing sewage treatment plant is permitted under strict provisions in the Land Use Code, requiring a City Council finding of no feasible alternative locations. **Pipeline:** In the public right-of-way.
3. Shoreline Master Program Compatibility	2	The pump station and storage tank may be within the shoreline district. Storage is most likely considered a "Utility Service Use". A Utility Service Use is allowed outright within the Shoreline District only if it can be demonstrated that it requires a shoreline location, although water-related uses (pump stations will likely be considered a water-related use) are preferred next in line to water-dependent uses within the Shoreline District. It may be possible to locate the storage facility outside the Shoreline District (i.e., more than 200 feet from the Puget Sound shoreline).	1	The pump station may require a shoreline permit. Treatment Facility would be within existing Carkeek Facility footprint. The Pipeline would be within the public beach. Utilities would be primarily buried underground which would only temporarily disrupt public access. Rating of 1 (red) is for permitting a pipeline on the beach.	2	The pump station may require a shoreline permit. Treatment Facility would be within existing Carkeek Facility footprint. The Pipeline would be within public right-of-way. Utilities would be primarily buried underground which would only temporarily disrupt public access.
4. Permitting Complexity	2	This alternative may require a Shoreline Permit. Affected roadways in residential area with regional transportation (railway) adjacent to site. Will require careful traffic planning to maintain access. Work hours likely to be restricted.	1	**Bottom of Basin Site:** Pump station may require shoreline substantial development permit. If so, Utility Service Uses are permitted in shoreline district only if they require a shorteline location. Shoreline permit is appealable to State Shorelines Hearings Board. Seattle ECA review, land use review, possible Shorelines permit. Special inspections may be required due to shoring and water control. Stormwater control will be complex due to likelihood of groundwater. **Carkeek Park Site: Treatment plant expansion would be required.** Permits to construct/upgrade facilities on existing County site require City Council approval and finding of no feasible alternative location. **Pipeline:** Marine access will add federal and state permits in addition to local permits. This could add up to a year or more to the schedule.	1	**Bottom of Basin Site:** may require shoreline permit. If so, Utility Service Uses are permitted in shoreline district only if they require a shorteline location. Shoreline permit is appealable to State Shorelines Hearings Board. **Carkeek Park Site:** Treatment plant expansion would be required. Permits to construct/upgrade facilities on existing County site require City Council approval and finding of no feasible alternative location. Seattle ECA review (environmentally critical areas) will be required. **Pipeline:** Pipeline within road right-of-way. Rating of 1 (red) for STP expansion in Carkeek Park - less complex than Alternative 2A because no beach pipeline.
5. Property Acquisition Complexity	2	**Bottom of Basin Site:** Single family residential. Possible concerns regarding acquisition from homeowners association. Approximately 1/2 Ac. **Holman Road Site:** Assume purchase from City of Seattle Parks **not** required. If purchase from City of Seattle Parks Dept. required would change to 1. Approximately 1/4 Ac. **Pipeline:** Extensive street right of way required.	2	**Bottom of Basin Site:** Single family residential. Possible concerns regarding acquisition from homeowners association. Approximately 1/2 Ac. **Carkeek Park Site:** Site owned by King County. **Pipeline:** Assumed within existing County easement.	2	**Blue Ridge Park Site:** Single family residential. Possible concerns regarding acquisition from homeowners association. Approximately 1/2 Ac. **Carkeek Park Site:** Site owned by King County. **Pipeline:** Extensive street right of way required.

NORTH BEACH BASIN ALTERNATIVES

CATEGORY / CRITERIA	ALTERNATIVE 1D: CENTRALIZED STORAGE AT BOTTOM OF BASIN WITH CONVEYANCE TO 8TH AVENUE INTERCEPTOR		ALTERNATIVE 2A: CONVEYANCE TO CARKEEK CSO TREATMENT PLANT WITH BEACH ALIGNMENT		ALTERNATIVE 2B: CONVEYANCE TO CARKEEK CSO TREATMENT PLANT WITH NEIGHBORHOOD ALIGNMENT	
	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION
ENVIRONMENT						
1. Cultural Resources	3	No known archaeological sites or historic resources. Based on site characteristics, the project area has a low probability of containing archaeological resources.	2	**NBPS Site:** No known archaeological sites or historic resources. Based on site characteristics, the project area has a low probability of containing archaeological resources. **FM Alignment & CSTP Sites:** Piper's Creek is identified as an ethnologic site. Based on site characteristics, the mouth of Piper's Creek and the CSTP area have a medium probability of containing archaeological resources. The Piper homestead orchard and garden are maintained in Carkeek Park, but it is assumed that they would not be affected by construction or operation of this alternative.	2	**NBPS Site:** No known archaeological sites or historic resources. Based on site characteristics, the project area has a low probability of containing archaeological resources. **FM Alignment & CSTP Site:** Piper's Creek is identified as an ethnologic site. Based on site characteristics, the CSTP area has a medium probability of containing archaeological resources. The Piper homestead orchard and garden are maintained in Carkeek Park, but it is assumed that they would not be affected by construction or operation of this alternative.
2. Fish and Wildlife	3	Construction and operation of this alternative would not affect fish and wildlife, or their habitat.	1	Construction of the forcemain along the Puget Sound beach and Piper's Creek alignments would likely adversely affect fish and wildlife and/or their habitat. Piper's Creek is a salmon-bearing stream and the lower portion of the creek is identified as a Priority Habitat and Species (PHS) area. Operation of this alternative would not adversely affect fish and wildlife, or their habitat.	2	Construction of the new treatment facility next to Piper's Creek in Carkeek Park may adversely affect fish and wildlife and/or their habitat. Piper's Creek is a salmon-bearing stream. Operation of this alternative would not adversely affect fish and wildlife, or their habitat.
3. Wetlands, Streams and Shoreline	3	**Bottom of Basin Site:** GIS maps show a piped stream crossing through this project area. This rating assumes that construction would not impact the stream or any wetlands or shoreline area. **Holman Road Site:** No wetlands, streams or shoreline in this project area.	1	**Bottom of Basin Site:** GIS maps show a piped stream crossing through this project area. It is assumed that construction would not impact the stream or any wetlands or shoreline area. **FM Alignment:** It is likely that construction of the forcemain along the Puget Sound beach and Piper's Creek alignments would directly impact shoreline, wetlands and Piper's Creek. **CSTP Site:** Construction of the treatment facility at Carkeek Park could affect the Piper's Creek stream buffer.	2	**Bottom of Basin Site:** GIS maps show a piped stream crossing through this project area. It is assumed that construction would not impact the stream or any wetlands or shoreline area. **FM Alignment & CSTP Site:** It is likely that construction of the forcemain and/or new treatment facility would directly impact the Piper's Creek stream buffer.
4. Soils and Sediments	2	No known contaminated sites in the vicinity of the Blue Ridge Park Site. There are known contaminated sites and potential to encounter contaminated soils in the vicinity of the drop structure and odor control facility site and pipeline alignment near Holman Road. Project area is not within liquifaction zone. No steep slopes and/or known landslide areas. Potential landslide areas are located within project area, but it is assumed that construction of this alternative would not increase the likelihood of landslides.	2	No known contaminated sites and pipeline alignment is in beach and Piper's Creek corridor where contaminated soils are not expected. No steep slopes and/or known landslide areas at Blue Ridge Park Site or along beach alignment. The pipeline alignment between the beach and the CSTP Site contains steep slopes and potential landslide areas.	3	No known contaminated sites and pipeline alignment is in a mostly residential area where contaminated soils are not expected. Project area is not within liquifaction zone. No steep slopes and/or known landslide areas at Blue Ridge Park Site and pipeline construction in not expected to increase the likelihood of landslides.
5. Water Quality	3	No new untreated discharges to surface waters.	3	No new untreated discharges to surface waters.	3	No new untreated discharges to surface waters.
TECHNICAL						
1. Technical Complexity	3	Primary facilites on single site. Simplified control approach with pump station sized for baseline flows only with gravity overflow to storage. Automatic cleaning and emptying after event will require telemetry and local controls. Flows exceeding tank capacity overflow at diversion structure to existing outfall.	1	Two sites. Complex approach with treatment facility required at Carkeek. Gravity overflow at new control structure pumped to treatment facility. Treatment facility can run automatically but coagulation/flocculation/sedimentation/disinfection processes are critical to meeting effluent limits. Flows exceeding tank capacity overflow at diversion structure to existing outfall.	1	Two sites. Complex approach with treatment facility required at Carkeek. Gravity overflow at new control structure pumped to treatment facility. Treatment facility can run automatically but coagulation/flocculation/sedimentation/disinfection processes are critical to meeting effluent limits. Flows exceeding tank capacity overflow at diversion structure to existing outfall.
2. Compatibility with Existing WW system	3	Stand alone alternative. Diversion structure to pump station built in collection system upstream of existing CSO control. Re-directs flow now going to Carkeek Pump Station. Potential impact at 3rd Street NW CSO and other downstream facilities needs to be evaluated.	2	Diversion structure to pump station built in collection system upstream of existing CSO control. Carkeek wet weather facility capacity would need to be increased to handle flows.	2	Diversion structure to pump station built in collection system upstream of existing CSO control. Carkeek wet weather facility capacity would need to be increased to handle flows.
3. Flexibility/Adaptive Management	1	Storage tank and pump station not easily modified for enlargement.	2	Treatment facility provides flexibility in peak flow treatment with limited space required to add significant additional capacity. The pump station would also require modification.	2	Treatment facility provides flexibility in peak flow treatment and limited space required to add significant additional capacity. The pump station would also require modification.
4. Constructability/ Implementation Schedule	2	Risks associated with shoring, groundwater and limited space for pump station and storage facility. Limited staging and access area due to residential area. Alternative can likely meet the construction schedule.	1	Risks associated with shoring, groundwater and limited space for pump station. Limited staging and access area due to residential area. Treatment facility site at Carkeek provides challenges due to remote location and uses surrounding site. Beach alignment of pipeline will provide additional construction challenges. Alternative can likely meet the construction schedule.	1	Risks associated with shoring, groundwater and limited space for pump station. Limited staging and access area due to residential area. Treatment facility site at Carkeek provides challenges due to remote location and uses surrounding site. Neighborhood alignment of pipeline will provide additional construction challenges. Alternative can likely meet the construction schedule.

NORTH BEACH BASIN ALTERNATIVES

CATEGORY / CRITERIA	ALTERNATIVE 1D: CENTRALIZED STORAGE AT BOTTOM OF BASIN WITH CONVEYANCE TO 8TH AVENUE INTERCEPTOR		ALTERNATIVE 2A: CONVEYANCE TO CARKEEK CSO TREATMENT PLANT WITH BEACH ALIGNMENT		ALTERNATIVE 2B: CONVEYANCE TO CARKEEK CSO TREATMENT PLANT WITH NEIGHBORHOOD ALIGNMENT	
	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION
O&M						
1. Staffing	3	Facility can be automatically started (gravity overflow) and run autonomously under design conditions. Minimal staffing required for operation and shut down. Some staffing/supervision may needed for cleaning. Facility should not impact downstream facilities.	1	Facility can be automatically started and run autonomously under design conditions. However, the treatment facility at Carkeek will likely require operator response to ensure proper startup and operation of the facility. Staffing/supervision will be needed for cleaning. Facility should not impact downstream facilities.	1	Facility can be automatically started and run autonomously under design conditions. However, the treatment facility at Carkeek will likely require operator response to ensure proper startup and operation of the facility. Staffing/supervision will be needed for cleaning. Facility should not impact downstream facilities.
2. Training	3	Staff familiar with pump stations and storage facilities. Similar control approaches to other facilities within the system can be specified for consistency.	1	Staff familiar with pump stations. Similar control approaches to other facilities within the system can be specified for consistency. However, County does not currently operate a high rate clarification facility. New control approaches and training procedures will need to be developed.	1	Staff familiar with pump stations. Similar control approaches to other facilities within the system can be specified for consistency. However, County does not currently operate a high rate clarification facility. New control approaches and training procedures will need to be developed.
3. Reliability	3	System is not complex. Gravity diversion over a weir. Power not critical for ability to store peak flows. Storage is a proven technology for controlling peak flow events.	2	A pump station is required to actively divert flows during a peak event. Power is critical for operation of telemetry & monitoring equipment. High rate clarification is a proven technology for treating peak flow events, however it is mechanically intensive which may impact the reliability.	2	A pump station is required to actively divert flows during a peak event. Power is critical for operation of telemetry & monitoring equipment. High rate clarification is a proven technology for treating peak flow events, however it is mechanically intensive which may impact the reliability.
4. Maintenance	2	Alternative requires more maintenance due to need for a two-stage pump station. Assumes no entry to storage.	1	Alternative requires significant maintenance for pump station and high rate clarification facility. More complex telemetry/controls including pump station monitors, flow meters, chemical metering systems, flocculation/sedimentation and disinfection facilities.	1	Alternative requires significant maintenance for pump station and high rate clarification facility. More complex telemetry/controls including pump station monitors, flow meters, chemical metering systems, flocculation/sedimentation and disinfection facilities.
5. Safety	3	No street access required. No traffic control procedures required. No street use/closure permit required.	3	No street access required. No traffic control procedures required. No street use/closure permit required.	3	No street access required. No traffic control procedures required. No street use/closure permit required.
COST EFFECTIVENESS						
1. Project Capital Costs	2	Relative Cost = 3.4 Potential benefit of avoided future costs since this eliminates the need for the existing North Beach Pump Station and Force Main.	1	Relative Cost = 6.0 Potential benefit of avoided future costs since this eliminates the need for the existing North Beach Pump Station and Force Main.	1	Relative Cost = 6.8 Potential benefit of avoided future costs since this eliminates the need for the existing North Beach Pump Station and Force Main.
2. Life Cycle Costs						
3. Cost Variability/Risk	3	Variability Ratio = 1.47	3	Variability Ratio = 1.04	3	Variability Ratio = 1.41
Note: Project Capital Costs						
COMMUNITY IMPACT						
1. Location	1	**Bottom of Basin Site:** Siting will require acquisition of private property. Facility will be visible from numerous properties uphill of the site. Design will need to address concerns about light, noise, or odor control. **Holman Road Site:** Site is currently privately owned. Site is visible but can be designed to be compatible with the surrounding commercial area.	1	**Bottom of Basin Site:** Siting will require acquisition of private property. Facility will be visible from numerous properties uphill of the site. Design will need to address concerns about light, noise, or odor control. **Carkeek Park Site:** Siting at Carkeek is not compatible with community's understanding of what Carkeek TP is scoped to do, and who it is supposed to serve. Additional effluent, even treated, from the Carkeek site may cause environmental concerns. Facility will be visible from numerous properties uphill of the site. Design will need to address concerns about light, noise, or odor control.	1	Alternative may be inconsistent with community's vision of itself with limited opportunity to address issues during design. Siting requires use of private property. Pump station facility will be visible from numerous properties uphill of the site . There will be significant concern about light, noise, or odor control that may exceed county design standards. Community and Parks may be concerned about potential expansion of facilities at Carkeek, and additional outfalls or effluent.
2. Potential Community Impacts	2	Use will require frequent visits by O&M and potential heavy equipment access, primarily following a peak flow event. Assuming portion of Blue Ridge Park can be restored to park activities, some O&M activites may conflict with site uses and adjacent facilities requiring close coordination between O&M and the community. Project eliminates need for a second project to upgrade existing infrastructure.	3	O&M work efforts will generally be infrequent, similar to existing pump station O&M efforts at North Beach and Carkeek. Project planning may need to address limited impacts to park use.	3	O&M work efforts will generally be infrequent, similar to existing pump station O&M efforts at both North Beach and Carkeek.
3. Construction Impacts	1	Construction staging may require acquisition of additional single family residential property. Construction will create noise, dust and construction traffic impacts on local traffic and neighboring residences. Work hour and noise restrictions may impact the construction duration. It may be difficult to mitigate impacts through standard construction methods. Limited private property required at the bottom of the basin. Siting will affect adjacent properties during construction. Construction impacts various areas of the basin due to pipeline construction and facilities at two sites. Blue Ridge Park will be inaccessible during construction.	1	Construction will create noise, dust and construction traffic impacts on local traffic and neighboring residences. Impacts may be difficult to mitigate using standard methods. Work hour and noise restrictions may impact the construction duration. Access and use of Blue Ridge Park will be limited.Beach alignment of pipeline will impact recreational users during construction.	1	Construction will create noise, dust and construction traffic impacts on local traffic and neighboring residences. Impacts may be difficult to mitigate using standard methods. Work hour and noise restrictions may impact the construction duration. Access and use of Blue Ridge Park will be limited during construction. This alternative would also affect additional residents living outside of the basin.

NORTH BEACH BASIN ALTERNATIVES

CATEGORY / CRITERIA	ALTERNATIVE 3A: BOTTOM OF BASIN TREATMENT FACILITY		ALTERNATIVE 3B: CENTRALIZED TREATMENT FACILITY UP IN BASIN		ALTERNATIVE 5A: I/I CONTROL	
	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION
LAND USE AND PERMITTING						
1. City of Seattle Comprehensive Plan	1	Seattle's Land Use Element of the Comprehensive Plan promotes public health and environmental quality (LU G3, for example). Many Land Use policies stress compatibility with neighboring uses, and discourage non-residential uses in residential zones except for those uses necessary to the functioning of residential areas (LU 12). This type of balancing will support some necessary wastewater facilities in residential zones. However, there is a strong emphasis on compatibility of function, character, and scale for non-residential uses. Establishing a new sewage treatment plant along the Puget Sound shoreline may run counter to many of these policies.	1	Seattle's Land Use Element of the Comprehensive Plan promotes public health and environmental quality (LU G3, for example). Many Land Use policies stress compatibility with neighboring uses, and discourage non-residential uses in residential zones except for those uses necessary to the functioning of residential areas (LU 12). This type of balancing will support some necessary wastewater facilities in residential zones. However, there is a strong emphasis on compatibility of function, character, and scale for non-residential uses. Establishing a new sewage treatment plant in a residential zone may run counter to many of these policies.	2	Section 6.5 of the Seattle Comprehensive Plan (Utilities Element of the Planning Policies, U16) states that the City should work cooperatively with King County to identify and expeditiously address combined sewer overflows for which the County maintains responsibility. The Comp Plan places much emphasis on sustainable solutions and restoration of natural drainages.
2. Seattle Municipal Code (SMC/Zoning Code)	1	Zoning is Single Family Residential. The establishment of new sewage treatment plants is prohibited in SFR zones (SMC 23.44.036.E.4).	1	**Blue Ridge Park Site:** Zoning is Single Family Residential. **North Beach Elementary Site:** Zoning is Single Family Residential. Establishing a new sewage treatment plant in a SF zone is prohibited by the land use code.	2	May be consistent with the Seattle Municipal Code.
3. Shoreline Master Program Compatibility	1	New treatment plants are not allowed in Shoreline District	2	The pump station may require a shoreline permit. Treatment Facility would not be within Shoreline District. The Pipeline would be within road right-of-way.	3	N/A - Not within Shoreline District.
4. Permitting Complexity	1	This alternative will require a Shoreline Permit for a prohibited use. Affected roadways in residential area with regional transportation (railway) adjacent to site. Will require careful traffic planning to maintain access. Work hours likely to be restricted. The large size of facility and associated construction impacts (temporary) may be considered a "high impact' use by the City.	1	This alternative may require a Shoreline Permit. Affected roadways in residential area with regional transportation (railway) adjacent to site. Will require careful traffic planning to maintain access. Work hours likely to be restricted. Approval will require a permit for a currently prohibited use in a single family zone (in the upper basin, possibly at the site of an elementary school).	2	ROW permits required. Water quality treatment issues may increase permitting complexity. Affected roadways have moderate traffic volume in residential and neighborhood commercial land uses. Will require careful traffic planning to maintain access. Work hours may be restricted. Permit review likely to be complex.
5. Property Acquisition Complexity	2	**Bottom of Basin Site:** Single family residential. Possible concerns regarding acquisition from homeowners association. Approximately 1/2 Ac.	1	**Bottom of Basin Site:** Single family residential. Possible concerns regarding acquisition from homeowners association. Approximately 1/2 Ac. **North Beach Elementary Site: Zoned commercial.** Purchase from Seattle School District. Approximately 1/2 Ac.	2	Street use permits, may require rights of entry for property disconnection. May require property acquisition for stormwater treatment facilities.

NORTH BEACH BASIN ALTERNATIVES

CATEGORY / CRITERIA	ALTERNATIVE 3A: BOTTOM OF BASIN TREATMENT FACILITY		ALTERNATIVE 3B: CENTRALIZED TREATMENT FACILITY UP IN BASIN		ALTERNATIVE 5A: I/I CONTROL	
	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION
ENVIRONMENT						
1. Cultural Resources	3	No known archaeological sites or historic resources. Based on site characteristics, the project area has a low probability of containing archaeological resources.	3	No known archaeological sites or historic resources. Based on site characteristics, the project area has a low probability of containing archaeological resources.	3	No known cultural resources.
2. Fish and Wildlife	3	Construction and operation of this alternative would not adversely affect fish and wildlife, or their habitat.	3	Construction and operation of this alternative would not affect fish and wildlife, or their habitat.	2	Construction of this alternative would not adversely affect fish and wildlife, or their habitat. Operation could have adverse effects on fish and wildlife if treatment was not required for stormwater discharges.
3. Wetlands, Streams and Shoreline	2	GIS maps show a piped stream crossing through the project area. This piped stream would likely have to be moved to construct this alternative. This alternative would not impact wetlands or shoreline areas.	3	**Bottom of Basin Site:** GIS maps show a piped stream crossing through this project area. It is assumed that construction would not impact the stream or any wetlands or shoreline area. **North Beach Elementary Site:** No wetlands, streams or shoreline in this project area.		need more information
4. Soils and Sediments	3	No known contaminated sites. Project area is not within liquifaction zone. No steep slopes and/or known landslide areas. Potential landslide areas are located within project area, but it is assumed that construction of this alternative would not increase the likelihood of landslides.	3	No known contaminated sites and pipeline alignment is in a mostly residential area where contaminated soils are not expected. Project area is not within liquifaction zone. No steep slopes and/or known landslide areas. Potential landslide areas are located within project area, but it is assumed that construction of this alternative would not increase the likelihood of landslides.		need more information
5. Water Quality	3	No new untreated discharges to surface waters.	3	No new untreated discharges to surface waters.	1	This assumes stormwater treatment is not required. If stormwater treatment is required, rating would change from 1 to 3.
TECHNICAL						
1. Technical Complexity	1	One site. Complex approach with treatment facility required. Gravity overflow at new control structure to treatment facility. Treatment facility can run automatically but coagulation/flocculation/sedimentation/disinfection processes are critical to meeting effluent limits. Flows exceeding tank capacity overflow at diversion structure to existing outfall.	1	Two sites. Complex approach with treatment facility required up in basin. Gravity overflow at new control structure pumped to treatment facility. Treatment facility can run automatically but coagulation/flocculation/sedimentation/disinfection processes are critical to meeting effluent limits. Flows exceeding tank capacity overflow at diversion structure to existing outfall.	2	Simple approach, however effectiveness to meet CSO control objectives is largely unknown until implemented.
2. Compatibility with Existing WW system	3	Stand alone alternative. Diversion structure to treatment facility built in collection system upstream of existing CSO control. Does not affect downstream capacity in county system.	3	Stand alone alternative. Diversion structure to treatment facility built in collection system upstream of existing CSO control. Does not affect downstream capacity in county system.	3	Upgrades existing infrastructure by removing excess infiltration in side sewers as the initial target.
3. Flexibility/Adaptive Management	3	Treatment facility provides flexibility in peak flow treatment with limited space required to add significant additional capacity.	2	Treatment facility provides flexibility in peak flow treatment and limited space required to add significant additional capacity. The pump station would also require modification.	3	Ability to adapt by increasing number of disconnections and side sewer repairs subject to capacity of stormwater system.
4. Constructability/ Implementation Schedule	1	Significant risks associated with shoring, groundwater and limited space for treatment facility. Limited staging and access area due to residential area. Alternative can likely meet the construction schedule.	2	Risks associated with shoring, groundwater and limited space for the pump station and treatment facility. Limited staging and access area due to residential area. Alternative can likely meet the construction schedule.	2	Unknown if approach can meet schedule. Low probability of groundwater effects if disconnected flow goes directly to stormwater system. Side sewer repair requires cooperation of homeowners. Number of disconnects can only be estimated. Both factors increases risk for compliance, but work could be implemented relatively soon.

NORTH BEACH BASIN ALTERNATIVES

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	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION
O&M						
1. Staffing	1	Facility can be automatically started and run autonomously under design conditions. However, the treatment facility will likely require operator response to ensure proper startup and operation of the facility. Staffing/supervision will be needed for cleaning. Facility should not impact downstream facilities.	1	Facility can be automatically started and run autonomously under design conditions. However, the treatment facility will likely require operator response to ensure proper startup and operation of the facility. Staffing/supervision will be needed for cleaning. Facility should not impact downstream facilities.	3	No operator attention required
2. Training	1	County does not currently operate a high rate clarification facility. New control approaches and training procedures will need to be developed.	1	Staff familiar with pump stations. Similar control approaches to other facilities within the system can be specified for consistency. However, County does not currently operate a high rate clarification facility. New control approaches and training procedures will need to be developed.	3	There are numerous stormwater conveyance and treatment facilities throughout the area.
3. Reliability	2	High rate clarification is a proven technology for treating peak flow events, however it is mechanically intensive which may impact the reliability. Power is critical for operation of telemetry & monitoring equipment.	2	A pump station is required to actively divert flows during a peak event. Power is critical for operation of telemetry & monitoring equipment. High rate clarification is a proven technology for treating peak flow events, however it is mechanically intensive which may impact the reliability.	3	System is not complex assuming no stormwater treatment. Gravity stormwater and treatment system. Peak flow reduction, when effectively implemented, is a proven technology for controlling peak flow events.
4. Maintenance	1	Alternative requires significant maintenance for high rate clarification facility. More complex telemetry/controls including flow meters, chemical metering systems, flocculation/sedimentation and disinfection facilities.	1	Alternative requires significant maintenance for pump station and high rate clarification facility. More complex telemetry/controls including pump station monitors, flow meters, chemical metering systems, flocculation/sedimentation and disinfection facilities.	3	Minimal maintenance compared to other alternatives assuming no stormwater treatment. Typical stormwater piping and treatment system maintenace.
5. Safety	3	No street access required. No traffic control procedures required. No street use/closure permit required.	3	No street access required. No traffic control procedures required. No street use/closure permit required.	3	Maintenance of storm sewers will require manhole access in streets.
COST EFFECTIVENESS						
1. Project Capital Costs	2	Relative Cost = 3.5	1	Relative Cost = 5.3	2/3	Relative Cost = 1.1 to 2.6
2. Life Cycle Costs						
3. Cost Variability/Risk	3	Variability Ratio = 1.04	3	Variability Ratio = 1.11	2	Variability Ratio = 2.98
Note: Project Capital Cost						
COMMUNITY IMPACT						
1. Location	1	Facility type is inconsistent with community's vision of itself. Siting will affect adjacent properties during construction and require acquisition of private property. Construction staging may require acquisition of additional single family residential property. Facility will be visible from numerous properties uphill of the site . Design will have to address noise, light, and odor concerns.	1	**Bottom of the basin:** Siting will require acquisition of private property. Facility will be visible from numerous properties uphill of the site . Design will need to address concerns about light, noise, or odor control that may exceed county design standards. **North Beach Elementary Site:** Proposed location is adjacent to a school playground and proximal to residences and may be viewed as inconsistent with community's vision of itself.	3	Will affect numerous homes throughout the basin to have a significant reduction in CSO flows but impact will be minimal and not visible, noisy or have lighting issues after construction. If stormwater treatment facilities are required, the rating of this alternative may change to a "1" to account for siting new above ground facilities that are inconsistent with the community's vision of itself.
2. Potential Community Impacts	1	O&M work efforts will be more involved than storage or pumping otions, including staff during a peak flow event and additional routine maintenance. Treatment option will also require chemical delivery and storage. Treatment facilities will require security fencing and significant screening efforts. Some O&M activites may require close coordination between O&M and the community.	1	O&M work efforts will be more involved than storage or pumping otions, including staff during a peak flow event and additional routine maintenance. Treatment option will also require chemical delivery and storage in a location adjacent to residences and a school. Treatment facilities will require security fencing and significant screening efforts. Some O&M activites may require close coordination between O&M and the community.	2	Design will need to address concerns about increased surface water in the area. If stormwater conveyance systems and treatment are required, the additional infrastructure required would change this rating to a "1".
3. Construction Impacts	1	Construction will create noise, dust and construction traffic impacts on local traffic and neighboring residences. Work hour and noise restrictions may impact the construction duration. During construction, there will be no park access. Additional property will be required for staging.	1	Construction will create noise, dust and construction traffic impacts on local traffic and neighboring residences. Work hour and noise restrictions may impact the construction duration. Access and use of Blue Ridge Park may be limited during construction. Special safety procedures may be required due to construction adjacent to school.	2	Construction may be carried out on private property and in streets; however, duration in any area is expected to be limited. If stormwater conveyance systems and treatment are required, construction impacts may change in rating to a "1".

North Beach Scoring Alternatives Workshop 505-3

August 4, 2010
King Street Center

Summary of Discussion

Attendance

King County		*Consultant*	*SPU*
Betsy Cooper	John Phillips	Ellen Blair	None
Hien Dung	Kevin Schock	Jennifer Corrigan	
Pam Erstad	Linda Sullivan	Karl Hadler	
Ron Kohler	Bob Swarner	Brian Matson	
Kathy Mathena	Martha Tuttle	Lloyd Skinner	
Tiffany McClaskey	Jim Weber	Alan Foster	
Sue Meyer	Monica Van der Vieren		
Shahrzad Namini	Karl Zimmer		
Chris Okuda			

Purpose of Summary
This document provides a summary of the workshop process and captures the discussion themes that support the project team's recommendation of a CSO control alternative to be forwarded for review by internal King County Wastewater Treatment Division (WTD) management. Internal management will propose a CSO control alternative to be carried forward to environmental review.

Workshop Process
Team members used a collaborative approach to review three alternative means for CSO control using a range of factors. Documenting the workshop process is a critical piece of the project.

<u>Workshop Goals and Objectives:</u>
1. Recommend one alternative for CSO control for the North Beach Basin to develop it in more detail and carry forward to environmental review, with remaining alternatives tabled at this time.
2. Discuss and document the reasons and rationale for the recommendation.

<u>Materials Available at the Workshop</u>
1. Project alternatives aerial photos and facility diagrams handout
2. Final revised alternatives rating sheets for North Beach (including description of ratings reflecting updates by category leads)
3. Project memo describing the history of alternative development, evaluation and screening
4. Cost information
5. Summary of Contents of Alternatives Development Documentation Binder

An enlarged chart of the selection factors and ratings for all alternatives for the North Beach Basin was posted on the wall along with a graph of the ratings for each alternative.

Workshop Agenda
Introduction
- Project updates for other Basins

North Beach Update
- Development of Alternatives

Presentations
- Efforts since narrowing Workshop
- Community Input from North Beach
- Changes to the evaluation criteria
- Evaluation Matrix results
- Cost estimates
- Interpretation of information
- Basin recommendation

Team Discussion
- Team efforts
- Community input
- Evaluation Criteria
- Evaluation Matrix Results
- Cost Estimate
- Interpretation of Results

Note: This section of the agenda was for the project team to discuss and provide input on the alternatives and hear responses to questions and comments. If team members wished to change the interpretation outcome and the Basin Lead's recommendation, the scoring on the evaluation matrix had to be changed.

- Truth Test – Do we have the right scoring for the alternatives?
- Confirm and add reasons and rationale for scoring

Workshop Outcome
King County staff agreed to recommend that Alternative 1B (Pipeline Bottom of Basin Storage) be forwarded for review by internal management.

Summary of Workshop Process and Discussion for North Beach Basin

General Considerations for North Beach Basin
- The project team changed the score of the "Permitting Complexity" criterion in the "Land Use and Permitting" criteria category from 2 to 1 for Alternatives 1A and 1D. This was based on the need for a code amendment or rezone to build the project in the shoreline conservancy zone.

- The evaluation matrix showed Alternative 1B with the most green scores (least impact) and the fewest red scores (most impact) compared to Alternative 1A and Alternative 1D.
- For any facilities in a park, WTD will endeavor to place all facilities underground, including odor control and electrical facilities. However, it must be feasible to access and maintain the facilities.
- O&M recommends CSO Beach projects set two different drain pump sizes to allow pump assets to be utilized across numerous facilities. This would include one small size for up to 4 pumps per facility and one large size for up to 4 pumps per facility. Designers choose proper size. O&M also requests unified WTD specifications for equipment commonality across all CSO projects.

Considerations for North Beach Basin CSO Control Alternatives

Alternative 1A: Rectangular Bottom of Basin Storage (Not recommended for further review)

Design Engineering
No discussion. Comments related to design engineering were captured in the evaluation document.

Cost
No discussion. Comments related to cost were captured in the evaluation document.

Land Use/Permitting
- Requires code amendment or rezone to build project in a shoreline conservancy zone.

Environmental
No discussion. Comments related to environmental issues were captured in the evaluation document.

Community Impact
No discussion. Comments related to community impact were captured in the evaluation document.

O&M
No discussion. Comments related to O&M were captured in the evaluation document.

Alternative 1B: Pipeline Bottom of Basin Storage (Recommended for further review)

Design Engineering
No discussion. Comments related to design engineering were captured in the evaluation document.

Cost
No discussion. Comments related to cost were captured in the evaluation document.

Land Use/Permitting

- Requires access agreement with SDOT for operations and maintenance.

Environmental

No discussion. Comments related to environmental issues were captured in the evaluation document.

Community Impact

- A substantial majority of comments received from residents in the basin expressed a strong preference for Alternative 1B. Residents have indicated an awareness that this alternative will have community impacts during construction and operations.
- It appears feasible to site the odor control facility adjacent to the existing North Beach Pump Station. Siting it below-grade, adjacent to existing facilities would minimize the visual impact.

O&M

- O&M concerns and requirements must be prioritized during the design phase to ensure that staff can access the facilities safely for operation and maintenance necessary to achieve the ultimate goal of CSO control in the basin. If the O&M design needs are not met, the alternative chosen may not meet O&M ability to operate effectively.
- O&M prefer at-grade access for these required facilities for lower life cycle for maintaining the facilities.
- Safe, off-road access for O&M staff is necessary or it will be necessary to close the street and use a traffic control team to access the facilities.
- Street closures will be required for long term maintenance of the storage tank. This will be needed due to the boom truck, vactor truck, flatbed, compressors etc. necessary to enter a below grade confined space.
- Intermediate hatches will be required. Hatch access further than 150' is problematic in securing a fire department entry agreement.
- If safe O&M access requires the removal of private property encroachment in the public right of way, this work must be addressed at the start of the project so as not to impede O&M access when it is needed. If this right of way impingement is not removed by this project, O&M will not have ability to enter the facility safely.

Alternative 1D: Centralized Bottom of Basin Storage with Conveyance to 8th Avenue Interceptor
(Not recommended for further review)

Design Engineering

No discussion. Comments related to design engineering were captured in the evaluation document.

Cost

No discussion. Comments related to cost were captured in the evaluation document.

Land Use/Permitting

- Requires code amendment or rezone to build project in a shoreline conservancy zone.

Environmental

No discussion. Comments related to environmental issues were captured in the evaluation document.

Community Impact

- It is likely cost prohibitive to locate the pump station underground.
- Above ground facilities, especially in Blue Ridge Park, would be strongly opposed.

O&M

No discussion. Comments related to O&M were captured in the evaluation document.

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TECHNICAL MEMORANDUM

Project Name:	BMMNB Beaches CSO Projects	**Date:**	October 8, 2010
Client:	King County DNRP, Wastewater Treatment Division	**Project Number:**	7562A.10
Prepared By:	Karl Hadler		
Reviewed By:	Brian Matson		
Subject:	North Beach Alternatives Update Information – Basis of Alternatives		
Distribution:	King County, Project Team		

1.0 INTRODUCTION AND BACKGROUND

This project memorandum (PM) presents updated alternatives information for the three North Beach Basin alternatives being considered to meet the CSO control objective.

The alternatives being considered are:

- Alternative 1A – A buried, rectangular concrete storage tank located adjacent to the existing county North Beach Pump Station within Blue Ridge Park. The storage tank volume is approximately 0.23 million gallons (MG) and would require a below grade odor control and electrical support facility because it assumed to be within Blue Ridge Park.
- Alternative 1B – A buried, storage pipeline located adjacent to the existing county North Beach Pump Station within the public right-of-way (Triton Drive NW and NW Blue Ridge Drive). The storage tank volume is approximately 0.23 MG and would require an odor control and electrical support facility on county property adjacent to the North Beach Pump Station.
- Alternative 1D – A buried, rectangular concrete storage tank located adjacent to the existing county North Beach Pump Station within Blue Ridge Park. The storage tank volume is approximately 0.15 MG.In addition, this alternative includes a 3.5 million gallon per day (mgd) high head pump station and above grade odor control and electrical support facility adjacent to the storage tank. This pump station would replace the existing North Beach Pump Station and convey base flows through two small-diameter (~8-inch) force mains, drop structure and gravity sewer (~12-inch) to the 8th Avenue Interceptor.

A data summary table follows on the next page.

Table 1 – North Beach Basin Alternatives Data Summary

	Alternative 1A	**Alternative 1B**	**Alternative 1D**
Type of Vessel, Dims., ft.	Buried, Rectangular Tank, 85 x 40 x 15	Buried, Pipeline Storage, 12 (diameter) x 325	Buried, Rectangular Tank 55 x 40 x 15 High Head PS 85 x 35 x 35 (15 above grade)
# Internal Channels	2	1	2
Sewer, Dia, in./length, ft/ construction	N/A	N/A	2@8/ 5,000 LF/Cut and Cover 12/ 3,000 LF/Cut and Cover
Excavation Limits to Shoring, L x W x H (depth), ft	90 x 50 x 35	335 x 25 x 25	65 x 50 x 40 High Head PS 60 x 40 x 30
Diversion Control Structure Dims L x W x H (depth), ft	N/A	10 x 10 x 10	N/A
Odor Control/ Electrical Footprint, L x W x H (height),ft	40 x 20 x 15	40 x 20 x 15	35 x 35 x 15 Attached to High Head Pump Station
Drop Structure Dims L x W x H (depth), ft	N/A	N/A	20 x 15 x 5
Land acquisition, SF	10,000	N/A	18,000
Construction Limits, Staging, SF	20,000	20,000 (in addition to 60-ft TCE along storage pipeline)	20,000
Street Use	N/A	See Property Acquisition Plan	See Property Acquisition Plan
Capital Cost(1), $	$8,800,000	$8,400,000	$27,400,000
Land(1), $	$600,000	$400,000	$785,000
Street Use(1), $	N/A	$350,000	$480,000
Notes: 1. In 2010 dollars.			

2.0 BASIS OF OPERATION

All alternatives operate in a similar manner by diverting combined sewage flow exceeding the capacity of either the North Beach Pump Station (3.0 mgd for Alternative 1A and 1B) or new high-head pump station (3.5 mgd for Alternative 1D) into a storage vessel.

2.1 Existing CSO Control

The existing North Beach Pump Station wet well includes an overflow weir (Elevation 122.83) to divert flows in excess of the pump station capacity. The combined overflows then enter a 15-inch overflow pipeline and are conveyed approximately 1,000 feet into Puget Sound.

A secondary overflow point exists at a manhole upstream of the North Beach Pump Station. The overflow weir is at approximately Elevation 124.89 and connects to a 30-inch storm drain pipe that discharges north of the railroad right-of-way.

2.2 Modified CSO Control

The CSO control philosophy for each of the three alternatives varies slightly. Modified CSO control for each alternative is discussed in further detail below.

2.2.1 Alternative 1A

The 15-inch overflow line will be routed from the North Beach Pump Station to the upstream end of the storage tank. Any flows during a peak wet weather event that exceed the capacity of the pump station (approximately 3.0 mgd) will overtop the weir at the North Beach Pump Station and flow to the storage tank via the outfall line. Once the capacity of the storage tank has been reached, flow will overtop the outfall weir (approximate elevation 123.00) in the storage tank and flow back to the existing 15-inch outfall line. See Figure 1 for a schematic of the flow control for Alternative 1A.

2.2.2 Alternative 1B

Flow to the North Beach Pump Station will be routed through a new diversion structure. During wet weather events, the water level in the wet well of the pump station will back-up and overflow the weir (approximate elevation 123.00) at the diversion structure. A new 15-inch overflow pipeline will run from the diversion structure to the head of the 12-foot diameter storage pipeline. When the maximum water surface elevation (approximately 121.00) is reached in the storage pipe, the rising water level will overtop the existing outfall weirs to Puget Sound. See Figure 2 for a schematic of the flow control for Alternative 1B.

2.2.3 Alternative 1D

Alternative 1D includes construction of a new 3.5 mgd high-head pump station. Flow will be routed directly from the collection system via the existing 18-inch line to the wet well of the new pump station. Flows exceeding 3.5 mgd will overtop the first weir (approximate elevation 120.00) in the wet well. Flows will be conveyed via a short pipeline to the underground storage tank. When the level in the tank reaches its maximum water surface elevation, flow in the wet well will overtop the overflow weir (approximate elevation 118.00). The overflow will flow by gravity to the existing outfall and Puget Sound. See Figure 3 for a schematic of the flow control for Alternative 1D.

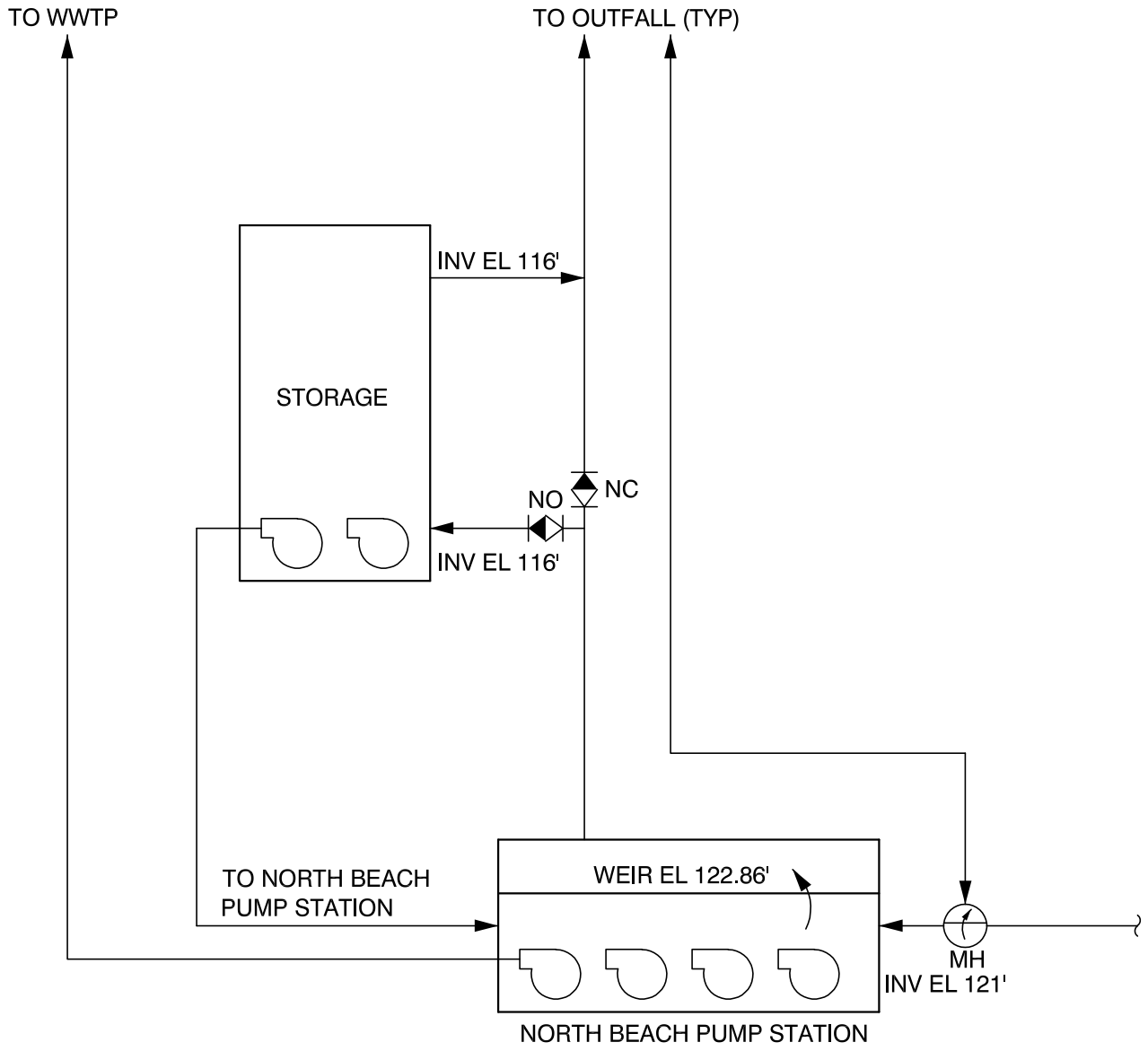


FIGURE 1
ALTERNATIVE 1A
OPERATING SCHEMATIC
KING COUNTY DEPARTMENT OF
NATURAL RESOURCES & PARKS

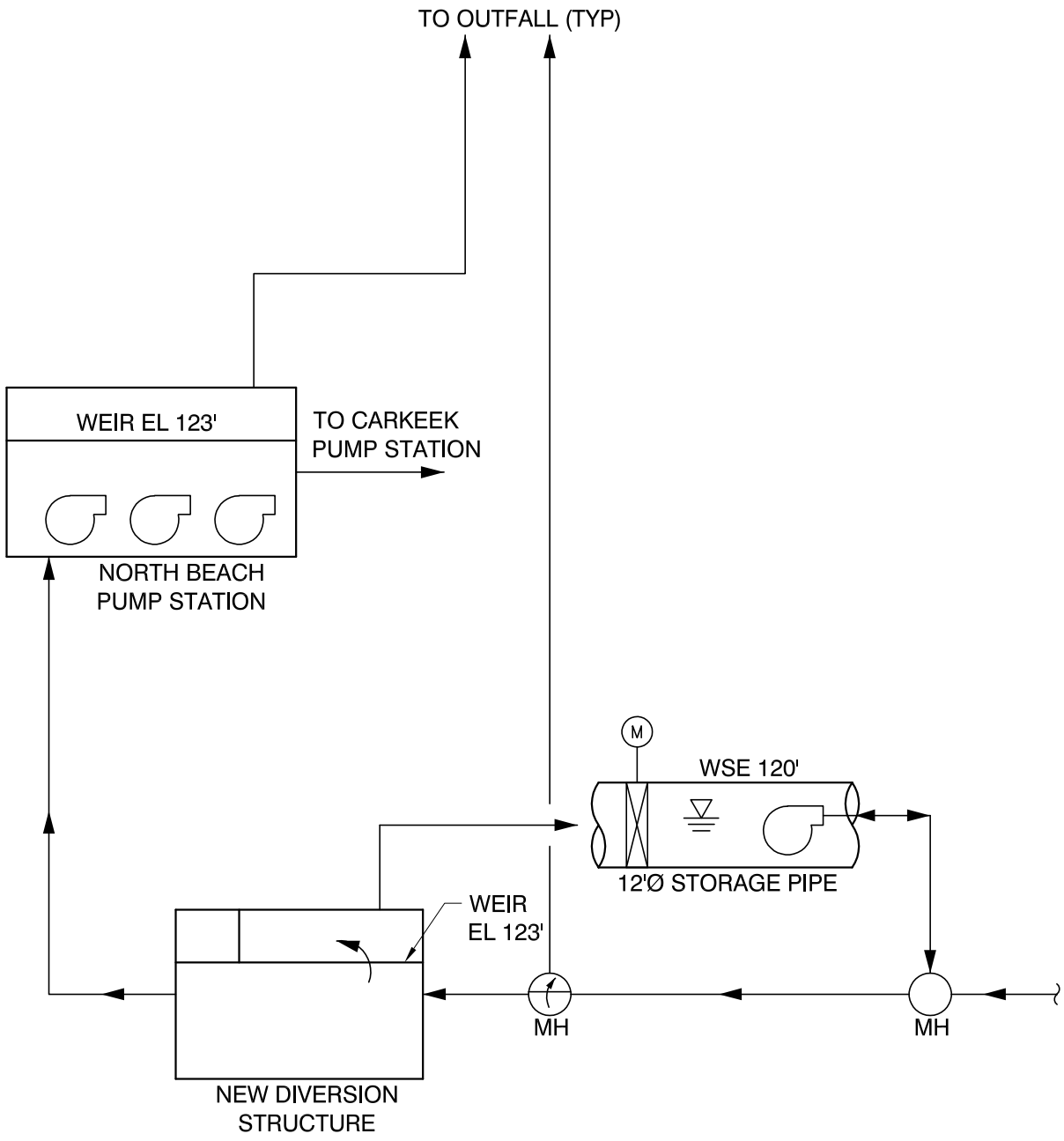


FIGURE 2
ALTERNATIVE 1B
OPERATING SCHEMATIC
KING COUNTY DEPARTMENT OF
NATURAL RESOURCES & PARKS

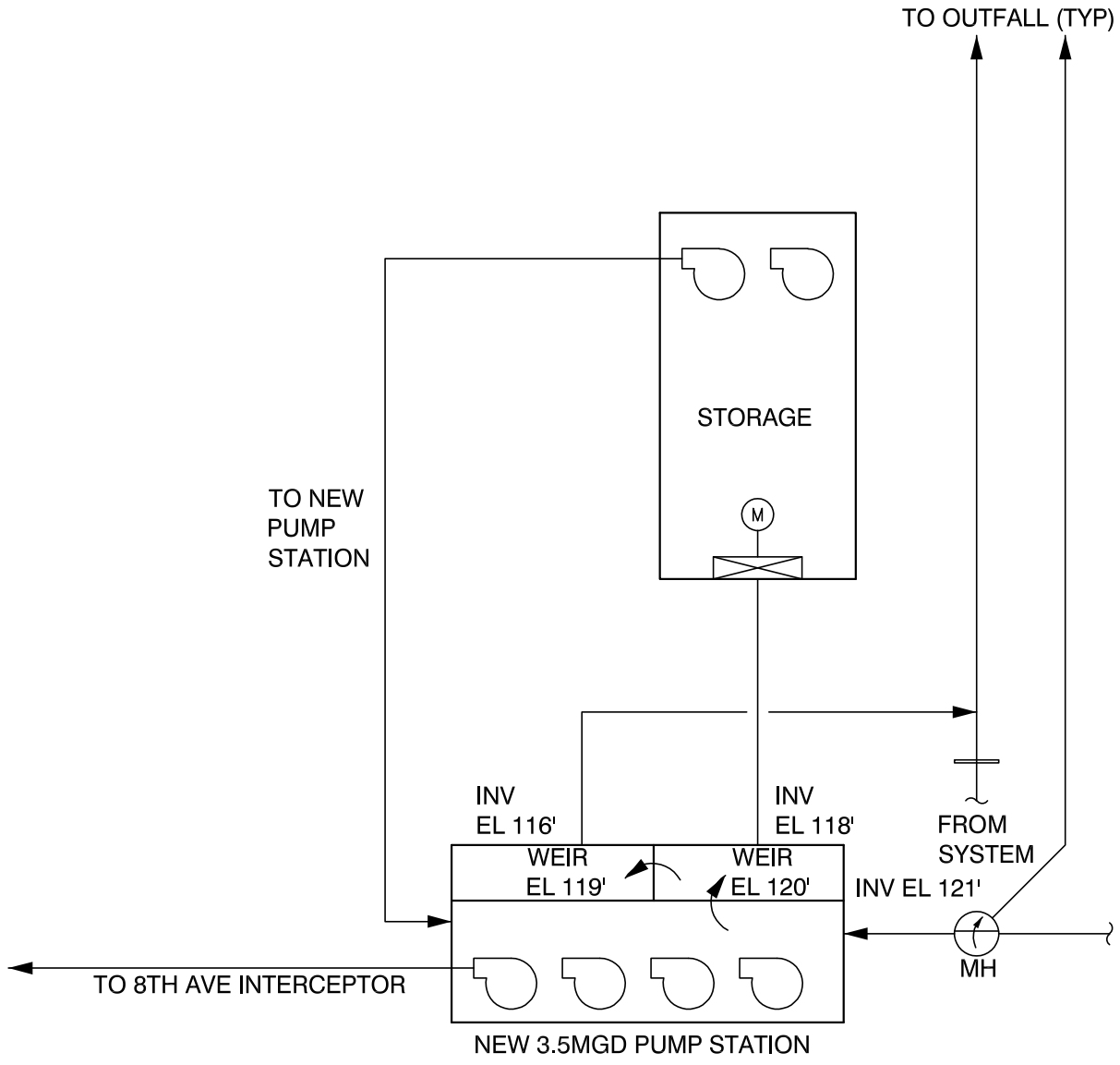


FIGURE 3
ALTERNATIVE 1D
OPERATING SCHEMATIC
KING COUNTY DEPARTMENT OF
NATURAL RESOURCES & PARKS

2.3 Storage Vessel Inlet Control

As described in Section 2.2, overtopping of the storage vessel will be prevented with an overflow weir connecting back into the existing 15-inch overflow line. For Alternative 1A, the overflow weir is located inside of the new storage tank. For Alternative 1B, the overflow occurs at a new diversion structure. For Alternative 1D, the overflow weir is located in the wet well of the new pump station.

