CSO LONG TERM CONTROL PLAN
SRF PROJECT NO. CS-330106-05

CITY OF PORTSMOUTH
PORTSMOUTH, NEW HAMPSHIRE

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CSO LONG TERM CONTROL PLAN
CITY OF PORTMOUTH, NH

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EXECUTIVE SUMMARY

The City of Portsmouth, New Hampshire, is a historic community situated along the confluence of the Piscataqua River and the Atlantic Ocean. As with many older cities and towns throughout New England, Portsmouth's sewer systems provide collection for both sanitary and storm water flows. During precipitation events, the combined flows often exceed the capacity of the existing system, causing overflows of combined sewage into the receiving waters. Flooding of downtown streets and backups into areas residences also occur due to the limited carrying capacity of the existing system.

The City has been implementing projects to rehabilitate the aged and undersized sewer system over the past 3 decades. In 1990, the City entered into a Consent Decree with the U.S. Environmental Protection Agency (EPA) and the New Hampshire Department of Environmental Services (NHDES) to address the combined sewer overflows (CSOs), as these caused violations to the wastewater facility permit. These efforts led to the present CSO Long Term Control Plan (LTCP), and a compliance schedule issued by Administrative Order (A/O) # 02-15.

The LTCP was first submitted in August 2002 in compliance with the A/O schedule. The present report is an update that incorporates comments from the NHDES as well as updated information on the City's progress on improving the system capacity and reducing CSO events.

The LTCP focuses on controlling overflows at outfalls #10A and #10B, located on the South Mill Pond, and outfall # 013 located at the end of Deer Street and the Piscataqua River. These 3 outfalls along with one other, manually gated outfall #012 located on Marcy Street, are specifically included in the City's National Pollutant Discharge Elimination System (NPDES) Permit. In addition, the LTCP provides a program to address the problems with upstream flooding and backups from the combined system.

Due to the magnitude and complexity of the LTCP, a 2-phase approach is proposed to be implemented over the following 15 to 20 years (Table ES-1). This plan was also presented in the City's Preliminary Design Submission letter to EPA in March 2003. Phase 1 of the LTCP consists of a 15-year plan to address the system conveyance capacity by implementing targeted sewer separation projects, upgrading main sewage pumping stations, and providing additional treatment facilities for separated storm water. Phase 2 will include reevaluation of the system conditions following completion of the Phase 1 projects to define any additional controls required to prevent untreated discharges to the receiving waters. Annual progress reports and continued monitoring and will be used throughout the LTCP to maintain communications with regulators and provide ongoing evaluation and direction for the program.

Table ES-1 ***Recommended Long Term Control Plan for CSOs***

	Project	Projected Sequence of Implementation	Estimated Cost for LTCP projects
Phase 1	**Group I** - Targeted separation projects for main sewer interceptor projects converging at the South Mill Pond (Lincoln Area / Mechanic Street Sewer Basin), construction of storm water treatment facilities, and restoration of main sewage pumping stations.	**Years 1 – 15** Initiated in 2003 with start of construction for Contract #1 Lincoln Area, and design of upgrades for Deer Street Pumping Station.	**$21.37 million** for sewer and drainage projects + **$0.5 million** for treatment of separated storm water + **$2.3 million** for upgrades to Deer St and Mechanic St Pumping Stations **Total Phase 1 projects** **$24.17 million**
	Group II - Targeted separation projects for collector system piping and continuation of upgrades to sewer interceptors in outer Lincoln Area / boundaries with Lafayette sewer basin.		
	Group III - Targeted separation projects for improvements in additional sewershed areas tributary to the Deer Street sewer basin.		
Phase 2	**Plus Abatement Projects** New flow monitoring and update of hydraulic modeling for evaluation, design and construction of additional controls for remaining CSOs.	**Years 15-20**	**Total Phase 2 projects** **$2.2 to 6 million**
All	Compliance monitoring and LTCP construction progress reports	**Annually**	**$0.33 million** **(first 5 years)**
	Comprehensive review and reporting of LTCP progress and effectiveness	**Every 5 years**	

The actual project sequence and costs for implementation of the LTCP will be adjusted as the projects proceed, depending on other City infrastructure needs / capital improvements planning. In addition to the projects identified above, the City continues to implement sewer improvements to address other critical sections of the combined sewer system. Some of the recent projects include:

- Additional sewer/drainage and other infrastructure work in Lincoln Area (2003-ongoing)
- Rehabilitation of Court Street area sewers completed in 2003 – 2004
- Rehabilitation of Dennett Street area sewers completed in 2002 – 2003
- Sewer separation and I/I reduction projects in Thaxter / Fells area, Essex / Sheffield, Panaway Manor, lower South Street, Coakley / Larry Lane, among others, in 2000– 2002
- Investigation and elimination of illicit sewer connections in collaboration with NHDES (CSO and cross connections status report issued June 2004), and
- Continued monitoring and monthly reporting for CSO outfalls 10A/10B and Deer St 013.

The City has been implementing the sewer separation projects at a rate of about $1 million per year since 1997 through funding provided in part by the State Revolving Fund (SRF) wastewater program. The SRF program provides low interest loans to assist communities to minimize user rate impacts caused by the design and construction of infrastructure projects. The City has received $22.5 million through the SRF wastewater program (through March 2004) to cover part of the costs for rehabilitation of its sewer and drainage systems. Additional funding options are being pursued to assist with other 'ineligible' costs related to the sewer and drainage improvements, including the SRF storm water and water programs. An application for assistance through the State and Tribal Assistance Grant (STAG) program was also submitted to the EPA in late 2003. Table ES-2 summarizes a projected cash flow for the LTCP program.

Table ES-2 ***Long range cash flow projections – LTCP projects***

Project		*2004*	*2005*	*2006*	*2007*	*2008*	*2009-2013*	*2014-2018*	*2019+*	
		Millions of $, rounded (2003 costs)								
Long Term Control Plan		***Phase 1***							***Phase 2***	***TOTAL***
	Lincoln Area Sewer Separation									
	Eligible Sewer/Drain	$1.00	$1.00	$2.10	$1.50	$1.50	$6.67	$7.60		**$21.37**
	Storm water treatment									
	Vortex type separators	$0.25	$0.25							**$0.50**
Phase 1	**Pumping Station Upgrades**									
	Deer Street	$0.5	$0.5	$1.0						**$2.00**
	Mechanic Street				$0.3					**$0.30**
	Compliance Monitoring					$0.33	TBD			**$0.33**
	Subtotal Phase 1 + compliance monitoring									**$24.5**
	Plus Abatement Projects for remaining CSOs									
Phase 2	Monitoring, evaluation, design and construction								$2.2 - 6.0	$6.0
Total LTCP		**$1.75**	**$1.75**	**$3.10**	**$1.80**	**$1.83**	**$6.67**	**$7.60**	**$2.2– 6.0**	**$30.5**

Note: Costs presented are order of magnitude conceptual estimates intended solely for the City's long-range planning needs.

The LTCP program costs have increased significantly beyond the original projected funding level of $22.5 million. The City will revisit these costs annually as part of its long-range capital improvements planning (CIP), to redirect its efforts in accordance with available funding, the success of sewer separation projects, and other infrastructure needs. Ideally, the City could implement the LTCP projects along with other necessary infrastructure improvements including, additional (ineligible) sewer / drainage, water, curbing, sidewalk, and road projects. Table ES-3 summarizes the additional CIP projects identified by the City as part of its long range infrastructure needs. The City is working to secure additional funding sources to assist with these programs.

Table ES-3 *Additional Capital Improvements Planning (CIP) needs*

Capital Improvements Plan		*2004*	*2005*	*2006*	*2007*	*2008*	*2009-2013*	*2014-2018*	*2019+*	*Total*
		Millions of $, rounded (2003 costs)								
	Ineligible Sewer/Drain	$0.61	$0.30	$1.25	$0.57	$0.19	$1.82	$2.03		$6.77
	Water	$0.08	$0.51	$0.32	$0.90	$0.35	$2.05	$2.33	TBD	$6.54
	Sidewalk/Curb	$0.17	$0.46	$0.45	$0.54	$0.26	$2.42	$2.71	TBD	$7.01
Total additional CIP		**$0.86**	**$1.27**	**$2.02**	**$2.01**	**$0.80**	**$6.29**	**$7.07**	**TBD**	**$20.3**

Note: Costs presented are order of magnitude conceptual estimates intended solely for the City's long-range planning needs.

1. INTRODUCTION

1.1 SEWER SYSTEM BACKGROUND

The City of Portsmouth is located in Rockingham County at the mouth of the Piscataqua River in the seacoast area of New Hampshire (Figure 1-1). The City's sewer system consists of approximately 115 miles of separate or combined sewers (excluding Pease International Tradeport), 19 pumping stations, and an advanced primary wastewater treatment plant (WWTP) located on Peirce Island. The Peirce Island WWTP has a design capacity of 4.8 mgd (average day) and peak capacity of 22 mgd. It is operated under the National Pollutant Discharge Elimination System (NPDES) Permit # NH0100234.

The City also has a long-term Municipal Services Agreement with the Pease Development Authority (PDA) to maintain and operate the wastewater collection and treatment facilities at the Pease International Tradeport, formerly Pease Air Force Base. The Pease collection system includes 15 miles of separate sanitary sewer, 1 pumping station, and a dedicated secondary wastewater treatment facility. Since these facilities are physically and operationally independent from the City's system, they are not included in the City's Long Term Control Plan (LTCP). The Pease wastewater facilities were reviewed in the City's 201 Wastewater Facilities Plan Update (Underwood Engineers, 1999).

1.2 COMBINED SEWER OVERFLOWS

Combined sewer systems are collection systems that convey both sanitary sewage and storm water. During dry weather, combined systems convey raw sewage, including domestic, industrial and commercial wastewater, as well as some levels of groundwater infiltration. During wet weather, the volume of combined sanitary sewage and storm water flows can exceed the carrying capacity of the collection system, causing surcharging, flooding, and combined sewer overflows (CSOs) into nearby receiving waters. In the City of Portsmouth, rain events as low as ½ inch have resulted in overflows of raw sewage and storm water to the South Mill Pond and the Piscataqua River.

Approximately 60% of the total sewer length of the City's collection system (exclusive of Pease) consists of combined sewers, portions of which are over 100 years old. The combined areas generally occur in the older urbanized portions of the City (see Figure 1-2). Specific information on which areas of the system remain as combined sewers is not available. However, it is known that the general areas north of the South Mill Pond rely on some of the original sewer lines. Other areas which include century-old piping include sections along Richards Avenue, Bartlett Street, and the areas of the old City breweries. In the 1970s, there were fourteen (14) identified locations of discharges of combined sewer overflows to the Piscataqua River, the North Mill and the South Mill Ponds. Since then, the City has undertaken numerous projects to separate portions of the collection system, upgraded sewage pumping facilities, and expanded the treatment plant. Nevertheless, areas where separation work has been completed may still present some unidentified sources of inflow, and continue to be evaluated on a case by case basis. Overall, efforts completed to date have resulted in significant reduction and better control of CSOs from the system.

The City's NPDES Permit in effect since 1985 (see Section 2 and Appendix 2-1), allows for two CSO outfalls for the City of Portsmouth, as follows:

1. South Mill Pond CSO 010 (10A and 10B)
2. Marcy Street Bypass CSO 012, on the Piscataqua River

There is also a unpermitted discharge identified as the Deer Street CSO 013, which discharges to the Piscataqua River. Figures 1-3 through 1-6 show the configuration at each of the four CSO locations. The Marcy Street bypass (Figure 1-6) is manually operated and is used only as an emergency relief, to prevent excessive flooding of downtown street areas. In recent years, the City reported operating this bypass once in March 2001, due to severe storm conditions (4" rainfall) coupled with failures at the Mechanic Street Pumping Station. This bypass may be plugged once the overall sewer improvements are completed.

Areas of the combined sewer system which are addressed as part of the LTCP are shown in Figure 1-2, Remaining Areas of Combined Sewers, and Figure 1-7 CSO Investigation Sites.

1.3 LTCP PURPOSE AND OBJECTIVES

The purpose of the City's CSO Long Term Control Plan (LTCP) is to provide a planning document and program to address the remaining CSOs and problem areas in the City's combined sewer system. The LTCP consists of the development of technically feasible, cost effective alternatives and recommendations to meet the objectives of the national CSO Control Policy, including compliance with federal and state water quality regulations.
The City has been implementing projects over the past 2 decades aimed at reducing and ultimately eliminating the CSOs. In 1990, continued violations of the City's NPDES permit caused the City to enter into a Consent Decree with the EPA and the State of New Hampshire to address the CSOs and come into compliance with its NPDES permit. The City submitted its first CSO Abatement Program in 1991 (see Section 1.4 Previous studies) in compliance with the Consent Decree.

The 1991 program recommendation to implement end of pipe treatment at the South Mill Pond has since been revisited, due to questions on its ability to provide a long term solution and consistently meet the water quality standards. In addition, problems with surcharging and flooding caused by the aging and undersized sewer piping have increased in the past few years.

From 1991 to the present, the City has continued more aggressively to rehabilitate and optimize the existing collection and treatment systems, while continuing to evaluate the most cost effective, long term program which can meet the water quality objectives. A new LTCP plan was submitted to EPA and NHDES in August 2002. As a result of the LTCP efforts, EPA issued an Administrative Order in July 2002, formalizing a schedule for compliance with the national CSO policy (see Section 2).

The LTCP is the basis for establishing the best integrated and cost-effective approach to achieve system optimization and protect the water quality. It consists of three main steps:

1. System characterization
2. Development and evaluation of abatement alternatives, and,
3. Selection and implementation of CSO abatement projects.

These objectives must be fulfilled by considering the following elements:

1. Characterization, monitoring, and modeling of the system
2. Public participation
3. Consideration of sensitive areas
4. Development of alternatives using either the "presumption" or "demonstration" approach
5. Cost / performance considerations
6. Operational plan
7. Maximizing treatment at existing treatment facilities
8. Implementation schedule
9. Post-construction compliance monitoring program.

The present report reflects an update of the August 2002 LTCP report to address comments issued by the NHDES, and to incorporate additional progress on the City's sewer system improvements.

1.4 PREVIOUS SEWER IMPROVEMENTS PROJECTS

This section summarizes major sewer improvements studies and efforts conducted between the late 1970s to the present, which have targeted the reduction and control of CSOs in the City of Portsmouth. A master table summary for cross referencing of previous sewer improvements projects completed by the City is included at the end of this section.

1.4.1 Wastewater Facilities Planning Study (Wright Pierce et. al, 1977)

In 1977, the wastewater facilities study (201 Facilities Plan) prepared by Wright, Pierce, Barnes and Wyman Engineers recommended the City conduct a ten-year sewer separation program to eliminate the combined sections of the City's sewerage collection system. At that time, twelve (12) CSOs were identified. Ten (10) separation projects were prioritized and recommended to be completed. The 1997 sewer improvements projects are listed below along with notes regarding their current status as of this report.

Table 1-1 ***Sewer improvements projects identified in 1977***

201 Facilities Plan Project Description	Status June 2004
1. Upgrade Market St. (Deer St.) Pumping Station. Sewer separation at Cutts Ave - Leslie Drive; Reduce I/I B&M Interceptor	- Deer Street Pumping Station - two major upgrades past 2 decades plus complete reconfiguration underway 2003 – 2005. - Leslie Drive separation completed. Potential cross connection in storm drain under investigation (Oct

201 Facilities Plan Project Description	Status June 2004
	2002 inspection). - B&M Interceptor improvements completed per Whitman & Howard (1985) Contract 1 design.
2. Atlantic Heights PS upgrades Woodbury Ave. sewer separation	- Atlantic Heights PS upgrades completed per 1985 design by Whitman & Howard (Contract 2) - Meadow Rd / Woodbury Ave area separation completed June 2004.
3. New Castle Ave / Pickering Ave Cross Connection and Mechanic St. Area sewer separation	- Disconnected from sanitary (Oct 2002 inspection) - Mechanic St areas remain as combined sewers, and will be addressed by upstream separation projects.
4. Dennett Street area cross connections. Islington Street South sewer separation.	- Dennett St separation work performed in 2003. Thornton & Sparhawk cross connection continues under evaluation (NHDES survey followup and Oct 2002 inspection). - Thaxter St area sewer separation completed 2001. - Islington St planning area included in LTCP
5. Islington Street to Deer Street Box Sewer cleaning and sewer separation	- Box Sewer cleaning and inspection completed in 2001. Islington St area included in LTCP.
6. Lafayette Rd to Broad Street (Lincoln Area) sewer separation projects	- Lincoln Area separation projects initiated 2003
7. Broad Street to Parrot Ave (Richards Ave) sewer separation projects	- Included in Lincoln Area projects initiated 2003
8. Parrot Ave Interceptor improvements up to Mechanic St PS	- Remain as combined sewers. Parrot Ave Interceptor improvements in 1986 and as part of LTCP.
9. Wentworth Acres	- Outside of City limits.
10. McDonough Street sewer separation	- Islington St area included in LTCP.

Ref: Wright, Pierce, Barnes & Wyman Engineers (1977). Wastewater Facilities Planning Study, City of Portsmouth, NH.

As a result of the City's sewer system improvements projects to date, CSOs have been reduced from 12 discharges identified in 1977 to 3 in 2004. Figure 1-2 shows the portions of the City sewers that remain as combined sewers and the areas where separation work has been completed. However, due to the age and incomplete knowledge of the actual piping systems, areas shown as separated may still present some unidentified inflow sources. These continue to be evaluated and addressed on a case by case basis.

1.4.2 Combined Sewer Overflow Abatement Program (Whitman and Howard, 1991)

In January 1991, the City submitted its first formal CSO Facilities Plan to the EPA and the State. This report recommended that the most cost effective solution for addressing the water quality violations from CSOs 10A and 10B was to install a 35-ft diameter swirl concentrator. This recommendation was supported by hydraulic modeling to select a peak design flow capacity of 70 mgd, based on a 10-year design storm. The cost for this option was estimated at $3.9 million, compared to off-line storage ($12 million) and sewer separation ($26.1 million). A screening facility was also evaluated for the South Mill Pond as compared to the swirl concentrator option, but was considered less cost effective due to a larger footprint and higher O&M costs.

Additional options evaluated but rejected as non-feasible including chlorination/dechlorination, in-line storage, and increased conveyance to the Peirce Island WWTP.

Since this Facilities Plan was submitted for approval, areas within the combined portions of the City continue to experience frequent sewage flooding and surcharging, and the NHDES raised concerns on the ability of treatment alone to meet the water quality standards. A series of meetings were held in 1998 which resulted in the requirement that the City re-evaluate the findings of the Facilities Plan, and develop a new CSO Long Term Control Plan, following the guidelines set forth by EPA's 1994 CSO Control Policy.

1.4.3 Nine Minimum Controls Program Updates (City of Portsmouth, 1997 to present)

In 1997 the City submitted a report documenting its progress on implementing EPA's Nine Minimum Controls (NMC) requirements. These efforts have continued through a variety of projects and programs by the City Public Works Department. An update on the City's NMC efforts was submitted in a letter from the City to the State dated August 1, 2002 which summarized the following additional efforts:

<u>NMC 1: Proper operation and regular maintenance programs</u>

a) Reduction of tidal inflow by:
   - Installation of stop logs at the Mechanic St PS bypass (1999)
   - Installation of tide gate flap valve at CSO 10B (1999)
   - Installation of tide gate flap valve at CSO 013, Deer St PS (1999)

b) Initiation in Fall 1999 of program for cleaning and inspection of main sewer interceptors, to remove debris and restore in-line storage and flow capacity. Program initiated with cleaning of 5,300 ft of the 36-inch and 48-inch Brick Box sewer interceptor from Bartlett Street to Market Street.

c) Upgrades to SCADA system and installation at all sewer pumping stations for improved monitoring and control (1999-2000). Improved communications and operation of pumping stations to reduce wet weather flooding impacts has resulted from these upgrades.
d) Updated mapping of the sewer system initiated in 1999 with the Facilities Plan Update, and continued through the present (2003-2004) design for Lincoln Area sewer separation projects.

<u>NMC 2: Maximizing use of the collection system for storage</u>

- Advancement of priority sewer separation projects to address critical problem areas, reduce infiltration / inflow, and install new dedicated storm and sanitary sewers where required (ongoing from 1990 to present).

<u>NMC 3: Review and modification of pretreatment requirements to minimize CSO impacts</u>

- Inspection of restaurants and food processing facilities to assess compliance with grease trap requirements as well as effectiveness of the existing systems (Jan – Mar 2000).

- Permitting and enforcement of pretreatment requirements for breweries and other significant industrial users (ongoing 1999 to present)

NMC 4: Maximizing flow to the WWTP for treatment
- Replacement of 24" force main from Mechanic Street to WWTP (1998)
- Upgrades to Mechanic Street Pumping Station (1990-1991 and 2000-2001)
- Upgrades of treatment efficiency for Peirce Island WWTP (1993 and 2003).
- Upgrades to Deer Street Pumping Station (1980s, 1990s, and complete reconfiguration 2003-2005).

NMC 5: Eliminating CSOs during dry weather
- Identification and elimination of illicit sanitary connections
- Detailed inspection and followup for remaining cross connections
- See Sections 1.4.5 NHDES Survey and 1.4.8 Status of CSOs and Cross Connections

NMC 6: Control of solid and floatable materials in CSOs
- Program of bi-annual street sweeping and catch basin cleaning
- Ongoing sewer separation projects (LTCP and others)
- Treatment of separated storm water at South Mill Pond and North Mill Pond (2003-2006 design and construction, Lincoln Area Contracts #1 and #2).
- Additional controls for remaining as part of LTCP (projected Phase 2 program).

NMC 7: Pollution prevention
- Heightened public awareness by ongoing sewer improvements projects.
- Ongoing investigation and elimination of illicit sanitary connections in collaboration with NHDES has reduced pollutant loads to the receiving waters.

NMC 8: Public notification of CSO occurrences and impacts
- Communication with local and state agencies including Jackson Estuarine Laboratory, New Hampshire Coastal Program, NHDES Watershed Management Bureau and Wastewater Engineering / NPDES Compliance Section
- House to house surveys and questionnaires conducted as part of downtown sewer separation projects (Lincoln Area Preliminary Design field surveys 2002 - 2003).

NMC 9: Monitoring to characterize CSO impacts and the efficacy of CSO controls
- Monthly compliance monitoring and reporting for CSOs 10A / 10B and 013.
- CSO characterization, flow monitoring and hydraulic modeling as part of LTCP
- Ongoing monitoring and studies by the Great Bay Coast Watch (UNH Sea Grant program) and NHDES Shellfish program.

1.4.4 201 Wastewater Facilities Plan Update (Underwood Engineers, 1999)

The Facilities Plan Update followed from the original (1977) facilities plan, and was intended for the City's use in scheduling and budgeting its wastewater capital improvements projects. The main projects identified in the plan update included, expanding sewer system capacity, correcting existing problem areas, and bringing the City into compliance with the 301(h) waiver (modified NPDES permit) and the Consent Decree provisions. The 1999 update included both the City sewer collection and treatment system and the Pease Development Authority collection system. However, CSO abatement was not addressed. Table 1-2 (see following page) lists 56 problem areas in the sewer collection system identified at that time, based on the Facilities Plan Update. Table 1-2 includes a column on the current (June 2004) status for each project, noting whether each issue has been addressed or remains to be addressed as part of the LTCP. Problem areas identified outside the City's combined sewer system are being addressed separately from the LTCP.

1.4.5 Shoreline Survey for Little Harbor and Back Channel, NH (NHDES Landry & Wood, 2001)

A sanitary survey was performed by the NHDES Coastal Watershed and Non-point Source programs to evaluate actual and potential discharges which might impact the NH Shellfish program. The NHDES is responsible for classifying waters for use in shellfish growing in New Hampshire. A followup meeting was held between the NHDES specialists and the City on November 25, 2003, wherein additional followup actions were agreed upon.

The field work for the shoreline survey was performed in Fall of 1999 and constituted an update of a previous survey performed by NHDES for this area (Jones and Langan, 1996). The limits of the survey extended from Jaffrey Point and Frost Point on the east, to Route 1 and Sagamore Ave limits on the west. New Castle Ave bounded the survey to the north. Pioneer Road marked the southern boundary of the survey.

A total of 58 sampling locations were selected to assess the impacts of direct and indirect discharges to Little Harbor and the Piscataqua River Back Channel, from sources along the shoreline as well as discharges to Sagamore Creek, Witch Creek and Berrys Brook. Each sample was selected to assess a potential pollution source, whether direct or indirect, active or intermittent discharge, storm drain or probably failure of a septic system. Samples were analyzed for fecal coliforms and *E.coli*. The results of the survey were used to identify 11 locations of active or potential pollutions sources (Table 1-3), based on positive coliform counts in downstream sampling sites.

Table 1-2 *Sewer collection system problem areas identified in 1999**

Proj. #	Location	Description	Status June 2004*
CS-1	Gosling Road Area	Sewer surcharging, root and grease problems	Cleaning, root removal ~ 2001
CS-2	Atlantic Heights	PS backups, high inflow	Repairs completed mid 1980s. Additional I/I sources to be identified.
CS-3	Marsh Lane PS	Tidal inflow	Completed.
CS-4	Woodlawn Circle at Hillcrest Drive	Sewer surcharging	Some separation completed.
CS-5	Onyx Lane / Opal Ave	Root problems	To be addressed separately from LTCP
CS-6	Dennett, Thornton, Sparhawk, Burkitt St	Cross connection, sewer surcharging	Rehab 2003. Continued eval with NHDES.
CS-7	Dennett and Stark St	Sewer surcharging	Same as CS-6
CS-8	Maplewood to Dennett St	Box sewer surcharges, illicit connections	Ongoing maintenance, cont'd eval w/NHDES
CS-9	Panaway Manor / Sherburne Rd	VC pipe high I/I	Separation completed 2001
CS-10	Sherburne Rd Area and Holly Lane	VC pipe high I/I	Separation completed 2001
CS-11	Borthwick Av from Bartlett to Gray Building	Grease problems, high I/I	Ongoing maintenance
CS-12	Essex Av Area	Combined sewers, high I/I	Essex - Sheffield separation completed 2001
CS-13	Thaxter St Area	Regular flooding and sewer backups	Rehab completed 2001
CS-14	Albany, Cass, Lovell St	Regular flooding and sewer backups	Islington planning area / LTCP
CS-15	Bartlett St @ RR Trussel	Sewer surcharging, flooding, VC pipe leaking	Lincoln Ave Contract #2 (2004-2005)
CS-16	Streets from Islington St to North Mill Pond	Surcharging, brick box sewer backups	Box sewer cleaning 2000. Islington planning/LTCP
CS-17	Brewster St	Combined sewers, brick box sewer backups	Box sewer cleaning 2000. Islington planning/LTCP
CS-18	Madison, Union, Cabot (Middle St ends)	Sewer surcharging	Areas 2 and 5 of LTCP
CS-19	Willard, Ash, Orchard	Combined sewers, backups to basements	Area 4/4A of LTCP
CS-20	Lincoln Av Middle St End	Combined sewers, regular flooding	Area 4/4A of LTCP
CS-21	Lincoln, Richards Av End	Combined sewers, regular flooding	Lincoln Ave Contract #1 construct 2004
CS-22	Miller Avenue at Rockland	Combined sewers, regular flooding	Area 2/2A of LTCP
CS-23	Deer St Bypass MH / Tide Structure	Tide inflow, knife gates leaking	Flap gate installed 1999. Monit'g upgrades 2004
CS-24	Ceres St Area CSO (Bow St area)	Sewer backups, grease problems	Eliminated. Confirmed Oct 02.
CS-25	Marcy St by Dunaway Store	Sewer backups	Completed
CS-26	Marcy St PS Area (New Castle Ave)	Plugged sewer	Completed per W/H design(1985). Confirmed Oct02
CS-27	Maplehaven Area / Woodlawn Circle	VC pipe high infiltration	Ongoing work 2004
CS-28	Elwyn Park	AC pipe, high infiltration	To be addressed separately from LTCP
CS-29	Lafayette Rd at Mirona Rd	Urban Forestry sewer overflows	To be addressed separately from LTCP
CS-30	State St and Penhallow St Area	Combined sewers, cross connections	Court St planning area / LTCP

Proj. #	Location	Description	Status June 2004*
CS-31	Downtown	Combined sewers	LTCP
CS-32	Summer St at Middle St	Collapsing Denny Shay pipe, odors	Area 5A LTCP
CS-33	Miller Av - 313 across to Richards Av	Main collapsed	Area 2 LTCP
CS-34	Main sewer line through Strawbery Banke	High I/I	I/I to be reduced by upstream sewer projects
CS-35	Gate St area	VC pipe needs replacement	Remains as combined sewer, no action
CS-36	Cabot St Sewer - State to McDonough	Collapsing Denny Shay pipe	Islington planning area / LTCP
CS-37	Court St Area	Combined sewers	Separation completed 2003-2004
CS-38	Brackett Road and Brackett Lane	Failing septic, high infiltration Clough Dr.	Sewer improvements completed 2003-2004
CS-39	Broad St and Rockland	Sewer flooding	Area 2/2A of LTCP
CS-40	Bridge St and Hill St	Sewer surcharging	Combined sewer, address by upstream projects
CS-41	CSO 10B Tide Structure - South Mill Pond	Active CSO, Tide inflow	Active CSO/ LTCP, flap gate installed
CS-42	Cross Connection at Clinton	Fecal counts in storm drainage	To be addressed by upstream projects
CS-43	Cross Connection Leslie Drive and Cutts St	Fecal counts in storm drainage	Inspected Oct 02 / further monitoring
CS-44	Rockland Ave at Leary Field	Sewer surcharging	Lincoln Ave Contract #1 construct 2004
CS-45	CSO at State and Marcy Street	Open drain to river	Sewer pipe leak to be repaired, Oct 02 inspec.
CS-46	Mechanic St PS Bypass	Tidal inflow	Stop logs installed. City may demolish bypass.
CS-47	CSO 10A South Mill Pond	Active CSO	Active CSO / LTCP
CS-48	Cross country sewer Springbrook Condos	Sewer near capacity	No action required
CS-49	Failed septic Elwyn Road	Failed septic	No plans for sewer extension at this time
CS-50	Failed septic Sagamore Av south of bridge	Failed septic	No plans for sewer extension at this time
CS-51	Failed septic Sagamore Av north of bridge	Failed septic	No plans for sewer extension at this time
CS-52	Failed Septic, Brackett Road	Failed septic	Sewer extension 2003-2004
CS-53	Failed Septic, McGee Drive	Failed septic	No plans for sewer extension at this time
CS-54	Hillcrest Estate Force Main Extension	Excess I/I	To be addressed separately from LTCP
CS-55	Country Club Road Sewer Upgrade		Completed (Travelport station).
CS-56	Greenland Road Sewer Extension		To be addressed separately from LTCP

* *Ref: Underwood Engineers (1999). 201 Wastewater Facilities Plan Update, Table 4-1. City of Portsmouth, NH.*

Table 1-3 ***Potential pollution sources impacting Little Harbor and Back Channel***

No.	Location	Impact	Relevant Monitoring Sites	Cross Reference to other sewer studies
PS1	Wentworth Marina	Direct	T1, T13, LH2	Outside of City Limits.
PS2	Wentworth condominium storm water discharge	Direct	T1, T13, LH2	
PS3	Little Harbor mooring field	Direct	T1, T13, LH2	
PS4	Wentworth golf course	Direct	T6, T6A	
PS5	Portsmouth Peirce Island WWTP	Indirect	T5, T9, T10	LTCP
PS6	Portsmouth CSO 10A/10B, South Mill Pond	Indirect	T5, T9, T10	LTCP
PS7	Sagamore Creek outlet into Little Harbor	Indirect	T8, T16	Outside of City Limits
PS8	Witch Creek at Sheafes Point	Indirect	T6, T6A	
PS9	Berrys Brook at Berrys Brook Flat	Direct	T7, T14	
PS10	Seavey Creek at Odiorne - East Flat	Direct	T14	
PS11	Back Channel at entrance to Little Harbor	Direct	T13	

Ref: NHDES Landry & Wood (2001). Shoreline Survey for Little Harbor and Back Channel, NH, Appendices C & E.

Most of the identified active or potential sources considered for impacts to shellfish growing waters in Little Harbor and Back Channel were found to be located outside of the City limits and combined sewer area, and therefore, are not discussed further in this report.

Two sites identified by the NHDES survey, **PS5 - WWTP discharge**, and **PS6 - CSOs at South Mill Pond,** are addressed through the City's NPDES permit requirements and the LTCP efforts. For these sites, the 1999 survey concurred with the 1996 findings in that *no impacts to shellfish growing waters were observed.* However, any malfunction in plant operations or CSO discharges during significant wet weather events, could pose an impact in the future. Control of CSOs to the South Mill Pond, as well as the WWTP operations and effluent discharges, are monitored continuously by the City with monthly reporting of CSO events and WWTP effluent characteristics.

A meeting was held with NHDES Coastal Watershed and Non-point source specialists on November 25, 2003. Three followup action items were agreed upon, as listed in Table 1-4. Notes on the current (June 2004) status of each Action Item and its cross-reference with problems areas identified in other sewer studies are listed.

Table 1-4 *Followup action items from City meeting with NHDES, November 25, 2003*

Location	Description	Followup / Cross Reference
1. Bartlett Road Granite Box Culvert	Eliminate cross connections which result in bacterial loads to the North Mill Pond. Reduce overflows at Deer St CSO.	Status: Lincoln Ave Contract #2 design underway (2004), improvements Bartlett St area and storm water treatment at North Mill Pond. Cross reference: 1999 Project CS-15 2004 CSO status report Site F
2. Outfall near Albacore Submarine (PM 8020)	Investigate potential illicit connections through dye testing select businesses on Rt 1 Bypass and Maplewood Av. TV inspection of storm drain piping. Identify source of petroleum / solvent type odors.	Status: Continued evaluation based on Oct 02 inspection and NHDES monitoring. Cross reference: 1999 (part) Project CS-8 2004 CSO status report CSO #003
3. Monthieth, Burkitt, Sparhawk, Stark and Dennett Streets	Investigate potential illicit connections. Dye / smoke testing of selected businesses on Rt 1 Bypass and Dennett St. Identify access point for possible TV inspection.	Status: Continued evaluation based on Oct 02 inspection and NHDES sampling. Cross reference: 1997 Project 4 – Dennett St 1999 (part) Project CS-6,7 2004 CSO status report Site H

Ref: NHDES N. Landry, Supervisor, Coastal Watershed Program. Memorandum to Portsmouth Illicit Discharge Detection & Elimination File. November 2003.

1.4.6 Sewer System Evaluation Survey (Underwood Engineers, 2002)

A limited Sewer System Evaluation Survey (SSES) was performed concurrent with the August 2002 LTCP report, and included evaluation of the five (5) major sewer interceptors in the City's combined sewer area (see below). The SSES was used to confirm the sewer layout for the LTCP hydraulic modeling, and to assess if there were major structural issues contributing to the localized flooding and sewer backups. Field investigations included video surveys, investigation of problem areas, flow monitoring, and inspection of all sewer and drainage structures in the combined sewer areas.

A database was prepared with the results of these investigations along with updated plans of the combined sewer system. A prioritized list of projects (Table 1-5) was developed to address critical flow restrictions, alleviate wet weather flooding, and reduce infiltration / inflow. Additional problem areas identified mostly from previous sewer studies were reviewed. Findings from the SSES were used to support the evaluation of alternatives for the LTCP. Problem areas identified outside the City's combined sewer system are being addressed separately from the CSO LTCP.

Table 1-5 ***Prioritized list of sewer projects identified in 2002 sewer survey***

Interceptor Name	Project description	Status June 2004
1. Market Street Interceptor	- Sewer cleaning between SMH 1525 and 1523	To be completed.
2. Borthwick Ave Sewer Interceptor	- Replace cross country sewer from Borthwick Ave to Cate Street	City planning to request engineering proposals in 2005
3. Maplewood Ave Sewer Interceptor	- Replace 900 ft Dennett St sewer from Sparhawk to Whipple St. Extend storm sewer from Burkitt Street to reduce inflow.	Completed in 2003
	- Line or replace 250 ft of 21-inch RCP sewer from Burkitt to Sparhawk Streets	Completed in 2003
	- Remove restriction downstream of MH 1470 (Dennett and Kane St), replace damaged 24" RCP piping	Completed in 2004
	- Cleaning and root removal between SMH 1463 and 1467, Thornton St	Completed in 2002
	- Cleaning and grit removal between Rockingham and Woodbury Ave	Not completed
	- Root removal between Farm Lane and Rockingham Ave	Not completed
	- Root removal between SMH 1508 and 1506, Maplewood Ave	Not completed
	- Review interceptor routing options including feasibility of diverting upper Maplewood Sewer Basin flows to the Pease WWTP	Continues under evaluation.
4. Mechanic Street Basin Interceptor	- Construct new sanitary sewer from Parrot Ave to Lafayette Road (Lincoln Ave Area)	Lincoln Ave Sewer Separation Projects initiated 2004.
	- Cleaning, root removal and repairs from Parrot Ave to Marcy Street	Not completed
	- Construct separate storm sewers within targeted areas (LTCP)	LTCP
	- Evaluate and replace targeted collection sewers as necessary	Lincoln Ave Sewer Separation projects initiated 2004
5. Lafayette Sewer Basin Interceptor	- Spot repairs Harding Rd between SMH 187 and 195	Not completed
	- Cleaning and grit removal between SMH 275 and 284, Taft Street	Not completed
	- Cleaning and grit removal cross country sewer from SMH 336 and 345	Not completed
	- Cleaning and grit removal between SMH 77 and 149, Lafayette Road	Not completed
	- Other upgrades as identified in 1999 Wastewater Facilities Plan Update.	See Table 1-4.

Ref: Underwood Engineers (2002). Sewer System Evaluation Survey, Phase I: Interceptor and Problem Areas. Portsmouth, NH.

1.4.7 Preliminary Design of Lincoln Area Sewer Separation Program (Underwood Engineers, 2003)

A preliminary design of new sewer and drainage routing was prepared in 2003 to establish a basis for the City's planning for required sewer infrastructure upgrades. Based on the City's experience with previous sewer separation and infrastructure projects for the downtown area, a phased program was developed to allow management of the construction work for this densely populated area of the City. A recommended project sequence was designed to maximize the separation benefits gained per dollars expended.

The Lincoln Area projects are loosely termed the 'targeted separation' projects, as the area encompasses most of the combined sewer area that is in need of upgrades. These projects have been incorporated as the first phase of the LTCP program, wherein critical areas of the system will be reconstructed and optimized through the installation of dedicated sanitary and storm systems, reduction of infiltration / inflow, and replacement of collapsed interceptors to allow increased conveyance of sewage flows to the WWTP. Once this program is complete, the LTCP (Phase 2) projects will be defined and implemented to address remaining CSOs from the system.

Construction of Lincoln Area Contract #1 (installation of new sewer interceptors and storm water treatment at the South Mill Pond) will be completed in 2004. Lincoln Area Contract #2 (storm water drainage and treatment at the North Mill Pond) is anticipated to be constructed in 2005.

