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Combined Sewer Overflow Master Plan Update Study for Westbrook, ME

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Portland Water District

December 2008

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COMMITMENT & INTEGRITY DRIVE RESULTS

COMBINED SEWER OVERFLOW MASTER PLAN UPDATE STUDY FOR WESTBROOK, MAINE

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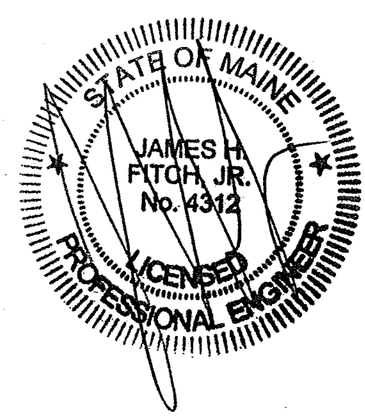

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1. EXECUTIVE SUMMARY

The Westbrook regional sewer/treatment system collects and treats wastewater from the City of Westbrook, Gorham and parts of Windham, Maine. There are five combined sewer overflow (CSO) outfalls that are part of the Westbrook sewer system.

The October 9, 1991 Administrative Consent Agreement between the Board of Environmental Protection, City of Westbrook (City) and the Portland Water District (PWD) required the submission to the Maine Department of Environmental Protection (MEDEP) of a sewer system master plan for the abatement of combined sewer overflows. This requirement was met with submissions of the *Sewer System Master Plan for Westbrook, Maine, December of 1993* and the *CSO Master Plan for Westbrook Maine, Volume II, December 1996* to MEDEP and the Environmental Protection Agency. The goal established in the *CSO Master Plan for Westbrook Maine, Volume II, December 1996* was to control CSOs to one overflow per year (on average). CSO monitoring over the last several years indicates that this abatement level has not been met.

The Portland Water District's most recent Maine Pollutant Discharge Elimination System Permit requires PWD to submit an update to the CSO master plan on or before December 31, 2008 for MEDEP's review and approval. In 2007 PWD initiated this study for the purposes of developing an updated CSO abatement plan and implementation schedule.

This study included the following tasks:

- Sewer system and rainfall monitoring.
- Sewer system modeling.
- A series of workshops with City and PWD staff to identify sources of surface water inflow and groundwater infiltration into the sewer system, identify major maintenance needs within the sewer system, the development of a list of potential CSO abatement projects, and identify planned road work that could be accomplished along with specific CSO abatement projects.
- The development of cost estimates for each CSO abatement project and any associated road work.
- The determination of the most cost effective CSO abatement projects.
- An examination of the appropriate CSO abatement level given current technologies and likely project costs.
- The development of a CSO Abatement Plan and an Implementation Schedule.

Conclusions and recommendations include:

- It is recommended that the CSO abatement level remains at one overflow per year (on average).
- It is likely that two of the five CSO outfalls can be closed once the CSO Abatement Plan has been fully implemented.
- The CSO Abatement Plan is presented in Section 6, the total cost of the CSO Abatement Plan is $21,639,000: this includes $14,687,000 for CSO abatement projects and $6,952,000 for extra road work

- The plan calls for eliminating all the remaining catch basins from the sewer system, replacing numerous old sewer pipes that experience excess infiltration with new sewer pipes, several sewer system optimization projects and off-line storage.
- Before off-line storage facilities are constructed all major CSO abatement projects should be completed and the sewer system is monitored for a period of time. Based on that monitoring the need for and the final size of the off-line storage facilities should be determined.
- The CSO Abatement Plan Implementation Schedule is presented in Section 8. The scheduling of projects was coordinated with the City to ensure a balance between implementing CSO abatement projects and planned road improvement projects. The Implementation Schedule is laid out such that project costs are more-or-less spread out evenly over 11 years. The first six years (2009 – 2014) of the schedule focuses on removing inflow and infiltration from the sewer system and several low cost optimization projects. The next four years (2015 – 2018) includes a combination of infiltration removal projects and optimization projects. The final years of the plan (2018 - 2019) calls for the determination if storage facilities are required and if they are then what would be their appropriate size.

2. BACKGROUND INFORMATION

2.1 INTRODUCTION

The Westbrook/Gorham/Windham regional sewer/treatment system collects and treats wastewater from the City of Westbrook (the City), Gorham and parts of Windham, Maine. The Portland Water District owns and operates the interceptor sewers, major pump stations and the treatment plant within this system. There are five combined sewer overflow (CSO) outfalls that are part of the Westbrook interceptor sewer system. These CSOs discharge to the Presumpscot River and are included in the Portland Water District's Maine Pollutant Discharge Elimination System (MEPDES) Permit #ME0100846, Maine Waste Discharge License (WDL) #W001510-5L-D-R, December 2006.

The October 9, 1991 Administrative Consent Agreement between the Board of Environmental Protection, City of Westbrook (City) and the Portland Water District (PWD) required the submission to the Maine Department of Environmental Protection (MEDEP) a sewer system master plan for the abatement of combined sewer overflows. This requirement was met with submission by the City and PWD of the Sewer System Master Plan for Westbrook, Maine, December of 1993 (a.k.a. CSO Master Plan for Westbrook, Maine, Volume I) to MEDEP and the Environmental Protection Agency (EPA). MEDEP and EPA provided review comments and requested additional information from 1994 to 1996. The PWD responded to the comments and requests for additional information in a series of letters over the same time frame. Copies of the MEDEP, EPA and PWD letters can be found in the CSO Master Plan for Westbrook Maine, Volume II, December 1996. The goal established in the CSO Master Plan for Westbrook Maine, Volume II, December 1996 was to control CSOs to the one year return period rain storm. This abatement level was approved by EPA on February 24, 1997 and MEDEP on March 26, 1997. CSO monitoring over the last several years has made it apparent that this abatement level has not been met.

The Portland Water District's Maine Pollutant Discharge Elimination System (MEPDES) Permit #ME0100846, December 2006 requires PWD to submit an update to the CSO abatement master plan on or before December 31, 2008 for MEDEP's review and approval.

In 2007 PWD initiated a study for the purposes of developing an updated CSO abatement plan and implementation schedule. The project team that worked on the study included PWD, the City of Westbrook, Woodard & Curran, Jordan Environmental Engineering, GIS Mapping and Analysis and Brown & Caldwell. This report summarizes the findings of the study and includes a recommended CSO Abatement Plan and an Implementation Schedule.

2.2 STUDY OBJECTIVES

The study objectives where:

- Determine the appropriate level of CSO abatement given current regulations, environmental awareness, likely construction costs and operational costs.
- Identify the appropriate set of CSO abatement projects that will result in meeting the target abatement level established above (CSO Abatement Plan).
- Develop an implementation schedule for the selected CSO abatement projects.

- Work with the City of Westbrook, Portland Water District and Maine Department of Environmental Protection to develop consensus and approval for the target abatement level, selected abatement projects and implementation schedule.

2.3 STUDY APPROACH

The following briefly describes the study's approach:

- A series of workshops was held with the City and PWD to identify potential CSO abatement projects including known sources of inflow such as catch basins and infiltration such as leaky sewers.
- Monitoring program – PWD collected flow data from the CSOs, selected locations within the sewer system, and the main pump stations within the study area. This data was analyzed to help identify areas of excess inflow/infiltration (I/I) and was used to help calibrate the sewer system model.
- Modeling – The sewer system model (EPA SWMM) developed during the original CSO study (circa 1990) was updated using the information gathered from the City during the workshops and calibrated (to the extent practical) using the monitoring data provided by PWD. The model was then used to analyze various abatement options.
- A list of potential abatement options was developed based on the aforementioned work shops with the City and PWD, a review of the monitoring data, and a hydraulic analysis of key portions of the sewer system. A cost estimate was developed for each project.
- A "cost per gallon of CSO removed" was developed for selected projects using the project cost estimates and the sewer system model. This information was used to help identify logical groups of projects that could be implemented to achieve varying levels of CSO abatement.
- The sewer system model was used to analyze various combinations of project groups to determine the most cost effective means of controlling CSOs to the one year return period rain storm. The sewer system model was also used to evaluate the recommended CSO abatement projects for the one, two and five year return period rain storms. Note: Return Period is defined as the average time interval between rain storms of a given or greater magnitude, usually expressed in years.
- A workshop was held with the City and PWD to coordinate the CSO work with other sewer system and road re-construction work. Based on this input a CSO Abatement Plan and an Implementation Schedule was developed.

2.4 SYSTEM DESCRIPTION

The Westbrook/Gorham/Windham regional sewer/treatment system collects and treats wastewater from the City of Westbrook, the town of Gorham and parts of the town of Windham, Maine. Ownership of the system is divided amongst the Towns of Gorham and Windham, the City of Westbrook and PWD. For the most part the collector sewers are owned by the town or city they are located in. PWD owns the interceptor sewers, major pump stations and the wastewater treatment facility (WWTF). The description of the sewer system that follows is based on where the sewers, interceptors and pump stations are located, not on who owns them. A map showing the major pump stations and sewer/drainage areas is located in the back of this report.

All flow to the Westbrook Regional Wastewater Treatment Facility (WWTF) comes from the systems two main pump stations, East Bridge Street Pump Station and Cottage Place Pump Station. The sewer/drainage areas flowing to each pump station are described below:

- East Bridge St. Pump Station Area – This area is located in the eastern part of the City and is composed of strictly sanitary sewers. All flows from this area are conveyed to the Westbrook WWTF via the East Bridge St. Pump Station. Since this area is completely separated and does not experience excessive inflow or infiltration it will not be considered in this study.
- Cottage Place Pump Station (CPPS) Area – This area is composed of the remaining sewers within the City of Westbrook and the sewers in Gorham and Windham.