2.4 Control Narrative

Flows directed to the storage vessels will be conveyed by gravity flow in all alternatives. A telemetry system is required to report ready status of all valves/gates and vessel emptying pumps, odor control, and electrical systems. All valves/gates are assumed to be motorized.

2.4.1 Filling

- Storage vessels in ready status. Diversion control valves are set in the proper position (Alternative 1A) or gates are open (Alternative 1B and Alternative 1D) and tank drainage pumps are verified ready by the telemetry and control system.
- Flows reach the capacity of the North Beach Pump Station (3.0 mgd for Alternative 1A and 1B) or the new high-head pump station (3.5 mgd for Alternative 1D) at approximately elevation 123.00 (Metro datum).
- Rising flow enters the 15-inch overflow pipeline (Alternative 1A), new pipeline from the diversion structure (Alternative 1B), or pipeline from the new pump station (Alternative 1D) and are diverted to the storage vessel.
- When the storage vessel reaches the maximum water level, continued flows overtop the storage vessel overflow weir (Alternative 1A), overflow weir at the diversion structure (Alternative 1B), or overflow weir at the wet well of the new headworks (Alternative 1D) and are directed to the 15-inch overflow. The objective is to prevent pressurization of the storage vessel.
- The odor control system will operate throughout the CSO event.
- Tank level will be continuously monitored.

2.4.2 Draining

- It is anticipated that flow from the either the North Beach Pump Station (Alternative 1A and Alternative 1B) or the new 3.5 mgd high-head pump station (Alternative 1D) and level in the respective wet wells will be monitored to control draining of the storage vessel.
- When flows drop below the capacity of the North Beach Pump Station or new high-head pump station and the level in the wet wells has dropped below the overflow weir (flow and level to be determined), the storage tank drain pumps will be activated to convey combined sewage flows back to the pump station wet wells.

- The maximum pumping rate will be approximately 0.5 mgd (320 gpm) to drain the storage vessel in a maximum of 12 hours.

2.4.3 Storage Vessel Cleaning Cycle

- The odor control system will shut down and air inlets will allow air to enter the storage vessel at the start of the cleaning cycle.
- The storage vessel flushing cycle will begin once the vessel is drained. Flushing and discharging vessel contents will be pumped, at a rate not exceeding 0.5 mgd, to the North Beach Pump Station wet well (Alternative 1A and Alternative 1B) or the new high-head pump station wet well (Alternative 1D).
- When the tanks are drained, the flushing pumps will cease operation and the system will be returned to a ready status.

3.0 DESCRIPTION OF ALTERNATIVES

Alternatives are described below. See Appendix 1 for plans, sections, and haul routes for these alternatives.

3.1 Alternative 1A – Rectangular Bottom of the Basin Storage

A buried, rectangular concrete storage tank, located adjacent to the existing county North Beach Pump Station on Triton Drive NW, provides approximately 0.23 MG of combined sewage storage volume. Below grade odor control and electrical facilities are included. To isolate the tank for maintenance, manual valves will be placed on the 15-inch line to the storage tank and on the 15-inch outfall line ahead of the tank overflow connection.

Construction comprises the following major elements:

- Construction Limits. An area of approximately 120 by 80 feet is identified as the construction limit.
- Access and Staging. Access will be primarily from Triton Drive NW and NW Blue Ridge Drive via NW Neptune Place and 24th Avenue NW. During construction, staging area in addition to the North Beach Pump Station property will be required. Construction access will be via NW Neptune Place.
- Residential Access. It is anticipated that this alternative will not significantly impact residential access and parking except for current access to Blue Ridge Park.
- Excavation and Shoring. This alternative includes excavation of approximately 6,000 cubic yards (CY) of material to facilitate construction. Temporary slope stabilization and protection will be required to maintain the integrity of the construction site. Shoring will be required for the storage tank, extending from the surface to approximately elevation 132 (Metro datum), about 35 feet in depth. The extent of shoring will be approximately 90 by 50 feet. Shoring will likely be removed after construction.

- Tank construction. Tank construction will be cast in place concrete, approximately 1,700 CY, supported most likely on a gravel pad. Approximate top and bottom elevations will be determined by hydraulic conditions. For purposes of this alternative, a storage vessel invert at approximately Elevation 107 (Metro datum) has been assumed. Ancillary tank equipment includes flushing gates and channel gates, mechanically or electrically operated, and submersible drainage pumps.
- Truck Hauling. Hauling of excavated soil away from the site, and hauling of materials to the site will be required for construction. Approximately 1,100 one way truck trips will be required for excavation hauling and delivery of concrete only. Most of these truck trips will occur in the first 6 months of construction and taper off over the following months during a total construction duration of approximately 12 months. The number of trips will be dependent on contractor planning and sequencing.
- Ancillary Facilities. Ancillary facilities include odor control and electrical equipment, as well as site paving and fencing. The odor control and electrical facility are planned to be a below grade structure, approximately 40 by 20 feet in plan. The structure would be approximately 15 feet deep. Odor control will include ventilation fans and activated carbon for use during wet weather events in which the storage tank is used. Odor control will not be activated unless the tank is in filling or draining mode. Site paving and fencing will enclose an operations and access area of about 7,200 square feet (SF) around the tank. Some additional area on top of the tank may also be paved as required by final design decisions.

3.2 Alternative 1B – Bottom of Basin Pipeline Storage

A buried, pipeline storage tank, located in Triton Drive NW and NW Blue Ridge Drive public right-of-way provides approximately 0.23 MG of combined sewage storage volume. Odor control and electrical facilities are included on the existing North Beach Pump Station property. These ancillary components are assumed to be below grade if feasible. A gate in the influent structure of the storage pipeline will be provided for isolation of the tank for maintenance.

Construction comprises the following major elements:

- Construction Limits. An area of approximately 40 by 20 feet on existing county property will be required for an odor control and electrical support facility. An area of approximately 325 by 25 feet has been identified as the construction limit for the underground storage tank. Construction of the storage vessel in public right-of-way would require a temporary 40 to 60-foot wide easement for the entire length of the tank during construction. Exact limits will be established during final design.
- Access and Staging. Access will be primarily from Triton Drive NW and NW Blue Ridge Drive via NW Neptune Place and 24th Avenue NW. During construction, staging area in addition to the North Beach Pump Station property will be required. Construction access will be via NW Neptune Place.

- Residential Access. It is anticipated that this alternative will impact residential access and parking. The final location of the storage vessel and construction sequencing will need to be refined to provide access to homeowners and emergency vehicles. The conceptual plan shown in Appendix 1 shows the approximate location of the storage vessel. Based on preliminary layout, the access for 3 residences on the north side and 3 residences on the south side of NW Blue Ridge Drive will need to be addressed.
- Excavation and Shoring. This alternative includes a large linear excavation in flat ground near Puget Sound for construction of 325 linear feet (LF) of 12-foot diameter reinforced concrete pipe. Approximately 7,000 CY of material will be removed to facilitate construction. Temporary slope stabilization and protection will be required to maintain the integrity of the construction site. Shoring will be required for the storage vessel, extending from the surface of the site to approximately elevation 108 (Metro datum) or about 25 feet in depth. Additional, shallower shoring will be needed for the smaller diameter sewers at either end of the storage vessel. The extent of shoring is approximately 335 by 25 feet in NW Blue Ridge Drive.
- Storage Vessel Construction. The storage vessel comprises approximately 325 LF of 12-foot diameter reinforced concrete pipe. Approximate top and bottom elevations will be determined by hydraulic requirements. For purposes of this alternative, a storage vessel invert at approximately Elevation 110 (Metro datum) has been assumed. Ancillary tank equipment includes flushing gates, mechanically or electrically operated, and submersible drainage pumps. The tank drain pipe will be approximately 6-inches in diameter and installed using cut and cover methods to the local collection system.
- Truck Hauling. Hauling of excavated soil away from the site, and hauling of materials to the site will be required for construction. Approximately 600 one way truck trips will be required for excavation hauling and delivery of concrete only. Most of these truck trips will occur in the first 6 months of construction and taper off over the following months during a total construction duration of 12 months. The number of trips will be dependent on contractor planning and sequencing.
- Ancillary Facilities. Ancillary facilities include odor control and electrical equipment, diversion structure, as well as site paving. The odor control and electrical facility is approximately 40 by 20 feet in plan. The structure would be approximately 15 feet high. Odor control will include ventilation fans and carbon for use during wet weather events in which the storage tank is used. The diversion structure will incorporate two weirs to divert flow to either the storage vessel or the outfall. During normal operation (flows less than 3.0 mgd), flows would pass through the structure to the North Beach Pump Station. Site paving will facilitate access to the odor control and electrical equipment on the existing North Beach Pump Station property.

3.3 Alternative 1D – Pump Station with Conveyance to 8th Avenue Interceptor and Rectangular Bottom of Basin Storage

A buried, rectangular concrete storage tank, located adjacent to a new county pump station on Triton Drive NW, provides approximately 0.15 MG of combined sewage storage volume. The new 3.5 mgd pump station would replace the existing North Beach Pump Station and convey base wastewater flows through two 8-inch diameter force mains to a drop structure at the top of the basin. The drop structure would provide a transition from the force mains to a 12-inch gravity sewer that conveys the flows to the 8th Avenue Interceptor. The drop structure includes odor control equipment. Odor control and electrical facilities are also included within the new pump station for the facilities at the bottom of the basin. In order to allow for isolation of the storage vessel for maintenance, a gate will be included on the influent pipeline to the tank.

Construction comprises the following major elements:

- Construction Limits. An area of approximately 90 by 90 feet is identified as the construction limit at the bottom of the basin. The construction limit of the drop structure and odor control facility is approximately 30 by 25 feet.
- Access and Staging. Access will be primarily from Triton Drive NW and NW Blue Ridge Drive via NW Neptune Place and 24th Avenue NW. During construction, staging area in addition to the North Beach Pump Station property will be required. Construction access will be via NW Neptune Place.
- Residential Access. It is anticipated that this alternative will not significantly impact residential access and parking except for current access to Blue Ridge Park.
- Excavation and Shoring. This alternative includes excavation of approximately 7,000 CY of material to facilitate construction. Temporary slope stabilization and protection will be required to maintain the integrity of the construction site. Shoring will be required for the storage tank and pump station. Shoring for the storage tank will extend from the surface to approximately Elevation 98 (Metro datum), about 40 feet in depth. Shoring for the pump station will extend from the surface to approximately Elevation 110 (Metro Datum), about 30 feet in depth. The shoring will comprise an area of approximately 5,000 SF. Shoring will likely be removed after construction.
- Tank and pump station construction. Construction for the tank as well as the wet well and pump room of the 3.5 mgd pump station will be cast in place concrete. The storage tank will require approximately 1,300 CY, supported most likely on a gravel pad. The wet well and pump room of the pump station will require approximately 600 CY, also supported by a gravel pad. Approximate top and bottom elevations will be determined by hydraulic conditions. For purposes of this alternative, a bottom slab elevation at approximately Elevation 103 (Metro datum) has been assumed for the storage tank. The pump station is assumed to include two-stage, dry-pit centrifugal pumps with variable frequency drives and ancillary equipment including utility water, odor control, electrical infrastructure, HVAC equipment and standby power. Based on preliminary hydraulic analysis, the approximate bottom of the wet well and pump room will be Elevation 110. Ancillary tank equipment

includes flushing gates and channel gates, mechanically or electrically operated, and submersible drainage pumps.

- Truck Hauling. Hauling of excavated soil away from the site, and hauling of materials to the site will be required for construction. Approximately 1,300 one way truck trips will be required for excavation hauling and delivery of concrete only. Most of these truck trips will occur in the first 12 months of construction and taper off over the following months during a total construction duration of 18 months. The number of trips will be dependent on contractor planning and sequencing.
- Ancillary Facilities. Ancillary facilities would be located within the pump station which is approximately 60 by 50 feet in plan. The pump station would be approximately one-story above grade as allowed by code. In addition, the facility requires site paving and fencing. Odor control will include ventilation fans and carbon vessels. The odor control equipment will operate continuously to support the pump station and storage tank during wet weather. Site paving and fencing will enclose an operations and access area of about 4,500 SF around the tank. Some additional area on top of the tank may also be paved as required by final design decisions.

3.4 Other Technical Considerations

3.4.1 Alternative 1A

Additional Alternative 1A technical considerations include:

- The capacity of the existing 15-inch outfall to handle combined sewer overflows in the future needs to be assessed.
- Potential locations for construction staging need to be examined and the county needs to determine if they will acquire a temporary construction easement (TCE) or require the contractor to obtain a TCE during construction.
- The anticipated useful life of the existing North Beach Pump Station and force main needs to be considered.

3.4.2 Alternative 1B

Additional Alternative 1B technical considerations include:

- The capacity of the existing 15-inch outfall to handle combined sewer overflows in the future needs to be assessed.
- Potential locations for construction staging need to be examined and the county needs to determine if they will acquire a TCE or require the contractor to obtain a TCE during construction.
- The anticipated useful life of the existing North Beach Pump Station and force main needs to be considered.

3.4.3 Alternative 1D

Additional Alternative 1D technical considerations include:

- The capacity of the existing 15-inch outfall to handle combined sewer overflows in the future needs to be assessed.
- Potential locations for construction staging need to be examined and the county needs to determine if they will acquire a TCE or require the contractor to obtain a TCE during construction.
- Increased operation and maintenance costs due to high-head, two-stage pumping should be carefully assessed for life cycle costing.
- Modifications to accommodate gravity sewers that are directly connected to the North Beach Force Main are required and should be assessed.
- Modification of Carkeek Pump Station operation would need to be addressed during final design and construction to prevent impacts on downstream facilities.

4.0 COST ESTIMATES

Appendix 2 contains the construction cost estimate as of the date of this memorandum.

5.0 ALTERNATIVE EVALUATIONS

Appendix 3 includes the evaluation criteria and evaluation matrix for the three alternatives under consideration.

Appendix 3 also contains the risk assessments developed by the project team in July 2010.

APPENDIX 1 – Alternative Graphics

- Alternative 1A
- Alternative 1B
- Alternative 1D

North Beach Alternative 1A: Rectangular Bottom of the Basin Storage

Project Elements:

- 0.23 MG underground storage tank
- Underground pumping equipment to drain stored flows
- Underground odor control and electrical facilities

Benefits:

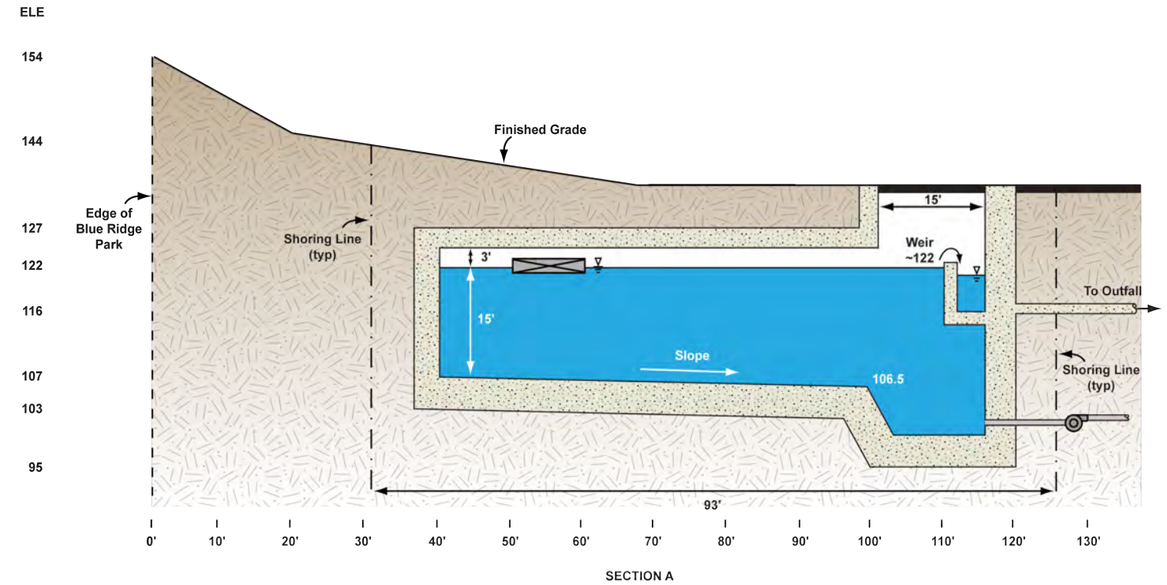
- Facility location where peak flows can be captured passively
- Similar to other King County operating facilities
- Efficient, safe access for operations and maintenance staff

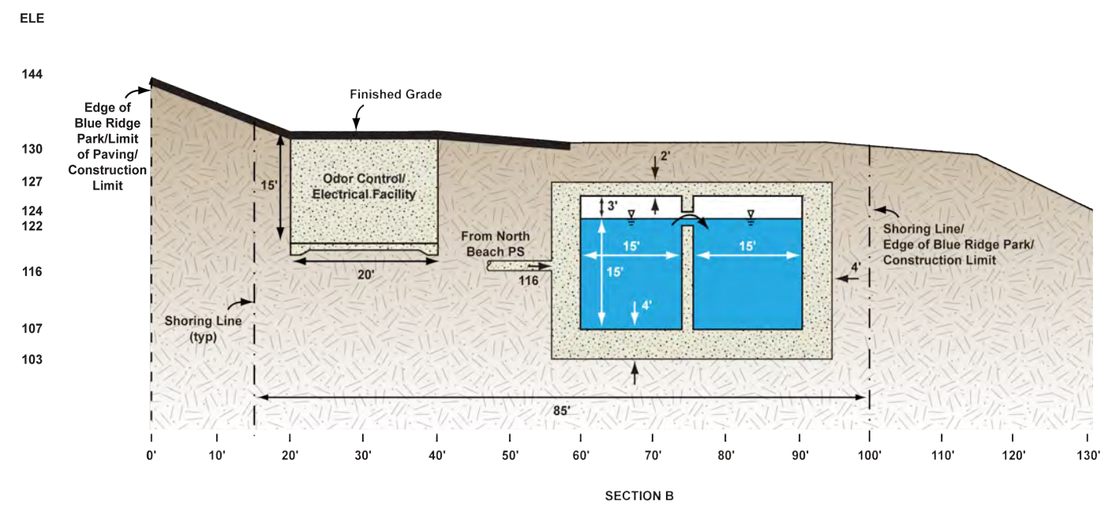
Challenges:

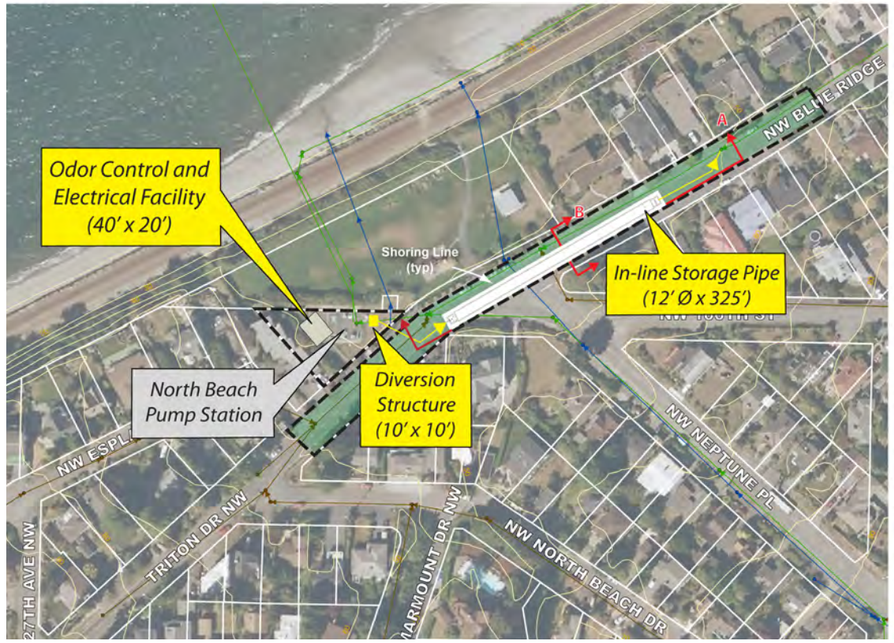
- Easement or acquisition of private park required
- Requires shoreline permit
- Access to Blue Ridge Park restricted during construction
- Shoreline zone is Conservancy Recreation

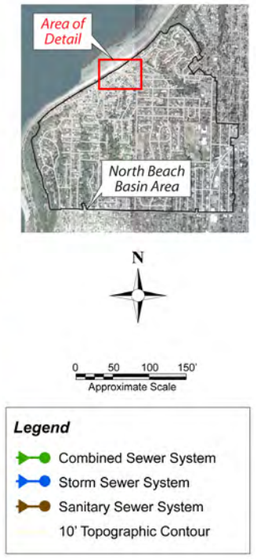
Planning Level Estimate:

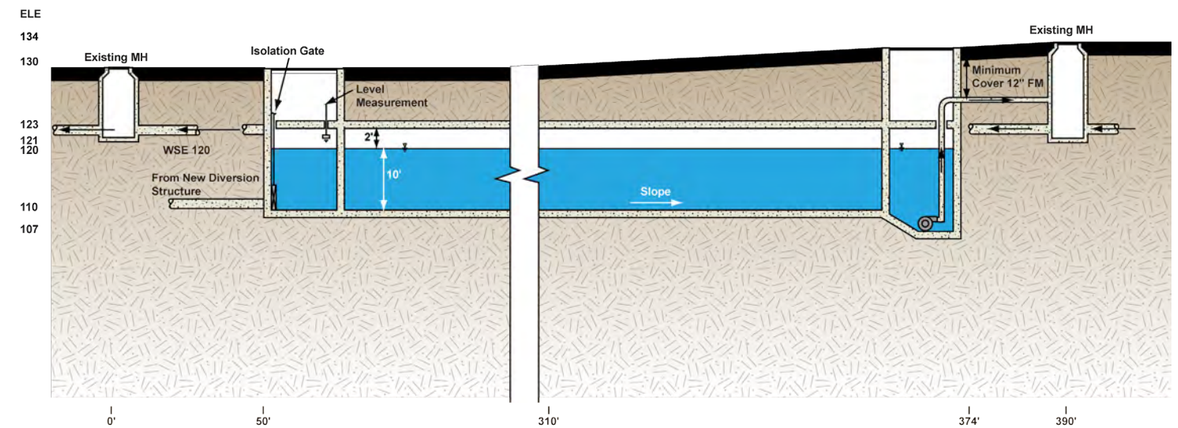
- $10.95 million











SECTION A

North Beach Alternative 1B: Pipeline Bottom of the Basin Storage

Project Elements:

- Underground diversion structure to direct flows to storage
- 0.23 MG underground storage pipeline in right-of-way
- Underground pumping equipment to drain stored flows in the in-line storage pipe
- Odor control and electrical facilities located on King County property

Benefits:

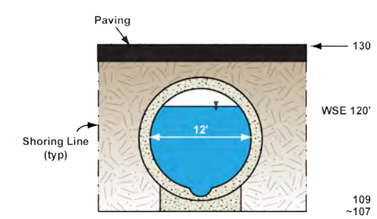
- Facility location where peak flows can be captured passively
- Similar to other King County operating facilities
- No apparent need to use or acquire private property

Challenges:

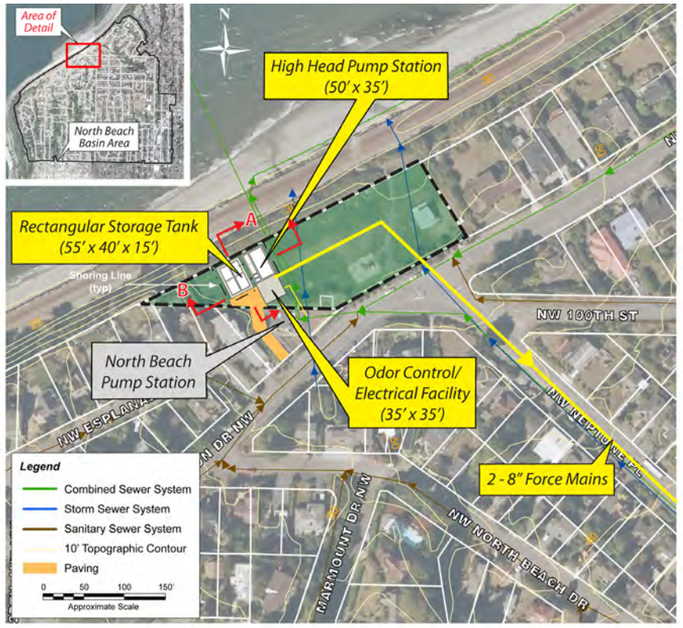
- Location in narrow street will result in access limitations to residences during extended construction period
- Long-term street access is needed for operations & maintenance activities

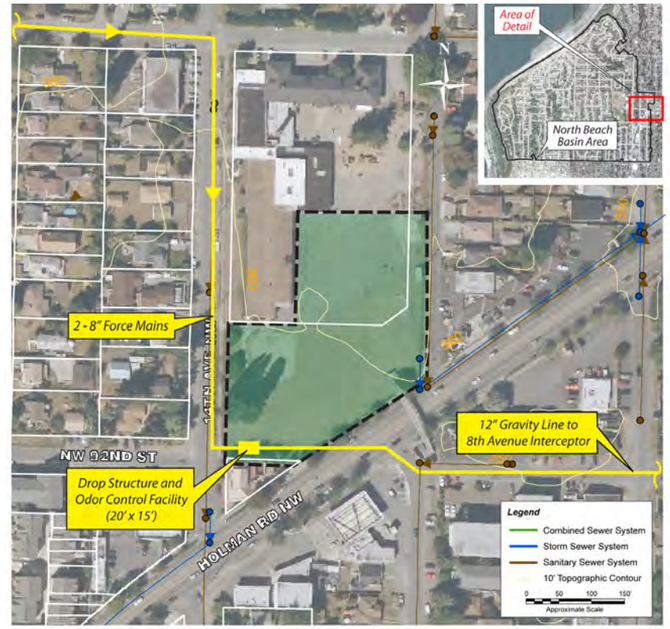
Planning Level Estimate:

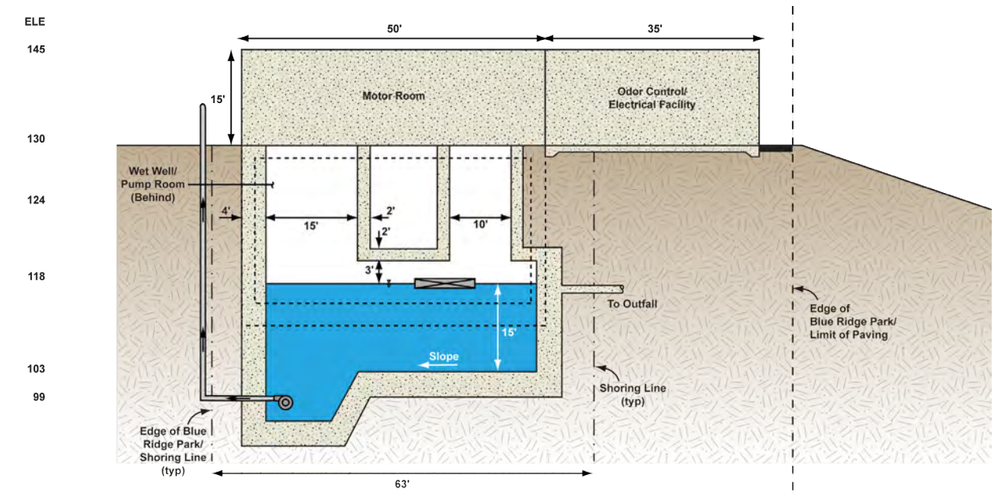
- $9.83 million

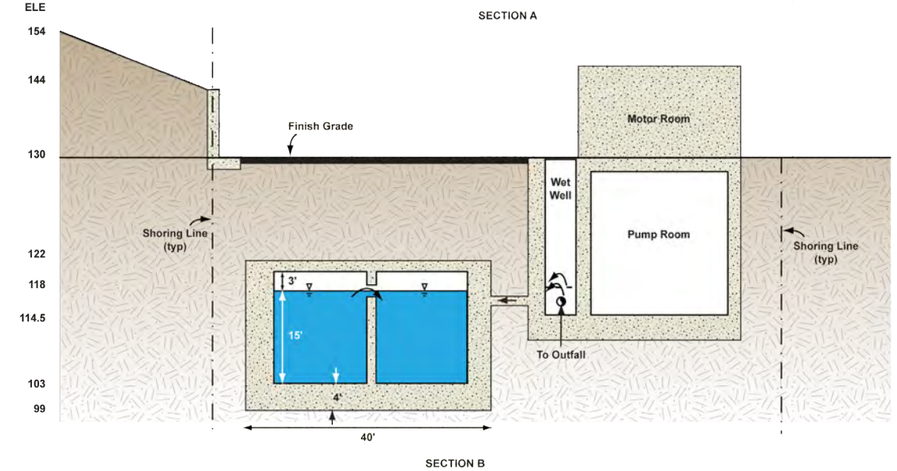


SECTION B









North Beach Alternative 1D: Centralized Storage at Bottom of Basin with Conveyance to 8th Avenue Interceptor

Project Elements:

- 3.5 mgd Pump Station at bottom of basin (300+ feet of head)
- 0.15 MG underground storage tank at bottom of basin
- Above ground odor control and electrical facilities adjacent to pump station
- 2 - 8" Force Mains from bottom of basin to Holman Rd NW (~5000 linear feet)
- Drop structure and odor control in utility easement
- 12" gravity sewer to 8th Avenue Interceptor (~3000 linear feet)

Benefits:

- Replaces existing force main in tidelands
- Facility located where peak flows can be captured passively
- Similar to other King County operating facilities
- Efficient, safe access for operations and maintenance staff

Challenges:

- Private property acquisition required for this alternative
- Increased O&M costs
- Requires shoreline permit
- Access to Blue Ridge Park restricted during construction
- Shoreline zone is Conservancy Recreation

Planning Level Estimate:

- $34.88 million

APPENDIX 2 – Costs

- Alternative 1A Cost Estimate
- Alternative 1B Cost Estimate
- Alternative 1D Cost Estimate
- Life Cycle Cost Summary

THREE ALTERNATIVES COST SUMMARY
NORTH BEACH BASIN

Alternative	Description	Capital Cost	Land Acquisition Cost	Street Use	Project Total Cost	Relative Cost
1A	Rectangular Bottom of Basin Storage	$8,800,000	$600,000	$0	$9,400,000	1.03
1B	Pipeline Bottom of Basin Storage	$8,400,000	$400,000	$350,000	$9,150,000	1.00
1D	Centralized Storage at Bottom of Basin with Conveyance to 8th Avenue Interceptor	$27,400,000	$785,000	$480,000	$28,665,000	3.13

Note:
A relative cost value of 1.0 is the lowest cost of the group of alternatives
Total construction cost includes total direct costs plus 30% allied costs and 45% contingency cost
Project total cost is the sum of total construction cost plus street use and land acquisition cost

1.0 - 2.0
2.0 - 4.0
>4.0

Project:	**King County CSO**				
Subject:	**North Beach Alternative 1A**				
By :	**CEH**				
Date :	**21-Sep-10**				
	Storage Tank				
Capital Cost Estimate					
Item	**Description**	**Quantity**	**Unit**	**Unit cost, $**	**Cost, $**
DIVISION 1 - GENERAL REQUIREMENTS					
	Temporary Traffic Control	1	LS	$78,846	$78,846
	Temporary Erosion & Sediment Control	1	LS	$39,423	$39,423
DIVISION 2 - SITE WORK					
	Equipment Mobilization	1	EA	$10,000	$10,000
	ACP Removal				
	Storage Tank	0	SY	$20	$0
	Odor Control Building	89	SY	$20	$1,778
	Diversion Structure	405	SY	$20	$8,100
	Clearing & Grubbing	0.37	AC	$25,000	$9,183
	Excavation				
	Storage Tank + Odor Control Building	8,887	BCY	$15	$133,300
	Haul/Disposal - Tank+Odor Control Building	7,867	LCY	$11	$86,538
	Shoring				
	Storage Tank	8,856	SF	$42	$375,494
	Odor Control Building	2,700	SF	$42	$114,480
	Diversion Structure	2,700	SF	$42	$113,400
	Dewatering	1	LS	$890,000	$890,000
	Backfill (native)	2,593	BCY	$15	$38,894
	Install 20-inch pipe	200	LF	$700	$140,000
	Pipe Bedding	15	CY	$18	$267
	24" Compacted Gravel Fill - Tank	305	CY	$20	$6,104
	Imported Backfill/Compaction	2,593	CY	$20	$51,859
	AC Surface Restoration	458	SY	$45	$20,600
	Generator fuel tank	1	LS	$12,000	$12,000

Project:	**King County CSO**				
Subject:	**North Beach Alternative 1A**				
By :	**CEH**				
Date :	**21-Sep-10**				
	Storage Tank				
Capital Cost Estimate					
Item	**Description**	**Quantity**	**Unit**	**Unit cost, $**	**Cost, $**
DIVISION 3 - CONCRETE					
	Diversion Structure				
	Base Slab	8	CY	$300	$2,400
	Walls	27	CY	$500	$13,500
	Top Slab	8	CY	$800	$6,400
	Storage Tank				
	Base Slab	642	CY	$300	$192,600
	External Walls	756	CY	$500	$378,000
	Internal Walls	70	CY	$500	$35,000
	Top Elevated Slab	228	CY	$800	$182,400
	Miscellaneous fill/appurtenances	20	CY	$500	$10,000
	Crane Mobilization	1	EA	$22,000	$22,000
	Crane Rental	175	HR	$1,500	$262,500
	Crane Crew	175	HR	$240	$42,000
	Odor Control and Electrical Bldg				
	Top Elevated Slab	30	CY	$800	$23,704
	External Walls	67	CY	$500	$33,333
	Internal Walls	11	CY	$500	$5,556
	Base slab	30	CY	$300	$8,889
DIVISION 4 - MASONRY					
	N/A				
DIVISION 5 - METALS					
	Hatches	10	EA	$10,000	$100,000
DIVISIONS 7 & 8 - ARCHITECTURAL					
	N/A				

Project:	**King County CSO**				
Subject:	**North Beach Alternative 1A**				
By :	**CEH**				
Date :	**21-Sep-10**				
	Storage Tank				
Capital Cost Estimate					
Item	**Description**	**Quantity**	**Unit**	**Unit cost, $**	**Cost, $**
DIVISION 15 - MECHANICAL					
	Storage Tank				
	Tipping Bucket	2	LS	$25,000	$50,000
	Drain Gates	2	LS	$10,000	$20,000
	Pumps	3	LS	$5,000	$15,000
	Miscellaneous Mechanical	1	LS	$12,000	$12,000
	Diversion Structure				
	Slide Gate	1	EA	$10,000	$10,000
	Level Sensor	1	EA	$5,000	$5,000
	Odor Control/Electrical/Generator Bldg				
	Heating, Ventilating, Plumbing	1	EA	$65,000	$65,000
	Odor Control Equipment				
	Scrubber, Fan, Sound Enclosure	1	LS	$25,000	$25,000
DIVISION 16 - ELECTRICAL					
	Electrical				
	Electrical	1	LS	$300,000	$300,000
	Standby Generator	1	LS	$60,000	$60,000
	Telemetry	1	LS	$50,000	$50,000
	Subtotal				*$4,060,547*
	Escalation to time of construction	14.60%			$592,840
	Total estimated construction cost				$4,653,387
	Contingency	45%			$2,094,024
	Engineering Design	15%			$698,008
	Construction Management	15%			$698,008
	Sales Tax	9.5%			$641,004
	Total Estimated Capital Cost				$8,784,000

Project:	**King County CSO**				
Subject:	**North Beach Alternative 1B**				
By :	**CEH**				
Date :	**21-Sep-10**				
	Storage Pipe				
Capital Cost Estimate					
Item	**Description**	**Quantity**	**Unit**	**Unit cost, $**	**Cost, $**
DIVISION 1 - GENERAL REQUIREMENTS					
	Temporary Traffic Control	1	LS	$285,946	$285,946
	Temporary Erosion & Sediment Control	1	LS	$35,743	$35,743
DIVISION 2 - SITE WORK					
	Equipment Mobilization	1	EA	$10,000	$10,000
	ACP Removal				
	Storage Pipe	795	SY	$20	$15,900
	Odor Control Building	89	SY	$20	$1,780
	Diversion Structure	11	SY	$20	$220
	Clearing & Grubbing	0	AC	$12,000	$0
	Excavation				
	Storage Tank	6,091	BCY	$15	$91,361
	Diversion Structure	405	BCY	$25	$10,125
	Haul/Disposal - Tank	5,332	LCY	$11	$58,655
	Shoring				
	Storage Pipe	23,943	SF	$42	$993,635
	Dewatering	1	LS	$890,000	$890,000
	Backfill (native)	1,825	BCY	$15	$27,374
	Intall 12-ft Diam RCP storage pipe	325	LF	$1,000	$325,000
	Install 20-inch pipe	200	LF	$700	$140,000
	Pipe Bedding	15	CY	$18	$267
	24" Compacted Gravel Fill - Storage Pipe	589	CY	$20	$11,778
	Imported Backfill/Compaction - Storage Pipe	1,825	CY	$20	$36,498
	AC Surface Restoration	805	SY	$45	$36,245
	Generator fuel tank	1	LS	$12,000	$12,000

Project:	**King County CSO**				
Subject:	**North Beach Alternative 1B**				
By :	**CEH**				
Date :	**21-Sep-10**				
	Storage Pipe				
Capital Cost Estimate					
Item	**Description**	**Quantity**	**Unit**	**Unit cost, $**	**Cost, $**
DIVISION 3 - CONCRETE					
	Diversion Structure				
	Base Slab	8	CY	$300	$2,400
	Walls	27	CY	$500	$13,500
	Top Slab	8	CY	$800	$6,400
	Odor Control and Electrical Bldg				
	Strip Footings	22	CY	$300	$6,667
	Foundation Walls	11	CY	$400	$4,444
	Slab on Grade	89	CY	$326	$28,978
DIVISION 4 - MASONRY					
	Odor Control Bldg				
	12" CMU Walls; Full grouted, 12-ft high, slab on grade	2,400	SF	$38	$91,200
DIVISION 5 - METALS					
	Fencing - Diversion Structure	200	LF	$8	$1,600
	Hatches	8	EA	$10,000	$80,000
	Odor Control Bldg				
	Metal Decking	2,400	SF	$6	$14,400
	Roof Joists, 8-ft OC Fabricated Steel	12,000	LB	$3	$32,400
	Miscellaneous Plates/Shapes	11,000	LB	$3	$33,000
	Metal Roof	2,400	SF	$6	$15,000

Project:	**King County CSO**				
Subject:	**North Beach Alternative 1B**				
By :	**CEH**				
Date :	**21-Sep-10**				
	Storage Pipe				
Capital Cost Estimate					
Item	**Description**	**Quantity**	**Unit**	**Unit cost, $**	**Cost, $**
DIVISIONS 7 & 8 - ARCHITECTURAL					
	N/A				
DIVISION 15 - MECHANICAL					
	Storage Tank				
	Tipping Bucket	1	LS	$25,000	$25,000
	Drain Gates	1	LS	$10,000	$10,000
	Level Sensor	1	LS	$5,000	$5,000
	Pumps	3	LS	$5,000	$15,000
	Miscellaneous Mechanical	1	LS	$13,500	$13,500
	Diversion Structure				
	Slide Gate	1	EA	$10,000	$10,000
	Level Sensor	1	EA	$5,000	$5,000
	Odor Control/Electrical/Generator Bldg				
	Heating, Ventilating, Plumbing	1	EA	$65,000	$65,000
	Odor Control Equipment				
	Scrubber, Fan, Sound Enclosure	1	LS	$25,000	$25,000
DIVISION 16 - ELECTRICAL					
	Electrical				
	Electrical	1	LS	$300,000	$300,000
	Standby Generator	1	LS	$60,000	$60,000
	Telemetry	1	LS	$50,000	$50,000
	Subtotal				*$3,896,015*
	Escalation to time of construction	14.60%			$568,818
	Total estimated construction cost				$4,464,834
	Contingency	45%			$2,009,175
	Engineering Design	15%			$669,725
	Construction Management	15%			$669,725
	Sales Tax	9.5%			$615,031
	Total Estimated Capital Cost				$8,428,000

Project:	**King County CSO**				
Subject:	**Magnolia Alternative 1D**				
By :	**CEH**				
Date :	**21-Sep-10**				
Capital Cost Estimate					
Item	**Description**	**Quantity**	**Unit**	**Unit cost, $**	**Cost, $**
DIVISION 1 - GENERAL REQUIREMENTS					
	Access	1	LS	$427,506	$427,506
	Temporary Erosion & Sediment Control	1	LS	$106,876	$106,876
DIVISION 2 - SITE WORK					
	Equipment Mobilization	1	EA	$10,000	$10,000
	ACP Removal				
	Pipelines	16,970	SY	$20	$339,407
	Clearing & Grubbing	0.20	AC	$25,000	$5,000
	Excavation				
	Storage Tank + Pump Station	6,148	BCY	$25	$153,708
	Diversion Structure	405	BCY	$25	$10,125
	Drop Structure	222	BCY	$25	$5,556
	Pipelines	18,904	BCY	$25	$472,593
	Haul/Disposal				
	Tank + Pump Station	6,414	LCY	$11	$70,559
	Diversion Structure	506	LCY	$11	$5,569
	Drop Structure	278	LCY	$11	$3,056
	Pipelines	3,998	LCY	$11	$43,977
	Shoring				
	Storage Tank + Pump Station	13,764	SF	$42	$583,594
	Diversion Structure	1,944	SF	$42	$82,426
	Drop Structure	233	SF	$42	$9,800
	Dewatering	1	LS	$2,150,000	$2,150,000
	8" PVC Gravity Sewer	5,800	LF	$100	$580,000
	8" PVC Forcemain	11,600	LF	$125	$1,450,000
	24" Compacted Gravel Fill - Tank + Pump Station	293	CY	$20	$5,852
	Pipe backfill above zone	15,705	CY	$18	$282,696
	Pipe bedding/zone and compaction	2,879	CY	$20	$57,583
	AC Surface Restoration				
	Storage Tank	244	SY	$45	$11,000
	Pipelines	16,970	SY	$45	$763,667
	Driveway	347	SY	$45	$15,615

Project:	**King County CSO**				
Subject:	**Magnolia Alternative 1D**				
By :	**CEH**				
Date :	**21-Sep-10**				
Capital Cost Estimate					
Item	**Description**	**Quantity**	**Unit**	**Unit cost, $**	**Cost, $**
DIVISION 3 - CONCRETE					
	Diversion Structure				
	Base Slab	8	CY	$300	$2,400
	Walls	27	CY	$500	$13,500
	Top Slab	8	CY	$800	$6,400
	Core Drill - 30" Dia, 2' wall				
	Odor Control and Electrical Bldg				
	Strip Footings	22	CY	$300	$6,667
	Foundation Walls	11	CY	$400	$4,444
	Slab on Grade	89	CY	$326	$28,978
	Drop Structure				
	Base Slab	44	CY	$300	$13,333
	External Walls	52	CY	$500	$25,926
	Top Elevated Slab	22	CY	$800	$17,778
	Storage Tank				
	Base Slab	459	CY	$300	$137,700
	External Walls	607	CY	$500	$303,500
	Internal Walls	45	CY	$500	$22,500
	Top Elevated Slab	155	CY	$800	$124,000
	Miscellaneous fill/appurtenances	20	CY	$500	$10,000
	Crane Mobilization	1	EA	$22,000	$22,000
	Crane Rental	350	HR	$1,500	$525,000
	Crane Crew	350	HR	$240	$84,000
	Retaining Wall	83	CY	$400	$33,333
DIVISION 4 - MASONRY					
	Odor Control Bldg				
	grade	2,400	SF	$38	$91,200
	Drop Structure				
	grade	300	SF	$38	$11,400
DIVISION 5 - METALS					
	Odor Control Bldg				
	Metal Decking	2,400	SF	$6	$14,400
	Roof Joists, 8-ft OC Fabricated Steel	12,000	LB	$3	$32,400
	Miscellaneous Plates/Shapes	11,000	LB	$3	$33,000
	Metal Roof	2,400	SF	$6	$15,000
	Drop Structure				
	Metal Decking	2,400	SF	$6	$14,400
	Roof Joists, 8-ft OC Fabricated Steel	12,000	LB	$3	$36,000
	Miscellaneous Plates/Shapes	11,000	LB	$3	$33,000
	Metal Roof	2,400	SF	$6	$14,400
	Fencing - Diversion Structure	200	LF	$8	$1,600
	Fencing - Drop Structure	200	LF	$8	$1,600
	Hatches	8	EA	$10,000	$80,000

Project:	**King County CSO**				
Subject:	**Magnolia Alternative 1D**				
By :	**CEH**				
Date :	**21-Sep-10**				
Capital Cost Estimate					
Item	**Description**	**Quantity**	**Unit**	**Unit cost, $**	**Cost, $**
DIVISIONS 7 & 8 - ARCHITECTURAL					
	Roofing, doors, windows, finishes, etc	1	LS	$24,000	$24,000
DIVISION 15 - MECHANICAL					
	Storage Tank				
	Tipping Buckets	2	LS	$25,000	$50,000
	Drain Gates	2	LS	$10,000	$20,000
	Pumps	3	LS	$5,000	$15,000
	Miscellaneous Mechanical	1	LS	$12,000	$12,000
	Diversion Structure				
	Slide Gate	1	EA	$10,000	$10,000
	Level Sensor	1	EA	$5,000	$5,000
	Odor Control/Electrical/Generator Bldg				
	Heating, Ventilating, Plumbing	2	EA	$65,000	$130,000
	Odor Control Equipment				
	Scrubber, Fan, Sound Enclosure	2	LS	$25,000	$50,000
	Pump Station	1	LS	$1,500,000	$1,500,000
DIVISION 16 - ELECTRICAL					
	Electrical				
	Electrical	1	LS	$1,068,764	$1,068,764
	Standby Generator	1	LS	$100,000	$100,000
	Telemetry	1	LS	$267,191	$267,191
	Subtotal				*$12,657,979*
	Escalation to time of construction	14.60%			$1,848,065
	Total estimated construction cost				$14,506,044
	Contingency	45%			$6,527,720
	Engineering Design	15%			$2,175,907
	Construction Management	15%			$2,175,907
	Sales Tax	9.5%			$1,998,208
	Total Estimated Capital Cost				$27,384,000

WTD Business Case Evaluation Results

North Beach CSO Life Cycle Cost

WTD Borrowing Cost as Discount Rate (1)

Scenario	Lifetime	Initial Capital Outlay	Total Project Life Costs (2)	Total Project Life Benefits	Net Project Life Costs	Average Project Annual Cost	Annual Costs over(under) Status quo
Status Quo							
"Status Quo"	0	$0	$0	$0	$0	$0	
Alternatives							
"Alt 1A"	20	$8,800,000	$9,055,525	$0	$9,055,525	$563,714	$563,714
"Alt 1B"	20	$8,400,000	$8,878,647	$0	$8,878,647	$552,703	$552,703
"Alt 1D"	20	$27,400,000	$28,689,414	$0	$28,689,414	$1,785,939	$1,785,939

Budget Office Discount Rate (3)

Scenario	Lifetime	Initial Capital Outlay	Total Project Life Costs (2)	Total Project Life Benefits	Net Project Life Costs	Average Project Annual Cost	Annual Costs over(under) Status quo
Status Quo							
"Status Quo"	0	$0	$0	$0	$0	$0	
Alternatives							
"Alt 1A"	20	$8,800,000	$8,970,829	$0	$8,970,829	$558,441	$558,441
"Alt 1B"	20	$8,400,000	$8,719,994	$0	$8,719,994	$542,827	$542,827
"Alt 1D"	20	$27,400,000	$28,262,024	$0	$28,262,024	$1,759,333	$1,759,333

First Year of Construction	2014	Additional inflation rate > 3%	1.00%

Notes:

(1) WTD Discount rate based on recent WTD borrowing costs net of 3% annual inflation. 2.18%

(2) Costs include risk and uncertainty, if estimated.