The Lincoln Area program provides for the targeted separation projects to be completed in 3 groups, with each group completed about every 5 years (total 15-year program). Annual progress reports will be prepared for review of the program with state and federal regulators. Within each target group, the separation areas are ordered in a logical build-out sequence, starting at the South Mill Pond and working upstream into the collection system, as follows:

> Group I – Main interceptor projects and some tributary collector system piping, general lower portion of Lincoln Ave, from the South Mill Pond to Wibird Street.
>
> Group II – General upper portion of Lincoln Ave to Lafayette Road, as well as buildout along Middle Street and Summer Street areas.
>
> Group III – Additional planning areas generally draining toward the South Mill Pond, including Islington St, Court St, and Borthwick Ave.

Section 6 provides additional detail on the targeted separation projects as part of the LTCP recommended abatement plan.

1.4.8 Combined Sewer Overflow Status Report (Underwood Engineers, 2004)

The status of past or present locations of CSOs and cross connections in the City of Portsmouth was investigated through inspections to each site in October 2002 and updated in June 2004. Photos were taken and a schematic was developed for each location. Observations were noted including presence or absence of flows, odors, or sewer debris, which could indicate whether the outfall remained active or had been disconnected from the sanitary sewer system. Figure 1-7 shows the investigation sites. A summary of the findings (Table 1-7) recommended 5 sites (CSO 003, 005, and Sites F, H, and I) for continued evaluation as part of the LTCP. Currently active CSOs 10A/10B, 012 Marcy Street (manually controlled) and 013 Deer Street continue to be monitored as part of the City's NPDES permit.

Table 1-6 ***Summary of CSO investigation sites***

Site ID	Location	Current status (June 2004)
CSO #002	Seacrest Village WWTF	Disconnected from sanitary sewer
CSO #003	Maplewood Avenue at Route 1 (Albacore Park)	CSO eliminated. However, site investigation continues for possible illicit connections.
CSO #004	Leslie Drive	Disconnected from sanitary sewer
CSO #005	Cutts Street at Leslie Drive	CSO eliminated. However, site investigation continues due to possible contamination in storm drain.
CSO #007	Preble Way at Ranger Way	Disconnected from sanitary sewer
CSO #008	Crescent Way near Saratoga Way	Disconnected from sanitary sewer
CSO #009	Marcy Street near New Castle Ave	Disconnected from sanitary sewer
CSO #011	Mechanic St Pump Station Overflow	Overflow elevation at ground surface. City considering demolition.
CSO #012	Marcy Street Bypass	Manually controlled for emergency relief only.
Site A	Pickering Ave at South Mill Street	Disconnected from sanitary sewer
Site B	Mechanic St at Hunking Street	Disconnected from sanitary sewer
Site C	Mechanic St at Gardner Street	Disconnected from sanitary sewer
Site D	Mechanic St Pump Station Overflow	See CSO #011
Site E	Bow Street at Ceres Street	Disconnected from sanitary sewer
Site F	Bartlett Street at North Mill Pond	CSO bricked up. Continued leakage from broken clay pipe. City addressing under Lincoln Ave Contract #2 (2004 design / 2005 construction).
Site G	Dearborn Place	Disconnected from sanitary sewer
Site H	Thornton Street near Sparhawk St.	CSO eliminated. However, site investigation continues to identify possible illicit connections.
Site I	Marcy Street at State Street	CSO eliminated. Additional repairs planned in 2004 to stop pipe leakage.

Note: Currently active CSOs #010 (South Mill Pond) and #013 (Deer Street) were not included in this survey.
Ref: Underwood Engineers (2004). Combined System Overflow Status Report. City of Portsmouth, NH. June 2004.

1.4.9 Summary of previous sewer separation projects (1977 – 2004)

A master table for cross reference of previous sewer separation projects is presented in the following pages to summarize previous and ongoing sewer improvements projects for the City of Portsmouth combined sewer system.

Table 1-7 ***Summary of problem areas identified in previous studies (1977-2004)***

2004 Site # Table 1-7	2003 Area or Item # Table 1-4 & Sect 6	2002 Proj # Table 1-5	1999 Proj # Table 1-2	1977 Proj # Table 1-1	Sewer System Problem Description	Status June 2004
		1	CS-1		Gosling Road Area surcharging, root problems	Cleaning, root removal ~ 2001
		1	CS-2	2	Atlantic Heights PS backups, high I/I	Repairs completed mid 1980s. Additional sources of I/I to be identified.
		1	CS-3		Marsh Lane PS tidal inflow	Completed.
		3	CS-4		Woodlawn Circle at Hillcrest Drive surcharging	Some separation completed.
		3	CS-5		Onyx Lane / Opal Ave root problems	To be addressed separately from LTCP.
H	Action Item 3	3	CS-6	4	Dennett, Thornton, Sparhawk, Burkitt St Surcharging, illicit connections	Rehab 2003. Continued eval with NHDES (2003+).
		3	CS-7	4	Dennett and Stark St sewer surcharging	Same as CS-6
CSO 003	Action Item 2	3	CS-8		Maplewood to Dennett St surcharges, illicit connect.	Ongoing maintenance, cont'd eval w/NHDES (2003+)
		2	CS-9		Panaway Manor / Sherburne Rd high I/I	Separation completed 2001
		2	CS-10		Sherburne Rd Area and Holly Lane high I/I	Separation completed 2001
	Borthwick planning	2	CS-11		Borthwick Av from Bartlett to Gray Building, grease problems, high I/I	Ongoing maintenance, Borthwick Av upgrades 2005
		2	CS-12		Essex Av / Sheffield area high I/I	Essex - Sheffield separation completed 2001
		2	CS-13	4	Thaxter / Fells Street flooding, sewer backups	Rehab completed 2001
	Islington Planning	2	CS-14		Albany, Cass, Lovell St flooding, sewer backups	Islington planning area / LTCP (2003+)
F	Action Item 1, Lincoln Cont #2	2	CS-15		Bartlett St @ RR Trussel, surcharging, flooding, bacterial loading to North Mill Pond	Lincoln Ave Contract #2 (2004-2005)
		2	CS-16	5	Streets from Islington St to North Mill Pond surcharging	Box sewer cleaning 2000. Islington planning/LTCP (2003+)
		2	CS-17		Brewster St sewer backups	Box sewer cleaning 2000. Islington planning/LTCP (2003+)
	Areas 2,5	4	CS-18		Madison, Union, Cabot (Middle St ends) surcharging	Areas 2 and 5 of LTCP (2006+)
	Area 4,4A	4	CS-19	6	Willard, Ash, Orchard sewer backups	Area 4/4A of LTCP (2008+)
	Area 4,4A	4	CS-20	6	Lincoln Av Middle St end - regular flooding	Area 4/4A of LTCP (2008+)

2004 Site # Table 1-7	2003 Area or Item # Table 1-4 & Sect 6	2002 Proj # Table 1-5	1999 Proj # Table 1-2	1977 Proj # Table 1-1	Sewer System Problem Description	Status June 2004
	Lincoln Cont #1	4	CS-21	6	Lincoln, Richards Av end - regular flooding	Lincoln Ave Contract #1 construction 2004
	Area 2,2A	4	CS-22	7	Miller Avenue at Rockland regular flooding	Area 2/2A of LTCP (2006+)
CSO 013	Monit'g		CS-23		Deer St Bypass MH / Tide Structure tidal inflow	Flap gate installed 1999. Monit'g upgrades 2004
E			CS-24		Ceres St Area CSO (Bow St area) sewer backups	Eliminated. Confirmed Oct 02.
		4	CS-25		Marcy St by Dunaway Store sewer backups	Completed
CSO 009		4	CS-26		Marcy St PS Area (New Castle Ave) plugged sewer	Completed per W/H design (1985). Confirmed Oct 02
		3	CS-27		Maplehaven Area / Woodlawn Circle high I/I	Ongoing work 2004+
		5	CS-28		Elwyn Park high I/I	To be addressed separately from LTCP
		5	CS-29		Lafayette Rd at Mirona Rd sewer overflows	To be addressed separately from LTCP
	Court St planning	4	CS-30		State St and Penhallow St Area cross connections	Court St planning area / LTCP (2003+)
	All	4	CS-31		Downtown combined sewers	LTCP (2003+)
	Area 5A	4	CS-32		Summer St at Middle St collapsing pipe	Area 5A LTCP (2009+)
	Area 2	4	CS-33	7	Miller Av - 313 across to Richards Av collapsed main	Area 2 LTCP (2006+)
		4	CS-34		Main sewer line through Strawbery Banke high I/I	I/I to be reduced by upstream sewer projects
		4	CS-35		Gate St area sewer pipe replacement	Remains as combined sewer
	Islington Planning	2	CS-36		Cabot St Sewer - State to McDonough collapsing pipe	Islington planning area / LTCP (2003+)
		4	CS-37		Court St Area combined sewers	Separation completed 2003-2004
		4	CS-38		Brackett Road and Brackett Lane high I/I, cross connect	Sewer improvements completed 2003-2004
	Area 2,2A	4	CS-39	7	Broad St and Rockland sewer flooding	Area 2/2A of LTCP (2006+)
		2	CS-40		Bridge St and Hill St sewer surcharging	Combined sewer, address by upstream projects
CSO 10B	Monit'g	4	CS-41		CSO 10B Tide Structure - South Mill Pond tidal inflow	Active CSO/ LTCP, flap gate installed
			CS-42	4	Cross connection at Clinton fecal counts storm drainage	To be addressed by upstream projects
CSO 005	Monit'g	1	CS-43	1	Cross connection Leslie Drive and Cutts St fecal counts	Inspected Oct 02 / further monitoring
	Lincoln Cont #1	4	CS-44	7	Rockland Ave at Leary Field sewer surcharging	Lincoln Ave Contract #1 construction 2004
I	Monit'g	4	CS-45		CSO at State and Marcy Street open drain to river	Sewer pipe leak to be repaired, Oct 02 inspec.
CSO 011			CS-46		Mechanic St PS Bypass tidal inflow	Stop logs installed. City may demolish bypass.

2004 Site #	2003 Area or Item #	2002 Proj #	1999 Proj #	1977 Proj #	Sewer System Problem Description	Status June 2004
Table 1-7	Table 1-4 & Sect 6	Table 1-5	Table 1-2	Table 1-1		
CSO 10A	Monit'g	4	CS-47		CSO 10A South Mill Pond active CSO	Active CSO / LTCP (2003+)
			CS-48		X-country sewer Springbrook Condos near capacity	No action required
			CS-49		Elwyn Road failed septic	No plans for sewer extension at this time
			CS-50		Sagamore Av south of bridge failed septic	No plans for sewer extension at this time
			CS-51		Sagamore Av north of bridge failed septic	No plans for sewer extension at this time
		4	CS-52		Brackett Road failed septic	Sewer extension 2003-2004
			CS-53		McGee Drive failed septic	No plans for sewer extension at this time
		3	CS-54		Hillcrest Estate force main extension	To be addressed separately from LTCP
		2	CS-55		Country Club Road sewer upgrade	Completed (Travelport station).
		2	CS-56		Greenland Road Sewer Extension	To be addressed separately from LTCP
			--		24" Force Main, MSPS to WWTP	Completed April 1998
			--		Peirce Island WWTP Upgrades	Major upgrades completed 1993 and 2003
			--		Mechanic Street Pump Station Upgrades	Completed 2001
			--	1	Deer Street Pump Station Upgrades	Upgrades 1980s and 1990s, reconfiguration 2003-2005
		4	--	8	Parrot Ave Interceptor (to Mechanic St PS)	Completed 1986
		4	--		Lower South Street and School Street sewer upgrades	Completed 2002
		2	--	1	B&M (Borthwick Ave) Interceptor improvements	Completed per W/H (1985) Cont 2 design
A			--	3	Pickering Ave at South Mill Street	Completed per W/H (1985) Cont 2 design. Confirmed Oct 02.
B			--	3	Mechanic Street at Hunking Street	Completed per W/H (1985) Cont 2 design. Confirmed Oct 02.
C			--	3	Mechanic Street at Gardner Street	Completed per W/H (1985) Cont 2 design. Confirmed Oct 02.
G			--		Dearborn Place CSO and Pump Station	CSO eliminated, PS upgrades completed per W/H (1985) design. Confirmed Oct 02.
CSO 002			--		Seacrest Village WWTF	Confirmed CSO has been eliminated (Oct 02 inspect).
CSO 004			--		Leslie Drive Outfall	Confirmed CSO has been eliminated (Oct 02 inspect).
CSO 007			--		Preble Way at Ranger Way	Confirmed CSO has been eliminated (Oct 02 inspect).
CSO 008			--		Crescent Way near Saratoga Way	Confirmed CSO has been eliminated (Oct 02 inspect).
CSO 012	Monit'g	4	--		Marcy Street Bypass	Manually controlled for emergency relief only.

Note: See references below.

References for Table 1-8 Summary of problems identified in previous studies

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NHDES Landry N. (2003). Memorandum to Portsmouth Illicit Discharge Detection & Elimination File. Nov 2003.

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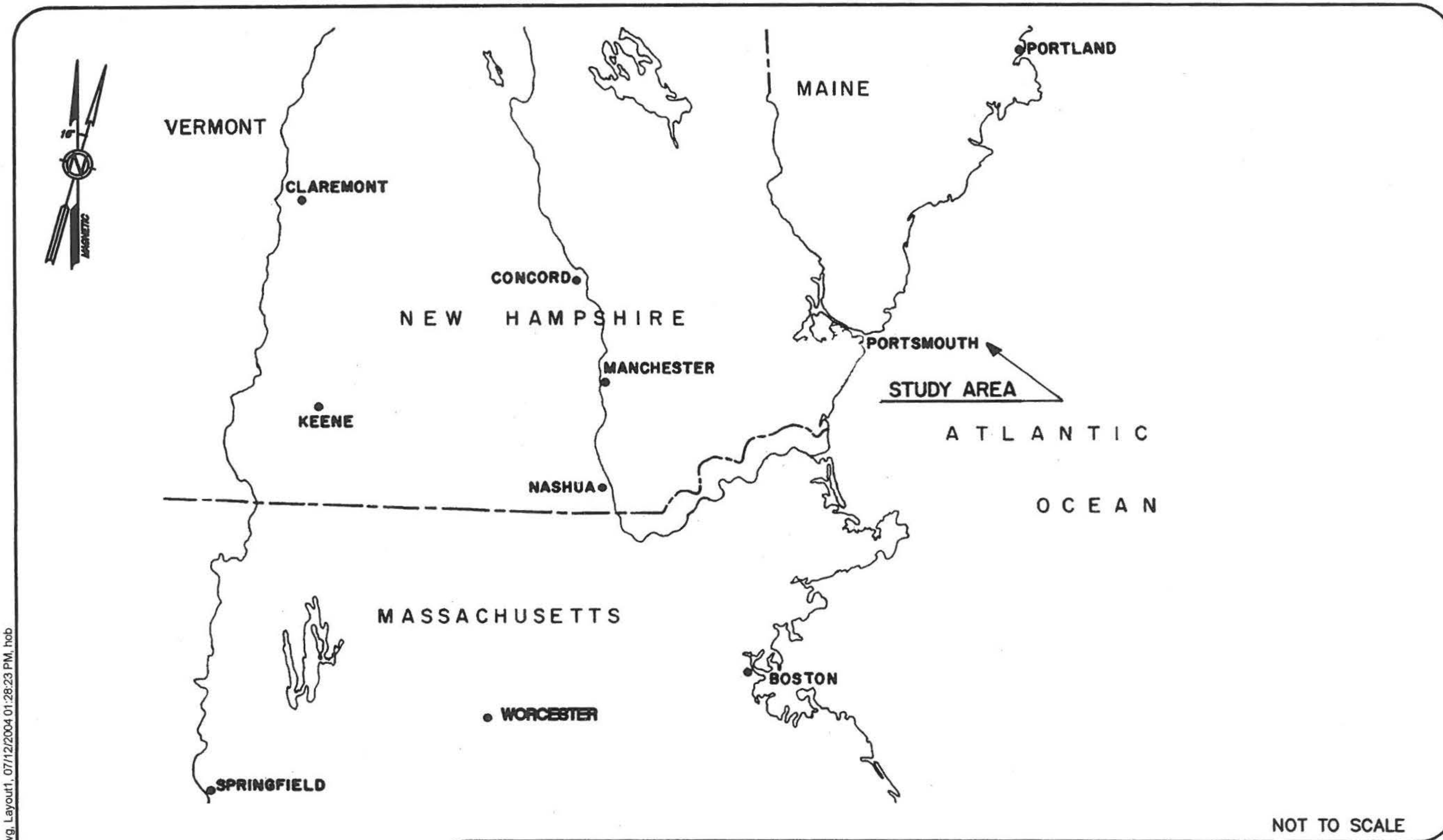

DATE	Underwood Engineers, Inc.	CSO LONG TERM CONTROL PLAN CITY OF PORTSMOUTH, NH LOCATION MAP	FIGURE
7/04			1-1
PROJECT			
1110			

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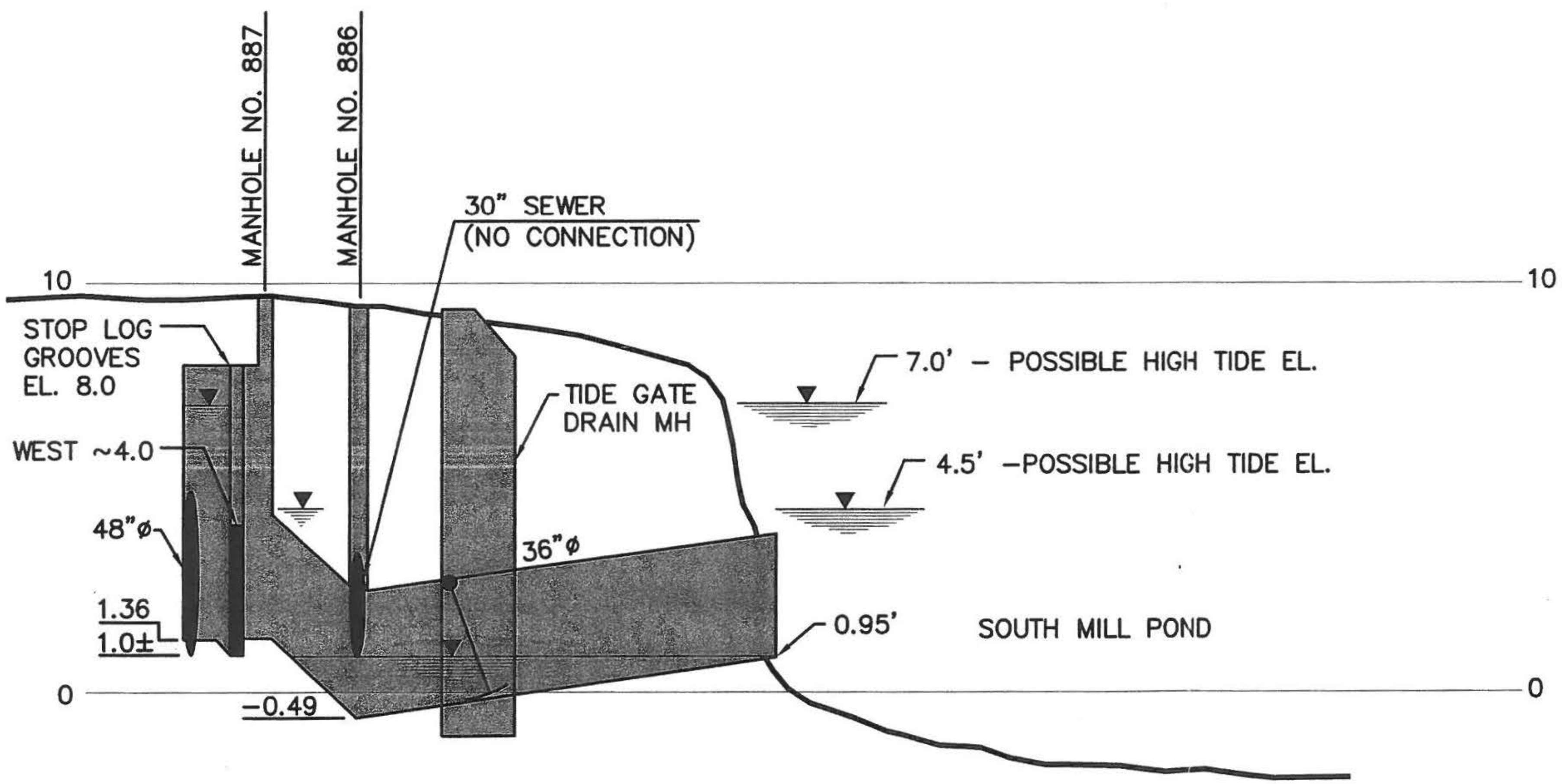

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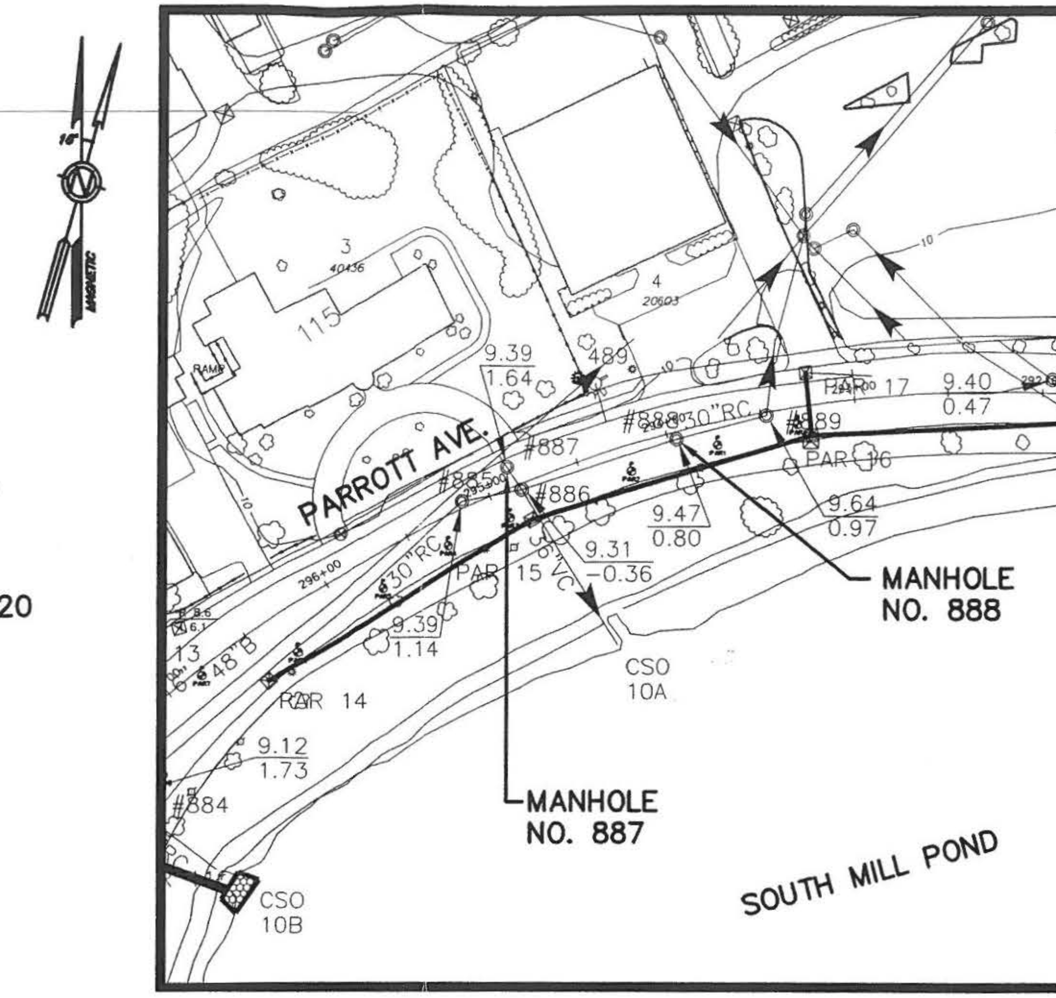

PLAN
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DATE			FIGURE
7/04	Underwood Engineers, Inc.	LONG TERM CONTROL PLAN CSO 10A SOUTH MILL POND PORTSMOUTH, NH	1-3
PROJECT 1110			

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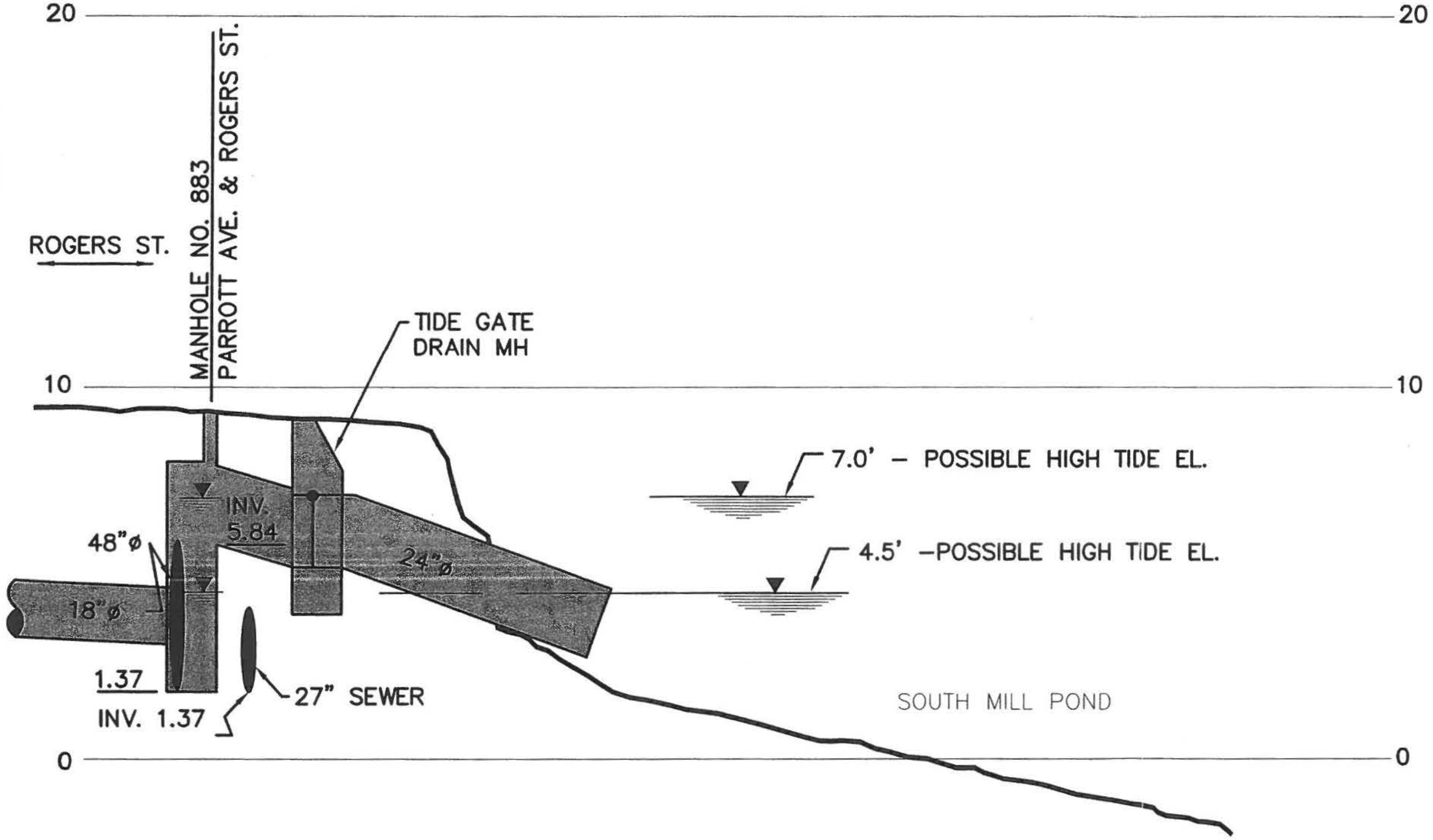

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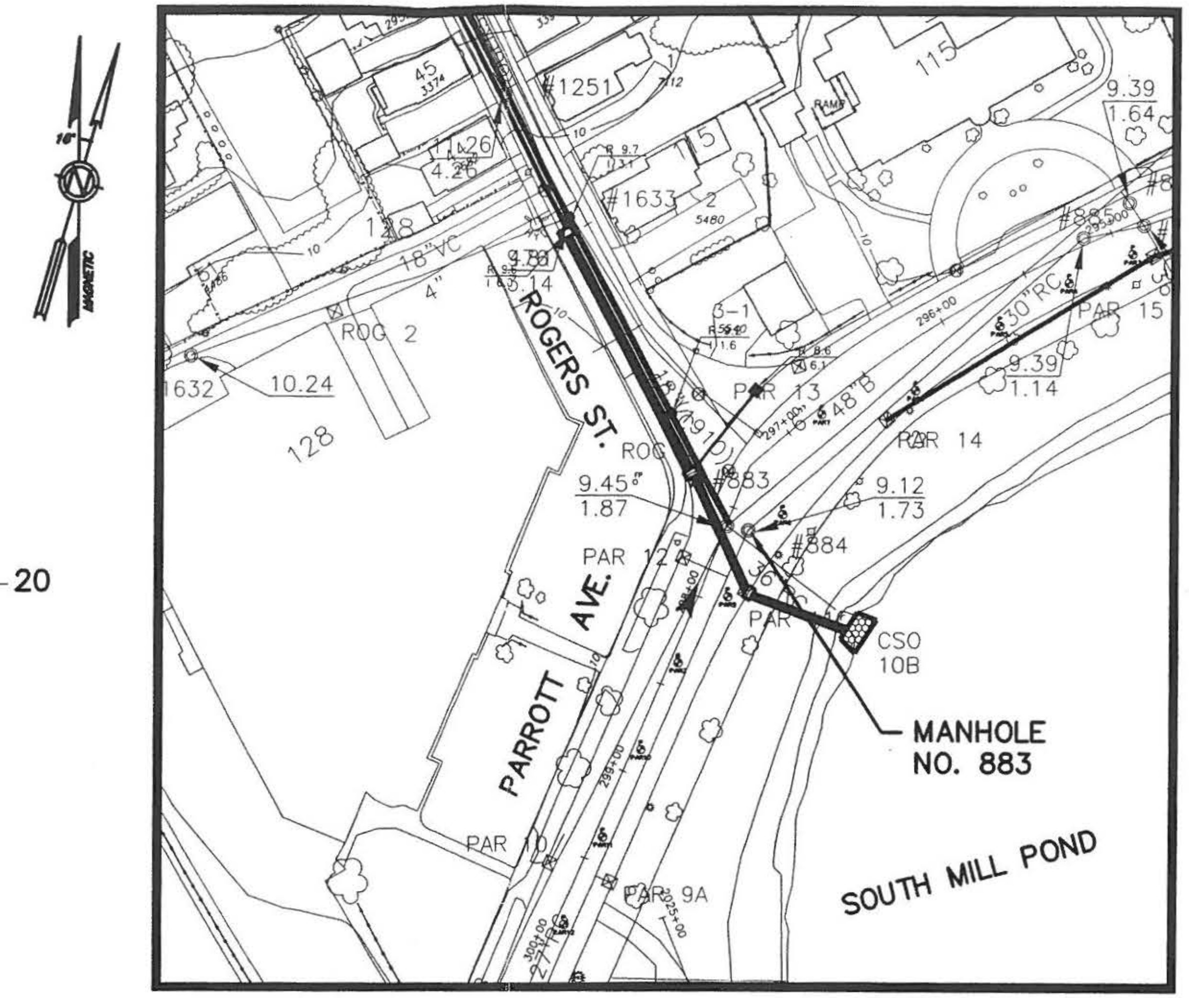

PLAN
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DATE			FIGURE
7/04	Underwood Engineers, Inc.	LONG TERM CONTROL PLAN CSO 10B SOUTH MILL POND PORTSMOUTH, NH	1-4
PROJECT 1110			

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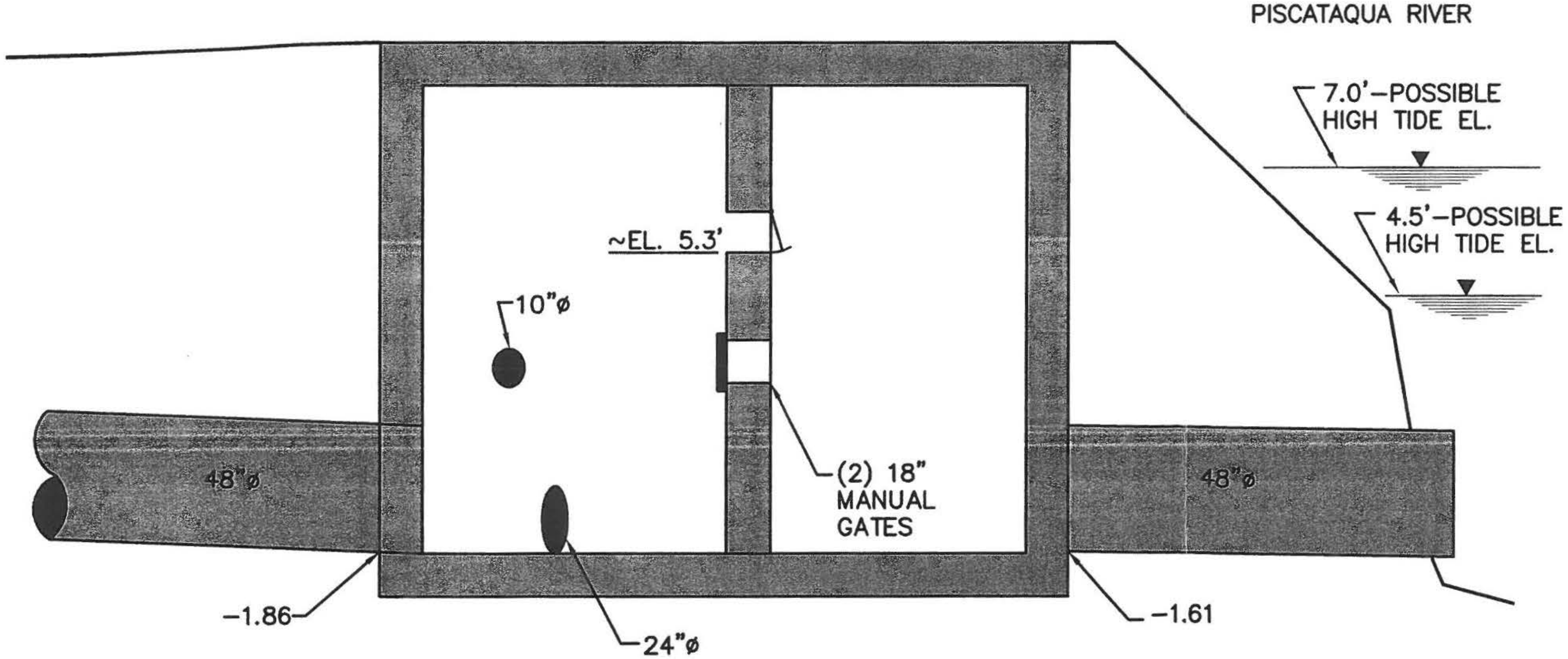

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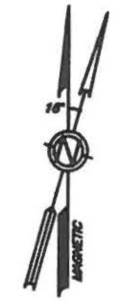

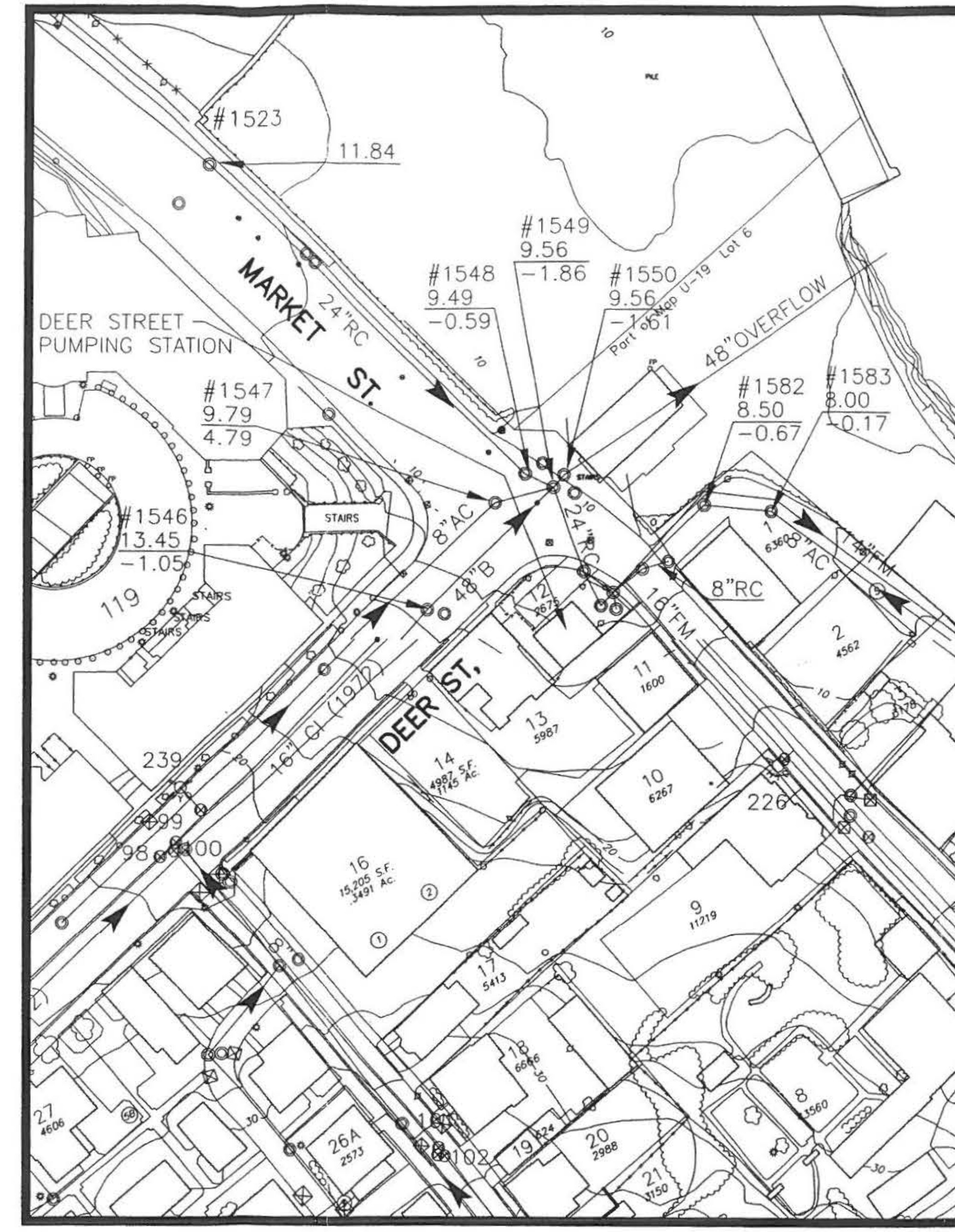

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DATE		LONG TERM CONTROL PLAN	FIGURE
7/04	Underwood Engineers, Inc.	CSO 013 DEER STREET	1-5
PROJECT 1110		PORTSMOUTH, NH	