Cottage Place Pump Station is fed by a single manhole that receives flow from two gravity sewer pipes and the Presumpscot River sewer crossing. These pipes and their associated sewer/drainage areas are described below:

- Park Road Area – A 15 inch diameter pipe that collects flow from an area that is mostly east of Cumberland Street and North of the Presumpscot River. There are no combined sewers or CSOs in this area.
- Water Street and Dana Court Pump Station Area – An 18 inch diameter pipe that collects flow primarily from the Dana Court Pump Station (DCPS) and several small gravity sewers in the Water Street area. Within the sewer system that flows to the DCPS there are several catch basins that are still tied into the sewer pipes and two active CSOs. The CSOs are the Brown Street overflow (CSO 007) and the King Street overflow (CSO 008). The sewer flow monitoring data and pump station flow records indicate that the sewers flowing to the DCPS experience a large amount of infiltration. Sewer flow monitoring is described in Section 3 – Sewer System Monitoring and Modeling.
- The Presumpscot River sewer crossing consists of a three barrel siphon. The outlet of the siphon is the aforementioned manhole that feeds the CPPS. The inlet of the siphon is located on the South side of the river.

The Siphon Inlet receives flow from two gravity sewer pipes and is also one of the three CSOs located on the South side of the Presumpscot River. The CSO located at this structure is referred to as the Siphon Inlet overflow (CSO 003). The two gravity sewer pipes and their associated sewer/drainage areas are described below:

- Main Street Area – A 21 inch diameter pipe collects flow from the areas on either side of Main Street. The Main Street area has two main sub-areas, these are the Deer Hill sub-area that flows to the Melcher Court Pump Station and the Warren Avenue sub-area that collects flow from the southern end of Haskell Street to Larrabee Road. The Warren Avenue sub-area flows to the Warren Avenue overflow (CSO 002).
- South Side Area – A 42 inch diameter pipe collects flow from the area West of Haskell Street and on the South side of the Presumpscot River. This is a large area and includes the sewer/drainage areas along Stroudwater Street, Spring Street, Saco Street, New Gorham Road and Way Side Drive (Route 25). This area includes one CSO, the Dunn Street overflow (CSO 004). The 42 inch pipe runs in a westerly direction to Gorham. This pipe is known as the South Side Interceptor and receives flow from the aforementioned sewer/drainage area and the towns of Gorham and Windham. The flows entering the South Side Interceptor from Gorham and Windham are measured at the Gorham Meter Station located near the Gorham/Westbrook town

line and Route 25. The flow data from the Gorham Meter Station indicates that as a whole, the Gorham and Windham sewer systems have very little extraneous inflow and infiltration in them and do not contribute to the CSO problem.

In summary, all the combined sewers and combined sewer overflows are located in the City of Westbrook. The hydraulic characteristics of the each CSO are discussed in Section 3 – Sewer System Monitoring and Modeling.

2.5 CSO ABATEMENT WORK COMPLETED SINCE 1993

Most, but not all of the abatement projects listed in the CSO Master Plan for Westbrook Maine, Volume II, December 1996 have been completed. The completed projects have resulted in two CSOs being eliminated from the Westbrook sewer system. The CSOs eliminated were the West Pleasant Street overflow (CSO 005) and the Dana Court overflow (CSO 006). In addition to the work in the 1996 Master Plan the City and PWD have recently completed (or have nearly completed) the CSO abatement projects listed in Table 2.1.

Table 2.1 – CSO Abatement Projects Implemented in 2008

No.	Project Name	Cost
N301	New bar racks at Cottage Place Pump Station – Scheduled completion date is December 31, 2008	$3,800,000
N504	Separate CB on Wayside Dr.	<$1,000
N601	Separate catch basin at intersection of Lincoln and Bridge Streets	<$1,000
N807	Replace 958 ft of sewers on Myrtle St.	~ $95,000

2.6 1996 TARGET ABATEMENT LEVEL

2.6.1 Background

The CSO Master Plan for Westbrook, Maine, Volume II, December 1996 established the abatement goal as the one year rain storm. This goal has not been met. The current objectives include establishing the appropriate abatement level for Westbrook given current regulations, environmental awareness, likely construction costs and operating costs. Over the years different measurements have been proposed for defining abatement levels. The two most common, "design storms" and "average number of overflows per year", are discussed below:

2.6.2. Design Storms

Design storms typically specify rainfall duration, total rainfall amount, rainfall distribution and (occasionally) the area that a rainstorm covers. Hydrology text books and storm water design manuals typically include information of this type. For example, Volume III: BMPs Technical Design Manual, Chapter 2 by the Maine Department of Environmental Protection (MEDEP) includes information on design storms for Southeast Cumberland County in Tables 2-1 and 2-2. The information in these tables establishes that a "one year storm" has a 24 hour rainfall of 2.5 inches with a SCS Type III rainfall distribution for an area of less than three square miles. Table 2.2 (in this report, see below) shows total rainfall and the rainfall distribution for a SCS Type III rainstorm for the 1 year, 2 year and 5 year return periods using the information in Volume III: BMPs Technical Design Manual.

Several challenges are associated with using a "design rainstorm" as an abatement goal, including:

- Real rainstorms seldom have a distribution that resembles the nice symmetrical distribution of a SCS Type III design storm.
- Occasionally the rainfall is not evenly distributed over the sewer system (this is often the case of summer time thunderstorms).
- Rainstorms occasionally last longer than 24 hours.
- This approach does not account for antecedent moisture conditions, groundwater infiltration, frozen ground or snowmelt, all of which can impact whether or not an overflow occurs for a particular rainstorm.

Table 2.2 - 24 Hour Rainfall Distribution (SCS Type III) for SE Cumberland County

Return Period →		1 year	2 year	5 year
Duration	% Rain	Rainfall Intensity (in/hr)		
6 min	8.4%	2.10	2.52	3.36
15 min	20%	2.00	2.40	3.20
1 hour	40%	1.00	1.20	1.60
2 hour	50%	0.63	0.75	1.00
3 hour	57%	0.48	0.57	0.76
6 hour	71%	0.30	0.36	0.47
12 hour	86%	0.18	0.22	0.29
24 hour	100%	0.10	0.13	0.17
Total Rainfall (inches)		**2.5**	**3.0**	**4.0**

2.6.3. Average Number of Overflows per Year

In this approach the average number of overflows per year (or the number of years between overflows on average) is specified. Although a fairly straight forward process, the data collection will require a number of years before it can be determined whether the abatement goal has been met.

To some extent the "average number of overflows per year" approach accounts for all the hard to measure variables such as frozen ground, snow melt, etc. For this reason it is recommended that the "average number of overflows per year" approach be used. Therefore, for the remaining portions of this report the 1996 goal will be interpreted as meaning "one overflow per year (on average)".

2.6.4. Comparison of Past Rain Storms to the SCS Type III Storm

Regardless of which approach is used, the City, PWD and DEP can get an estimate of whether or not an actual storm was close to a particular design storm by comparing summary statistics of the actual storm to the design storm of interest. Table 2.3 shows the 24 hour rainfall and maximum rainfall rates at various time periods for the SCS Type III, 1 year Return Period storm and several recent storms.

Table 2.3 - Summary statistics for an SCS Type III storm and several recent storms.

Maximum Rainfall Intensity for Selected Time Periods for Each Storm						
	SCS Type III, 1 yr storm	Jun 1, 2006	May 2, 2006	Oct 12, 2006	Apr 16, 2007	Sep 6, 2008
Time Period	Rainfall Intensity (in/hr)					
6 min	2.60	**9.22**	1.44	**3.31**	1.15	**3.02**
15 min	2.00	**4.36**	0.72	**2.32**	0.88	1.72
1 hour	1.00	**1.38**	0.54	0.93	0.59	0.99
2 hour	0.63	**0.69**	0.42	0.61	0.57	**0.88**
3 hour	0.47	0.46	0.39	**0.49**	**0.54**	**0.76**
6 hour	0.30	0.25	**0.31**	**0.44**	**0.50**	**0.67**
12 hour	0.18	0.12	**0.23**	**0.24**	**0.40**	**0.46**
24 hour	0.10	0.06	**0.17**	**0.12**	**0.25**	**0.23**
24 hr Rainfall	2.5 in	1.49 in	4.04 in	2.9 in	5.89 in	5.57 in

Note: Bold numbers indicate rainfall rates that exceed the SCS Type III, 1 Return Period storm.

2.6.5. Discussion

The DEP has requested that in addition to looking at how to control CSOs to one overflow per year (on average), that the study also consider various abatement alternatives to essentially eliminate all combined sewer overflows from the system (see letter from John True (DEP) to Mike Greene (PWD) dated January 2, 2007). The target abatement level needs to consider both technical feasibility and affordability. Therefore, before an abatement level can be recommended both the technical feasibility and likely costs need to be assessed; these issues will be addressed in Sections 4 and 5 of this report and the recommended abatement level will be discussed in Section 7.

3. SEWER SYSTEM MONITORING & MODELING

3.1 INTRODUCTION

The analysis of flow data and sewer system modeling were important parts of this study. The sewer system monitoring and modeling efforts are briefly described below. A separate report providing additional details on the monitoring and modeling program will be issued in 2009.

3.2 SEWER SYSTEM MONITORING PROGRAM

PWD collected rainfall and flow data and made it available for analysis. The flow data was used to help identify problems within the sewer system as well as calibrate the sewer system model. Additional details regarding the monitoring program will be provided in a separate report.

3.3 SEWER SYSTEM MODEL

The Westbrook sewer system model was first developed in 1990 using an early version of EPA's Storm Water Management Model (SWMM). The Westbrook model has since been updated to EPA's SWMM5 version. Over the years minor adjustments to the model have been made but no overall calibration on a catchment by catchment basis has been conducted.

The accuracy of any sewer system model is dependent upon the calibration of the model using monitoring data collected at key points within the sewer system. Unfortunately, only a few large storm events have occurred since the start of this study thus providing only a limited amount of data for calibrating the model. The base flow used in the model has been adjusted to reflect recent additions to the sewer system as well as a moderate amount of future growth in the sewer system.

The current model is appropriate for facility level planning decisions, such as the development of a CSO abatement plan. However, additional calibration should be performed prior to using the model as a design tool for the final sizing of storage facilities, upgrading pump stations, etc. A separate report describing the model, its current calibration and recommendations for additional monitoring will be issued in 2009.