(3) Discount rate net of inflation, per the King County Budget Office. 7.00%

The option with the largest net equivalent annualized cost is the financially preferred option.

Describe Alternate 1A:---> Bottom of Basin Storage Tank w/ Conveyance to Carkeek PS

"Alt 1A"

" "
" "

Lifetime (in years)--->	20	Please provide the appropriate information in the shaded areas
First year of O&M costs --->	2015	
Electricity Supplier (SCL or PSE) --->	SCL	
Indicate "Plant" or "Off-Site" --->	Off-site	

See instructions below

	All project costs through 2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Current year (from Results summary sheet)																			
Total Benefits (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capital and O&M	$8,813,639	$13,775	$13,913	$14,052	$14,192	$14,334	$14,478	$14,622	$14,769	$14,916	$15,065	$15,216	$15,368	$15,522	$15,677	$15,834	$15,992	$16,152	$16,314
Debt-related and O&M	$737,446	$561,582	$561,720	$561,859	$561,999	$562,141	$562,285	$562,429	$562,576	$562,723	$562,872	$563,023	$563,175	$563,329	$563,484	$563,641	$563,799	$563,959	$564,121
Risk (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Uncertainty (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capital outlays	$8,800,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt issuance	$176,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt service	$547,807	$547,807	$547,807	$547,807	$547,807	$547,807	$547,807	$547,807	$547,807	$547,807	$547,807	$547,807	$547,807	$547,807	$547,807	$547,807	$547,807	$547,807	$547,807
		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
				$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Energy use	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Natural Gas	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
therms	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Electricity Use kwh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Demand kW or kVa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical spending	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sodium hypochlorite required in gal.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bisulfide required in gal.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other chemical costs - enter $	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials and Supplies	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Labor	$13,639	$13,775	$13,913	$14,052	$14,192	$14,334	$14,478	$14,622	$14,769	$14,916	$15,065	$15,216	$15,368	$15,522	$15,677	$15,834	$15,992	$16,152	$16,314
Labor Hours	276	276	276	276	276	276	276	276	276	276	276	276	276	276	276	276	276	276	276
Benefits																			
1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of benefits 1, 2, etc."

UNCERTAINTIES

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of uncertainties 1, 2, etc."

RISKS

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of risks 1, 2, etc."

Describe Alternate 1A:--->

"Alt 1A"

Lifetime (in years)--->
First year of O&M costs --->
Electricity Supplier (SCL or PSE) --->
Indicate "Plant" or "Off-Site" --->

	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
Current year (from Results summary sheet)																						
Total Benefits (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capital and O&M	$16,477	$16,642	$16,808	$16,976	$17,146	$17,317	$17,490	$17,665	$17,842	$18,020	$18,201	$18,383	$18,567	$18,752	$18,940	$19,129	$19,320	$19,514	$19,709	$19,906	$20,105	$20,306
Debt-related and O&M	$564,284	$16,642	$16,808	$16,976	$17,146	$17,317	$17,490	$17,665	$17,842	$18,020	$18,201	$18,383	$18,567	$18,752	$18,940	$19,129	$19,320	$19,514	$19,709	$19,906	$20,105	$20,306
Risk (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Uncertainty (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capital outlays	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt issuance	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt service	$547,807	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Energy use	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Natural Gas	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
therms	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Electricity Use kwh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Demand kW or kVa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical spending	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0												
Sodium hypochlorite required in gal.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bisulfide required in gal.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other chemical costs - enter $	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials and Supplies	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Labor	$16,477	$16,642	$16,808	$16,976	$17,146	$17,317	$17,490	$17,665	$17,842	$18,020	$18,201	$18,383	$18,567	$18,752	$18,940	$19,129	$19,320	$19,514	$19,709	$19,906	$20,105	$20,306
Labor Hours	276	276	276	276	276	276	276	276	276	276	276	276	276	276	276	276	276	276	276	276	276	276
Benefits																						
1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
"Additional description of benefits 1, 2, etc."																						
UNCERTAINTIES																						
1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
"Additional description of uncertainties 1, 2, etc."																						
RISKS																						
1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
"Additional description of risks 1, 2, etc."																						

Describe Alternate 1A:--->

"Alt 1A"

Lifetime (in years)--->
First year of O&M costs --->
Electricity Supplier (SCL or PSE) --->
Indicate "Plant" or "Off-Site" --->

Current year (from Results summary sheet)	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067
Total Benefits (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capital and O&M	$20,509	$20,714	$20,921	$21,130	$21,342	$21,555	$21,771	$21,988	$22,208	$22,430	$22,655	$22,881	$23,110
Debt-related and O&M	$20,509	$20,714	$20,921	$21,130	$21,342	$21,555	$21,771	$21,988	$22,208	$22,430	$22,655	$22,881	$23,110
Risk (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Uncertainty (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capital outlays	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt issuance	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt service	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Energy use	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Natural Gas	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
therms	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Electricity Use kwh	0	0	0	0	0	0	0	0	0	0	0	0	0
Demand kW or kVa	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical spending													
Sodium hypochlorite required in gal.	0	0	0	0	0	0	0	0	0	0	0	0	0
Bisulfide required in gal.	0	0	0	0	0	0	0	0	0	0	0	0	0
Other chemical costs - enter $	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials and Supplies	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Labor	$20,509	$20,714	$20,921	$21,130	$21,342	$21,555	$21,771	$21,988	$22,208	$22,430	$22,655	$22,881	$23,110
Labor Hours	276	276	276	276	276	276	276	276	276	276	276	276	276
Benefits													
1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
"Additional description of benefits 1, 2, etc."													
UNCERTAINTIES													
1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
"Additional description of uncertainties 1, 2, etc."													
RISKS													
1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
"Additional description of risks 1, 2, etc."													

Describe Alternate 1B:---> Bottom of Basin Storage Pipe w/ Conveyance to Carkeek PS
" "
" "
" "

"Alt 1B"

Lifetime (in years)--->	20	Please provide the appropriate information in the shaded areas
First year of O&M costs --->	2015	
Electricity Supplier (SCL or PSE) --->	SCL	
Indicate "Plant" or "Off-Site" --->	Off-Site	

See instructions below

	All project costs through 2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Current year (from Results summary sheet)																			
Total Benefits (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capital and O&M	$8,425,548	$25,803	$26,061	$26,322	$26,585	$26,851	$27,119	$27,390	$27,664	$27,941	$28,220	$28,503	$28,788	$29,075	$29,366	$29,660	$29,957	$30,256	$30,559
Debt-related and O&M	$716,454	$548,710	$548,968	$549,228	$549,492	$549,757	$550,026	$550,297	$550,571	$550,848	$551,127	$551,409	$551,694	$551,982	$552,273	$552,567	$552,863	$553,163	$553,465
Risk (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Uncertainty (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capital outlays	$8,400,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt issuance	$168,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt service	$522,907	$522,907	$522,907	$522,907	$522,907	$522,907	$522,907	$522,907	$522,907	$522,907	$522,907	$522,907	$522,907	$522,907	$522,907	$522,907	$522,907	$522,907	$522,907
		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
				$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Energy use	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Natural Gas	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
therms	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Electricity Use kwh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Demand kW or kVa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Chemical spending	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sodium hypochlorite required in gal.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bisulfide required in gal.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other chemical costs - enter $	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials and Supplies	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Labor	$25,548	$25,803	$26,061	$26,322	$26,585	$26,851	$27,119	$27,390	$27,664	$27,941	$28,220	$28,503	$28,788	$29,075	$29,366	$29,660	$29,957	$30,256	$30,559
Labor Hours	517	517	517	517	517	517	517	517	517	517	517	517	517	517	517	517	517	517	517
Benefits																			
1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of benefits 1, 2, etc."

UNCERTAINTIES

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of uncertainties 1, 2, etc."

RISKS

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of risks 1, 2, etc."

Describe Alternate 1B:--->

"Alt 1B"

Lifetime (in years)--->
First year of O&M costs --->
Electricity Supplier (SCL or PSE) --->
Indicate "Plant" or "Off-Site" --->

	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055
Current year (from Results summary sheet)																							
Total Benefits (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capital and O&M	$30,864	$31,173	$31,485	$31,799	$32,117	$32,439	$32,763	$33,091	$33,422	$33,756	$34,093	$34,434	$34,779	$35,126	$35,478	$35,832	$36,191	$36,553	$36,918	$37,287	$37,660	$38,037	$38,417
Debt-related and O&M	$553,771	$31,173	$31,485	$31,799	$32,117	$32,439	$32,763	$33,091	$33,422	$33,756	$34,093	$34,434	$34,779	$35,126	$35,478	$35,832	$36,191	$36,553	$36,918	$37,287	$37,660	$38,037	$38,417
Risk (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Uncertainty (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capital outlays	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt issuance	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt service	$522,907	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Energy use	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Natural Gas	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
therms	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Electricity Use kwh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Demand kW or kVa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Chemical spending	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sodium hypochlorite required in gal.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bisulfide required in gal.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other chemical costs - enter $	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials and Supplies	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Labor	$30,864	$31,173	$31,485	$31,799	$32,117	$32,439	$32,763	$33,091	$33,422	$33,756	$34,093	$34,434	$34,779	$35,126	$35,478	$35,832	$36,191	$36,553	$36,918	$37,287	$37,660	$38,037	$38,417
Labor Hours	517	517	517	517	517	517	517	517	517	517	517	517	517	517	517	517	517	517	517	517	517	517	517
Benefits																							
1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of benefits 1, 2, etc."

UNCERTAINTIES

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of uncertainties 1, 2, etc."

RISKS

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of risks 1, 2, etc."

Describe Alternate 1B:--->

"Alt 1B"

Lifetime (in years)--->
First year of O&M costs --->
Electricity Supplier (SCL or PSE) --->
Indicate "Plant" or "Off-Site" --->

Current year (from Results summary sheet)	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067
Total Benefits (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capital and O&M	$38,801	$39,189	$39,581	$39,977	$40,377	$40,781	$41,188	$41,600	$42,016	$42,436	$42,861	$43,289
Debt-related and O&M	$38,801	$39,189	$39,581	$39,977	$40,377	$40,781	$41,188	$41,600	$42,016	$42,436	$42,861	$43,289
Risk (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Uncertainty (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capital outlays	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt issuance	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt service	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Energy use	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Natural Gas	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
therms	0	0	0	0	0	0	0	0	0	0	0	0
Electricity	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Electricity Use kwh	0	0	0	0	0	0	0	0	0	0	0	0
Demand kW or kVa	0	0	0	0	0	0	0	0	0	0	0	0
Total Chemical spending	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sodium hypochlorite required in gal.	0	0	0	0	0	0	0	0	0	0	0	0
Bisulfide required in gal.	0	0	0	0	0	0	0	0	0	0	0	0
Other chemical costs - enter $	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials and Supplies	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Labor	$38,801	$39,189	$39,581	$39,977	$40,377	$40,781	$41,188	$41,600	$42,016	$42,436	$42,861	$43,289
Labor Hours	517	517	517	517	517	517	517	517	517	517	517	517

Benefits

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of benefits 1, 2, etc."

UNCERTAINTIES

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of uncertainties 1, 2, etc."

RISKS

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of risks 1, 2, etc."

Describe Alternate 1D:---> Centralized Storage at Bottom of Basin w/ Conveyance to 8th Ave Interceptor

" "

"Alt 1D" " "

" "

Lifetime (in years)--->	20	Please provide the appropriate information in the shaded areas
First year of O&M costs --->	2015	
Electricity Supplier (SCL or PSE) --->	SCL	
Indicate "Plant" or "Off-Site" --->	Off-Site	

See instructions below

	All projects costs through 2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Current year (from Results summary sheet)																							
Total Benefits (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capital and O&M	$27,468,822	$69,510	$70,205	$70,907	$71,616	$72,332	$73,056	$73,786	$74,524	$75,269	$76,022	$76,782	$77,550	$78,326	$79,109	$79,900	$80,699	$81,506	$82,321	$83,144	$83,976	$84,816	$85,664
Debt-related and O&M	$2,322,494	$1,775,182	$1,775,877	$1,776,579	$1,777,288	$1,778,004	$1,778,728	$1,779,458	$1,780,196	$1,780,941	$1,781,694	$1,782,454	$1,783,222	$1,783,997	$1,784,781	$1,785,572	$1,786,371	$1,787,178	$1,787,993	$1,788,816	$83,976	$84,816	$85,664
Risk (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Uncertainty (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capital outlays	$27,400,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt issuance	$548,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt service	$1,705,672	$1,705,672	$1,705,672	$1,705,672	$1,705,672	$1,705,672	$1,705,672	$1,705,672	$1,705,672	$1,705,672	$1,705,672	$1,705,672	$1,705,672	$1,705,672	$1,705,672	$1,705,672	$1,705,672	$1,705,672	$1,705,672	$1,705,672	$0	$0	$0
		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
				$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Energy use	$15,898	$16,057	$16,218	$16,380	$16,544	$16,709	$16,876	$17,045	$17,216	$17,388	$17,562	$17,737	$17,915	$18,094	$18,275	$18,458	$18,642	$18,829	$19,017	$19,207	$19,399	$19,593	$19,789
Natural Gas	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
therms	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity	$15,898	$16,057	$16,218	$16,380	$16,544	$16,709	$16,876	$17,045	$17,216	$17,388	$17,562	$17,737	$17,915	$18,094	$18,275	$18,458	$18,642	$18,829	$19,017	$19,207	$19,399	$19,593	$19,789
Electricty Use kwh	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000
Demand kW or kVa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Chemical spending	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sodium hypochlorite required in gal.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bisulfide required in gal.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other chemical costs - enter $	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials and Supplies	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Labor	$52,923	$53,453	$53,987	$54,527	$55,072	$55,623	$56,179	$56,741	$57,309	$57,882	$58,460	$59,045	$59,635	$60,232	$60,834	$61,442	$62,057	$62,677	$63,304	$63,937	$64,577	$65,222	$65,875
Labor Hours	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071

Benefits

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of benefits 1, 2, etc."

UNCERTAINTIES

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of uncertainties 1, 2, etc."

RISKS

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of risks 1, 2, etc."

Describe Alternate 1D:--->

"Alt 1D"

Lifetime (in years)--->
First year of O&M costs --->
Electricity Supplier (SCL or PSE) --->
Indicate "Plant" or "Off-Site" --->

Current year (from Results summary sheet)	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062
Total Benefits (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capital and O&M	$86,520	$87,385	$88,259	$89,142	$90,033	$90,934	$91,843	$92,761	$93,689	$94,626	$95,572	$96,528	$97,493	$98,468	$99,453	$100,447	$101,452	$102,466	$103,491	$104,526	$105,571	$106,627	$107,693	$108,770	$109,858	$110,956
Debt-related and O&M	$86,520	$87,385	$88,259	$89,142	$90,033	$90,934	$91,843	$92,761	$93,689	$94,626	$95,572	$96,528	$97,493	$98,468	$99,453	$100,447	$101,452	$102,466	$103,491	$104,526	$105,571	$106,627	$107,693	$108,770	$109,858	$110,956
Risk (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Uncertainty (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capital outlays	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt issuance	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt service	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Energy use	$19,987	$20,187	$20,389	$20,593	$20,798	$21,006	$21,216	$21,429	$21,643	$21,859	$22,078	$22,299	$22,522	$22,747	$22,974	$23,204	$23,436	$23,671	$23,907	$24,146	$24,388	$24,632	$24,878	$25,127	$25,378	$25,632
Natural Gas	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
therms	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity	$19,987	$20,187	$20,389	$20,593	$20,798	$21,006	$21,216	$21,429	$21,643	$21,859	$22,078	$22,299	$22,522	$22,747	$22,974	$23,204	$23,436	$23,671	$23,907	$24,146	$24,388	$24,632	$24,878	$25,127	$25,378	$25,632
Electricty Use kwh	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000	238000
Demand kW or kVa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Chemical spending	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sodium hypochlorite required in gal.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bisulfide required in gal.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other chemical costs - enter $	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Materials and Supplies	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Labor	$66,533	$67,199	$67,871	$68,549	$69,235	$69,927	$70,627	$71,333	$72,046	$72,767	$73,494	$74,229	$74,972	$75,721	$76,478	$77,243	$78,016	$78,796	$79,584	$80,380	$81,183	$81,995	$82,815	$83,643	$84,480	$85,325
Labor Hours	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071	1071

Benefits

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of benefits 1, 2, etc."

UNCERTAINTIES

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of uncertainties 1, 2, etc."

RISKS

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of risks 1, 2, etc."

APPENDIX 3 – Evaluations

- Evaluation Criteria
- Evaluation Matrix
- Risk Assessments

Category	Sample Criteria	Sample Questions	Scale		
			Low Impact (rating of 3)	Moderate Impact (rating of 2)	High Impact (rating of 1)
LAND USE AND PERMITTING					
[REV 11/23/09]	**1. City of Seattle Comprehensive Plan**				
		1. Will location of new facilities be consistent with Seattle's short and long-term planning policies?	Yes	Partly consistent	Potentially inconsistent with policies
[REV 11/23/09]	**2. Seattle Municipal Code**				
		1. Is the location and type of construction consistent with Seattle's Municipal Code (SMC) and the Growth Management Act (GMA) requirements?	Yes	Partly consistent	Inconsistent; requires change to code or major exception to existing regulations
[REV 11/23/09]	**3. Shoreline Master Program**	1. Will location of facilities be consistent with the City of Seattle Shoreline Master Program?	Not located in shoreline zone	Located in shoreline zone, generally consistent with SMP	Located in shoreline zone, potentially inconsistent with SMP
	4. Permitting Complexity				
[REV03/08/10]		1. Will descretionary permits be required?	SEPA and local permits (no conditional use or variances required)	SEPA and local permits (conditional use and/or variance required)	COE Individual Section 10 or 404 permit required with Public Notice or NWP 404 and Section 10 Review required; HPA Permit; Shoreline permit and ECA reviews required
[REV03/08/10]		2. Will multiple departmental reviews from City of Seattle be required?	1 departmental review only	2 departmental reviews required	3 or more departmental reviews required
[REV04/05/10] **NEW QUESTION**		3. Are above-ground structures at the site (e.g. odor control/electrical) consistent with City of Seattle height restrictions?	Yes	Consistent with Conditions (CCU required)	No - prohibited
[REV 11/23/09]		4. Wil the site location require marine access or in-water work? If so, will multiple work closures be imposed due to the presence of important fish/wildlife habitat?	No marine access required. No known fish or wildlife impact likely.	Marine access may be required. Fish and wildlife impacts low to moderate may occur.	Marine access believed required for project. Fish and wildlife impacts higher and more certain.
		5. Will traffic and noise impacts be potentially significant due project location?	Roadways not affected, or affected roadways are low volume and provide access to few residents for a short duration project.	Affected roadways will require careful attention to traffic control and maintaining access to properties during a moderate duration project	Major traffic and access issues raised by the alternative during a long duration project.
[REV 11/16/09]	**5. Property Acquisition Complexity**				
		1. Ability to acquire property rights within project timeline *(Can we get it?)*	King County has ownership, or Existing use of ROW	Voluntary seller has been/will be identified, or Acquisition	Ability to acquire property rights unknown Property ownership requires work with other agencies Acquisition difficulty evaluated case-by-case basis by KC
		2. Potential acquisition variables that impact cost *(How will it costs impact probability of success?)*	Owner accepts appraised value, or King County offers listed price	Owner requests additional compensation that is supported	Significant costs of acquisition probable
		3.Impacts on stakeholders & current use *(Who is impacted? = level of impact)*	No conflict w/ current use	Owner(s) /tenant(s) require relocation	Agency, neighbors or other stakeholders may have strong opposition
ENVIRONMENT					
[REV 11/23/09]	**1. Cultural Resources**				
		1. Will construction of the alternative impact archaeological resources?	The project site area does not contain any known archaeological sites. And, based on site characteristics, there is low potential for archaeological resources to be present in the project site area.	The project site area does not contain any known archaeological sites. However, based on site characteristics, there is potential for archaeological resources to be present in the project site area.	The project site area contains or is adjacent to a known archaeological site(s).
[REV 11/23/09]		2. Will construction of the alternative impact historic resources?	Historic properties not located in or near the project site area.	Historic properties are located in or near the project site area, but construction of the alternative is not likely to impact those properties.	Historic properties are located in or near the project site area and construction of the alternative will likely impact those properties.
[REV 11/23/09]	**2. Fish and Wildlife**				
		1. Will construction or operation of the alternative adversely affect fish and wildlife or their habitat?	Construction and operation of the alternative will not adversely affect, or will beneficially affect, fish and wildlife and/or their habitat.	Construction and/or operation of the alternative may adversely affect fish and wildlife or their habitat.	Construction and/or operation of the alternative is likely to adversely affect fish and wildlife and/or their habitat.
[REV 11/23/09]	**3. Wetlands, Streams, and Shoreline**				
[REV 12/3/09]		1. Will construction of the alternative impact wetlands, streams, or shoreline areas?	It is unlikely that the alternative will impact wetlands, streams, their buffers, or shoreline areas.	It is likely that the alternative will directly impact wetland and/or stream buffer, and/or piped streams, but not wetlands, non-pipe streams, or shoreline areas.	It is likely that the alternative will directly impact wetlands, non-piped streams, and/or shoreline areas.
[REV 11/23/09]	**4. Soils and Sediments**				
[REV 12/3/09]		1. Will construction of the alternative disturb contaminated soils or sediments?	The project site area is not known to contain contaminated soils. And, based on site characteristics, there is low potential for contaminated soils to be present in the project site area.	The project site area is not known to contain contaminated soils. However, based on site characteristics, there is potential for contaminated soils to be present in the project site area.	The project site area is known to contain contaminated soils. New discharges of untreated stormwater could impact sediment quality.
		2. Will construction of the alternative require disruption of steep slopes or increase the likelihood of landslides?	It is unlikely that the alternative will disrupt steep slopes or increase the potential for landslides.	It is likely that the alternative will temporarily impact steep slopes and/or temporarily increase the potential for landslides.	It is likely that the alternative will result in long-term disruptions to steep slopes and/or result in long-term increase in the potential for landslides.
[REV 11/23/09]	**5. Water Quality**				
		1. Will operation of the alternative result in the discharge of a new source of untreated stormwater to a surface waterbody?	Operation of the alternative will not result in the discharge of a new source of untreated stormwater to a surface waterbody.	N/A	Operation of the alternative will result in the discharge of a new source of untreated stormwater to a surface waterbody.

Category	Sample Criteria	Sample Questions	Scale		
			Low Impact (rating of 3)	Moderate Impact (rating of 2)	High Impact (rating of 1)
TECHNICAL					
	1. Technical Complexity				
		1. Does Implementation require complex flow measurement, algorithms, or PLC programming and infrastructure to direct flow to the alternative storage or treatment facility? Will the technology reliably meet CSO control objectives using the required controls? (Note: Re-worded to clarify.)	Routing of flows is simple, with overflow weirs, automatic gates, or similar controls. Alternative is located adjacent to or part of the infrastructure. Flow measurement is simple and controls require only simple 'on/off' controls.	Implementation requires remote measurement of flows, measurement of flows in downstream infrastructure to coordinate and control routing of flows to the alternative storage or treatment facility. Location of the alternative is remote from the measurement point. Modifications to infrastructure include simple structures and limited pipelines.	There are more than two locations included in flow control. The alternative includes modifications to existing infrastructure and complex controls to route flow including complex measurement of upstream and downstream flows. Pump stations may be required to route flows to the alternative storage or treatment facility. New pipelines of significant length may be needed to implement.
		2. How many individual sites are included in the alternative and what is the consistency of technical and construction approach across the sites?	There is one site included in the alternative. All controls and infrastrcture are located within the site or on adjacent existing rights of way or county-owned property.	There are two non adjacent sites included in the alternative. There may be differing construction methodologies, e.g. a pump station combined with a storage tank. Flow routing and diversion structures may be located adjacent to the sites on rights of way or county-owned property.	There are multiple non-adjacent sites included in the alternative. There may be two or more differing construction technologies involved, e.g. pump stations, storage tanks, and pipelines that are not contiguous.
	2. Compatibility with Existing WW system				
[REV 3/01/10]		1. Do the standards of other agencies affect the design and operation of the facility?	King county design standards are the only applicable standards. Construction and operation is entirely within county infrastructure.	Structures required for flow routing may be located in City of Seattle right of way, and be subject to City sewer operational standards. No City access permissions are needed for access. (WTD would not accept City operational standards for operations. Some engineering elements for design may need to meet City design standards.)	Major structures may be located within City of Seattle right of way, e.g. pipeline storage adjacent to collector sewers, where City standards control design and operation. Access permissions and coordination are needed for normal O&M activities. (Can't see where any City issues would affect operational designs. Structures would need to meet City
[REV 3/01/10]		2. Is the alternative stand alone or does its implementation affect other parts of the WW system including the West Point Treatment Plant?	The alternative is stand alone, and does not affect downstream or upstream county facilities. Peak flows at the WPTP are not affected.	The alternative may require modifications to the county's infrastructure upstream and downstream for implementation, e.g. modification of pump stations, pipelines, or operational methods for existing infrastructure. Peak flows at the WPTP may be affected. (Should delete affecting peak flows at WP as a criteria. This is a no go criteria.)	The alternative requires modification of both City of Seattle and county infrastructure and operational methods for both, e.g. flow patterns may be changed in City sewers, changes in capacity of wet weather treatment plants may occur. (Should delete affecting peak flows at WP as a criteria. This is a no go criteria.)
	3. Flexibility/Adaptive Management				
		1. Can the alternative meet changing control criteria?	Yes, with minimal modification of controls.	Yes, with moderate modification of controls.	Yes, but significant modification of complex controls likely.
[REV 3/01/10]		2. Can the alternative be easily modified to meet future flow conditions?	Infrastructure can readily be modified in the future.	Infrastructure can be modified in the future with significant effort.	Infrastructure can not be modified in the future.
[REV 3/01/10]	4. Contructability/Implementation Schedule				
		1. Are construction risks associated with groundwater, steep slopes, or soil materials significant?	Alternatives are on stable, low-slope sites, with groundwater elevations not affected during construction or operation.	Sites may have low to moderate slopes, require some dewatering, and robust foundations including piles or tiebacks.	Sites have steep slopes with groundwater and soils conditions that increase instability if disturbed. Erosion potential may be high. Special construction and permanent measures are needed to stablize the site such as caissons, slurry walls, tiebacks, permanent dewatering.
[REV 3/01/10]		2. Are construction risks associated with access, staging, availability of specialty contractors, availability of power, etc. significant? (All construction requires some type of staging. Here we are rating alternatives based on the ease of close staging? This is a usual contractor secured item AND is a short duration item. Staging areas should not impact permanent decisions.	Site is not constrained. Adequate area for access and staging and operation of special equipment can be accomodated. There is adequate room on site for contractor staging and operations.	Site may be constrained, but access and staging are not required for adequate construction sequencing. Constractor may have to provide offsite staging and operations.	Site is constrained, requiring careful construction sequencing, with several move-in, move-out stages to accommodate specialty contractors as well as conventional construction. Contractor must provide offsite staging and operations.
		3. Can the alternative meet the project schedule?			
O&M					
	1. Staffing				
[REV 03/01/10]		1. Can the facility be easily (automatically) started up? Can the facility operate autonomously under the design conditions?	The facility can be automatically started. The facility can operate autonomously under the design conditions.	The facility can be automatically started. The facility may requires operator attention during design conditions (e.g. monitoring, sampling, chemical control, etc.).	The facility will likely require operator attention during startup or operations. The facility will likely require operator attention during design conditions (e.g. monitoring, sampling, chemical control, etc.).
[REV 03/01/10]		2. What level of staffing is required for operation and shutdown (how often is the facility used, how long is the facility in use, how many operators are required, what level of operator experience is required, what are travel times)? What are peak staff requirements?	The facility can be remotely operated. Peak staff times require no operator be present during operation or startup. The facility can be shut down via automated processes. Cleanup work is automated.	The facility can generally be remotely operated. An operator may need to be present periodically for sampling, chemical make-up, chemical delivery acceptance or other discrete tasks. Peak staff times require 1-2 operators. The facility can be shut down with minimal staff time. Cleanup work is generally just monitored however, 1-2 personnel may very infrequently be required. Some procedures of shutdown may need to be conducted immediately, however, most work can be automated or scheduled to be integrated with other staff duties.	The facility requires operator attention during the event. Peak staff times require 2 or more operators. The facility requires significant effort for shut down (e.g. vac/boom truck, several days for cleanup). Cleanup work is generally manual with 2 or more personnel required for more than one day. Most procedures of shutdown need to be conducted immediately.
[REV 03/01/10]		3. Does the alternative impact downstream treatment facility processes?	No impact on downstream secondary processes. No impact on secondary treatment bypass frequency.	Impact on downstream secondary processes minimal but no effect on permit compliance. Increase on secondary treatment bypass frequency but within permit limits.	Impact on downstream secondary processes that may affect permit compliance or require construction of additional facilities. Increase on secondary treatment bypass frequency.
[REV 03/01/10]		4. Does the alternative require hi labor annual type cleaning requirements or does the design allow for passive post event cleanup systems?	The facility by design does not require post event cleanup activities.	the facility by design requires post event cleanup activities. Previous designs of this type have successfully designed automated cleanup systems that reduce staffing requirements to a single individual.	The facility by design will require annual or schedule large effort confined space entries by multiple staff. These type of activities will require large number of mobile resources and require large amounts of area to stage in.

Category	Sample Criteria	Sample Questions	Scale		
			Low Impact (rating of 3)	Moderate Impact (rating of 2)	High Impact (rating of 1)
	2. Training				
[REV 03/01/10]		1. What level and frequency of training is required? Is the existing staff familiar with the technology? Is similar equipment in use in the West Section?	Minimal routine annual training is required. Staff is familiar with the technology and similar processes are used at other WTD facilities.	Minimal routine annual training is required. Staff does not routinely operate similar processes or the processes are distinctly different than those used at other CSO projects.	Significant routine annual training is required. Staff does not routinely operate similar processes and the processes are distinctly different than those used at other CSO projects.
		2. Are similar control approaches specified with identical components? Can the facilities be used to simulate an event for testing and training?	Similar control approaches are specified with identical components at each facility. Control procedures are similar to exsting West Section facilities. The facilities can be used to simulate an event during testing and training.	Somewhat similar control approaches are specified at each facility, however there may be differences due to different equipment requirements. Control procedures are not similar to exsting West Section facilities. The facilities can be used to simulate an event during testing and training.	Differnt control approaches are specified at each facility. Control procedures are not similar to exsting West Section facilities. The facilities can not be used to simulate an event during testing and training.
	3. Reliability				
[REV 03/01/10]		1. How complex is the system (number and type of components)? How complex are the startup procedures and controls? Are redundant control systems provided? Is dedicated backup power available ?	The alternative has a single control facility with one or two inlet/outlet structures.. Startup procedures are passive or automated remotely with redundant control systems and backup power.	The alternative has several components in that control is not achieved at a single structure with one or two inlet/outlet structures.. Startup procedures are automated locally with redundant control systems and backup power.	The alternative has numerous components (>4 pump stations, storage facilities, treatment processes, etc.). Startup procedures are generally automated locally but may require operator testing/monitoring with redundant control systems and backup power.
		2. Proven technology? Are the control systems routinely used for similar facilities and similar applications?	The alternative employs standard processes commonly used in the West Section and within the industry. Control requirements are minimal and routinely used for similar facilities.	The alternative employs standard processes commonly used within the industry. Control requirements may be significant but are routinely used for similar facilities.	The alternative employs processes not commonly used within the industry. Control requirements may be significant and unique.
	4. Maintenance				
[REV 03/01/10]		1. What is the level of normal maintenance? How many mechanical/instrumentation components are required?	The facilities only requires annual preventive maintenance. The processes have minimal mechanical/instrumentation components .	The facilities require monthly maintenance such as bumping pumps. The processes have an increasing level of mechanical/instrumentation components.	The facilities require monthly maintenance such as bumping pumps. The processes have an increasing level of mechanical/instrumentation components.
[REV 03/01/10]		2. Are facility components accessible? Is there access and staging for chemical, vactor and boom trucks? Are traffic control procedures required for routine maintenance?	The facilities are accessible.	The facilities are accessible for routine O&M. Special procedures or traffic control may be required for irregular maintenance.	The facilities have restricted access for routine O&M. Special procedures or traffic control may be required for irregular maintenance.
[REV 03/01/10]		3. Do the facilities require interaction with other agencies?	Coordination with other agencies (Seattle Parks, etc.) is not required for operation and maintenance.	Coordination with other agencies (Seattle Parks, etc.) is not required for operation. Coordination is required for routine maintenance.	Coordination with other agencies is required for operation and maintenance. Coordination not required for operations however maintenance coordination is extensive requiring multiple days notice before significant entry.
	5. Safety				
		1. Does the facility have access requirements in the right of way or require confined space entry? Are traffic control procedures required? Does access require street use permit or lane closure?	The facility does not have right of way access requirements or require confined space entry. No traffic control procedures are required during operations and maintenance.	The facility has right of way access requirements or confined space entry during for non-routine operation and/or maintenance procedures. Traffic control procedures are required during non-routine operations and maintenance procedures.	The facility has right of way access requirements or confined space entry during for routine operation and/or maintenance procedures. Traffic control procedures are required during routine operations and maintenance procedures.
COST EFFECTIVNESS					
[REV 12/08/09]	**1. Relative Project Costs**				
		1. Are the Project Costs relatively clost to one another (i.e. project cost is not a differentiating factor in selecting an alternative), or is there a high degree of variability in Project Cost between the alternatives?	Alternative has the lowest Project Cost, or the Project Cost is tightly grouped near the lowest cost alternative relative to the expected accuracy of the estimate.	Alternative has a Project Cost that is significantly higher than the low cost alternative, and significantly lower than the high cost alternative, relative to the expected accuracy of the estimate.	Alternative has the highest Project Cost and/or is significantly higher than the next lowest cost alternative, relative to the expected accuracy of the estimate.
[REV 12/08/09]	**2. Relative Life-Cycle Costs**				
		1. Are the Life-Cycle Costs relatively clost to one another (i.e. life-cycle cost is not a differentiating factor in selecting an alternative), or is there a high degree of variability in Life-Cycel Cost between the alternatives?	Alternative has the lowest Life-Cycle Cost, or the Life-Cycle Cost is tightly grouped near the lowest cost alternative relative to the expected accuracy of the estimate.	Alternative has a Life-Cycle Cost that is significantly higher than the low cost alternative, and significantly lower than the high cost alternative, relative to the expected accuracy of the estimate.	Alternative has the highest Life-Cycle Cost and/or is significantly higher than the next lowest cost alternative, relative to the expected accuracy of the estimate.

Category	Sample Criteria	Sample Questions	Scale		
			Low Impact (rating of 3)	Moderate Impact (rating of 2)	High Impact (rating of 1)
[REV 12/08/09]	**3. Relative Variability/Risk**				
		1. At this level Project Costs are represented as having a range (low to high). Is there a high degree of variability in the estimated range of Project Cost for a particular alternative? (i.e. are their risk factors that could cause the cost of an alternative to increase significantly?)	There is a minimal spread in the Project Cost range (i.e. the difference between the high end and the low end of the Project Cost range is small relative to the expected accuracy of the estimate). There is low risk of the Project Cost growing significantly as the project develops.	There is a minimal spread in the Project Cost range (i.e. the difference between the high end and the low end of the Project Cost range is moderate relative to the expected accuracy of the estimate). There is moderate risk of the Project Cost growing significantly as the project develops.	There is a large spread in the Project Cost range (i.e. the difference between the high end and the low end of the Project Cost range is high relative to the expected accuracy of the estimate). There is a high risk of the Project Cost growing significantly as the project develops.
COMMUNITY IMPACT					
[REV 11/20/09]	**1. Location**				
		1. Does facility change or impede surrounding land and marine uses?	Facility does not change or impede surrounding land and marine use.	Facility design must be considered to limit changes or impediments to surrounding land and marine use.	Facility changes or impedes surrounding land and marine use, and changes can't be addressed during design.
[REV 11/20/09]	**2.Potential Community Impacts**				
[REV 11/30/09]		1. Can design make the facility compatible with community vision of itself at this stage, before specific conversations with potentially affected parties can occur?	Facility is consistent with or does not affect community's vision of itself.	Facility and grounds can be designed to remain consistent with community's vision of itself.	Facility type/size is distinct from character, use, community's vision of area and distinction can't be addressed through design.
		2. What are the impacts of O&M activities on the surrounding community?	Minimal staff will be present infrequently (intermittent or only during/after storms) and maintenance is carried out within facilities.	Routine maintenance will be needed by staff, and staff may be onsite round the clock to check facilities during large storms. Some special equipment may be necessary to maintain the facility, but noise/light/work hours, and/or traffic disruptions are minor.	Routine maintenance will be needed by staff, and multiple staff will be present around the clock during large storms, for special parking, traffic disruptions and or/access limitations to homes and businesses during maintenance operations.
[REV 11/20/09]	**3. Construction Impacts**				
		1. What is the construction schedule/duration?	Short term project in residential area, long term project in business/industrial area, or longer term project on alignment.	Project extends over 1 year on a site near residences of any kind, or over two years on an alignment.	Project extends several years, or follows another substantial construction project in one area.
		2. Will construction be carried out in public access areas, including parks, beaches and roadways?	Project located on site with no public access, or public access can be maintained during construction, and project is short duration or constructed outside main user season.	Project located in public access area; access may be reduced, but some access can be maintained during construction. Duration may be longer.	Project lasts year or more, located in heavy use roadway, park or beach area , with serious and unavoidable area closures, resulting in significant use impact.
		3. What are anticipated construction impacts to near neighbors? What are	Neighbors and businesses will experience limited impacts from	Construction will be located near residences and businesses, but impacts	Construction will be located adjacent to residences and businesses, and it
		4. How will truck traffic affect area?	Limited amount of hauling required for materials/equipment; roadways sufficient to support traffic (arterials).	Project requires moderate level of hauling that may occur on residential streets but can be scheduled and routed to avoid conflicts with neighborhood traffic, transportation, and services.	Project requires high volume, long term truck traffic on constricted roadways that cannot be carried out on a restricted schedule or route.
		5. What is construction area requirement?	Construction can be carried out on facility site, with limited offsite area required.	Construction can be carried out on facility site, but additional offsite areas will be required for equipment/materials storage or other activities.	Additional property or extensive easements must be obtained for the alternative to be constructed. Multiple offsite areas will be required for equipment/materials storage with ongoing transport of materials to primary construction site.
		2. Will construction be carried out in public access areas, including parks, beaches and roadways?	Project located in area with no public access, few neighbors, little commuter traffic.	Project located in public access area; however, area is closed only during winter (note high flow months).	Project located in heavy use roadway, park or beach area , resulting in area closure or significant use impact, with duration an entire dry weather season or longer.
		3. What are anticipated construction impacts to near neighbors? What are the traffic disruptions?	Construction will be located distant to residences and businesses. Haul routes.	Construction will be located near residences and businesses, but impacts will be minimal, or can be mitigated.	Construction will be located near residences and businesses, and it will be difficult or impossible to mitigate impacts such as noise, after hours work, light, vibration, and access.

NORTH BEACH BASIN ALTERNATIVES

CATEGORY / CRITERIA	ALTERNATIVE 1A: RECTANGULAR BOTTOM OF BASIN STORAGE WITH CONVEYANCE TO CARKEEK PUMP STATION		ALTERNATIVE 1B: PIPELINE BOTTOM OF BASIN STORAGE WITH CONVEYANCE TO CARKEEK PUMP STATION		ALTERNATIVE 1D: CENTRALIZED STORAGE AT BOTTOM OF BASIN WITH CONVEYANCE TO 8TH AVENUE INTERCEPTOR	
	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION
LAND USE AND PERMITTING						
1. City of Seattle Comprehensive Plan	2	Section 6.5 of the Seattle Comprehensive Plan (Utilities Element of the Planning Policies, U16) states that the City should work cooperatively with King County to identify and expeditiously address combined sewer overflows. Elsewhere in the Comp Plan (Land Use Element, Section 2.1, LU 61 & 62), uses in Single Family Residential neighborhoods should affirm and encourage residential use by one household as the principal use or should only encourage uses that are permitted outright.	3	Section 6.5 of the Seattle Comprehensive Plan (Utilities Element of the Planning Policies, U16) states that the City should work cooperatively with King County to identify and expeditiously address combined sewer overflows. Elsewhere in the Comp Plan (Land Use Element, Section 2.1, LU 61 & 62), uses in Single Family Residential neighborhoods should affirm and encourage residential use by one household as the principal use or should only encourage uses that are permitted outright. Because of the small size of the facilities, the alterantive may be consistent with the comprehensive plan.	2	Section 6.5 of the Seattle Comprehensive Plan (Utilities Element of the Planning Policies, U16) states that the City should work cooperatively with King County to identify and expeditiously address combined sewer overflows. Elsewhere in the Comp Plan (Land Use Element, Section 2.1, LU 61 & 62), uses in Single Family Residential neighborhoods should affirm and encourage residential use by one household as the principal use or should only encourage uses that are permitted outright.
2. Seattle Municipal Code	2	Located on or adjacent to existing pump station. Zoning is Single Family Residential. Utility Service Use is permitted as a City Council conditional use.	2	Located on or adjacent to existing pump station. Zoning is Single Family Residential. Utility Service Use is permitted as a City Council conditional use.	2	**Bottom of Basin Site:** Located on or adjacent to existing pump station. Zoning is Single Family Residential. Utility Service Use is permitted as a City Council conditional use. **Holman Road Site:** Zoning is Commercial. Utility Service Uses are permitted in C1-40 zones.
3. Shoreline Master Program	1	The storage tank would be located in a privately-owned park designated "Conservancy Recreation" (CR) in Seattle's Shoreline Master Program. Storage is considered a "Utility Service Use." Utility lines are permitted in CR, but Utility Service Uses are prohibited.	3	Storage is outside of the shoreline zone.	1	The storage tank would be located in a privately-owned park designated "Conservancy Recreation" (CR) in Seattle's Shoreline Master Program. Storage is considered a "Utility Service Use." Utility lines are permitted in CR, but Utility Service Uses are prohibited. Expansion of the pump station is permitted with City Council approval.
4. Permitting Complexity	2	This alternative will require a Shoreline Permit. Affected roadways in residential area with regional transportation (railway) adjacent to site. Will require careful traffic planning to maintain access. Work hours likely to be restricted.	3	This alternative likely does not require a Shoreline Permit. Affected roadways in residential area with regional transportation (railway) adjacent to site. Will require careful traffic planning to maintain access. Work hours likely to be restricted.	2	This alternative will require a Shoreline Permit. Affected roadways in residential area with regional transportation (railway) adjacent to site. Will require careful traffic planning to maintain access. Work hours likely to be restricted.
5. Property Acquisition Complexity	2	Private park zoned single family residential. Partial acquisition required. Concerns regarding acquisition from homeowners association. Approximately 1/4 Ac.	3	Assumes street use of 250 lineal feet for pipeline storage.	2	**Bottom of Basin Site:** Private park zoned single family residential. Partial acquisition required. Concerns regarding acquisition from homeowners association. Approximately 1/2 Ac. **Holman Road Site:** Assumes use of utility easement. Approximately 1/8 Ac. **Pipeline:** Extensive street right of way required.