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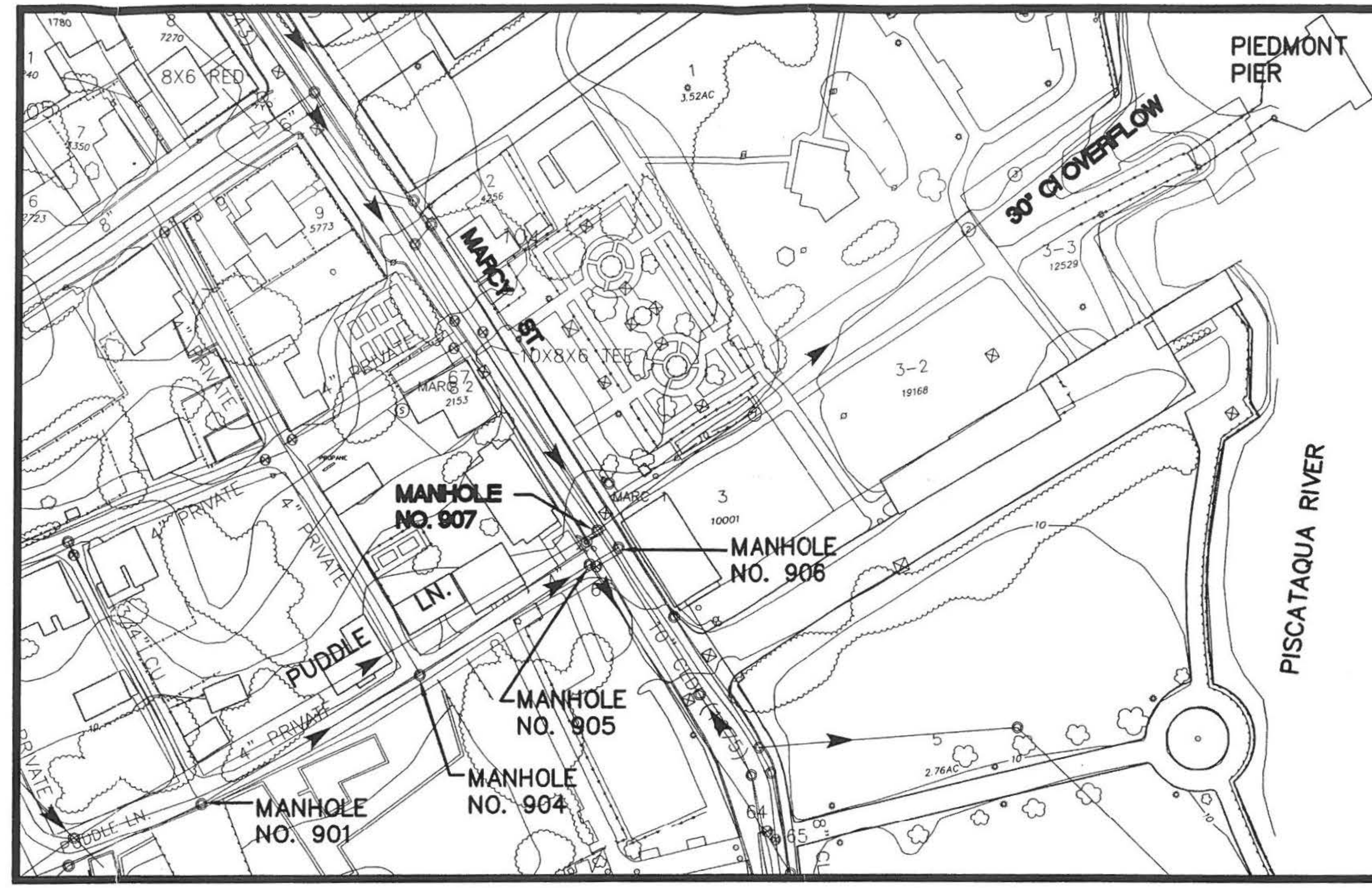

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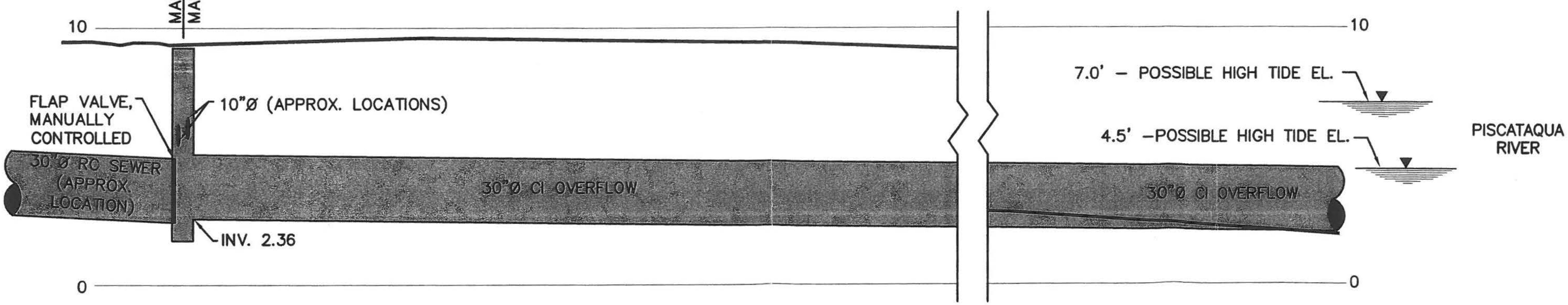

PROFILE
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DATE 7/04	Underwood Engineers, Inc.	LONG TERM CONTROL PLAN CSO 012 MARCY STREET PORTSMOUTH, NH	FIGURE 1-6
PROJECT 1110			

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LOCATIONS OF CSO INVESTIGATION SITES:

CSO 002 SEACREST VILLAGE WWTF
CSO 003 MAPLEWOOD AVE. AT ROUTE 1 (ALBACORE PARK)
CSO 004 LESLIE DRIVE
CSO 005 CUTTS ST. AT LESLIE DRIVE
CSO 007 PREBLE WAY AT RANGER WAY
CSO 008 CRESCENT WAY NEAR SARATOGA WAY
CSO 009 MARCY ST. NEAR NEWCASTLE AVE.
CSO 010 PARROTT AVE. NEAR ROGERS ST.
CSO 011 MECHANIC ST. PUMP STATION OVERFLOW
CSO 012 MARCY ST. BY-PASS
CSO 013 MARKET ST. AT DEER ST.
SITE (A) PICKERING AVE. AT SOUTH MILL ST.
SITE (B) MECHANIC ST. AT HUNKING ST.
SITE (C) MECHANIC ST. AT GARDNER ST.
SITE (D) MECHANIC ST. PUMP STATION
SITE (E) BOW ST. AT CERES ST.
SITE (F) BARTLETT ST. AT NORTH MILL POND
SITE (G) DEARBORN PLACE
SITE (H) THORNTON ST. NEAR SPARHAWK ST.
SITE (I) MARCY ST. AT STATE ST.

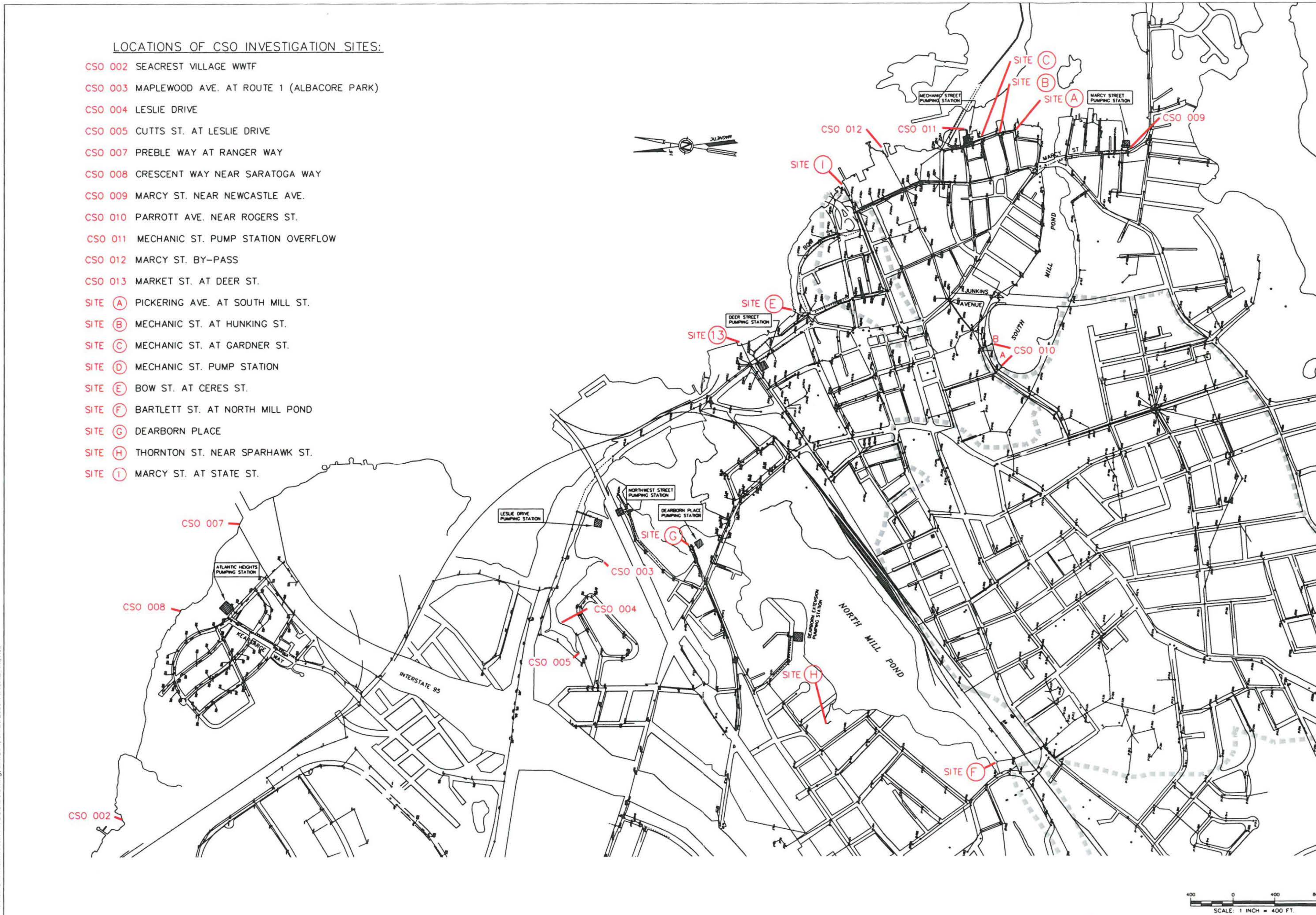

FIGURE 1-7

Underwood Engineers, Inc.
25 Vaughan Mall, Portsmouth, N.H. 03801
Tel. 603-436-6192 Fax. 603-431-4733

CSO INVESTIGATION SITES
CSO LONG TERM CONTROL PLAN
CITY OF PORTSMOUTH
PORTSMOUTH, NH

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2. REGULATORY STANDARDS

2.1 BACKGROUND

The City of Portsmouth is required to meet water quality limits established by State and Federal water quality legislation for all wastewater discharges, including combined sewer overflows (CSOs) and the Peirce Island WWTP. In accordance with Section 402 of the Clean Water Act (as amended in 1977), and the national CSO control policy (as expanded in 1994), effluent requirements for CSOs are enforced through the National Pollutant Discharge Elimination System (NPDES) permitting program. In 1990, the City entered into a Consent Decree with the EPA and the State of New Hampshire due to violations of its NPDES permit effluent requirements. The Consent Decree included the requirement to develop and submit a CSO abatement program to achieve compliance with the Clean Water Act. An Administrative Order was issued by the EPA in July 2002 which provided the final schedule for compliance with the CSO abatement program. Copies of these documents are provided in Appendices 2-1 and 2-2.

Separated storm water systems are also regulated through the NPDES permit program under EPA's Phase I and Phase II Rules, and are applicable to municipalities with separated storm systems serving populations of 10,000 persons or greater. Phase I of the storm water program was promulgated in 1990 under the Clean Water Act, and applied to medium and large municipalities, generally serving populations of 100,000 or more. Phase II of the storm water program was promulgated in December 1999 to extend the program requirements to the smaller municipal separate storm systems.

This section summarizes the regulatory requirements applicable to CSO and storm water discharges from the City of Portsmouth sewer system.

2.2 NATIONAL CSO POLICY

The EPA issued the "Combined Sewer Overflow Control Policy" on April 19, 1994 (59 FR 18688), to establish a consistent national approach for controlling CSO discharges through the NPDES permit program. The policy elaborates upon EPA's National CSO Control Strategy (issued in 1989), to expedite compliance with the Clean Water Act, and provide needed guidance to municipalities, to state, and federal permitting authorities, on how to meet pollution control goals as flexibly and cost-effectively as possible.

Under the new policy, CSO permittees are required to,

- immediately undertake a process to characterize their system and CSO discharges,
- demonstrate implementation of minimum technology-based controls (Nine minimum controls) as identified in the policy, and,
- develop long term control plans (LTCP) for CSOs which evaluate alternatives for attaining compliance with the Clean Water Act.

The policy contains four fundamental principles to ensure that the CSO LTCP will be cost-effective and meet local environmental objectives, as follows:

1. Clear levels of control to meet health and environmental objectives.
2. Flexibility to consider the site-specific nature of CSOs and find the most cost-effective way to control them.
3. Phased implementation of CSO controls to accommodate a community's financial capability.
4. Review and revision, as appropriate, of water quality standards during the development of CSO control plans to reflect the site-specific wet weather impacts of CSOs.

These objectives may be fulfilled by either of two approaches. The City of Portsmouth has elected to implement both the Presumptive and Demonstrative approaches for its LTCP, by reducing CSO events and performing compliance monitoring to verify compliance with water quality standards.

a) **Presumptive Approach**, based on the presumption that water quality standards will be attained by the elimination or capture of at least 85% by volume and by mass of pollutants in its combined sewage collected during precipitation events, without exceeding an average of 4 CSO events per year. Any remaining CSOs should be treated, at a minimum, by primary clarification, removal and disposal of floatable and settleable solids, and disinfection, if necessary, to meet the receiving water quality standards and protect designated water uses.

b) **Demonstration Approach**, wherein the permittee may demonstrate that the selected control program, though non-compliant with the presumptive approach requirements, can meet the receiving water quality standards and protect designated water uses. The demonstration approach program must also provide the maximum pollution reduction benefits reasonably attainable.

The CSO Policy also required immediate implementation of minimum technology-based controls referred to as the Nine Minimum Controls (NMCs), to achieve some optimization of system capacity as quickly as possible. The NMCs were intended to provide cost effective and easily implemented measures which could be pursued in the short term to help reduce the volume, pollutant load and frequency of CSO events. Each permittee was required to submit, as soon as practical, but no later than January 1997, a report documenting their implementation of the NMCs. They are summarized as follows:

1. Proper operation and regular maintenance programs for the sewer system and CSO outfalls.
2. Maximum use of the collection system for storage.
3. Review and modification of pretreatment requirements to ensure that CSO impacts are minimized.
4. Maximization of flow to the POTW for treatment.
5. Prohibition of CSOs during dry weather.
6. Control of solid and floatable materials in CSOs
7. Pollution prevention.

8. Public notification to ensure that the public receives adequate notification of CSO occurrences and CSO impacts.
9. Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls.

The City of Portsmouth submitted its Nine Minimum Controls report in January 1997 in compliance with the CSO policy. Section 1.4 - Previous Studies presents a summary of the City's NMC efforts completed to date.

2.3 WATER QUALITY STANDARDS

New Hampshire surface water quality regulations (Env-Ws 1700) and State Statute (RSA 485-A:8) include standards for Class "A" and Class "B" receiving waters. The South Mill Pond and the Piscataqua River are both classified as Class B waters.

The State has indicated that bacterial limits for protection of shellfish are required for the City of Portsmouth, due to the fact that the South Mill Pond and the Piscataqua River are Class B tidal waters. The shellfish limits are 70 colonies/100 mL for total coliforms and 14 colonies/100 mL for fecal coliforms.

Temporary deviations from the designated water quality standards may be allowed if it is demonstrated that Class B criteria cannot reasonably be met at all times, as a result of CSO events. NH Section Env-Ws 1703.05 Combined Sewer Overflows outlines the steps necessary to apply for deviations from class B criteria, as follows:

(a) To demonstrate that the class B criteria cannot reasonably be met in surface waters as a result of the combined sewer overflows, the applicant shall conduct and submit to the department, a use attainability analysis (UAA) in accord with 40 CFR Part 131.

(b) If, after public notice and comment, the department determines, based on the information provided in (a) above, that the UAA supports the establishment of less stringent criteria, it shall recommend a change in the classification of the waterbody to the legislature.

(c) Deviations from Class B criteria and uses shall be limited to those identified in the Combined Sewer Overflow Facilities Plan after full implementation of the control measures.

In addition to state water quality standards, the national CSO Policy also allows for possible water standard revisions to account for CSO events. EPA guidance on implementing water quality based provisions for CSO control provide that states may consider possible revisions including (EPA, 1995):

1. Applying bacteria standards at the point of contact rather than at the end-of-pipe (i.e., adopting a mixing zone),
2. Segmenting the water body to preserve recreation in areas where it actually occurs,
3. Reviewing water uses to create subclasses which allow for intermittent deviations from bacteriological standards.

Table 2-1 summarizes the applicable water quality standards for the City of Portsmouth.

Table 2-1 ***Water quality standards applicable to City of Portsmouth CSOs***

Criteria	Class B Waters (South Mill Pond and Piscataqua River)	Temporary Standard (CSO events)
Uses	Fishing, swimming, water supply after adequate treatment. Potential shellfish growing waters.	Applies during up to 3 days after a CSO event.
Dissolved oxygen % saturation and mg/L	>75% saturation or > 5-6 mg/L for the conditions of temperature and salinity of City of Portsmouth receiving waters.	> 5 mg/L
Total coliforms # colonies / 100 mL	< 70 Shellfish growing waters	--
Fecal coliforms # colonies / 100 mL	<14 Shellfish growing waters	--
E. coli # colonies / 100 mL	<126 geo. mean (>3 samples over 60 days) <406 maximum any sample	--

NHDES (1999). NH Code of Administrative Rules Env-Ws 1700, Surface Water Quality Regulations.

2.4 STORMWATER STANDARDS

EPA's Storm Water Phase II Rule (EPA, 1999) extended control of pollutant loads from storm water runoff to small municipal separate storm systems (MS4s) including the City of Portsmouth. Storm water discharges from urbanized areas are of concern due to common pollutants including street litter, sediment, road salt, oils, and other debris. The storm water program relies on the use of narrative, rather than numeric effluent limitations, requiring the implementation of best management practices (BMPs) applied to the "maximum extent practicable".

Small MS4 systems must implement the following six (6) minimum control measures as part of their storm water management program:

1. Public education and outreach
2. Public participation and involvement
3. Illicit discharge detection and elimination
4. Construction site runoff control
5. Post construction runoff control
6. Pollution prevention / good housekeeping.

These measures must be fully implemented by the end of the first permit term, typically 5 years. The City of Portsmouth submitted a Notice of Intent detailing its selection of storm water BMPs and measurable goals for evaluation of their effectiveness in 2003.

State standards for storm water treatment vary considerably between the states. Vermont and Massachusetts require net annual suspended solids (TSS) removal of 80% from separated storm water discharges, others including New Hampshire do not require additional standards beyond the federal rules. The City of Portsmouth has elected a proactive approach to implement storm water treatment alternatives that meet annual TSS removals of 80% or greater.

2.5 NPDES PERMIT NH 0100234

The City's Peirce Island WWTP operates under NPDES permit # NH0100234 and 301 (h) waiver issued in 1985. The permit includes effluent limits for the WWTP and for CSO 010 (South Mill Pond 10A and 10B) and CSO 012 (Marcy Street). A copy of the current NPDES permit is provided as Appendix 2-1. Relevant excerpts regarding CSO discharges include the following:

- "...The permittee is authorized to discharge from combined sewer overflows (CSOs 003 – 010, and 012)... provided the discharges receive Best Practicable Treatment. Best Practicable Treatment (BPT), at minimum, is the most economical treatment necessary so that the discharge does not violate the water quality standards of the receiving water and contains no septage or holding tank waste."
- "CSO number 003 through 009 shall be eliminated as described in Section D."
- "A monitoring program adequate to evaluate compliance with paragraph 1 above shall be developed for CSOs 010 and 012. The monitoring program shall be designed to:
  - o Adequately assess compliance or non-compliance with water quality standards for the receiving water during wet and dry weather and low flow conditions.
  - o Provide an assessment of individual overflow impacts on the receiving water.
  - o Provide sampling locations, frequencies, and parameters necessary to obtain representative results and comparison with water quality standards.
  - o Provide for reporting of results to EPA and the State periodically, but no less than annually."
- "Within two months of the effective date of this permit, the permittee shall submit a proposed monitoring program to EPA and the State for review and approval. Upon approval, the permit will be modified to incorporate this program".

The City has implemented a monitoring program for flow and rainfall at CSO outfalls 10A, 10B and 013 (Deer Street), and submits monthly reports to EPA and NHDES as required by EPA's 308 letter dated June 26, 2001. The City also conducted several technical evaluations in response to EPA's 308 letter including an Outfall Dilution Study and a 301(h) Monitoring Program (River Study). Based on this supporting documentation, the City has submitted a 301 (h) Waiver Renewal Application and NPDES Permit renewal application.

2.6 CONSENT DECREE AND ADMINISTRATIVE ORDER

In May 1990, the City of Portsmouth entered into a Consent Decree (Civil No. 89-234-D, included as Appendix 2-2), with the EPA and the State of New Hampshire due to violations of its NPDES permit. The objective of the Consent Decree was for the City to come into compliance with the Clean Water Act, including the terms and conditions of its NPDES Permit, and the provisions of applicable federal and state regulations. The Consent Decree required the City to upgrade the Peirce Island WWTP to meet the NPDES requirements by February 25, 1992, and to submit a CSO Facilities Plan by January 1991.

The City submitted its first CSO Facilities Plan in compliance with the Consent Decree (see Section 1.4 Previous studies) in 1991. The program recommended treating the remaining CSO outfalls at the South Mill Pond using a swirl type concentrator, for removal of floatables and solids. However, this recommendation has since been revisited, due to questions on the feasibility of treatment alone to provide a long term solution and consistently meet the water quality standards. Meanwhile, problems with surcharging and flooding due to limitations with the existing collection piping continued to plague the system.

Since the recommended end of pipe treatment would not eliminate upstream flooding and surcharging, and could in fact exacerbate the problems due to limited available head to operate a swirl concentrator, the City has continued rehabilitating and optimizing the existing system, while a more comprehensive, long term plan could be agreed upon.

As a result of the LTCP efforts, the EPA issued an Administrative Order in July 2002 (A/O 02-15, Appendix 2-2), to enforce additional deadlines for compliance with the CSO Policy and the NPDES permit requirements. The A/O includes the following requirements:

1. Submit a final CSO Long Term Control Plan (LTCP) by August 1, 2002
2. Submit an update of the Portsmouth Nine Minimum Controls for CSOs by August 1, 2002
3. Complete a Preliminary Design Report for the Combined Sewer Area, including a schedule for final design and construction, by February 28, 2003, and,
4. Advertise for Bids for the construction in Area #1 project, vicinity of Outfalls 10A and 10B (known as the Lincoln Ave basin), by March 3, 2003.

The above requirements have been met by the City. The present LTCP report is an update / re-issue of the LTCP report issued in August 2002 (requirement 1 of the A/O), to address comments received by the NHDES and incorporate additional results from the City's ongoing sewer separation projects.

3. CHARACTERIZATION OF RECEIVING WATERS AND CSOS

Characterization of receiving waters for the LTCP was based on data collected as part of the 1991 CSO Abatement Program (Whitman & Howard, 1991), the Great Bay Coast Watch program (1997 to present), and the NHDES Watershed Management Bureau Shellfish program (1987 to present).

Characterization of CSO discharges included flow monitoring, physical, and bacteriological water quality sampling, and was supplemented by bench scale disinfection and settling testing performed on 'first flush' CSO samples. The bench scale tests were performed to establish design parameters for the LTCP evaluation of abatement alternatives.

3.1 RECEIVING WATER QUALITY

Ambient water quality data for the South Mill Pond and the Piscataqua River were gathered from previous or ongoing monitoring studies. Dry-weather sampling of the receiving waters was used to provide baseline water quality data. Relevant monitoring stations for the City's LTCP are shown in **Figure 3-1**, and include:

- 1991 CSO Abatement Program Stations 1 through 5
- Great Bay Coast Watch (GBCW) monitoring program Stations GB20 and GB21
- NHDES Watershed Management Bureau monitoring Stations T09 and T10

3.1.1 1991 CSO Abatement Program sampling

Sampling of receiving water stations 1-5 for the 1991 program was conducted for the summer (warm) water characterization on August 16-17, 1990, and for winter (cold) water characterization on December 11-12, 1990. The sampling results are presented in Table 3-1 and Appendix 3-1 Ambient Baseline sampling.

Table 3-1 ***Baseline water quality from 1991 sampling program***

Parameter	Date	Station 1 So. Mill Pond CSO10A/10B	Station 2 Junkins Ave West	Station 3 Junkins Ave East	Station 4 Marcy Street	Station 5 Outlet to Channel
Total Coliform #/ 100 mL	Aug-90	400	300	60	40	150
	Dec-90	340	240	128	159	404
Fecal Coliform #/ 100 mL	Aug-90	0	20	10	<10	50
	Dec-90	148	38	19	25	115
Dissolved Oxygen mg/L	Aug-90	8.5	9.2	8.7	8.8	8.8
	Dec-90	9.4	9.2	9.5	9.5	9.4
BOD5 mg/L	Aug-90	3.7	<2	<2	<2	<2
	Dec-90	3.0	2	2	<2	<2
TSS mg/L	Aug-90	51	37	47	26	34
	Dec-90	13	8	7	5	6
VSS mg/L	Aug-90	40	30	40	21	29

Parameter	Date	**Station 1** So. Mill Pond CSO10A/10B	**Station 2** Junkins Ave West	**Station 3** Junkins Ave East	**Station 4** Marcy Street	**Station 5** Outlet to Channel
	Dec-90	10	6	4	3	3
	Aug-90	0.4	<0.1	<0.1	<0.1	<0.1
TKN mg/L	Dec-90	0.58	0.5	0.5	0.31	0.35

The baseline water quality data showed total coliform levels above the Class B water criteria for shellfish growing waters of 70 #/100mL (see Regulatory Standards, Section 2), but below the maximum day level of 406 #/100 mL *E.coli* applicable to other Class B receiving waters in New Hampshire. Additional historical data for the South Mill Pond background water quality is discussed in the following sections, from monitoring stations by the NHDES (from 1987) and the GBCW (from 1997) programs.

The minimum DO level for Class B waters is >75 % saturation. For the South Mill Pond tidal waters, 75% saturation is generally reached above 5 – 6 mg/L DO for conditions of 0-20 °C and 20-30 ppt salinity. The 1991 baseline water quality DO levels between 8.5 to 9.5 mg/L were well above the minimum DO criteria.

Wet weather sampling of the receiving waters during CSO events was also performed as part of the 1990 program. Ambient water quality data concurrent with CSO events are reviewed in the following section for the GBCW sites.

3.1.2 Great Bay Coast Watch Monitoring Sites

The Great Bay Coast Watch (GBCW) is a volunteer group working within the University of New Hampshire Cooperative Extension / Sea Grant program. The GBCW has been monitoring water quality in the Great Bay Estuary since 1990 and in the South Mill Pond since 1997. The South Mill Pond sampling stations are located west of Junkins Ave (GB20) and at Pleasant / Marcy St (GB21), as shown in **Figure 3-1**. These stations are similar to Stations 2 and 4 of the 1991 program.

The GBCW typically samples once a month from April to November. **Figures 3-2 and 3-3** show the fecal coliform concentrations at these stations between 1997 and 2001. Corresponding CSO events recorded at CSO outfalls 10A/10B are also noted. Generally, fecal coliform levels increased more sharply at site GB20 (Junkins Ave / inner South Mill Pond) following a CSO event. However, high coliform levels also occurred with no CSO events, and were not proportional to the volume of the discharge.

Dissolved oxygen concentrations from 1997 to 2001 for the South Mill Pond monitoring stations are shown in **Figures 3-4 and 3-5**. As discussed above, DO levels above 5-6 mg/L will generally exceed the 75% saturation criteria for the South Mill Pond water temperature and salinity characteristics. Low tide DO levels at site GB20 were observed to dip below 5 mg/L. However, summer low tide DO levels are often due to naturally occurring, sediment oxygen demands.

3.1.3 NHDES coastal watershed monitoring

The NHDES Watershed Management Bureau conducts routine monitoring throughout Little Harbor and the Piscataqua Back Channel waters as part of its Coastal Watershed and Shellfish program activities. Periodic surveys are conducted for evaluation of potential impacts from direct and indirect discharges to the receiving waters. A 1999 shoreline survey of this area included sampling at 58 locations (see Section 1.4.5, NHDES Landry & Wood, 2001).

Data from Feb 1988 to Dec 1999 for stations T09 and T10 were obtained from the NHDES Shellfish program (NHDES Nash 2001). As shown in **Figure 3-6**, these locations provide ambient water quality data downstream of the City's Peirce Island WWTP effluent (site T10) and the lower end of the Piscataqua near the City of Portsmouth (T09). For the 11-year period reviewed, water temperatures ranged between 0 to 21°C, and salinities were generally between 20 to 30 ppt.

Fecal coliform counts at station T09 (lower Piscataqua) were always below 500 #/100 mL and generally below 100 #/100mLs for the period May 1989 to Dec 1999 (see **Figure 3-7**). However, some spikes as high as 2,400 - 5,500 #/100 mL were observed in 1988 and early 1989. At the upper monitoring station T10, fecal counts were greater and highly variable (110 to >16,000), but have been reduced to below 200 #/100 mL since Nov 1994 **(Figure 3-8)**. From 1995 to 1999, fecal coliform levels were below 50#/100 mL in all but 5 of 40 sampling results. These levels remain above the shellfish growing standard for Fecal Coliforms of 14 #/100 mL. Additional data for NHDES monitoring sites T09 and T10 is included in Appendix 3-2.

3.2 CSO CHARACTERIZATION

The pollutant load from CSOs is dependent on the period of dry weather prior to a CSO event, rainfall intensity and quantity, overflow volume and peak rate, and the success of street sweeping and catch basin cleaning programs. CSO characterization for the City of Portsmouth has included flow monitoring and sampling for 'first flush' and composite CSO discharges.

3.2.1 Flow Monitoring

The City of Portsmouth has performed continuous flow monitoring at the South Mill Pond CSOs 10A and 10B since 1991. Flow monitoring at Deer Street CSO 013 has been ongoing since 2000. Monthly reports for these outfalls are submitted to the EPA and NHDES in accordance with EPA's 308 letter requirements (EPA 2001). Flow monitoring instrumentation includes American Sigma Model 920 Area Velocity flow meters and backup ultrasonic sensors. No flow monitoring is performed at the Marcy Street Bypass (CSO 012) because it is manually controlled, and is used as an emergency relief only. CSO events from the Marcy Street Bypass are reported to the NHDES when operation of this bypass has been necessary.

Monitoring results for the South Mill Pond CSOs 10A, 10B and Deer Street CSO 013 from 1994 through 2003 are shown in **Figure 3-9**. The number of CSO events per year are shown along with annual rainfall data, as recorded at the City Hall rain gauge. Most events continue to occur at CSO 10A but these have been reduced from over 45 in 1997, to 29 events in 2003, and only 3 events through June 2004. Discharges at 10B have been reduced more significantly, from a high of 29 in 1994 to 11 in 2003. The Deer Street CSO had increased discharges in 2001 and 2002 due to pumping problems at the Deer Street Pumping Station.

3.2.2 CSO Characteristics

Wet weather CSO discharges were sampled in September and October of 1990 as part of the first CSO abatement plan. Sampling began shortly after the start of a CSO event and was continued up to 3 hours after cessation of the overflow. Automatic samplers were used to collect and store discrete aliquots over the duration of the CSO event. Grabs were taken every 15 minutes for the first three (3) hour period and labeled as 'first flush'. Subsequent grabs were collected every hour until the end of the event.

Total CSO volumes for the five (5) events sampled ranged from 0.90 MG to 25 MG (Table 3-2). Samples were analyzed for dissolved oxygen (DO), pH, biochemical oxygen demand (BOD_5), total suspended solids (TSS), volatile suspended solids (VSS), total kjeldahl nitrogen (TKN), total coliform, fecal coliform and oil & grease. In addition, two of the wet-weather CSO first flush samples were analyzed for heavy metals, pesticides, and volatile organic compounds (VOCs). The results are summarized below. Raw data from Whitman and Howard (1991) is included as Appendix 3-3.

Table 3-2 ***Sampling Results for CSO 10A South Mill Pond***

Event Date	Total Rainfall (inches)	Total Volume MG	Avg / Peak Flow mgd	Avg BOD_5 mg/L	Avg TSS mg/L	Avg Total Coliforms #/100mL	Avg Fecal Coliforms #/100mL
9/15/90	0.53	1.3	8.7 / 21	64	151	7.4 x10^6	10 x10^5
9/23/90	0.74	0.9	7.2 / 16	46	78	1.1 x10^7	1.6 x10^5
10/9/90	0.3	1.2	6.9 / 17	60	142	4.8 x10^7	19 x10^5
10/13/90	2.9	25	12 / 26	50	119	3.8 x10^8	2.2 x10^5
10/23/90	2.9	20	9.8 / 25	70	138	7.0 x10^7	4.0 x10^5

Ref: Whitman & Howard (1991) CSO Abatement Plan. City of Portsmouth, NH

The low BOD_5 concentrations (46 to 70 mg/L) suggest that the overflows consisted primarily of storm water runoff. Typically, sanitary wastewater BOD5 concentrations are on the order of 220 mg/L (Metcalf & Eddy, 1991). Fecal coliform levels were similar to those reported in Moffa et al. (1997), where bacterial concentrations in CSO discharges generally range between 10^3 –10^6.

Two first flush samples were analyzed for total metals (Table 3-3). Although some results were above the water quality standards, the concentrations found are not unusual for urban storm water runoff pollutants (NHDES 1999). Testing results for VOCs and pesticides in the first flush samples collected in 1990 showed most compounds were below the analytical detection limit.

Table 3-3 ***Metals concentrations in CSO 10A and 10B - first flush samples***

Parameter	Units	Marine WQS		CSO 10A	CSO 10B	Urban[3]
		Chronic	Acute	9/15/90	10/23/90	Runoff
Hardness						
Cadmium	mg/L	0.0093	0.042	0.01	0.004	0.0009
Total Chromium	mg/L	0.05/NA	1.1/10.3	<0.005	<0.01	0.0112
Copper	mg/L	0.0031	0.048	0.10/0.11	0.02	0.0401
Mercury	mg/L	0.00094	0.0018	<0.002	0.001	N/A
Nickel	mg/L	0.0082	0.074	<0.04	<0.01	<0.0107
Lead	mg/L	0.0081	0.210	<0.04	0.009	0.0322
Zinc	mg/L	0.081	0.090	0.11	0.03	0.259

References:
- *Whitman & Howard (1991) CSO Abatement Plan. City of Portsmouth, NH.*
- *NHDES Non-point Source Program (1999). Study of Urban Runoff Pollutant Concentrations and Loadings, Non-point Source Management Plan, New Hampshire.*

3.3 BENCH SCALE TESTING

Bench-scale chlorination and settling tests were performed on three (3) CSO first flush samples collected at CSO 10A, to estimate disinfection requirements and settling characteristics. The test procedures are included as Appendix 3-4. Samples were analyzed in accordance with Standard Methods for Water and Wastewater (APHA 1992).

Samples for the bench scale tests were collected on June 2, June 17, and September 21, 2001 from the overflow discharging over the weir, at the CSO 10A manhole. The grab samples were split in the lab and processed immediately for the disinfection and settling testing.

Raw wastewater samples were analyzed for TSS, BOD_5, ammonia, COD and fecal coliforms (Table 3-4). The first flush samples showed similar fecal coliform levels as samples collected in 1990 (Table 3-2), on the order of $1.5x10^5$ #/100 mL. BOD and TSS levels on June 17 and September 21 samples were also similar to the 1990 samples. The low BOD levels suggest that the overflows are predominantly from storm water inflow.

Table 3-4 ***CSO 10A samples used for bench scale disinfection and settling tests***

Sample Date	Sample type	BOD_5 mg/L	TSS mg/L	Fecal coliform #/100mL	COD mg/L	Ammonia mg/L as N
6/02/01	First flush	290	153*	Invalid data	600	1.5
6/17/01	grab	105	50	1.45×10^5	220	0.9
9/21/01	samples	62	189	1.49×10^5	113	ND

* TSS measured on decanted supernatant.

3.3.1 Disinfection Testing

Sodium hypochlorite doses of 10, 20, and 30 mg Cl_2/L were evaluated with disinfection contact times of 5, 10, 20, and 30 minutes. Samples were transferred to a jar testing apparatus and mixing was begun prior to dosing the disinfectant, and sustained at high speed for 15 seconds after dosing. Mixing intensity was reduced and maintained at low speed for the remainder of the contact time. Disinfected samples were analyzed for fecal coliforms and total residual chlorine.

For samples collected on 6/17/01 and 9/21/01, the raw wastewater sample was allowed to settle for 15 minutes and the decanted supernatant was used for the disinfection tests. In addition, raw and disinfected splits were taken from the 9/21/01 sample and blended in a whirring blender to check for possible shielding effects from suspended solids.