4. POTENTIAL CSO ABATEMENT PROJECTS

4.1 INTRODUCTION

This Section of the Report identifies all potential CSO abatement projects considered as part of this study. This Section also provides cost estimates for most of these projects and a brief description of the major projects that are included in the Recommended CSO Abatement Plan. The Recommended CSO Abatement Plan is presented later in this Report (see Section 6 – CSO Abatement Plan).

Over the course of the study, potential CSO abatement projects were identified and evaluated. Some of the means in which projects were identified included:

- A series of workshops were held with Westbrook City staff that was familiar with the existing sewers. City staff identified all the remaining catch basins within the sewer system and areas where excessive infiltration occurs.
- A review of the monitoring data helped identify where problems exist within the system. The problems included areas of excess inflow/infiltration as well as sewer system backups. With this knowledge, potential projects were identified that would resolve these problems.
- A hydraulic analysis of key portions of the sewer system was conducted. This analysis helped identify capacity issues in sewer pipes and CSO regulators (overflow weir elevations and flow orifices).
- Brown & Caldwell reviewed the list of potential CSO projects and provided ideas for additional projects based on their national CSO abatement experience.

Section 4.2 presents an overview of the types of projects that were considered as part of this study while Section 4.3 provides additional discussion regarding these projects. A list of all projects considered as part of this study and a short description of each project is provided in Appendix 1.

4.2 TYPES OF CSO ABATEMENT PROJECTS CONSIDERED

In Westbrook, CSOs are primarily caused by inflow, although excess infiltration certainly contributes to CSOs during extended wet periods. Since inflow is the primary cause of CSOs, any successful abatement plan will need to consider projects that reduce inflow or manage it once it is in the system.

The statement that "CSOs are primarily caused by inflow" is not meant to diminish the importance of sewer replacement projects and other infiltration reduction projects. Excess infiltration uses up sewer pipe capacity, pump station capacity and storage capacity (if storage is included in the sewer system). Therefore, if in the long run, CSOs are to be eliminated or at least minimized to the extent practical, excess infiltration needs to be eliminated where it is affordable.

Inflow Reduction: Sewer system monitoring and modeling have shown that the amount of inflow that is easily removed from the combined sewer system (i.e. removing the remaining catch basins from the combined sewer system) will not by itself allow the sewer system to reach the 1996 abatement goal of the one overflow per year (on average). CSOs can be further abated by reducing miscellaneous inflow sources such as roof drains, field drains, etc. Identifying and eliminating miscellaneous inflow sources is likely to be an important part of a long term CSO abatement strategy, but given the monitoring data available it is not possible to quantify the amount of miscellaneous inflow that can economically be removed from the overall sewer system. Since it is difficult to estimate how much miscellaneous inflow can be removed from the system it has been assumed that only a relatively small amount will be removed. Miscellaneous inflow removal will be discussed in more detail later in the report (see Section 6.3.2).

Inflow Management: Independently or in conjunction with inflow removal, there are three main abatement strategies that can be used to reduce CSOs or their impacts on receiving water quality; these are: 1) increase the peak flow from the Dana Court and Cottage Place pump stations, 2) install end of the pipe treatment technologies such as swirl treatment, high rate disinfection and floatables control, and 3) install storage facilities. These strategies are further described below:

- Increase Peak Flow from the Dana Court and Cottage Place Pump Stations - A series of SWMM model runs were conducted to determine the peak capacity of the Dana Court and Cottage Place pump stations required to eliminate overflows resulting from the one year storm event, assuming all inflow sewer separation projects had been completed. The model indicated that the CPPS would need to be upgraded from 12 MGD to 22 MGD and that the Dana Court Pump Station would need to be upgraded from 3.5 MGD to 7.1 MGD. The CPPS pumps wastewater to the Westbrook Waste Water Treatment Facility (WWTF). Therefore, the Westbrook WWTF will require upgrading in conjunction with the CPPS project. Increasing the peak flow capacity of the CPPS and the Westbrook WWTF would be very expensive and likely cause operational problems at the WWTF. Therefore, increasing the CPPS peak flow capacity will not be further considered.
- End of the Pipe Treatment (Solids Reduction and Disinfection) – Although this may be a potential option, there is a very real concern regarding the reliability of such systems when they are located at a remote sight such as the Siphon Inlet. These types of facilities are expected to automatically start up without any prior notice while having been inactive for an extended period of time and require the storage of large volumes of a chemical disinfectant at the remote site. For this reason the City and PWD have agreed not to include an analysis of end of the pipe treatment options as part of this study. Once a draft abatement plan and the associated costs have been developed using sewer separation, sewer rehabilitation, system optimization, storage, etc. the decision to look at end of the pipe treatment can be re-visited if appropriate.
- End of the Pipe Treatment (Floatables Control) – Floatables control was considered for all overflows that are likely to remain after all recommended CSO abatement projects have been implemented.
- Storage – Installation of new storage facilities, in conjunction with optimization projects, will aid in meeting the 1996 abatement goal. These storage and optimization projects were investigated as part of this CSO Abatement Study and the results of these investigations are presented in this report.

4.3 PROJECTS

Potential CSO abatement projects identified for Westbrook have been divided into the following categories:

Inflow Reduction – These projects reduce or eliminate direct inflow into the sewer system, they are primarily sewer separation projects that eliminate catch basins from the combined portions of the sewer system or remove miscellaneous inflow sources such as roof drains.

Infiltration Reduction – Infiltration reduction projects typically sewer replacement projects that replace old, leaky sewers with new sewers or the lining of old sewers. It is very hard to estimate just how much infiltration will be removed from the sewer system for any particular sewer replacement/lining project. The inclusion of sewer replacement/lining projects in a CSO abatement plan are typically based on one of the following criteria:

- Observations from operating staff or flow monitoring data indicate that a particular stretch of sewer generates a significant amount of flow when the groundwater is high. A good example of this is the old stone sewer on Seavey Street.
- Field inspection has indicated that a sewer has severely deteriorated and is likely to structurally fail in the near future. Sewers to be replaced for this reason are often done as part of an overall street reconstruction program.

Infiltration reduction is important because excessive infiltration reduces sewer capacity and increases the volume of combined sewer overflows during rain events. Infiltration reduction projects are typically not the most cost effective means of reducing CSOs, but they are an important part of most CSO abatement plans and sewer system capital improvement plans for the reasons stated above.

For the purposes of this Report, "sewer replacement projects" are roughly defined as projects that are required as part of a long term sewer maintenance program and also reduce CSOs by reducing infiltration.

Storage and Optimization – The previous two categories reduce CSOs by reducing the amount of storm water or groundwater entering the combined sewer system. Storage and optimization projects, on the other hand, reduce CSOs by effectively managing storm water and/or groundwater after it enters the combined sewer system. In Westbrook, there are two locations where storage could be effectively used; the Siphon Inlet (SI) and the Dana Court Pump Station (DCPS). Potential optimization projects for the Westbrook sewer system include increasing the capacity of the Dana Court Pump Station, increasing the size of selected sewer pipes and modifying CSO regulators.

Non-CSO System Upgrades and Repairs – For the purposes of this report "non-CSO system upgrades and repairs" do not directly reduce CSOs, but are necessary to avoid structural, mechanical or electrical failures that may result in increased CSOs, erosion or other adverse consequences. These projects are identified in this report because they need to be part of the overall sewer system capital improvement plan from both scheduling and budgeting standpoints. An example of this type of project would be the installation of bar racks at the CPPS: this project in itself will not reduce CSOs, but experience has indicated that if proper screening is not provided at the pump station the pumps clog during wet weather thus reducing the stations peak capacity which results in increased CSO volumes at the Siphon Inlet and Dunn Street overflows.

Floatable Control – Floatable control projects reduce the amount of visible debris contained in overflows. PWD retained the services of Brown & Caldwell to evaluate floatable control options for the Portland, Maine CSOs. Many of the conclusions found in Brown & Caldwell's report (*Conceptual Design of CSO Floatable and Odor Control, July 2005*) are applicable to the Westbrook CSOs. The report concluded that for CSOs that overflow less than five times per year and with flow rates of less than 5 MGD, static screens are typically the most appropriate screening technology. The floatable controls considered for this project were limited to static screens and underflow baffles.

Potential CSO abatement projects, as sorted by the categories defined above are presented in Tables A2.1 through A2.5 located in Appendix 2. These projects are described as "potential" because not all projects are likely to be cost effective and some may be unnecessary to meet the abatement goal or may even be counter productive depending upon what other projects are included in the final abatement plan.

Many of the abatement projects will require excavation and partial repaving of City streets. Many of these same streets are in need of additional work such as full width repaving, side walks, etc. The City has identified the additional road work they are likely to want to undertake along with the associated CSO abatement project.

Tables A2.1 through A2.5 also include a cost estimate for most of the projects. The cost estimates should be considered conceptual (appropriate for planning purposes only), given that the "scope of work" may change prior to approval of the abatement plan by MEDEP. The costs are broken into two categories; "Base Cost" is defined as the costs directly tied to CSO abatement; these costs are likely to be eligible for State Revolving Funds (SRF). The costs identified as "Extra Road Work" include the costs associated with road work and sidewalks which may be completed by the City in conjunction with the CSO abatement projects. Detail cost estimates for most projects are provided in Appendix 3.

The Inflow Reduction projects are listed in Table A2.1; these are the most cost effective (lowest cost per gal) projects for reducing CSOs available to the City and PWD. The Infiltration Reduction projects are listed in Table A2.2. As discussed in Section 4.2, it is hard to estimate the reduction in CSO volume associated with a given infiltration reduction project. However, including these projects into the abatement plan is important for the following reasons:

- Infiltration contributes to the CSO volume during wet periods.
- Failure to maintain the sewer system can result in pipe failures which may lead to dry weather overflows.
- Timing the project with street reconstruction presents significant cost savings.

The Potential Storage and Optimization projects are listed in Table A2.3. In order to see a benefit from most of the optimization projects that are applicable to the Westbrook sewer system, the projects need to be done in conjunction with storage at the Siphon Inlet or increased pumping and/or storage at the Dana Court pump station, otherwise optimization projects (like raising overflow weirs or increasing pipe sizes) in most cases will simply push the problem downstream to the next CSO.