NORTH BEACH BASIN ALTERNATIVES

CATEGORY / CRITERIA	ALTERNATIVE 1A: RECTANGULAR BOTTOM OF BASIN STORAGE WITH CONVEYANCE TO CARKEEK PUMP STATION		ALTERNATIVE 1B: PIPELINE BOTTOM OF BASIN STORAGE WITH CONVEYANCE TO CARKEEK PUMP STATION		ALTERNATIVE 1D: CENTRALIZED STORAGE AT BOTTOM OF BASIN WITH CONVEYANCE TO 8TH AVENUE INTERCEPTOR	
	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION
ENVIRONMENT						
1. Cultural Resources	3	No known archaeological sites or historic resources. Based on site characteristics, the project area has a low probability of containing archaeological resources. No historic properties within the project area.	3	No known archaeological sites or historic resources. Based on site characteristics, the project area has a low probability of containing archaeological resources. No historic properties within the project area.	3	No known archaeological sites or historic resources. Based on site characteristics, the project area has a low probability of containing archaeological resources. No historic properties within the project area.
2. Fish and Wildlife	3	Construction and operation of this alternative would not adversely affect fish and wildlife, or their habitat.	3	Construction and operation of this alternative would not adversely affect fish and wildlife, or their habitat.	3	Construction and operation of this alternative would not adversely affect fish and wildlife, or their habitat.
3. Wetlands, Streams and Shoreline	3	GIS maps show a piped stream crossing through the project area. This rating assumes that construction may relocate the pipe but there would be no adverse impacts to the stream, wetlands or shoreline.	3	GIS maps show a piped stream crossing through the project area. This rating assumes that construction may relocate the pipe but there would be no adverse impacts to the stream, wetlands or shoreline.	3	**Bottom of Basin Site:** Alternative replaces (by abandonment) the force main in the beach and along Piper's Creek with force mains located in areas that are not environmentally sensitive. GIS maps show a piped stream crossing through this project area. This rating assumes that construction may relocate the pipe but there would be no adverse impacts to the stream, wetlands or shoreline. **Holman Road Site:** No wetlands, streams or shoreline in this project area.
4. Soils and Sediments	3	No known contaminated sites. Project area is not within liquifaction zone. No steep slopes and/or known landslide areas. Potential landslide areas are located within project area, but it is assumed that construction of this alternative would not increase the likelihood of landslides.	3	No known contaminated sites. Project area is not within liquifaction zone. No steep slopes and/or known landslide areas. Potential landslide areas are located within project area, but it is assumed that construction of this alternative would not increase the likelihood of landslides.	2	No known contaminated sites in the vicinity of the Blue Ridge Park Site. There are known contaminated sites and potential to encounter contaminated soils in the vicinity of the drop structure and odor control facility site and pipeline alignment near Holman Road. Project area is not within liquifaction zone. No steep slopes and/or known landslide areas. Potential landslide areas are located within project area, but it is assumed that construction of this alternative would not increase the likelihood of landslides.
5. Water Quality	3	No new untreated discharges to surface waters.	3	No new untreated discharges to surface waters.	3	No new untreated discharges to surface waters.
TECHNICAL						
1. Technical Complexity	3	Single site. Simple approach. Gravity overflow from existing pump station wet well to gravity fill tank. Automatic cleaning and emptying after event will require telemetry and local controls. Flows exceeding tank capacity overflow to existing outfall. Undergrounding of support facilities required.	3	Single site. Simple approach. Gravity overflow from existing pump station wet well to gravity fill tank. Automatic cleaning and emptying after event will require telemetry and local controls. Flows exceeding tank capacity overflow to existing outfall. Undergrounding of support facilities likely.	2	Primary facilites on single site. Simplified control approach with pump station sized for baseline flows only with gravity overflow to storage. Automatic cleaning and emptying after event will require telemetry and local controls. Flows exceeding tank capacity overflow to existing outfall. Requires high head pumping
2. Compatibility with Existing WW System	3	Stand alone alternative. Passive diversion from existing overflow line.. Does not affect downstream capacity in county system.	3	Stand alone alternative. Passive diversion from existing overflow line. Does not affect downstream capacity in county system.	2	Stand alone alternative. Re-directs flow now going to Carkeek Pump Station. Passive diversion from new pump station wet well. Flows from new pump station and Carkeek Pump Station need to be limited. Effectively accelerates two future projects (new PS and forcemain). However, benefit is offset by high head pumping.
3. Flexibility/Adaptive Management	2	Storage tank not easily modified for enlargement.	2	Storage tank not easily modified for enlargement.	2	Storage tank and pump station not easily modified for enlargement.
4. Constructability/ Implementation Schedule	2	Risks associated with shoring, groundwater and limited space. Very limited staging and access area due to residential area. Alternative can likely meet the construction schedule. Better constructability in park, but offset (by ranking elsewhere), related to permitting.	2	Risks associated with shoring, groundwater and limited space. Very limited staging and access area due to residential area. Alternative can likely meet the construction schedule.	2	Risks associated with shoring, groundwater and limited space for pump station and storage facility. Limited staging and access area due to residential area. Alternative can likely meet the construction schedule. However, a more compressed design/construction period relative to other alternatives is required because of increased design complexity and construction effort.

NORTH BEACH BASIN ALTERNATIVES

CATEGORY / CRITERIA	ALTERNATIVE 1A: RECTANGULAR BOTTOM OF BASIN STORAGE WITH CONVEYANCE TO CARKEEK PUMP STATION		ALTERNATIVE 1B: PIPELINE BOTTOM OF BASIN STORAGE WITH CONVEYANCE TO CARKEEK PUMP STATION		ALTERNATIVE 1D: CENTRALIZED STORAGE AT BOTTOM OF BASIN WITH CONVEYANCE TO 8TH AVENUE INTERCEPTOR	
	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION	IMPACT RATING	DESCRIPTION
O&M						
1. Staffing	3	Facility can be automatically started (gravity overflow) and run autonomously under design conditions. Minimal staffing required for operation and shut down. Some staffing/supervision may be needed for cleaning. Facility should not impact downstream facilities.	2	Facility can be automatically started (gravity overflow) and run autonomously under design conditions. Minimal staffing required for operation and shut down. Additional staffing/supervision needed for cleaning due to location within public right-of-way. Facility should not impact downstream facilities.	3	Facility can be automatically started (gravity overflow) and run autonomously under design conditions. Minimal staffing required for operation and shut down. Some staffing/supervision may be needed for cleaning. Facility should not impact downstream facilities.
2. Training	3	Staff familiar with storage facilities. Similar control approaches to other facilities within the system can be specified for consistency.	3	Staff familiar with storage facilities. Similar control approaches to other facilities within the system can be specified for consistency.	3	Staff familiar with pump stations and storage facilities. Similar control approaches to other facilities within the system can be specified for consistency.
3. Reliability	3	System is not complex. Gravity diversion over a weir. Power not critical for ability to store peak flows. Storage is a proven technology for controlling peak flow events.	3	System is not complex. Gravity diversion over a weir. Power not critical for ability to store peak flows. Storage is a proven technology for controlling peak flow events.	3	System is not complex. Gravity diversion over a weir. Power not critical for ability to store peak flows. Storage is a proven technology for controlling peak flow events.
4. Maintenance	3	Alternative requires little maintenances. Minimal telemetry/controls to maintain (typical level sensing and pump system controls). Assumes no entry to storage.	2	Alternative requires little maintenances. Minimal telemetry/controls to maintain (typical level sensing and pump system controls). Assumes limited entry required to facilitate cleaning of pipeline storage.	2	Alternative requires more maintenance due to need for a two-stage pump station. Assumes no entry to storage.
5. Safety	3	No street access required. No traffic control procedures required. No street use/closure permit required.	2	No street access required for typical operations. Infrequent maintenance issues will require traffic control procedures and street use/closure permit.	3	No street access required. No traffic control procedures required. No street use/closure permit required.
COST EFFECTIVENESS						
1. Relative Project Costs	3	Relative Cost = 1.03	3	Relative Cost = 1.00	2	Relative Cost = 3.13
2. Relative Life Cycle Costs	3	Relative Cost = 1.02	3	Relative Cost = 1.00	2	Relative Cost = 3.22
3. Relative Variability/Risk	3	Assumed low. To be confirmed by risk analysis.	3	Assumed low. To be confirmed by risk analysis.	2	Assumed moderate compared to other alternatives. To be confirmed by risk analysis.
COMMUNITY IMPACT						
1. Location	1	Alternative requires acquisition of private property. Facility can be designed to be consistent with community's vision of itself. Does not address PS/FM facilities.	3	Pipeline in street is not visible. Ancillary facilites located within existing North Beach Pump Station site. Design will need to address concerns about light, noise, or odor control. Acquisition of private property is not required for this alternative. Does not address PS/FM facilities.	1	**Bottom of Basin Site:** Siting will require acquisition of private property. Facility will be visible from numerous properties uphill of the site. Design will need to address concerns about light, noise, or odor control. **Holman Road Site:** Facility would be located within existing utility easement. Site is visible but can be designed to be compatible with the surrounding commercial area.
2. Potential Community Impacts	1	Use will require frequent visits by O&M and potential heavy equipment access, primarily following a peak flow event. Assuming portion of Blue Ridge Park can be restored to park activities, some O&M activites may conflict with site uses and adjacent facilities requiring close coordination between O&M and the community.	2	Use will require frequent visits by O&M and potential heavy equipment access, primarily following a peak flow event. Maintenance activity in the right of way may require street closures.	1	Use will require frequent visits by O&M and potential heavy equipment access, primarily following a peak flow event. Assuming portion of Blue Ridge Park can be restored to park activities, some O&M activites may conflict with site uses and adjacent facilities requiring close coordination between O&M and the community. Project eliminates need for a second project to upgrade existing infrastructure.
3. Construction Impacts	1	Siting will affect adjacent properties during construction. Construction will create noise, dust and construction traffic impacts on local traffic and neighboring residences. Work hour and noise restrictions may impact the construction duration. It may be difficult to mitigate impacts through standard construction methods. Blue Ridge Park will be inaccessible during construction.	1	Siting will affect adjacent properties during construction. Construction will create noise, dust and construction traffic impacts on local traffic and neighboring residences. Work hour and noise restrictions may impact the construction duration. It may be difficult to mitigate impacts through standard construction methods. Blue Ridge Park will have limited access during construction.	1	Construction will create noise, dust and construction traffic impacts on local traffic and neighboring residences. Work hour and noise restrictions may impact the construction duration. It may be difficult to mitigate impacts through standard construction methods. Siting will affect adjacent properties during construction. Construction impacts various areas of the basin due to pipeline construction and facilities at two sites. Blue Ridge Park will be inaccessible during construction.

North Beach - CSO Risk Workshop -- Alternative 1A

7/28/2010

Risk Indentification			Risk Type		Risk Qualification			Risk Mitigation / Response
Risk #	Description of Risk Event	Addt'l Info	Threat (T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Probability	Impact	Workshop Rating	Description (Accept/Avoid/Transfer/Mitigate)
	Example Threat with Cost Impacts		T	C	H	L	HL	
	Example Opportunity with Schedule Impacts		O	S	M	H	MH	
1.0	**Land Use and Permitting**							
1.03	Challenge to Shoreline Permit application; appeal successful		T	B	H	H	HH	the project would be stopped and another alternative used
1.04	Code revisions due to SMP update will impact proposed uses at the site		O	S	L	M	LM	
1.05	Shoreline permit appealed; appeal unsuccessful	Design continues; risk differs from	T	S	L	M	LM	
1.06	City will not issue permit for storage in "Conservancy Recreation" Shoreline Designation; rezone or code amendment required	Design continues	T	S	H	H	HH	
1.08	City changes zoning rules prohibiting utility structures in Urban Residential zone	We show them in the park	T	B	L	H	LH	
1.09	Unanticipated delays or rejection of contractor procured permits		T	S	L	M	LM	
1.10	County procured construction permits delayed	(e.g. building, street use; clearing and	T	S	H	H	HH	Mitigate: Begin a code amendment process now
1.11	One or more construction codes change during design.		T	B	M	L	ML	
1.18	SDOT delays traffic permit	(includes haul	T	B	L	L	LL	
1.19	Structures cannot be located below-grade	1D will be above	T	C	M	L	ML	This is a project requirement
1.20	Industrial Waste requires that dewatering does not enter active system during peaking events during construction	Alternate discharge point (or Baker Tanks)	T	C	H	L	HL	
1.21	Force main discovered to be in poor shape during design; overlapping projects		T	S	L	M	LM	
2.0	**Environmental**							
2.02	SEPA appeal filed (successful), EIS required		T	B	L	H	LH	If appeal succesful, another alternative would be pursued
2.03	New species listed under ESA - section 7 consultation must be reinitiated		T	B	L	M	LM	
2.05	Archaeological resources found during construction		T	B	L	M	LM	
2.06	SEPA appeal filed (unsuccessful)		T	B	H	M	HM	
3.0	**Technical**							
3.03	Unknown utilities discovered during construction	Public utilities	T	C	M	L	ML	
3.04	Unanticipated difficult soils during construction		T	S	L	L	LL	
3.04	Unanticipated difficult soils during construction		T	S	L	L	LL	
3.09	Design errors and omissions	Delay	T	C	M	M	MM	This is contengency $$
3.11	Private property damage results from construction	Not appplicable to 1A and 1D	T	C	L	L	LL	
3.12	Dewatering volume greater than anticipated		T	B	M	L	ML	
3.15	Limited haul routes require significant restoration		T	B	H	M	HM	
3.21	Existing deep water outfall is not adequate to handle ultimate flow							
4.0	**Operations & Maintenance**							
4.01	Major change in configration after 30% design is completed		T	C	M	L	ML	Note: any major change will cost more
4.09	Auto cleaning not as effected as designed; change out of carbon required more frequently	Life cycle cost impact	T	C	M	L	ML	
5.0	**Community Impacts**							
5.08	Stakeholders request additional meetings to discuss the project (delay tactic)		T	S	H	H	HH	Accept
5.09	Community lobbies for expanded project scope and/or elements	(i.e. force main, pump station; but excludes	T	B	M	L	ML	
5.12	Park access as agreed cannot be maintained during construction; community protests		T	B	M	L	ML	Note: general park access will be agreed prior
5.16	Construction staging impacts community; complaints slow and/or stop work		T	S	H	M	HM	
5.22	Multiple communities have differing agendas; community advisory committee formed		T	C	H	L	HL	
6.0	**Experience/Capability of the Team / Resource Availability**							
6.01	KC Project Manager leaves		T	B	L	M	LM	
6.02	Key Staff leave project	King County or Consultant	T	B	H	M	HM	
6.04	Change in KC management direction / philosophy / policy and/or design criteria after Gate 3		T	B	L	M	LM	
6.05	Team member or contractor has insufficient experience/expertise to perform the work		T	B	M	L	ML	
6.06	Workload impacts ability of consultant or county team member to complete the work on schedule		T	S	M	L	ML	
7.0	**Contractor / Vendor Issues**							
7.02	Small Contractor Supplies (SCS) requirements change.		T	S	H	H	HH	Mitigate: work with KC Small Business Resource Economic Development; get interpretation in
7.03	Bid protest	No rebid	T	B	M	L	ML	
7.04	Final design consultant team uses significantly different design assumptions, causing an Amendment to the Facility Plan design		T	B	L	M	LM	
7.05	Off-site staging required; difficult to negotiate	Assume KC	T	B	H	M	HM	
7.06	Lack of competition increase bids		T	C	L	M	LM	
7.08	Contractor cannot meet noise limits		T	B	H	L	HL	
7.09	Vibration impacts adjacent properties		T	C	H	L	HL	
7.11	Current bid climate lowers bids by 20% or more		O	C	M	M	MM	

North Beach - CSO Risk Workshop -- Alternative 1A								
7/28/2010								
Risk Indentification			Risk Type		Risk Qualification			Risk Mitigation / Response
Risk #	Description of Risk Event	Addt'l Info	Threat (T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Probability	Impact	Workshop Rating	Description (Accept/Avoid/Transfer/Mitigate)
7.12	Bid protest	Rebid	T	B	L	H	LH	
9.0	**Property Acquisition**							
9.01	Blue Ridge Board agrees to grant an easement then changes mind	New board members not receptive to working with	T	B	H	H	HH	Neither of these alternatives would be pursued without easement already being obtained
9.05	Homeowners' review process takes longer than scheduled		T	S	H	M	HM	
9.07	Easement discovered that conflicts with use for project		T	B	L	M	LM	
9.11	Blue Ridge Board sued; all negotiations stopped with KC	Assume design continues	T	S	H	H	HH	Avoid: exercise eminent domain
10.0	**Project Funding**							
10.02	Low rate loan funding opportunities become available		O	C	H	H	HH	This would not deduct from risk cost
10.04	Current economic climate has favorable bid environment.		O	C	H	L	HL	
11.0	**CSO program**							
11.02	The staffing levels to manage and maintain facilities are inadequate for number of CSO facilities added to the system	Permit violations	T	C	M	L	ML	
12.0	**Interfaces**							
12.02	Project compliance schedule in permit not met	No fine; 12/31/13 scheduled for	T	C	L	M	LM	
13.0	**Safety**							
13.03	Auto accident in construction zone	Protected site	T	C	L	L	LL	
13.04	Vandalism or theft at jobsite		T	B	M	L	ML	
13.05	Sewage backup during construction	into basements	T	C	L	L	LL	
13.06	Death due to construction work in confined space	captures risk with	T	C	L	M	LM	
13.07	Injury due to occupational health	During O&M	T	C	H	L	HL	
13.08	Fatality during O&M		T	C	L	H	LH	

North Beach - CSO Risk Workshop

Alternative 1B

7/28/2010

Risk Indentification			Risk Type		Risk Qualification			Risk Mitigation / Response
Risk #	Description of Risk Event	Addt'l Info	Threat (T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Probability	Impact	Workshop Rating	Description (Accept/Avoid/Transfer/Mitigate)
	Example Threat with Cost Impacts		T	C	H	L	HL	
	Example Opportunity with Schedule		O	S	M	H	MH	
1.0	**Land Use and Permitting**							
1.09	Unanticipated delays or rejection of contractor procured permits		T	S	L	M	LM	
1.10	County procured construction permits delayed	(e.g. building, street use;	T	S	L	M	LM	
1.11	One or more construction codes change during design.		T	B	M	L	ML	
1.18	SDOT delays traffic permit	(includes	T	B	M	M	MM	
1.19	Structures cannot be located below-grade	1D will be	T	C	M	L	ML	This is a project requirement
1.20	Industrial Waste requires that dewatering does not enter active system during peaking events during construction	Alternate discharge point (or	T	C	M	L	ML	
2.0	**Environmental**							
2.02	SEPA appeal filed (successful), EIS required		T	B	L	H	LH	If appeal succesful, another alternative would be pursued
2.03	New species listed under ESA - section 7 consultation must be reinitiated		T	B	L	M	LM	
2.05	Archaeological resources found during construction		T	B	L	M	LM	
2.06	SEPA appeal filed (unsuccessful)		T	B	L	M	LM	
3.0	**Technical**							
3.03	Unknown utilities discovered during	Public	T	C	M	L	ML	
3.04	Unanticipated difficult soils during		T	S	L	L	LL	
3.10	Basis of design in error during design phase	(example: modeling leads to	T	B	L	M	LM	(mitigate with sizing factor of safety)
3.11	Private property damage results from construction	Not appplicable	T	C	L	L	LL	
3.12	Dewatering volume greater than		T	B	M	L	ML	
3.15	Limited haul routes require significant		T	B	M	L	ML	
3.20	Conflict with utilities causes alignment change during design		T	B	M	L	ML	
4.0	**Operations & Maintenance**							
4.01	Major change in configration after 30% design is completed		T	C	M	L	ML	Note: any major change will cost more
4.09	Auto cleaning not as effected as designed; change out of carbon required	Life cycle cost impact	T	C	M	L	ML	
5.0	**Community Impacts**							
5.09	Community lobbies for expanded project scope and/or elements	(i.e. force main, pump station; but	T	B	M	M	MM	
5.12	Park access cannot be maintained during construction; community protests		T	B	M	L	ML	Note: general park access will be agreed prior
5.16	Construction staging impacts community; complaints slow and/or stop work		T	S	H	M	HM	
6.0	**Experience/Capability of the Team / Resource**							
6.01	KC Project Manager leaves		T	B	L	M	LM	
6.02	Key Staff leave project	King County or	T	B	M	M	MM	
6.04	Change in KC management direction / philosophy / policy and/or design criteria		T	B	L	M	LM	
6.05	Team member or contractor has insufficient experience/expertise to		T	B	M	L	ML	
6.06	Workload impacts ability of consultant or county team member to complete the		T	S	M	L	ML	
7.0	**Contractor / Vendor Issues**							
7.02	Small Contractor Supplies (SCS) requirements change.		T	S	H	H	HH	Mitigate: work with KC Small Business Resource Economic Development; get interpretation in writing
7.03	Bid protest	No rebid	T	B	M	L	ML	
7.04	Final design consultant team uses significantly different design assumptions, causing an Amendment to the Facility		T	B	L	M	LM	
7.05	Off-site staging required; difficult to	Assume KC	T	B	M	M	MM	
7.06	Lack of competition increase bids		T	C	L	M	LM	
7.08	Contractor cannot meet noise limits		T	B	M	L	ML	
7.09	Vibration impacts adjacent properties		T	C	H	L	HL	
7.11	Current bid climate lowers bids by 20% or		O	C	M	M	MM	
7.12	Bid protest	Rebid	T	B	L	H	LH	
9.0	**Property Acquisition**							
9.07	Easement discovered that conflicts with use for project		T	B	L	M	LM	
10.0	**Project Funding**							
10.02	Low rate loan funding opportunities become available		O	C	H	H	HH	This would not deduct from risk cost

North Beach - CSO Risk Workshop								
Alternative 1B								
7/28/2010								
Risk Indentification			Risk Type		Risk Qualification			Risk Mitigation / Response
Risk #	Description of Risk Event	Addt'l Info	Threat (T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Probability	Impact	Workshop Rating	Description (Accept/Avoid/Transfer/Mitigate)
10.04	Current economic climate has favorable bid environment.		O	C	H	L	HL	
11.0	**CSO program**							
11.02	The staffing levels to manage and maintain facilities are inadequate for number of CSO facilities added to the	Permit violations	T	C	M	L	ML	
12.0	**Interfaces**							
12.02	Project compliance schedule in permit not met	No fine; 12/31/13 scheduled	T	C	L	M	LM	
13.0	**Safety**							
13.03	Auto accident in construction zone	Protected	T	C	L	L	LL	
13.04	Vandalism or theft at jobsite		T	B	M	L	ML	
13.05	Sewage backup during construction	into	T	C	L	L	LL	
13.06	Death due to construction work in confined space	captures risk with	T	C	L	H	LH	
13.07	Injury due to occupational health	During O&M	T	C	H	L	HL	
13.08	Fatality during O&M		T	C	L	H	LH	

North Beach - CSO Risk Workshop

Alternative 1D

7/28/2010

Risk Indentification			Risk Type		Risk Qualification			Response
Risk #	Description of Risk Event	Addt'l Info	Threat (T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Probability	Impact	Workshop Rating	Description (Accept/Avoid/Transfer/Mitigate)
	Example Threat with Cost Impacts		T	C	H	L	HL	
	Example Opportunity with Schedule		O	S	M	H	MH	
1.0	**Land Use and Permitting**							
1.03	Challenge to Shoreline Permit application; appeal successful		T	B	H	H	HH	the project would be stopped and another alternative used
1.04	Code revisions due to SMP update will impact proposed uses at the site		O	S	L	M	LM	
1.05	Shoreline permit appealed; appeal unsuccessful	Design continues; risk differs	T	S	L	M	LM	
1.06	"Conservancy Recreation" Shoreline Designation; rezone or code amendment required	Design continues	T	S	H	H	HH	
1.08	City changes zoning rules prohibiting utility structures in Urban Residential zone	We show them in the	T	B	L	H	LH	
1.09	Unanticipated delays or rejection of contractor procured permits		T	S	L	M	LM	
1.10	County procured construction permits delayed	(e.g. building, street use;	T	S	H	H	HH	Mitigate: Begin a code amendment process now
1.11	One or more construction codes change during design.		T	B	M	L	ML	
1.18	SDOT delays traffic permit	(includes	T	B	H	L	HL	
1.20	Industrial Waste requires that dewatering does not enter active system during peaking events during construction	Alternate discharge point (or	T	C	M	L	ML	
2.0	**Environmental**							
2.01	Contaminated soils/groundwater encountered during construction greater		T	B	M	L	ML	
2.02	SEPA appeal filed (successful), EIS required		T	B	L	H	LH	If appeal succesful, another alternative would be pursued
2.03	New species listed under ESA - section 7 consultation must be reinitiated		T	B	L	M	LM	
2.05	Archaeological resources found during construction		T	B	L	M	LM	
2.06	SEPA appeal filed (unsuccessful)		T	B	H	M	HM	
3.0	**Technical**							
3.03	Unknown utilities discovered during	Public	T	C	M	L	ML	
3.04	Unanticipated difficult soils during		T	S	L	L	LL	
3.10	Basis of design in error during design phase	(example: modeling leads to	T	B	L	M	LM	(mitigate with sizing factor of safety)
3.11	Private property damage results from construction	Not appplicable	T	C	L	L	LL	
3.12	Dewatering volume greater than anticipated		T	B	M	L	ML	
3.13	Extending utilities to new facilities is more difficult than expected	Power	T	B	M	H	MH	
3.15	Limited haul routes require significant		T	B	M	L	ML	
3.20	Conflict with utilities causes alignment change during design		T	B	M	M	MM	
4.0	**Operations & Maintenance**							
4.01	Major change in configration after 30% design is completed		T	C	M	L	ML	Note: any major change will cost more
4.09	Auto cleaning not as effected as designed; change out of carbon required more	Life cycle cost impact	T	C	M	L	ML	
5.0	**Community Impacts**							
5.08	Stakeholders request additional meetings to discuss the project (delay tactic)		T	S	H	H	HH	Accept
5.12	maintained during construction; community protests		T	B	M	L	ML	Note: general park access will be agreed prior
5.13	Other basin residents use political channels to file complaints about unequal negotiations and/or outreach		T	B	M	H	MH	
5.16	Construction staging impacts community; complaints slow and/or stop work		T	S	H	M	HM	
5.22	agendas; community advisory committee formed		T	C	H	L	HL	
6.0	**Experience/Capability of the Team / Resource**							
6.01	KC Project Manager leaves		T	B	L	M	LM	
6.02	Key Staff leave project	King County or	T	B	H	M	HM	
6.04	Change in KC management direction / philosophy / policy and/or design criteria		T	B	L	M	LM	
6.05	Team member or contractor has insufficient experience/expertise to perform		T	B	M	L	ML	
6.06	Workload impacts ability of consultant or county team member to complete the work		T	S	M	L	ML	

North Beach - CSO Risk Workshop

Alternative 1D

7/28/2010

Risk Indentification			Risk Type		Risk Qualification			Response
Risk #	Description of Risk Event	Addt'l Info	Threat (T); Opportunity (O)	Cost (C); Schedule (S); Both (B)	Probability	Impact	Workshop Rating	Description (Accept/Avoid/Transfer/Mitigate)
7.0	**Contractor / Vendor Issues**							
7.02	Small Contractor Supplies (SCS) requirements change.		T	S	H	H	HH	Mitigate: work with KC Small Business Resource Economic Development; get
7.03	Bid protest	No rebid	T	B	M	L	ML	
7.04	Final design consultant team uses significantly different design assumptions, causing an Amendment to the Facility Plan		T	B	L	M	LM	
7.05	Off-site staging required; difficult to	Assume KC	T	B	H	M	HM	
7.06	Lack of competition increase bids		T	C	L	M	LM	
7.07	Unanticipated long lead time items		T	S	L	H	LH	
7.08	Contractor cannot meet noise limits		T	B	H	L	HL	
7.09	Vibration impacts adjacent properties		T	C	H	L	HL	
7.10	Value Engineering of Facility Plan during design	Not a typical KC policy	O	B	H	M	HM	
7.11	Current bid climate lowers bids by 20% or		O	C	M	H	MH	
7.12	Bid protest	Rebid	T	B	L	H	LH	
9.0	**Property Acquisition**							
9.01	Blue Ridge Board agrees to grant an easement then changes mind	New board members not receptive to working with	T	B	H	H	HH	Neither of these alternatives would be pursued without easement already being obtained
9.05	Homeowners' review process takes longer than scheduled		T	S	H	M	HM	
9.07	Easement discovered that conflicts with use for project		T	B	L	M	LM	
9.10	Existing building encroaches on easement in Crown Hill Park		T	B	H	H	HH	Mitigate: clarify survey data for possible encroachment
9.11	Blue Ridge Board sued; all negotiations stopped with KC	Assume design	T	S	H	H	HH	Avoid: exercise eminent domain
10.0	**Project Funding**							
10.02	Low rate loan funding opportunities become available		O	C	H	H	HH	This would not deduct from risk cost
10.04	Current economic climate has favorable bid environment.		O	C	H	M	HM	
11.0	**CSO program**							
11.02	The staffing levels to manage and maintain facilities are inadequate for number of CSO facilities added to the system	Permit violations	T	C	M	L	ML	
12.0	**Interfaces**							
12.02	Project compliance schedule in permit not met	No fine; 12/31/13 scheduled for last day of construction	T	C	M	M	MM	
12.04	Project in conflict with other SDOT and 3rd party projects in vicinity; site access and construction conflict issues		T	B	M	M	MM	
13.0	**Safety**							
13.03	Auto accident in construction zone		T	C	M	L	ML	
13.04	Vandalism or theft at jobsite		T	B	M	L	ML	
13.05	Sewage backup during construction	into	T	C	L	L	LL	
13.06	Death due to construction work in confined space	captures risk with	T	C	L	M	LM	
13.07	Injury due to occupational health	During O&M	T	C	H	L	HL	
13.08	Fatality during O&M		T	C	L	H	LH	

Appendix D-1

STATE ENVIRONMENTAL REVIEW PROCESS (SERP) DOCUMENTATION

WASHINGTON STATE WATER POLLUTION CONTROL REVOLVING FUND
STATE ENVIRONMENTAL REVIEW PROCESS
ENVIRONMENTAL ISSUES CHECKLIST

Project Name: North Beach Combined Sewer Overflow Control Project

Applicant: King County Wastewater Treatment Division (WTD)

Application Number:

Reviewed By:

Date: May 16, 2011

Wesley Sprague

Wesley Sprague, WTD Community Services & Environmental Planning Supervisor

In Compliance: X

Not In Compliance: O

BACKGROUND

X Purpose and need.

To meet the combined sewer overflow (CSO) control standard of the National Pollutant Discharge Elimination System (NPDES) permit for the West Point Treatment Plant, the King County Department of Natural Resources and Parks Wastewater Treatment Division (WTD) proposes to reduce CSOs in its North Beach basin. CSOs occur when heavy rains cause flows of combined sanitary and storm sewage to exceed the capacity of the wastewater system. When this happens, a combination of untreated stormwater and diluted sewage is discharged to Puget Sound through two existing outfalls located near the North Beach Pump Station.

Between 2000 and 2007, there was an average of ten such CSOs annually in the North Beach Basin. The average annual total overflow volume was 2.2 million gallons (MG). King County's NPDES permit for the West Point Treatment Plant requires that the County implement controls to reduce CSOs in the North Beach Basin to an average of no more than one per year on a long term average.

To meet the CSO control standard, King County proposes to construct a wastewater storage pipeline in street right-of-way adjacent to the existing North Beach Pump Station and associated facilities on the King County-owned pump station property. In addition to the storage pipeline, the proposed project would include construction of a new diversion

structure and ancillary equipment facility (see Vicinity Map and Site Layout Plan in Appendix 1). Also, modifications would be made to the North Beach Pump Station site and adjacent public right-of-way where the storage pipeline would be located. Each of these project components is described in more detail below.

Diversion Structure and Storage Pipeline

All flow to the North Beach Pump Station would be routed through a new approximately 12'(l) x 8'(w) x 17'(h) diversion structure which would be located below ground on the North Beach Pump Station site. The structure would divert flows exceeding the capacity of the pump station and downstream force main to a new storage pipeline through a new approximately 20-inch-diameter influent pipeline.

The approximately 325-foot-long, 12-foot-diameter buried storage pipeline would be located in Triton Drive NW and NW Blue Ridge Drive public right-of-way and provide 0.23 MG of storage volume for combined sewage. The Site Layout Plan in Appendix 1 shows the area where it would be technically feasible to locate the pipeline. The exact location would be determined during design. The pipeline would contain submersible pumps that would be used to empty the pipeline following a wet weather event. Flows would be pumped into a new six-inch-diameter effluent pipeline that would connect to the local sewer system and flow to the North Beach Pump Station. The storage pipeline would also contain a flushing system to facilitate pipeline cleaning, and access features for routine and long-term operations and maintenance.

Ancillary Equipment Facility

An approximately 40'(l) x 20'(w) one-story (about 15 feet) tall ancillary equipment facility would be constructed on the North Beach Pump Station site to support the storage pipeline. The facility would house electrical and motor control panels, a standby power generator and diesel fuel storage tank, an odor control system, a ventilation system, and a utility water system.

Site Modifications

Modifications to the North Beach Pump Station site would include the following: 1) the existing access road would be permanently relocated from the southwest side of the pump station site to the northeast side in order to make room for the new ancillary equipment facility and provide access to that facility and the pump station for operations and maintenance purposes, 2) the existing fence that surrounds the pump station site would be restored or replaced to restrict public access during construction and after project completion, 3) bioretention facilities would be installed to treat stormwater runoff, and 4) the existing rockery retaining wall along the southwestern property boundary would be modified or replaced to facilitate site grading and construction.

Modifications to the Triton Drive NW and NW Blue Ridge Drive public right-of-way would include the following: 1) hatches and removable concrete lifting slabs would be installed to provide access to the buried storage pipeline, 2) pavement would be removed and restored, and 3) landscaping would be removed and the area replanted. Additionally, green stormwater infrastructure best management practices (BMPs) may be implemented

to control and treat stormwater (for example, use of bioretention facilities).

Construction of the proposed project is expected to begin in the first half of 2013 and take approximately 18-24 months to complete.

X Description of future environment without the project.

Without the proposed project, CSOs in the North Beach basin would not be controlled to Ecology's standard of no more than one CSO event per year on a long-term average.

X Description of existing environment.

The proposed project site is located in a single-family residential community in North Seattle next to Puget Sound. The ancillary equipment facility and diversion structure would be constructed on King County's existing North Beach Pump Station property. This property is bordered to the northwest by railroad tracks and Puget Sound, to the southwest by single-family residences, and to the southeast by Triton Drive NW and single-family residences. It is bordered to the northeast by Blue Ridge Park, an open space owned by the Blue Ridge Homeowners' Association.

The storage pipeline would be constructed in City of Seattle right-of-way under Triton Drive NW and NW Blue Ridge Drive. Adjacent properties on the southeast side of the right-of-way contain single-family residences. Adjacent properties on the northwest side of the right-of-way contain single-family residences, Blue Ridge Park, and the North Beach Pump Station.

Refer to Page 5 of Appendix 3 ("Environmental Baseline" Section) for a detailed discussion of the existing environment.

X Analysis of alternatives including where applicable: 1) flow and waste reduction measures, including infiltration/inflow reduction and pretreatment requirements; 2) alternative locations, capacities, and construction phasing of facilities; 3) alternative waste management techniques, including pretreatment, treatment and discharge, Wastewater reuse, land application, and individual systems; 4) alternative methods for management of sludge; and improving effluent quality through more efficient operation and maintenance.

Refer to the December 2010 Draft North Beach Combined Sewer Overflow Facility Plan for discussion of alternatives.

X Documentation.

A SEPA Determination of Nonsignificance (DNS) and Environmental Checklist were issued for the project on April 28, 2011. These documents are attached as Appendix 2.

X Public notice and participation.

Public notice for the project is in accordance with the State Environmental Policy Act.

ENVIRONMENTAL ELEMENTS

X Earth.

The Seattle geologic map indicates that surface deposits on the project site are Vashon recessional outwash, typically consisting of sand or gravel. The map indicates that this deposit is underlain by glaciolacustrine silt and clay, commonly called the Lawton Clay. Typically, the Lawton Clay in the project area is 50 feet or more thick and contains interbeds of fine sand.

The footprints of the proposed facilities are on lands that are flat or gently sloped.

A total of approximately 10,000 cubic yards (CY) of soil would be excavated during project construction, as described in the following paragraphs.

Approximately 100 cubic yards of material would be excavated for construction of the proposed diversion structure on the east end of the pump station site. The excavation would extend to a depth of approximately 17 feet and most likely be shored with stacked trench boxes or cantilevered shoring. Shoring is the process of bracing excavation walls in order to prevent their collapse. The use of shoring systems provides safety for workers in excavations and facilitates the excavation process.

An open trench would be excavated for construction of the proposed buried storage pipeline in Triton Drive NW and/or NW Blue Ridge Drive, depending on where the storage pipeline was located. Up to approximately 9,000 CY of material would be excavated and the depth of the excavation would be approximately 25 feet. The excavation would likely be supported by a braced, soldier pile and lagging shoring system in conjunction with dewatering and possible groundwater recharge. Soldier pile tie backs may be required. It is possible that the storage pipeline could also require the installation of piles to support it or tie downs to prevent it from uplifting.

If drawdown-induced settlement-sensitive soils were present and groundwater recharge was not feasible to prevent unacceptable settlement, then a relatively impermeable or watertight shoring system could be required. This would likely consist of soldier piles and sheet piles, secant piles, or a soil-mixed or slurry wall system. Soldier piles are steel beams with an I-shaped cross section. To create a relatively impermeable shoring system, they are installed approximately four to six feet apart and steel plates are placed between them. Secant pile walls consist of intersecting concrete piles. Piles would likely be sunk to depths of between 30 and 60 feet.

Open trenches would also be excavated between the proposed diversion structure and storage pipeline for installation of the proposed influent and effluent pipelines. This

would require excavation of approximately 1,000 CY of material. Trench boxes would most likely be used to shore the effluent pipeline excavation. Excavation for the influent pipeline would use the same type of shoring system that was used for the storage pipeline excavation.

Approximately 100 CY of material would be excavated for construction of the proposed ancillary equipment facility just west of the existing North Beach Pump Station. The facility would likely be supported on spread footings or a mat foundation. Minor over-excavation could be required if soft or loose soils were present at or below the foundation grade elevation. Shoring would probably not be required for construction of the ancillary equipment facility.

Up to approximately 7,500 CY of fill would be required to backfill the excavations described above. If the native materials were suitable, excavation spoils would be stockpiled and used for backfill. Excavated soils not used as backfill would be legally disposed of off-site at a location determined by the contractor. If the excavated soils were not of the appropriate quality for backfill, other material would be brought to the site and used as backfill. The source of imported material would be determined by the contractor and meet all pertinent project and legal requirements.

The existing rockery retaining wall along the southwestern property boundary would be partially or completely removed to facilitate site grading and construction. It would be replaced with a similar three-to five-foot-tall rock or concrete retaining wall following construction of the ancillary equipment facility.

Project construction activities would utilize construction-related BMPs such as temporary erosion and sediment control measures to minimize the potential for erosion and sedimentation. Typical BMPs that could be used include installing silt fences, covering bare soil and stockpiles, and regularly inspecting and repairing erosion and sediment control measures. Additional BMPs and other measures could include using appropriate means to minimize tracking of sediment onto public roadways by construction vehicles and restoring disturbed areas by replanting or repaving as soon as practical after construction is completed.

During construction, measures would be taken to ensure that surrounding structures were not damaged as a result of vibration or settlement. These measures would be specified in project plans and construction specifications and could include monitoring for vibration and/or settlement at the project site and/or nearby residences.

King County would conduct subsurface geotechnical investigations during design. Soil and groundwater information collected during these investigations would be used to design a shoring system(s) and dewatering plan that minimized the potential for vibration and settlement that could impact nearby structures.

Groundwater reinjection could be done to limit potential groundwater drawdown-induced settlement that could result from the dewatering of excavations.

X Clean Air Act, 42 U.S.C. 7506(c).

During construction of the project, the primary source of air emissions would include fossil fuel combustion by-products from construction equipment and trucks used to haul material to and from the project site, and dust from the excavation and grading activity. Air emissions from engines could increase during certain activities, such as queuing trucks for loading and offloading of materials, or during heavy excavation. BMPs that would be implemented to control dust include street sweeping, watering exposed soil surfaces, and covering soil stockpiles to help minimize the amount of fugitive dust and particulate pollution to the surrounding areas.

When the project is completed, diesel engine emissions would be emitted through a new exhaust stack on the pump station property during maintenance and operation of the standby power generator. It is anticipated that the generator would be operated for maintenance purposes once a month for approximately one hour. It is anticipated that the generator would be operated during emergency circumstances one or two times per year for a maximum of 24 hours.

Long-term impacts from odors associated with operation of the proposed project would be minimized and mitigated through several design features. Odor generation in the proposed diversion structure would be minimized by designing the structure to limit turbulence and keeping the hatches to the structure closed. Odors generated at the proposed storage pipeline would be minimized through use of the flushing system that would be installed to clean settled solids from the pipeline after each storage event.

Any odors generated within the pipeline from stored wastewater or solids not removed from the wash-down system would be mitigated through operation of the odor control facility housed in the ancillary equipment facility. The odor control system would consist primarily of a carbon adsorption scrubber vessel, mist eliminator, and fan. Gas concentrations at the odor control facility would be actively monitored to determine the functional performance of the facility and create an accurate schedule for replacement of the carbon filter media.

X Safe Drinking Water Act, Section 1424(e), PL 92-523, as amended.

During construction of the proposed project, no waste materials would be purposely discharged to surface waters, ground water, or the ground. Construction-related materials could enter ground or surface waters due to accidental spills, mechanical failures, or if construction activities are performed outside specified conditions.

The project would be constructed in accordance with applicable state and local permits, which would specify a range of measures designed to reduce or control potential surface, ground, or runoff water impacts. BMPs and erosion and sediment control measures would be employed during construction to minimize impacts to surface and ground water (e.g., maintaining spill containment and clean up material at the construction site,

disposing of spoils at an approved disposal site).

The purpose of the proposed project is to reduce the number of CSOs that are discharged to Puget Sound from the North Beach basin. After the project is completed, CSOs from the North Beach Basin would be reduced to an average of no more than one per year on a long-term average.

X Wild and Scenic Rivers Act, PL 90-542, as amended.

The project is not located on a river.

X Coastal Barrier Resources Act, 16 U.S.C. 3501 et seq..

There are no designated Coastal Barrier Islands in Washington State. The project would not affect any barrier islands.

X Executive Order 11990, Protection of Wetlands.

The project site does not contain any wetlands.

X Appropriate water conservation measures.

Not applicable.

X Executive Order 11988, Floodplain Management

The project does not lie within a 100-year floodplain.

X Plants.

Most of the vegetation on the pump station property and near the storage pipeline location in the right-of-way would be removed during construction. This would include grass, small shrubs, and small trees.

Vegetated areas removed or disturbed during construction would be replanted with drought-tolerant or native plantings, or both. Bioretention facilities would be created to control and treat stormwater on the pump station property and possibly in the right-of-way.

X Animals.

Animals that have been observed on or near the site include birds (e.g., hawks, eagles, songbirds) and rodents. Fish such as salmon, trout, and shellfish are found near the project site in Puget Sound, but the project would not involve any work in Puget Sound. Animals listed as threatened or endangered under the Federal Endangered Species Act (ESA) are discussed in the following Section.

BMPs would be used to preserve or enhance wildlife, such as storing materials away from surface waters and maintaining spill containment and clean up material at the construction site.

The project itself is a measure to minimize potential impacts to wildlife. Construction of the proposed project would reduce the volume of untreated sanitary sewage and stormwater that is discharged to Puget Sound from the North Beach basin, thereby reducing the potential for related adverse affects on aquatic life.

X Endangered Species Act 16 U.S.C. 1531 et. seq..
Fish and Wildlife Coordination Act, PL 85-624, as amended.

WTD prepared a Biological Assessment (BA) for the Environmental Protection Agency (EPA – the federal action agency) to evaluate the need for consultation on the project with the National Marine Fisheries Service (NMFS) and United States Fish and Wildlife Service (USFWS) under Section 7 of the ESA. The BA is attached as Appendix 3. The BA evaluated the project's potential effects to the ESA-listed species identified in the table below and their designated Critical Habitats. It concluded that the project would have no adverse effects on the species or their Critical Habitats.

Common Name	**Scientific Name**	**ESA Status**	**Jurisdiction**
Puget Sound ESU Chinook Salmon	*Oncorhynchus tshawytscha*	T	NMFS
Puget Sound DPS Steelhead	*Oncorhynchus mykiss*	T	NMFS
Coastal-Puget DPS Bull Trout	*Salvelinus confluentus*	T	USFWS
Canary Rockfish	*Sebastes pinniger*	T	NMFS
Yelloweye Rockfish	*Sebastes rubberrimus*	T	NMFS
Boccaccio Rockfish	*Sebastes paucispinis*	E	NMFS
Southern DPS North American Green Sturgeon	*Thaleichthys pacificus*	T	NMFS
Steller Sea Lion	*Eumetopias jubatus*	T	NMFS
Humpback Whale	*Megaptera novaeangliae*	E	NMFS
Southern Resident Killer Whale	*Orcinus orca*	E	NMFS
Marbled Murrelet	*Brachyramphus marmoratus*	T	USFWS

ESU = Evolutionarily Significant Unit
DPS = Distinct Population Segment
T = Threatened
E = Endangered
NMFS = National Marine Fisheries Service
USFWS = United States Fish and Wildlife Service

X Energy and natural resources.

Project construction and operation would utilize fossil fuels and electricity.

X Appropriate energy reduction measures.

Proposed lighting systems would be energy efficient.

X Environmental health.

Petroleum products, including fossil fuels, lubricants and solvents, would be used during construction. It is possible that spills of these substances could result in health hazards, however the potential for adversely affecting the environmental health of workers and nearby residents is very low.

BMPs and other measures would be used to avoid or contain/control any spills or other releases of hazardous materials during project construction. The contractor would prepare a health and safety plan as part of the contract for the proposed project. This plan would comply with all applicable health regulations and would detail measures to control environmental health hazards.

The project itself is a measure to reduce environmental health hazards. Installation of the CSO storage pipeline would reduce the risk of wastewater overflows to Puget Sound.

X Noise.

Construction noise would typically consist of engine and mechanical and scraping noises associated with the use of heavy equipment such as bulldozers, graders, excavators, and concrete mixers. These types of equipment typically generate noise in the range of 80-90 dBA at a distance of 50 feet. Construction noise levels would vary depending on the specific equipment used for particular activities. Hauling activities to and from the project site would contribute to traffic noise.

Noise levels associated with the installation of shoring systems and storage pipeline support piles (if required) would depend on the type of shoring and piles used and the method of installation. This would be determined by the contractor. An impact pile driver can generate noise measuring up to approximately 100 dBA at a distance of 50 feet. Other installation tools, such as a vibratory hammer or drilling, would generate less noise.

Noise would also be generated during construction by pumps used to dewater the storage pipeline excavation. The pumps would generate noise levels measuring approximately 80 dBA at a distance of 23 feet. Exact noise levels would depend on the dewatering method used, which would be determined by the contractor, and the amount of dewatering required. The dewatering pumps would likely be powered by a generator that would create noise levels measuring up to 60 dBA at a distance of 23 feet.

All demolition and construction activities would be performed consistent with the City of Seattle's Noise Control Ordinance. All impacts from noise generated by demolition and construction would be short-term and temporary in nature and would not constitute a substantial effect on the surrounding land uses. Construction activity would take place during daytime hours. It is anticipated that nighttime construction activity would not be

required. Dewatering pumps would run 24 hours per day during storage pipeline excavation. It is anticipated that dewatering pumping would occur for approximately 12-16 months.