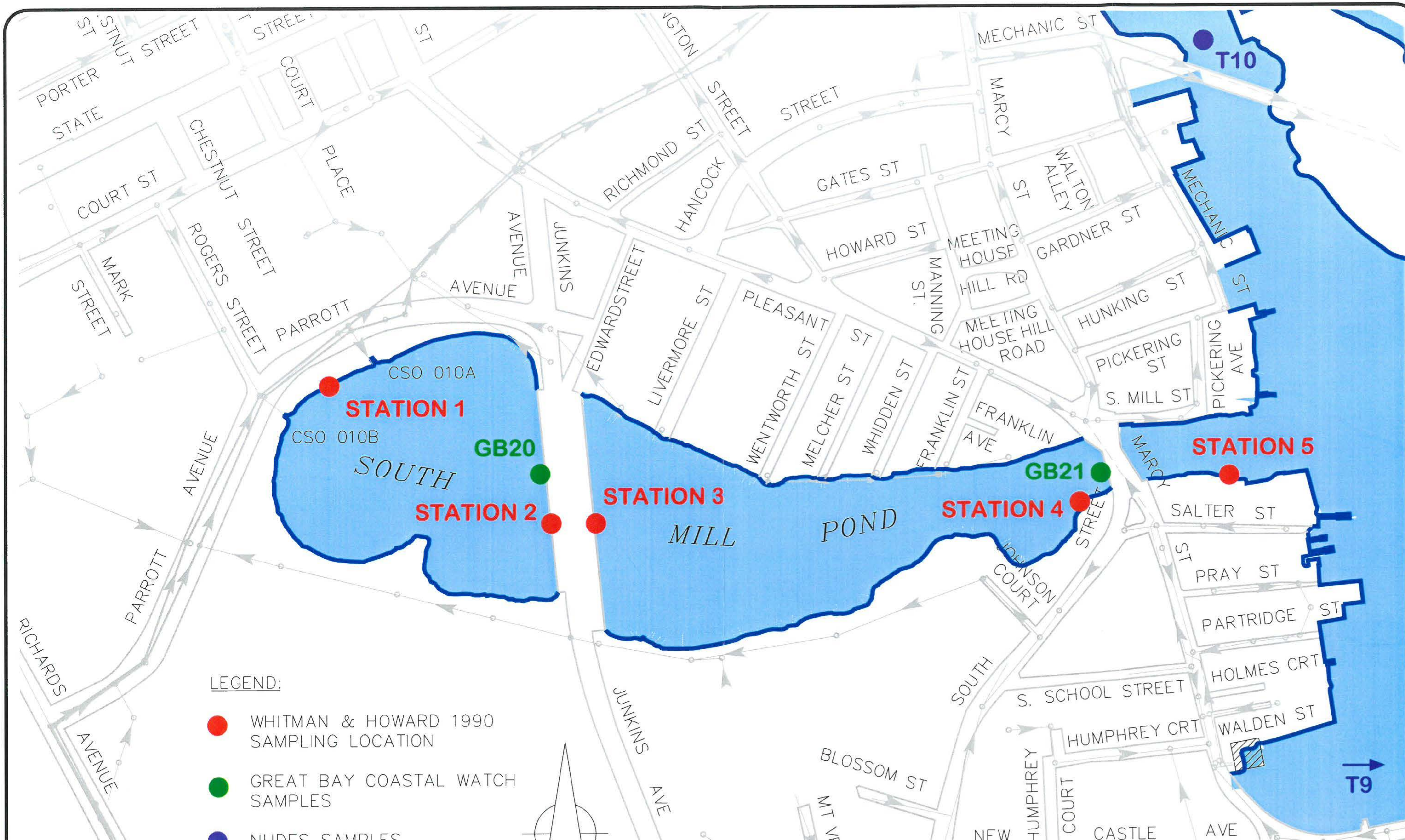
The disinfection test results showed that chlorine demand was generally satisfied within the first 5 minutes of contact time, and that hypochlorite doses between 10 to 20 mg/L were adequate to provide a measurable disinfectant residual (**Figure 3-10**). Chlorine residual was present in all disinfected samples except the 10 mg/L dosage on 6/2/01 (non-settled sample).

Fecal coliforms were reduced more than 4-logs (99.99%) from 1.5x 10^5 in the raw water to below the detection level of 10 #/100 mL, for *all of the conditions* tested. These results suggest that adequate bacterial kill may be accomplished under rapid (15 min) disinfection conditions for settled storm water supernatant. However, additional testing is recommended to be performed to establish basis of design parameters for future treatment facilities.

3.3.2 Settling Tests

In addition to disinfection tests, a solids settling column test was performed on the 6/02/01 and 6/17/01 first flush CSO samples. A settling column was used and samples of the settled solids were extracted at specific time intervals up to 2 hours total settling. The test procedure is included as Appendix 3-4. Settling tests are useful in evaluating the applicability of solids separations technologies for CSO and storm water treatment. Urban CSO discharges tested in other areas have shown mean particle settling velocities of 0.2 cm/sec (Pisano and Brombach, 1996).

Sludge samples from the settling tests were analyzed for TSS and plotted by particle velocity (**Figure 3-11**). Both samples tested showed settling velocities greater than 0.1 cm/sec for 90% of the solids, and greater than 0.2 cm/sec for at least 70% of the solids. These characteristics suggest that high rate swirl type solids concentrators would be feasible for treatment of CSO discharges from the City of Portsmouth.



LEGEND:

- WHITMAN & HOWARD 1990 SAMPLING LOCATION
- GREAT BAY COASTAL WATCH SAMPLES
- NHDES SAMPLES

SCALE: 1"=100'

SOURCE: WHITMAN & HOWARD INC. (1991)

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DATE	Underwood Engineers, Inc.	AMBIENT WATER QUALITY MONITORING STATIONS City of Portsmouth, NH	FIGURE
7/04			3-1
PROJECT 1110			

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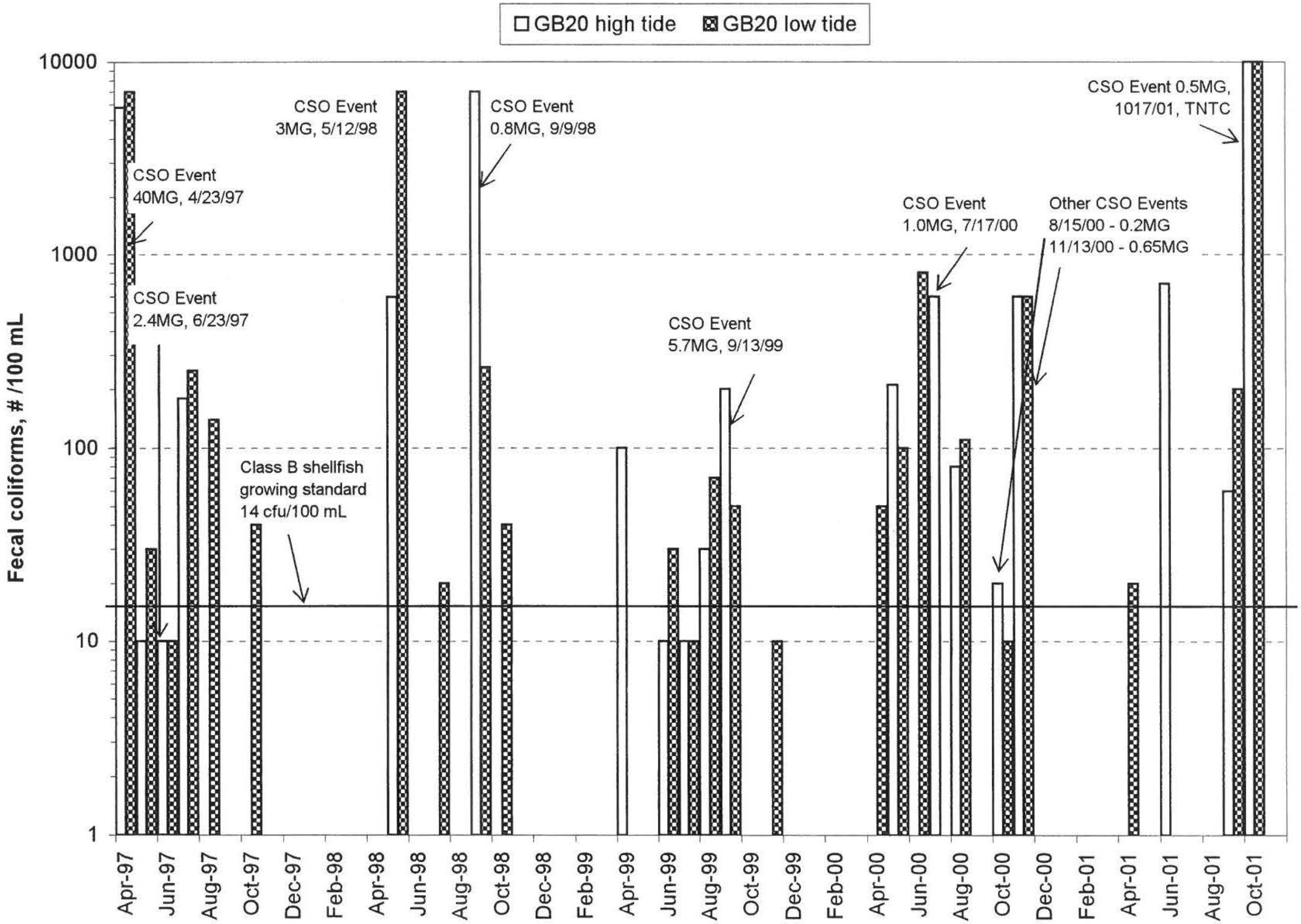
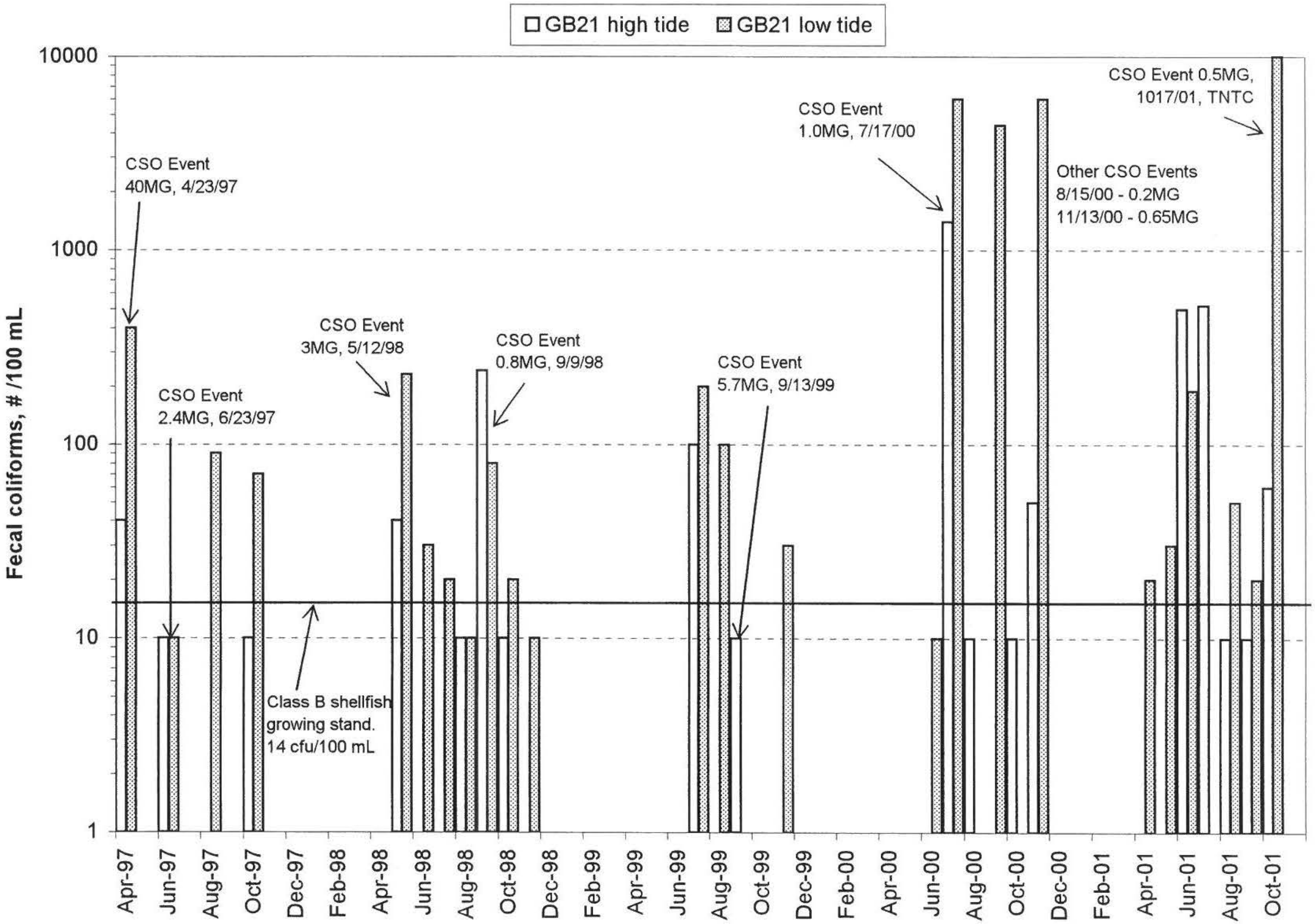
Figure 3-2 Fecal Coliform Levels at Site GB20
Inner South Mill Pond, West of Junkins Ave



Reference: Great Bay Coast Watch (2001)

1110\08_comp\GBCW fecal.xls,GB20 fecal

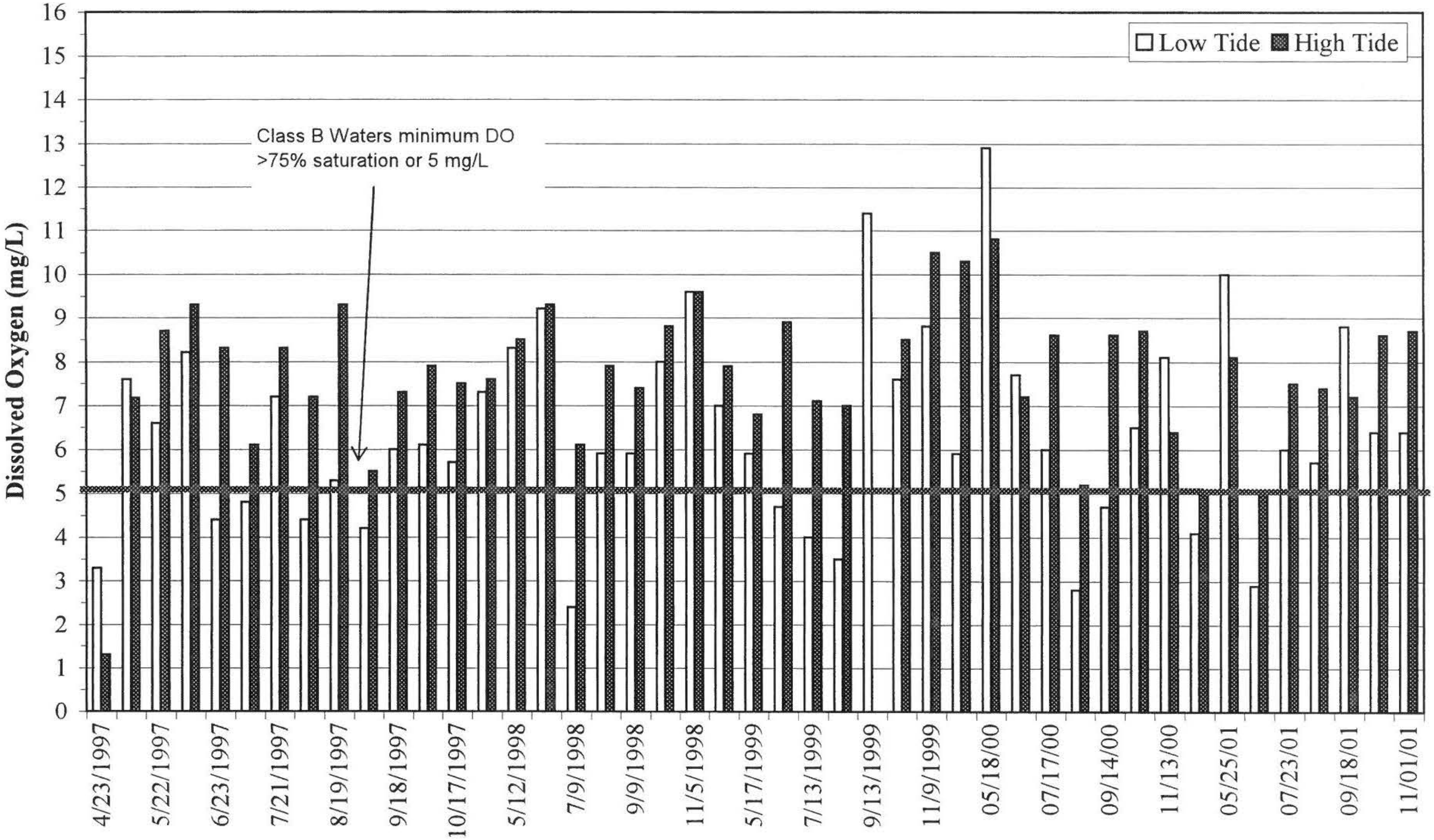
Figure 3-3 Fecal Coliform Levels at Site GB21
Outer South Mill Pond (at Marcy Street)



Reference: Great Bay Coast Watch (2001)

1110\08_comp\GBCW fecal.xls,GB21 fecal

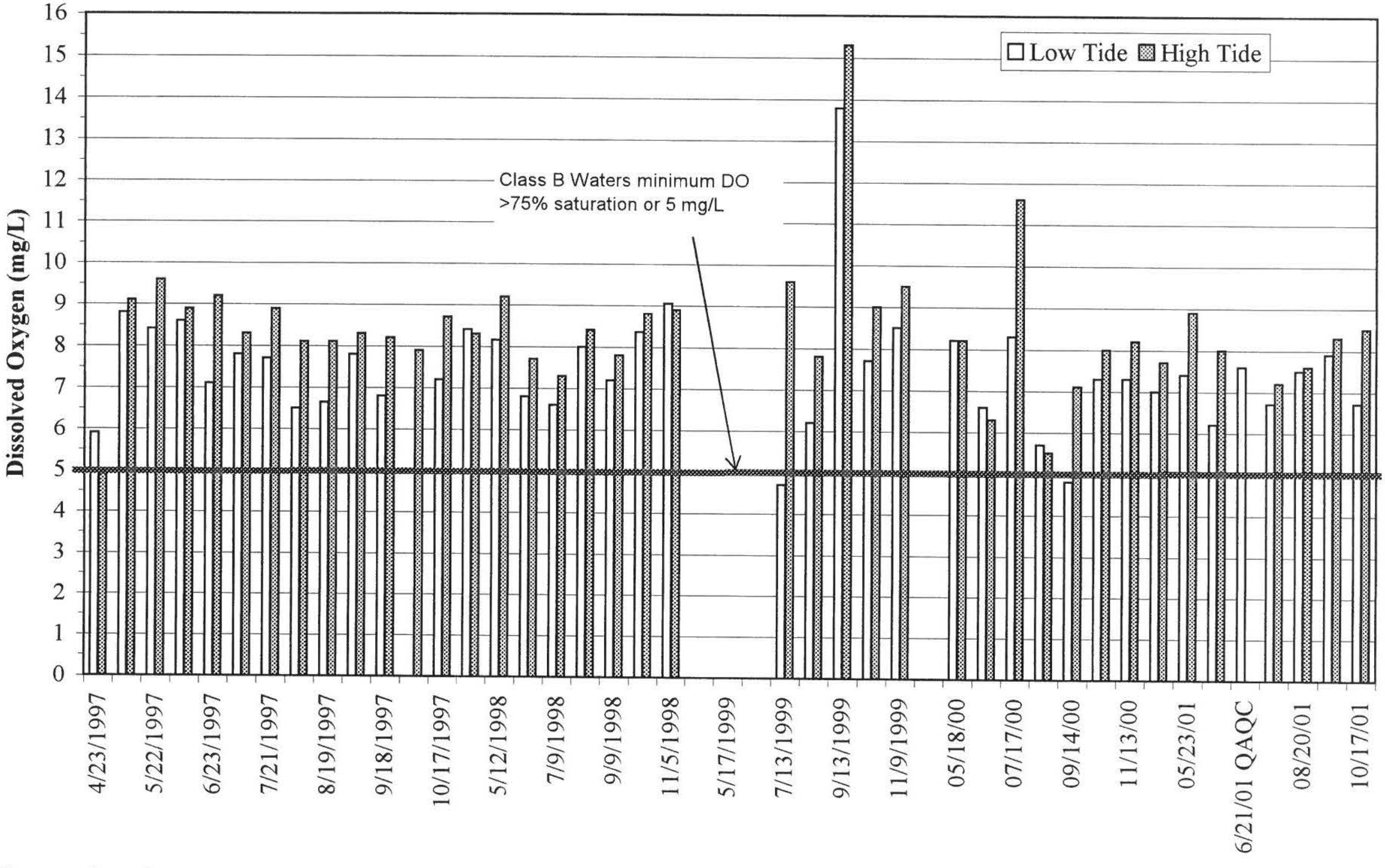
Figure 3-4 Dissolved Oxygen Concentrations Site GB20
Inner South Mill Pond, West of Junkins Ave



Reference: Great Bay Coast Watch (2001)

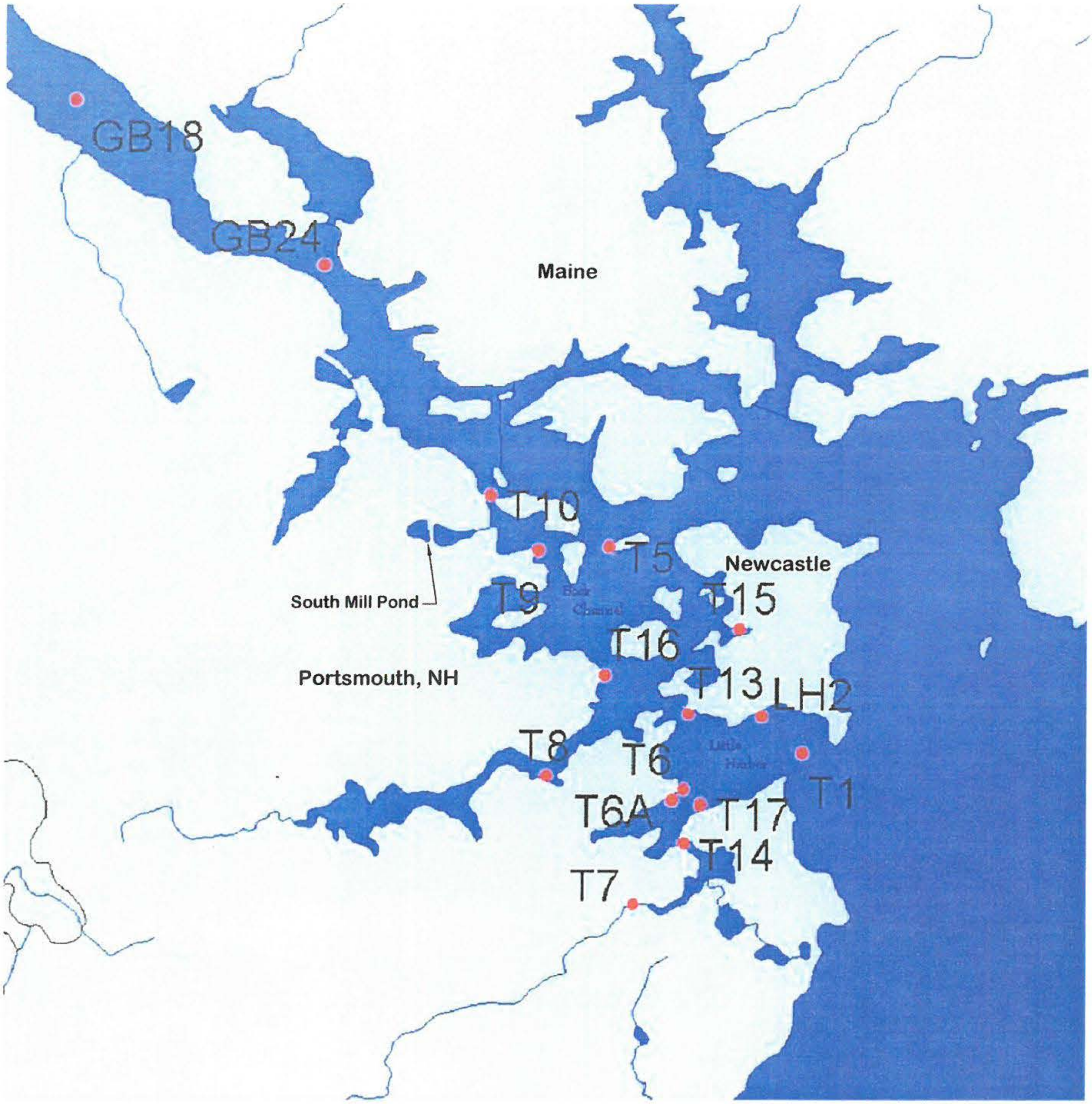
1110\08B_comp\GBCW DO.xls

Figure 3-5 Dissolved Oxygen Concentration Site GB21
Outer South Mill Pond (at Marcy Street)



Reference: Great Bay Coast Watch (2001)

1110\08B_comp\GBCW DO.xls



SOURCE:

FIGURE COURTESY OF NHDES SHELLFISH PROGRAM

LEGEND:

● NHDES SAMPLE LOCATONS

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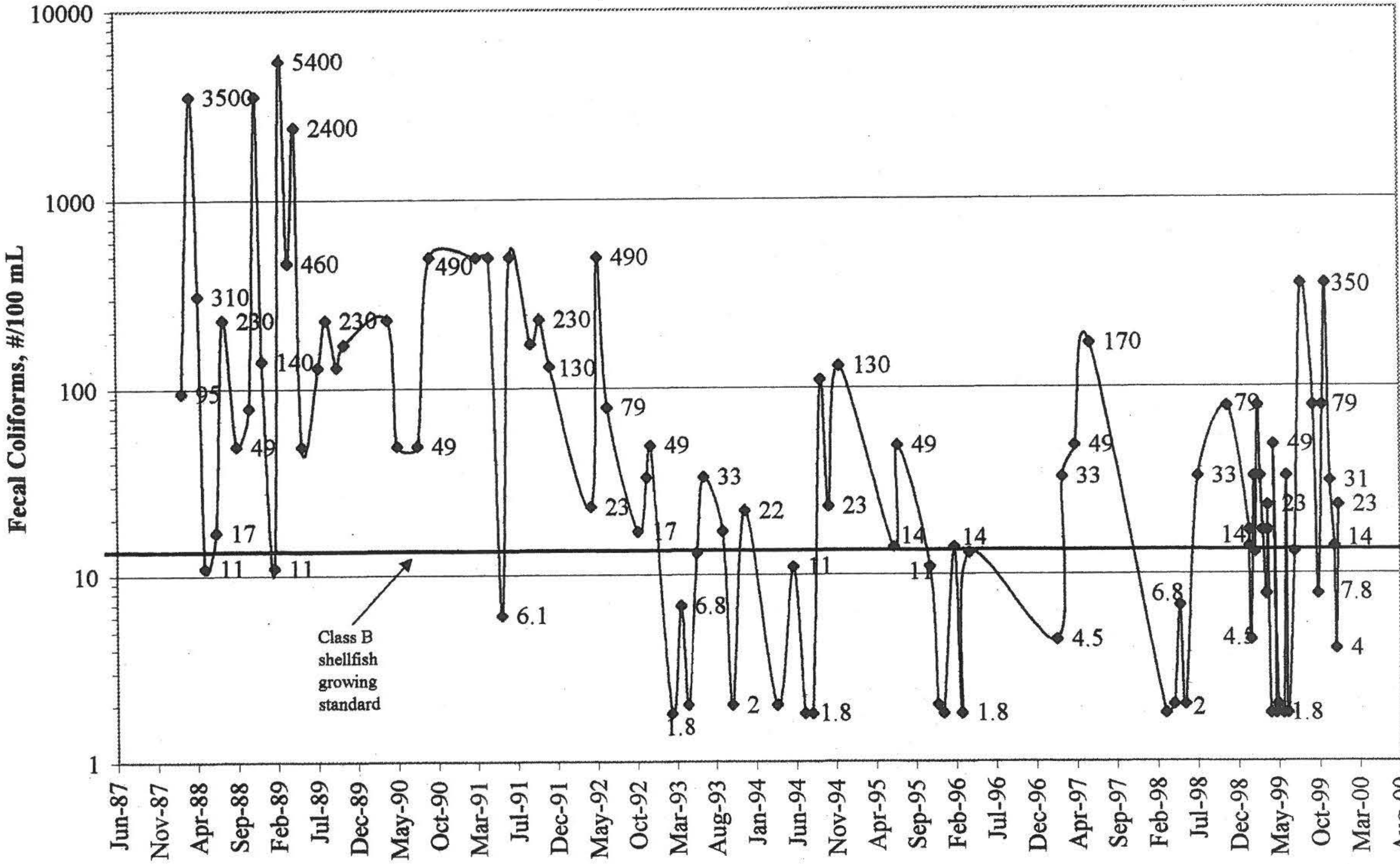
NOT TO SCALE

DATE			FIGURE
07/04	Underwood Engineers, Inc.	LITTLE HARBOR, BACK CHANNEL AND LOWER PISCATAQUA RIVER MONITORING STATIONS	3-6
PROJECT 1110			

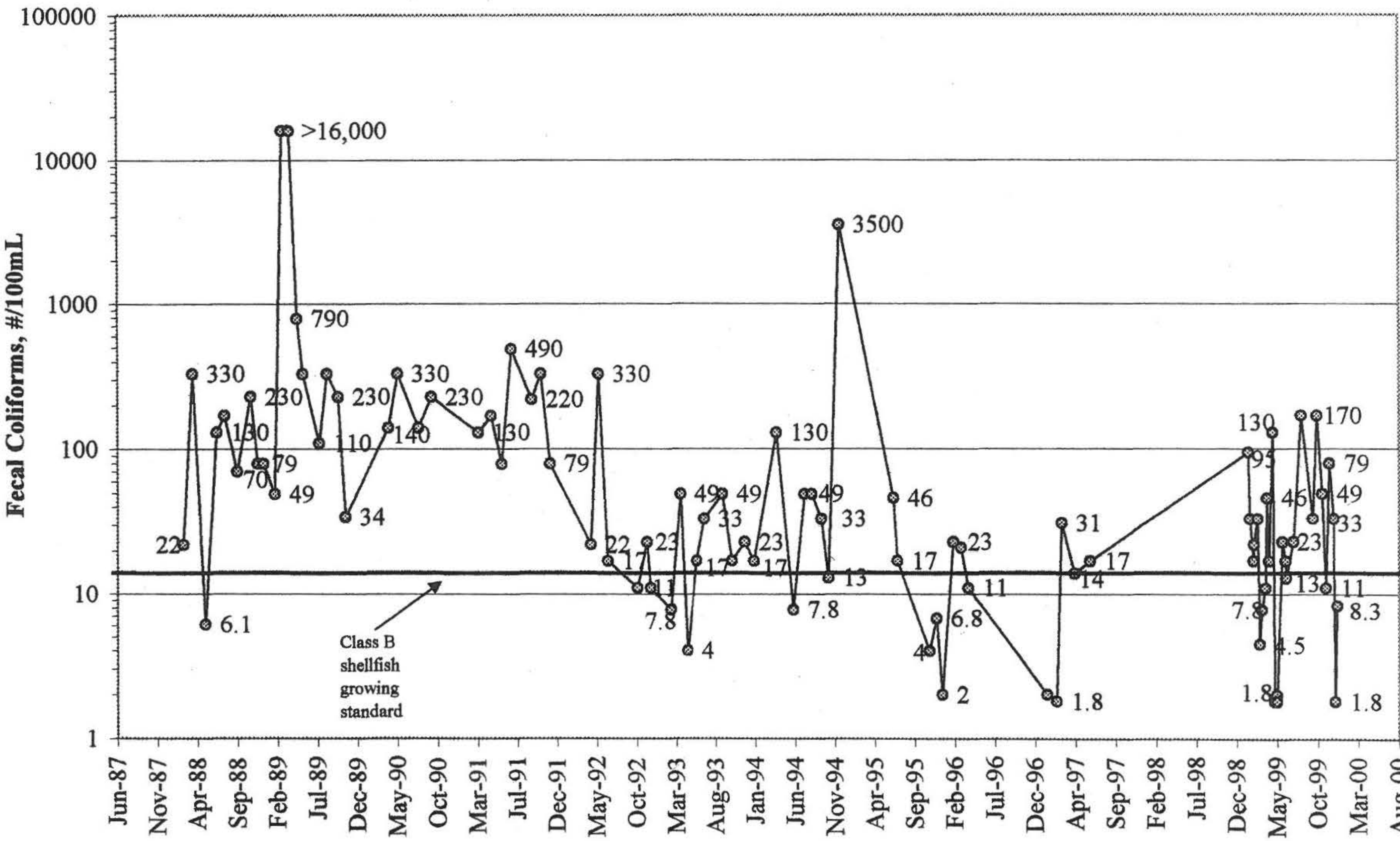
Figure 3-7
Fecal Coliform Levels Site T09
Lower Piscataqua River



1110\08_comp\NHDES t9-t10.xls,chart T9

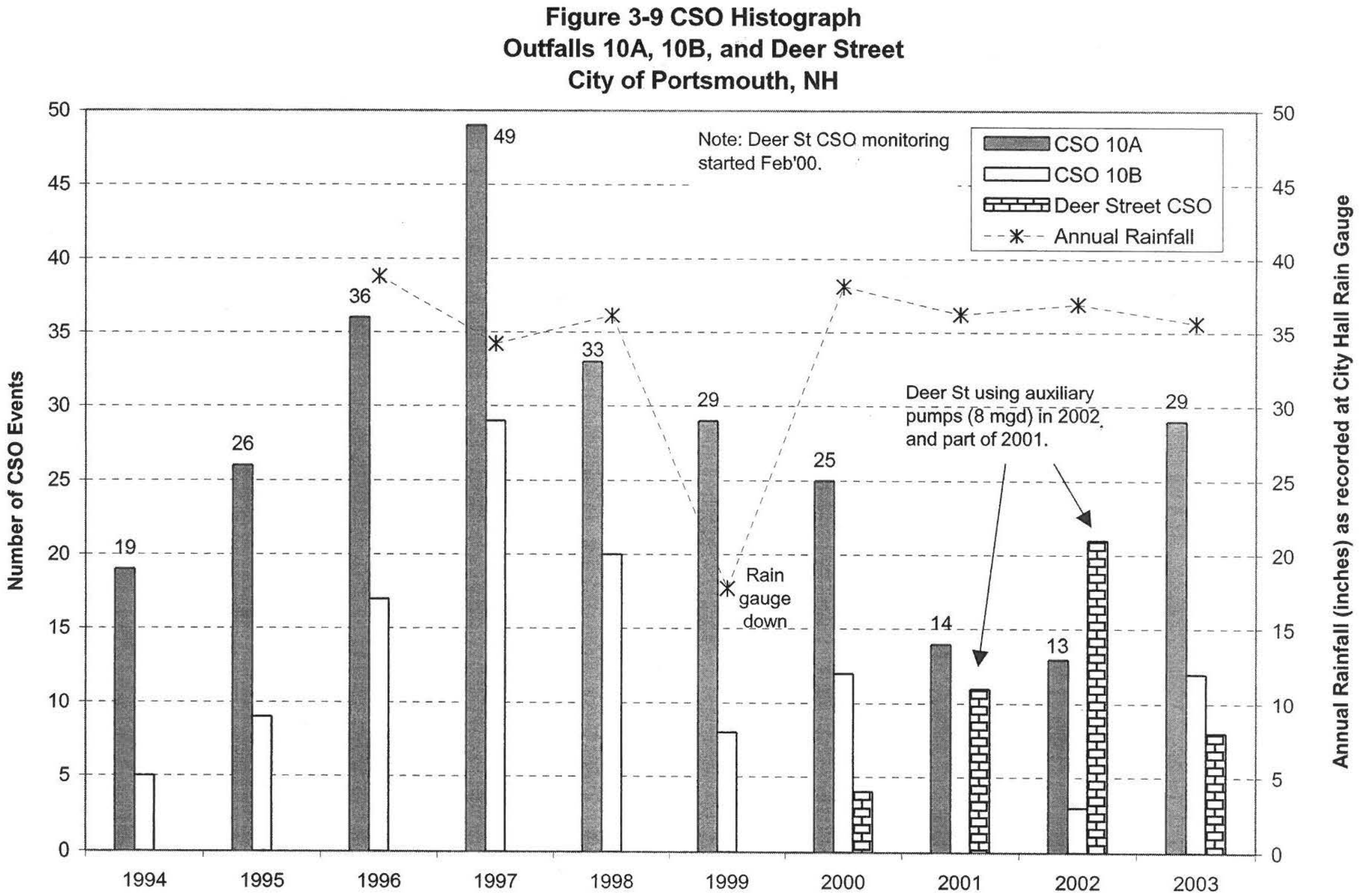
Ref: NHDES Nash (2001)

Figure 3-8
Fecal Coliform Levels Site T10
Downstream of Peirce Island WWTP



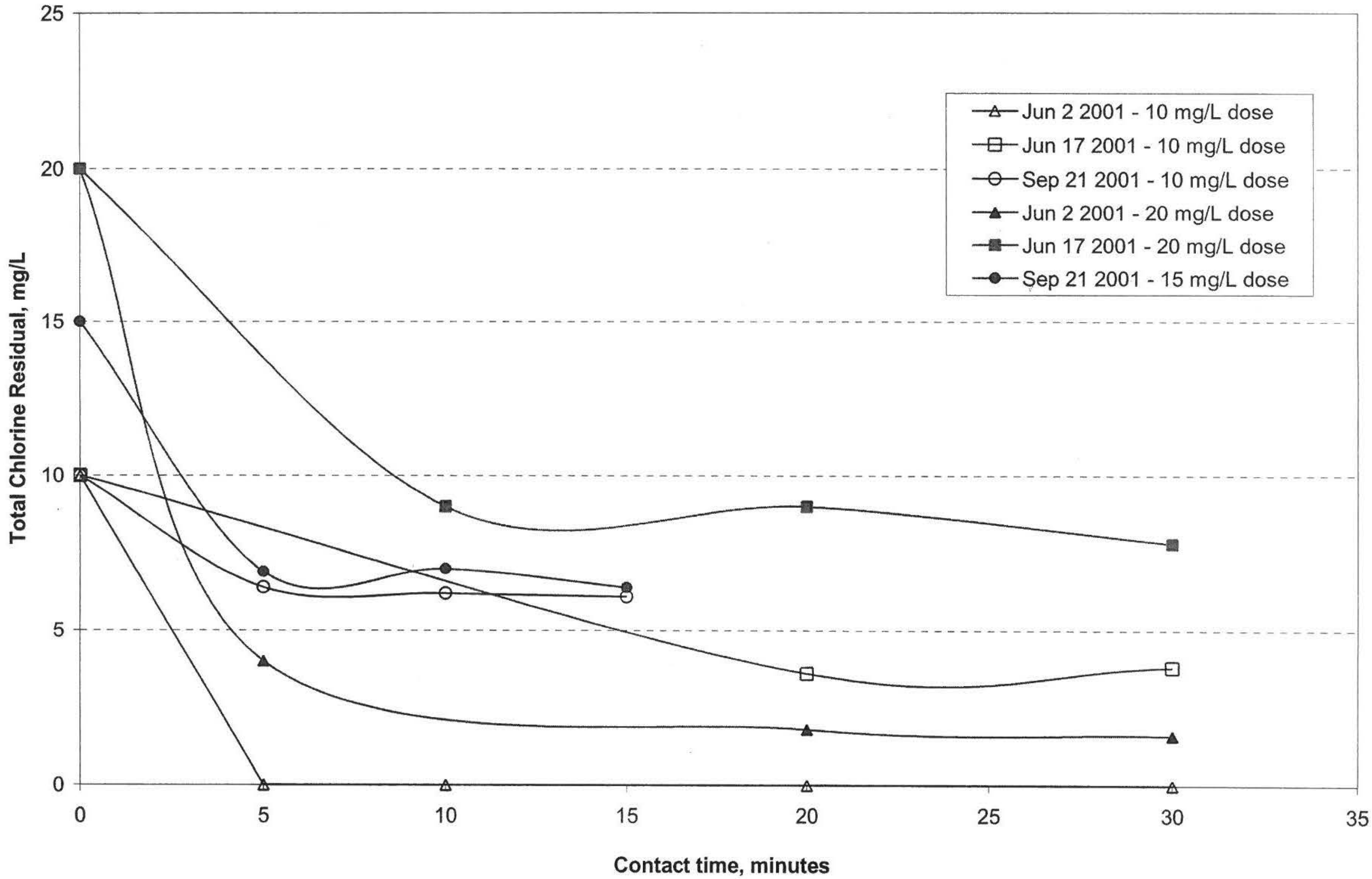
1110\08_comp\NHDES t9-t10.xls,Chart T10

Ref: NHDES Nash (2001)



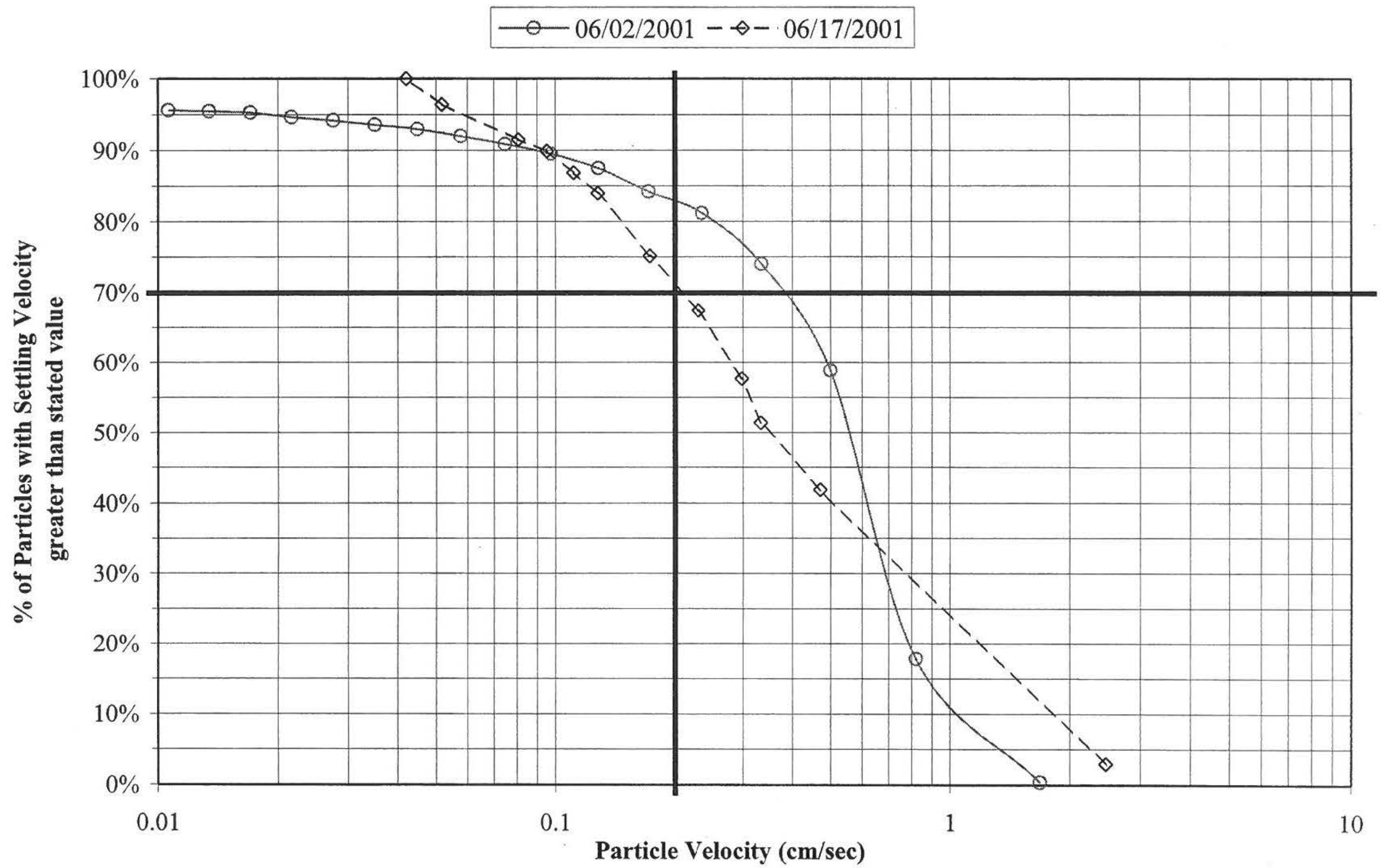
891\data\CSO\CSO monthly reports.xls,Annual events

Figure 3-10 Disinfection Testing for CSO 10A First Flush Samples



1110\08_comp\disinfection tests.xls

Figure 3-11 Settling Velocity for CSO 10A First Flush Samples
CSO Events June 2 and June 17, 2001



1110\08B_comp\Settling velocity.xls

4. HYDRAULIC MODELING

Hydraulic modeling for the LTCP was performed by Moffa & Associates of Syracuse, NY (a unit of Brown and Caldwell), as a continuation of the modeling work performed for the 1991 CSO Abatement Program. For this update, the modeled areas were expanded to include the Deer Street CSO, the brick-box sewer interceptor, and the Mechanic Street Basin interceptor.