Non-CSO system upgrades and repairs are listed in Table A2.4. The largest of these projects, the installation of new screens at the Cottage Place Pump Station, is scheduled to be substantially complete by the end of 2008. Table A2.5 lists the floatable control projects that were considered as part of this study.

4.4 PROJECT COST ESTIMATES

Many of the potential CSO abatement projects require street work as part of the project. It was recognized that it would be to everyone's advantage to coordinate the CSO work with any street work (such as full width reconstruction, side walks, etc.) that the City was planning to under take. Once the potential projects had been identified they were reviewed with the City to determine if the City wanted to undertake additional street work and what the scope of work would be.

When developing cost estimates, each CSO project cost estimate was developed as if that project was a stand alone project; the CSO project cost estimates are referred to as the project's "Base Cost". The costs associated with any additional road work are identified as "Extra Road Work".

Unless stated otherwise, all cost estimates are based on 2008 dollars (ENR Construction Cost Index = 8200). Many of the projects identified in this study will not be built for some years, thus their actual costs will likely be greater to the extent that inflation increases the cost of engineering, materials and construction.

5. ABATEMENT OPTIONS

5.1 INTRODUCTION

One of the goals of the Study was to develop a CSO Abatement Plan. This section of the Report outlines how projects were selected for inclusion into the recommended CSO Abatement Plan. During each step of the selection process the following criteria were used to be sure that each project fit in with the overall CSO Abatement Plan and the City's long term road/utility maintenance plans:

- CSO volume or peak flow rate reduction
- Cost effectiveness, i.e. "Cost per Gallon of CSO Removed"
- Interactions with other projects, i.e. some projects only make sense when paired with another project
- Sewer system maintenance needs
- Coordination with needed road work or other utility work

Many parts of the Westbrook sewer system are hydraulically connected to other parts of the system thus there is little value in analyzing individual CSO abatement projects since one CSO abatement project is very likely to impact the net results of nearby abatement projects. For this reason the approach used in the study was to develop logical groups of projects and to evaluate their effectiveness in abating CSOs. The following process was used for selecting and evaluating projects for meeting various CSO abatement levels and for inclusion into the final CSO Abatement Plan.

- Selected projects from each project category (see Section 4.3) were evaluated on an individual basis to determine their cost effectiveness and to establish a representative "Cost per Gallon of CSO Removed" for each category.
- Based on the previous step, an initial group of projects was identified as being the most cost effective projects to be implemented.
- Additional groups of projects were identified that could be implemented in conjunction with the initial group of projects to obtain a higher level of CSO abatement.
- The SWMM model was run for the "Base Case" using the SCS Type III, 1 year return period (2.5 inches) rainfall. This rainstorm was selected for the initial evaluations because it was the goal that was established in the CSO Master Plan for Westbrook, Maine, Volume II, December 1996. The "Base Case" model simulates the sewer system as it existed as of June 1, 2008 and calibrated using data supplied by the City and PWD.
- The SWMM model was modified to represent the implementation of a group or groups of projects then run using the aforementioned rainfall distribution. The CSO volumes for the Base Case and the modified model were compared for each overflow. This provided an estimate of the CSO reduction of initial group of projects and combinations of project groups.
- The "average cost per gallon of CSO reduction" for the initial group of projects and combinations of projects was calculated using the cost information presented in Appendix 2 and the CSO reduction estimates made in the previous step.

5.2 DETERMINATION OF "COSTS PER GALLON OF CSO REMOVED" FOR LOGICAL GROUPS OF PROJECTS

The process for selecting projects for a particular grouping began by selecting the projects with the most favorable cost/benefit ratio (hereinafter referred to as Group 1); then adding what was likely to be the next most economical project or groups of projects until all CSOs were abated for the one year storm. A brief description of the six project groups is presented Table 5.1.

Table 5.1 – Description of Project Groups

Project Group	General Description
Group 1	Inflow reduction projects (sewer separation projects).
Group 2	Disconnecting approximately 100 roofs from the sewer system.
Group 3	Selected optimization projects, 0.25 Mgal of storage at the Siphon Inlet and upgrading the DCPS to 5.2 MGD.
Group 4	Same as Group 3 except that the storage at the Siphon Inlet was increased to 0.40 Mgal.
Group 5	Same as Group 3 except the storage at the Siphon Inlet was increased to 0.50 Mgal and 0.09 Mgal of storage was added at DCPS.
Group 6	Same as Group 3 except the storage at the Siphon Inlet was increased to 0.50 Mgal and the peak flow from the DCPS was increased to 7.1 MGD.

Six model runs were made to determine the abatement levels resulting from the following combination of projects:

- Run 1 – Group 1 projects
- Run 2 – Group 1 + Group 2 projects
- Run 3 – Group 1 + Group 3 projects
- Run 4 – Group 1 + Group 4 projects
- Run 5 – Group 1 + Group 5 projects
- Run 6 – Group 1 + Group 6 projects

Tables 5.2 through 5.7 list the individual projects that were included in each of the six model runs. These tables include cost estimates for each project (see Section 4.4 for additional details regarding cost estimates).

Tables 5.8 present the results of the six SWMM model runs. Table 5.9 summaries the cost for each of the project group combinations for the model runs and the associated cost per gal of CSO removed relative to the base case.

Table 5.2 – Run 1 (Group 1 Projects)

No.	Project Name (or Brief Description)	Base Cost	Extra Road Work Cost	Total Cost
N201A	Separate catch basin on Rochester and Haskell Streets	$85,000	$0	$85,000
N207	Progressively monitor sewer pipes to determine what parts of the system still have excessive I/I.	$25,000	$0	$25,000
N302	Connect 8 catch basins on Cumberland Street to storm drain system.	$1,200,000	---	$1,200,000
N303	Replace or eliminate various sewer pipes near the end of Melcher Court.	Incl. in N302	---	
N304	Replace sewer in gully next to Melcher Court (from Newcomb Place).	Incl. in N302	---	
N305	Monitor sewers East of Siphon.	$25,000	$0	$25,000
N401	Separate catch basins on Pleasant St., etc.	$1,271,000	$1,175,000	$2,446,000
N501	Separate catch basins on Maple Street	$410,000	$422,000	$832,000
N503	Separate catch basins on Glenwood St.	$80,000	$0	$80,000
N504	Separate catch basins on Wayside Dr.	Done	---	
N601	Separate catch basin at intersection of Lincoln and Bridge Streets	Done	---	
N606	Sewer system monitor in Pike St. area.	$25,000	$0	$25,000
N703	Separate catch basin at intersection of Brown and Reserve Streets	$168,000	$0	$168,000
N803	Flow monitor incoming pipes to better quantify CSO peak flows and volumes.	$25,000	$0	$26,000
	Total	**$3,314,000**	**$1,597,000**	**$4,911,000**

Table 5.8 - Model results for various abatement options for the one year design rainstorm.

	CSO 002	CSO 003	CSO 004	CSO 007	CSO 008	Total	
Project Group	CSO Vol (ft^3)	CSO Vol (ft^3)	CSO Vol (ft^3)	CSO Vol (ft^3)	CSO Vol (ft^3)	**CSO Vol (Mgal)**	Comments
Base Case	8389	44011	50029	7504	13443	**0.923**	
Run 1	1517	21516	19513	4730	13443	**0.454**	Group 1 Projects - All major sources (catch basins) of inflow removed from combined sewer system
Run 2	915	17139	17969	3858	12129	**0.389**	Group 1 projects plus 2.0 ac of misc. Inflow (roof drains) removed
Run 3	0	12066	1204	3911	0	**0.129**	Group 1 projects plus most Optimization projects, 0.25 Mgal of storage at the Siphon Inlet and DCPS Qpeak = 5.2 MGD
Run 4	0	0	0	3911	0	**0.029**	Same as Run 3 except storage at Siphon Inlet was increased to 0.4 Mgal
Run 5	0	0	0	0	0	**0**	Same as Run 3 except storage at Siphon Inlet was increased to 0.5 Mgal and 0.09 Mgal of storage was added at the DCPS
Run 6	0	0	0	0	0	**0**	Same as Run 3 except storage at Siphon Inlet was increased to 0.5 Mgal and DCPS Qpeak = 7.1 MGD

Table 5.9 - Summary of cost information for project groups.

	Model Run					
	Run 1	**Run 2**	**Run 3**	**Run 4**	**Run 5**	**Run 6**
Run Description	Group 1 Projects	Group 1 Projects + 100 roof drains disconnected	Group 1 Projects + Optimization projects, storage at SI = 0.25 Mgal	Same as Run 3 except storage at SI increased to 0.40 Mgal	Same as Run 3 except storage at SI = 0.50 Mgal,, storage at DCPS = 0.09 Mgal	Same as Run 3 except storage at SI = 0.50 Mgal,, increase Qpeak at DCPS to 7.1 MGD
Cost of New Projects	$3,314,000	$100,000	$4,061,000	$920,000	$860,000	$860,000
Total Cost	$3,314,000	$3,414,000	$7,375,500	$8,295,000	$9,155,000	$9,155,000
Incremental "Cost per gal"	$7.07/gal	$1.54/gal	$12.50/gal	$9.20/gal	$29.66/gal	$29.66/gal
Average "Cost per gal"	$7.07/gal	$6.39/gal	$9.29/gal	$9.28/gal	$9.92/gal	$9.92/gal

needs to be conducted. As an alternative to increasing the peak flow to 7.1 MGD off-line storage may be more reliable and cost effective (see Run 5).

6. CSO ABATEMENT PLAN

6.1 RECOMMENDED CSO ABATEMENT PLAN

The City's and PWD's preferred approach for abating CSOs in Westbrook is to identify and eliminate as much inflow/infiltration as is practical, to optimize the sewer system to eliminate any bottle necks within it, and as a last resort to install storage facilities. Most of the projects analyzed in Section 5.2 have been included in the CSO Abatement Plan.