Construction BMPs would be used to minimize demolition and construction noise. Examples of BMPs that could be used include:

- *using effective vehicle mufflers, engine intake silencers, and engine enclosures, and shutting off equipment when not in use*
- *locating activities away from sensitive receptors when possible*
- *using portable noise barriers placed around stationary equipment*
- *encouraging equipment drivers to avoid backing up as much as possible to reduce the use of back-up alarms*
- *using broadband back-up alarms to eliminate impacts of single-frequency high-pitched alarms*
- *notifying residents and businesses near the project area of upcoming noisy construction activities*
- *creating a 24-hour construction hotline to promptly respond to questions and complaints*

Following construction, noise would be generated by equipment such as the odor control unit, effluent pumps, and the standby diesel generator for very limited durations when maintenance occurred and during the one to two times each year that this equipment is expected to operate.

X Land use.

The project site is located in a single-family residential waterfront area. The proposed storage pipeline would be constructed in public right-of-way under Triton Drive NW and NW Blue Ridge Drive. The proposed ancillary equipment facility and diversion structure would be located on the adjacent King County-owned North Beach Pump Station property.

X Farmland Protection Policy Act, 7 U.S.C. 4201 it seq..

There are no prime or unique farmlands located in the project area.

X Coastal Zone Management Act of 1972, PL 92-538, as amended.

King County would document the project's compliance with the Federal Coastal Zone Management Act and Washington State's Coastal Zone Management Program by preparing and submitting to Ecology a federal consistency certification stating that the proposed project would not affect the coastal zone because it would not impact any land use, water use, or natural resource of the coastal zone.

X Shoreline management.

The project site is located next to Puget Sound and is designated as "Urban Residential" under Seattle's Shoreline Master Program. The project would not involve any work in Puget Sound or work within 200 feet of Puget Sound.

A City of Seattle Shoreline Substantial Development Permit would be required by the City of Seattle. The project would be constructed in accordance with the permit conditions and requirements.

X Housing.

No impacts to housing are anticipated.

X Aesthetics.

The visual quality of the immediate project area would be temporarily impacted during the approximately 18- to 24-month construction period. The most intensive construction work would occur during a six-month period when excavation for the storage pipeline is performed. Temporary visual impacts during construction would include the presence of construction equipment, work crews, dust/exhaust, materials, signage, temporary fencing, staging areas in the construction zone, and traffic congestion along haul routes. An approximately 50-foot-tall crane could be located on the project site for approximately four months.

After the project was completed, views of the North Beach Pump Station site would continue to be partially screened by a chain-link fence and landscaping. However, the ancillary equipment facility would be noticeable from surrounding properties that currently have views of the site and from vehicles traveling on Triton Drive NW, NW Blue Ridge Drive, and NW Neptune Place. The presence of the new above grade facility would alter views, but not block them.

The design process for the ancillary equipment facility would follow City of Seattle policies and guidelines for incorporating aesthetic considerations into design. King County would also consider input from the community on exterior materials and architectural elements of the facility to ensure that it is consistent with the residential waterfront setting. The design would likely include plantings of shrubs around the exterior which would provide partial screening of the facility. Any areas where landscaping was removed to construct the proposed project would be replanted.

X Light and glare.

Temporary lighting may be used at the beginning and end of work days when daylight hours are short. No nighttime construction is anticipated.

The proposed ancillary equipment facility would include exterior security lighting that would be used during nighttime hours. Full cutoff, low-intensity light fixtures would be

used. Additionally, the light fixtures would be configured so that light is not cast beyond the edge of the storage facility site to minimize light that would be noticeable from surrounding properties.

The use of highly reflective building materials and/or finishes in the design of the ancillary equipment facility exterior would be restricted.

X Multiple use including recreation, other open space, and environmental education.

Activities required for construction of the proposed facilities would result in temporary visual and noise impacts on recreational users of Blue Ridge Park. Blue Ridge Park is a 1.4-acre private, covenant-restricted, members-only facility that includes playground equipment, a playfield, picnic tables, and a picnic shelter. Impacts could also include temporary and intermittent access disruptions when construction is occurring in the right-of-way next to the park. It is possible that the contractor would occasionally not be able to provide safe pedestrian access to the park for several days at a time during construction. Additionally, the approximately five to six on-street parking spaces in front of the park along Triton Drive NW would be unavailable for use during most of the construction period.

The contractor would be required to maintain safe pedestrian access to Blue Ridge Park during construction, to the maximum extent practicable. Measures to ensure pedestrian safety could include the use of signage regarding park access routes, the placement of steel plates over open excavations to provide access, the use of temporary fencing or ecology blocks to designate safe walkways, and the use of flaggers or escorts to assist people accessing the park through or near the construction area. It is possible that access to the park could be intermittently unavailable for several days at a time during the construction period. Measures that could be taken to limit the number and duration of access restrictions to the park include considering the ability to maintain park access during design (siting) of the storage pipeline and development of construction sequencing. Additionally, a second park gate could be installed in a location where pedestrian access could be safely provided when access to the existing gate is blocked by construction activity.

Operation of the proposed facilities would not displace any existing recreational uses.

X Archaeological and Historic Preservation Act of 1974, PL 93-291. Executive Order 11593, Protection and Enhancement of the Cultural Environment. National Historic Preservation Act of 1966, PL 89-665, as amended.

A preliminary assessment of archaeological and historical resources in the North Beach basin was completed for the proposed project in November 2009. The assessment identified the project site as having a low probability for archaeological resources.

The proposed project would comply with the requirements of the National Historic Preservation Act. This includes the completion of a cultural resources survey for the

project site. If artifacts were uncovered during excavation, work would be stopped pending notification of and response from appropriate agencies.

X Transportation.

Temporary localized traffic impacts are anticipated during the approximately 18- to 24-month construction period. Temporary traffic impacts in the project area would include street closures, traffic and parking restrictions, and restricted access to residences and Blue Ridge Park.

Construction of the proposed storage pipeline in Triton Drive NW and NW Blue Ridge Drive would entail large open excavations in the right-of-way. This would require the temporary closure of portions of Triton Drive NW and NW Blue Ridge Drive in the project area for approximately six to twelve months. The road segments closed would change as excavation for the storage pipeline progressed. During the six- to twelve-month period, vehicular access to residences on the northwest and southeast sides of NW Blue Ridge Drive closest to the active construction zone may be limited and, at times, unavailable. The contractor would be required to provide safe pedestrian access to all residences at all times.

The duration of road closures and specific impacts to individual homes would be determined during final design and would depend upon the final location of the storage pipeline, the type of construction methods used, and construction sequencing. Impacts to specific properties would depend upon the extent and duration of construction activities next to each parcel, as disturbance at each parcel could vary greatly. King County would work with residents during final design to evaluate residential access needs. Siting of the storage pipeline and construction sequencing would be developed so as to minimize the impacts to residential access.

Temporary impacts to bus service would occur as a result of road closures, particularly along Triton Drive NW and NW Blue Ridge Drive. Detours and/or temporary bus routes would be required to maintain service to the area. School bus routes, garbage and recycling service, mail delivery, and other services requiring vehicular access in this area would also be temporarily disrupted. The extent and duration of the road closures, as well as temporary revisions to bus routes and other services, would be determined prior to the start of construction.

It is estimated that construction of the project would generate approximately 3,600 one-way truck trips to and from the project site.

During construction, most of the on-street parking on the sections of Triton Drive NW and NW Blue Ridge Drive that lie within the project site, including the parking area for five to six cars in front of Blue Ridge Park, would be temporarily unavailable. The duration of disruption would vary depending upon the location and stage of construction activity. The majority of the residences in the area have off-street parking and on-street parking is available just outside of the project area.

If necessary, contractor parking in and near the project area would be limited in order to ensure adequate on-street parking for residents and visitors. Contractors could be required to park off-site and carpool or shuttle to the project area.

Between approximately two and four parking spaces within the public right-of-way on Triton Drive NW and/or NW Blue Ridge Drive would be permanently eliminated. Two approximately 4'(w) x 8'(l) metal hatches would need to be placed on top of or near the proposed CSO storage pipeline to provide access for operation and maintenance staff. If these hatches were placed outside of the travelled right-of-way, parking would not be allowed on top of the hatches. Additionally, one or two on-street parking spaces could be permanently reserved for WTD operations and maintenance staff to ensure that they could safely and quickly access the proposed storage pipeline with the necessary equipment

At each end of the proposed storage pipeline, an approximately 10'(w) x 12'(l) opening would be covered with concrete lifting slabs. These slabs would be removed approximately once every three to five years so that the pipeline could be intensively cleaned. The slabs would most likely be located in the travelled right-of-way, but on-street parking spaces next to the slabs could be temporarily unavailable for approximately one or two weeks when this maintenance is occurring.

Additional on-street parking spaces could be permanently replaced by the installation of bioretention facilities. These modifications to the right-of-way would be determined during design and depend, in part, on City of Seattle requirements.

To construct the proposed project, a street use right-of-way permit would be required from the City of Seattle. Permit conditions would require a traffic control plan to be submitted and approved prior to the start of construction. The plan would identify traffic and parking restrictions and the locations of traffic control devices and signage. It would include detailed measures to address residential access, emergency vehicle access, road closures and detours, temporary bus route changes, and pedestrian safety. Potential measures that could be implemented include the use of protective barriers, fences, flaggers, foot and/or vehicle bridges, specified hours of residential vehicular access during active construction, provisions for emergency access, and steel plating.

Following construction, the right-of-way in the project area would be repaved (travelled portion) or otherwise restored (non-travelled portion) to meet current City of Seattle Department of Transportation pavement and street restoration requirements.

X Public Services.

The project would not impact or increase the need for public services.

X Utilities.

The completed project would use water and electricity provided by the City of Seattle.

Construction of the proposed project would require the temporary or permanent relocation of some utilities.

X Evaluating environmental consequences of proposed action. (Measures to mitigate adverse impacts, irreversible or irretrievable commitments of resources to the project, and the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.

No significant adverse environmental impacts or irreversible or irretrievable commitment of resources are associated with the proposed project. Refer to the SEPA DNS and Environmental Checklist in Appendix 2 for a more detailed discussion of the environmental impacts associated with the project.

X Minimizing adverse effects of the proposed action.

King County would comply with all permit conditions associated with the proposed project. Typical BMPs and other mitigation measures that could be implemented to minimize impacts to the environment are described in the SEPA environmental checklist and would be included in the construction plans and specifications for the project.

APPENDIX 1:

Project Maps
for the
North Beach Combined Sewer Overflow Control Project

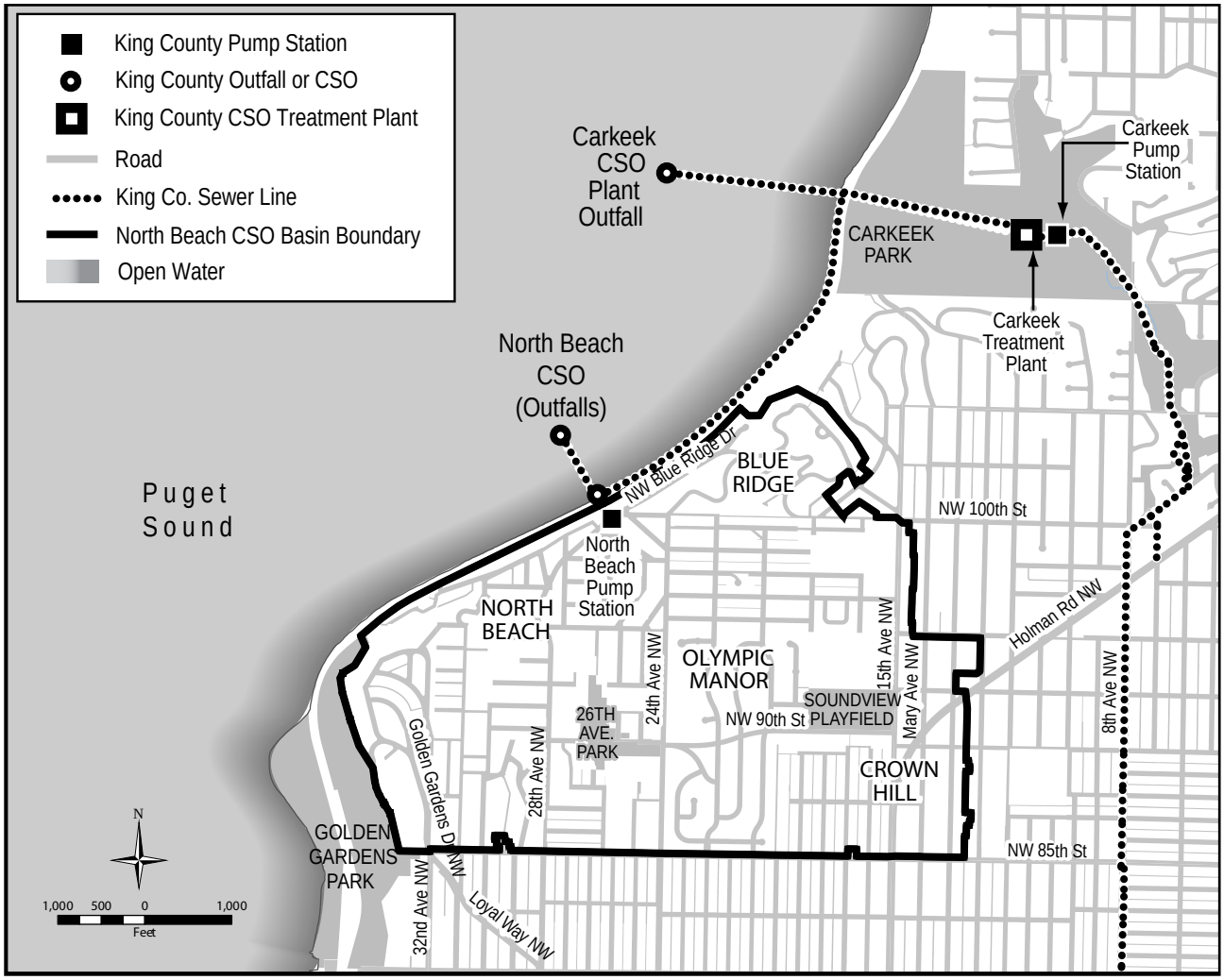
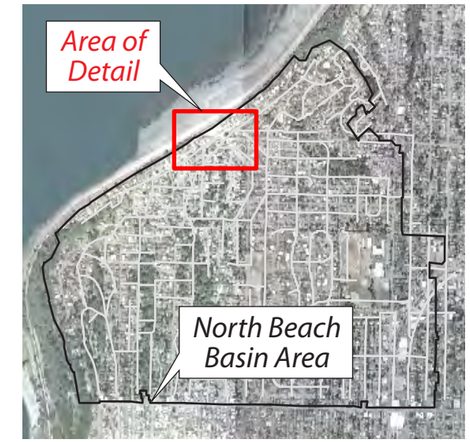


Figure 2-1_new.ai

NORTH BEACH COMBINED SEWER OVERFLOW CONTROL PROJECT VICINITY MAP

King County
Department of Natural Resources and Parks
Wastewater Treatment Division



N

0 50 100 150'
Approximate Scale

Legend

- Combined Sewer System
- Storm Sewer System
- Sanitary Sewer System
- 10' Topographic Contour
- Feasible Area for Pipe Location

NORTH BEACH
COMBINED SEWER OVERFLOW
CONTROL PROJECT SITE LAYOUT PLAN

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Figure 6-1_new.ai

APPENDIX 2:

State Environmental Policy Act
Determination of Nonsignificance/Environmental Checklist
for the
North Beach Combined Sewer Overflow Control Project

King County

Department of Natural Resources and Parks • Wastewater Treatment Division
Community Services and Environmental Planning • 201 South Jackson Street, MS KSC-NR-0505
Seattle, WA 98104-3855 • Phone 206-684-1714 • FAX 206-684-1278

DETERMINATION OF NONSIGNIFICANCE

TITLE OF PROPOSAL: North Beach Combined Sewer Overflow Control Project

DESCRIPTION OF PROPOSAL: To meet the combined sewer overflow (CSO) control standard of the National Pollutant Discharge Elimination System permit for the West Point Treatment Plant, the King County Wastewater Treatment Division proposes to construct a wastewater storage pipeline in street right-of-way adjacent to the existing North Beach Pump Station and associated facilities including a new diversion structure and ancillary equipment facility on the King County-owned pump station property. Construction of the proposed project is expected to begin in the first half of 2013 and take approximately 18-24 months to complete.

LOCATION OF PROPOSAL, INCLUDING STREET ADDRESS, IF ANY: The proposal is located at King County's North Beach Pump Station property and adjacent Triton Drive NW and NW Blue Ridge Drive public right-of-way. The street address of the pump station is 9921 Triton Drive NW. It is located in the City of Seattle, which is in King County, Washington. The project site is located in Section 35, Township 26N, Range 3E.

SEPA Responsible Official: Pam Elardo, P.E.

Position/Title: Director, King County Wastewater Treatment Division

Address: 201 South Jackson Street, MS KSC-NR-0501
Seattle, WA 98104-3855

Date: 4-21-11 **Signature:**

Proponent and Lead Agency: King County Department of Natural Resources and Parks
Wastewater Treatment Division

Contact Person: Sue Meyer, Water Quality Planner
King County Wastewater Treatment Division
201 South Jackson Street, MS KSC-NR-0505
Seattle, WA 98104
phone: 206-684-1171; e-mail: sue.meyer@kingcounty.gov

Issue Date: April 28, 2011

The State Environmental Policy Act (SEPA) lead agency for this proposal has determined that it does not have a probable significant adverse impact on the environment. An environmental impact statement is not required under RCW 43.21C.030(2)(c). This decision was made after review of a completed environmental checklist and other information on file with the lead agency. This information is available to the public on request.

☒ This Determination of Nonsignificance (DNS) is issued under WAC 197-11-340 (2); the lead agency will not act on this proposal for 17 days from the issue date. **Comments must be submitted by May 16, 2011.** Submit comments to Wesley Sprague, Supervisor, Community Services and Environmental Planning, King County Wastewater Treatment Division, 201 South Jackson Street, MS KSC-NR-0505, Seattle, WA 98104-3855.

☒ The Director of King County Department of Natural Resources and Parks, consistent with King County Public Rule 7-4-1, Section 6.2.14 and RCW 43.21C.240, has determined that the environmental impacts identified in the SEPA environmental checklist for the North Beach CSO Control Project will be adequately addressed by the development regulations and other applicable requirements of the City of Seattle and by all other applicable state and federal regulations referred to in the environmental checklist for the North Beach CSO Control Project. Therefore, no administrative appeal of issuance of the DNS will be allowed for the North Beach CSO Control Project. The rule may be viewed at http://www.kingcounty.gov/operations/policies/rules/utilities/put741pr.aspx, or contact Sue Meyer, Water Quality Planner, at 206-684-1171 or sue.meyer@kingcounty.gov to obtain a copy of the rule.

[Statutory authority: RCW 43.21C.110. 84-05-020 (Order DE 83-39), §197-11-970, filed 2/10/84, effective 4/4/84.]

King County
Department of Natural Resources and Parks
Wastewater Treatment Division
King Street Center, KSC-NR-0505
201 South Jackson Street
Seattle, WA 98104

Environmental Checklist

for the

North Beach Combined Sewer Overflow Control Project

April 14, 2011

Prepared in compliance with the State Environmental Policy Act (SEPA) (RCW 43.21C), the SEPA Rules (WAC 197-11), and Chapter 20.44 King County Code, implementing SEPA in King County procedures.

This information is available in accessible formats upon request at 206-684-1280 (voice) or 711 (TTY).

ENVIRONMENTAL CHECKLIST

A. BACKGROUND

1. Name of proposed project, if applicable:

North Beach Combined Sewer Overflow Control Project

2. Name of applicant:

King County Wastewater Treatment Division (WTD), Department of Natural Resources and Parks (DNRP)

3. Address and phone number of applicant and contact person:

King County Wastewater Treatment Division
201 South Jackson Street, MS: KSC-NR-0505
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4. Date checklist prepared:

April 14, 2011

5. Agency requesting checklist:

King County Wastewater Treatment Division, Department of Natural Resources and Parks

6. Proposed timing or schedule (including phasing, if applicable):

Construction of the proposed project is expected to begin in the first half of 2013 and take approximately 18-24 months to complete.

7. Do you have any plans for future additions, expansions, or further activity related to or connected with this proposal? If yes, explain.

In the future, King County plans to identify and evaluate approaches for inspecting the North Beach force main to obtain a current estimate of remaining service life. The inspection of this buried pipeline is complicated by its location in sensitive tidelands and its dedication as the single conveyance line from the North Beach Pump Station to the Carkeek Wet Weather Treatement Facility.

8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.

Archaeological and Historical Resources in the North Beach Sub-Basin, Seattle, Washington, Cascadia Archaeology, November 2, 2009.

Environmental Conditions Technical Memorandum, North Beach Basin Puget Sound CSO Project, ESA Adolfson, April 23, 2010.

Noise Technical Memorandum, North Beach Basin Alternative 1B; Barton, Murray, Magnolia and North Beach CSO Project, ESA Adolfson, December 6, 2010.

Recreation and Aesthetic Resources Technical Memorandum, North Beach Basin Alternative 1B; Barton, Murray, Magnolia and North Beach CSO Project, ESA Adolfson, December 6, 2010.

Traffic Technical Memorandum, North Beach Basin Alternative 1B; Barton, Murray, Magnolia and North Beach CSO Project, ESA Adolfson, March 10, 2011.

Preliminary Geologic/Geotechnical Evaluation of North Beach Alternatives, Seattle, Washington, Shannon & Wilson, Inc., August 24, 2010.

Draft North Beach Combined Sewer Overflow Control Facility Plan, Carollo Engineers, December 2010. This report will be finalized and submitted to Ecology for approval by July 2011.

North Beach CSO Control Project Biological Assessment—Letter of "No Effect", ESA Adolfson, March 10, 2011.

Washington State Water Pollution Control Revolving Fund State Environmental Review Process Environmental Issues Checklist—North Beach CSO Control Project, King County Wastewater Treatment Division, March 24, 2011.

Additional environmental information that will be prepared for the proposed project includes reports summarizing the findings of a cultural resources survey and subsurface geotechnical investigations that will be performed in the project area.

9. Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? If yes, explain.

None known

10. List any government approvals or permits that will be needed for your proposal, if known.

<u>City of Seattle</u>

Department of Planning and Development:

- Master Use Permit (includes Shoreline Substantial Development Permit)
- Noise Variance Permit

Department of Transportation:

- Street Use: Major Utility Permit or Street Improvement Permit
- Street Use Permit

<u>King County</u>

- Industrial Waste Permit

<u>Puget Sound Clean Air Agency</u>

- Air Quality Permit

Washington State Department of Ecology

- National Pollutant Discharge Elimination System (NPDES) Construction Stormwater General Permit
- Underground Storage Tank Notification
- State Environmental Review Process

11. Give brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page. (Lead agencies may modify this form to include additional specific information on project description).

King County's North Beach Pump Station receives flows of combined sanitary sewage and stormwater collected in the North Beach Basin, which is located in north Seattle on Puget Sound. The Basin includes Seattle's Loyal Heights, Crown Hill and Greenwood areas. Wastewater in the Basin is collected by City of Seattle facilities and conveyed to the North Beach Pump Station. From there, flows are conveyed by the North Beach Force Main to the Carkeek Pump Station. During dry weather, flows are then routed to the West Point Treatment Plant in the Magnolia neighborhood of the City of Seattle where they are treated, disinfected, and then discharged to Puget Sound. Under peak flow conditions, some of the flow pumped from the North Beach Pump Station receives primary treatment at the Carkeek Wet Weather Treatment Facility and is then discharged to Puget Sound.

The North Beach Pump Station and Force Main have the capacity to convey a peak flow rate of approximately three million gallons per day (MGD). When heavy rains cause flows to exceed the capacity of the wastewater system, a combination of stormwater and diluted sewage is discharged to Puget Sound through two existing outfalls located near the pump station. Between 2000 and 2007, there was an average of 10 such combined sewer overflows (CSOs) annually in the North Beach Basin. The average annual total overflow volume was 2.2 million gallons (MG). King County's NPDES permit for the West Point Treatment Plant requires that the County implement controls to reduce CSOs in the North Beach Basin to an average of no more than one per year on a long term average.

To meet the CSO control standard, King County proposes to construct a wastewater storage pipeline in street right-of-way adjacent to the existing North Beach Pump Station and associated facilities on the King County-owned pump station property. In addition to the storage pipeline, the proposed project would include construction of a new diversion structure and ancillary equipment facility (see attached Site Layout Plan). Also, site modifications would be made to the North Beach Pump Station site and adjacent public right-of-way where the storage pipeline would be located. Each of these project components is described in more detail below.

Diversion Structure and Storage Pipeline

All flow to the North Beach Pump Station would be routed through a new approximately 12'(l) x 8'(w) x 17'(d) diversion structure which would be located below ground on the North Beach Pump Station site. The structure would divert flows exceeding the capacity of the pump station and downstream force main to a new storage pipeline through a new approximately 20-inch-diameter influent pipeline.

The approximately 325-foot-long, 12-foot-diameter buried storage pipeline would be located in Triton Drive NW and NW Blue Ridge Drive public right-of-way and

provide 0.23 MG of storage volume for combined sewage. The attached Site Layout Plan shows the area where it would be technically feasible to locate the pipeline. The exact location would be determined during design. The pipeline would contain submersible pumps that would be used to empty the pipeline following a wet weather event. Flows would be pumped into a new six-inch-diameter effluent pipeline that would connect to the local sewer system and flow to the North Beach Pump Station. The storage pipeline would also contain a flushing system to facilitate pipeline cleaning, and access features for routine and long-term operations and maintenance.

Ancillary Equipment Facility
An approximately 40'(l) x 20'(w) one-story (about 15 feet) tall ancillary equipment facility would be constructed on the North Beach Pump Station site to support the storage pipeline. The facility would house electrical and motor control panels, a standby power generator and diesel fuel storage tank, an odor control system, a ventilation system, and a utility water system.

Site Modifications
Modifications to the North Beach Pump Station site would include the following items: 1) the existing access road would be relocated from the southwest side of the pump station site to the northeast side in order to make room for the new ancillary equipment facility and provide access to that facility and the pump station for operations and maintenance purposes, 2) the existing fence that surrounds the pump station site would be restored or replaced to restrict public access during construction and after project completion, 3) bioretention facilities would be installed to treat stormwater runoff, and 4) the existing rockery retaining wall along the southwestern property boundary would be modified or replaced to facilitate site grading and construction.

Modifications to the Triton Drive NW and NW Blue Ridge Drive public right-of-way would include the following items: 1) hatches and removable concrete lifting slabs would be installed to provide access to the buried storage pipeline, 2) pavement would be removed and restored, and 3) landscaping would be removed and the area replanted. Additionally, green stormwater infrastructure best management practices (BMPs) may be implemented to control and treat stormwater (for example, use of bioretention facilities).

12. Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.

The project site would include the approximately 10,300 square-foot King County-owned parcel on which the North Beach Pump Station is located and approximately 48,000 square feet of adjacent Triton Drive NW and NW Blue Ridge Drive public right-of-way. The street address of the pump station is 9921 Triton Drive NW. It is located in the City of Seattle, which is in King County, Washington. The project site is located in Section 35, Township 26N, Range 3E. Please see attached Vicinity Map and Site Layout Plan.

Offsite staging areas would be identified by the construction contractor.

B. ENVIRONMENTAL ELEMENTS

1. Earth

a. General description of the site (circle one): Flat, rolling, hilly, steep slopes, mountainous, other: gentle slopes.

In the project area, Triton Drive NW rises gently to the southwest and NW Blue Ridge Drive rises gently to the northeast. The North Beach Pump Station property is generally flat.

b. What is the steepest slope on the site? (approximate percent slope)?

The steepest slope on the site is approximately 10 percent.

c. What general types of soils are found on the site? (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any prime farmland.

The Seattle geologic map indicates that surface deposits on the project site are Vashon recessional outwash, typically consisting of sand or gravel. The map indicates that this deposit is underlain by glaciolacustrine silt and clay, commonly called the Lawton Clay. Typically, the Lawton Clay in the project area is 50 feet or more thick and contains interbeds of fine sand.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

The westernmost tip of the North Beach Pump Station Site is identified by the City of Seattle as a potential landslide area. Excavation within this area is not planned.

e. Describe the purpose, type, and approximate quantities of any filling or grading proposed. Indicate source of fill.

A total of approximately 10,000 cubic yards (CY) of soil would be excavated during project construction, as described in the following paragraphs.

Approximately 100 cubic yards of material would be excavated for construction of the proposed diversion structure on the east end of the pump station site. The excavation would extend to a depth of approximately 17 feet and most likely be shored with stacked trench boxes or cantilevered shoring. Shoring is the process of bracing excavation walls in order to prevent their collapse. The use of shoring systems provides safety for workers in excavations and facilitates the excavation process.

An open trench would be excavated for construction of the proposed buried storage pipeline in Triton Drive NW and/or NW Blue Ridge Drive, depending on where the storage pipeline was located. Up to approximately 9,000 CY of material would be excavated and the depth of the excavation would be approximately 25 feet. The excavation would likely be supported by a braced, soldier pile and lagging shoring system in conjunction with dewatering and possible groundwater recharge (see Section B.3.b.1). Soldier pile tie backs may

be required. It is possible that the storage pipeline could also require the installation of piles to support it or tie downs to prevent it from uplifting.

If drawdown-induced settlement-sensitive soils were present and groundwater recharge was not feasible to prevent unacceptable settlement, then a relatively impermeable or watertight shoring system could be required. This would likely consist of soldier piles and sheet piles, secant piles, or a soil-mixed or slurry wall system. Soldier piles are steel beams with an I-shaped cross section. To create a relatively impermeable shoring system, they are installed approximately four to six feet apart and steel plates are placed between them. Secant pile walls consist of intersecting concrete piles. Piles would likely be sunk to depths of between 30 and 60 feet.

Open trenches would also be excavated between the proposed diversion structure and storage pipeline for installation of the proposed influent and effluent pipelines. This would require excavation of approximately 1,000 CY of material. Trench boxes would most likely be used to shore the effluent pipeline excavation. Excavation for the influent pipeline would use the same type of shoring system that was used for the storage pipeline excavation.

Approximately 100 CY of material would be excavated for construction of the proposed ancillary equipment facility just west of the existing North Beach Pump Station. The facility would likely be supported on spread footings or a mat foundation. Minor over-excavation could be required if soft or loose soils were present at or below the foundation grade elevation. Shoring would probably not be required for construction of the ancillary equipment facility.

Up to approximately 7,500 CY of fill would be required to backfill the excavations described above. If the native materials were suitable, excavation spoils would be stockpiled and used for backfill. Excavated soils not used as backfill would be legally disposed of off-site at a location determined by the contractor. If the excavated soils were not of the appropriate quality for backfill, other material would be brought to the site and used as backfill. The source of imported material would be determined by the contractor and meet all pertinent project and legal requirements.

The existing rockery retaining wall along the southwestern property boundary would be partially or completely removed to facilitate site grading and construction. It would be replaced with a similar three-to five-foot-tall rock or concrete retaining wall following construction of the ancillary equipment facility.

f. Could erosion occur as a result of clearing, construction, or use? If so, generally describe.

Yes, construction activities such as site grading and excavation, materials handling, and stockpiling could cause erosion on a short-term basis. Short-term erosion could also result from the exposure of stockpiled spoils and fill. Erosion control measures would be implemented to minimize potential erosion (see Section B.1.h., below).

Operation of the completed project would not result in any erosion.

g. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?

Approximately 3,800 square feet of the approximately 10,800 square-foot pump station site (where the ancillary equipment facility would be built) is currently covered with impervious surface. After the project was completed, the site would contain an additional approximately 1,400 square feet of impervious surface. It is estimated that the impervious surface on the pump station site would increase from 35 percent to 48 percent.

Approximately 46,000 square feet of the approximately 48,000 square-foot pipeline storage project area is currently covered with impervious surface. After the project is completed, this area could contain an additional approximately 2,000 square feet of impervious surface, depending on permit requirements. The impervious surface on the pipeline storage area could increase from 96 percent to 100 percent.

h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any:

Project construction activities would utilize construction-related BMPs such as temporary erosion and sediment control measures to minimize the potential for erosion and sedimentation. Typical BMPs that could be used include installing silt fences, covering bare soil and stockpiles, and regularly inspecting and repairing erosion and sediment control measures. Additional BMPs and other measures could include using appropriate means to minimize tracking of sediment onto public roadways by construction vehicles and restoring disturbed areas by replanting or repaving as soon as practical after construction is completed.

Temporary erosion and sediment control measures would be identified in the project plans and construction specifications and would be implemented as required by the City of Seattle.

During construction, measures would be taken to ensure that surrounding structures were not damaged as a result of vibration or settlement. These measures would be specified in project plans and construction specifications and could include monitoring for vibration and/or settlement at the project site and/or nearby residences.

King County would conduct subsurface geotechnical investigations during design. Soil and groundwater information collected during these investigations would be used to design a shoring system(s) and dewatering plan that minimized the potential for vibration and settlement that could impact nearby structures.

Groundwater reinjection could be done to limit potential groundwater drawdown-induced settlement (Section B.3.b.1 describes potential excavation dewatering activities).

2. Air

a. What types of emissions to the air would result from the proposal (i.e., dust, automobile emissions, odors, industrial wood smoke) during construction

and when the project is completed? If any, generally describe and give approximate quantities if known.

During construction of the project, the primary source of air emissions would include fossil fuel combustion by-products from construction equipment and trucks used to haul material to and from the project site, and dust from the excavation and grading activity. Air emissions from engines could increase during certain activities, such as queuing trucks for loading and offloading of materials, or during heavy excavation.

After the project is constructed, it is not anticipated that sewage odors would be noticeable outside of the proposed facility under normal operating conditions. Odors associated with operation and maintenance of the facility would be minimized and mitigated through several design features (see Section B.2.c).

When the project is completed, diesel engine emissions would be emitted through a new exhaust stack on the pump station property during maintenance and operation of the standby power generator. It is anticipated that the generator would be operated for maintenance purposes once a month for approximately one hour. It is anticipated that the generator would be operated during emergency circumstances one or two times per year for a maximum of 24 hours.

A King County Greenhouse Gas Emissions Worksheet is attached.

b. Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe.

No

c. Proposed measures to reduce or control emissions or other impacts to air, if any:

BMPs would be implemented to control dust during construction. Types of BMPs that would be used include street sweeping, watering exposed soil surfaces, and covering soil stockpiles to help minimize the amount of fugitive dust and particulate pollution to the surrounding areas.

Long-term impacts from odors associated with operation of the proposed project would be minimized and mitigated through several design features. Odor generation in the proposed diversion structure would be minimized by designing the structure to limit turbulence and keeping the hatches to the structure closed. Odors generated at the proposed storage pipeline would be minimized through use of the flushing system that would be installed to clean settled solids from the pipeline after each storage event.

Any odors generated within the pipeline from stored wastewater or solids not removed from the wash-down system would be mitigated through operation of the odor control facility housed in the ancillary equipment facility. The odor control system would consist primarily of a carbon adsorption scrubber vessel, mist eliminator, and fan. Gas concentrations at the odor control facility would be actively monitored to determine the functional performance of the facility and create an accurate schedule for replacement of the carbon filter media.

The standby power generator would use a diesel engine designed to minimize the discharge of gaseous pollutants to the atmosphere. The engine would meet a minimum of Environmental Protection Agency Non-road Tier One diesel engine emissions requirements.

3. Water

a. Surface:

1) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, or wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.

The project site is located next to Puget Sound.

Two streams enter the storm drainage system approximately 200 feet southeast of the proposed project site near the intersection of Marmount Drive NW and NW North Beach Drive. The storm drain that carries the streams crosses through the project area and discharges to Puget Sound.

Stormwater is conveyed by sections of open ditch and pipe along the southeast side of the NW Blue Ridge Drive right-of-way. After the stormwater enters a pipe at the intersection of NW Neptune Place and NW Blue Ridge Drive, it is conveyed to Puget Sound by a stormwater pipe.

2) Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans.

Yes. The ditch located along NW Blue Ridge Drive would be in or next to the proposed storage pipeline excavation footprint. Stormwater conveyed by this ditch would likely be diverted around the storage pipeline excavation during construction (See Section B.3.a.4).

The storm sewer pipeline that carries the two streams described in Section B.3.a.2 could be in or next to the storage pipeline excavation footprint. Flow in this pipeline may need to be temporarily bypassed around or over the excavation in order to construct the proposed project.

The proposed project would not require any in-water work or work within 200 feet of Puget Sound.

3) Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.

None

4) Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.

Yes. During project construction, surface water runoff carried by the ditch along NW Blue Ridge Drive would most likely need to be diverted around the storage pipeline excavation. Street frontage modifications required for the proposed project could involve permanent reconfiguration or replacement of the ditch for stormwater conveyance. Modifications to the right-of-way could also include implementation of green stormwater infrastructure BMPs to control and treat stormwater (for example, use of bioretention facilities).

Flow in the storm sewer pipeline that carries the two streams described in Section B.3.a.2 may need to be temporarily bypassed around or over the storage pipeline excavation in order to construct the proposed project.

Following construction of the proposed project, stormwater runoff on the pump station site would be directed to new bioretention facilities on the property.

The completed project would reduce the volume of untreated stormwater and sanitary sewage that is discharged to Puget Sound in the form of CSOs. During wet weather events where the capacity of the North Beach Pump Station and Force Main was exceeded, sanitary sewage and stormwater collected in the North Beach Basin would be diverted to the storage pipeline then pumped back to the local sewer system when capacity was available. These flows would be conveyed to the Carkeek and/or West Point Treatment Plants for treatment prior to being discharged to Puget Sound.

5) Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.

No

6) Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.

No. As described above in Section B.3.a.4, the proposed project would reduce the discharge of untreated sanitary sewage and stormwater to Puget Sound.

b. Ground:

1) Will ground water be withdrawn, or will water be discharged to groundwater? Give general description, purpose, and approximate quantities if known.

The depth to groundwater at the project site is not currently known, but it is probably close to the ground surface because the project site is located at the bottom of the North Beach surface water drainage basin. It is assumed that groundwater would be encountered during excavation for the proposed storage pipeline, diversion structure, and pipelines that would connect those two facilities. Some form of dewatering would be required to keep the excavations free of water. It is expected that dewatering would be required for approximately 12-16 months.

The amount of dewatering required would depend, in part, on the type(s) of shoring system used for the excavations and selection of shoring methods would be determined, in part, by groundwater conditions. If a permeable shoring system was used, such as soldier piles and wood lagging, dewatering volumes could be 700,000 gallons per day or more. Some of this water may be reinjected into the ground to limit potential groundwater drawdown-induced settlement. If a relatively impermeable shoring system was used, such as secant piles, dewatering volumes would be closer to approximately 25,000 gallons per day.

Dewatering water would be discharged to the King County sewer system or directly to Puget Sound through the existing stormwater drainage system. The stormwater drainage system would only be used if capacity were available. Some dewatering water could also be reinjected into the ground. Discharge of dewatering water to the sewer system would require a King County Industrial Waste Discharge Permit. Any dewatering water discharged directly to Puget Sound would have to meet Washington State Water Quality Standards.

2) Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example, Domestic sewage; industrial, containing the following chemicals...; agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.

None

c. Water Runoff (including storm water):

1) Describe source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

The source of runoff during and after construction would be rainfall. Runoff on the site currently enters a storm drainage system that either discharges to Puget Sound or flows into the sewer system. Runoff control measures during and after construction would comply with the City of Seattle's stormwater management requirements.

Stormwater conveyed in the existing drainage ditch located along the southeast side of NW Blue Ridge Drive right-of-way would likely be diverted around the storage pipeline excavation. It would then be directed back into either the wastewater system or a storm drain that discharges to Puget Sound.

After the proposed project is completed, stormwater on the pump station site would flow into new bioretention facilities on the property. The soils and plantings in the bioretention facilities would settle, absorb, and filter the stormwater runoff prior to infiltration. Runoff from the construction area in Triton Drive NW and NW Blue Ridge Drive would continue to enter the existing stormwater drainage system or a new system that would

consist of a combination of pipe, ditch and/or bioretention facilities in the right-of-way.

2) Could waste materials enter ground or surface waters? If so, generally describe.

Construction-related materials could enter ground or surface waters due to accidental spills, mechanical failures, or if construction activities were performed outside specified conditions.

Following completion of the project, diesel fuel could enter ground or surface waters if accidentally spilled during filling of the approximately 200-gallon storage tank. It is anticipated that the storage tank would be filled one or two times per year.

See Section B.1.h and B.3.d for measures to minimize the potential for these impacts.

d. Proposed measures to reduce or control surface, ground and runoff impacts, if any:

Erosion and sedimentation control BMPs would be used during construction to reduce and control stormwater runoff impacts. Examples of typical BMPs that would be used during construction are presented in Section B.1.h.

Additional construction BMPs that could be implemented to prevent the introduction of contaminants into surface water or groundwater during construction include:

- maintaining spill containment and clean up materials in areas where equipment fueling is conducted
- refueling construction equipment and vehicles away from surface waters whenever practicable
- containing equipment and vehicle wash water associated with construction and keeping it from draining into surface waters
- storing fuels and other potential contaminants away from excavation sites and surface waters in secured containment areas
- conducting regular inspections, maintenance and repairs on fuel hoses, hydraulically operated equipment, lubrication equipment, and chemical/petroleum storage containers
- establishing a communication protocol for the unlikely event of a spill

If dewatering water were discharged to the King County sewer system, reinjected, or discharged directly to Puget Sound, it would be monitored to ensure that it met applicable standards. If necessary to meet those standards, measures would be taken to improve the water's quality before it was discharged. Dewatering water would only be discharged to the sewer system if adequate capacity was available. Discharges of dewatering water directly to Puget Sound would be routed through a settling tank, if necessary, to reduce turbidity.

Measures would be taken to minimize the potential for fuel spills associated with the standby power generator's diesel fuel storage tank. These measures could include installation of a double-walled tank, automatic shut-off valves, a leak detection system, or a concrete spill containment berm. In addition, appropriate BMPs would be implemented to minimize the risk of fuel spills. These could include installation of a fuel level indicator, signage to discourage overfilling, and staff training.

The proposed project includes implementation of green stormwater infrastructure BMPs to the maximum extent feasible. These BMPs would include, but not be limited to the creation of bioretention facilities for stormwater control and treatment on the project site.

The project itself is a measure to reduce surface water impacts. The purpose of the proposed project is to reduce the number of CSOs that are discharged to Puget Sound from the North Beach Basin.

4. Plants

a. Check or circle types of vegetation found on the site:

__X__ deciduous tree
__X__ evergreen tree
__X__ shrubs
__X__ grass
_____ pasture
_____ crop or grain
_____ wet soil plants
_____ water plants:
_____ other types of vegetation

The pump station property is sparsely landscaped with grass and shrubs. The edges of the right-of-way along Triton Drive NW and NW Blue Ridge Drive are landscaped with grass, shrubs and small trees.

b. What kind and amount of vegetation will be removed or altered?

Most of the vegetation on the pump station property and near the storage pipeline location in the right-of-way would be removed during construction. This would include grass, small shrubs, and small trees.

c. List threatened or endangered species known to be on or near the site.

None known

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

Vegetated areas removed or disturbed during construction would be replanted with drought-tolerant or native plantings, or both. Bioretention facilities would be created to control and treat stormwater on the pump station property and possibly in the right-of-way. Landscaping would be consistent with City of Seattle standards and King County would consider input from the community

when developing the landscaping plan. Temporary irrigation systems would be used for one or two years following construction to reduce plant mortality.

5. Animals

a. Circle any birds and animals which have been observed on or near the site or are known to be on or near the site:

birds: hawk, heron, eagle, songbirds, other:

mammals: deer, bear, elk, beaver, other: rodents

fish: bass, salmon, trout, herring, shellfish, other:

b. List any threatened or endangered species known to be on or near the site.

The following species are listed under the federal Endangered Species Act (ESA) and could be near the site. The proposed project is not expected to adversely affect these species.

Common Name	Scientific Name	ESA Status	Jurisdiction
Puget Sound ESU Chinook Salmon	*Oncorhynchus tshawytscha*	T	NMFS
Puget Sound DPS Steelhead	*Oncorhynchus mykiss*	T	NMFS
Coastal-Puget DPS Bull Trout	*Salvelinus confluentus*	T	USFWS
Canary Rockfish	*Sebastes pinniger*	T	NMFS
Yelloweye Rockfish	*Sebastes rubberrimus*	T	NMFS
Boccaccio Rockfish	*Sebastes paucispinis*	E	NMFS
Southern DPS North American Green Sturgeon	*Thaleichthys pacificus*	T	NMFS
Steller Sea Lion	*Eumetopias jubatus*	T	NMFS
Humpback Whale	*Megaptera novaeangliae*	E	NMFS
Southern Resident Killer Whale	*Orcinus orca*	E	NMFS
Marbled Murrelet	*Brachyramphus marmoratus*	T	USFWS

ESU = Evolutionarily Significant Unit
DPS = Distinct Population Segment
T = Threatened
E = Endangered
NMFS = National Marine Fisheries Service
USFWS = United States Fish and Wildlife Service

c. Is the site part of a migration route? If so, explain.

The entire Puget Sound is part of the Pacific flyway migration route.

d. Proposed measures to preserve or enhance wildlife, if any:

The project itself is a measure to minimize potential impacts on wildlife. Construction of the proposed CSO storage facility would reduce the volume of untreated sanitary sewage and stormwater that is discharged to Puget Sound from the North Beach Basin, thereby reducing the potential for related adverse effects on aquatic life.

6. Energy and Natural Resources

a. What kinds of energy (electric, natural gas, oil, woodstove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

Temporary project energy needs would be limited to those required to operate construction equipment. Construction equipment would use fossil fuels.

In the completed project, electricity would be used for lighting and to operate equipment in the storage pipeline and ancillary equipment facility. This would include the effluent pumps and flushing system equipment, the odor control system, and the ventilation system. The standby power generator would be powered by diesel fuel.

b. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.

No

c. What kind of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:

The proposed lighting systems would be energy efficient.

7. Environmental Health

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, that could occur as a result of this proposal? If so, describe.

Potential exposure to construction-related materials such as fuel and hydraulic fluid could occur as the result of accidental spills, mechanical failures, or if the construction activities deviate from the project construction specifications or permit conditions.

Diesel fuel could be spilled when the approximately 200-gallon storage tank is filled.

1) Describe special emergency services that might be required.

None

2) Proposed measures to reduce or control environmental health hazards, if any:

Section B.3.d discusses typical BMPs that could be implemented to prevent spills of contaminants and minimize exposure to environmental health hazards in the event of a spill.

The project itself is a measure to reduce environmental health hazards. Installation of the CSO storage pipeline and associated facilities would reduce the risk of CSOs, which can present a public health hazard.

b. Noise

1) What types of noise exist in the area which may affect your project (for example: traffic, equipment, operation, other)?

The project site is located in a residential community where the primary regular sources of noise include light automobile traffic along surrounding roadways and train traffic along the adjacent Burlington Northern Santa Fe (BNSF) railroad tracks. Noise generated by these sources would not affect the proposed project.

2) What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.

Construction of the proposed project would create a new, temporary source of noise in the project area that would be audible to nearby residences and within Blue Ridge Park. Construction-related noise would include engine and mechanical and scraping noises associated with the use of heavy equipment such as bulldozers, graders, loaders, excavators, and concrete mixers. These types of equipment typically generate noise in the range of 80-90 dBA at a distance of 50 feet. Hauling activities to and from the project site would contribute to traffic noise.

Noise levels associated with the installation of the shoring system(s) and storage pipeline support piles (if necessary) would depend on the type of shoring used and the method of pile installation. This would be determined by the contractor. An impact pile driver can generate noise measuring up to approximately 100 dBA at a distance of 50 feet. Other installation tools, such as a vibratory hammer or drilling, would generate less noise. It is anticipated that it would take three to four months to install a shoring system that used soldier piles.