The main interceptors were televised and mapping updated as part of the concurrent Sewer System Evaluation Survey by Underwood Engineers (see Section 1.4) to confirm the system physical configuration. This section summarizes the hydraulic modeling evaluations and results. The modeling report by Moffa & Associates (2002) is included as Appendix 4-1.

4.1 Model Development and Tributary Areas

EPA's Storm Water Management Model (SWMM) version 4.4GU (EPA, 1999b) was used for the model development. SWMM consists of five base model components which can be applied together or separately, including Runoff, Transport, Extended transport (Extran), Storage transport, and Receiving water. The LTCP model included use of the Runoff and Extran blocks. The Runoff block was used to estimate stormwater runoff and sewer infiltration, based on total rainfall and distinct hydrological characteristics for each tributary area modeled. The Extran block was used to estimate flow rate and volumes within the collection system.

The objectives of the hydraulic modeling were to:

- Establish the hydrologic parameters for the combined sewer areas
- Develop a calibrated mathematical model for the combined sewer collection system
- Project overflow volumes and rates at each CSO location and for different design storm intensities
- Establish the minimum storm event that causes an overflow to occur
- Estimate the number of CSO events and cumulative annual discharge volume that may be expected to occur on a annual basis, if the total annual rainfall is approximately equal to the historical average rainfall for the City (simulation of CSO events for the "Average Year")
- Support the evaluation of CSO abatement alternatives.

4.1.1 Modeled tributary areas

The modeled area included approximately 560 acres of the City's combined sewer area which are tributary to the Mechanic Street Pumping Station (**Figure 4-1**). All the wastewater influent to the Peirce Island WWTP is pumped via the Mechanic Street Pumping Station. Three major sewer interceptors which converge at this pump station were included

- The Mechanic Street Basin Sewer Interceptor from Lafayette Pumping Station to Mechanic Street (Lincoln Ave Area), 9,990 ft length
- The Box Sewer Basin Interceptor from the head of the North Mill Pond to the Deer Street Pumping Station, 5,100 ft length

- The main sewer through Strawbery Banke which connects the Deer Street and Mechanic Street Pumping Stations.

The modeled area was divided into 22 subcatchment areas as listed in Table 4-1 and shown in Figure 4-1. Of the total area evaluated, approximately 160 acres are tributary to the Deer Street Pumping Station and 400 acres were modeled as tributaries to the Mechanic Street Pumping Station. Data collected from aerial maps and topographic maps were used to establish specific sewershed characteristics for each subcatchment tributary area, including ground area, percent impervious area, and average slope.

Table 4-1 ***Modeled CSO Tributary Areas***

Subcatchment Number	Subcatchment Tributary Area, acres	Estimated Impervious Area %	Average Ground Slope ft/ft
Deer Street Basin			
011	32	2	0.030
012	23	2	0.013
013	52	60	0.010
014	19.5	50	0.020
015	20	40	0.010
016	11.8	65	0.020
Deer Street PS tributaries	**158 acres**	--	--
Mechanic Street (Lincoln) Basin			
030	11.5	75	0.028
036	11.2	4	0.030
037	17.6	4	0.040
038	24.7	5	0.012
039	15.4	7	0.001
040	30	5	0.016
050	54.4	20	0.006
060	72	6	0.013
070	19	22	0.017
080	22.6	40	0.021
081	30	45	0.004
090	25.7	15	0.010
110	11.3	15	0.030
120	21.7	95	0.018
130	18.2	15	0.020
140	16	95	0.020
Mechanic Street PS tributaries	**401 acres**	--	--

4.1.2 Modeled junction nodes

The collection system model is a simplified representation of the actual physical collection system. The model uses junctions only where significant changes occur in the actual system, such as a significant change in pipe diameter or slope. This simplification helps to reduce the computer run time to model the system while maintaining the hydraulic accuracy of the system. **Figure 4-2** shows a schematic of the collection system model, including the modeled junction nodes, flow monitoring locations, and CSO locations.

4.2 Flow monitoring for model calibration

Flow meters were installed at 12 locations in the collection system to collect wet weather flow data for calibration of the hydraulic model (see **Figures 4-2 and 4-3**). Severn Trent Pipeline Services of Auburn, NH (formerly Utility Pipeline) performed the flow monitoring field work. In addition, data from flow meters installed at South Mill Pond CSOs 10A, 10B and Deer Street CSO 013 (see Section 3.2) were used, for a total of 15 flow monitoring locations.

Wet weather flows (velocity and depth) and corresponding rainfall data were collected from April to July 2000. Additional data was collected at Marcy Street SMH #905 (meter #6) through August 7, 2000. Rainfall was recorded from the rain gauge at the Deer Street Pumping Station. Rainfall was monitored using a continuous recording device with minimum increments of 0.01 inch every 15 minutes. Six (6) storm events were used for the calibration flow monitoring as follows:

Table 4-2 *Calibration Storms and CSO discharges, April to July 2000*

Storm Event	Total Rainfall (inches)	Duration (hr:min)	Peak 15-min Intensity (in/hr)	CSO 10A Peak Flow (mgd)	CSO 10B Peak Flow (mgd)	CSO 013 Peak Flow (mgd)
04/21/00	4.28	43:15	0.44	6.8	5.5	7.6
05/13/00	0.46	3:00	0.68	3.5	1.9	0
05/24/00	0.99	11:30	0.44	2.6	1.1	0.9
06/06/00	1.34	21:30	0.40	1.5	1.8	0
06/12/00	0.42	5:15	0.48	2.3	0	0
07/16/00	2.32	10:00	1.16	13.6	13.6	9.3

Note: CSO 012 (Marcy Street SMH 907) was not monitored because it is controlled manually. Flow data was collected at Marcy Street SMH 905 (meter #6).

The storm events monitored allowed for calibration of the model over a broad range of rainfall conditions with varying duration, intensity and volume. All events except the June 12, 2000 event caused overflows at South Mill Pond CSOs 10A and 10B, while only 3 events caused overflows at CSO 013. The flow data was used to develop model calibration plots for each of the 15 monitoring sites (see Appendix 4-1), and showed close agreement between the actual and computed flow data. Comparison of measured vs. predicted flows for the three active CSOs (Table 4-3) show that the model is generally conservative in that it mostly *overpredicted* flows for the CSO locations.

Table 4-3 ***Modeled vs. Actual CSO flows and volumes, April to July 2000***

Parameter	South Mill Pond CSO 10A	South Mill Pond CSO 10B	Combined CSO 10A & 10B	Deer Street CSO 013
Actual Peak Flow, mgd	**30**	**24**	**53**	**18**
Modeled Peak Flow, mgd	25	34	59	27.5
% difference from actual	*-18%*	*41%*	*11%*	*54%*
Actual Volume, MG	**4.8**	**1.7**	**6.5**	**3.8**
Modeled Volume, MG	5.1	2.7	7.8	5.4
% difference from actual	*5%*	*63%*	*20%*	*41%*

4.3 Design storms

Historical rainfall data for the City of Portsmouth area was obtained for the National Weather Service Stations in Durham and Greenland, NH (NOAA, 2001) for selection of representative historical rainfall data. Precipitation records were used as input to the SWMM model for estimating CSO frequency and volumes under varying design storm scenarios.

A two (2) hour storm duration and storm return frequencies of ½ , 1, 2, 5 and 10 years were selected as the design storm basis for the City of Portsmouth. Hyetographs depicting the varying rainfall intensities for the five design storms were developed using the Synthetic Storm Water Drainage Pattern method developed by Keifer & Chu (1957), as shown in Table 4-4 and Figure 4-4. The design storms are *single, 2-hour* rain events of varying intensity which assume no cumulative impact on the collection system.

Table 4-4 ***Design storm rainfall intensities for Portsmouth, NH***

	Peak 15-min Rainfall Intensity (inches/hour)				
Time (min)	**½ year return freq.**	**1 year return freq.**	**2 year return freq.**	**5 year return freq.**	**10 year return freq.**
0-15	0.1	0.3	0.3	0.4	0.4
15-30	0.2	0.3	0.4	0.4	0.5
30-45	0.2	0.4	0.4	0.5	0.7
45-60	0.4	0.8	0.8	1.1	1.2
60-75	0.9	1.8	2.5	3.2	3.7
75-90	0.2	0.4	0.5	0.7	1.2
90-105	0.2	0.3	0.4	0.4	0.7
105-120	0.1	0.3	0.4	0.4	0.5
120-135	0.1	0.2	0.3	0.4	0.4
Total for 2-hr storm (inches)	**0.6**	**1.2**	**1.5**	**1.9**	**2.3**

4.4 Modeling results

The design storm data (section 4.3) was input to the calibrated model (section 4.2) for simulation of system flows and projected CSO discharges. The model predicted maximum (peak) discharge flows between 0.6 mgd (1/2 year storm) and 46 mgd (5-year storm) for the existing collection system and the different rainfall intensities (Table 4-5 and Figure 4-5). The model predicts that the maximum overflow rates are reached under the conditions of a 1-year storm event for the Deer structures (19 mgd), and between the 2-year and 5-year storm intensities for the South Mill Pond structures (40 to 46 mgd). Total CSO discharge volumes were estimated between 0 and 2 MG for the range of design storms modeled (Table 4-6 and Figure 4-6).

Table 4-5 ***Projected peak CSO flows for varying storm conditions***

	Projected Peak Flow (mgd)			
Outfall Location	**1/2 year**	**1-year**	**2-year**	**5-year**
South Mill Pond CSOs 10A/10B	0.6	36	40.7	46.1
Deer Street CSO 013	0	18.7	19	19
TOTAL	**0.6 mgd**	**55 mgd**	**60 mgd**	**65 mgd**

Table 4-6 ***Projected CSO volume for varying storm conditions***

	TOTAL CSO VOLUME (MG)			
Outfall Location	**1/2 year**	**1-year**	**2-year**	**5-year**
South Mill Pond CSOs 10A/10B	0.02	1.2	1.5	2
Deer Street CSO 013	0	0.5	0.6	0.9
TOTAL	**0.03 MG**	**1.7 MG**	**2.1 MG**	**2.9 MG**

Based on the model results, the capacity of the existing collection system may be summarized as follows:

- The Mechanic Street Basin / Lincoln Ave Area drainage capacity is **limited to a 1/2–year storm event (0.6 inches total rainfall)**. This is evidenced by the start of CSO discharges projected at the South Mill Pond CSO 10A at this storm intensity.

- The Deer Street Pumping Station drainage area is limited to a **1-year storm event (1.2 inches total rainfall),** at which time the outfall is projected to reach its maximum overflow rate of 19 mgd.

- The Mechanic Street Pumping Station capacity to convey flows to the Peirce Island WWTP is reached between the **2-year and 5-year storm intensity (1.5 – 1.9 inches total rainfall)**.

4.5 Long Term Simulation – Cumulative CSO events in an Average Year

Additional simulations were run using 5 years of hourly rainfall data to more closely predict the system response under the actual precipitation conditions for the City of Portsmouth. In the previous section, the model was used to predict the system response to a single, 2-hour storm event. For the 'Average Year' simulation, the model was used to predict the *cumulative annual* CSO volume that may be anticipated over a one year period.

For purposes of the long term modeling, the average year was defined as any year when the total annual rainfall is approximately equal to the historical average annual rainfall for the Portsmouth area of **44 inches per year**. Records from 1950 to 1998 were reviewed from the National Weather Service Durham NH Station (NOAA 2001) to select hourly precipitation records for representative 'average' years. From this review, records for the years 1968, 1988, 1989, 1990 and 1993 were selected, based on the criteria of having approximately 44 inches total annual rainfall, and exhibiting similarly representative storm events over the year. Non-consecutive years were used due to significant data gaps for the Durham weather station.

Simulation of long term rainfall data using the SWMM Extran block required significant computer resources and run time (on the order of days). However, this method was chosen as the best and most conservative way to predict the system response over the long term, under a wide range of rainfall conditions represented by the selected model years.

The Average Year simulation results (Table 4-7) estimated that, under the current sewer system conditions and the anticipated average annual rainfall of 44 inches/year, the City of Portsmouth may be discharging up to 13 MG of CSO volume per year to the receiving waters (9.4 MG to the South Mill Pond and 3.7 MG to the Piscataqua River at Deer Street). CSO discharges were projected to occur with a frequency of 12 times per year in an average year.

Table 4-7 ***Projected cumulative CSOs for an average year rainfall of 44 inches***

Location	Estimated Cumulative CSO Volume, MG	Peak CSO Flow, mgd	Estimated Number of CSO events
South Mill Pond CSOs 10A/10B	9.4	47	---
Deer Street CSO 013	3.7	19	---
TOTAL	**13 MG / year**	**66 mgd**	**12 events**

In addition, the City may also observe peak overflow rates in an average year depending on the intensity of the individual storm events. Peak CSO flows for the average year were the same as predicted for a 1-year storm intensity for the Deer Street structures (19 mgd), and similar to the 5-year design storm intensity (47 mgd) for the South Mill Pond outfalls.

4.5 SUMMARY

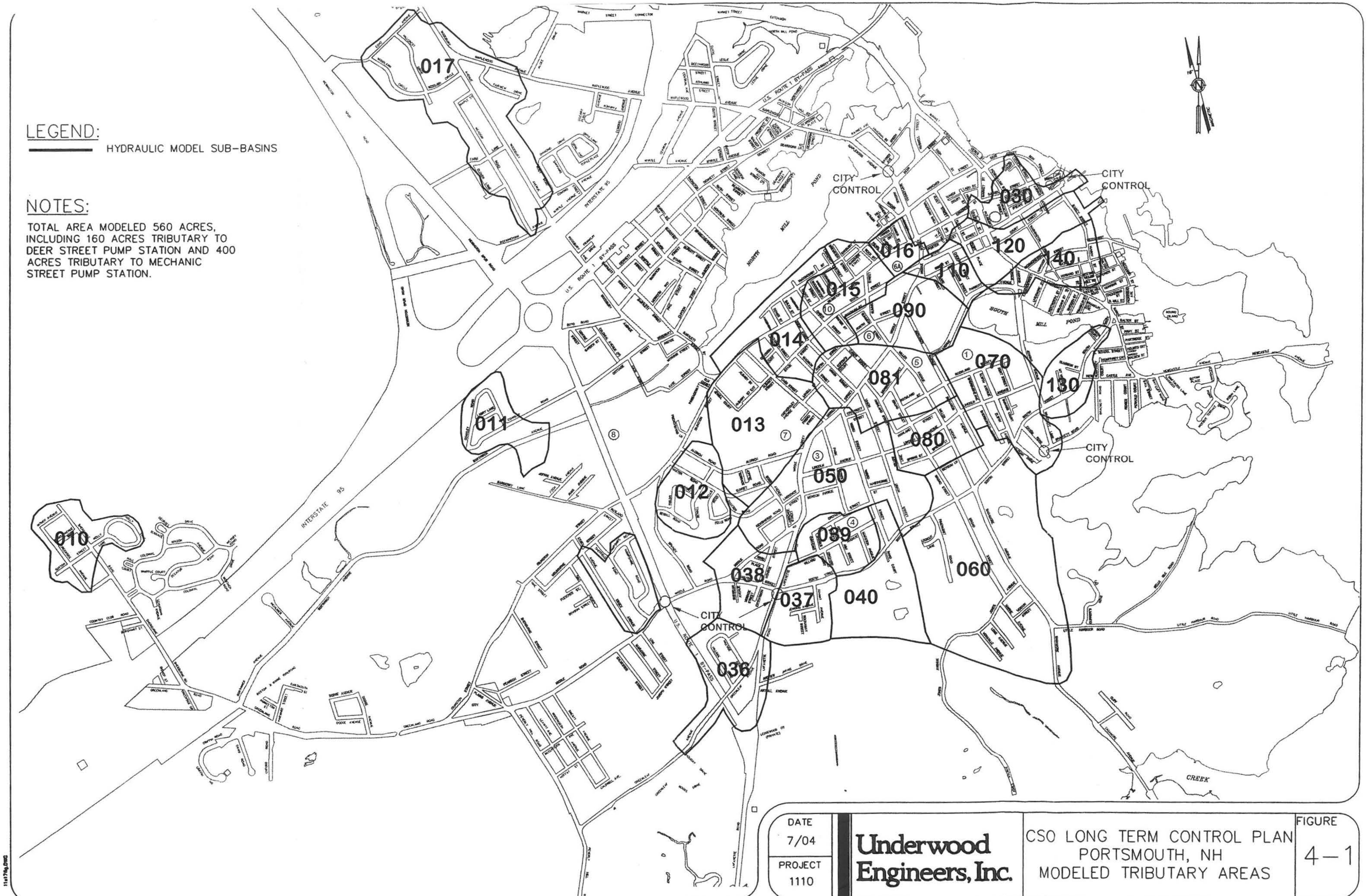
EPA's SWMM model is a highly sophisticated and widely applied modeling tool used by experienced urban hydrologists for storm water management evaluations. However, valid model predictions are directly dependent upon the quality of the input data.

Modeling of the City of Portsmouth combined sewer system suggests that the system capacity is reached at approximately a ½ year design storm intensity (0.6 inch total rainfall over 2 hours), wherein CSO discharges begin to occur at the South Mill Pond CSO 10A. Higher intensity storm events (1-year, 2-year, 5-year) result in progressively higher overflow volumes and flows both at the South Mill Pond and the Deer Street outfalls.

The model also served to show that maximum system conveyance capacity is reached between the 2-year and 5-year storm intensities. Under such rainfall conditions, peak overflow rates between 40 to 47 mgd are likely to occur at the South Mill Pond outfalls. The Deer Street basin peak overflow rate of 19 mgd is reached under the conditions of a 1-year storm event.

A long term simulation was also performed based on 5 years of hourly rainfall data, to estimate the cumulative annual CSO discharges that might be expected in an average year. The 'average year' was defined as any year when the total annual rainfall is approximately equal to the historical average annual rainfall for the Portsmouth area of 44 inches per year. Based on the existing sewer system conditions, the model predicted that up to 13 MG may be discharged per year to the receiving waters, with an estimated 12 CSO events per year.

The hydraulic model is applied further in Section 5 to support the evaluation and recommendation of CSO abatement alternatives. Future hydraulic modeling will also be necessary to gauge the effectiveness of the City's ongoing sewer system improvements, and to design additional CSO abatement solutions as necessary.



DATE		CSO LONG TERM CONTROL PLAN	FIGURE
7/04	Underwood Engineers, Inc.	PORTSMOUTH, NH	4–1
PROJECT 1110		MODELED TRIBUTARY AREAS	

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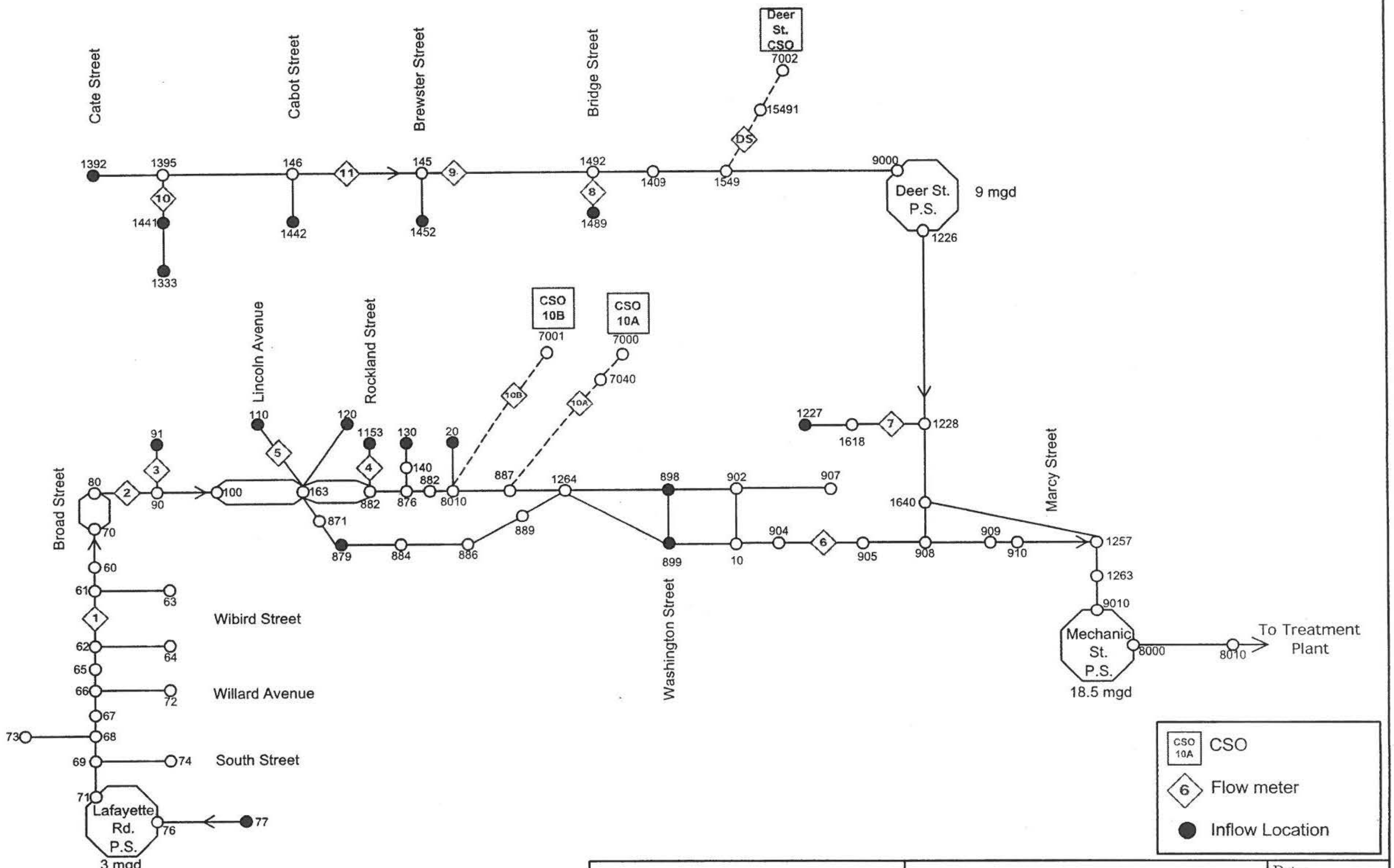
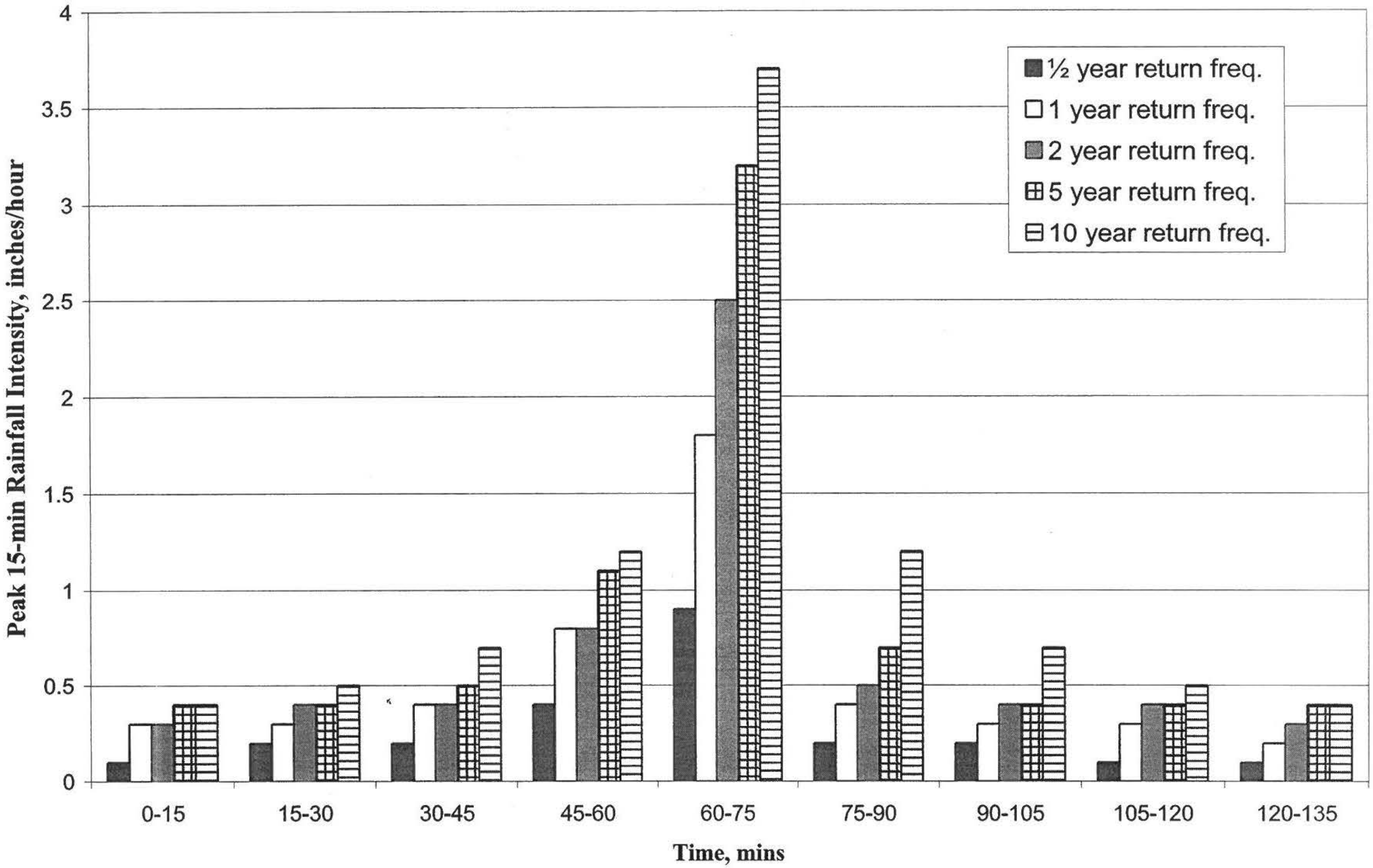


NOT TO SCALE	Portsmouth, New Hampshire	Date: **July 2002**
Moffa & Associates A UNIT OF BROWN AND CALDWELL	Modeled Collection System Schematic	Figure: **4-2**

USERS\ADDdata1\Portsmouth\Sewer Schematic.dwg

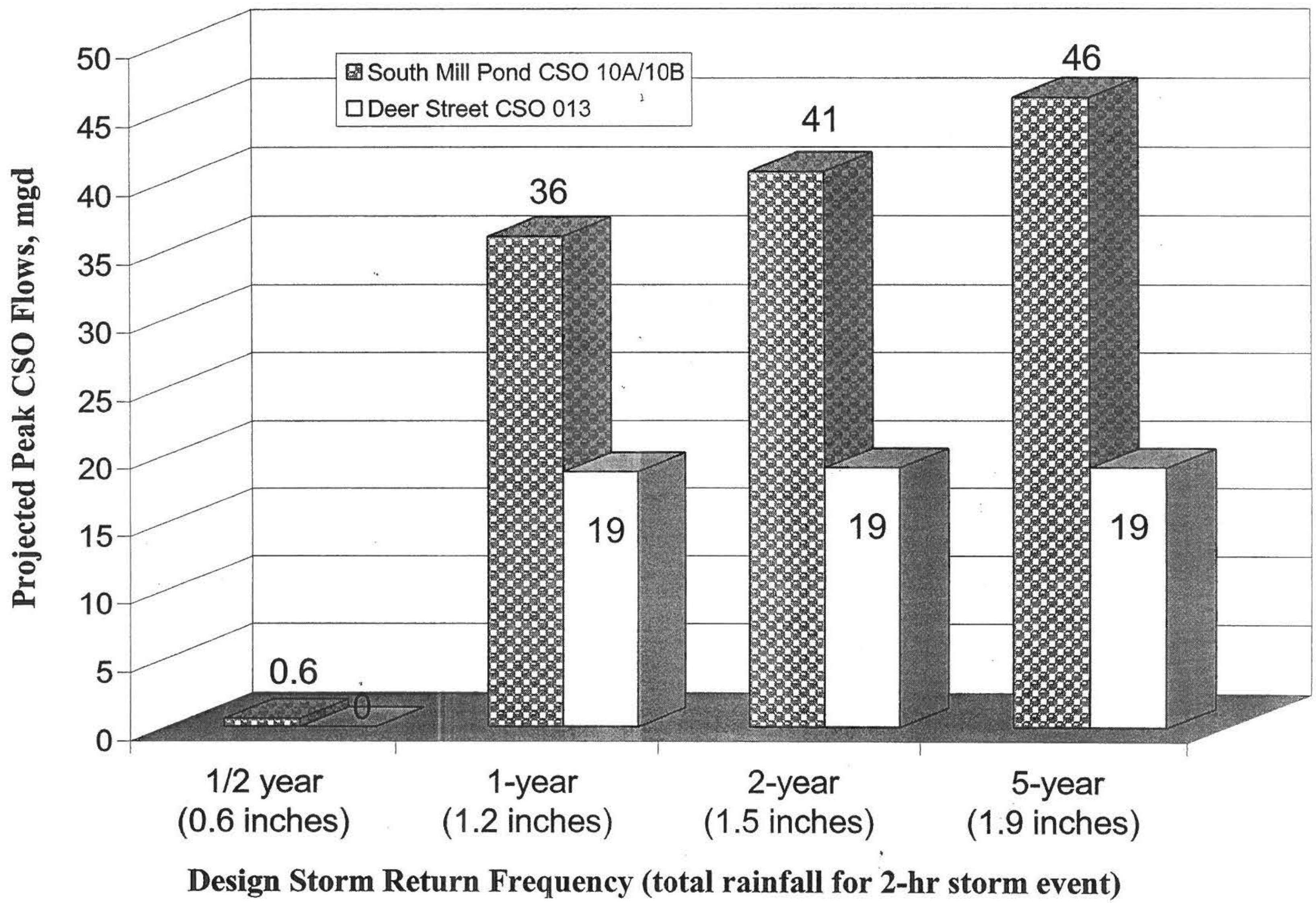
Figure 4-4
Design Storm Hyetograph for Portsmouth, NH



1110\08_comp\design storms.xls

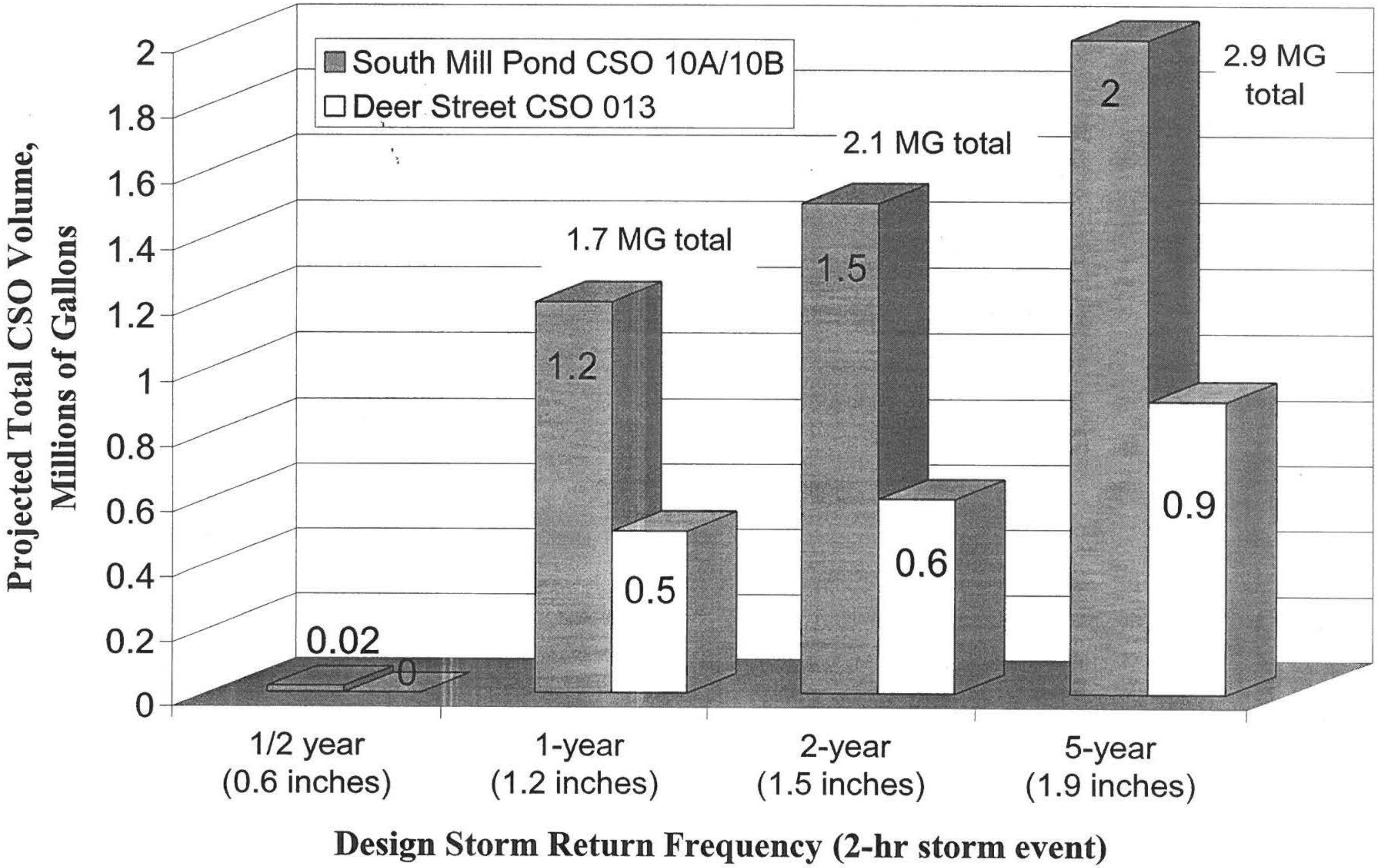
Ref: NOAA (2001). Climatography of the U.S. #40, Durham, NH Station

Figure 4-5 Peak CSO Flows for varying storm conditions



1110\08_comp\design storms.xls, model results Chart 1

Figure 4-6 Total CSO Volume for varying storm conditions



1110\08_comp\design storms.xls,model results Chart 2

5. DEVELOPMENT AND EVALUATION OF ABATEMENT ALTERNATIVES

This section reviews applicable CSO abatement technologies for the City of Portsmouth and develops several alternatives for the long term control of CSOs. Development of the recommended abatement plan is presented in Section 6.