Section 5.2 focused on inflow reduction, sewer system optimization and storage projects in part because these types of projects are typically more cost effective at abating CSOs when compared to infiltration reduction projects, and in part because these types of projects are easier to model than infiltration reduction projects. In the development of the CSO Abatement Plan, infiltration reduction projects have been included for the following reasons:

- The DEP has requested that in addition to looking at how to abate the CSOs to one overflow per year (on average) that the study also consider various abatement alternatives to essentially eliminate all combined sewer overflows from the system (see letter from John True (DEP) to Mike Greene (PWD) dated January 2, 2007). One approach to eliminating all CSOs would be to reduce the inflow/ infiltration to the point were the sewers and pump stations could convey all flows to the WWTF. This has been the approach that the City of Westbrook has been pursuing for a long time, and to the extent practical would like to continue to pursue. Therefore, in the development of the abatement plan and the associated implementation schedule, inflow and infiltration reduction projects have been given a high priority.
- There are a number of City Streets that need repaving over the next 10 years; the sewers within many of these streets are older sewers in bad condition and sources of excess infiltration. It makes economic sense to replace these sewers at the same time the streets are being re-paved. Eliminating the excess infiltration associated with theses old sewers will reduce CSOs by freeing up sewer pipe and pump station capacity.

The infiltration reduction projects that were included in the CSO Abatement Plan are primarily sewer replacement projects. Several workshops were held with the City to identify which projects were likely to result in the greatest reduction of CSO volume and to coordinate the implementation of the sewer replacement projects with street reconstruction plans.

A draft CSO abatement plan was developed and presented to the City and PWD. The draft plan was modified based on comments received from the City and PWD. The CSO Abatement Plan is presented in Table 6.1; many of the projects are self explanatory but if the reader is interested in additional details these can be found in Appendix A-1. The Implementation Schedule associated with the CSO Abatement Plan is presented in Section 8.

The CSO Abatement Plan was based on meeting the 1996 abatement goal of one overflow per year (on average). Abatement options for a higher level of control are discussed in Section 7.

Table 6.1 – 2008 CSO Abatement Plan

No.	Project Name (or Brief Description)	Base Cost	Extra Road Work Cost	Total Cost
N207, etc.	Continue monitoring the Westbrook sewer system to identify excessive inflow/infiltration. $50k per year for 11 years.	$550,000	---	$550,000
N205, etc.	Develop and implement a miscellaneous removal program	$100,000	---	$100,000
N201A	Separate catch basin on Rochester and Haskell Streets	$85,000	---	$85,000
N202A	Enlarge sewer pipe form Warren Ave. regulator to Interceptor	$57,000	---	$57,000
N203A	Raise overflow weir	$5,000	---	$5,000
N204	Replace stone sewer on Seavey Street	$362,000	---	$362,000
N302	Connect 8 catch basins on Cumberland Street to storm drain system.	$1,200,000	---	$1,200,000
N303	Replace or eliminate various sewer pipes near the end of Melcher Court.	Incl. in N302	---	---
N304	Replace sewer in gully next to Melcher Court (from Newcomb Place).	Incl. in N302	---	---
N311	Line sewer on Main St.	$209,000	---	$209,000
N313	Replace sewers on Spiers and Stevens Streets	$500,000	$500,000	$1,000,000
N401	Separate CBs on Pleasant St., etc.	$1,271,000	$1,175,000	$2,446,000
N402	Seal off overflow flap gate	$1,000	---	$1,000
N403A	Raise overflow weir	$50,000	---	$50,000
N404	Decrease plugging by enlarging sewer connection to interceptor.	$66,000	---	$66,000
N406	Replace sewers on Cloudman St., etc.	$611,000	$1,166,000	$1,777,000

N407	Line sewer on Stroudwater St., etc.	$243,000	---	$243,000
N501	Separate catch basins on Maple Street	$410,000	$422,000	$832,000
N503	Separate CB on Glenwood St.	$80,000	---	$80,000
N505	Replace sewers on New Gorham Road & Longfellow St.	$904,000	$1,356,000	$2,260,000
N506	Replace sewers on Conant St. and Route 25	$1,088,000	$730,000	$1,818,000
N602	Replace sewers on Mitchell St., etc.	$800,000	$1,502,000	$2,302,000
N603	Replace sewer on Chestnut St.	Included in N602	---	---
N604	Line leaky sewer on Kennard St.	Included in N602	---	---
N702B	Connect upper part of Cole St. Gully sewer to storm drain	$200,000	---	$200,000
N703	Separate catch basin at intersection of Brown and Reserve Streets	$168,000	---	$168,000
N704	Enlarge pipe from CSO 007 to Dana Court PS	$512,000	---	$512,000
N705A N705B	Raise overflow weir & install underflow baffle at Brown St. overflow	$12,000	---	$12,000
N801	Enlarge pipe from CSO 008 to Dana Court PS	$359,000	$101,000	$460,000
N802A N802B	Raise overflow weir & install underflow baffle at King St. overflow	$12,000	---	$12,000
N203B	Install static screen for floatables control at Warren Ave. overflow	$29,000	---	$29,000
N308	Install static screen for floatables control at Siphon Inlet overflow	$44,000	---	$44,000
N403B	Install static screen for floatables control at Dunn St. overflow	$34,000	---	$34,000
N701A	Evaluate the sewer system flowing to the Dana Court PS to determine the best way to continue to abate CSOs	$25,000	---	$25,000

N701B N708	Storage facility at DCPS and/or increase capacity of Dana Court PS	$1,200,000	---	$1,200,000
N306A	Evaluate the Westbrook sewer system, CSO 003 & CSO 004 to determine the best way to continue to abate CSOs	$40,000	---	$40,000
N306B	Storage Facility (0.50 Mgal) at Siphon Inlet	$3,460,000	---	$3,460,000
	Total	**$14,687,000**	**$6,952,000**	**$21,639,000**

The total cost of the CSO Abatement Plan is $21,639,000: this includes $14,687,000 for CSO abatement projects and $6,952,000 for extra road work.

6.2 ANALYSIS OF CSO ABATEMENT PLAN

The base case SWMM model was modified to reflect the implementation of the 2008 CSO Abatement Plan projects and run using rainfall data for both single event simulations and extended period simulations. The single event simulations were the SCS Type III, 1 year, 2 year and 5 year return period rainstorms, the extended period simulation used rainfall data for 2006 and 2007. The 2006 and 2007 rainfall data was actual rainfall data collected in Westbrook and modified to account for snowfall and snowmelt. The results of the simulations are presented in Table 6.2 and 6.3.

Table 6.2 – Simulation Results for Single Event Simulations

Overflow Volume (Mgal)			
	1 yr Return Period	2 yr Return Period	5 yr Return Period
CSO 002	0	0	0
CSO 003	0	0	0.41
CSO 004	0	0	0.12
CSO 007	0	0	0.01
CSO 008	0	0	0
Total	**0**	**0**	**0.54**

Table 6.3 – Simulation Results for Extended Period Simulations

Overflow Volume (Mgal)		
	June 1, 2006	April 16, 2007
CSO 002	0	<0.01
CSO 003	0	1.3
CSO 004	<0.01	0.1
CSO 007	0.1	0
CSO 008	0	0
Total	**0.1**	**1.4**

The results of single event simulations showed no overflows for the one and two year rain events, and no overflows at the Warren Avenue overflow (CSO 002) and the King Street overflow (CSO 008) for the five year rain event. The Siphon Inlet, Dunn Street and Brown Street CSOs did overflow for the five year return period storm.

There were only two overflows for the extended period simulation (2006 and 2007 rainfall) as indicated in Table 5.12. Similar to the single event simulations there was little or no overflow activity at the Warren Avenue and King Street overflows for the extended period simulation.

The results of the simulations shows that the CSO Abatement Plan meets or exceeds the one overflow per year (on average) goal established in the *CSO Master Plan for Westbrook, Maine, Volume II, December 1996.* In order to obtain higher levels of abatement, the storage facility at the Siphon Inlet would need to be enlarged and the storage facility at the Dana Court Pump Station would need to be added or enlarged (see Section 7 for additional discussion).

6.3 DISCUSSION OF KEY PROJECTS

The design and implementation of most of the projects contained in the CSO Abatement Plan will be straight forward, but there are several projects that require additional discussion. These projects are presented and discussed below.

6.3.1 N207, Etc. – Continued Monitoring

Continued monitoring is important for the following reasons:

- The monitoring data collected to date was not adequate to fully calibrate the Westbrook sewer system model, therefore additional data is needed to calibrate key parts of the model. Having a well calibrated model is essential in order to have confidence in its predictions and ultimately in having confidence that the CSO Abatement Plan will result in the target abatement level.

- Additional monitoring is one of the main tools available to identify areas of excess infiltration/inflow (I/I) within the system. By knowing where the excess I/I is occurring, projects can be developed and evaluated to determine if it is cost effective to remove the excess I/I.
- Monitoring during the implementation period will allow the City, PWD and DEP to track how effective individual abatement projects are once they have been constructed and how effective the overall program is at any point in time.
- Once the CSO Abatement Plan has been fully implemented ongoing monitoring will be required to determine if the abatement goal has been meet.

6.3.2 N205, Etc. – Develop and Implement a Miscellaneous I/I Removal Program

Two sources of inflow that are considered primary contributors to CSO volume are roof drains and sump pumps that are directly connected to the sanitary sewer system. Currently, these types of connections to the sanitary sewer system are in violation of Westbrook City Code Section 26-29(a). While increased enforcement of the code is an option, a formal disconnection program based on public education (and potentially financial assistance) is likely to be a more politically acceptable solution. This type of program is currently utilized in many communities across the country and has been shown to be cost effective.