Noise would also be generated during construction by pumps used to dewater the storage pipeline excavation. The pumps would generate noise levels measuring approximately 80 dBA at a distance of 23 feet. Exact noise levels would depend on the dewatering method used, which would be determined by the contractor, and the amount of dewatering required. The dewatering pumps would likely be powered by a generator that would create noise levels measuring up to 60 dBA at a distance of 23 feet.

Construction activity would take place during daytime hours. It is anticipated that nighttime construction activity would not be required. Dewatering pumps would run 24 hours per day during storage pipeline excavation and move as the excavation proceeded. It is anticipated that dewatering pumping would occur for approximately 12-16 months.

Following construction, noise would be generated by equipment such as the odor control unit, effluent pumps, and the standby diesel generator for very limited durations when maintenance occurred and during the one to two times each year that this equipment is expected to operate.

3) Proposed measures to reduce or control noise impacts, if any:

During construction, all activities would be performed consistent with the City of Seattle's Noise Control Ordinance. All impacts from noise generated by construction would be short-term and temporary in nature and would not constitute a significant effect on the surrounding land uses. Construction BMPs would be used to minimize construction noise. Examples of BMPs that could be used include:

- using effective vehicle mufflers, engine intake silencers, and engine enclosures, and shutting off equipment when not in use
- locating activities away from sensitive receptors when possible
- using portable noise barriers placed around stationary equipment
- encouraging equipment drivers to avoid backing up as much as possible to reduce the use of back-up alarms
- using broadband back-up alarms to eliminate impacts of single-frequency high-pitched alarms
- notifying residents and businesses near the project area of upcoming noisy construction activities
- creating a 24-hour construction hotline to promptly respond to questions and complaints

Additionally, King County would notify adjacent residences in advance of project construction scheduling and sequencing of construction activities.

8. Land and Shoreline Use

a. What is the current use of the site and adjacent properties?

The project site is located in a residential waterfront community. King County's North Beach Pump Station site, which would house the ancillary equipment facility and diversion structure, is bordered to the northwest by railroad tracks and Puget Sound, to the southwest by single family residences, and to the southeast by Triton Drive NW and single family residences. It is bordered to the northeast by Blue Ridge Park, an open space owned by the Blue Ridge Homeowners' Association.

The storage pipeline site is in City of Seattle right-of-way under Triton Drive NW and NW Blue Ridge Drive. Adjacent properties on the southeast side of the right-of-way contain single family residences. Adjacent properties on the northwest side of the right-of-way contain single family residences, Blue Ridge Park, and the North Beach Pump Station.

b. Has the site been used for agriculture? If so, describe.

No

c. Describe any structures on the site.

King County's North Beach Pump Station is located on the project site. It is an approximately 1,600 square-foot below-grade structure.

d. Will any structures be demolished? If so, what?

No

e. What is the current zoning classification of the site?

The current zoning classification of the site is Single Family Residential.

f. What is the current comprehensive plan designation of the site?

The current comprehensive plan designation of the site is Single Family Residential.

g. If applicable, what is the current shoreline master program designation of the site?

The current shoreline master program designation of the site is Urban Residential.

h. Has any part of the site been classified as an "environmentally sensitive" area? If so, specify.

Yes. The westernmost tip of the North Beach Pump Station property is identified by the City of Seattle as a potential landslide area. Excavation within this area is not planned.

i. Approximately how many people would reside or work in the completed project?

No people would reside in the completed project. It is estimated that the completed project would be visited by King County staff between one and three times per month for routine operation and maintenance purposes. The proposed storage pipeline would be intensively cleaned approximately once every three to five years. This would require the temporary closure of one lane of traffic in Triton Drive NW and/or NW Blue Ridge Drive for approximately one or two weeks.

j. Approximately how many people would the completed project displace?

None

k. Proposed measures to avoid or reduce displacement impacts, if any:

None needed

l. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

The proposed project would be consistent with current and projected land uses. The ancillary equipment facility would be designed with community input on architectural design features and materials to ensure that it is consistent with the residential waterfront setting. The other project components (for example, storage pipeline and diversion structure) would be located below grade.

9. Housing

a. Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.

None

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.

None

c. Proposed measures to reduce or control housing impacts, if any:

None

10. Aesthetics

a. What is the tallest height of any proposed structure(s), not including antennae; what is the principal exterior building material(s) proposed?

The footprint of the proposed ancillary equipment facility would be approximately 40 feet by 20 feet and the height of the building would be approximately 15 feet. Exhaust stacks for the odor control system and standby generator would extend above the roofline. The facility's principal exterior building material would be determined during the final design phase with consideration of community input.

b. What views in the immediate vicinity would be altered or blocked?

The visual quality of the immediate project area would be temporarily impacted during the approximately 18- to 24-month construction period. The most intensive construction work would occur during a six-month period when excavation for the storage pipeline is performed. Temporary visual impacts during construction would include the presence of construction equipment, work crews, dust/exhaust, materials, signage, temporary fencing, staging areas in the construction zone, and traffic congestion along haul routes. An approximately 50-foot-tall crane could be located on the project site for approximately four months.

After the project was completed, views of the North Beach Pump Station site would continue to be partially screened by a chain-link fence and landscaping. However, the ancillary equipment facility would be noticeable from surrounding properties that currently have views of the site and from vehicles traveling on Triton Drive NW, NW Blue Ridge Drive, and NW Neptune Place. The presence of the new above grade facility would alter views, but not block them.

c. Proposed measures to reduce or control aesthetic impacts, if any:

The design process for the ancillary equipment facility would follow City of Seattle policies and guidelines for incorporating aesthetic considerations into design. King County would also consider input from the community on exterior materials and architectural elements of the facility to ensure that it is consistent with the residential waterfront setting. The design would likely include plantings of shrubs around the exterior which would provide partial screening of the facility.

Any areas where landscaping was removed to construct the proposed project would be replanted. Bioretention facilities may be installed in some of these areas. This will depend, in part, on City of Seattle stormwater management requirements.

The large decorative "Blue Ridge" rock sign located in front of Blue Ridge Park would either be protected in place or moved and temporarily stored in a secure place to avoid damage during construction. If moved, the sign would be returned to its existing location at the end of the construction period.

11. Light and Glare

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

Temporary lighting may be used at the beginning and end of work days when daylight hours are short. No nighttime construction is anticipated.

The proposed ancillary equipment facility would include exterior security lighting that could result in light and glare effects. This would mainly occur during nighttime hours.

b. Could light and glare from the finished project be a safety hazard or interfere with views?

The ancillary equipment facility's exterior security lighting would be noticeable from surrounding properties that currently have views of the site.

c. What existing off-site sources of light or glare may affect your proposal?

None

d. Proposed measures to reduce or control light and glare impacts, if any:

Full cutoff, low-intensity light fixtures would be used for the ancillary equipment facility's exterior security lighting. The light fixtures would be configured so that light was not cast beyond the edge of the pump station property and to minimize light and glare that would be noticeable from surrounding properties.

The use of highly reflective building materials and/or finishes in the design of the ancillary equipment facility exterior would be restricted.

12. Recreation

a. What designated and informal recreational opportunities are in the immediate vicinity?

Blue Ridge Park is located northeast of and adjacent to the North Beach Pump Station site at the intersection of NW Neptune Place and Triton Drive NW/NW Blue Ridge Drive. The 1.4-acre park is a private, covenant-restricted, members-only facility that includes playground equipment, a playfield, picnic tables, and a picnic shelter.

Other nearby parks include Golden Gardens Park and Carkeek Park. Both of these City of Seattle parks are located along the shore of Puget Sound and approximately 0.75 mile from the project site to the southwest and northeast, respectively.

b. Would the proposed project displace any existing recreational uses? If so, describe.

Activities required for construction of the proposed facilities would result in temporary visual and noise impacts on recreational users of Blue Ridge Park. Impacts could also include temporary and intermittent access disruptions when construction is occurring in the right-of-way next to the park. It is possible that the contractor would occasionally not be able to provide safe pedestrian access to the park for several days at a time during construction. Measures would be implemented to minimize impacts to park access (see Section B.12.c). Additionally, the approximately five to six on-street parking spaces in front of the park along Triton Drive NW would be unavailable for use during most of the construction period.

Operation of the proposed facilities would not displace any existing recreational uses.

c. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any:

The contractor would be required to maintain safe pedestrian access to Blue Ridge Park during construction, to the maximum extent practicable. Measures to ensure pedestrian safety could include the use of signage regarding park access routes, the placement of steel plates over open excavations to provide access, the use of temporary fencing or ecology blocks to designate safe walkways, and the use of flaggers or escorts to assist people accessing the park through or near the construction area. It is possible that access to the park could be intermittently unavailable for several days at a time during the construction period. Measures that could be taken to limit the number and duration of access restrictions to the park include considering the ability to maintain park access during design (siting) of the storage pipeline and development of construction sequencing. Additionally, a second park gate could be installed in a location where pedestrian access could be safely provided when access to the existing gate is blocked by construction activity.

Construction BMPs would be implemented to minimize construction noise (see Section B.7.b.3). Likewise, traffic control measures would be implemented to ensure that people could access Blue Ridge Park safely (see Section B.14.g).

King County would provide advance notification of construction activities to all residents adjacent to the construction area, including notification of periods during which the contractor could not provide safe access to Blue Ridge Park. Advance notifications would include posting signage at the site, as well as written notification to the Blue Ridge Club, Incorporated, Board of Directors. The notification would include the name and phone number of the King County staff to be contacted regarding questions or concerns about construction activity.

13. Historic and Cultural Preservation

a. Are there any places or objects listed on, or proposed for, national, state or local preservation registers known to be on or next to the site? If so, generally describe.

None known

b. Generally describe any landmarks or evidence of historic, archaeological, scientific or cultural importance known to be on or next to the site.

None known

c. Proposed measures to reduce or control impacts, if any:

The proposed project would comply with the requirements of the National Historic Preservation Act. This would include the completion of a cultural resources survey at the project site. If artifacts were uncovered during excavation, work would be stopped pending notification of and response from appropriate agencies.

14. Transportation

a. Identify public streets and highways serving the site, and describe proposed access to the existing street system. Show on site plans, if any.

Access to the project site is primarily provided by Triton Drive NW and NW Blue Ridge Drive via NW Neptune Place and 24th Avenue NW. These roadways are two-lane residential streets that serve limited residential access only. Access to 24th Avenue NW is provided by NW 96th Street and 15th Avenue NW.

The proposed storage pipeline and associated influent/effluent pipelines would be constructed in the Triton Drive NW and NW Blue Ridge Drive rights-of-way.

b. Is site currently served by public transit? If not, what is the approximate distance to the nearest transit stop?

Yes. King County Metro Transit provides bus service to the area. Route 18 provides service along 24th Avenue NW, NW Neptune Place, and Triton Drive NW. There is a transit stop located on Triton Drive NW in front of the North Beach Pump Station site.

c. How many parking spaces would the completed project have? How many would the project eliminate?

During construction, most of the on-street parking on the sections of Triton Drive NW and NW Blue Ridge Drive that lie within the project site, including the parking area for five to six cars in front of Blue Ridge Park, would be temporarily unavailable. The duration of disruption would vary depending upon the location and stage of construction activity. The majority of the residences in the area have off-street parking and on-street parking is available just outside of the project area.

The completed project would not create any parking spaces. Between approximately two and four parking spaces within the public right-of-way on Triton Drive NW and/or NW Blue Ridge Drive would be permanently eliminated. Two approximately 4'(w) x 8'(l) metal hatches would need to be placed on top of or near the proposed CSO storage pipeline to provide access for operation and maintenance staff. If these hatches were placed outside of the travelled right-of-way, parking would not be allowed on top of the hatches. Additionally, one or two on-street parking spaces could be permanently reserved for WTD operations and maintenance staff to ensure that they could safely and quickly access the proposed storage pipeline with the necessary equipment

At each end of the proposed storage pipeline, an approximately 10'(w) x 12'(l) opening would be covered with concrete lifting slabs. These slabs would be removed approximately once every three to five years so that the pipeline could be intensively cleaned. The slabs would most likely be located in the travelled right-of-way, but on-street parking spaces next to the slabs could be temporarily unavailable for approximately one or two weeks when this maintenance is occurring.

Additional on-street parking spaces could be permanently replaced by the installation of bioretention facilities. These modifications to the right-of-way would be determined during design and depend, in part, on City of Seattle requirements.

d. Will the proposal require any new roads or streets, or improvements to existing roads or streets, not including driveways? If so, generally describe (indicate whether public or private).

A portion of the project site in Triton Drive NW and NW Blue Ridge Drive public right-of-way would be excavated during construction for the storage pipeline and influent/effluent pipelines. Following construction, the right-of-way in the project area would be repaved (travelled portion) or otherwise restored (non-travelled portion) to meet current City of Seattle Department of Transportation pavement and street restoration requirements. Restoration of the disturbed right-of-way would include the installation of landscaping and stormwater control and/or treatment facilities that would meet City of Seattle standards and requirements. The restored right-of-way would also include the access hatches described in Section B.14.c.

The existing access road on the southwest side of the King County-owned pump station property would be relocated to the northeast side of the property to make room for the new ancillary equipment facility.

Northwest Neptune Place, which could be identified as part of a construction haul route for the proposed project, has recently experienced numerous failures (sinkholes). Improvements to this road, and to any other roads near the project site that are proposed for use by heavy equipment, may be required before and/or after construction to ensure that they can be travelled safely.

e. Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.

Yes, construction at the North Beach Pump Station property would occur somewhat near the active BNSF railroad tracks that border the park to the northwest. The project would not disrupt railroad activity.

f. How many vehicular trips per day would be generated by the completed project? If known, indicate when peak volumes would occur.

Construction of the proposed project would require hauling of excavated soil from the site and delivery of construction materials by truck to the site. Excavation hauling and delivery of concrete/piping would require approximately 3,600 one-way truck trips. The most intense truck traffic would occur during a six- to eight-month period. It is estimated that during peak months, the project would generate up to approximately 60 one-way truck trips per day. The number of trips would be dependent on contractor planning and sequencing, and the daily average noted above could be exceeded at times. Additional vehicular trips would occur related to materials delivery, as well as workers going to and coming from the site.

g. Proposed measures to reduce or control transportation impacts, if any:

Temporary localized traffic impacts are anticipated during the approximately 18- to 24-month construction period. Temporary traffic impacts in the project area would include street closures, traffic and parking restrictions, and restricted access to residences and Blue Ridge Park. These impacts and measures that could be implemented to reduce or control them are described generally in the following paragraphs.

Construction of the proposed approximately 325-foot-long, 12-foot-diameter storage pipeline in Triton Drive NW and NW Blue Ridge Drive would entail large open excavations in the right-of-way. This would require the temporary closure of portions of Triton Drive NW and NW Blue Ridge Drive in the project area for approximately six to twelve months. The road segments closed would change as excavation for the storage pipeline progressed. During the six- to twelve-month period, vehicular access to residences on the northwest and southeast sides of NW Blue Ridge Drive closest to the active construction zone may be limited and, at times, unavailable. The contractor would be required to provide safe pedestrian access to all residences at all times.

The duration of road closures and specific impacts to individual homes would be determined during final design and would depend upon the final location of the storage pipeline, the type of construction methods used, and construction sequencing. Impacts to specific properties would depend upon the extent and duration of construction activities next to each parcel, as disturbance at each parcel could vary greatly. King County would work with residents during final design to evaluate residential access needs. Siting of the storage pipeline and construction sequencing would be developed so as to minimize the impacts to residential access.

If necessary, contractor parking in and near the project area would be limited in order to ensure adequate on-street parking for residents and visitors. Contractors could be required to park off-site and carpool or shuttle to the project area.

Temporary impacts to bus service would occur as a result of road closures, particularly along Triton Drive NW and NW Blue Ridge Drive. Detours and/or

temporary bus routes would be required to maintain service to the area. School bus routes, garbage and recycling service, mail delivery, and other services requiring vehicular access in this area would also be temporarily disrupted. The extent and duration of the road closures, as well as temporary revisions to bus routes and other services, would be determined prior to the start of construction.

To construct the proposed project, a street use right-of-way permit would be required from the City of Seattle. Permit conditions would require a traffic control plan to be submitted and approved prior to the start of construction. The plan would identify traffic and parking restrictions and the locations of traffic control devices and signage. It would include detailed measures to address residential access, emergency vehicle access, road closures and detours, temporary bus route changes, and pedestrian safety. Potential measures that could be implemented include the use of protective barriers, fences, flaggers, foot and/or vehicle bridges, specified hours of residential vehicular access during active construction, provisions for emergency access, and steel plating.

King County would provide advance notification of construction activity to all residents adjacent to the construction area. Advance notification would include posting signage at the site, as well as written notification of the Blue Ridge Club, Incorporated, Board of Directors and impacted residences. The notification would include the name and phone number of the King County staff person to be contacted regarding questions or concerns about construction activity.

After the proposed project is completed, maintenance of the storage pipeline would require infrequent, intensive cleaning. To provide adequate work space for crews to perform this work, one lane of traffic in Triton Drive NW and/or NW Blue Ridge Drive would need to be closed temporarily. It is anticipated that intensive cleaning of the storage pipeline would take one or two weeks to complete and occur approximately once every three to five years.

15. Public Services

a. Would the project result in an increased need for public services (for example: fire protection, police protection, health care, schools, other)? If so, generally describe.

No

b. Proposed measures to reduce or control direct impacts on public services, if any:

The contractor would be required to maintain access to residences by fire, emergency medical technician, and police vehicles and personnel at all times during construction.

16. Utilities

a. Circle the utilities currently available at the site: <u>electricity</u>, <u>natural gas</u>, <u>water</u>, <u>refuse service</u>, <u>telephone</u>, <u>sanitary sewer</u>, septic system, other.

b. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.

The completed project would use water and electricity provided by the City of Seattle.

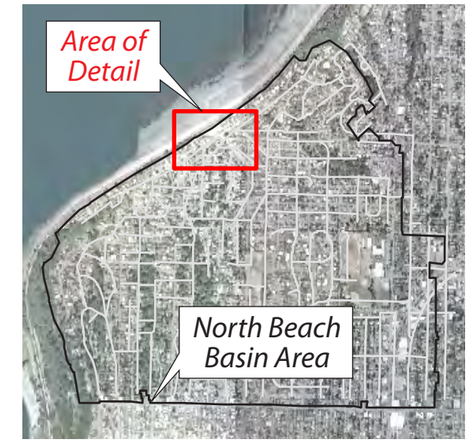
Some of the utilities in Triton Drive NW and NW Blue Ridge Drive would most likely need to be relocated to construct the storage pipeline and influent/effluent pipelines. This could cause temporary, short-term disruption of some utility service to some residences.

C. SIGNATURE

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Signature: Wesley Sprague

Date Submitted: 4/15/11



N

0 50 100 150'
Approximate Scale

Legend

- Combined Sewer System
- Storm Sewer System
- Sanitary Sewer System
- 10' Topographic Contour
- Feasible Area for Pipe Location

NORTH BEACH
COMBINED SEWER OVERFLOW
CONTROL PROJECT SITE LAYOUT PLAN

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Figure 6-1_new.ai

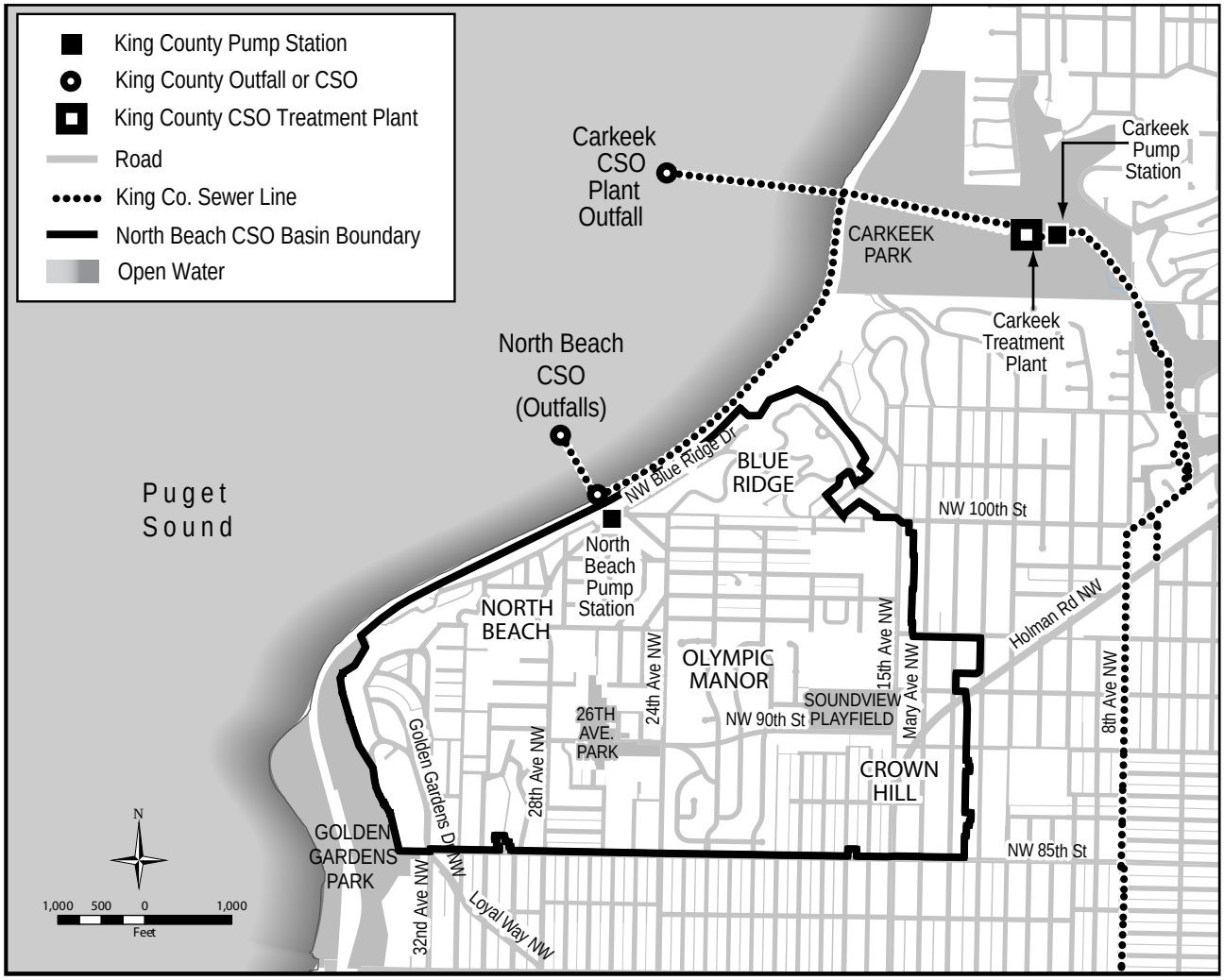


Figure 2-1_new.ai

NORTH BEACH COMBINED SEWER OVERFLOW CONTROL PROJECT VICINITY MAP

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

King County Greenhouse Gas Emissions Worksheet—North Beach CSO Control Project

Section I: Buildings

			Emissions Per Unit or Per Thousand Square Feet (MTCO2e)			
Type (Residential) or Principal Activity (Commercial)	# Units	Square Feet (in thousands of square feet)	Embodied	Energy	Transportation	**Lifespan Emissions (MTCO2e)**
Single-Family Home.....	0		98	672	792	**0**
Multi-Family Unit in Large Building	0		33	357	766	**0**
Multi-Family Unit in Small Building	0		54	681	766	**0**
Mobile Home.....	0		41	475	709	**0**
Education		0.0	39	646	361	**0**
Food Sales		0.0	39	1,541	282	**0**
Food Service		0.0	39	1,994	561	**0**
Health Care Inpatient		0.0	39	1,938	582	**0**
Health Care Outpatient		0.0	39	737	571	**0**
Lodging		0.0	39	777	117	**0**
Retail (Other Than Mall).....		0.0	39	577	247	**0**
Office		0.0	39	723	588	**0**
Public Assembly		0.0	39	733	150	**0**
Public Order and Safety		0.0	39	899	374	**0**
Religious Worship		0.0	39	339	129	**0**
Service		0.0	39	599	266	**0**
Warehouse and Storage		0.0	39	352	181	**0**
Other		1.0	39	1,278	257	**1574**
Vacant		4.0	39	162	47	**990**

Section II: Pavement.....

Pavement.....		10.00				**500**

Total Project Emissions: **3064**

Note: The proposed project consists of a new approximately 325-foot-long, 12-foot-diameter buried storage pipeline, an approximately 96-square-foot diversion structure, and an approximately 800 square foo ancillary equipment facility. It also includes restoration of the existing street above the proposed storage pipeline and, possibly, the installation of curbs, gutters and sidewalks.

APPENDIX 3:

Endangered Species Act Biological Assessment
for the
North Beach Combined Sewer Overflow Control Project

ESA Adolfson

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March 10, 2011

Sue Meyer
Environmental Planner
King County Wastewater Treatment Division
201 S. Jackson Street, MS: KSC-NR-0505
Seattle, WA 98104

Subject: North Beach CSO Control Project Biological Assessment – Letter of "No Effect"

Dear Ms. Meyer:

To protect public health and the environment, King County Department of Natural Resources and Parks Wastewater Treatment Division (WTD) is proposing to reduce combined sewer overflows (CSOs). CSOs occur in older parts of the City of Seattle during heavy rain events when stormwater enters the sewer system. If volumes exceed system capacity, a combination of stormwater and diluted sewage is discharged through outfalls into Puget Sound. The Washington State Department of Ecology (Ecology) has established a control target of one untreated event per outfall per year (WAC 173-245). In order to meet this target, WTD has developed a CSO Control Program to meet Ecology's requirement by 2030. The North Beach CSO Control Project is part of this planning effort.

With the assistance of ESA Adolfson, WTD has prepared this Biological Assessment (BA) for the United States Environmental Protection Agency (federal action agency) to evaluate the need for consultation with the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) under Section 7 of the Endangered Species Act (ESA). WTD received a State Revolving Fund loan to develop a facilities plan for the proposed action. The loan is administered through Ecology. This is the federal nexus for the proposed action.

Project Location

The North Beach Basin is located along the Puget Sound shoreline north of NW 85th Street in Seattle. Its western and northern borders are defined by the shoreline between Golden Gardens Park on the south and Carkeek Park on the north. The eastern boundary of the basin extends from Carkeek Park on the north to the east side of 15th Ave NW on the south. Figure 1 illustrates the basin's location. Project construction would be limited to a small segment of Triton Drive NW and NW Blue Ridge Drive public right-of-way and the existing North Beach Pump Station property (Figure 2).

Project Description

The North Beach Pump Station and Force Main have the capacity to convey a peak flow rate of approximately 3 million gallons per day (mgd). When heavy rains cause flows to exceed the capacity of the wastewater system, a combination of stormwater and diluted sewage is discharged to Puget Sound through two existing outfalls located near the pump station. The outfalls are shown on Figure 2.

The purpose of the proposed action is to reduce the number of CSO discharge events in the North Beach basin to an average of no more than one per year on a long-term average. The proposed action includes construction of a new diversion structure, buried storage pipeline, and ancillary equipment facility (Figure 2). Also, site

improvements would be made to the North Beach Pump Station Site and adjacent public right-of-way where the storage pipeline would be located. Each of these project components is described in more detail below.

- **Diversion Structure:** All flow to the North Beach Pump Station would be routed through a new approximately 12'(l) x 8'(w) x 17'(d) diversion structure which would be located below ground on the North Beach Pump Station site. The structure would divert flows exceeding the capacity of the pump station and downstream force main to a new storage pipeline through a new approximately 20-inch-diameter influent pipeline.

- **Storage Pipeline:** An approximately 325-foot-long, 12-foot-diameter buried storage pipeline would be located in Triton Drive NW and NW Blue Ridge Drive public right-of-way and provide 0.23 mg of storage volume for combined sewage. The pipeline would contain submersible pumps that would be used to empty the pipeline following a wet weather event. Flows would be pumped into a new a six-inch-diameter effluent pipeline that would connect to the local combined sewer system. The storage pipeline would also contain a flushing system to facilitate pipeline cleaning, and access features for routine and long-term operations and maintenance.

- **Ancillary Equipment Facility:** An approximately 40'(l) x 20'(w) one-story-tall ancillary equipment facility would be constructed on the North Beach Pump Station site to support the storage pipeline. The facility would house electrical and motor control panels, a standby power generator and diesel fuel storage tank, an odor control system, a ventilation system, and a utility water system.

- **Site Improvements:** Improvements to the North Beach Pump Station site would include the following items: 1) the existing access road would be relocated from the west side of the pump station site to the east side in order to make room for the new ancillary equipment facility and provide access to that facility and the pump station for operations and maintenance purposes, 2) the existing fence that surrounds the pump station site would be restored or replaced to restrict public access during construction and after project completion, 3) bioretention facilities would be installed to treat stormwater runoff from the site, and 4) the existing rockery retaining wall along the eastern property boundary would be modified or replaced to facilitate site grading and construction.

  Improvements to the Triton Drive NW and NW Blue Ridge Drive public right-of-way would include the following items: 1) hatches and removable lifting slabs would be installed to provide access to the buried storage pipeline, 2) pavement would be removed and restored, 3) green stormwater infrastructure best management practices (BMPs) would be implemented to control and treat stormwater requirements (e.g., use of bioretention facilities and permeable pavement), and 4) landscaping would be removed and the area replanted.

Construction Limits

The project site would include the approximately 10,300 square-foot parcel on which King County's North Beach Pump Station is located and approximately 48,000 square feet of adjacent Triton Drive NW and NW Blue Ridge Drive public right-of-way.

Access and Staging

Access would be primarily from Triton Drive NW and NW Blue Ridge Drive via NW Neptune Place and 24th Avenue NW. During construction, staging area in addition to the North Beach Pump Station property would be required. This staging area would be acquired by the contractor. It is anticipated that this alternative would impact residential access and parking. The final location of the storage pipeline and construction sequencing would need

to provide access to homeowners and emergency vehicles. Figure 2 shows the location of where it would be technically feasible to locate the storage pipeline.

Excavation and Shoring

The proposed action would include approximately 10,000 cubic yards (CY) of excavation, which includes quantities estimated as follows:

- 100 CY of excavation for the diversion structure at the east end of the pump station site to a depth of approximately 15 feet,
- 9,000 CY of open trench excavation for the proposed buried storage pipeline to a depth of 25 feet,
- 1,000 CY of open trench excavation for installation of the influent and effluent pipelines between the diversion structure and the storage pipeline, and
- 100 cubic yards of surface excavation for the ancillary equipment facility.

Temporary slope stabilization and protection would be required to maintain the integrity of the construction site during the majority of excavation activities. Excavations would be braced with stacked trench boxes, cantilevered, and soldier pile and lagging shoring systems. A relatively impermeable shoring system could be required for deeper excavations, such as that for the buried storage pipeline, and would depend on groundwater conditions. If required, this would likely consist of soldier piles and sheet piles, secant piles, or a soil-mixed or slurry wall system. The installation of soldier piles and secant piles, whichever was used, would likely be accomplished by placing the piles into pre-drilled holes in order to minimize vibrations and settlement.

Fill

Up to approximately 7,500 CY of fill would be required to backfill the excavations described above. If the native materials were suitable, excavation spoils would be stockpiled and used for backfill. Excavated soils not used as backfill would be legally disposed of off-site at a location determined by the contractor. If the excavated soils were not of the appropriate quality for backfill, other material would be brought to the site and used as backfill. The source of imported material would be determined by the contractor and meet all pertinent project and legal requirements.

Truck Hauling

Construction of the proposed action would require hauling of excavated soil from the site and delivery of construction materials by truck to the site. Excavation hauling and delivery of fill material and concrete would require approximately 1,800 truck trips. Most of these truck trips would occur in the first six months of the approximately 18- to 24-month construction period and taper off over the following months. It is estimated that during those first six months, the project would generate up to 30 truck trips per day during peak times. The number of trips would be dependent on contractor planning and sequencing. Additional vehicular trips would occur related to materials delivery, as well as workers going to and coming from the site.

Construction Schedule and Equipment

Overall construction is anticipated to occur over an 18 to 24 month period. There is no in-water work associated with the proposed action. All work would take place a minimum of 200 feet away from the marine waters of Puget Sound. The project would require the use of heavy equipment including excavators, cranes, pile drivers, and dump trucks.

Land Use in the Vicinity

The North Beach Basin is a largely single-family residential area north of the Ballard neighborhood in Seattle. Two large parks are located along the Puget Sound shoreline on the western and northern borders of the basin: Golden Gardens Park and Carkeek Park. The BNSF rail line closely follows the shoreline, and the land rises steeply from the water, with a band of steep slopes that parallel the shoreline. Several streams flow through ravines to the Sound in the basin. At the upper end of the basin, commercial and multifamily uses are located along the arterial streets, Holman Road and 15th Avenue NW. Single-family residential development and open space typifies land use in the construction area.

Listed Species Present

The proposed North Beach CSO Project occurs within the general range of several ESA listed species. The species listed below were determined through a review of species information provided by various sources listed at the end of this document, the USFWS, NMFS, and on habitat information provided by Washington Department of Fish and Wildlife (USFWS, 2010; NMFS, 2009; WDFW, 2010). The following ESA regulated species may occur within the vicinity of the construction area:

Common Name	Scientific Name	ESA Status *	Jurisdiction
Puget Sound Evolutionarily Significant Unit (ESU) Chinook Salmon	*Oncorhynchus tshawytscha*	Threatened	NMFS
Puget Sound Distinct Population Segment (DPS) Steelhead	*Oncorhynchus mykiss*	Threatened	NMFS
Coastal-Puget DPS Bull Trout	*Salvelinus confluentus*	Threatened	USFWS
Canary Rockfish	*Sebastes pinniger*	Threatened	NMFS
Yelloweye Rockfish	*Sebastes rubberrimus*	Threatened	NMFS
Boccaccio Rockfish	*Sebastes paucispinis*	Endangered	NMFS
Southern DPS North American Green Sturgeon	*Thaleichthys pacificus*	Threatebned	NMFS
Steller Sea Lion	*Eumetopias jubatus*	Threatened	NMFS
Humpback Whale	*Megaptera novaeangliae*	Endangered	NOAA Fisheries
Southern Resident Killer Whale	*Orcinus orca*	Endangered	NOAA Fisheries
Marbled Murrelet	*Brachyramphus marmoratus*	Threatened	USFWS

* **Threatened**: Species are likely to become endangered within the foreseeable future. **Endangered:** Species that is in danger of extinction throughout all or a significant portion of its range.

Due to the urbanized land use in the project vicinity, it has been determined that suitable habitat for several species that have been identified as potentially occurring in King County, including northern spotted owl, grizzly bear, Canada lynx, golden paintbrush, and gray wolf, do not occur within the project vicinity (USFWS, 2010). Therefore, the proposed action would have *no effect* on northern spotted owl, golden paintbrush, grizzly bear, Canada lynx, or gray wolf.

Environmental Baseline

The project construction footprint lies entirely within a developed urban area in North Seattle, within the North Beach Pump Station property and in adjacent existing road right-of way. Two unnamed streams enter the storm drainage system approximately 200 feet southeast of the proposed project site near the intersection of Marmount Drive NW and NW North Beach Drive. The storm drain crosses through the project area and discharges to Puget Sound. The unnamed streams contain no documented use by salmonids (WDFW, 2010a; WDFW 2010b). Flow in the storm sewer pipeline that carries the unnamed streams may need to be temporarily bypassed around or over the storage pipeline excavation in order to construct the proposed project. Stormwater is also conveyed by sections of open ditch and pipe along the southeast side of the NW Blue Ridge Drive right-of-way. After the stormwater enters a pipe at the intersection of NW Neptune Place and NW Blue Ridge Drive, it is either conveyed to Puget Sound by a stormwater pipe or conveyed to a wastewater pipe that flows to the North Beach Pump Station. Stormwater conveyed by this ditch would probably need to be diverted around the storage pipeline excavation during construction.

Puget Sound is located approximately 200 feet west of the proposed construction activities, with steep slopes and the Burlington Northern Santa Fe Railroad between the project area and Puget Sound. A narrow band of trees exists at the edge of the steep slope between Puget Sound and the project area. The proposed action would not require any in-water work or work within 200 feet of Puget Sound. Under existing and proposed conditions, CSO discharges would continue to occur via the two existing outfalls that discharge to Puget Sound approximately 900 feet offshore and to the beach north of the BNSF railroad tracks, respectively. However, the purpose of the proposed action is to reduce CSO discharge events to Puget Sound by providing additional storage capacity.

Suitable Habitat Availability

Known life history and specific habitat requirements of several listed species identified were reviewed to determine habitat need. A list of reference materials that were consulted in order to prepare this assessment is attached to the end of this document.

Birds Species:

Marbled murrelets may forage in the marine waters of Puget Sound in the vicinity of the existing CSO outfall. Marbled murrelets generally forage in waters less than 100 feet in depth (WDW, 1991). The proposed action would not require any in-water work or work within 200 feet of Puget Sound, is not in the direct line of sight of Puget Sound, and would result in an overall reduction in CSO discharge events. Therefore, direct effects to marbled murrelet from increased noise and human activity or indirect effects resulting from operation of the proposed facilities are not anticipated. The proposed action would not affect marbled murrelet forage species or their habitat. It has been determined that the proposed North Beach CSO Project would have *no effect* on marbled murrelets. In addition, there are no mature forested habitats within several miles of the project that contain habitat elements suitable for marbled murrelet nesting. The project area does not contain designated critical habitat for marbled murrelet; therefore the project would have *no effect* on critical habitat for marbled murrelet.

Fish Species:

Chinook salmon, steelhead, bull trout, canary rockfish, yelloweye rockfish, boccacio rockfish, and North American green sturgeon may all occur in the marine waters of Puget Sound in various life history forms throughout the year and within the vicinity of the existing CSO outfall. The proposed action would not require any in-water work or work within 200 feet of Puget Sound. In addition, the implementation of temporary erosion and sediment control (TESC) measures and a Spill Prevention Countermeasure and Control (SPCC) plan during construction would minimize the potential for accidental spills of construction related contaminants such as fuel, oil, and hydraulic fluids or erosion of upland soils into Puget Sound. Operation of the proposed facilities is

anticipated to result in an overall reduction in CSO discharge events. Based on this information, the proposed North Beach CSO Project would have *no effect* on Chinook salmon, steelhead, bull trout, canary rockfish, yelloweye rockfish, boccacio rockfish, and North American green sturgeon.

Critical habitat for Chinook salmon extends from the Puget Sound shoreline out to the maximum depth of the photic zone. Bull trout critical habitat extends offshore to a depth of 10 meters. The project would not require any in-water work or work within 200 feet of Puget Sound. Therefore, the proposed North Beach CSO Project would have *no effect* on critical habitat for Chinook salmon and bull trout. Critical habitat for the North American green sturgeon is not designated within the project area. No critical habitat has been designated for steelhead, canary rockfish, bocaccio rockfish, or yelloweye rockfish at this time.

Marine Mammals:

Humpback whales are common off the Washington coast; however, they are infrequently observed in the inland waters of Puget Sound (Norberg, personal communication, 2000). One to two individuals are typically sighted in Puget Sound in an average year. Humpback whales are not expected to occur in the project area during proposed activities.

Sightings of Steller sea lions in Puget Sound number 50 or fewer per year (Jeffries, personal communication, 1995) and are most abundant from late fall to early spring (NOAA and EPA, 1980). There are no Steller sea lion haul-out or breeding sites within the project area. Steller sea lions are not expected to occur in the project area during proposed activities.

The Southern Resident Population of killer whales is one of four populations known to occur in Washington (Wiles, 2004). Three of these populations, the Southern Resident Population, Northern Resident Population and the transient population, periodically use the region around the San Juan Islands. These three groups of whales do not interbreed and do not normally interact. The Southern Resident Population (Eastern North Pacific Southern Resident Population) consists of three pods totaling about 83 animals. They range widely between California and the Queen Charlotte Islands, but spend most of their time, especially from spring to fall, in northern Puget Sound, Georgia Strait, and the Strait of Juan de Fuca (Carretta et al., 2004). While in inland waters during the warmer summer months, all pods concentrate their activities in Haro Strait, Boundary Passage, the southern Gulf Islands, the eastern end of the Strait of Juan de Fuca, and several localities in the southern Georgia Strait (Heimlich-Boran, 1988; Fellemen et al., 1991; Olson, 1998; Ford et al., 2000). Less time is spent elsewhere including the areas surrounding the San Juan Islands, Admiralty Inlet west of Whidbey Island, and Puget Sound, although J pod is the only group known to regularly venture inside the San Juan Islands (Balcomb, unpublished data). Killer whale use of the project area would be rare or uncommon, which makes it unlikely that they would be present during construction activities.

In addition to the unlikely occurrence of listed marine mammal species within the project area, the proposed action does not include any in-water work or work within 200 feet of Puget Sound. In addition, the proposed action is located inland and on a steep bluff elevated above Puget Sound. The project would not disrupt feeding behaviors, movements, or other behavioral patterns of listed marine mammals. The proposed action would not affect the prey base for either of the listed species. For these reasons the proposed action would have *no effect* on Steller sea lion, humpback whale, or the Southern Resident population killer whale or on designated critical habitat for southern resident population killer whale.

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires Federal agencies to consult with NMFS on activities that may adversely affect Essential Fish Habitat (EFH). The Pacific Fisheries management Council (PFMC) has designated EFH for the Pacific salmon fishery, federally managed groundfish, and coastal pelagic fisheries. Designated EFH for the Pacific salmon fishery and groundfish occurs in the vicinity

of the proposed project. Potential effects to Pacific salmon EFH, including Chinook salmon habitat, is similar to that discussed in the body of this letter. It was determined that the project would not have *no adverse effect* on EFH for any of the managed fisheries due to the limited nature of this project and overall beneficial effects to water quality within Puget Sound.

The information in this letter may be included with federal permit applications to satisfy the federal action agency's responsibility under section 7c of the ESA and the MSA. We are prepared to re-evaluate this project as necessary upon change in the status to these species, new listings, or significant alterations in the proposed scope of work.

Sincerely,

Steve Krueger
Senior Scientist

Enclosures: References; Figure 1 – Site Vicinity Map; Figure 2 – Site Layout Plan; USFWS and NMFS species listings

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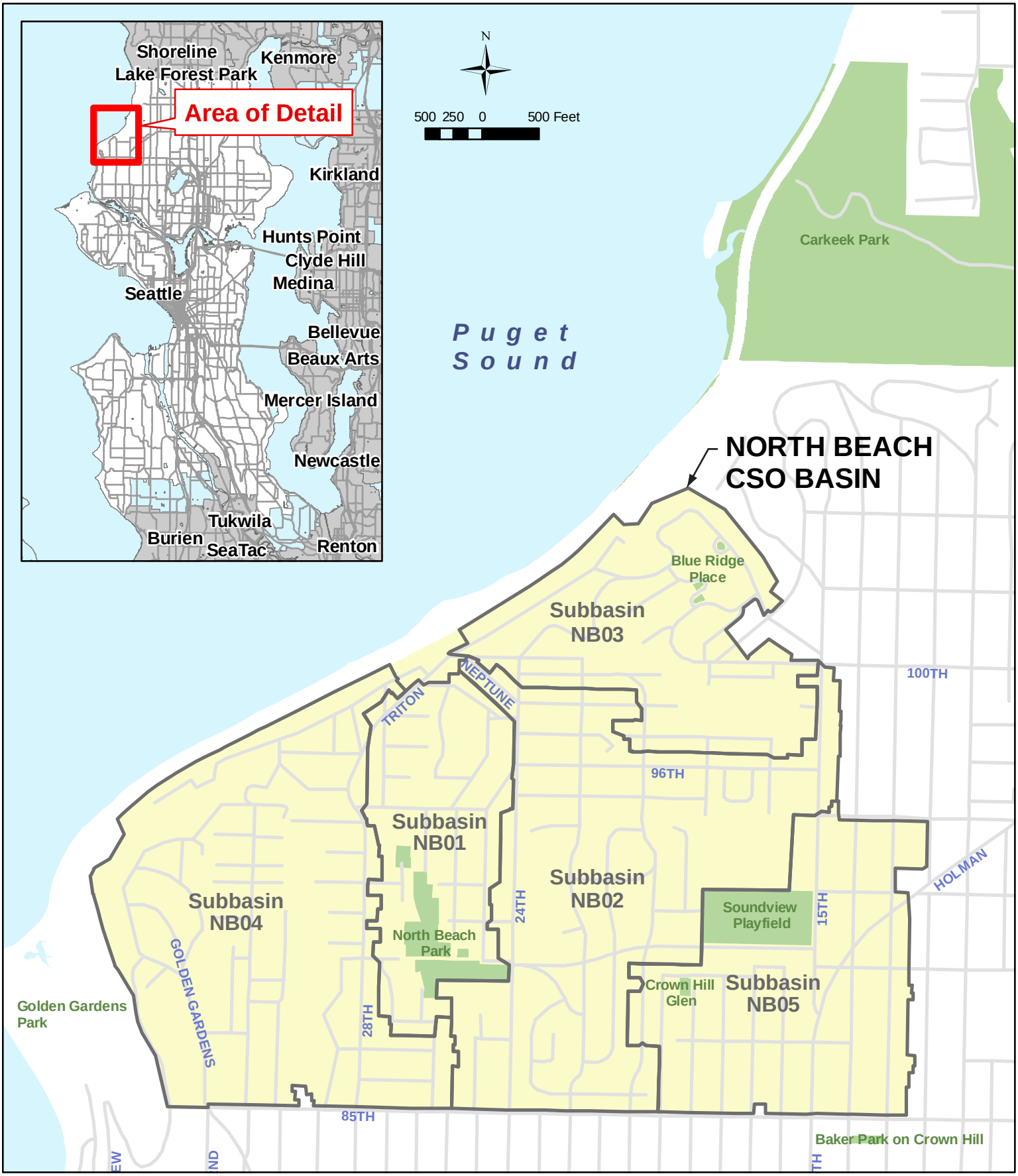
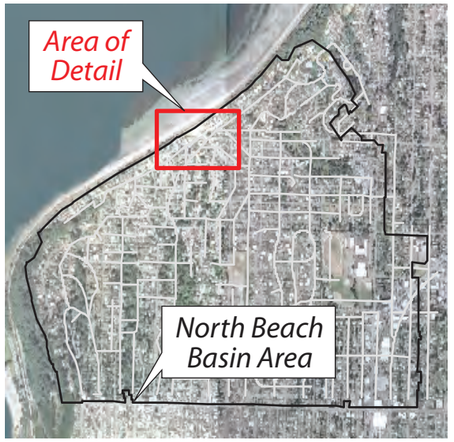


Barton, Murray, Magnolia and North Beach CSO Project . 207057

Figure 1
North Beach Vicinity Map
King County, Washington

King County
Department of Natural Resources and Parks
Wastewater Treatment Division



N

0 50 100 150'
Approximate Scale

Legend

- Combined Sewer System
- Storm Sewer System
- Sanitary Sewer System
- 10' Topographic Contour
- Feasible Area for Pipe Location

FILE NAME: Fig02_NBeach_Alt1B.ai
CREATED BY: JAB / DATE LAST UPDATED: 01/12/11

SOURCE: Carollo and Tetra Tech, 2011.

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Barton, Murray, Magnolia and North Beach CSO Project . 207057

Figure 2
North Beach Alternative 1B
King County, Washington

LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES AND CRITICAL HABITAT; CANDIDATE SPECIES; AND SPECIES OF CONCERN
IN KING COUNTY
AS PREPARED BY
THE U.S. FISH AND WILDLIFE SERVICE
WASHINGTON FISH AND WILDLIFE OFFICE

(Revised August 26, 2010)

LISTED

Bull trout *(Salvelinus confluentus)* – Coastal-Puget Sound DPS
Canada lynx *(Lynx canadensis)*
Gray wolf *(Canis lupus)*
Grizzly bear *(Ursus arctos = U. a. horribilis)*
Marbled murrelet *(Brachyramphus marmoratus)*
Northern spotted owl *(Strix occidentalis caurina)*

Major concerns that should be addressed in your Biological Assessment of project impacts to listed animal species include:

1. Level of use of the project area by listed species.

2. Effect of the project on listed species' primary food stocks, prey species, and foraging areas in all areas influenced by the project.