5.1 Basis of Design for CSO Abatement

Different abatement technologies were considered to control CSOs to allow the City to comply with the national CSO policy for protection of the receiving water quality. Only technologies that reliably and cost-effectively reduce or eliminate CSO discharges to meet the water quality standards were considered. The evaluation of abatement technologies was based on controlling CSOs occurring under the conditions of a **1-year design** storm return frequency (1.2 inches total rain over 2 hours), since the system capacity is exceeded somewhere between the ½ year and 1-year storm intensities (see Section 4.4 Modeling Results). Table 5-1 summarizes the basis of design CSO flows and volumes considered as the baseline for the evaluation of technologies. Some technologies were based on more conservative design flows projected to occur under the conditions of a 2-year storm (1.5 inches) or even 5-year storm intensity (1.9 inches over 2 hours).

Table 5-1 ***Basis of design for evaluation of CSO abatement technologies***

Outfall Location	1-year design storm (1.2 inches total rain over 2 hrs)	
	Peak Flow mgd	Peak Volume MG
South Mill Pond CSOs 10A/10B	36	1.2
Deer Street CSO 013	18.7	0.5

Applicable control technologies were also selected based on experience with CSO and storm water control at other municipalities in the U.S. (EPA, 1995 and Moffa, 1997). It should be noted that the technologies considered for the LTCP are *in addition* to the short term best management practices implemented through the City's Nine Minimum Controls Plan, also part of the national CSO control policy. The current status of the City's NMC efforts are described in Section 1.4.

The following technologies were considered for CSO control for the LTCP:

1. Construction of separate storm and sanitary sewers (targeted or complete separation).
2. Rapid treatment for CSO flows.
3. Temporary storage (offline or inline).
4. Increased conveyance capacity (pumping station upgrades) to convey CSO flows to the WWTP
5. Increased WWTP capacity to treat CSO flows
6. Relocation of the South Mill Pond CSO Outfalls.

A conceptual review of each technology and its applicability to the City of Portsmouth sewer system is presented in Section 5.2. The technologies that are recommended for further evaluation are grouped into feasible CSO abatement alternatives in Section 5.3.

5.2 Presentation of Abatement Technologies

This section presents conceptual reviews of individual abatement technologies including a general description, conceptual layout, and order of magnitude implementation costs as a stand alone technology. The grouping of these technologies into suitable alternatives and their evaluation for the long term control of CSOs is presented in the following Section 5.3.

5.2.1 Sewer Separation

Sewer separation is accomplished by removing the storm water catch basins from the sanitary sewers and connecting them to the storm sewer system. This can also be performed by constructing new storm drains, using the existing sanitary sewers as storm drains and building new sanitary sewers, or a combination of these. Due to the age of the system in the City of Portsmouth, most of the existing piping is undersized, structurally deficient, and in need of rehabilitation or replacement. Therefore, sewer separation will generally require the construction of new sewer and storm drains. This section review two sewer separation options: Targeted vs. Complete Separation.

TARGETED SEPARATION

A targeted sewer separation program is one option to control CSOs in the City which can be coupled with other control technologies to provide a complete abatement alternative for the City of Portsmouth (see Section 5.3). Due to existing problems with flooding and sewer backups, some degree of sewer separation is considered necessary as a first step for any of the abatement alternatives to be implemented. Additional technologies which may be implemented concurrently with targeted sewer separation would include:

- Treatment for separated storm water
- Restoration of sewage pumping stations
- Treatment or storage of remaining CSO flows

The City has been implementing targeted separation and reconstruction projects from the early 1990s to the present. This abatement option continues to be considered the most feasible and efficient means to maximize separation benefits per dollars expended.

Targeted separation projects for the LTCP were selected based on historical information from the City of Portsmouth, home surveys and questionnaires from area residents, and the results of extensive field work performed under the City's Lincoln Area Sewer Separation project (City of Portsmouth, 2003 and Underwood Engineers, 2003). These efforts served to identify 10 priority areas to address chronic flooding and sewer backups in the downtown area. The overall scope of the Lincoln Area Sewer Separation Program is proposed to be completed over a period of 15 years.

The targeted separation project areas are identified in Figure 5-1, and listed in Table 5-2. These areas generally drain toward the South Mill Pond and the Mechanic Street Pumping Station. In addition, planning for the Lincoln Area program has considered several tributary areas which drain to the Deer Street sewer basin. Estimated costs were developed for each targeted area as follows (Underwood Engineers, 2003 and Appendix 5-1).

Table 5-2 *Targeted separation areas for LTCP program*

Area #	Description	Approx. Project Length, ft	Approx. Area, acres	Estimated Sewer cost*
1	Parrot, Rockland, Sherburne, Lincoln Ave Interceptors	2,600	32	$ 1.05 M
1A	Collectors along Rockland, Kent, Elwyn, McNabb, Sherburne, Lincoln Ave	3,600	24	$ 1.02 M
2	Middle, Miller, Rockland, Lincoln, South Street Interceptors	5,500	28	$ 2.13 M
2A	Collectors along Madison, Lovell, Union, Austin, Coffin, Cabot, Middle, Chauncy, Highland, Merrimac, Broad, Rockland, Miller and Lincoln Ave	4,500	33	$ 1.45 M
3	Lincoln, Union, Willow, Spring, Broad, Bersum Interceptors	4,500	23	$ 1.47 M
3A	Collectors along Wibird, Lincoln, Union, Hawthorne & Broad	1,400	15	$ 0.44 M
4	Lincoln, Wibird, Hawthorne, Orchard, Ash, Willard, Lafayette Interceptors	4,900	22	$ 2.02 M
4A	Collectors along Boss, Thaxter, Lawrence, Kensington, Middle, Lafayette, Mendum, Park, Orchard, Wibird, Willard, Marston, Ash, Orchard, and South Streets	11,600	53	$ 3.41 M
5	Richards and Parrot Ave Interceptors	2,200	9	$ 0.54 M
5A	Collectors along Austin, Winter, Summer, Middle Streets	1,000	12	$ 0.29 M
--	Islington Street Planning Area	13,400	84	$ 4.22 M
--	Court Street Planning Area #	6,300	11	$ 2.22 M
--	Borthwick Avenue Planning Area	3,700	n/a	$ 1.11 M
Estimated Total for Targeted Separation projects		**65,200 ft**	**346 ac**	**$21.37 M**

* Includes costs for sewer / drain projects eligible to be funded under the State Revolving Fund wastewater program.
- Costs based on December 2003 dollars (ENR CCI 6782), including contingency (20%) and engineering (20%).
- Costs do not include upgrades to other infrastructure which may be required along the same corridors, such as additional (ineligible) sewer / drain piping, water, roads, sidewalk or curbing improvements.

Targeted separation is recommended to be considered in the development of CSO abatement alternatives in Section 5.3.

COMPLETE SEPARATION

The construction of new dedicated sanitary and storm sewers throughout the City of Portsmouth would address CSOs at the South Mill Pond and Deer Street by increasing the system conveyance capacity and eliminating storm flows in the sanitary sewers. It should also address the current flooding and sewer backups into area residences which occur due to the hydraulic limitations of the existing system. Ideally, complete separation would enable conveyance of all sanitary flows to the Peirce Island WWTP for treatment. Separated storm water would require additional controls for meeting applicable storm water standards. Upgrades to restore capacity of the sewage pumping stations would also be required in conjunction with complete separation.

Conceptual costs for construction of new dedicated sanitary and storm sewers were estimated at **$31 million,** for coverage of approximately 486 acres and 84,100 ft project length (Table 5-3). These costs were derived from the more detailed evaluation of the Lincoln Area targeted separation program (approx. $330 / ft, Appendix 5-1), plus the additional remaining combined sewer areas at an average cost of **$500 / ft** project length. The additional areas considered for complete separation are shown in Figure 5-1 and Table 5-3, Areas A-G. A higher unit cost of $500/ft for separation of the additional combined areas was used to account for the higher contingencies associated with these less well-defined areas.

Table 5-3 ***Opinion of cost for complete separation of storm and sanitary sewers***

Area	Description	Approx. Project Length, ft	Approx. Area, acres	Estimated Sewer cost*
Targeted separation areas (Table 5-2)		65,200	346	$ 21.37 M
Additional areas for Complete Separation				
A	Washington Street	4,400	35	$ 2.2 M
B	Congress Street	4,300	20	$ 2.2 M
C	Bridge Street	1,900	5	$ 1.0 M
D	Sparhawk Street	1,200	10	$ 0.6 M
E	Maplewood Avenue	1,600	15	$ 0.8 M
F	Cottage Street	3,500	25	$ 1.8 M
G	Hillside Drive	2,000	30	$ 1.0 M
Estimated cost for construction of new dedicated sanitary & storm sewer piping		**84,100 ft**	**486 ac**	**$30.97 M**
		Say, $31 million		

* Includes costs for sewer / drain projects eligible to be funded under the State Revolving Fund wastewater program.

- Unit cost of $500/ft project length based on December 2003 dollars (ENR CCI 6782), including contingency (20%) and engineering (20%).
- Costs do not include upgrades to other infrastructure which may be required along the same corridors, such as additional (ineligible) sewer / drain piping, water, roads, sidewalk or curbing improvements.

Similarly as for targeted separation, additional technologies to be implemented along with complete separation would include treatment of separated storm water (Section 5.2.2) and basic upgrades to pumping stations (Section 5.2.4).

Other considerations for complete separation are non-economical factors including its feasibility and length of time required for its implementation. Even if reconstruction of the complete sewer system could be performed, the difficult topography of the area physically limits the size of new sewer and drainage piping that can be installed. In any case, the higher priority targeted separation projects would be completed first and these will address approximately 70% of the combined sewer area..

For these reasons, and the higher costs associated with complete vs. targeted separation, additional sewer separation projects up to 100% (complete separation) will be considered only as part of the Phase 2 LTCP projects, once the effectiveness of the targeted separation program can be evaluated.

5.2.2 Rapid Treatment

Rapid treatment technologies may be applied for control of CSOs as well as for separated storm water. Current regulations (Section 2) will require treatment for remaining CSO events to ensure that bacterial limits are met for discharges to the South Mill Pond or the Piscataqua River. Applicable limits for Class B / Shellfish growing waters are ≤70 #/100 mL total coliforms or ≤14 #/100 mL fecal coliforms. Preliminary bench scale testing with CSO first flush samples (Section 3.3) showed that solids separation and disinfection are feasible treatment technologies for CSO control in the City of Portsmouth.

Storm water discharges are also required to be controlled via the implementation of best management practices to reduce pollutant loads (EPA, 2000). The LTCP includes treatment for removal of suspended solids for separated storm water. Disinfection is not required for storm water discharges.

This section reviews the following rapid treatment options:

- Screening, vortex / swirl separators, and chemical treatment, for control of solids and floatables in storm water and CSOs
- Disinfection with sodium hypochlorite and dechlorination for CSOs

SCREENING

Screening can provide removal of large solids from CSOs or storm water. A variety of screen types are available including mechanically cleaned fixed screens, rotary drum screens, traveling screens and brush screens, each with different aperture sizes for different particle removal applications.

Coarse screens are generally applied for control of gross floatables and solids in CSOs or storm water (Moffa, 1997). Fresh Creek bag screens and Romag horizontal screens were considered for installation at the South Mill Pond, CSO Outfall 10A.

A conceptual design for screening treatment at the South Mill Pond was developed as shown in Figure 5-2, as follows:

<u>South Mill Pond CSOs 10A/10B</u>

- 10' x 20' below ground screening facility
- Design peak flow rate 46 mgd (5-year storm)
- Estimated project cost **$0.86 million**, incl. engineering and contingency, not including land acquisition or legal fees.

Appendix 5-1 includes the detailed cost tables. Screening costs for storm water treatment were not estimated.

VORTEX / SWIRL SEPARATORS

Vortex separators are flow-through structures for settleable and floatable solids control that are especially suited to highly variable and intermittent flows such as those from storm water or CSOs. No moving parts are required as the unit is designed to self-induce a swirling vortex-like flow regime. The heavier, denser solids concentrate at the bottom of the unit and are removed with the underflow, which is typically between 6-10% of the influent flow rate. The underflow and solids are collected in a bottom hopper for later removal. Units which incorporate a weir and baffle will provide capture and storage of floatables. The floatables are carried out with the underflow when the storm flow subsides. For lower intensity storm events, vortex separators also provide offline storage.

Conceptual sizing of vortex type separators for control of CSOs and / or storm water for the City of Portsmouth (Figures 5-3 Deer Street, and Figure 5-4 South Mill Pond are presented as follows:

<u>Deer Street CSO 013</u>

- 1 x 36-ft diameter vortex separator unit
- Design peak flow rate 18.7 mgd (1-year storm)
- Estimated project cost **$2.1 million**, incl. engineering and contingency, not including land acquisition or legal fees.

<u>South Mill Pond CSOs 10A/10B</u>

- 2 x 43-ft diameter vortex separator units
- Design peak flow rate 46 mgd (5-year storm)
- Estimated project cost $**2.7 million**, incl. engineering and contingency, not including land acquisition or legal fees.

<u>Storm water treatment</u>

- 1 x 24-ft diameter vortex separator unit
- Design peak flow rate up to 45 mgd (70 cfs)
- Estimated project cost **$0.5 million per treatment unit**, incl. engineering and contingency, not including land acquisition or legal fees.

Appendix 5-1 includes the detailed cost tables.

CHEMICAL TREATMENT

Chemical treatment for enhancing solids settling and removal performance was considered for CSO abatement for Portsmouth. Ballasted flocculation type packaged treatment units (such as the Actiflo® by U.S. Filter) and upflow clarification / solids contact clarifier units (such as the DensaDeg® by Infilco Degremont) were considered. Chemical treatment may provide improved solids removals compared to physical vortex separators or coarse screening units. However, these technologies are not recommended for CSO control for the City of Portsmouth due to their relative complexity for operation, high maintenance mechanical equipment (including sand or sludge recirculation pumping), and the requirement for handling of additional chemicals. Conceptual costs were not developed for these options.

DISINFECTION WITH HYPOCHLORITE

Disinfection with hypochlorite was considered the most applicable since City personnel are familiar with this disinfectant (used at the Peirce Island WWTP), and bench scale testing results presented earlier (Section 3.4) showed that adequate disinfection could be achieved in relatively short (5 to 10 mins) contact times using high rate mixing. Pretreatment for solids removal would be necessary in conjunction with this technology to ensure disinfection limits can be met for CSO discharges. Dechlorination facilities using sodium bisulfite were also assumed to be installed with disinfection treatment.

The following conceptual design was developed for rapid disinfection for CSO flows:

<u>Deer Street CSO 013</u>

- Design peak flow rate 18.7 mgd (1-year storm)
- High rate mixing
- 54 ft x 26 ft x 8 ft side water depth (5 minutes contact time)
- Dechlorination with sodium bisulfite
- Estimated project cost **\$ 1.4 million**, incl. engineering and contingency, not including land acquisition or legal fees.

<u>South Mill Pond CSOs 10A/10B</u>

- Design peak flow rate 46 mgd (5-year storm)
- 78 ft x 36 ft x 8 ft side water depth (5 minutes contact time)
- Dechlorination with sodium bisulfite
- Estimated project cost **\$ 1.8 million**, incl. engineering and contingency, not including land acquisition or legal fees.

Figures 5-3 and 5-4 show a conceptual layout of the chlorine contact tanks following solids pretreatment with vortex type separators. Appendix 5-1 includes the cost tables.

Based on the review of rapid treatment technologies for solids separation and disinfection presented above, and the results of preliminary bench scale testing, it is recommended that vortex swirl type separators followed by chlorination / dechlorination be considered as the rapid treatment option in the evaluation of CSO abatement alternatives (Section 5.3). The recommendation of vortex type separators is based on the proven track record for these technologies in similar applications, their effective solids removal, small footprint, simplicity of operation, and minimization of treatment chemicals. Screening facilities may also be used as pretreatment for removal of larger solids.

5.2.3 Storage

Temporary storage of CSO flows may be used to reduce discharges of untreated sewage to the receiving waters. If available, excess capacity in the collection system may be used (in-line storage), or dedicated off-line storage facilities may be constructed. Excess flows are stored until the storm event subsides, after which flows are pumped back through the system for treatment at the WWTP. For the City of Portsmouth system, the existing collection system limitations are such that both in-line and off-line storage options would require new construction.

Some pretreatment such as coarse screening is necessary to be implemented along with either in-line or off-line storage facilities. Conceptual designs were developed based on storage of 0.85 million gallons at Deer Street and 1.9 million gallons at the South Mill Pond. These volumes would provide storage for projected CSO volumes occurring between the 2-year to 5-year design storm return frequency (1.5 to 1.9 inches total rainfall over 2 hours), conditions which are more conservative than the 1-year minimum basis of design (1.2 inches total rainfall over 2 hours).

IN-LINE STORAGE

The SWMM modeling showed that the existing collection system has very limited capacity available for in-line storage. Therefore, this option assumed new construction of box culverts for in-line storage. Costs also included preliminary screening and a flow diversion structure. Disadvantages to the use of in-line storage may include increased risk of flooding or sewer backups, odor potential, and high maintenance costs.

The following conceptual design was developed for in-line storage requirements:

<u>Deer Street CSO 013</u> (Figure 5-5)

- 1,600 ft of 8 ft x 10 ft box culvert, along Market Street up to Deer Street.
- Design peak CSO volume 0.85 MG (2 to 5-year storm)

<u>South Mill Pond CSO 10A/10B</u> (Figure 5-6).

- 3,000 ft of 8 ft x 10 ft box culvert, constructed along Parrott Ave and following the main interceptor to the Mechanic Street Pumping Station
- Design peak CSO volume 1.9 MG (2 to 5-year storm)

The total cost for in-line storage at both Deer Street and the South Mill Pond was estimated at **$13 million**, including engineering and contingency (40%), but not including costs for additional land acquisition or legal fees.

OFF-LINE STORAGE

Off-line storage facilities were assumed to consist of a flow diversion structure, pre-screening facilities, above ground storage tank, and a new pumping station at each site for return of stored flows to the collection system.

The following conceptual design was developed for off-line storage requirements:

<u>Deer Street CSO 013</u> (Figure 5-7)

- 80 ft x 160 ft storage tank
- Design peak CSO volume 0.85 MG (2 to 5-year storm)

<u>South Mill Pond CSO 10A/10B</u> (Figure 5-8).

- 120 ft x 200 ft storage tank
- Design peak CSO volume 1.9 MG (2 to 5-year storm)

The opinion of cost for off-line storage tanks at Deer Street and the South Mill Pond was estimated at **$16 million.** Appendix 5-1 includes the detailed cost tables.

Based on the review of CSO storage options, this technology is recommended to be considered in the development of CSO abatement alternatives.

5.2.4 Increased conveyance capacity - Pumping Station Upgrades

Increasing the existing collection system capacity to convey combined sewer flows to the WWTP was investigated as another technology for CSO control. A total peak flow rate of 65 to 70 mgd was assumed to be required, to convey approximately 46 mgd projected peak flows from the South Mill Pond drainage area, as well as the estimated 19 mgd projected peak flow from the Deer Street drainage area. The peak combined sewage flow of 70 mgd was also based on projected peak future flows for sanitary (15 mgd) and infiltration / inflow (55 mgd), for buildout scenarios for the City of Portsmouth in the year 2020 (Wastewater Facilities Plan Update by Underwood Engineers, 1999).

For the LTCP options, three levels of pumping station upgrades were considered (see cost tables in Appendix 5-1):

a) Reconfiguration and restoration of design capacity (12 mgd) of Deer Street Pumping Station and minor (electrical) upgrades for the Mechanic Street pumping station:

Deer Street Pumping Station	$2 million
Mechanic Street Pumping Station	$0.3 million
Total to restore design capacity	$2.3 million

b) Expansion to enable increased conveyance of sewage to the WWTP, either by expansion of Mechanic Street pumping station to 36 mgd, or by installation of a new force main from Deer Street direct to the WWTP:

- Installation of new Force Main (12 mgd) from Deer Street direct to the WWTP — $4.7 million

- Expansion of Mechanic Street Pumping Station to 36 mgd — $4.5 million

c) Expansion of pumping station capacity to convey all the projected combined sewer flows up to 65 - 70 mgd to the WWTP - this option was not considered feasible.

Basic upgrades to restore the pumping stations ($2.3 million), and the option of expanding conveyance capacity to 34 or 36 mgd ($4.5 – 4.7 million) were considered viable options for consideration in the development of CSO abatement alternatives (Section 5.3).

5.2.5 Increased WWTP Treatment Capacity

Significant capital upgrades would be necessary to expand the WWTP capacity to treat increased CSO flows. Current peak capacity of the Peirce Island WWTP is 22 mgd. Upgrades considered for expansion of capacity included upgrades to the headworks, an additional primary clarifier or vortex type primary treatment unit, additional chlorine contact tanks, and a new outfall. These upgrades assume that the plant can continue to be operated as an advanced primary treatment facility. However, future effluent limitations may be changed.

To match the different levels of upgrades considered for the pumping station conveyance capacity, the following options for the WWTP were considered:

a) Baseline upgrades to maintain design peak flows up to 22 mgd - no additional costs beyond current operations and maintenance.

b) Expansion of WWTP to treat up to 36 mgd combined sewer flows (See Appendix 5-1 cost tables). — **$9.2 million**

c) Expansion of WWTP capacity to treat all the projected combined sewer flows up to 65 - 70 mgd - this option was not considered feasible.

Expansion of WWTP capacity to 36 mgd ($9.2 million) is considered further in the development of CSO abatement alternatives (Section 5.3).

5.2.6 CSO Outfall Relocation

Water quality standards are currently the same for discharges at either the South Mill Pond or the Piscataqua River (Class B, Shellfish growing waters). Therefore, treatment requirements will be the same and relocation of the outfall would not provide any benefit for the City of Portsmouth.

Should water quality standards be changed in the future, relocation of CSO 10A and 10B outfalls from the South Mill Pond to the Piscataqua River may be considered. This option would require a new pumping station either at the South Mill Pond with a force main to the river, or at Prescott Park with a gravity line from the South Mill Pond. The pumping station would be designed for 46 mgd peak flow, similar to other abatement technologies considered for the South Mill Pond. An order of magnitude cost for this option is $6.6 million, including engineering and contingency (40%), but not including legal fees or land acquisition (see Appendix 5-1).

5.2.7 Summary of abatement technologies

Potential CSO control technologies were screened for feasibility and order of magnitude costs in order to recommend those applicable for the development of CSO abatement alternatives for the City of Portsmouth. A 1-year design storm (1.2 inches total rainfall over 2 hours) was used as the minimum basis for CSO controls, but the conceptual evaluation often used a more conservative basis of design up to a 5-year design storm intensity.

Based on this review, the following technologies are carried forward for the development of abatement technologies:

- Targeted sewer separation
- Rapid treatment technologies including screening, vortex / swirl separators, disinfection by chlorination / dechlorination
- Storage of CSO flows
- Restoration or expansion of pumping station capacity up 36 mgd
- Maintenance or expansion of WWTP capacity up to 36 mgd

The following technologies were <u>not recommended</u> to be considered for the evaluation of abatement alternatives:

- Complete sewer separation (except as applicable for Phase 2 abatement projects)
- Chemical treatment of CSO flows
- Expansion of pumping stations to convey all CSO flows up to 70 mgd to the WWTP
- Expansion of WWTP to treat all CSO flows up to 70 mgd
- Relocation of South Mill Pond CSO outfalls 10A and 10B

5.3 Development of Alternatives

The technologies recommended for further evaluation for CSO control were grouped into abatement alternatives for more detailed evaluation. All the alternatives were developed to meet the objectives of the national CSO Policy (Section 2), which are summarized as follows:

- Elimination or capture of 85% or more by volume and by mass of pollutants, of the combined sewage collected during precipitation events,
- Reducing CSO events to an average of less than 4 events per year,
- Treating remaining CSO flows by clarification, removal and disposal of floatable and settleable solids, and disinfection as necessary, to meet water quality standards and protect designated water uses.
- Sampling to demonstrate the attainment of water quality standards.

To meet these criteria, four proposed alternatives were developed by combining different abatement technologies, to include the following baseline controls:

- Targeted separation program to reduce flooding and sewer backups in the downtown area, improving and optimizing sewage collection and conveyance capacity
- Treatment of separated storm water
- Upgrades to restore the Deer Street and Mechanic Street pumping stations.
- Additional controls, as necessary (to be evaluated in the latter phase of the LTCP), to meet water quality standards in the receiving waters.

The alternatives were then evaluated for their effectiveness using the hydraulic model developed in Section 4.

5.3.1 Description of alternatives

This section provides a description of each alternative including the results of modeling of their effectiveness to reduce the number of CSO events in an "average year", wherein the total annual rainfall for the City of Portsmouth area is about 44 inches/year. Residual annual CSO flows and volumes, general advantages and disadvantages, and opinions of cost are presented for each alternative. Detailed cost tables are included as Appendix 5-2.

The hydraulic model assumptions were adjusted to account for the implementation of targeted separation as the first step for each abatement alternative. Assumed separation effectiveness of the modeled areas ranged from 0% (no separation) to 90% effective separation, depending on the subcatchment area and the results of separation projects already completed by the City (see Appendix 4-1 Modeling Report and Section 1.4 Previous improvements projects), or planned to be completed as part of the LTCP. Since separated areas would also include new sewer piping, the model was also adjusted for lower infiltration rates for these areas.

The following four alternatives were evaluated:

Alternative A* - Targeted separation plus rapid treatment / disinfection
Alternative B - Targeted separation plus expansion of Mechanic St PS and Peirce Island WWTP
Alternative C - Targeted separation plus new force main and expansion of WWTP
Alternative D - Targeted separation plus storage at South Mill Pond
*Note: Alternatives A and E of the August 2002 LTCP report have been combined for this evaluation.

ALTERNATIVE A – TARGETED SEPARATION PLUS RAPID TREATMENT / DISINFECTION AT OUTFALLS 10A / 10B

<u>Description</u>

- Targeted separation addressing 70% of the combined sewer area
- Restoration of Deer Street and Mechanic Street Pumping Stations to their design capacities of 12 mgd and 22 mgd
- Treatment of separated storm water collected at the South Mill Pond
- Rapid treatment / disinfection for any remaining CSOs at Outfalls 10A/10B
- Elimination of Deer Street CSOs up to and including a 5-year design storm
- 97% reduction in CSO volume and flows for the conditions of a 1-year design storm event, and 75-79% reduction under a 2-year design storm event (Figure 5-9)

- Projected CSO volumes reduced from 1.7 to 0.05 MG (1-year storm), and from 2.1 to 0.44 MG (2-year storm), see Figure 5-10.
- Reduction of CSO events at the South Mill Pond from 12 to 2 events total in an average year, with a total cumulative CSO volume of 0.57 MG per year.

Opinion of cost

- Targeted Separation	$ 21.37 M
- Restoration of Deer St and Mechanic St Pumping Stations	$ 2.3 M
- Treatment of separated storm water at South Mill Pond	$ 0.5 M
- Rapid treatment of remaining CSOs at Outfalls 10A/10B	$ 4.5 M
Total estimated opinion of cost for **Alternative A**	**$28.17 M**

Advantages
- Allows City to reduce and ultimately treat all CSOs and storm water discharges to the South Mill Pond
- Increased conveyance capacity will address sewer backups and street flooding
- Separation of storm flows and reduced infiltration essentially eliminates CSOs to the Piscataqua River (at Deer Street)
- CSO events reduced to 2 events per year and a total of 0.57 MG for the average year rainfall of 44 inches/year
- Reduced CSO flows reduce treatment costs
- Lower overall costs compared to increased conveyance alternatives

ALTERNATIVE B – TARGETED SEPARATION PLUS EXPANSION OF MECHANIC STREET PUMPING STATION AND PEIRCE ISLAND WWTP TO 36 MGD

Description:
- Targeted separation addressing 70% of the combined sewer area
- Upgrade of Deer Street Pumping Station to design capacity of 12 mgd
- Upgrade and Expansion of Mechanic Street Pumping Station to 36 mgd
- Expansion of Peirce Island WWTP capacity to 36 mgd
- Treatment of separated storm water
- Elimination of Deer Street CSOs up to and including a 5-year design storm
- 99% reduction in CSO volume for the conditions of a 2-year storm, and 58% reduction in flow and 83% reduction in volume for a 5-year design storm (Figure 5-9)
- Projected CSO volumes reduced from 2.1 to 0.01 MG (2-year storm), and from 2.9 to 0.5 MG (5-year storm), see Figure 5-10.
- Reduction of CSO events at the South Mill Pond from 12 to less than 1 event in an average year, with a total cumulative CSO volume of 0.04 MG per year.

Opinion of cost

- Targeted Separation	$ 21.37 M
- Restoration of Deer Street Pumping Station	$ 2.0 M
- Mechanic St Pumping Station Upgrades and Expansion	$ 4.5 M

-	WWTP Expansion to 36 mgd	$ 9.2 M
-	Treatment of separated storm water	$ 0.5 M
	Total estimated opinion of cost for **Alternative B**	**$37.57 M**

Advantages

- Increased conveyance capacity will address sewer backups and street flooding
- Separation of storm flows and reduced infiltration essentially eliminates CSOs to the Piscataqua River (at Deer Street)
- Upgrade and expansion of conveyance and treatment capacity allows increased treatment of combined flows at the WWTP
- CSOs at the South Mill Pond would be significantly reduced to less than 1 per year, with an average projected annual CSO volume of 40,000 gallons per year
- Storm water discharges at the South Mill Pond will be treated

Disadvantages

- CSO discharges may occur once per year under the average year rainfall conditions, with projected *untreated* discharges up to 40,000 gallons, and possible violation of water quality standards
- Higher costs due to major capital upgrades for increased conveyance and treatment capacity at the Peirce Island WWTP
- Regulatory requirements for increased WWTP discharge may change in the future.

ALTERNATIVE C – TARGETED SEPARATION PLUS NEW FORCE MAIN TO WWTP

Description

- Targeted separation addressing 70% of the combined sewer area.
- Restoration of Mechanic Street Pumping Station to design capacity of 22 mgd
- Relocation / upgrades to Deer Street Pumping Station and new 12 mgd force main direct to the WWTP
- Expansion of Peirce Island WWTP capacity to 36 mgd
- Treatment of separated storm water
- Elimination of Deer Street CSOs up to and including a 5-year design storm.
- 100% reduction in CSO volume and flows for the 1-year and 2-year storm conditions, and 56% reduction in flows and 83% reduction in volume for a 5-year design storm (Figure 5-9)
- Projected CSO volumes reduced from 2.1 MG to 0 MG (2-year storm), and from 2.9 to 0.57 MG (5-year storm), see Figure 5-10.
- Reduction of CSO events at the South Mill Pond from 12 per year to an average of 1 event every 2 years, with a total annual cumulative CSO volume of 0.05 MG per year.

Opinion of cost

-	Targeted Separation	$ 21.37 M
-	Restoration of Deer St and Mechanic St Pumping Stations	$ 2.3 M
-	New Force Main direct from Deer St Pump Station	$ 4.7 M

- WWTP Expansion to 36 mgd	$ 9.2 M
- Treatment of separated storm water	$ 0.5 M
Total estimated opinion of cost for **Alternative C**	**$38.07 M**

Advantages

- Increased conveyance capacity will address sewer backups and street flooding
- Separation of storm flows, reduced infiltration, and direct conveyance from Deer Street essentially eliminates CSOs to the Piscataqua River
- CSO events at the South Mill Pond will be reduced to about 1 event every 2 years, with a projected cumulative CSO volume of 50,000 gallons for the average year
- Storm water discharges at the South Mill Pond will be treated

Disadvantages

- CSO discharges may occur once every two years under average rainfall conditions, with projected discharges up to 50,000 gallons of *untreated* flows, and possible violation of water quality standards
- High costs associated with construction of a new force main to the WWTP and expansion of WWTP treatment capacity
- Regulatory requirements for increased WWTP discharge may change in the future.

ALTERNATIVE D – TARGETED SEPARATION PLUS STORAGE AT SOUTH MILL POND

Description

- Targeted separation addressing 70% of the combined sewer area
- Restoration of Deer Street and Mechanic Street Pumping Stations to their design capacities of 12 mgd and 22 mgd respectively
- Treatment of separated storm water at the South Mill Pond.
- Storage for any remaining CSOs at outfalls 10A/10B
- Elimination of Deer Street CSO up to and including a 5-year design storm
- 98% reduction inf CSO volume and flows for the conditions of a 2-year storm event, and 65% reduction in flow and 78% reduction in volume for a 5-year design storm (Figure 5-9)
- Projected CSO volume reduced from 2.1 to 0.03 MG (2-year storm), and from 2.9 to 1.1 MG (5-year storm), see Figure 5-10.
- Reduction of CSO events at the South Mill Pond from 12 to less than 1 in an average year, with a total annual cumulative CSO volume of 0.60 MG per year.

Opinion of cost

- Targeted Separation	$ 21.37 M
- Restoration of Deer St and Mechanic St Pumping Stations	$ 2.3 M
- Treatment of separated storm water	$ 0.5 M
- Storage of remaining CSOs at South Mill Pond (allowance)	$ 6.0 M
Total estimated opinion of cost for **Alternative D**	**$30.17 M**

Advantages

- Allows City to meet water quality standards by reducing, storing, and ultimately treating all CSOs and / or storm water discharges
- Increased conveyance capacity will address sewer backups and street flooding
- Separation of storm flows and reduced infiltration essentially eliminates CSOs to the Piscataqua River (Deer Street)
- CSO events reduced to less than 1 per year and total 0.60 MG cumulative volume over an average year rainfall of 44 inches/year
- Lower CSO volume reduces storage costs
- Lower costs compared to increased conveyance alternatives

5.3.2 Qualitative ranking of alternatives

A qualitative ranking was developed to evaluate the alternatives in terms of other critical factors for their implementation, including, ability to address upstream flooding and sewer backups, effectiveness to eliminate discharge of untreated CSOs, ease of implementation, simplicity of operation and maintenance, and relative capital cost. Underwood Engineers held work sessions with the City of Portsmouth Public Works staff to perform the ranking for each criteria, on a scale of 1 (worst) to 5 (best), as shown below. The ranking suggests that either Alternative A (treatment) or D (storage) of remaining CSO flows following targeted separation would be relatively easier to implement, would provide upstream relief, and would be more effective at eliminating untreated discharges by either storing or treating any remaining overflows at the South Mill Pond.

Table 5-4 ***Ranking of abatement alternatives***

ABATEMENT ALTERNATIVE	**CRITERIA RANKING**					
	Upstream Relief	Ability to eliminate Untreated CSOs	Ease of Implemen-tation	O & M	Relative Capital Cost	**Total Rank**
Existing System (No Action)	0	0	4	2	2	**8**
Alternative A* – Targeted Separation plus Rapid Treatment at South Mill Pond	4	5	3	3	3	**18**
Alternative B – Targeted Separation plus Expansion of Mechanic St PS and WWTP	4	2	1	3	1	**11**
Alternative C – Targeted Separation plus new Force Main to WWTP	4	2	1	3	1	**11**
Alternative D – Targeted Separation plus Storage at South Mill Pond	4	5	2	3	3	**17**

Ranking based on a scale of 1 (worst) to 5 (best).
*Alternatives A and E from August 2002 LTCP report have been combined for this evaluation.

5.4 Summary and cost benefit analyses

Based on the development of the alternatives presented in the previous sections, a cost benefit analysis was prepared to compare the projected benefits of each alternative with the estimated capital cost for its implementation. A summary of the costs as developed in Section 5.3 (and Appendix 5-2) are provided as follows:

Table 5-5 ***Summary of costs for abatement alternatives***

ABATEMENT ALTERNATIVE	Estimated Cost, $M rounded*
Alternative A – Targeted Separation plus Rapid Treatment at South Mill Pond	**$ 28 M**
Alternative B – Targeted Separation plus Expansion of Mechanic Street Pumping Station and WWTP	**$ 38 M**
Alternative C – Targeted Separation plus new Force Main to WWTP	**$ 38 M**
Alternative D – Targeted Separation plus Storage at South Mill Pond	**$ 30 M**

* See Section 5.3 and Appendix 5-2 for further detail on the alternatives' scope and opinion of costs. Dec 2003 dollars (ENR 6782). Includes contingency and engineering at 40%.

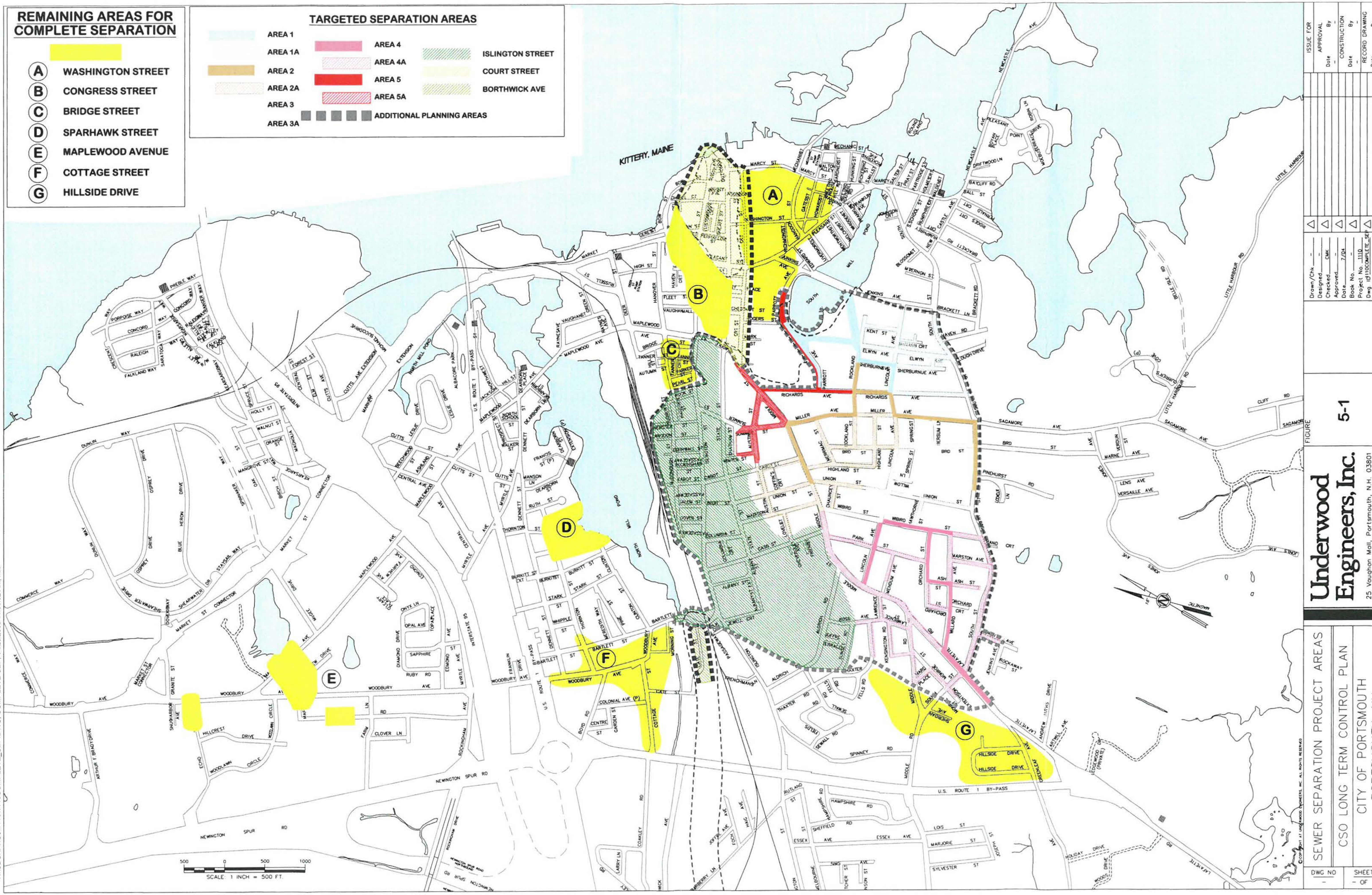
Figure 5-11 depicts the estimated costs in millions of dollars (Dec 2003 estimates) vs. the projected remaining CSO volume in millions of gallons following the implementation of the abatement alternatives.