It is recommended that the City of Westbrook consider the development of a program to accomplish roof drain and sump pump disconnections where soils, topography, and land use make it feasible. The separation program should be developed to identify critical areas of need, map and inventory private connections, and provide outreach, incentives and technical support to landowners willing to consider separation. The program could be established through the following steps:

- Develop a GIS-based map of the sanitary sewer drainage areas that exhibit excess inflow. Use this drainage map as a basis for further investigation. GIS analysis within the target drainage areas would include an evaluation of hydrologic soil groups present, parcel size, type of land use, and existing storm and sanitary sewer infrastructure.
- Based on preliminary analysis of the drainage areas, disconnection performance standards should be established to avoid creation of other problems. Typical performance standards for disconnections include; property slope, property soils, setbacks from buildings, basement versus slab foundations, access complications related to downspout surface extensions, and likely flow paths from disconnected outlet. The development of appropriate performance standards could be drainage area or property specific and should be developed with consultation from public works and plumbing/code enforcement. It may be determined through this process that some drainage areas or properties are not appropriate for disconnection due to performance criteria and are dropped from future steps and program incentives.
- Conduct door-to-door surveys within target drainage areas to determine parcel specific connections. Surveys could be conducted by summer interns with specific training related to project background, information to be collected, how to approach landowners, effective homeowner education tips, personal safety and data collection technologies. The City may want to consider using digital data collection forms where appropriate in order to streamline data entry and quality control. Rooftop connections will be apparent to surveyors while sump pump connections may require pre-stamped mailings or detailed property owner interviews.

- Once surveys are complete the City should determine the appropriate level of a rebate/incentive program for private disconnection. The rebate/incentive program may apply only to priority disconnection areas or may apply city-wide.
- Develop outreach letters and/or education materials to be sent to landowners with roof drains or that may have sump pumps. The outreach information would include a letter/pamphlet outlining the importance of disconnection and an overview of the disconnection program and policies. The outreach material could also include a "how-to" for do-it-yourself disconnection and the development of a property map that will assist City program managers with the implementation of a disconnection project. The development of a web-based link on design and installation of more complex systems such as rain gardens, soakage trenches, drywells and others should be considered as a part of the outreach development program.
- Conduct follow-up within target drainage areas for implementation of disconnection projects.

6.3.3 N403A – Raise Overflow Weir at Dunn Street Overflow

The Dunn Street overflow consists of a one foot square overflow flap gate with an invert elevation of 43.5 feet and an overflow weir at elevation 45.0 feet. The Dunn Street overflow is located upstream of the Siphon Inlet, therefore the hydraulic grade line at the Dunn Street overflow is always at a higher elevation than it is at the Siphon Inlet. During heavy rains the hydraulic grade line at the Dunn Street overflow can be as much as 5 feet higher than it is at the Siphon Inlet. Currently, the invert of the flap gate at the Dunn Street overflow is 1.5 feet below the overflow weir at the Siphon Inlet, this means that overflows start earlier and continue longer at the Dunn Street overflow as compared to the Siphon Inlet overflow. It is relatively easy to seal off the Dunn Street flap gate and this should be done as soon as possible.

Once the flap gate is sealed off, the overflow weirs at Dunn Street and the Siphon Inlet will be at the same elevation. In order to optimize the system the relative elevations of the two weirs should be adjusted such that the Dunn Street overflow weir is at least 2 feet higher (and preferably 3 feet higher) than the overflow weir at the Siphon Inlet. Optimizing the system in this manner is important since it is one of the key factors in reducing the CSO frequency and volumes at the Dunn Street overflow.

The potential for cellar flooding in the Dunn Street area needs to be investigated prior to raising the overflow weir at the Dunn Street CSO regulator. If cellar flooding is a potential then the means for preventing it should be investigated and implemented.

If the dam on the Presumpscot River at Cumberland Street is removed, another option for obtaining the desired elevation differential between the overflow weirs would be to lower the weir at the Siphon Inlet. This is less desirable than raising the weir at Dunn Street because it reduces the effective depth available for off-line storage (see project N306B).

6.3.4 N203B, N308 & N403B – Install Static Screens at Overflows

The existing overflow structures at the Siphon Inlet, Warren Avenue and Dunn Street appear to be such that static screens for the control of floatables can be readily installed within these structures with only minor modifications to these structures. If future monitoring indicates that the Warren Avenue overflow can be closed after implementing the CSO Abatement Plan then a static screen will not be necessary at this location.

6.3.5 N705B and N802B – Install Underflow Baffles in Brown St. and King St. CSOs

The overflow manholes for the Brown Street and King Street CSOs are too small to install static screens. These manholes are relatively deep thus making them good candidates for underflow baffles for floatables control. For these reasons the installation of underflow baffles rather than static screens is recommended at these two locations. If future monitoring indicates that the King Street overflow can be closed after implementing the CSO Abatement Plan then an underflow baffle will not be necessary at this location.

6.3.6 N704 & N801 – Enlarge the Sewer Pipe from King St. CSO to DCPS

Based on the limited monitoring data available for the King Street overflow and the results of the sewer system modeling it appears that if enough extraneous I/I in the areas draining to the King Street overflow can be removed and if the new sewer pipe from King Street to the DCPS is sized appropriately that the King Street overflow can be eliminated. Therefore extraneous I/I identification and removal should be a relatively high priority and the peak flow capacity of the new pipe from the King Street overflow to the DCPS should be carefully considered during design.

6.3.7 N701A & N701B – Re-Evaluate and Implementation of Best Option to Further Abate CSOs at the Brown Street Overflow

The sewer system model indicated that the I/I removal projects identified for the areas upstream of the Dana Court Pump Station will not reduce the CSOs at the Brown Street (CSO 007) to one overflow per year (on average). During the time period that I/I removal projects are being implemented and for at least one year afterwards, the sewer system flowing to the Dana Court Pump Station should be monitored. The monitoring data should be analyzed to determine the best way to further abate the Brown Street overflow. There are three likely methods to further abate the CSOs at Brown Street, they are:

- The identification and removal of additional I/I sources
- Upgrade the DCPS peak flow capacity
- Install a storage facility adjacent to the DCPS

To the extent practical the areas draining to the DCPS should be monitored and extraneous sources of I/I identified and removed from the sewer system.

The DCPS is approximately 30 years old and will likely need to have a major overhaul by 2015. Therefore, increasing the peak flow capacity should be at least part of the overall plan to further abate CSOs at the Brown Street overflow. The unknown is whether or not it makes more sense to dramatically increase the peak pump capacity or to just undertake a moderate increase in peak pumping capacity and focus additional abatement efforts on further I/I removal or a small storage facility located at the DCPS. Therefore, once all major projects located in the Dana Court Pump Station drainage area have been implemented the area should be monitored for at least a year and an evaluation conducted to determine the best way to further abate CSOs at Brown Street and King Street overflows. Project N701B has a budget of $1,200,000 which should be sufficient to implement a moderate upgrade to the DCPS and install a small storage facility adjacent to it or to undertake a major upgrade to the pump station.

6.3.8 N306B – Storage Facility at the Siphon Inlet

The success of the various I/I removal projects will in part determine whether the proposed 0.50 million gallon storage facility at the Siphon Inlet is the right size to meet the 1996 abatement goal of one overflow per year (on average). Prior to designing the Siphon Inlet storage facility, the sewer system model should be updated and calibrated using the latest monitoring data available to determine the appropriate size of the storage facility. Appendix 3 provides additional detail regarding the cost estimate for this project.

7. DISCUSSION OF ABATEMENT LEVELS

The goal established in the *CSO Master Plan for Westbrook Maine, Volume II, December 1996* was to control CSOs to the one year return period rain storm. The CSO Abatement Plan presented in Section 6 outlines a set of projects to meet this goal. The plan calls for the separation of all catch basins, the elimination of all known major sources of inflow and the implementation of a private I/I removal program. Once these projects are complete the Westbrook sewer system will essentially be a separated system. Sewer system modeling has indicated that CSOs will continue to occur during intense rainstorms even though all known sources of inflow and infiltration have been removed from the system. This means that there are other sources of I/I that have not yet been identified. These other sources are likely to be spread throughout the system and may or may not be easy to identify and eliminate. The CSO Abatement Plan calls for additional monitoring to identify these sources so a determination can be made whether or not it is economical to eliminate these sources of I/I. To cover the possibility that the 1996 goal can not be met by I/I removal alone, the plan calls for a series of optimization projects and the installation of a 0.5 million gallon storage tank at the Siphon Inlet and possibly a smaller storage facility at the Dana Court Pump Station.

The DEP has requested that in addition to looking at how to control CSOs to one overflow per year (on average) that the study also consider various abatement alternatives to essentially eliminate all combined sewer overflows from the system. Based on current modeling it looks like the Warren Avenue overflow (CSO 002) and the King Street overflow (CSO 008) may possibly be eliminated once the CSO Abatement Plan has been fully implemented. In order to further abate the Siphon Inlet overflow (CSO 003), Dunn Street overflow (CSO 004) and Brown Street overflow (CSO 007) more sources of I/I would need to be identified and eliminated, the CPPS and DCPS capacities would need to be increased and/or larger storage facilities would need to be constructed.

Since it is unknown how much miscellaneous (private) I/I can be removed from the sewer system or how many other sources of extraneous I/I can be located and economically removed it would be complete speculation to guess at what additional abatement level might be achieved by this route.

As noted in Sections 4.2 and 5.4 it is not feasible to increase the Cottage Place Pump Station beyond its current capacity or to increase the Dana Court Pump Station much above 7.1 MGD, therefore further abatement by increasing pump station capacity does not appear economical.

Larger storage facilities at the Siphon Inlet and the Dana Court Pump Station could be constructed and would reduce the frequency of overflows. At a cost in 2008 dollars of $7 to $9 per gallon for offline storage, a significant increase in size of both the Siphon Inlet and Dana Court storage facilities would be rather expensive, for example if these two facilities were doubled in size the additional cost to the overall plan would be on the order of $4,000,000 to $5,000,000.

The recommended approach for abating CSOs in Westbrook is described below:

- Implement all major I/I removal projects listed in the CSO Abatement Plan.
- Implement all system optimization projects listed in the CSO Abatement Plan except storage at the Siphon Inlet and Dana Court Pump Station and the upgrade in capacity to the Dana Court Pump Station.