3. Impacts from project activities and implementation (e.g., increased noise levels, increased human activity and/or access, loss or degradation of habitat) that may result in disturbance to listed species and/or their avoidance of the project area.

Castilleja levisecta (golden paintbrush) [historic]

Major concerns that should be addressed in your Biological Assessment of project impacts to listed plant species include:

1. Distribution of taxon in project vicinity.

2. Disturbance (trampling, uprooting, collecting, etc.) of individual plants and loss of habitat.

1. Changes in hydrology where taxon is found.

DESIGNATED

Critical habitat for bull trout
Critical habitat for the marbled murrelet
Critical habitat for the northern spotted owl

PROPOSED

Revised critical habitat for bull trout

CANDIDATE

Fisher *(Martes pennanti)* – West Coast DPS
Oregon spotted frog *(Rana pretiosa)* [historic]
Yellow-billed cuckoo *(Coccyzus americanus)*

SPECIES OF CONCERN

Bald eagle *(Haliaeetus leucocephalus)*
Beller's ground beetle *(Agonum belleri)*
California wolverine *(Gulo gulo luteus)*
Cascades frog *(Rana cascadae)*
Hatch's click beetle *(Eanus hatchi)*
Larch Mountain salamander *(Plethodon larselli)*
Long-eared myotis *(Myotis evotis)*
Long-legged myotis *(Myotis volans)*
Northern goshawk *(Accipiter gentilis)*
Northern sea otter *(Enhydra lutris kenyoni)*
Northwestern pond turtle *(Emys (= Clemmys) marmorata marmorata)*
Olive-sided flycatcher *(Contopus cooperi)*
Pacific lamprey *(Lampetra tridentata)*
Pacific Townsend's big-eared bat *(Corynorhinus townsendii townsendii)*
Peregrine falcon *(Falco peregrinus)*
River lamprey *(Lampetra ayresi)*
Tailed frog *(Ascaphus truei)*
Valley silverspot *(Speyeria zerene bremeri)*
Western toad *(Bufo boreas)*
Aster curtus (white-top aster)
Botrychium pedunculosum (stalked moonwort)
Cimicifuga elata (tall bugbane)

Endangered Species Act Status of West Coast Salmon & Steelhead

(Updated July 1, 2009)

Species[1]			*Current Endangered Species Act Listing Status*[2]	*ESA Listing Actions Under Review*
Sockeye Salmon (*Oncorhynchus nerka*)	1	Snake River	***Endangered***	
	2	Ozette Lake	***Threatened***	
	3	Baker River	*Not Warranted*	
	4	Okanogan River	*Not Warranted*	
	5	Lake Wenatchee	*Not Warranted*	
	6	Quinalt Lake	*Not Warranted*	
	7	Lake Pleasant	*Not Warranted*	
Chinook Salmon (*O. tshawytscha*)	8	Sacramento River Winter-run	***Endangered***	
	9	Upper Columbia River Spring-run	***Endangered***	
	10	Snake River Spring/Summer-run	***Threatened***	
	11	Snake River Fall-run	***Threatened***	
	12	Puget Sound	***Threatened***	
	13	Lower Columbia River	***Threatened***	
	14	Upper Willamette River	***Threatened***	
	15	Central Valley Spring-run	***Threatened***	
	16	California Coastal	***Threatened***	
	17	Central Valley Fall and Late Fall-run	***Species of Concern***	
	18	Upper Klamath-Trinity Rivers	*Not Warranted*	
	19	Oregon Coast	*Not Warranted*	
	20	Washington Coast	*Not Warranted*	
	21	Middle Columbia River spring-run	*Not Warranted*	
	22	Upper Columbia River summer/fall-run	*Not Warranted*	
	23	Southern Oregon and Northern California Coast	*Not Warranted*	
	24	Deschutes River summer/fall-run	*Not Warranted*	
Coho Salmon (*O. kisutch*)	25	Central California Coast	***Endangered***	
	26	Southern Oregon/Northern California	***Threatened***	
	27	Lower Columbia River	***Threatened***	• Critical habitat
	28	Oregon Coast	***Threatened***	
	29	Southwest Washington	*Undetermined*	
	30	Puget Sound/Strait of Georgia	***Species of Concern***	
	31	Olympic Peninsula	*Not Warranted*	
Chum Salmon (*O. keta*)	32	Hood Canal Summer-run	***Threatened***	
	33	Columbia River	***Threatened***	
	34	Puget Sound/Strait of Georgia	*Not Warranted*	
	35	Pacific Coast	*Not Warranted*	
Steelhead (*O. mykiss*)	36	Southern California	***Endangered***	
	37	Upper Columbia River	***Threatened***	
	38	Central California Coast	***Threatened***	
	39	South Central California Coast	***Threatened***	
	40	Snake River Basin	***Threatened***	
	41	Lower Columbia River	***Threatened***	
	42	California Central Valley	***Threatened***	
	43	Upper Willamette River	***Threatened***	
	44	Middle Columbia River	***Threatened***	
	45	Northern California	***Threatened***	
	46	Oregon Coast	***Species of Concern***	
	47	Southwest Washington	*Not Warranted*	
	48	Olympic Peninsula	*Not Warranted*	
	49	Puget Sound	***Threatened***	• Critical habitat
	50	Klamath Mountains Province	*Not Warranted*	
Pink Salmon (*O. gorbuscha*)	51	Even-year	*Not Warranted*	
	52	Odd-year	*Not Warranted*	

1 The ESA defines a "species" to include any distinct population segment of any species of vertebrate fish or wildlife. For Pacific salmon, NOAA Fisheries Service considers an evolutionarily significant unit, or "ESU," a "species" under the ESA. For Pacific steelhead, NOAA Fisheries Service has delineated distinct population segments (DPSs) for consideration as "species" under the ESA.

Appendix D-2

PUBLIC MEETING AGENDAS AND SUMMARIES

May 3, 2011

Wesley Sprague, Supervisor
Community Services and Environmental Planning
King County Wastewater Treatment Division
201 South Jackson Street, MS: KSC-NR-0505
Seattle, WA 98104-3855

Dear Wesley,

I wish to comment on the DNS issued under the SEPA determination for the above referenced project. I attended some of the public outreach meetings held in advance of this determination. I asked various questions regarding the actual construction and required staging for that construction. As I'm sure you are aware, the vehicular arterials in the North Beach neighborhood are failing; potholes, sink holes and differential settlement plague the streets. The bus routes are particularly bad and indeed, hazardous.

I did not receive any answers to my questions regarding the location of the staging for the construction equipment and materials. One engineer suggested that the staging could be situated on 24th Ave NW in front of North Beach Elementary. Really?!! The staging should be adjacent to the site to increase safety and construction efficiency but I suggest that the staging not be north of the project along NW Blue Ridge Dr. Blue Ridge Drive will be severely disrupted with the construction zone and the Blue Ridge neighborhood will effectively be cut off from its park and beach access. We have many seniors along Blue Ridge Drive that are greatly concerned about emergency vehicle access as well. From a constructability standpoint, access to the staging area to the north of the project site would be very difficult if deliveries were ferried down the winding and blind Blue Ridge Drive to the north end of the staging area. Vehicles would then have to turn around in a very tight space and climb their way back up to 15th Street.

We suffered 2 in home deaths within the past 12 months and direct EMS access to as many homes as possible will put may minds at ease. It seems that the west end of 100th St. would work very well and not further impact access the park, existing bus routes and pedestrians.

The heavy construction equipment will put even more stress on the failing road system in the area. The roads in our neighborhood are not only poorly constructed and frightfully maintained but they are downright dangerous for public transit, bicycles and cars alike. I hope the miserable condition of NW 24th Street and Neptune Drive will be addressed and repaired with proper road building techniques and materials at the completion of the project.

Please do not hesitate to contact me to discuss the thoughts depicted here.

With regards,

John Graham
2408 NW Blue Ridge Dr.
Seattle, WA 98177
206.669.5262
John@GramorWA.com

King County
Department of Natural Resources and Parks
Wastewater Treatment Division
Community Services and Environmental Planning
King Street Center, KSC-NR-0505
201 South Jackson Street
Seattle, WA 98104-3855

July 5, 2011

John Graham
2408 NW Blue Ridge Drive
Seattle, WA 98177

Response to Comments on the North Beach Combined Sewer Overflow Control Project

Dear Mr. Graham:

Thank you for your comments on the North Beach Combined Sewer Overflow (CSO) Control Project State Environmental Policy Act (SEPA) Determination of Nonsignificance. Following are responses to the specific concerns expressed in your letter.

Staging. The amount of staging that takes place at the project site will be determined with consideration of the need to minimize associated impacts on traffic and access to homes and Blue Ridge Park. Off-site staging areas will be identified by the construction contractor and will be subject to City of Seattle permitting requirements.

Road Conditions. On recent visits to the project site, the King County project team has noticed several sinkholes in roads near the site. The team is aware that this has been an ongoing problem in the area and will take road conditions into consideration when determining construction haul routes. Any roads used as haul routes or by heavy equipment during construction must be able to safely accommodate construction trucks and equipment in addition to normal vehicular traffic. King County will work with the Seattle Department of Transportation (SDOT) to identify safe construction haul routes. Following construction, roads disturbed by project construction activities will be restored to conditions specified by SDOT in the Street Use Permit that will be required for the project.

Residential Access. King County appreciates your concern regarding the ability of residents to access their homes during construction and assures you that this will be a key consideration when the County and consultant design team is determining the exact location and configuration of the storage pipeline. The sequencing of construction activities will also be developed so as to minimize impacts to residential access. Impacts to vehicular and pedestrian traffic and access to Blue Ridge Park are also important factors that will be considered when the storage pipeline is designed and sited and when construction sequencing is developed.

Measures will also be taken during construction to minimize impacts to residential and park access. As described in the SEPA environmental checklist, construction contract specifications will require the contractor to provide safe pedestrian access to all residences at all times and safe vehicular access to residential properties to the maximum extent practicable. The contractor will also be required to maintain safe pedestrian access to Blue Ridge Park to the maximum extent practicable, although it is possible that the park could be intermittently unavailable for several days at a time during construction.

Per City of Seattle requirements, the contractor will be required to maintain access to residences for emergency vehicles and personnel (example, fire, police, and medical) at all times during construction. In addition to project design and construction sequencing, measures taken to meet this requirement could include having materials and equipment on-site to create immediate access for emergency vehicles, such as steel plates to cover excavations.

King County will provide advance notification of construction activities to residents adjacent to the construction area, including times when safe passage to Blue Ridge Park and vehicular access to homes will not be available. King County understands that restricted vehicular access to homes is very inconvenient and will make every effort to minimize these impacts and clearly communicate about times when these impacts cannot be avoided.

If you have SEPA-related questions about the North Beach CSO Control Project, please contact Sue Meyer, Water Quality Planner, at 206-684-1171 or sue.meyer@kingcounty.gov. For other questions about the project, please contact the project manager, Shahrzad Namini, at 206-263-6038.

Sincerely,

for Wesley Sprague

Wesley Sprague
Supervisor

cc: Shahrzad Namini, Project Manager, King County Wastewater Treatment Division (WTD)
Sue Meyer, Water Quality Planner, WTD

RECEIVED
MAY 16 2011
ENVIRONMENTAL PLANNING
AND COMMUNITY RELATIONS

9910 Triton Drive N.W.
Seattle, WA 98117
May 13, 2011

Wesley Sprague, Supervisor
Community Services + Environmental Planning
King County Wastewater Division
201 South Jackson Street MS: KSC-NR-0505
Seattle, WA 98104-3855

Dear Mr. Sprague:

I'm writing in regard to the SEPA "determination of nonsignificance" that has been issued for the North Beach CSO project. While it does seem ironic to be talking about environmental impact in reference to a project which will ultimately have a positive impact on the environment, a couple of thoughts seem relevant.

One concern is that both a sea lion and a sea otter have been seen in my neighbor Susie Hussong's pond. Perhaps she has already written to you about their ability to swim through the pipe connecting her pond to Puget Sound. (Water from that pipe will be diverted during the CSO construction project.)

Another issue which it seems to me would be considered to have an environmental impact is the fact

that this whole region seems to be riddled with springs and creeks and sink holes. You might find a lot of surprises that turn out to be "environmentally significant." 24th N. West seems to be falling apart, even before the grant construction vehicles begin their assault. It appears there are sink holes all over the place. (In addition to lots of pot holes, of course.)

Then there is Triton Drive N.W. My house shudders often, when one of the 40+ daily trains goes by, but what really makes it rattle is the number 18 bus when it hits the intersection of Triton Drive and N.W. N. Beach Drive, the site, I believe of a large sink hole. This is not far from where the County will begin digging its 25 foot hole.

No doubt skillful engineers will know how to deal with these problems — or potential problems to keep them from being considered "significant." I must say I have a great appreciation for the thoughtful way the County has approached the project so far and trust you will keep our concerns in mind.

Sincerely,

Bonnie Hefty

King County
Department of Natural Resources and Parks
Wastewater Treatment Division
Community Services and Environmental Planning
King Street Center, KSC-NR-0505
201 South Jackson Street
Seattle, WA 98104-3855

July 5, 2011

Bonnie Hefty
9910 Triton Drive NW
Seattle, WA 98177

Response to Comments on the North Beach Combined Sewer Overflow Control Project

Dear Ms. Hefty:

Thank you for your comments on the North Beach Combined Sewer Overflow (CSO) Control Project State Environmental Policy Act Determination of Nonsignificance. Following are responses to the specific concerns expressed in your letter.

Geotechnical conditions. In your comment letter, you expressed concern about problems with sinkholes in the project area and unknown subsurface conditions. One of the first tasks to be performed during project design is a geotechnical investigation of the project site. King County's design consultant will collect and review existing geotechnical information on the project site, including available geotechnical, historical land use, dredging, photographic, soil contamination, and groundwater data for projects completed at or in the vicinity of the project site. The consultant will conduct a field reconnaissance of surface geology to identify areas of unstable soils, rock outcroppings, corrosive soils, erosion, etc. Finally, the consultant will conduct geotechnical borings to characterize soil and groundwater conditions at the project site. The information collected during the geotechnical investigation will be used by the consultant to make recommendations for project construction activities such as excavation, shoring, backfilling, and groundwater control. This effort will greatly reduce the likelihood of encountering unexpected conditions during construction and ensure that the project design and construction techniques are appropriately suited to project site conditions.

Stormwater drainage. Another task that will be performed during project design is an investigation of the project site's storm drainage system. The investigation will include field observations and review of geographic information systems data, record drawings, closed-circuit television inspection videos, and information provided by community members. It will identify stormwater sources in the project area and parts of the storm drainage system that may need to be temporarily or permanently relocated in order to construct the proposed project. It will also

identify areas where additional investigations may be required. The storm drainage system investigation will help the project design team determine the appropriate capacity and configuration of the temporary stormwater diversion system and permanent drainage infrastructure constructed as part of the proposed project. King County will coordinate this work with Seattle Public Utilities, which is the agency responsible for the stormwater drainage system in this area.

Road conditions. On recent visits to the project site, the King County project team has noticed several sinkholes in roads near the site. The team is aware that this has been an ongoing problem in the area and will take road conditions into consideration when determining construction haul routes. Any roads used as haul routes or by heavy equipment during construction must be able to safely accommodate construction trucks and equipment in addition to normal vehicular traffic. King County will work with the Seattle Department of Transportation (SDOT) to identify safe construction haul routes. Following construction, roads disturbed by project construction activities will be restored to conditions specified by SDOT in the Street Use Permit that will be required for the project.

Vibration. In your comment letter, you stated that your house often shudders or rattles when trains and busses pass nearby. King County will take measures during project design and construction to minimize the potential for construction-induced vibration and settlement. During project design, a settlement and vibration evaluation will be performed to identify structures and improvements in the vicinity of the project that could be at risk of settlement and vibration damage by construction of the proposed project. Measures that can be implemented to minimize and mitigate construction-induced settlement and vibration damage of these structures will be identified and incorporated into the project's design and construction contract specifications.

Animals. Your comment regarding use of the storm drain that carries water from your neighbor's property to Puget Sound by a sea lion and sea otter is noted. Flow in this pipeline will need to be diverted during construction, but this activity is not expected to have any adverse effects on wildlife since the diversion will be temporary and use of the pipe by wildlife is infrequent.

Finally, King County appreciates your positive feedback on its approach to the proposed project. The County also appreciates the community's involvement in the project and will continue to work with the community during project design and construction.

If you have SEPA-related questions about the North Beach CSO Control Project, please contact Sue Meyer, Water Quality Planner, at 206-684-1171 or sue.meyer@kingcounty.gov. For other questions about the project, please contact the project manager, Shahrzad Namini, at 206-263-6038.

Sincerely,

Erika Peterson for Wesley Sprague

Wesley Sprague
Supervisor

cc: Shahrzad Namini, Project Manager, King County Wastewater Treatment Division (WTD)
Sue Meyer, Water Quality Planner, WTD

Susi Hussong 2640 NW North Beach Dr. Seattle, WA 98117 (206) 783-9493

Wesley Sprague, Supervisor
King County Wastewater Div.
201 South Jackson St.
MS KSC-NR-0505
Seattle, WA 98104-3855

May 9, 2011

Dear Mr. Sprague,

This letter is in response to the Determination of Nonsignificance that I received in the mail. I have been in correspondence with Monica Van der Vieren. My concerns and comments were recorded at the May 3rd neighborhood meeting but she suggested I send a letter directly to you.

My environmental concern is in regard to the SEPA checklist (the water section on pp. 9-13). Before the meeting I invited Shahrzad Namini, Karl Hadler and Monica to see my property and view where the two streams enter and exit my yard. They informed me that the flow from the streams would have to be diverted during the construction. When we have heavy rains the volume of water coming through is much greater and I am concerned that there will not be a pipe large enough to handle it.

I also wanted to mention that in the 12 years that I have lived here I have had a sea otter and a large sea lion enter my pond via the existing pipe that exits at the beach.

I understand that Monica plans to bring someone named Bruce to see the system that is here since there does not seem to be anything recorded showing the existing pipes that are under NW North Beach Drive and Triton Dr. NW.

I have been very impressed with Monica's promptness and ability to hear, respect and respond to our concerns. Awhile back I noticed murkiness in the water that continued long after the storm had passed and emailed her. She contacted the proper department who came out right away and were able to take samples and find the problem up further on the hill.

You may reach me at 206-783-9493 or harp4u@comcast.net if you have any questions.

Thank you.

Sincerely,

Susi Hussong

RECEIVED
MAY 11 2011
ENVIRONMENTAL PLANNING
AND COMMUNITY RELATIONS

King County
Department of Natural Resources and Parks
Wastewater Treatment Division
Community Services and Environmental Planning
King Street Center, KSC-NR-0505
201 South Jackson Street
Seattle, WA 98104-3855

July 5, 2011

Susi Hussong
2640 NW North Beach Drive
Seattle, WA 98177

Response to Comments on the North Beach Combined Sewer Overflow Control Project

Dear Ms. Hussong:

Thank you for your comments on the North Beach Combined Sewer Overflow (CSO) Control Project State Environmental Policy Act Determination of Nonsignificance. Following are responses to the specific concerns expressed in your letter.

Surface water/Water runoff. One of the first tasks to be performed during project design is an investigation of the project area's storm drainage system. The investigation will include field observations and review of geographic information systems data, record drawings, closed-circuit television inspection videos, and information provided by community members. It will identify stormwater sources in the project area and parts of the storm drainage system that may need to be temporarily or permanently relocated in order to construct the proposed project. It will also identify areas where additional investigations may be required. The storm drainage system investigation will help the project design team determine the appropriate capacity and configuration of the temporary stormwater diversion system and permanent drainage infrastructure constructed as part of the proposed project. King County will coordinate this work with Seattle Public Utilities, which is the agency responsible for the stormwater drainage system in this area. The information you have provided on the two streams that enter and exit your yard is very helpful and these flows will be carefully considered during the design of temporary and permanent project-related drainage systems.

In addition to the design considerations described above, measures will be included in the project's construction contract specifications to ensure that the temporary stormwater diversion system is sized appropriately and functions properly. For example, the contractor will be required to regularly inspect the stormwater diversion system and store back-up equipment on or near the project site in case any part of the system needs to be replaced.

Animals. Your comment regarding use of the storm drain that carries water from your property to Puget Sound by a sea lion and sea otter is noted. Flow in this pipeline will need to be diverted

during construction, but this activity is not expected to have any adverse effects on wildlife since the diversion will be temporary and use of the pipe by wildlife is infrequent.

Thank you for your comments and the information you have provided to the project team. If you have SEPA-related questions about the North Beach CSO Control Project, please contact Sue Meyer, Water Quality Planner, at 206-684-1171 or sue.meyer@kingcounty.gov. For other questions about the project, please contact the project manager, Shahrzad Namini, at 206-263-6038.

Sincerely,

Erika Peterson for Wesley Sprague

Wesley Sprague
Supervisor

cc: Shahrzad Namini, Project Manager, King County Wastewater Treatment Division (WTD)
Sue Meyer, Water Quality Planner, WTD

May 17, 2011

SEPA Determination of Nonsignificance
North Beach Combined Sewer Overflow Control Project

Items listed in SEPA that we would like to provide clarification and additional comment to clarify the neighborhood and waterfront community that this project is proposed to be located within. The main reason for our contesting/appeal of the SEPA is that we don't feel that the SEPA adequately describes the impact to the views accurately.

Environmental checklist:
Page 2
10. Permits

- Shoreline Substantial Development Permit
  Seattle Shoreline Master Program
  The criteria for the SMC 25.09 and ECA appear to be difficult to satisfy for this project.
  Is this Seattle Shoreline Master Program a required public process?
- City of Seattle – Building Permit (Residential Zone)
  The site plan does not have dimensions on the drawings. However, the proposal is suggesting an approximately 10-20 foot rear yard setback. I don't feel that the current proposal satisfies the rear yard setback requirement for a single family home per City of Seattle regulations (25 feet). Please verify the rear yard distance proposed.

Page 9
3. a. 1) and 2) Surface:

- Shoreline Substantial Development Permit
  Seattle Shoreline Master Program
  The criteria for the SMC 25.09 and ECA appear to be difficult to satisfy for this project for surface water.
  Is this Seattle Shoreline Master Program a required public process?

Page 14
5. a. Animals:

- Please add that there are blue herons near the site.

Page 19
10. a. Aesthetics:

- Please provide a height which the exhaust stacks would be extended to.

10. b. c. Aesthetics:

- Please correct the following sentence: "*The presence of the new above grade facility would alter views, but not block them.*" We do not feel this statement is correct. There are a handful of homes, where the views would be blocked. This reduces property values and significantly alters the feel and quality of the neighborhood.

- We do not want a building structure on the property. We feel that it changes the feel of the intersection and blocks views. The option that the neighborhood supported during the initial outreach was the option that placed all the equipment and infrastructure below the surface streets. We feel that the proposed measures to control aesthetic impacts of plantings and chain link fencing do not adequately address the negative visual impacts of the project.

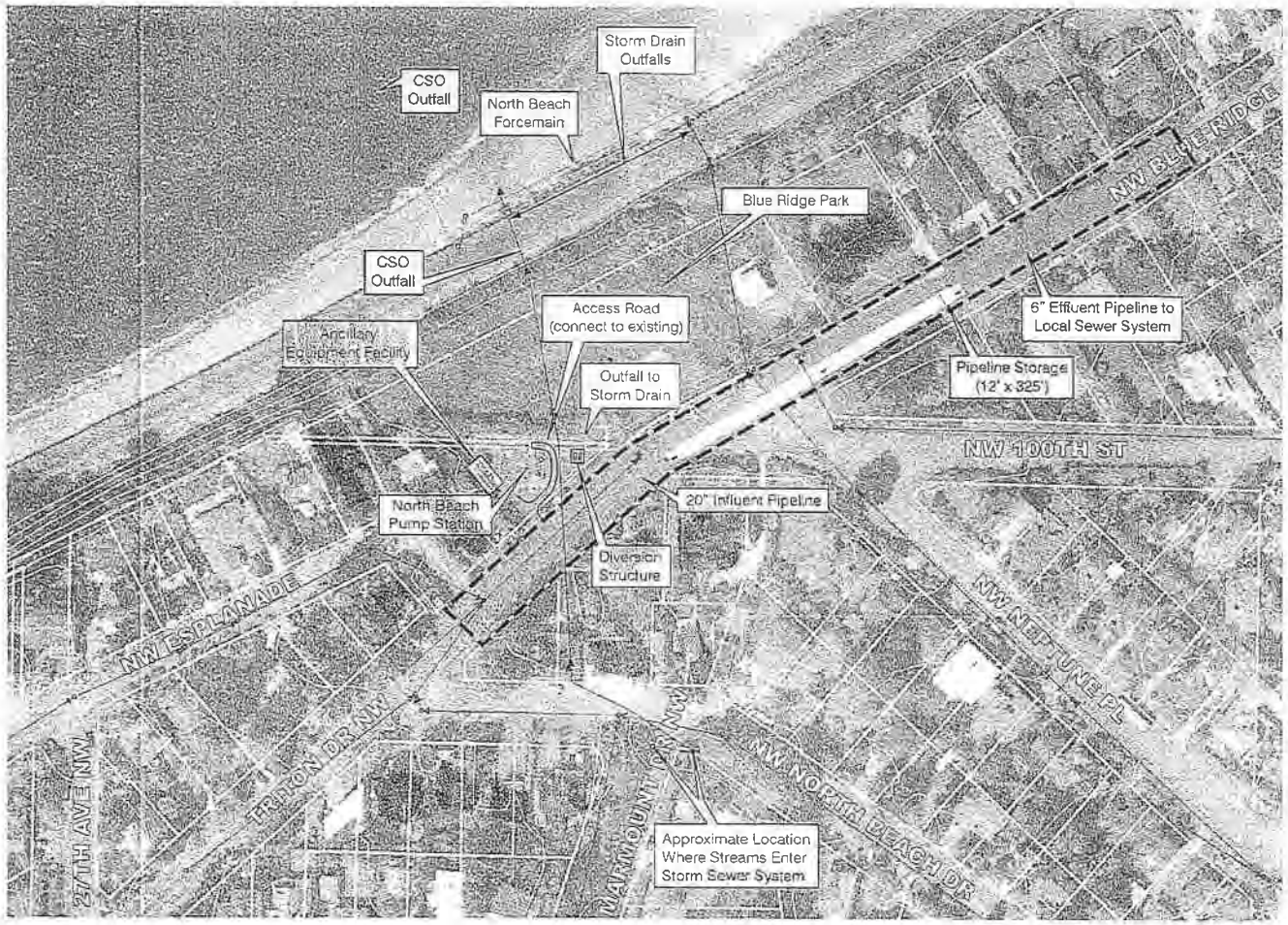
Page 20
11. a. Light and Glare

- Light and glare is identified to be impacting the neighborhood during the evening. I would request that no lights be illuminated in the evening to protect the surrounding residential neighborhood.

We appreciate your consideration of the above comments.

Sincerely,

Liz and Jean-Marc LeRoy
2624 NW Esplanade
206-331-7381



N

0 50 100 150'
Approximate Scale

Legend

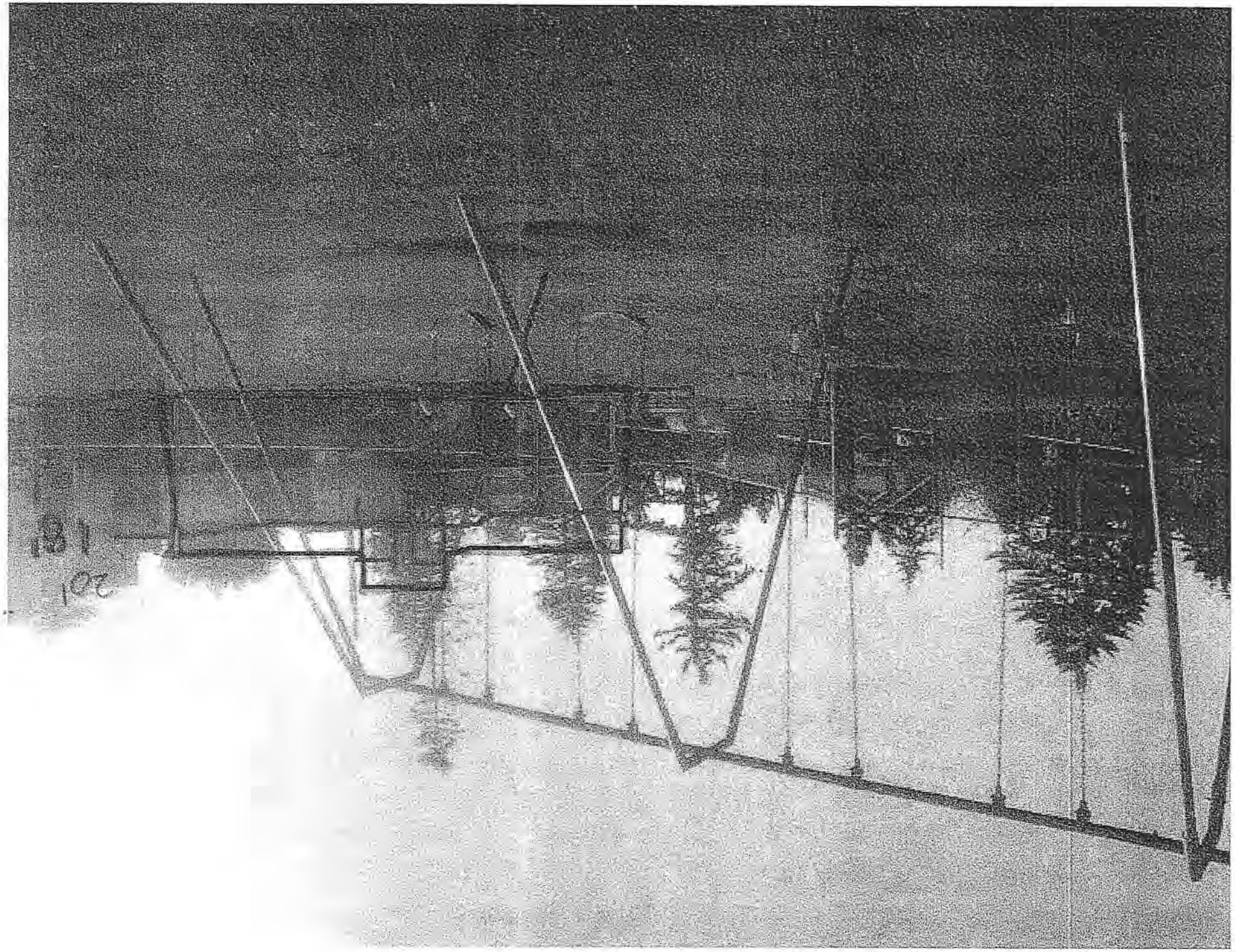
- Combined Sewer System
- Storm Sewer System
- Sanitary Sewer System
- 10' Topographic Contour
- Feasible Area for Pipe Location

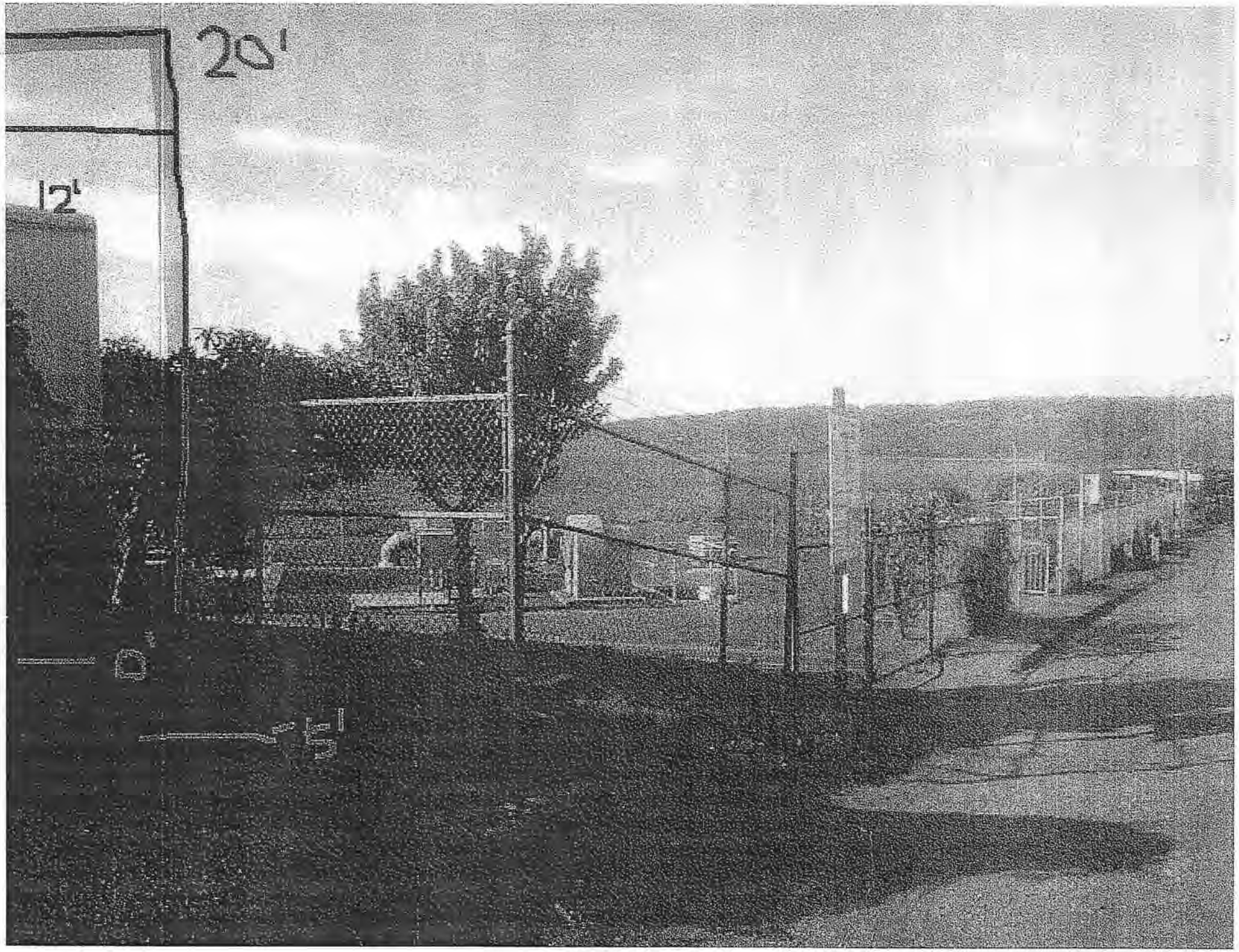
NORTH BEACH COMBINED SEWER OVERFLOW CONTROL PROJECT SITE LAYOUT PLAN

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Figure 6_1_new.ai

No. of homes who's view will be compromised with a 10 x 20 structure




20'
12'
0
5'

20'
18'

King County
Department of Natural Resources and Parks
Wastewater Treatment Division
Community Services and Environmental Planning
King Street Center, KSC-NR-0505
201 South Jackson Street
Seattle, WA 98104-3855

July 5, 2011

Liz and Jean-Marc LeRoy
2624 NW Esplanade
Seattle, WA 98177

Response to Comments on the North Beach Combined Sewer Overflow Control Project

Dear Mr. and Ms. LeRoy:

Thank you for your comments on the North Beach Combined Sewer Overflow (CSO) Control Project State Environmental Policy Act (SEPA) Determination of Nonsignificance. Following are responses to the specific questions and concerns expressed in your letter.

Permits. If a portion of the proposed project takes place in the shoreline zone, a Shoreline Substantial Development Permit consistent with Seattle's Shoreline Master Program will be required. In response to the question in your comment letter regarding whether or not this would require a public process, the answer is yes. The public process requirements are described in section 23.60 of the Seattle Municipal Code.

In your comment letter, you expressed concern about the footprint of the proposed ancillary equipment facility and whether or not it complies with City of Seattle land use codes. The project is currently in the early stages of design and the site plan included in the SEPA environmental checklist shows a preliminary layout for the ancillary equipment facility. The exact location of the ancillary equipment facility and other proposed structures will be determined during design and comply with applicable City of Seattle land use codes.

Animals. Your comment regarding the presence of blue herons near the project site is noted. The project is not expected to have any adverse effects on blue herons or other wildlife.

Aesthetics. King County understands that the community has concerns regarding the presence of a new above ground structure and its potential to block views, as stated in your comment letter. The location, configuration, and design details of the ancillary equipment facility and its exhaust stack will be determined during project design and be consistent with requirements in the Seattle Municipal Code. As currently proposed, exhaust stacks for the odor control system and standby power generator will extend approximately three feet above the roofline of the approximately 15-foot-tall ancillary equipment facility.

The facility will be constructed on the North Beach Pump Station site, which is at a lower elevation than nearby residential properties. The County and its consultant design team will work closely with the community during the design phase to ensure that the ancillary equipment facility's exterior aesthetic; including its exterior design, fencing, and landscaping, blends in with the surrounding community and minimizes impacts to views from nearby properties. For these reasons, the County maintains that while the presence of a new building will alter views, it will not block views, reduce property values, or significantly alter the feel or quality of the neighborhood.

Constructing the facility below ground is undesirable for several reasons. The County is uncertain whether or not adequate space is available on the pump station property to construct the facility below ground, constructing a below grade facility would generate more construction impacts and likely increase project costs, and many features of the ancillary equipment facility would have to be located above ground in order to meet building and fire code requirements.

Light and Glare. Exterior lighting for the proposed ancillary equipment facility is a requirement of the building code to ensure that the facility can be safely accessed. The exterior lighting will be designed by King County to minimize light and glare impacts. As stated in the SEPA environmental checklist, measures to minimize impacts will include using full cutoff, low intensity light fixtures and configuring them so that they do not cast light beyond the edge of the pump station property. Additionally, the use of highly reflective building materials and/or finishes in the design of the ancillary equipment facility will be restricted.

If you have SEPA-related questions about the North Beach CSO Control Project, please contact Sue Meyer, Water Quality Planner, at 206-684-1171 or sue.meyer@kingcounty.gov. For other questions about the project, please contact the project manager, Shahrzad Namini, at 206-263-6038.

Sincerely,

Erika Peterson for Wesley Sprague

Wesley Sprague
Supervisor

cc: Shahrzad Namini, Project Manager, King County Wastewater Treatment Division (WTD)
Sue Meyer, Water Quality Planner, WTD

Carkeek Watershed Community Action Project
386 NW 112TH · Seattle · Wa · 98177 · (206) 363-4116

May 12,2011

RECEIVED
MAY 16 2011
ENVIRONMENTAL PLANNING
AND COMMUNITY RELATIONS

Wesley Sprague, Supervisor
Community Services and Environmental Planning
King County Wastewater Treatment Division
201 South Jackson Street, MS: KSC-NR-0505
Seattle, WA 98104-3855

RE: State Environmental Policy Act Determination of Nonsignificance
Issued for North Beach Combined Sewer Overflow Control Project
Issue of Concern: Delay in Inspection of North Beach Force Main Conveyance Line in Sensitive Tidelands
(Environmental Checklist - A. Background - 7.)

Dear Mr. Sprague:

The Carkeek Watershed Community Action Project (CWCAP) feels it is imprudent for King County to have issued a DNS to this project without requiring an inspection of the North Beach Force Main Conveyance Line and a plan if needed for replacement or repair of the line.

In 1962 METRO/King County took over the operation of the Carkeek Primary Treatment Plant from the Greenwood Sewer District. At that time METRO decided the plant at Carkeek would also be used to treat the sewage from North Beach and Blue Ridge areas. In 1963 a 15" concrete force main was installed in sensitive tidelands between North Beach and the Carkeek beach to carry the sewage. The line was then buried and taken east to the treatment plant. It was common community knowledge that the concrete force main in the tidelands had a 'life span' of 50 years.

In 2013 the tidelines force main will be 50 years old. Since the force main was installed there have been three major earthquakes. First, April 29, 1965 (6.5), Second, February 28,2001 (6.8) and Third, February 30, 2009 (4.5) according to the current US Geological Survey.

Question: Is the force main at risk during earthquakes?
Question: Have there been breaks in the line?

King County states in the Environmental Checklist that in the "future" they plan "to identify and evaluate approaches for inspecting the North Beach force main to obtain a current estimate of remaining service life". CWCAP contends that should have been done as part of the North Beach CSO Control Project before any more load is placed on the force main. In addition, if the force main needs to be replaced and cannot be permitted in the tidelands a Plan for an overland system should be negotiated with community groups, Seattle Parks staff and elected officials. Thank you for your attention to these concerns!

Very sincerely,
Nancy R. Malmgren
Nancy R. Malmgren, Director CWCAP

cc: BCC, BRC, CPAC, CWCAP, Seattle Parks, Seattle Public Utilities, Sally Bagshaw, Mike O'Brien, Richard Conlin, Sally Clark

King County
Department of Natural Resources and Parks
Wastewater Treatment Division
Community Services and Environmental Planning
King Street Center, KSC-NR-0505
201 South Jackson Street
Seattle, WA 98104-3855

July 5, 2011

Nancy R. Malmgren
Director
Carkeek Watershed Community Action Project
386 NW 112th
Seattle, WA 98177

Response to Comments on the North Beach Combined Sewer Overflow Control Project

Dear Ms. Malmgren:

Thank you for your comments on the North Beach Combined Sewer Overflow (CSO) Control Project State Environmental Policy Act (SEPA) Determination of Nonsignificance (DNS). Following are responses to the specific concerns expressed in your letter.

The SEPA DNS that was issued for the North Beach CSO Control Project evaluated King County's proposal to control CSOs in its North Beach basin to an average of no more than one CSO per year on a long term average, as required by King County's current National Pollution Discharge Elimination System (NPDES) permit for the West Point Treatment Plant. As described in the SEPA DNS and environmental checklist, the proposal is to construct a wastewater storage pipeline in street right-of-way adjacent to the existing North Beach Pump Station and associated facilities on the King County-owned pump station property. After the project is completed, wastewater flows exceeding the capacity of the North Beach Pump Station and downstream North Beach force main will be diverted to the new storage pipeline and then be pumped back to the North Beach Pump Station when capacity in the wastewater system is available.

In your comment letter, you expressed concern about the proposed project resulting in more load being placed on the North Beach force main. Neither construction nor operation of the proposed project will affect the North Beach force main and the project will not require an increase in the conveyance capacity of the force main. After the project is completed, wastewater that is currently discharged as CSOs will be stored in the underground storage facility until the storm has passed and peak flows have subsided. Stored flows will be pumped back into the conveyance system at volumes within current design capacity for the North Beach pump station and force main.

As a separate effort, King County is looking at approaches to evaluate the North Beach force main and assess maintenance needs or other identified issues. Careful evaluation of available technologies is required due to the location of the force main and the dedication of this line as a sole means of wastewater conveyance from North Beach to the County's Carkeek facility. In response to the questions you presented in your comment letter, King County has not identified the North Beach force main as being at risk during an earthquake. The County manages over 350 miles of conveyance pipelines that have continued to provide service after major earthquakes in our region such as the 1965 and 2001 earthquakes that occurred after construction of the force main.

In the meantime, King County intends to proceed with the North Beach CSO Control Project to satisfy the West Point NPDES requirements that project design be completed by the end of 2012 and project construction begin by 2013.

If you have SEPA-related questions about the North Beach CSO Control Project, please contact Sue Meyer, Water Quality Planner, at 206-684-1171 or sue.meyer@kingcounty.gov. For other questions about the project, please contact the project manager, Shahrzad Namini, at 206-263-6038.

Sincerely,

Erika Peterson for Wesley Sprague

Wesley Sprague
Supervisor

cc: Shahrzad Namini, Project Manager, King County Wastewater Treatment Division (WTD)
Sue Meyer, Water Quality Planner, WTD

Ray Sneeringer
2444 NW Blue Ridge Drive
Seattle, WA 98177
May 16, 2011

RECEIVED
MAY 18 2011
ENVIRONMENTAL PLANNING
AND COMMUNITY RELATIONS

Wesley Sprague, Supervisor,
Community Services and Environmental Planning
King County Wastewater Treatment Division
201 South Jackson Street
MS KSC-NR-0505
Seattle, WA 98104-3855

Reference: North Beach CSO Environmental Checklist – Comments

I have the following comments on the CSO Environmental Checklist:

1) Section B3a1) Discusses storm water drainage on BR Drive. Much of the storm water currently flows on the northwest side of Blue Ridge drive and during periods of heavy rainfall, floods my front yard (see photo, below). I am hoping that this can be addressed during the design. However, I am not in favor of having a bioretention system and its associated standing water located in front of my property. Please consider the installation of a catch basin and a tight line to convey the storm water to the on-site bioretetion facility mentioned in Section A.11.

2) Section B7b2) When discussing the shoring options during the design process, please consider the fact that I work from home and the noise and vibrations generated by a pile driver system are not desirable.

3) Section B7b2) States the dewatering pumps will run 24 hours a day during excavation and be powered by a generator. Please consider powering the pumps with city power and using the generators as a backup to reduce the overall noise level in the neighborhood over this 12-16 month period.

4) B14g: I am very concerned about losing vehicular access to my residence during the construction period. What are the provisions for emergency vehicle access in the event of a fire or health emergency? Please investigate using larger diameter concrete pipe to reduce the overall length of the excavation. A 14 foot diameter pipe will reduce the overall length of the excavation by approximately 85 feet and allow full time access to the homes on BR Drive. A 16 foot diameter pipe will reduce the excavation length by approximate 140 feet and allow permanent access to Blue Ridge Park via a new gate on the NE corner.

Sincerely,

Ray Sneeringer
(206) 365-1784

King County
Department of Natural Resources and Parks
Wastewater Treatment Division
Community Services and Environmental Planning
King Street Center, KSC-NR-0505
201 South Jackson Street
Seattle, WA 98104-3855

July 5, 2011

Ray Sneeringer
2444 NW Blue Ridge Drive
Seattle, WA 98177

Response to Comments on the North Beach Combined Sewer Overflow Control Project

Dear Mr. Sneeringer:

Thank you for your comments on the North Beach Combined Sewer Overflow (CSO) Control Project State Environmental Policy Act (SEPA) Determination of Nonsignificance. Following are responses to the specific concerns expressed in your letter.

Stormwater drainage. One of the first tasks to be performed during project design is an investigation of the project area's storm drainage system. The investigation will include field observations and review of geographic information systems data, record drawings, closed-circuit television inspection videos, and information provided by community members. It will identify stormwater sources in the project area and parts of the storm drainage system that may need to be temporarily or permanently relocated in order to construct the proposed project. It will also identify areas where additional investigations may be required. The storm drainage system investigation will help the project design team determine the appropriate capacity and configuration of the temporary stormwater diversion system and permanent drainage infrastructure constructed as part of the proposed project. King County will coordinate this work with Seattle Public Utilities, which is the agency responsible for the stormwater drainage system in this area. The information and photos you provided related to stormwater drainage on Beach Drive NW is helpful and will be carefully considered during the design of temporary and permanent project-related drainage systems.

The permanent stormwater drainage system will be developed to meet the City of Seattle's stormwater management requirements. The preferences you expressed in your comment letter for the installation of a catch basin and tight line to a bioretention facility on the North Beach Pump Station property and for not having a bioretention facility located in front of your home are noted and will be taken into consideration by the project's design team.

Noise. In your comment letter, you expressed concern about noise that could be created by a generator to power dewatering pumps and suggested powering the pumps with City of Seattle

power. This will be determined by King County's construction contractor. Whichever power source is used, measures such as those described in the SEPA environmental checklist will be taken to reduce or control noise impacts (example, use of portable noise barriers) and project activities will comply with the City of Seattle's Noise Control Ordinance.

Vibration. In your comment letter, you also expressed concern about vibration that may result from shoring installation. King County will take measures during project design and construction to minimize the potential for construction-induced vibration and settlement. During project design, a settlement and vibration evaluation will be performed to identify structures and improvements in the vicinity of the project that could be at risk of settlement and vibration damage by construction of the proposed project. Measures that can be implemented to minimize and mitigate construction-induced settlement and vibration damage of these structures will be identified and practicable measures will be incorporated into the project's design and construction contract specifications. The potential vibration impacts of shoring installation and measures that can be taken to minimize these impacts will be considered as part of this evaluation.