Based on this comparison, all of the alternatives effectively reduce CSO volumes by 85% or greater, and reduce CSO events to an average of less than 4 per year.
However, Alternatives A and D provide increased effectiveness because they will essentially eliminate untreated discharges at a lower overall cost, by treating or storing (and repumping to treatment) any remaining CSO flows at the South Mill Pond. On the other hand, Alternatives B and C provide increased conveyance capacity for treatment at the WWTP, but do so at a higher cost, and do not provide added capture or treatment for any remaining overflows that may occur at the South Mill Pond. On this basis, Alternatives B and C donot meet the long term goal of eliminating untreated discharges to the receiving waters.

For Alternative A (same as Alternative E in Appendix 4-1 and in the August 2002 LTCP report), the model assumptions were gauged to account for additional separation work completed by the City in late 2000 and 2001, as well as other corrections to more accurately reflect the actual system configuration. Therefore, the projected effectiveness of Alternative A to reduce CSO events from the current 12 or more to about 2 per year, with a residual CSO volume after implementation of targeted separation projects of about 50,000 to 440,000 gallons, depending on the intensity of the storm event, may be considered as a more conservative, worst case scenario for any of the alternatives presented.

Either Alternative A (treatment) or Alternative D (storage) of remaining CSOs following targeted separation are recommended as the most cost effective plans for development of the LTCP.

This recommendation is consistent with previous recommendations submitted by the City (August 2002 LTCP report), as well as with ongoing work presented as part of the Preliminary Design Submission (City of Portsmouth, 2003), and the Preliminary Design for Lincoln Area Sewer Separation Program (Underwood Engineers, 2003).



REMAINING AREAS FOR COMPLETE SEPARATION
A WASHINGTON STREET
B CONGRESS STREET
C BRIDGE STREET
D SPARHAWK STREET
E MAPLEWOOD AVENUE
F COTTAGE STREET
G HILLSIDE DRIVE
TARGETED SEPARATION AREAS
AREA 1
AREA 1A
AREA 2
AREA 2A
AREA 3
AREA 3A
AREA 4
AREA 4A
AREA 5
AREA 5A
ADDITIONAL PLANNING AREAS
ISLINGTON STREET
COURT STREET
BORTHWICK AVE
KITTERY, MAINE
SCALE: 1 INCH = 500 FT.
Underwood Engineers, Inc.
25 Vaughan Mall, Portsmouth, N.H. 03801
Tel. 603-436-6192 Fax. 603-431-4733
SEWER SEPARATION PROJECT AREAS
CSO LONG TERM CONTROL PLAN
CITY OF PORTSMOUTH
PORTSMOUTH, NH
FIGURE
5-1
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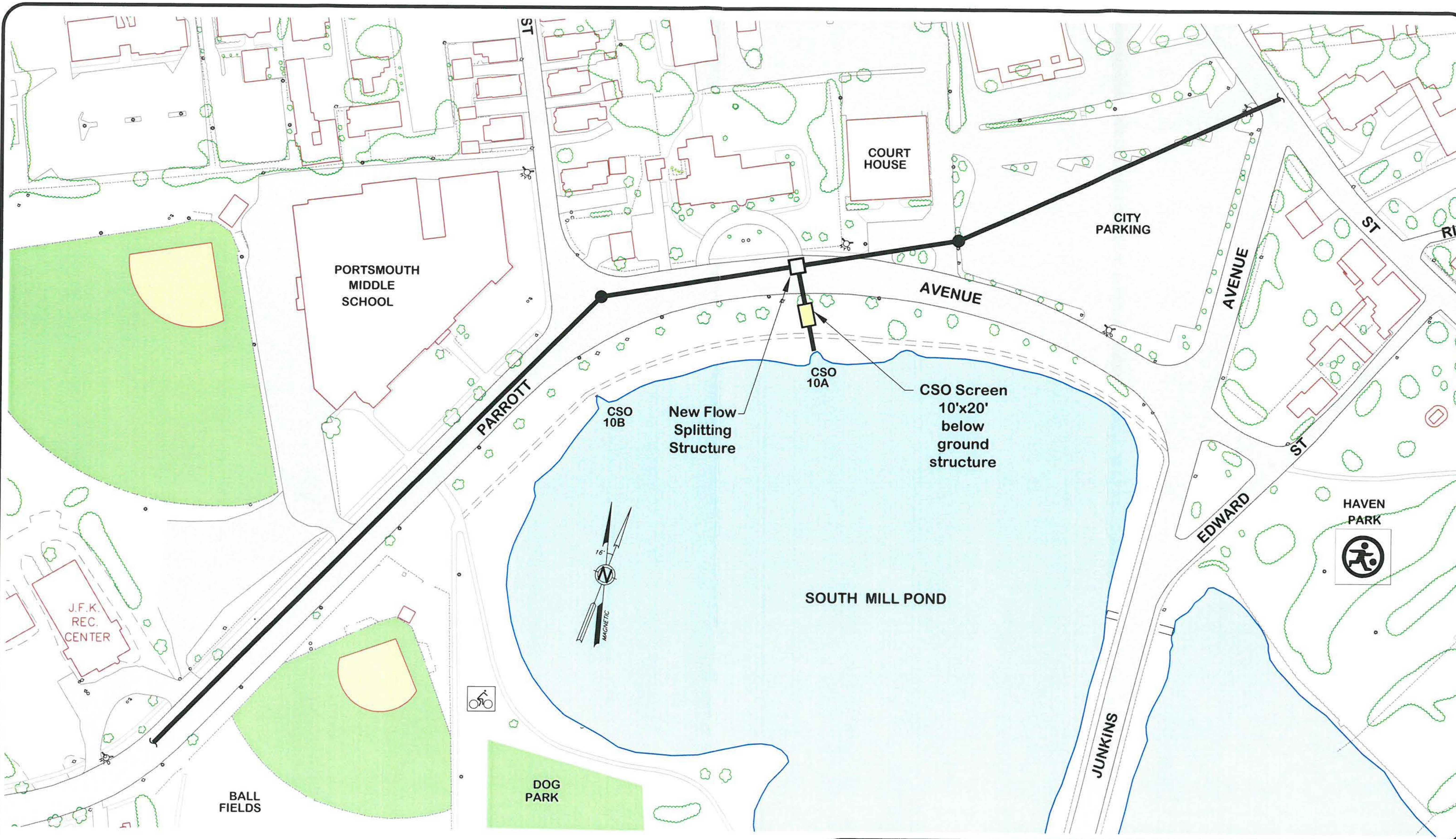

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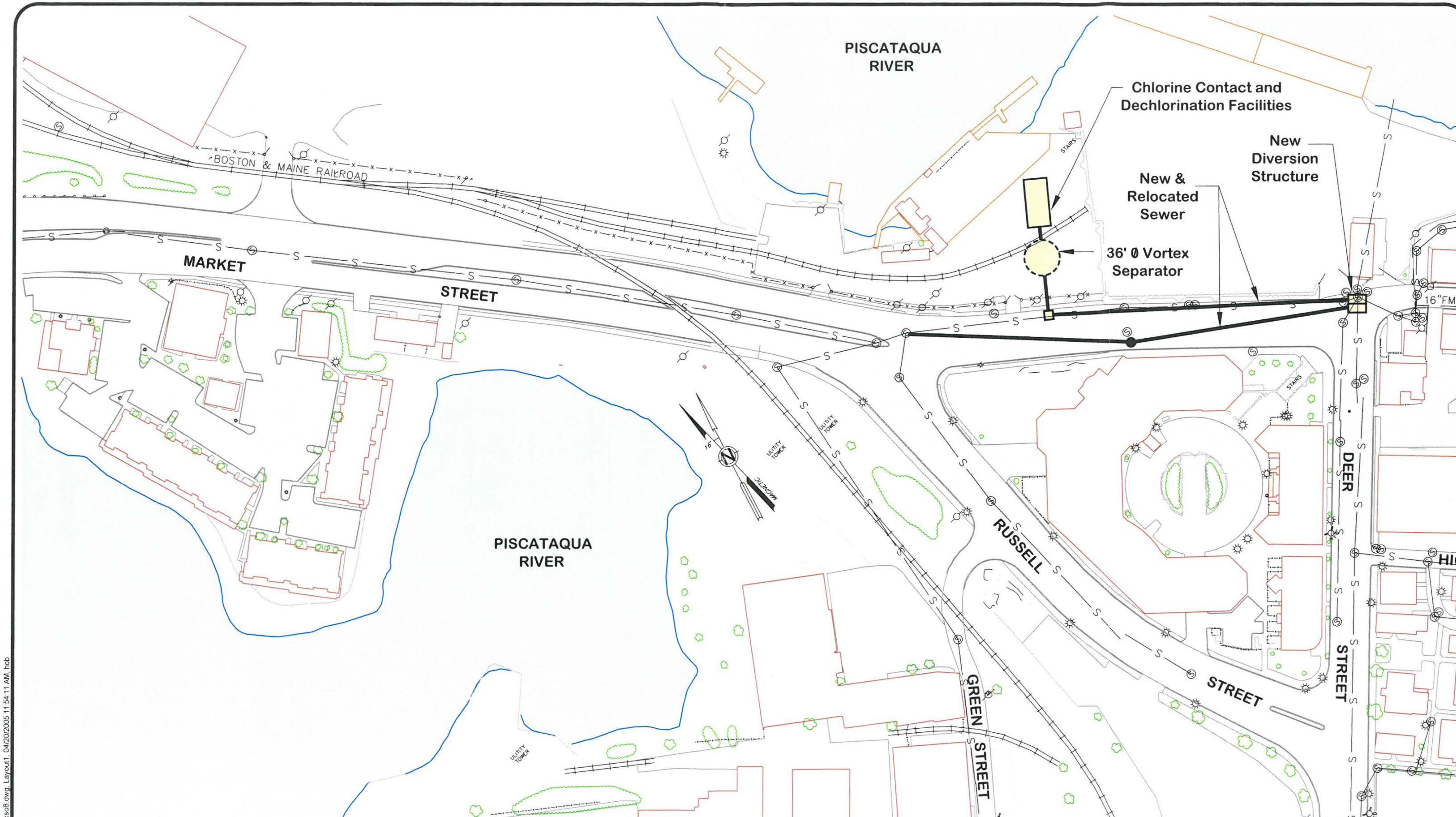
DATE 7/04	Underwood Engineers, Inc.	CSO LONG TERM CONTROL PLAN PORTSMOUTH, NH SCREENING FACILITY SOUTH MILL POND	FIGURE
PROJECT 1110			5-2



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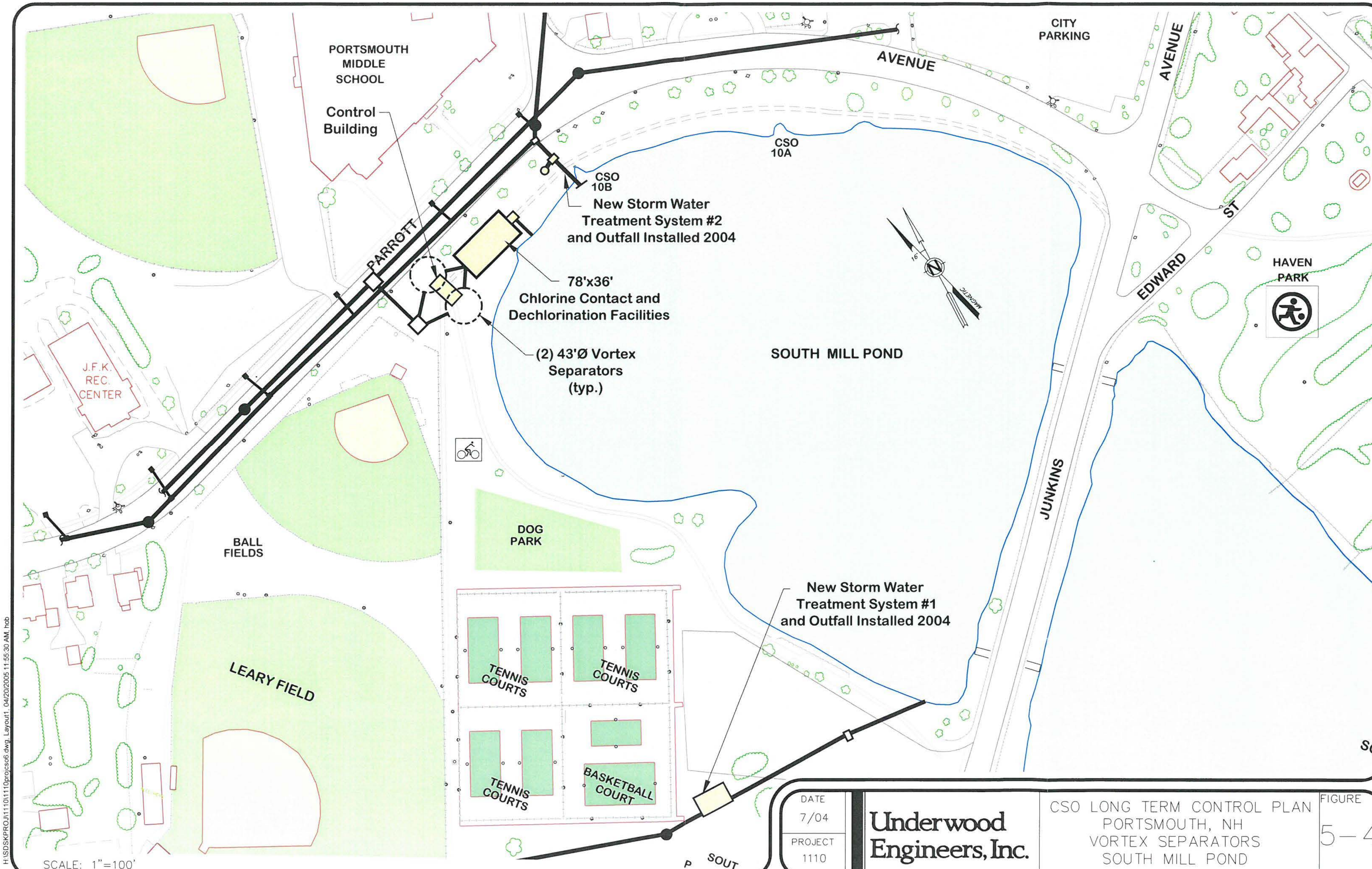
DATE 7/04 PROJECT 1110	Underwood Engineers, Inc.	CSO LONG TERM CONTROL PLAN PORTSMOUTH, NH VORTEX SEPARATOR DEER STREET	FIGURE 5-3

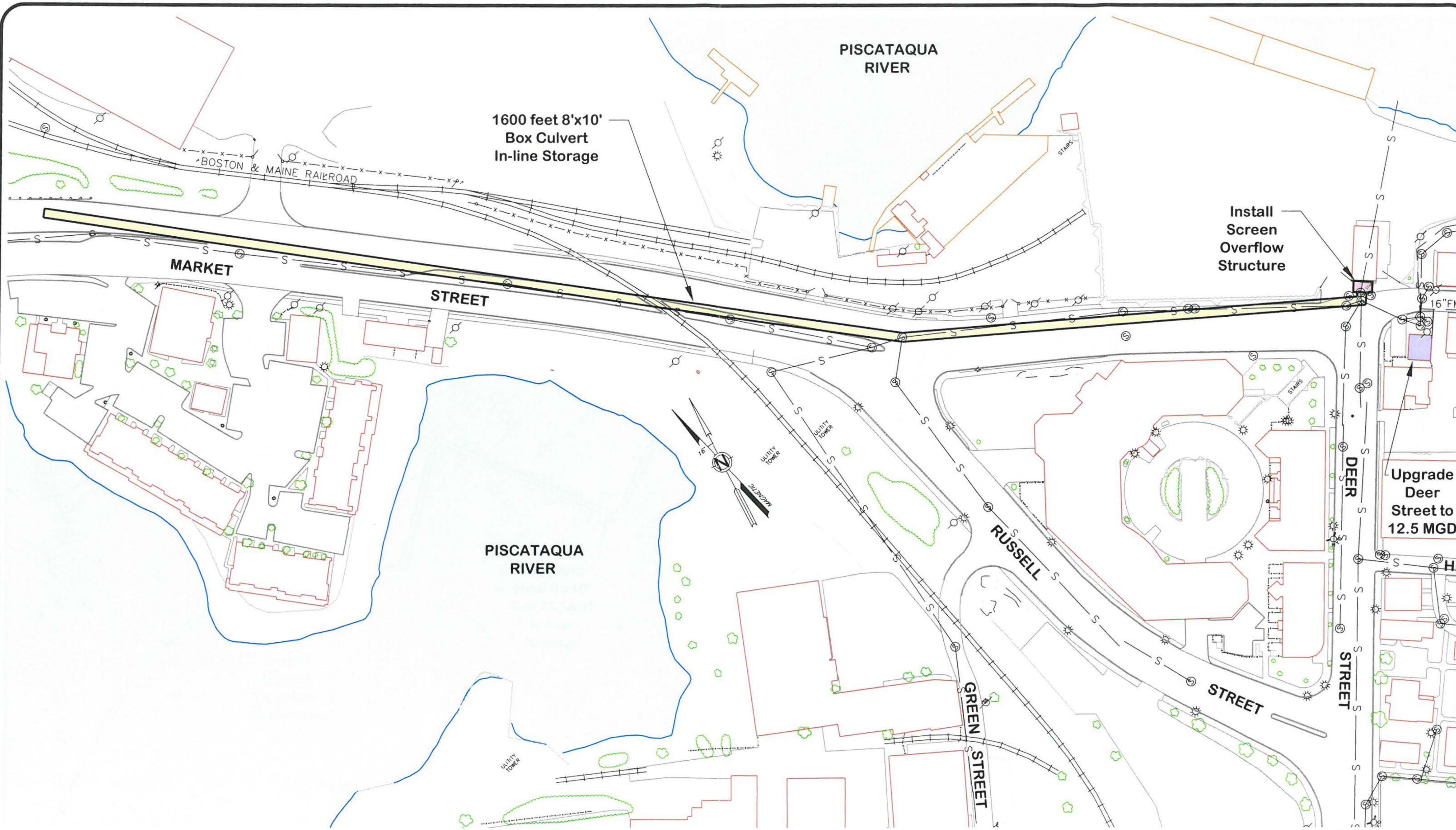


DATE	7/04
PROJECT	1110

Underwood Engineers, Inc.

CSO LONG TERM CONTROL PLAN
PORTSMOUTH, NH
VORTEX SEPARATORS
SOUTH MILL POND

FIGURE 5-4



SCALE: 1"=100'

DATE		CSO LONG TERM CONTROL PLAN	FIGURE
7/04	Underwood Engineers, Inc.	PORTSMOUTH, NH	5–5
PROJECT		IN-LINE STORAGE	
1110		DEER STREET	

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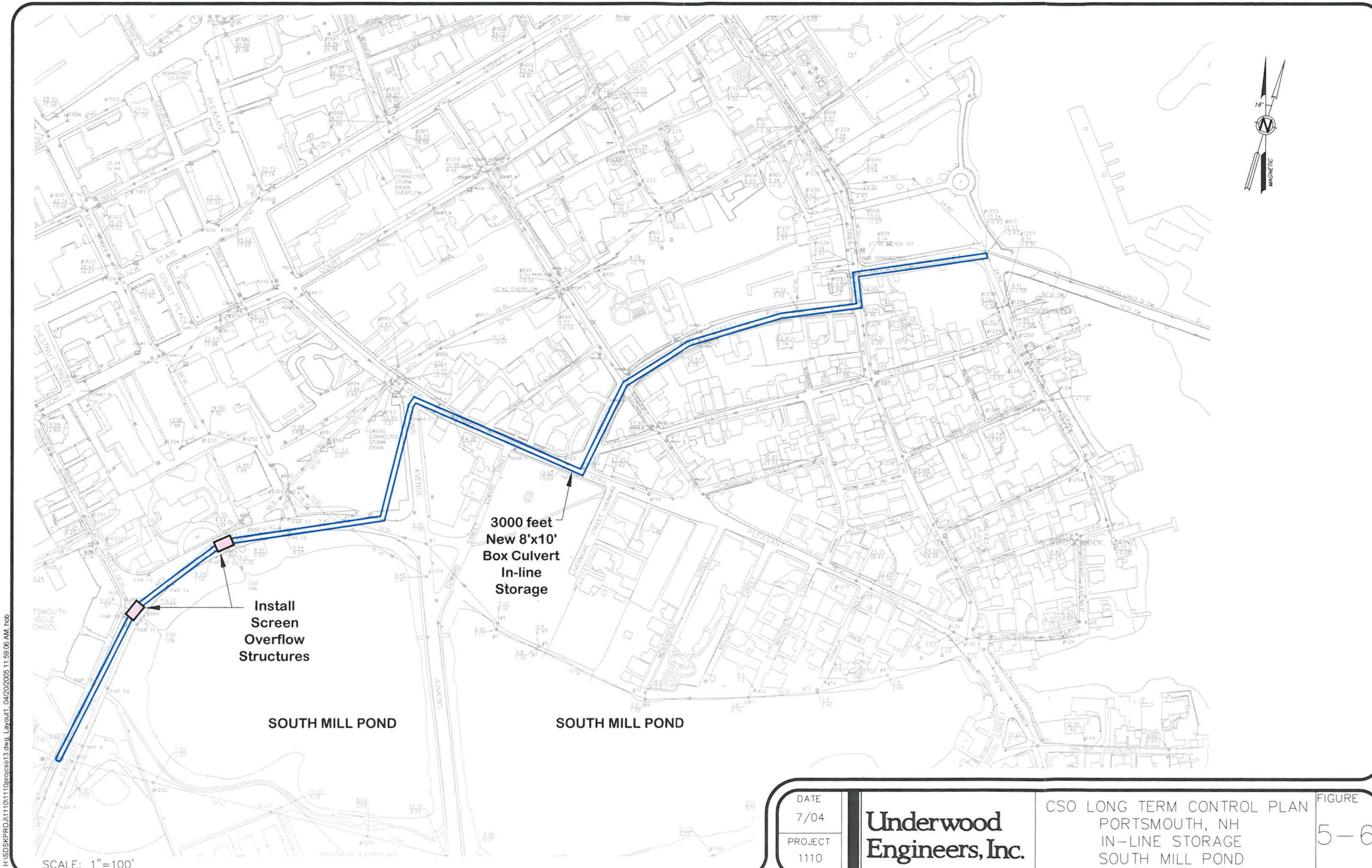

DATE	Underwood Engineers, Inc.	CSO LONG TERM CONTROL PLAN PORTSMOUTH, NH IN-LINE STORAGE SOUTH MILL POND	FIGURE
7/04			5-6
PROJECT			
1110			

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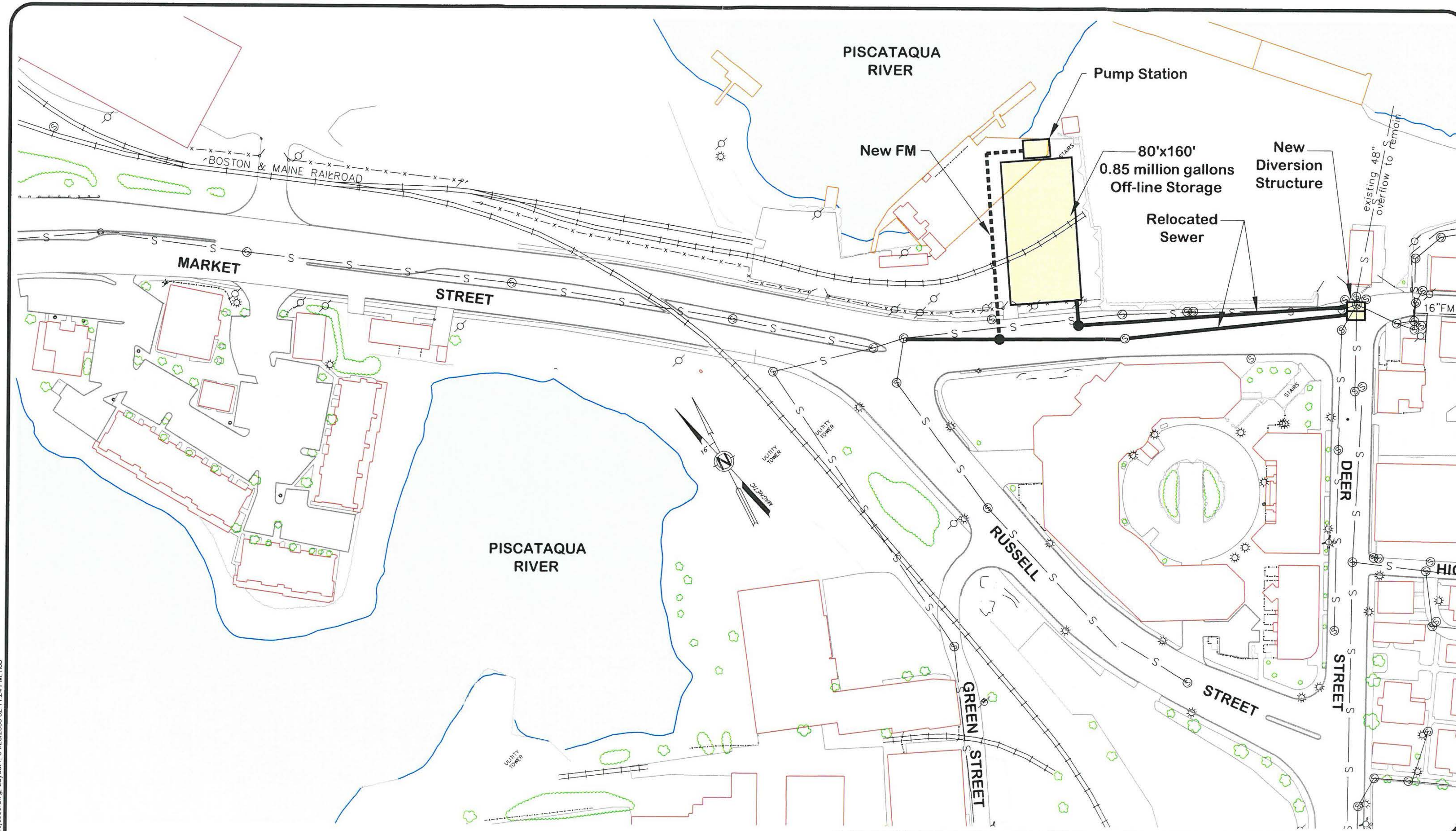

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7/04			5-7
PROJECT			
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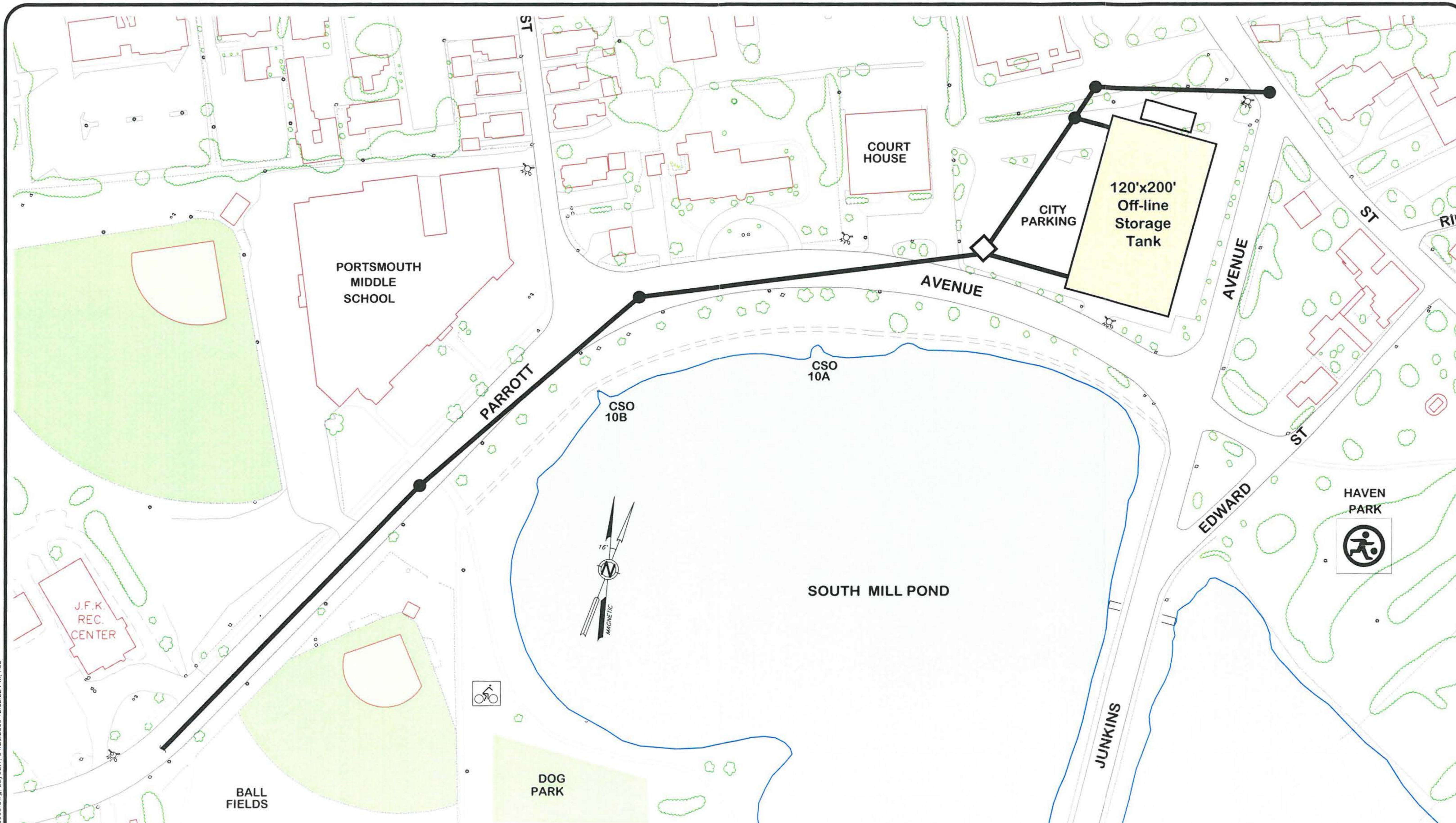

DATE	PROJECT
7/04	1110

Underwood Engineers, Inc.

CSO LONG TERM CONTROL PLAN
PORTSMOUTH, NH
OFF-LINE STORAGE
SOUTH MILL POND

FIGURE 5-8

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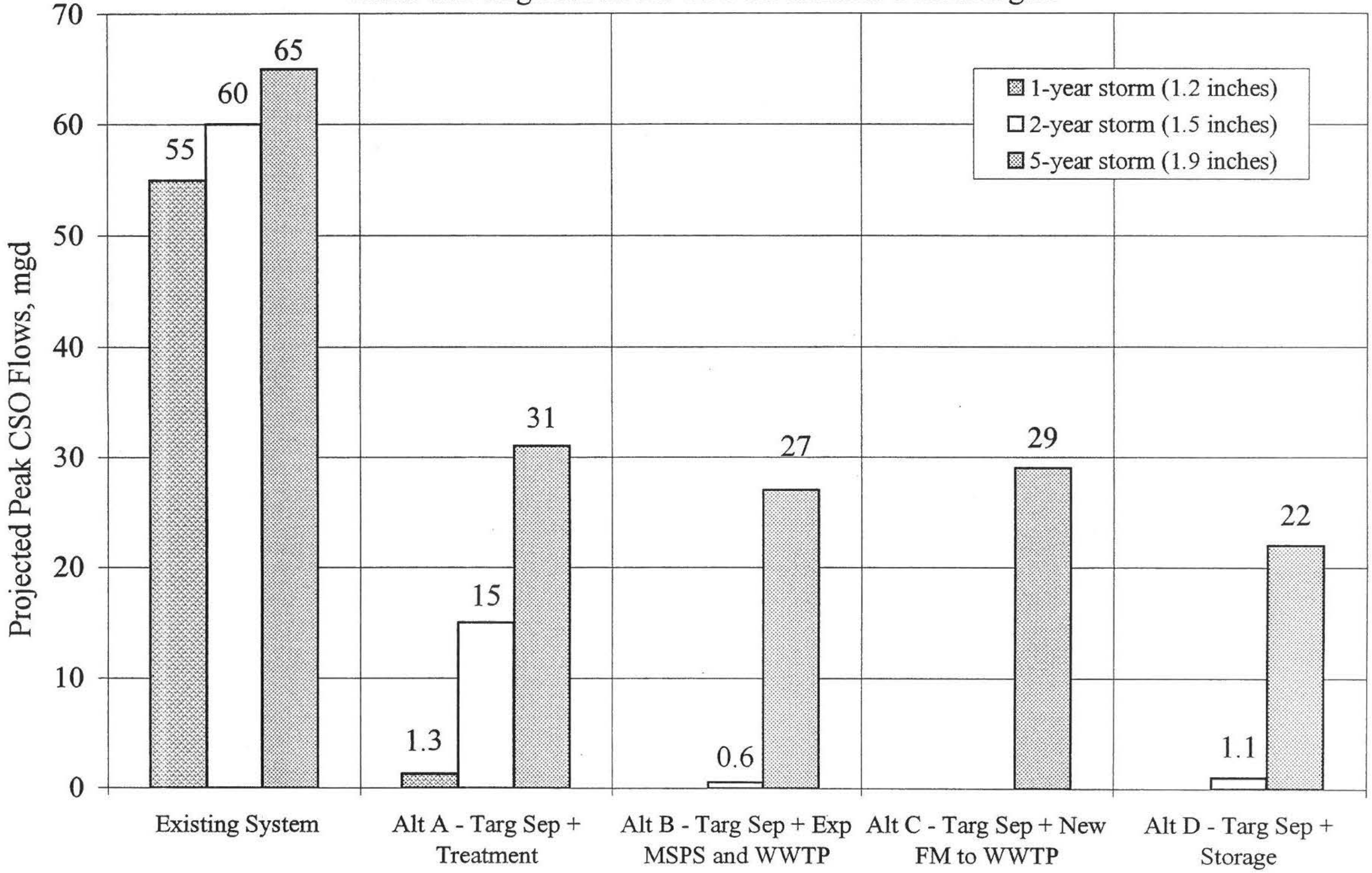
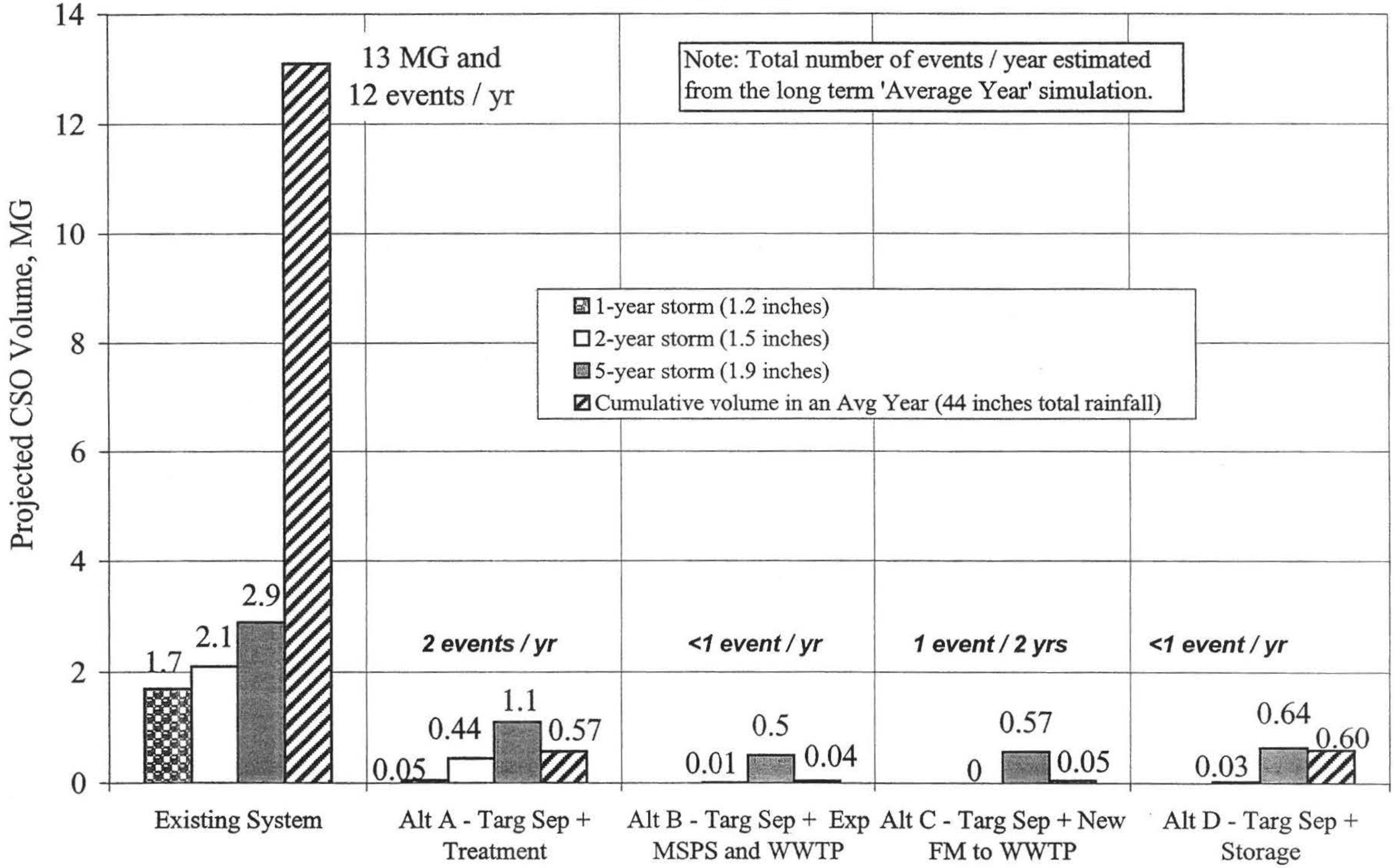
Figure 5-9 Projected CSO Flows following Abatement Alternatives

- Basis of Design Flows for CSO Abatement Technologies -



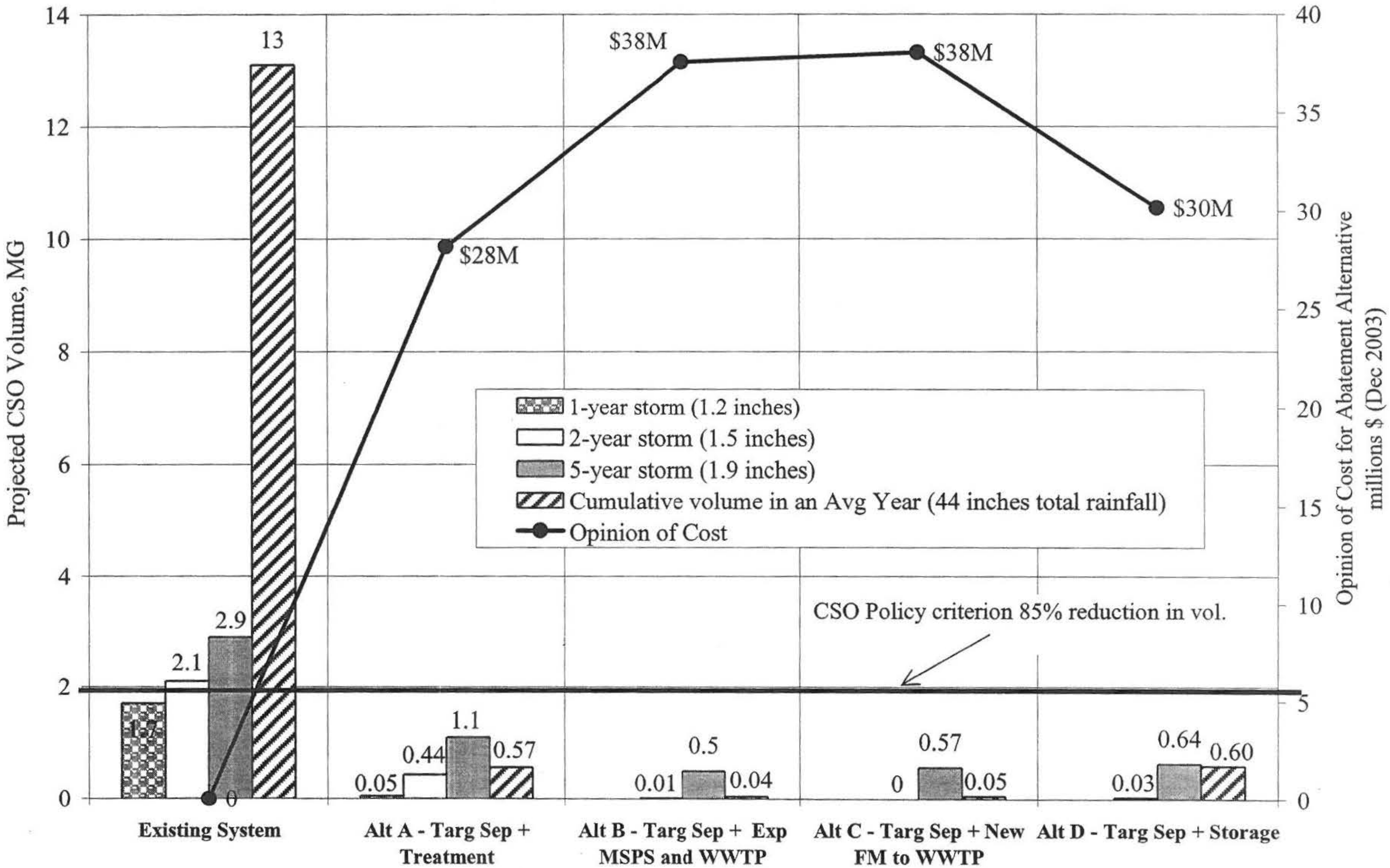
1110\08_comp\design storms.xls\model results (2) Chart 1

Figure 5-10 Projected CSO Volume and Number of Events following Abatement Alternatives



1110\08B_comp\model results (2) Chart 5

Figure 5-11 Cost Benefit of CSO Abatement Alternatives



1110\08B_comp\design storms.xls,Cost benefit chart

6. RECOMMENDED ABATEMENT PLAN

The recommended abatement plan is proposed to be implemented in 2 phases over the following 15 to 20 years. This section details a logical sequence for development of the LTCP projects, such that they can be managed by the City as part of its long term capital improvements planning. Funding for the LTCP projects is discussed in Section 7 of this report.