- While implementing the CSO Abatement Plan continue to look for and remove, where affordable, extraneous sources of I/I. If enough extraneous I/I is located and removed from the system then the need for storage may be reduced or eliminated.
- After all the I/I removal projects and the aforementioned optimization projects have been implemented, monitor the appropriate portions of the sewer system for at least one year,
- Update the sewer system model using the latest monitoring data,
- Based on the updated model and other relevant factors, determine if storage facilities are required, and if they are determine their appropriate size. Determine the appropriate peak pumping capacity of the Dana Court Pump Station (DCPS). Submit to DEP for their review and approval a recommendation on whether or not storage facilities are necessary and if they are then what size they should be and the peak pumping capacity of the DCPS.
- Upgrade the Dana Court Pump Station and construct storage facilities as needed.

Regardless of the abatement level eventually achieved, the Siphon Inlet overflow and the Brown Street overflow should be kept open and used as emergency overflows in case of a prolonged failure at the Cottage Place Pump Station or the Dana Court Pump Station respectively.

Based on the above discussion it is recommended that controlling the Westbrook CSOs to one overflow per year (on average) continue to be the abatement goal.

8. CONCLUSIONS AND IMPLEMENTATION SCHEDULE

8.1 CONCLUSIONS

Based on the discussion presented in Section 7, it is recommended that the abatement goal for Westbrook continues to be one overflow per year (on average). Section 6 presents a CSO Abatement Plan that will meet the aforementioned goal. The plan identifies numerous CSO abatement projects and associated road work projects. The total cost of the CSO abatement projects is $14,687,000, while the total cost associated with additional road work that the City may want to undertake at the same time is $6,952,000.

The following is a summary of the key findings for each CSO:

- **Warren Avenue Overflow (CSO 002)** – It may be possible to close the Warren Avenue (CSO 002) once the CSO Abatement Plan has been fully implemented. Closing this CSO will in part be dependent upon identifying and reducing excess I/I in the Warren Avenue sewer/drainage area as well as the sewer/drainage areas adjacent to Main Street. Closing this overflow will also be dependent upon raising the overall flow weir and increasing the pipe size from the Warren Avenue CSO regulator to the interceptor that runs from the Siphon Inlet eastward.
- **Siphon Inlet Overflow (CSO 003)** – This overflow will remain active even after all the CSO Abatement Plan projects are completed. This location is also an ideal site for an offline storage facility. The CSO Abatement Plan calls for a 0.5 million gallon storage facility at this location; the final size of the facility should be determined after all the other major CSO abatement projects have been implemented, the sewer system monitored for a year and the sewer system model updated.
- **Dunn Street Overflow (CSO 004)** – The Dunn Street overflow is upstream of the Siphon Inlet overflow and as such the hydraulic grade line at Dunn Street is higher than it is at the Siphon Inlet. Currently the overflow weirs at the Siphon Inlet and at Dunn Street are at the same elevation (please see discussion in Section 5.5.3 regarding flap gate), in order to affordably abate the Dunn Street overflow it is essential to establish a differential in elevation between the two weirs.
- **Brown Street Overflow (CSO 007)** – The Brown Street overflow will continue to be active once the CSO Abatement Plan is implemented. Several inflow/infiltration projects have been identified that will help reduce the CSO activity at this overflow. Additional flow monitoring and analysis is needed before the best way to control to the one overflow per year (one average) goal can be determined.
- **King Street Overflow (CSO 008)** – It may be possible to close the King Street overflow if enough extraneous I/I is removed from the drainage area upstream of the overflow and the pipe between this overflow and the Brown Street overflow is made sufficiently large.

8.2 RECOMMENDED IMPLEMENTATION SCHEDULE

The recommended Implementation Schedule for the CSO Abatement Plan is presented in Table 8.1. The Implementation Schedule is laid out such that project costs are more-or-less spread out evenly over 11 years. The first six years (2009 – 2014) of the schedule focuses on removing inflow and infiltration from the system and several low cost optimization projects. The next four years (2015 – 2018) includes a combination of infiltration removal projects and optimization projects. The final year of the plan (2011) calls for a large storage facility at the Siphon Inlet.

Table 8.1 - Implementation Schedule (Cost in $1000), Page 1 of 3.

No.	Project Name	Who	2008	2009	2010	2011	2012	2013	2014	2015	2016
N207, etc.	Ongoing monitoring & data analysis	PWD	M $30	M $50	M $50						
N205, etc.	Develop and implement a misc. I/I removal program	WB				I/I $20	I/I $20	I/I $20	I/I $20	I/I $20	
N402	Seal off overflow flap gate in Dunn St, regulator	PWD	C < $1k								
N504	Separate CB on Wayside Dr.	PWD	C < $1k								
N601	Separate CB on Linclon St	WB	C < $1k								
N301	Cottage Pl Pump Sta new bar racks	PWD	D&C $3,800								
N402	Seal off overflow flap gate in Dunn St, regulator	PWD		C $1							
N302, etc	Separate Melcher Court and Cumberland St	WB	D $100	C $1,100							
N401	Separate Pleasant St., Doyle, Highland & Sargent	WB		D $246	C $2,200						
N202A	Enlarge sewer pipe from Warren Ave regulator	PWD			D $7	C $50					
N404A	Dunn St. regulator: Enlarge connection to interceptor	PWD			D $9	C $57					
N404B	Rasie overflow weir at Dunn St. CSO regulator	PWD			D $10	C $40					
N602 etc.	Replace leaky sewers on Conant, Chestnut & Mitchell	WB			D $222	C $2,080					
			2008	2009	2010	2011	2012	2013	2014	2015	2016
Annual Costs											
	Sewer Work ($k)		$3,932	$1,279	$1,299	See next page	See next page				
	Extra Road Work ($k)		$0	$118	$1,199						
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	Total		$3,932	$1,397	$2,498						

Key: M = Monitoring, E = Evaluation, D = Design, C = Construction

Table 8.1 - Implementation Schedule (Cost in $1000), Page 2 of 3.

No.	Project Name	Who	2011	2012	2013	2014	2015	2016	2017	2018	2019
N207, etc.	Ongoing monitoring & data analysis	PWD	M $50	M $50	M $50	M $50					
N201A	Separate Rochester and Haskell	WB	D $8	C $77							
N203A	Raise overflow weirat Warren Av CSO regulator	PWD	D $1	C $4							
N204	Replace stone sewer on Seavy S	WB	D $36	C $326							
N406	Replace leaky sewers on Cloudman, Foster, Dunn, etc.	WB	D $177	C $1,600							
702B	Separate Cole St gully sewer	WB		D $20	C $180						
N501	Separate CBs on Maple St. & replace Union St. sewer	WB		D $82	C $750						
N313	Replace leaky sewrs on Spiers & Stevens	WB		D $100	C $900						
N506	Replace leaky sewer on Conant St & Route 25	WB			D $178	C $1,640					
N703	Separate CB on Reserve St.	PWD				D $17	C $151				
N704	Enlarge pipe from Brown St CSO to Dana Ct PS	PWD				D $50	C $462				
N801	Enlarge pipe from King St CSO to Brown St CSO	PWD				D $45	C $415				
			2011	2012	2013	2014	2015	2016	2017	2018	2019
Annual Costs											
	Sewer Work		$1,042	$1,138	$1,176	$1,164	See next page				
	Extra Road Work		$1,477	$1,141	$902	$658					
			---------	---------	---------	---------	---------	---------	---------	---------	---------
	Total		$2,519	$2,279	$2,078	$1,822					

Key: M = Monitoring, E = Evaluation, D = Design, C = Construction

Table 8.1 - Implementation Schedule (Cost in $1000), Page 3 of 3.

No.	Project Name	Who	2015	2016	2017	2018	2019	2020	2021	2022	2023
N207, etc.	Ongoing monitoring & data analysis	PWD	M $50	M $50	M $50	M $50	M $50	M $50	M $20	M $20	M $20
N701A	Re-evaluate best option to further abate Brown St and King St CSOs	PWD	E $25								
N503	Separate CBs on Glennwood St.	WB	D $8	C $72							
N505	Replkace leaky sewers on New Gorman Rd., etc.	WB	D $220	C $2,040							
N701B	Increase capacity of, or new storage facility at Dana Ct PS	PWD		D $140	C $1,060						
N705A	Raise oveflow weir in Brown St. CSO regulator	PWD		D $1	C $11						
N802A	Raise oveflow weir in King St. CSO regulator	PWD		D $1	C $11						
N311	Line leaky sewer on Main Street	WB			D $21	C $188					
N407	Line leaky sewer on Stroudwater St., etc.	WB			D $24	C $219					
N306A	Evaluate size and options for a storage facility at the Siphon Inlet	PWD			E $40						
N203B, etc	Install screens in Warren Ave, Siphon Inlet & Dunn St CSOs	PWD			D $10	C $97					
N306B	New storage facilty at Siphon Inlet	PWD				D $300	C $3,160				
			2015	2016	2017	2018	2019	2020	2021	2022	2023
	Annual Costs										
	Sewer Work ($M)		$1,216	$1,083	$1,227	$854	$3,210				
	Extra Road Work ($M)		$135	$1,221	$0	$0	$0				
			---------	---------	---------	---------	---------	---------	---------	---------	---------
	Total		$1,351	$2,304	$1,227	$854	$3,210				

Key: M = Monitoring, E = Evaluation, D = Design, C = Construction

APPENDIX A LIST OF POTENTIAL CSO PROJECTS SORTED BY OVERFLOW

Table A1.1 – List of Potential CSO Abatement Projects

CSO 002 – Warren Avenue Overflow		
No.	Project Name (or Brief Description)	Project Scope & Notes
N201A	Separate catch basin on Rochester and Haskell Streets	Separate catch basins on Rochester & Haskell Streets by installing storm drain pipes.
N201B	Replace sewers and rebuild roads on Rochester St., etc.	Replace old sewers rebuild roads on Rochester St. (1350 ft), Haskell St. (1400 ft), Boothbay Ave (250 ft), Lawrence St. (350 ft), Libby Ave. (200 ft), Cedar St. (450 ft), Forest St. (1400 ft) and Gray St. (450 ft).
N202A	Enlarge sewer pipe form Warren Ave. regulator to interceptor	Install larger sewer from Warren Avenue regulator to interceptor running eastward from Siphon Inlet.
N202B	Enlarge interceptor sewer running eastward from Siphon Inlet	Enlarge interceptor sewer running eastward from Siphon Inlet to the point where the Warren Ave sewer ties into it.
N203A	Raise overflow weir at Warren Ave. overflow	Raise overflow weir
N203B	Install static screen for floatables	Install static screen for floatables control
N204	Replace stone sewer on Seavey Street	Install new storm drain system including several new catch basins and connect to existing storm drain on Seavey St. Abandon (disconnect) stone drain pipe from sanitary sewer. Note: a relative new sanitary sewer already serves this area.