Residential and Blue Ridge Park access. King County appreciates your concern regarding the ability to access your home during construction and assures you that this will be a key consideration when the County and consultant design team is determining the location and configuration of the storage pipeline. The sequencing of construction activities will also be developed so as to minimize impacts to residential access. Impacts to vehicular and pedestrian traffic and access to Blue Ridge Park are also important factors that will be considered when the storage pipeline is designed and sited and when construction sequencing is developed.

In your comment letter, you suggested that the County investigate using larger diameter pipe to reduce the overall length of the excavation for the storage pipeline and, consequently, reduce impacts to residential and Blue Ridge Park access. The design team will consider the use of pipes with larger diameters and other storage pipeline configurations that could reduce impacts to the community during design.

Measures will also be taken during construction to minimize impacts to residential and park access. As described in the SEPA environmental checklist, construction contract specifications will require the contractor to provide safe pedestrian access to all residences at all times and safe vehicular access to residential properties to the maximum extent practicable. The contractor will also be required to maintain safe pedestrian access to Blue Ridge Park to the maximum extent practicable, although it is possible that the park could be intermittently unavailable for several days at a time during construction.

Per City of Seattle requirements, the contractor will be required to maintain access to residences for emergency vehicles and personnel (example, fire, police, and medical) at all times during construction. In addition to project design and construction sequencing, measures taken to meet this requirement could include having materials and equipment on-site to create immediate access for emergency vehicles, such as steel plates to cover excavations.

King County will provide advance notification of construction activities to residents adjacent to the construction area, including times when safe passage to Blue Ridge Park and vehicular access to homes will not be available. King County understands that restricted vehicular access to homes is very inconvenient and will make every effort to minimize these impacts and clearly communicate about times when these impacts cannot be avoided.

If you have SEPA-related questions about the North Beach CSO Control Project, please contact Sue Meyer, Water Quality Planner, at 206-684-1171 or sue.meyer@kingcounty.gov. For other questions about the project, please contact the project manager, Shahrzad Namini, at 206-263-6038.

Sincerely,

for Wesley Sprague

Wesley Sprague
Supervisor

cc: Shahrzad Namini, Project Manager, King County Wastewater Treatment Division (WTD)
Sue Meyer, Water Quality Planner, WTD

Appendix D-3

SEPA AFFIDAVITS OF PUBLICATION

The Seattle Times

seattletimes.com
PO Box 70, Seattle, WA 98111

KC WASTEWATER TREATMENT
ATTN ENVIRONMENTAL PLANNING
201 S JACKSON ST KSC-NR-0505
SEATTLE, WA 98104

Re: Advertiser Account #66257505
Ad #: 796734900

Affidavit of Publication

4123800 / 1

STATE OF WASHINGTON
Counties of King and Snohomish

The undersigned, on oath states that he/she is an authorized representative of The Seattle Times Company, publisher of The Seattle Times of general circulation published daily in King and Snohomish Counties, State of Washington. The Seattle Times has been approved as a legal newspaper by orders of the Superior Court of King and Snohomish Counties.

The notice, in the exact form annexed, was published in the regular and entire issue of said paper or papers and distributed to its subscribers during all of the said period.

Newspaper	Publication Date
The Seattle Times	**04/28/11, 05/05/11**

Marilyn Peredo Signature Marilyn Peredo

Subscribed and sworn to before me on May 6, 2011
(DATE)

Maureen E Duggan MAUREEN E. DUGGAN
(NOTARY SIGNATURE) Notary Public in and for the State of Washington, residing at Seattle

MAUREEN E. DUGGAN
NOTARY PUBLIC
COMMISSION EXPIRES 12-28-12
STATE OF WASHINGTON

The Seattle Times

seattletimes.com

Re Advertiser Account #66257505 Ad # 796734900

Ad TEXT: NOTICE OF ISSUANCE-DETERMINATION OF NONSIGNIFICANCE.

Notice is hereby given that on April 28, 2011, the King County Wastewater Treatment Division issued a State Environmental Policy Act (SEPA) Determination of Nonsignificance (DNS) for the North Beach Combined Sewer Overflow (CSO) Control Project. The project involves constructing a wastewater storage pipeline in street right-of-way adjacent to the existing North Beach Pump Station and associated facilities including a new diversion structure and ancillary equipment facility on the King County-owned pump station property. The purpose of the project is to reduce CSOs from the North Beach basin. Comments will be accepted on this project until 5 p.m. on May 16, 2011. Send comments to Wesley Sprague, Supervisor, Community Services and Environmental Planning, King County Wastewater Treatment Division; 201 S. Jackson St., MS: KSC-NR-0505; Seattle, WA 98104-3855. The Director of King County Department of Natural Resources and Parks, consistent with King County Public Rule 7-4-1, Section 6.2.14, and RCW 43.21C.240, has determined that the environmental impacts identified in the SEPA environmental checklist for the North Beach CSO Control Project will be adequately addressed by the development regulations and other applicable requirements of the City of Seattle and by all other applicable state and federal regulations referred to in the environmental checklist for the North Beach CSO Control Project. Therefore, no administrative appeal of issuance of the DNS will be allowed for the North Beach CSO Control Project. The rule may be viewed at http://www.kingcounty.gov/operations/policies/rules/utilities/put741pr.aspx. For a copy of the SEPA DNS and environmental checklist, King County Public Rule 7-4-1, or more information, contact Sue Meyer, Water Quality Planner, at 206-684-1171 or sue.meyer@kingcounty.gov.

Appendix D-4

SEPA COMMENTS AND RESPONSES

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Puget Sound Beach Combined Sewer Overflow (CSO) Control Projects

Public Meeting for North Beach Basin

March 30, 2010, 6:00 PM – 8:30 PM
Loyal Heights Community Center
2101 NW 77th St, Seattle, WA 98117

Agenda

Meeting Purpose: This meeting is intended to –

- Present three alternative means for CSO control in the North Beach basin
- Present how these alternatives were developed
- Explain why the three alternatives are being considered for further evaluation
- Hear from the community about the alternatives

6:15 pm	Welcome & Introduction to Project Team
6:20 pm	PowerPoint Presentation • CSO Control Program Overview • CSO Beaches Projects Objectives • CSO Control Approaches • North Beach Basin Requirements • North Beach Basin Alternatives • Next Steps
7:00 PM	Questions, Responses and Input *A summary of tonight's meeting will be available on the project website (www.kingcounty.gov/csobeachprojects) or you can sign up to receive a copy by mail.*
8:00 PM	View Displays
8:30 PM	Adjourn

Alternative Formats Available
206-684-1280 or 711 TTY Relay

Puget Sound Beach Combined Sewer Overflow (CSO) Control Projects

North Beach Basin

Public Meeting Summary

March 30, 2010, 6:00-8:30 pm
Loyal Heights Community Center, 2101 NW 77th St, Seattle, WA 98117

Overview

On March 30, 2010, the King County Wastewater Treatment Division (WTD) hosted a public meeting for the Puget Sound Beach Combined Sewer Overflow (CSO) Control Projects in the North Beach basin. Approximately 15 members of the public attended the meeting.

Meeting Purpose

The meeting was intended to –

- Present three alternative means for CSO control in the North Beach basin
- Present how these alternatives were developed
- Explain why the three alternatives are being considered for further evaluation
- Hear from the community about the alternatives

Public Meeting Approach

Shahrzad Namini, King County project manager, started the meeting and introduced the team. John Phillips, King County CSO Program; Monica Van der Vieren, King County WTD Community Relations; Brian Matson, consultant team project manager; Karl Hadler, lead engineer for the North Beach basin; and Bob Wheeler, meeting facilitator, gave a PowerPoint presentation that included the following topics:

- CSO Control Program Overview
- CSO Beaches Projects Objectives
- CSO Control Approaches
- North Beach Basin Requirements
- North Beach Basin Alternatives
- Next Steps

Following the presentation, there was a period for meeting attendees to ask questions of the project team and to provide input on the alternative means of CSO control. Afterwards, meeting attendees were encouraged to view informational posters that were set up around the meeting room and talk with members of the project team. Flip charts were available to record questions and input.

Meeting attendees were informed of and encouraged to use a variety of methods for submitting questions and input, which include the following:

- Web: www.kingcounty.gov/csobeachprojects
- E-mail: CSOBeachProjects@kingcounty.gov
- Phone: 206-263-7301
- Feedback forms (available at the public meeting)

Because of the project schedule, meeting attendees were encouraged to provide input by mid-April, 2010. Input received by then will provide the best opportunity to inform the evaluation of the three alternatives. Input is always welcome and will be used throughout the facility planning process.

List of Informational Posters

- Basin Map showing City System/County System & Combined System/Separated System
- Map of each alternative with basin inset (3 boards)
- Map of all three alternatives
- "What is a Combined Sewer Overflow?"
- CSO Control approaches overview
- Factors used for alternatives evaluation
- Decision Process graphic

List of Handouts Available

- Information Packet
    - Meeting agenda
    - Public Information Document
    - Map and aerial photo of basin
    - Feedback form
- Dept. of Ecology CSO fact sheet
- Ratepayer report
- "Don't Flush Trouble" flier
- RainWise brochure (City of Seattle)
- "Natural Drainage Systems" (City of Seattle)

Summary of Questions and Input

Questions and input from the public are summarized below.

There were multiple questions and remarks on the following topics.

Design and siting of potential facilities in Blue Ridge Park

- How tall would the above grade facilities be?
- Would the above grade facilities be located right on the bluff? Could you move them farther west?
- Is it possible to show a rendering of the above ground facilities so we have an idea how the facilities might impact our view? That would help us provide informed input.
- Could WTD sink the above grade facilities a few feet in the ground to make the above grade portion shorter?
- Is there flexibility in how the odor control and electrical facilities are designed? Will the design team include an architect?
- The above grade facilities could be moved into the hillside at the south end of the park. Then the facilities would no longer be visible.
- Would the storage tank be below grade? Could you put grass on top of it? Would you be able to see if after construction?
- Is the diversion structure below grade? Could you put grass on top of it?
- I am concerned about how much of the park and which parts of the park would be occupied by this project. How close must the above ground structure be to the below grade structure?
- There is a property for sale next to the park. Has it been considered for potential acquisition as a site for facilities? A property to the east of the existing North Beach Pump Station will likely be available for sale soon.
- For the alternative with a pump station in Blue Ridge Park, could the new pump station be located where the existing pump station is now?

Response: The above grade odor control and electrical facilities will be about one story high, or a maximum of fifteen feet. The current drawings show one possible location for the above ground facilities, but there is flexibility in where they could go.

The storage tank and the diversion structure would be located below grade. An access hatch big enough for a person to fit through would be needed for the diversion structure.

The specifics of where facilities will be located and how the construction site will be restored will be determined with public input during the design phase for the proposed alternative. King County will work with the community during design to refine the appearance of any above grade facilities. The design team will include an architect and a landscape architect. King County has completed several examples of above grade facilities that have been designed to blend in with the surrounding area.

The project team will need to discuss the possibility of producing a rendering of above grade facilities.

It is early in the project planning process to be in direct discussions about property issues. As WTD moves forward with a proposed alternative, we will consider the availability of properties and options for siting specific facilities.

A new pump station at the bottom of the basin could not be located on the site of the existing North Beach Pump Station because the existing pump station would need to remain in service until the new pump station is complete.

Construction impacts

- For the alternative with pipeline storage in Triton Dr NW and NW Blue Ridge alternative, how would you deal with the underground power and other utilities that are already located in the street right-of-way?
- How long will construction last and how will WTD assist residents with access to their homes?

Response:
Underground utilities would be avoided or relocated.

Construction would last about 12-18 months for the alternatives with tank storage in or near Blue Ridge Park and for the alternative with pipe storage in the street right-of-way. Construction would last about 18-24 months for the alternative with a pump station in Blue Ridge Park and a pipeline connecting to the 8th Ave interceptor pipeline. King County works with residents closely during the design phase to anticipate and reduce construction impacts. King County puts requirements for limiting construction impacts into contractors' contracts. King County staff are available via a 24-hour hotline during construction.

Rectangular underground storage alternative with pump station in Blue Ridge Park with conveyance to 8th avenue interceptor

- What is the area called where the drop structure and odor control facility are shown?
- What is a drop structure and what does it look like?
- What is the purpose of this alternative, if there is still storage in Blue Ridge Park?
- How long would it be before the existing North Beach pump station and the North Beach force main would needed to be replaced?
- How old was the pipeline in Lincoln Park that failed?
- Could the North Beach force main be re-lined to increase its longevity?
- How close can structures be built to the property line or to residential buildings? There is a federal development covenant for the Crown Hill site and multifamily housing next door.
- Could the drop structure and odor facility be located on a different property at the top of the basin? There are other properties that are not as restricted by a federal covenant.
- Would the 20 foot by 15 foot structure in Crown Hill Park be above ground?

Response: The area where the drop structure and odor control facility are shown is a utility easement in Crown Hill Park. A drop structure is where a pressurized force main transitions to a gravity pipe. Two eight inch pipes would come above grade and "gooseneck" to a box about five feet by five feet in size that provides a transition to the gravity sewer.

Building a new pump station and pumping flows directly to the 8th Ave interceptor pipeline would eliminate the need for the existing North Beach pump station and the North Beach force main, which runs along the beach from the pump station to Carkeek Park. The existing pump station and the North Beach force main were built in the 1960s. This alternative would eliminate the need to upgrade or replace the North Beach pump station and the North Beach force main in the future if needed.

During final design, King County will perform additional inspections to better understand the condition and expected lifespan of the existing North Beach pump station and the North Beach force main. These inspections will help determine the options for rehabilitating or replacing the North Beach force main. One consideration with re-lining is that it would reduce the capacity of the force main.

The minimum distance between new facilities and the property line or residences is governed by city code.

An approximately 20 foot by 15 foot structure, as shown in Crown Hill Park area, would be above ground. If this is the alternative that is proposed for environmental review, the project team will work to minimize the above ground structure.

Decision process

- Does King County have a preferred alternative at this point?
- Are King County's internal reports available for review? It would be helpful to know what the County is considering.

Response: King County does not have a preferred alternative at this time. All three alternatives are being refined and they will be evaluated using the selection factors that were described in the presentation.

Please submit any requests for reports or documentation from King County in writing, and we will be happy to provide information through our public disclosure process.

How storage for combined sewer overflow control works

- Do CSO events last just one day?
- Would the storage facility be designed to flow out by gravity so sludge is not left at the bottom?
- Could the CSO control facility be overwhelmed by a storm event?

Response: CSO storage facilities operate intermittently, only about ten times a year. The amount of time it takes for storage to fill depends on the intensity of the storm event. On average, the storage facility will be full of water for six hours, though it could be up to a maximum of 24 hours. It will then take about six to twelve hours for the storage facility to empty. The facility will be designed with a slope and a bottom sump that can be dewatered at the end of a CSO event. The storage tank would also include flushing capabilities for cleaning after the CSO event.

If storage were to reach capacity during a storm event, there would be an overflow similar to what happens now at the pump station. The requirement is to have no more than one overflow per year on a 20 year average.

Environmental considerations

- What are the energy requirements to build and operate each alternative? Sometimes we overlook the use of energy during construction. Total energy use seems like an important element to consider while evaluating the alternatives.
- How vulnerable are these facilities to earthquakes?
- The proposed odor control facilities are similar to existing King County odor control facilities. Are there incident reports that would indicate how reliable these facilities are? Should neighbors worry about odor?

Response: The storage facilities operate intermittently, only about ten times a year when there are major storm events, and they do not use a great deal of energy. WTD encourages contractors to recycle, salvage materials, use biodiesel and take other measure to operate sustainably. The environmental review process will consider overall energy use for construction and operation of facilities.

The Pacific Northwest is a seismically vulnerable area. All facilities will be constructed to International Building Code (IBC) standards for seismic safety. Geotechnical analysis of sites will be performed to inform design.

There are many King County odor control facilities that people generally don't notice, for example at Seattle Center, in Carkeek Park, and in a residential area on Mercer Island. King County considers installing odor control for new facilities. Odor control works by filtering air to remove hydrogen sulfide gas. King County routinely tests and inspects the odor control facilities to make sure they are working. King County maintains a 24-hour a day hotline for odor complaints, with a commitment to respond to complaints within two hours.

Additional questions and input from the public included the following:

- Rats and raccoons use the storm system. If they are displaced they will run through the neighborhood. How will your project affect the animals in the sewer system? (Response: There is a brochure about deal with rats in sewers. Contact King County community relations staff, Monica Van der Vieren for a copy.

- How are you dealing with natural creeks that are coming down the hill? There are two creeks on the property behind mine that flow into a pipe that goes under the street into Blue Ridge Park. (Response: We will look into where that water goes.)
- If we could get rid of infiltration and inflow into the combined sewer system, would this project still be necessary? (Response: There is a relatively small amount of inflow in this basin compared to the amount of infiltration that occurs through cracked pipes. The project team looked at combinations of infiltration and inflow reduction in various parts of the basin to reduce or eliminate the need for storage. This approach is not being considered at this time because of the potential for groundwater and surface water impacts, such as increase in flooding and the potential to exacerbate problems with slope stability in the area. If you "tighten up" the sewer system, groundwater levels will rise. When we were out the public open house last fall and at briefings for community groups, we heard concern about flooding and slope stability in this basin.)
- Do King County projects have an art component? (Response: Yes, state law governs the budget of the art component of King County projects.)

Attendance

Puget Sound Beach CSO Control Project Team

King County Wastewater Treatment Division
Shahrzad Namini, Project Manager; Linda Sullivan, Capital Projects Managing Supervisor; John Phillips, CSO Control Program; Mary Wohleb, Assistant Project Manager; Bill Wilbert, Environmental Programs Managing Supervisor; Hien Dung, Real Estate Services; Sue Meyer, Environmental Planning ; Martha Tuttle, Community Relations; Monica Van der Vieren, Community Relations

Carollo Engineers
Brian Matson, consultant team project manager; Karl Hadler, lead engineer for North Beach basin

Triangle Associates, Inc.
Bob Wheeler, facilitator; Ellen Blair, community relations support

Seattle Public Utilities

Sahba Mohandessi

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Puget Sound Beach Combined Sewer Overflow (CSO) Control Projects

Technical Information Sharing for North Beach Basin
June 26, 2010, 10:00 AM – 2:00 PM
Loyal Heights Community Center
2101 NW 77th St, Seattle, WA

Light refreshments will be provided

Agenda

Meeting Purpose: This meeting is intended to –

- Respond to citizens' request for technical information and information about the process to identify and screen CSO control alternatives
- Hear and discuss input from the community for King County to consider
- Explain next steps for the North Beach Basin CSO Control project.

Time	Agenda Item	Discussion Lead
10:00 – 10:10 am	Sign-in	
10:10 – 10:20 am	Welcome • Meeting organized around community questions and comments	Bob Wheeler, Triangle Associates
10:20 - 10:45 am	Project Background & Decision-Making Process • Updates to King County's process in response to community concerns • Review: what is a CSO? • How will the community influence the decision?	Linda Sullivan, WTD
10:45 – 11:15 am	Understanding Your Basin • How wastewater flows in North Beach basin • Volume requiring control to prevent overflows	Brian Matson, Carollo Engineers
11:15 – 12:00 pm	Developing and Evaluating Alternatives for CSO control • Options considered for the North Beach Basin • Green Infrastructure or Inflow and Infiltration Reduction • Factors for comparing alternatives	Brian Matson, Carollo Engineers
12:00 – 12:30 pm	*Break*	

Alternative Formats Available
206-684-1280 or 711 TTY Relay

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Time	Agenda Item	Discussion Lead
12:30 – 1:15 pm	Facility Design and Construction • Underground facilities in neighborhoods • Restoration after facility construction • Community relations during design and construction	Panel Discussion: Linda Sullivan, WTD; Peg Staeheli, SVR Design; Brian Matson, Carollo Engineers; Monica Van der Vieren, WTD
1:15 – 1:40 pm	Q&A	Project team
1:40 – 2:00 pm	Next Steps	Bob Wheeler, Triangle Associates & Linda Sullivan, WTD

Puget Sound Beach Combined Sewer Overflow (CSO) Control Projects

North Beach Basin

Technical Information Session
Summary of Discussion
June 26, 2010, 10:00-2:00 pm
Loyal Heights Community Center, 2101 NW 77th St, Seattle, WA

Overview

On June 26, 2010, the King County Wastewater Treatment Division (WTD) hosted a public meeting to share technical information about the combined sewer overflow (CSO) control project in the North Beach Basin. The meeting was organized in response to citizen requests for additional technical information about how the wastewater system works in the North Beach Basin, how WTD developed and evaluated CSO control alternatives for the basin, and whether green stormwater infrastructure and/or infiltration and inflow control are options in the North Beach Basin.

Thirty-three members of the public attended the meeting.

Presentations

Through presentations from the project team, meeting attendees learned about the nature of the CSO problem and the project decision-making process. There were detailed discussions of flow requirements in the North Beach Basin, with hydrographs demonstrating various scenarios. A detailed discussion of infiltration and inflow reduction and green stormwater infrastructure followed. The nine alternatives that were considered for the North Beach Basin were reviewed. King County outlined next steps in the project and how the county will work with the community during design and construction.

Summary of Questions and Input

Questions and input from the meeting attendees are summarized below.

Impacts to downstream infrastructure
The question arose whether CSO control in North Beach would impact facilities in Carkeek Park and whether there was capacity in the force main and at Carkeek to take additional flow from the North Beach Basin. The CSO control alternatives currently under consideration will not increase flows or require any changes to facilities at Carkeek Park.

Existing North Beach Basin infrastructure/Alternative 1D
Meeting attendees expressed desire for more information about the remaining service life of the North Beach pump station and force main and whether it can be replaced in its current location in the tidelands. Residents have expressed concerns about potential future construction projects that may result in back-to-back construction, new facilities constructed in Blue Ridge Park, and/or above ground structures that may impede views.

The existing facilities at North Beach are almost 50 years old. Alternative 1D for CSO control in North Beach includes replacement of the existing pump station and a new force main that runs uphill to the county's 8th Avenue Interceptor instead of along the tidelands to Carkeek Park. The engineering consultant stated that it would be technically very challenging to locate the new pump station completely underground. The new pump station would require two-stage pumping to reach an elevation of over 300 feet. If the pump station cannot be located underground, it could be up to one story high.

Some meeting attendees recommended that the county inspect the existing force main before deciding whether to build Alternative 1D. If this proposal is not recommended for CSO control at North Beach, King County will continue operations and regular maintenance of the existing pump station and begin planning for an updated force main inspection. Inspecting force mains requires careful planning since these conveyance pipelines are in service and under pressure all the time. The findings from an updated inspection will help the county plan for any future projects to rehabilitate or replace the existing infrastructure. If Alternative 1A or 1B were to be selected for the current CSO project, a later project could be implemented to address existing facilities and include conveyance of flows from storage built at this time for CSO control.

The project team indicated that permitting a rehabilitation or replacement of the force main in the tidelands will be challenging, but can't be ruled out at this time.

WTD staff said the potential new drop structure and odor control facility at the top of the basin for Alternative 1D would be located in a utility easement at the old Crown Hill Elementary site. It is unknown whether the structure could be located underground, but it appears that the diversion structure would not interfere with the plans for playfields at the school site.

A meeting attendee asked what happens if pump station pumps fail. Wastewater overflows can happen when pumps fail; overflows would discharge through the two North Beach outfalls . The North Beach Pump Station has a standby generator to prevent overflows from a power failure.

Reduction of Infiltration and Inflow (I/I)
Meeting attendees expressed interest in reducing the amount of infiltration and inflow that enters the wastewater system as a way to control CSOs. The project team explained that stormwater entering the wastewater system via I/I contributes to a significant amount of the flow during CSO events, however removing stormwater from the system would likely require building a dedicated stormwater collection system throughout the basin, which is more expensive for CSO control compared to storage. A separate storm system might need to include treatment facilities which would create additional costs and impacts.

An attendee inquired whether controlling I/I in just the areas of the North Beach Basin that have an existing stormwater collection system would reduce the size of a CSO storage facility. WTD staff said that the potential reduction in storage size would be minimal and would not reduce fixed costs and construction impacts for a storage project.

A discussion centered around whether WTD would consider offering an incentive to encourage voluntary participation for property owners to replace their side sewers, which might be effective since area homeowners know that they have older infrastructure. WTD staff said that a pilot project is currently underway to help King County assess the affect of I/I control on sewer flows, noting that I/I control has not been proven to control CSOs. The cost of controlling I/I is estimated to be substantially more than the CSO control alternatives that WTD is now considering. King County's policy is to control I/I where it is cost-effective to do so.

In response to a question about whether cracked sewer pipes could be leaking into the ground, WTD staff explained that wastewater does not typically leak from pipes into the ground, even though groundwater may leak into pipes via cracks. Water flows in the easiest way. It's easier to flow in a pipe than through the soil, so if there is a pipe with a crack, the groundwater will enter. Water is unlikely to exit a pipe for the same reason -- it is easier to flow in the pipe than through the soil.

A meeting attendee asked about the trend of I/I levels over time in the North Beach basin. WTD said that I/I levels are predicted to be at a peak. Most structures are 50-60 years old and if they deteriorate further they will need to be replaced, which will reduce I/I. If areas with older structures are redeveloped, I/I will be reduced because side sewers will be replaced.

Green Stormwater Infrastructure (GSI)
In response to questions about the use of green stormwater infrastructure to help control CSOs, WTD staff and consultants explained that most GSI projects that have been built to date were designed to reduce or slow stormwater into stormwater systems, not to control CSOs. They said that designing GSI to control CSOs requires a high degree of certainty that the CSO regulation will be met for the Department of Ecology and EPA to approve the project.

The project team described how GSI was evaluated for all four basins in the CSO Beach Projects, and the factors such as steep slopes and groundwater level limit the use of this approach for CSO control in North Beach.

WTD staff clarified that installing rain barrels on private property will not help reduce CSOs, but it is a way to conserve water. Stormwater containment systems were described as small underground storage tanks that could encompass an entire yard. They directed attendees to the City of Seattle RainWise program for information about GSI on private property.

Other Alternatives That WTD Considered
An attendee asked about pumping flow from the bottom of the basin to storage elsewhere in the basin. WTD staff said a pump station needed to pump to storage elsewhere would be larger than a storage facility at the bottom of the basin.

An attendee asked about increasing the capacity of the pumps at the existing North Beach Pump Station. The engineering consultant said increasing the capacity of the pumps is possible, but it would require increasing the capacity of the North Beach force main and increasing the pumping and treatment capacity at Carkeek Park.

An attendee expressed concern about new facilities meeting noise requirements. WTD staff said new facilities would be required to meet single family residential noise requirements at the fence lines.

Decision-making process
The timeline for obtaining permits for the CSO control project was discussed. WTD will apply for permits after the environmental review process. Alternative 1A and 1D would require a permit to work in the shoreline and in a conservancy recreation zone.

In response to a question, WTD staff explained that the King County Council would be briefed about the decision and that the King County Executive would ultimately approve the proposal.

Meeting attendees wondered if it would be possible to choose anything but the least costly alternative during the tough economy. WTD staff noted that cost is not the only factor considered, but the decision must be justifiable to ratepayers throughout the regional service area. WTD staff clarified that construction of the Puget Sound Beach CSO Control projects are already funded in WTD's capital improvement program.

Staff Attendance

The following project team members attended the technical information session:

King County Wastewater Treatment Division
Linda Sullivan, Capital Projects Managing Supervisor; Shahrzad Namini, Project Manager; Mary Wohleb, Assistant Project Manager; John Phillips, CSO Control Program; Monica Van der Vieren, Community Relations

Carollo Engineers
Brian Matson, consultant team project manager; Karl Hadler, North Beach Basin Lead

Triangle Associates
Bob Wheeler, facilitator; Ellen Blair, community relations support

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Puget Sound Beach Combined Sewer Overflow (CSO) Control Projects

Proposed Alternative Presentation for North Beach Basin
October 19, 2010, 6:30-8:30 PM
Loyal Heights Community Center
2101 NW 77th St, Seattle, WA

Agenda

Meeting Purpose: This meeting is intended to –

- Review the county's decision process for the recommended CSO control project
- Convey how community input influenced the decision process
- Provide further detail on the recommended project
- Describe how King County works with communities during design and construction
- Present next steps in the project
- Address concerns and questions about this project
- Provide information for people to keep up to date on the project

7:00 p.m.	PowerPoint Presentation • Welcome and Introductions to Project Team • North Beach CSO Facility project status • North Beach basin proposal to control CSOs • Design and construction • Next steps
8:05 p.m.	Questions, Responses and Input *A summary of tonight's meeting will be available on the project website (www.kingcounty.gov/csobeachprojects) or you can sign up to receive a copy by mail.*
8:15 p.m.	View displays and continue discussion with staff
8:30 p.m.	Adjourn

Alternative Formats Available for All Materials in Packet
206-684-1280 or 711 TTY Relay

King County

Department of Natural Resources and Parks
Wastewater Treatment Division

Puget Sound Beach Combined Sewer Overflow (CSO) Control Projects

North Beach Basin

Public Meeting Summary

October 19, 2010 6:30-8:30 pm
Loyal Heights Community Center, 2101 NW 77th St, Seattle, WA 98117

Overview

On October 19, 2010, the King County Wastewater Treatment Division (WTD) hosted a public meeting for the Puget Sound Beach Combined Sewer Overflow (CSO) Control Projects in the North Beach basin. The meeting was intended to present the recommended proposal for CSO control in North Beach, review the County's decision process for the control project, convey how community input influenced the decision, describe how King County works with communities during design and construction, and discuss next steps in the project.

Seventeen members of the public attended the meeting.

Presentations

Through presentations from the project team, meeting participants learned about the recommended proposal for CSO control in the North Beach basin. Participants were updated on the CSO project status. The project team reviewed the project history, provided details on the proposed project including how the facility would function, outlined known construction impacts and likely operation and maintenance activities, and shared how King County works with communities during design and construction. The presentation ended with a timeline for next steps. The presentation and other meeting materials can be found at www.kingcounty.gov/csobeachprojects.

Before the presentation, there was a period for meeting attendees to view display boards, ask questions of the project team and express concerns related to design and construction of the proposed project. Afterwards, meeting attendees had the opportunity to view informational posters that were set up around the meeting room and talk with members of the project team. Flip charts were available to record questions and input.

Meeting attendees were informed of and encouraged to use a variety of methods for submitting questions and input, which include the following:

- Web: www.kingcounty.gov/csobeachprojects

- E-mail: monica.vandervieren@kingcounty.gov
- Phone: 206-263-7301
- Feedback forms (available at the public meeting)

Meeting attendees were encouraged to ask questions, express concerns, and provide input. King County staff indicated that input is always welcome and will be used throughout the facility design process.

Summary of Questions and Input

Questions, feedback, and discussion from the meeting attendees are summarized below.

Storage capacity and flows

One meeting attendee expressed concerns about the ability of the proposed storage tank to hold sufficient flows during storm events. WTD staff and the consultant team explained that the size of the storage tank had been determined based on flow monitoring and hydraulic models using historic rainfall records that simulate sewer flows during peak wet weather events. The hydraulic models were used to determine storage and/or conveyance criteria to meet the Department of Ecology requirements for no more than one overflow per year on a long-term average.

Participants learned that the peak flow during a large storm is estimated at 8.5 mgd (million gallons per day). This peak is an instantaneous rate that may last for only a short duration (5-10 minutes), exceeding the pump station capacity of 3 mgd during that period. The storage tank will be approximately 230,000 gallons and, based on extensive modeling, is sized to limit CSOs to no more than one overflow per year on a long-term average.

A meeting participant asked what would happen if there is more than one overflow per year on average after the project is completed. The analysis that has gone into the project shows that the tank will be sized for the worse conditions so it will be in compliance with Department of Ecology requirements. To measure compliance, King County will continue monitoring and reporting requirements for the North Beach Facility.

Separating wastewater and stormwater

One participant asked whether there was a plan to separate stormwater from the sewage system. It is being discussed in some parts of King County and the City of Seattle, but not in North Beach, partly due to the cost of putting in an entirely new stormwater conveyance system.

A participant asked whether road runoff is separated or combined. Olympic Manor has a dedicated stormwater collection system with an outfall to Puget Sound. The rest of the basin is composed of ditch and culvert; water flows overland and does not necessarily enter the combined sewer system except in the form of I/I (infiltration and inflow).

Construction staging

In response to questions about the size and location of the construction staging area, WTD staff and consultants explained that the staging area will be remote due to lack of available space near the construction site. The lead engineer explained that staging will require about an acre. WTD

staff recognizes the impact of staging on the community, and will work to engage neighbors of staging area(s) when they are identified.

Construction impacts
Community members expressed concern about local road conditions and the ability of roads to handle heavy construction equipment. Participants felt that the most obvious haul route- 24th Avenue NW- is already failing and expressed concern that heavy truck traffic will result in further damage. Attendees commented that even buses make the road shake. Participants expressed the desire for road improvements prior to construction to insure the road will remain usable.

Participants asked about the duration and impacts of construction on Triton Dr N.W. and N.W. Blue Ridge Dr. In the PowerPoint presentation, the project team described potential impacts to private improvements in the right-of-way and a range of construction impacts that can be expected on this type of project. Construction in the public right-of-way is expected to take 18-24 months. King County will have a permitted traffic plan and a public involvement plan based on community concerns and feedback. The details will be addressed during the design phase of the project, when the team will define the exact location of the facility and work out details that will maintain residential access and needed services. Traffic impacts, including rerouting of Metro bus service, will be addressed during this time.

A meeting participant asked about the maximum noise level allowed during construction. The City of Seattle determines construction sound limits. A construction permit may outline the times of day construction activities are allowed.

New facility impact on current outfalls
Participants asked how the new facility will impact current outfalls on the local beaches. WTD staff explained that one of the pipe outfalls is a dedicated stormwater pipe from Olympic Manor; a second pipe collects two streams that converge higher up in the basin and drains them to the beach. The CSO control project will reduce CSO discharges from the beach outfall to no more than one per year, but the outfall will not be eliminated as a result of the project. Staff indicated that King County is aware of concerns about human and environmental exposure from this outfall and will investigate addressing the issue as a separate project.

Community members expressed concern about waiting three or more years to address the beach outfall, and asked whether WTD could encourage community education regarding care for the wastewater and combined sewer system. WTD staff offered tours of Carkeek Treatment Plant and will incorporate information as part of project outreach.

Impacts on Carkeek Treatment Plant
One participant suggested that repositioning the collection system higher in the basin would eliminate the need for the North Beach Pump Station and storage tank. A project engineer explained that water flows by gravity down to the North Beach Pump Station and is then pumped to Carkeek. The pump station is needed to convey flows collected lower in the North Beach basin than the elevation of Carkeek Pump Station, so a collection system at a higher elevation does not eliminate the need for a pump station. Three million gallons per day is the current

maximum that is transferred to the Carkeek Treatment Plant and that would not change with the proposed storage tank.

Above ground structures
One participant asked about potential for odor from the facility and odor control. Odor control will be included in this project. The odor control facility will operate by passing air through carbon scrubbers before releasing it into the atmosphere. The lead engineer explained that CSOs are dilute wastewater with over 95% stormwater, and CSO flows are stored for short time periods before they are returned to the conveyance system. Therefore, the odor potential from the CSO facilities should be minimal.

Meeting participants expressed concerns about the size of the odor and electrical facility to be located on the North Beach Pump Station property. The maximum size for the facility is approximately 40 feet by 20 feet, or 800 square feet. The maximum height is one story, or approximately 18 feet as set by City of Seattle code. One participant requested that the facility be built underground. WTD staff understands the importance of visual impacts on views and will work closely with the community during design to minimize those impacts.

Closing
The project team thanked the participating citizens for their active involvement in the planning phase of the project. Citizen input was very important to informing the decision process, resulting in a recommended CSO proposal for North Beach that will meet the technical needs while addressing citizen concerns. Staff reminded the audience that there is still a lot of work remaining in the design phase of the project and encouraged the community to remain involved and continue to provide input.

Attendance

Puget Sound Beach CSO Control Project Team
King County Wastewater Treatment Division
Shahrzad Namini, Project Manager; Linda Sullivan, Capital Projects Managing Supervisor; Mary Wohleb, Assistant Project Manager; Monica Van der Vieren, Community Relations

Carollo Engineers
Brian Matson, consultant team project manager; Karl Hadler, lead engineer for North Beach basin

Triangle Associates, Inc.
Bob Wheeler, facilitator; Kristine Cramer, community relations support

Appendix E

COST DATA

Project:	**King County CSO**				
Subject:	**North Beach Alternative 1B**				
By :	**CEH**				
Date :	**20-Dec-10**				
Construction Cost Estimate					
Item	**Description**	**Quantity**	**Unit**	**Unit cost, $**	**Cost, $**
DIVISION 1 - GENERAL REQUIREMENTS					
	Temporary Traffic Control	1	LS	$287,946	$287,946
	Temporary Erosion & Sediment Control	1	LS	$35,993	$35,993
DIVISION 2 - SITE WORK					
	Equipment Mobilization	1	EA	$10,000	$10,000
	ACP Removal				
	Storage Pipe	795	SY	$20	$15,900
	Odor Control Building	89	SY	$20	$1,780
	Diversion Structure	11	SY	$20	$220
	Clearing & Grubbing	0	AC	$12,000	$0
	Excavation				
	Storage Tank	6,091	BCY	$15	$91,361
	Diversion Structure	405	BCY	$25	$10,125
	Haul/Disposal - Tank	5,332	LCY	$11	$58,655
	Shoring				
	Storage Pipe	23,943	SF	$42	$993,635
	Dewatering	1	LS	$890,000	$890,000
	Backfill (native)	1,825	BCY	$15	$27,374
	Intall 12-ft Diam RCP storage pipe	325	LF	$1,000	$325,000
	Install 20-inch pipe	200	LF	$700	$140,000
	Pipe Bedding	15	CY	$18	$267
	24" Compacted Gravel Fill - Storage Pipe	589	CY	$20	$11,778
	Imported Backfill/Compaction - Storage Pipe	1,825	CY	$20	$36,498
	AC Surface Restoration	805	SY	$45	$36,245
	Generator fuel tank	1	LS	$12,000	$12,000

Project:	**King County CSO**				
Subject:	**North Beach Alternative 1B**				
By :	**CEH**				
Date :	**20-Dec-10**				
Construction Cost Estimate					
Item	**Description**	**Quantity**	**Unit**	**Unit cost, $**	**Cost, $**
DIVISION 3 - CONCRETE					
	Diversion Structure				
	Base Slab	8	CY	$300	$2,400
	Walls	27	CY	$500	$13,500
	Top Slab	8	CY	$800	$6,400
	Odor Control and Electrical Bldg				
	Strip Footings	22	CY	$300	$6,667
	Foundation Walls	11	CY	$400	$4,444
	Slab on Grade	89	CY	$326	$28,978
DIVISION 4 - MASONRY					
	Odor Control Bldg				
	12" CMU Walls; Full grouted, 12-ft high, slab on grade	2,400	SF	$38	$91,200
DIVISION 5 - METALS					
	Fencing - Diversion Structure	200	LF	$8	$1,600
	Hatches	8	EA	$10,000	$80,000
	Odor Control Bldg				
	Metal Decking	2,400	SF	$6	$14,400
	Roof Joists, 8-ft OC Fabricated Steel	12,000	LB	$3	$32,400
	Miscellaneous Plates/Shapes	11,000	LB	$3	$33,000
	Metal Roof	2,400	SF	$6	$15,000

Project:	**King County CSO**				
Subject:	**North Beach Alternative 1B**				
By :	**CEH**				
Date :	**20-Dec-10**				
Construction Cost Estimate					
Item	**Description**	**Quantity**	**Unit**	**Unit cost, $**	**Cost, $**
DIVISIONS 7 & 8 - ARCHITECTURAL					
	N/A				
DIVISION 15 - MECHANICAL					
	Storage Tank				
	Tipping Bucket	1	LS	$25,000	$25,000
	Drain Gates	1	LS	$10,000	$10,000
	Level Sensor	1	LS	$5,000	$5,000
	Pumps	3	LS	$5,000	$15,000
	Miscellaneous Mechanical	1	LS	$13,500	$13,500
	Diversion Structure				
	Slide Gate	1	EA	$10,000	$10,000
	Level Sensor	1	EA	$5,000	$5,000
	Odor Control/Electrical/Generator Bldg				
	Heating, Ventilating, Plumbing	1	EA	$65,000	$65,000
	Odor Control Equipment				
	Scrubber, Fan, Sound Enclosure	1	LS	$25,000	$25,000
DIVISION 16 - ELECTRICAL					
	Electrical				
	Electrical	1	LS	$325,000	$325,000
	Standby Generator	1	LS	$60,000	$60,000
	Telemetry	1	LS	$50,000	$50,000
	Subtotal				*$3,923,265*
	Contingency	30%			$1,176,980
	Total Estimated Construction Cost(1)				$5,100,000
Notes:					
(1) Total estimated construction cost does not include sales tax or escalation.					

WTD Business Case Evaluation Results

North Beach CSO Life Cycle Cost

WTD Borrowing Cost as Discount Rate (1)

Scenario	Lifetime	Initial Capital Outlay	Total Project Life Costs (2)	Total Project Life Benefits	Net Project Life Costs	Average Project Annual Cost	Annual Costs over(under) Status quo
Status Quo							
"Status Quo"	0	$0	$0	$0	$0	$0	
Alternatives							
:om of Basin Storage	35	$9,850,000	$11,455,809	$0	$11,455,809	$512,065	$512,065

Budget Office Discount Rate (3)

Scenario	Lifetime	Initial Capital Outlay	Total Project Life Costs (2)	Total Project Life Benefits	Net Project Life Costs	Average Project Annual Cost	Annual Costs over(under) Status quo
Status Quo							
"Status Quo"	0	$0	$0	$0	$0	$0	
Alternatives							
:om of Basin Storage	35	$9,850,000	$10,713,783	$0	$10,713,783	$478,897	$478,897

First Year of Construction	2014	Additional inflation rate > 3%	1.00%

Notes:

(1) WTD Discount rate based on recent WTD borrowing costs net of 3% annual inflation. 2.73%

(2) Costs include risk and uncertainty, if estimated.

(3) Discount rate net of inflation, per the King County Budget Office. 7.00%

The option with the largest net equivalent annualized cost is the financially preferred option.

Alternative 1B - Pipeline Bottom of Basin Storage

Lifetime (in years)--->	35	Please provide
First year of O&M costs --->	2015	the appropriate
Electricity Supplier (SCL or PSE) --->	SCL	information in the
Indicate "Plant" or "Off-Site" --->	Off-Site	shaded areas

	All project costs through 2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Current year (from Results summary sheet)																		
Total Benefits (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capital and O&M	$9,895,799	$46,941	$48,115	$49,323	$50,564	$51,840	$53,152	$54,500	$55,887	$57,313	$58,779	$60,287	$61,837	$63,431	$65,071	$66,757	$68,491	$70,274
Debt-related and O&M	$683,085	$487,228	$488,402	$489,609	$490,850	$492,126	$493,438	$494,787	$496,174	$497,600	$499,066	$500,573	$502,124	$503,718	$505,357	$507,043	$508,777	$510,561
Risk (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Uncertainty (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capital outlays	$9,850,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt issuance	$197,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt service	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287
		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
				$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
					$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Energy use	$4,676	$4,723	$4,770	$4,818	$4,866	$4,915	$4,964	$5,013	$5,063	$5,114	$5,165	$5,217	$5,269	$5,322	$5,375	$5,429	$5,483	$5,538
Natural Gas	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
therms	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity	$4,676	$4,723	$4,770	$4,818	$4,866	$4,915	$4,964	$5,013	$5,063	$5,114	$5,165	$5,217	$5,269	$5,322	$5,375	$5,429	$5,483	$5,538
Electricity Use kwh	70000	70000	70000	70000	70000	70000	70000	70000	70000	70000	70000	70000	70000	70000	70000	70000	70000	70000
Demand kW or kVa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Chemical spending	$5,000	$5,050	$5,101	$5,152	$5,203	$5,255	$5,308	$5,361	$5,414	$5,468	$5,523	$5,578	$5,634	$5,690	$5,747	$5,805	$5,863	$5,922
Sodium hypochlorite required in gal.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bisulfide required in gal.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other chemical costs - enter $	$5,000	$5,050	$5,101	$5,152	$5,203	$5,255	$5,308	$5,361	$5,414	$5,468	$5,523	$5,578	$5,634	$5,690	$5,747	$5,805	$5,863	$5,922
Generator Fuel	$1,200	$1,212	$1,224	$1,236	$1,249	$1,261	$1,274	$1,287	$1,299	$1,312	$1,326	$1,339	$1,352	$1,366	$1,379	$1,393	$1,407	$1,421
Pipeline Cleaning Equipment	$700	$707	$714	$721	$728	$736	$743	$750	$758	$766	$773	$781	$789	$797	$805	$813	$821	$829
Labor	$34,223	$35,249	$36,307	$37,396	$38,518	$39,673	$40,863	$42,089	$43,352	$44,653	$45,992	$47,372	$48,793	$50,257	$51,765	$53,318	$54,917	$56,565
Labor Hours	650	650	650	650	650	650	650	650	650	650	650	650	650	650	650	650	650	650

Benefits

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of benefits 1, 2, etc."

UNCERTAINTIES

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of uncertainties 1, 2, etc."

RISKS

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of risks 1, 2, etc."

Alternative 1B - Pipeline Bottom of Basin Storage

Lifetime (in years)--->
First year of O&M costs --->
Electricity Supplier (SCL or PSE) --->
Indicate "Plant" or "Off-Site" --->

Current year (from Results summary sheet)	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Total Benefits (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capital and O&M	$72,108	$73,994	$75,935	$77,930	$79,983	$82,094	$84,266	$86,500	$88,798	$91,162	$93,594	$96,096	$98,670	$101,318	$104,042	$106,845	$109,729
Debt-related and O&M	$512,395	$514,281	$516,221	$518,217	$520,269	$522,381	$524,552	$526,786	$529,084	$531,448	$533,880	$536,382	$538,956	$541,604	$544,329	$547,132	$550,015
Risk (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Uncertainty (from below)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capital outlays	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt issuance	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt service	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287	$440,287
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Energy use	$5,593	$5,649	$5,706	$5,763	$5,820	$5,878	$5,937	$5,997	$6,057	$6,117	$6,178	$6,240	$6,303	$6,366	$6,429	$6,494	$6,558
Natural Gas	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
therms	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electricity	$5,593	$5,649	$5,706	$5,763	$5,820	$5,878	$5,937	$5,997	$6,057	$6,117	$6,178	$6,240	$6,303	$6,366	$6,429	$6,494	$6,558
Electricity Use kwh	70000	70000	70000	70000	70000	70000	70000	70000	70000	70000	70000	70000	70000	70000	70000	70000	70000
Demand kW or kVa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Chemical spending	$5,981	$6,041	$6,101	$6,162	$6,224	$6,286	$6,349	$6,412	$6,476	$6,541	$6,606	$6,673	$6,739	$6,807	$6,875	$6,943	$7,013
Sodium hypochlorite required in gal.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bisulfide required in gal.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other chemical costs - enter $	$5,981	$6,041	$6,101	$6,162	$6,224	$6,286	$6,349	$6,412	$6,476	$6,541	$6,606	$6,673	$6,739	$6,807	$6,875	$6,943	$7,013
Generator Fuel	$1,435	$1,450	$1,464	$1,479	$1,494	$1,509	$1,524	$1,539	$1,554	$1,570	$1,586	$1,601	$1,617	$1,634	$1,650	$1,666	$1,683
Pipeline Cleaning Equipment	$837	$846	$854	$863	$871	$880	$889	$898	$907	$916	$925	$934	$943	$953	$962	$972	$982
Labor	$58,262	$60,009	$61,810	$63,664	$65,574	$67,541	$69,567	$71,654	$73,804	$76,018	$78,299	$80,648	$83,067	$85,559	$88,126	$90,770	$93,493
Labor Hours	650	650	650	650	650	650	650	650	650	650	650	650	650	650	650	650	650

Benefits

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of benefits 1, 2, etc."

UNCERTAINTIES

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of uncertainties 1, 2, etc."

RISKS

1.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
3.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
4.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

"Additional description of risks 1, 2, etc."