Different alternatives were developed to meet the objectives of the national CSO Policy as discussed in Section 5.3. The most cost-effective approach to reduce CSO discharges was recommended to begin with an extensive rehabilitation program to construct dedicated storm and sanitary sewers for an estimated 70% of the combined sewer area. This separation program along with several other short term improvements projects are proposed to be completed as Phase 1 of the LTCP. Following the Phase 1 improvements, additional projects will be carried out including re-evaluating the system to establish the basis of design for control of remaining CSO flows (Phase 2 projects).

6.1 PHASE 1 PROJECTS

This phase was initiated in 2003 with the bidding and start of construction for the Lincoln Area Sewer Separation program. Prior to and concurrent with the Lincoln Area program, the City has also been performing several other major sewer improvements projects. Table 6-1 provides a summary of the Phase 1 LTCP sewer projects including approximate costs and significant milestones. Additional description for the Phase 1 projects is provided in the following sections.

Table 6-1 ***Phase 1 LTCP projects***

Project name	Significant Milestones	Estimated Cost*
Lincoln Area Sewer Separation	- Start March 2003 (Lincoln Area Contract #1 bidding). - Annual progress reports in March of each year. First report submitted March 2004.	$ 21.37 M
Treatment of separated Storm Water	- Vortex / swirl treatment installed in 2004 for storm water drainage at the South Mill Pond (Lincoln Contract #1). - Additional storm water treatment currently being designed for North Mill Pond area (Lincoln Contract #2).	$0.5 M
Deer Street Pumping Station Upgrades	- Design 2003 / 2004 - Construction anticipated in 2005	$ 2.0 M
Mechanic Street Pumping Station Upgrades	- Schedule to be defined, anticipated 2006 – 2007.	$ 0.3 M
Estimated Total Phase 1 projects		**$24.17 M**

* See additional project descriptions in the following sections and cost tables in Appendix 5-1.

In addition to the LTCP Phase 1 projects, the City continues to implement sewer improvements to address other critical areas in the combined sewer area. Some of the recent projects include:

- Additional sewer/drainage and other infrastructure work in Lincoln Area (2003-ongoing)
- Rehabilitation of Court Street area sewers completed in 2003 – 2004
- Rehabilitation of Dennett Street area sewers completed in 2002 – 2003
- Sewer separation and I/I reduction projects in Thaxter / Fells area, Essex / Sheffield, Panaway Manor, lower South Street, Coakley / Larry Lane, among others, in 2000– 2002
- Ongoing investigations and elimination of illicit sewer connections in collaboration with NHDES (CSO and cross connections Status Report issued June 2004, see Section 1.4),
- Continued monitoring and reporting for CSO outfalls 10A/10B (South Mill Pond) and Deer Street CSO 013, as part of NPDES permit requirements. Additional compliance monitoring for CSO outfalls as part of the LTCP is described in Section 6.3 of this report.

Based on the City's experience with previous sewer improvements projects, and the need to maintain other business and residential activities open for the downtown areas, the Phase 1 projects are proposed to be completed at a rate of about ¾ mile per year (and $1 to 3 million per year), with about 1/3 of the total projects completed every 5 years. However, the actual sequence and schedule to be followed will depend on other City infrastructure projects and funding needs. A proposed Project Sequence for the LTCP implementation is provided as **Figure 6-1**.

Additional description for the LTCP Phase 1 projects is as follows:

6.1.1 Lincoln Area Sewer Separation

The scope of the overall Lincoln Area separation program was presented in the City's Preliminary Design Submission Letter (March 27, 2003), and further defined in the Preliminary Design of the Lincoln Area Sewer Separation Program (Underwood Engineers, December 2003, see Section 1.4). The preliminary design efforts included detailed field surveys to identify 10 priority areas in the Mechanic Street Sewer Basin, and 3 additional planning areas tributary to the Deer Street Sewer Basin, to be addressed in the targeted separation program (see **Figure 6-2**). The "Lincoln Area" was essentially expanded to encompass most of the downtown combined sewer area. As proposed, the overall Lincoln area program will impact an estimated 346 acres (70%) of the total remaining combined sewer area and an estimated 65,200 ft road or project length.

The project areas are generally numbered beginning from the South Mill Pond main sewer interceptors (Area 1), in a sequence to work upstream to Lafayette Road (Area 4) and north toward Middle Street (Area 5), as shown in Figure 6-1, Suggested Project Sequence. The areas are identified as 1, 2, 3, 4 and 5 for the main interceptor projects, and as 1A, 2A, 3A, 4A and 5A for the collection piping projects. The additional tributary 'planning areas' include Islington St, Court St, and Borthwick Avenue sewers. The project sequence is proposed to allow the most separation benefits to be achieved with the implementation of each project. The actual sequence and schedule will depend on many other factors, including the effectiveness of each separation project, other City infrastructure projects, and funding needs.

Lincoln Area Contract #1 was bid in March 2003 and rebid in October 2003, due to high bid costs received in the first round. Construction began in December 2003 and will be completed by Summer 2004. Contract #1 includes construction of new storm drainage interceptors along Parrot and Sherburne Avenues for collection of drainage north and south of the South Mill Pond, and a new sanitary sewer interceptor along Sherburne and Lincoln Avenues. This work addresses most of the areas identified as Areas 1 and 1A of Figure 6-2. Total project costs were approximately $2.25 million, including 5,300 ft of new drain and sewer piping, new storm water treatment facilities, and overall project length of about 3,900 ft.

Lincoln Area Contract #2 is currently (June 2004) under design. It includes collector sewers in Elwyn and Kent Street areas, and new sewer interceptors in the Bartlett Street area. New storm water treatment facilities will also be constructed at the North Mill Pond. Contract #2 construction is anticipated to be completed in 2005 – 2006.

The general scope of the LTCP Lincoln area program is summarized as follows:

Table 6-2 ***Summary of Lincoln Area Sewer Separation Projects***

Project	Anticipated Construction Completion	Approximate Project Road Length (ft)	Estimated Cost* $ millions, rounded
Group I Projects Areas 1,1A, 2, 2A, 3	March-08	20,900	$ 7.10 M
Group II Projects Areas 3A, 4, 4A, 5, 5A	March-13	21,000	$ 6.67 M
Group III Projects Islington St, Court Street, Borthwick Av	March-18	23,300	$ 7.60 M
TOTALS		**65,200 ft**	**$21.37 M**

* Costs for eligible sewer / drain piping included in LTCP program. The City may elect to implement additional sewer / drain or other infrastructure projects in conjunction with the LTCP projects.

6.1.2 Storm water treatment

Separated storm water will be controlled as part of the Phase 1 LTCP projects. Minimum controls to meet the EPA Storm water Phase II rules will be followed. In addition, the City has elected to provide treatment beyond the Phase II requirements, as a proactive approach to further reduce pollutant loads to the receiving waters. Storm water treatment will include solids removal by vortex / swirl type concentrator units with an annual removal efficiency of 80%. Disinfection is not required for storm water discharges.

Contract #1 (Lincoln Area) includes new storm water facilities for drainage collected at the South Mill Pond. The South Mill Pond facilities were constructed in 2004. Contract #2 (Bartlett Street area, currently under design) includes new storm water facilities for drainage collected at the North Mill Pond. Contract #2 construction is anticipated to be completed in 2005. Estimated costs for the storm water treatment units are approximately $0.5 million.

6.1.3 Deer Street Pumping Station Upgrades

The Deer Street Pumping station pumps flow from the Box Sewer Basin, Maplewood Avenue, Gosling Road, Atlantic Heights and Leslie Drive sewerage basins to the Mechanic Street sewer drainage area. The design capacity of the station was 12 mgd at 57 feet of head. However, drawdown tests indicated its current capacity is actually around 9 mgd, due to higher headloss and air binding.

Design of upgrades for the Deer Street Pumping Station was initiated in 2003 with construction anticipated to be performed in 2005. The station will be reconfigured to a new triplex pumping station (2 pumps online for peak flows), to provide additional capacity and redundancy when either of the main pumps is down for repair. New higher head sewage pumps will be provided as well as replacement or refurbishment of air relief valves. Major electrical upgrades will be installed, instrumentation upgrades, and a new odor control system. A new architectural building will be constructed to improve the pump station aesthetics and harmony with the historical downtown area. As presented in Section 5.2, the estimated cost for restoration of the Deer Street Pumping Station is $2 M (see also Appendix 5-1).

6.1.4 Mechanic Street Pumping Station Upgrades

The Mechanic Street pumping station pumps all the flow collected within the City of Portsmouth to the Peirce Island WWTP. The station's design capacity was 22 mgd, however, its current capacity is estimated at about 18.5 mgd.

Restoration of the Mechanic Street Pumping Station could range from minor upgrades to its complete reconfiguration to a triplex pumping station. For the LTCP projects, minor electrical upgrades were considered adequate to address current flows for an estimated $0.3 million.

6.2 PHASE 2 – PLUS ABATEMENT PROJECTS

As the LTCP Phase 1 separation and upgrades are completed and assessed, planning will continue toward the Phase 2 LTCP program. This will include reviewing the LTCP recommendations and CSO abatement options in light of the accomplishments of the Phase 1 program. Phase 2 is proposed to include the following projects:

- Additional flow monitoring and update of the hydraulic model to assess the success of the LTCP Phase 1 projects
- Evaluation of additional controls needed for any remaining CSO flows
- Evaluation of technologies and preparation of conceptual designs and costs for additional controls as required ('Plus Abatement Projects')
- Update of LTCP recommendations.

The modeling of abatement alternatives (Section 5.3) projected that the targeted separation program will allow the City to reduce CSO flows by more than 95% and to reduce the number of CSO events to 2 or less per year. However, some CSO events will inevitably continue to occur and will require additional controls to protect the receiving waters. The modeling simulations predicted that remaining CSO flows may reach up to 30 mgd and 600,000 gallons under the most conservative scenario of a 5-year storm event (Alternatives A and D). Lower intensity storm events could still cause CSO overflows of up to 1.3 and 15 mgd respectively (Alternative A).

It is acknowledged that any CSO discharge may impact the receiving water quality and therefore will require additional controls as part of the Phase 2 program. However, the basis of design flows and recommendations for the most cost effective abatement technology will need to be revisited depending on the success of the Phase 1 projects.

Potentially applicable "Plus Abatement" technologies for control of remaining CSO flows in Phase 2 of the LTCP may include:

- Rapid treatment of CSOs by solids removal and disinfection
- Storage of CSO volume and re-pumping for conveyance and treatment at the WWTP
- Additional sewer separation projects
- New technologies developed for CSO abatement over the following 15 years
- Additional monitoring and testing.

Opinions of cost were developed for possible Plus Abatement Projects, including a sensitivity analysis for CSO flows predicted to occur under the conditions of a 1-year, 2-year, and 5-year design storm. The costs were developed as follows (see Figure 6-3).

Table 6-3 ***Cost sensitivity of plus abatement project alternatives***

Alternative	Phase 1 - Baseline Controls*	Phase 2 – Plus Projects		
		1-year storm event Up to 1.3 mgd or 0.05 MG	**2-year storm event** Up to 15 mgd or 0.44 MG	**5-year storm event** 22 to 31 mgd 0.5 to 1.1MG
Alt A – Targeted Separation plus Treatment	$ 24.17 M	$ 2.2 M	$3.6 M	$4.0 M
Alt B – Targeted Separation plus Expansion of Mechanic Street Pumping Station and WWTP		$ 4.6 M	$6.0 M	$12.2 M
Alt C – Targeted Separation plus New Force Main from Deer Street and Expansion WWTP		$9.3 M	$10.7 M	$ 13.9 M
Alt D – Targeted Separation plus Off-line Storage		No events	$ 3.0 M	$ 6.0 M

* Phase 1 Baseline controls include Lincoln area targeted separation, storm water treatment, and pumping station upgrades. See Appendix 5-1 for cost tables. Costs are rounded to millions of dollars, Dec 2003 ENR CCI 6782.

As reviewed in Section 5.3, either rapid treatment (A) or storage (D) appear to be the more cost effective, long term abatement projects. Both Alternatives A and D will essentially eliminate untreated discharges to the receiving waters, by either treating (A) or storing (D) remaining CSO flows. Alternatives B and C would provide increased conveyance capacity (via Mechanic Street or Deer Street pumping stations) to the WWTP, but would not provide capture or treatment for potential CSO events under high intensity storm conditions (5 year storm event).

The sensitivity analyses (Figure 6-3) shows that the costs escalate quickly for increasing conveyance capacity (Alternatives B and C) to capture and treat increased CSO flows between the 1-year to the 5-year storms at the WWTP. On the other hand, incremental costs for either treatment or storage at the South Mill Pond (A or D), are not as sensitive to the increased flows projected for the higher intensity storm events. Nevertheless, the plus abatement project recommendations will need to be revisited pending the effectiveness of the Phase 1 program.

6.3 Compliance Monitoring and LTCP Evaluation

The City will continue and expand its current CSO monitoring program in order to qualitatively and quantitatively evaluate the effectiveness of the LTCP projects.

The proposed monitoring and evaluation program includes:

1. Continued real time flow monitoring at CSO structures 10A, 10B and Deer Street CSO 013, and submittal of monthly reports to NHDES and EPA (NPDES permit requirements)
2. Upgrade of flow monitoring instrumentation at CSOs 10A, 10B and 013, to improve notification of CSO events, and enable remote monitoring through the WWTP SCADA system
3. Annual sampling of at least one CSO event at each of the three active outfalls, CSOs 10A, 10B and 013, for analysis of settleable solids, total and fecal coliforms
4. Annual status reports to NHDES and EPA in March of each year, throughout the Phase 1 and Phase 2 LTCP, to include:
    - Work completed to date
    - Contracts let and status of contracts underway
    - Schedule updates
    - Funding commitments (i.e., eligible/ineligible portions)
    - Project cost updates
    - Results of compliance flow monitoring and CSO sampling

The first Annual Progress Report was submitted by the City in March, 2004. The first annual sampling of CSO events will be performed in 2005 for submittal with the March 2005 Annual Report. Estimated costs for the first 5-years of compliance monitoring and LTCP review are estimated at **$0.33 million**.

6.4 Public outreach and information

The City has maintained open communications with the public throughout its many public works projects by providing specific project information and feedback through public meetings, the City website, and other activities. Some of these practices which have been successful and will be continued throughout the LTCP projects will include the following:

- Maintaining a project information telephone line
- Posting project updates throughout the project construction period on City website
- Holding Public Meetings at the start of each construction project

6.5 Summary

The recommended abatement plan for long term control of CSOs in the City of Portsmouth consists of a 2-phase, 20 year program (Table 6-4). Phase 1 projects include targeted sewer separation, storm water treatment, and pumping station upgrades estimated at $24.17 million. Phase 2 projects will be revisited pending the success of the Phase 1 program, and may include additional monitoring, treatment, storage, or other abatement technologies depending on the volume and flow of remaining CSOs. Phase 2 costs are projected to reach $2.2 to $6 million. Throughout the LTCP, annual monitoring and reporting will be maintained for continued evaluation of the effectiveness of the program. The estimated costs for the first 5 years of compliance monitoring and LTCP review were estimated at $0.33 million. The LTCP costs, schedule and project sequence are proposed for the City's planning purposes only, and will be updated as the projects proceed, depending on other City needs / capital improvements planning.

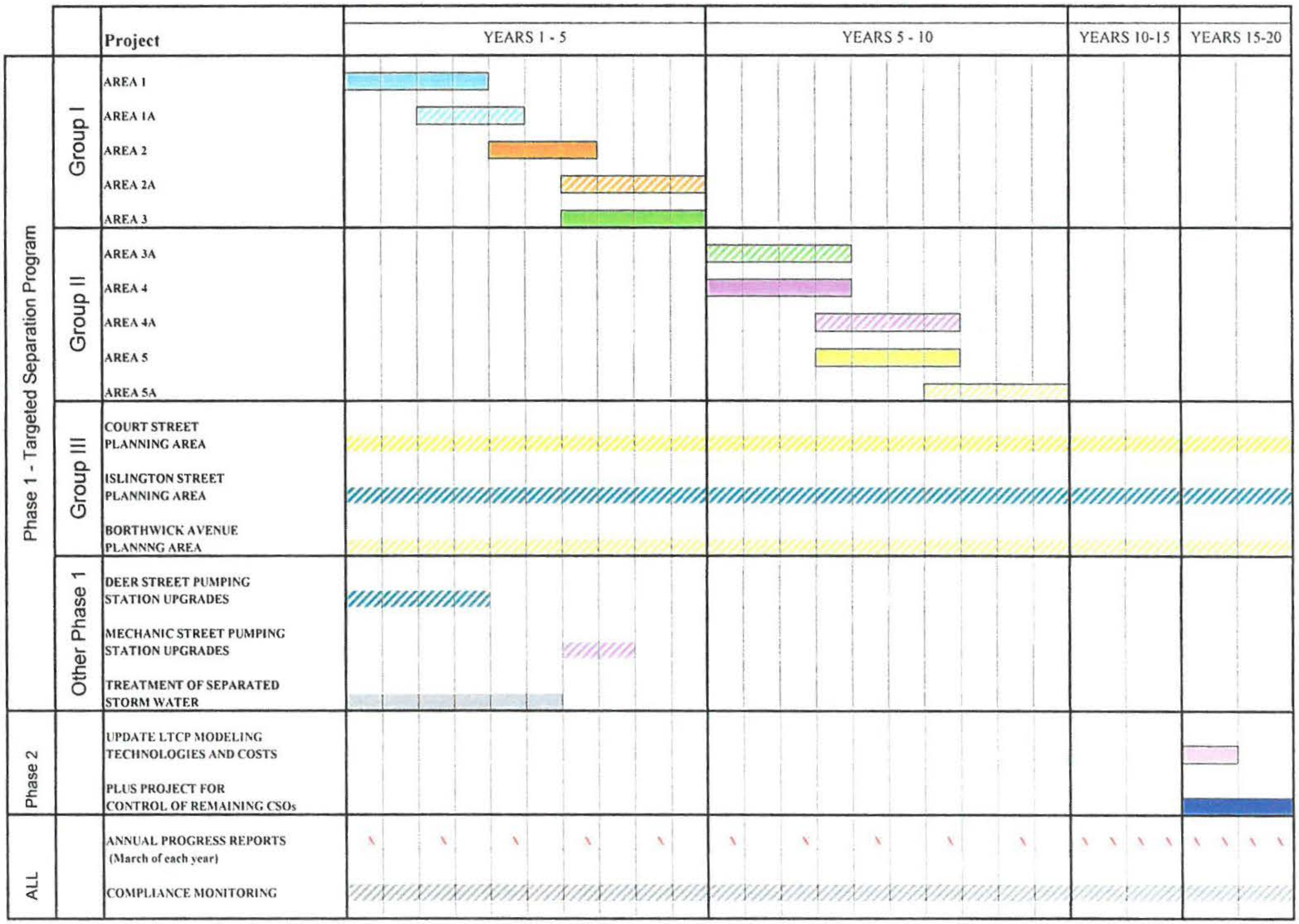
Table 6-4 ***Recommended Long Term Control Plan for CSOs***

	Project	Projected Sequence of Implementation	Estimated Cost for LTCP projects
Phase 1	**Group I** - Targeted separation projects for main sewer interceptor projects converging at the South Mill Pond (Lincoln Area / Mechanic Street Sewer Basin), construction of storm water treatment facilities, and restoration of main sewage pumping stations.	**Years 1 – 15** Initiated in 2003 with start of construction for Contract #1 Lincoln Area, and design of upgrades for Deer Street Pumping Station.	**$21.37 million** for sewer and drainage projects + **$0.5 million** for treatment of separated storm water + **$2.3 million** for upgrades to Deer St and Mechanic St Pumping Stations **Total Phase 1 projects $24.17 million**
	Group II - Targeted separation projects for collector system piping and continuation of upgrades to sewer interceptors in outer Lincoln Area / boundaries with Lafayette sewer basin.		
	Group III - Targeted separation projects for improvements in additional sewershed areas tributary to the Deer Street basin.		

Table 6-4 *Recommended Long Term Control Plan for CSOs (continued)*

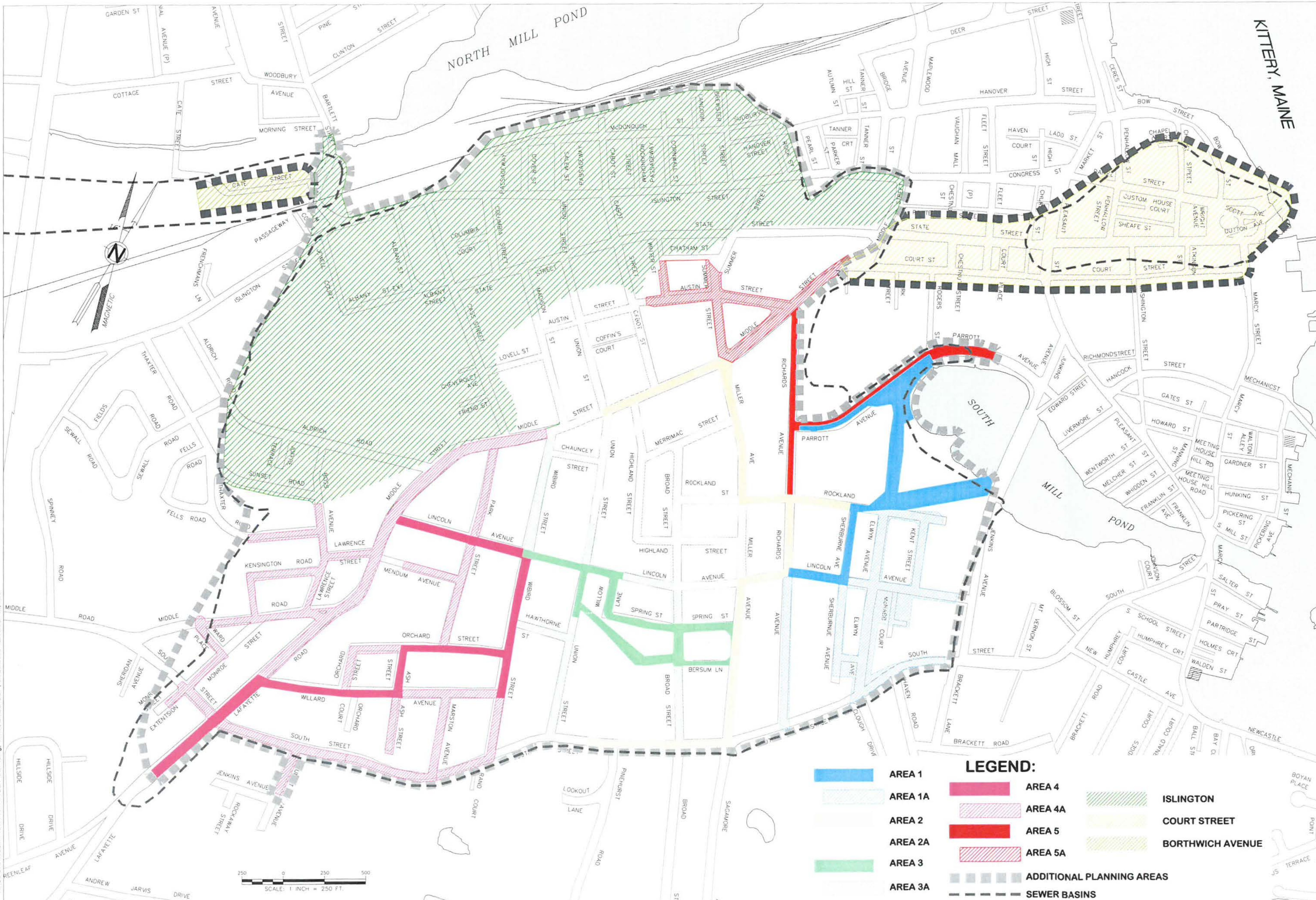
	Project	Projected Sequence of Implementation	Estimated Cost for LTCP projects
Phase 2	**Plus Abatement Projects** New flow monitoring and update of hydraulic modeling for evaluation, design and construction of additional controls for remaining CSOs.	**Years 15-20**	**Total Phase 2 projects** **$2.2 to 6 million**
All	Compliance monitoring and LTCP construction progress reports	**Annually**	**$0.33 million** **(first 5 years)**
	Comprehensive review and reporting of LTCP progress and effectiveness.	**Every 5 years**	

Figure 6-1
Suggested Project Sequence
LTCP City of Portsmouth, New Hampshire



NOTES

- See Figure 6-2 for definition of project areas.
- The proposed project sequence is designed to obtain the maximum separation benefits with the completion of each project.
- Actual project sequence may vary depending on other City projects and funding needs.



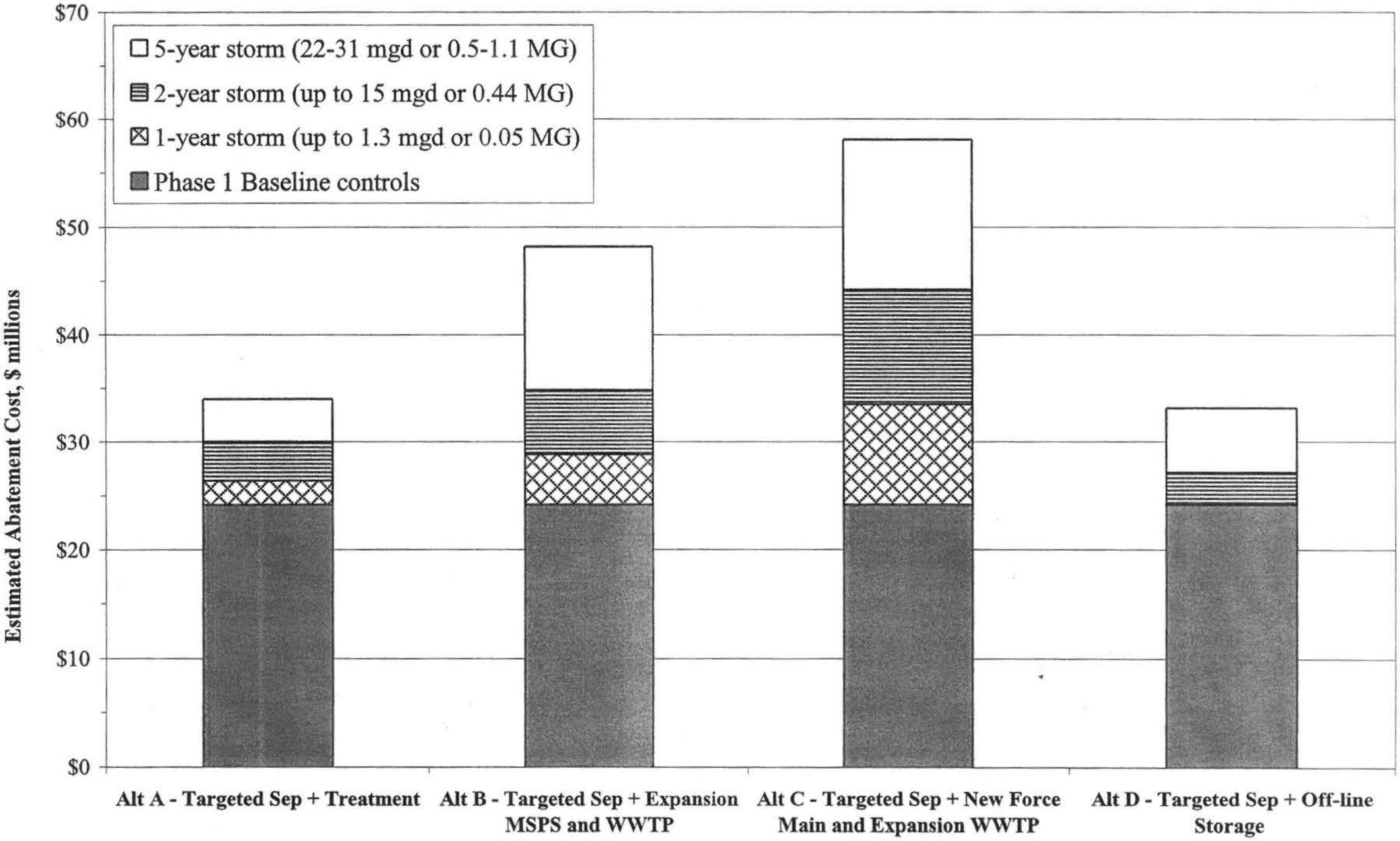
Underwood Engineers, Inc.
25 Vaughan Mall, Portsmouth, N.H. 03801
Tel. 603-436-6192 Fax. 603-431-4733

FIG 6-2

TARGETED SEPARATION PROJECTS
LINCOLN AREA SEWER SEPARATION
CSO LONG TERM CONTROL PLAN
PORTSMOUTH, NH

DWG NO
SHEET - OF -

Figure 6-3 Cost Sensitivity of Plus Abatement Alternatives



Note: Phase 1 baseline controls of $24.17 M for all alternatives include: Lincoln area targeted separation, storm water treatment and upgrades to pumping stations.

1110\08B_comp\Alternatives Cost.xls,cost chart

7. FUNDING

The LTCP represents a long term and major financial commitment for the City of Portsmouth. Since 1997, the City has invested approximately $1 million per year and more recently (2003), an estimated $5 million were spent for the construction of sewer and drainage improvements projects (City of Portsmouth, 2003 and 2004). The LTCP projects must now be incorporated in the City's long range capital improvements planning for their implementation along with other critical infrastructure needs including additional sewer / drain, water, roads, curbing and sidewalk improvements.

This section presents the funding sources considered for implementation of the LTCP projects and their incorporation in the City's capital improvements planning (CIP).

7.1 State Aid Grant

The State of New Hampshire has established a wastewater grant program that provides up to 30% of eligible costs to municipalities to assist with the planning, design and construction of sewage disposal facilities including CSO controls. Based on an average sewer user fee of $534 / year for a typical residential user in the City of Portsmouth, the City qualifies for the maximum grant amount of 30% under the SAG program. The eligibility criterion is included as Appendix 7-1. The City must fund the project in its entirety first and the SAG program then reimburses up to 30% of the eligible costs based on the City's debt schedule.

7.2 State Revolving Loan Fund

The State Revolving Loan Fund (SRF) Program provides low interest loans to assist communities with the design and construction of eligible wastewater and other infrastructure projects. The requirements for obtaining SRF loans are generally the same as for the SAG program (see above and Appendix 7-1). In addition, SRF loans require the participation of minority and women's business enterprises, as well as the preparation and approval of an environmental assessment for each project.

The City has appropriated $22.5 million through the SRF program through March 2004 (City of Portsmouth, 2004). The appropriation will be disbursed in several loans. Most of the appropriated $22.5 million will be used to assist with the LTCP projects. The City is pursuing additional funding through the SRF storm water and water programs to assist with other critical infrastructure projects it may elect to implement concurrently with the LTCP. Section 7.4 presents a summary of the overall LTCP program costs (SRF eligible / ineligible) along with the costs for other infrastructure improvements identified by the City.

7.3 State and Tribal Assistance Grants

The federal government provides funds through the State and Tribal Assistance Grants (STAG) program for water, wastewater, and groundwater infrastructure projects. Projects to be funded are approved annually and are administered through regional EPA offices. The grants require 45% local cost-sharing match. The City of Portsmouth submitted a STAG application for

$976,500 including $440,000 (45%) local match in October 2003. A copy of the application is included as Appendix 7-2. If approved, these funds are anticipated to be applied to the construction of the Lincoln Area separation projects.

7.4 Capital improvements planning

The sewer improvements projects were incorporated as part of the City's capital improvements planning since 1999 (Underwood Engineers, Wastewater Facilities Plan Update). These costs are reviewed and updated annually for the City's planning along with other critical infrastructure needs including additional sewer / drain, storm water, water, curbing, sidewalk, and road projects. A summary of the projected cash flow for the LTCP and other CIP projects are shown in Tables 7-1 and 7-2. These are budgetary costs intended for long range planning by the City. Actual costs will depend on the effectiveness of the sewer improvements, the implementation of other infrastructure projects, and the availability of funding.

Table 7-1 ***Long range cash flow projections – LTCP projects***

Project		2004	2005	2006	2007	2008	2009-2013	2014-2018	2019+	
		Millions of $, rounded (2003 costs)								
Long Term Control Plan		Phase 1							Phase 2	TOTAL
	Lincoln Area Sewer Separation									
	Eligible Sewer/Drain	$1.00	$1.00	$2.10	$1.50	$1.50	$6.67	$7.60		**$21.37**
	Storm water treatment									
	Vortex type separators	$0.25	$0.25							**$0.50**
Phase 1	**Pumping Station Upgrades**									
	Deer Street	$0.5	$0.5	$1.0						**$2.00**
	Mechanic Street				$0.3					**$0.30**
	Compliance Monitoring					$0.33	TBD			**$0.33**
	Subtotal Phase 1 + compliance monitoring									**$24.5**
	Plus Abatement Projects for remaining CSOs									
Phase 2	Monitoring, evaluation, design and construction								$2.2 - 6.0	$6.0
Total LTCP		**$1.75**	**$1.75**	**$3.10**	**$1.80**	**$1.83**	**$6.67**	**$7.60**	**$2.2– 6.0**	**$30.5**

Note: Costs presented are order of magnitude conceptual estimates intended solely for the City's long-range planning needs.

Table 7-2 ***Additional Capital Improvements Planning (CIP) needs***

Capital Improvements Plan		2004	2005	2006	2007	2008	2009-2013	2014-2018	2019+	Total
		Millions of $, rounded (2003 costs)								
	Ineligible Sewer/Drain	$0.61	$0.30	$1.25	$0.57	$0.19	$1.82	$2.03		$6.77
	Water	$0.08	$0.51	$0.32	$0.90	$0.35	$2.05	$2.33	TBD	$6.54
	Sidewalk/Curb	$0.17	$0.46	$0.45	$0.54	$0.26	$2.42	$2.71	TBD	$7.01
Total additional CIP		**$0.86**	**$1.27**	**$2.02**	**$2.01**	**$0.80**	**$6.29**	**$7.07**	**TBD**	**$20.3**

Note: Costs presented are order of magnitude conceptual estimates intended solely for the City's long-range planning needs.

7.5 Financial capability assessment

The City prepared the financial assessment recommended in EPA's guidance for Financial Capability Assessment and Schedule Development (EPA, 1987). Based on the appropriated SRF funds of $22.5M, the City's residential indicator score is 1.86% of the median household income. Therefore, the overall sewer improvements program costs are likely to exceed 2% of the City's median household income. The costs per household worksheets are included as Appendix 7-3.

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