N205	Private inflow removal in areas flowing to the Warren Avenue CSO	Develop private I/I removal program. Program could be strictly voluntary or some level of compliance could be required depending by incorporating the program into City sewer ordinance.
N206	Extend outfall pipe to new low water mark once Dam is removed.	
N207	Progressively monitor sewer pipes to determine what parts of the system still have excessive I/I.	A lot of the CSO activity may be because the downstream sewer pipe does not have capacity due to all the I/I that flows into it. Do not start till after known sources of inflow have been removed (N201 & N204).
CSO 003 – Siphon Inlet Overflow		
N301	Increase reliability of Cottage Place pump station	New bar racks under design by PWD Total project cost $3,800,000; 2008 Design & Construction
N302	Connect 8 catch basins on Cumberland Street to storm drain system.	Projects N302 to N304 are under design by City, estimated project cost = $1,200,000 Construction scheduled for 2009 and 2010
N303	Replace or eliminate various sewer pipes near the end of Melcher Court.	Ditto
N304	Replace sewer in gully next to Melcher Court (from Newcomb Place).	Ditto

N305	Monitor sewers East of Siphon.	Progressively monitor sewer flows from Sappi and Melcher Court areas once Projects N302 through N304 have been completed. Excess flow from Sappi and Melcher Court areas back up interceptor thereby reducing the sanitary flow from the Warren Ave. CSO structure (CSO 002).
N306A	Evaluate size of storage facility	
N306B	Siphon Inlet Storage Facility	See Appendix 3 for additional information
N307	Private inflow removal	See Project N205
N308	Install static screen for floatables control	
N309	Extend outfall pipe to new low water mark (after dam is removed).	
N310	Replace leaky sewers on Mason St., etc.	Replace leaky sewers on Forest St. (290 ft), Mason St. (1000 ft), Sewer adjacent to Melcher Ct. (300 ft) and Edge of RR ROW (540 ft) and rebuild streets.
N311	Line leaky sewer on Main St.	Line leaky sewer on Main St. (1220 ft)
N312	Replace leaky sewers on Berkley and Clifford Streets	Replace leaky sewers on Berkeley St. (930 ft) and Clifford St. (320 ft) and rebuild streets.
N313	Replace leaky sewers on Spiers & Stevens St.	Replace leaky sewers and rebuilt streets on Spiers and Stevens Streets.

CSO 004 – Dunn Street Overflow		
N401	Separate CBs on Pleasant St., etc.	Remove 14 catch basins on Pleasant St, etc. by installing new sanitary sewers and storms drains. Work includes new sewers, storms drains and street reconstruction on Pleasant St. (30 ft), Doyle St. (480 ft), Highland St. (250 ft) and Sargent St. (540 ft).
N402	Seal off overflow flap gate	
N403A	Raise overflow weir	Need to determine cellar inverts; coordinate with PWD & Westbrook.
N403B	Install static screen at Dunn St. overflow	
N403C	Extend outfall pipe to new low water mark (after dam is removed)	
N404	Decrease plugging by enlarging sewer connection to interceptor.	
N405	Private inflow removal in areas flowing to the Dunn Street CSO	See Project N205
N406	Replace sewers on Cloudman St., etc.	Replace old sewers and rebuild streets on Cloudman St. (670 ft), Cloudman Ct. (330 ft), Foster St. (510 ft), Main St. (510 ft), Allen Ave. (230 ft) and Pleasant St. (100 ft). Line leaky sewer on Dunn St. and segment of sewer West of Cloudman St.

N407	Line leaky sewer on Stroudwater St., etc.	Line leaky sewers on Stroudwater St. and Hawkes St. (540 ft) (Note: sewer is very deep), no extra road work.
N408	Line or replace leaky sewer on Sunset Court	Line or replace leaky sewers on Sunset Court area (900 ft) and rebuild streets. Sunset Court area includes those sewers East of Monroe Street between Robinson Court and Woods Road. This area may need new storm drain sewers also.
West Pleasant St Area (Old CSO 005)		
N501	Separate catch basins on Maple Street	Connect 2 CBs near mid point of street into cross country storm drain system. Cross country storm drain system needs re-building. Road work: Rebuild Maple St., add storm drains.
N502	McKinley St: Replace section of broken pipe.	PWD to TV section of broken pipe. Scope – WB will provide additional information once TV inspection is completed. Road Work: None
N503	Separate catch basins on Glenwood St.	Separate catch basins on Glenwood Street by providing a new storm drain to Spring Street. Road work: Cut and patch construction.
N504	Separate catch basins on Wayside Dr.	Connect catch basins on Wayside Drive (Conant St.) to storm drain system. Project completed in 2008, cost was less than $1000.
N505	Replace leaky sewers on New Gorham Road and Longfellow St.	Replace leaky sewers on New Gorham Road and Longfellow St. and add new sewer to Fairlawn Ave. Line cross country sewer from New Gorham Rd. to Saco St (450 ft)
N506	Replace leaky sewers on Conant St. and Route 25	Replace or eliminate old leaky sewer on Conant St. and Route 25.

Dana Court Area (Old CSO 006)		
N601	Separate catch basin at intersection of Lincoln and Bridge Streets	Completed in 2008
N602	Replace sewers on Mitchell St., etc.	Replace old, leaky sewers on Mitchell St. (500 ft), Lincoln St. (section that connects to Bridge St.) and Dodge St. (200 ft)
N603	Replace sewer on Chestnut St.	Replace old sewers and rebuild Chestnut St. (580 ft)
N604	Line leaky sewer on Kennard St.	Line leaky sewers and rebuild Kennard St. (500 ft) and repair broken pipes from Chestnut St.
N605	Pike St: Repair broken house service.	Privately owned sewer, City to address with home owner.
N606	Sewer system monitor in Pike St. area.	Monitor Pike St. area to determine quantity of excess I/I.
N701A	Re-evaluate abatement options for Brown & King St. CSOs	
N701B	Increase capacity of Dana Court PS.	Increase peak pumping capacity to 5 MGD. This can easily be accomplished by adding one new pump (space is already available), increasing impeller and motor sizes on two pumps and adding a VFD to one low flow pump. It may be desirable to increase the peak pumping rate to as much as 7 MGD.

N702A	Cole St. Gully Sewer: Redirect sanitary services and convert pipe to a storm drain.	Most of the sewer connections have been removed from the Cole Street Gully Sewer. The only known connection is #7 Cole St.; if this house can be connected (will likely require a sump pump) to the Cole Street sewer then the Cole St. Gully Sewer can be converted to a storm drain and completely disconnected from the sewer system. City to further investigate / consider.
N702B	Connect upper part of Cole St. Gully sewer to storm drain	Connect Cole St gully sewer to Cole St. gully SD just above where No. 7 connects in. This project is an alternate to N702A. City may want to consider extending storm drain to No. 7.
N703	Separate catch basin at intersection of Brown and Reserve Streets	Install new storm drain pipe from catch basin at Brown and reserve to nearest storm drain system.
N704	Enlarge pipe from CSO 007 to Dana Court PS	Some preliminary engineering has already been done. Road work: Full width overlay.
N705A	Raise overflow weir & install underflow baffle	Need to check elevation of basements in area.
N705B	Install static screen for floatables control.	
N706	Rebuild outfall pipe and extend outfall to new low water mark (after dam is removed)	
N707	Private inflow removal in areas flowing to the Brown Street CSO	See Project N205
N708	Install off-line storage facility at DCPS	Install 0.09 Mgal off-line storage facility at DCPS. The parking lot in front of the station would be an ideal spot but easements would need to be obtained.

King Street Area (CSO 008)		
N801	Enlarge pipe from CSO 008 to Dana Court PS	
N802A	Raise overflow weir & install underflow baffle	Need to check elevation of basements in area.
N802B	Install static screen	
N802C	Extend outfall pipe to new low water mark (after dam is removed)	PWD to determine the condition of existing outfall pipe.
N803	Flow monitor incoming pipes to better quantify CSO peak flows and volumes.	Flow monitoring should also be geared towards identifying areas or sources of extraneous I/I. Already started.

APPENDIX B LIST OF POTENTIAL CSO PROJECTS SORTED BY PROJECT CATEGORY

Table A2.1 - Potential Inflow Reduction Projects

No.	Project Name (or Brief Description)	Base Cost	Extra Road Work Cost	Total Cost
N201A	Separate catch basin on Rochester and Haskell Streets	$85,000	$0	$85,000
N205	Private inflow removal in areas flowing to the Warren Avenue CSO	$20,000	$0	$20,000
N207	Progressively monitor sewer pipes to determine what parts of the system still have excessive I/I.	$25,000	$0	$25,000
N302	Connect 8 catch basins on Cumberland Street to storm drain system.	$1,200,000	---	$1,200,000
N303	Replace or eliminate various sewer pipes near the end of Melcher Court.	Incl. in N302	---	
N304	Replace sewer in gully next to Melcher Court (from Newcomb Place).	Incl. in N302	---	
N305	Monitor sewers East of Siphon.	$25,000	$0	$25,000
N307	Private inflow removal	$25,000	$0	$25,000
N401	Separate CBs on Pleasant St., etc.	$1,271,000	$1,175,000	$2,446,000
N405	Private inflow removal in areas flowing to the Dunn Street CSO	$15,000	$0	$15,000
N501	Separate catch basins on Maple Street	$410,000	$422,000	$832,000
N503	Separate CB on Glenwood St.	$80,000	$0	$80,000
N504	Separate CB on Wayside Dr.	Completed 2008	---	
N601	Separate catch basin at intersection of Lincoln and Bridge Streets	Completed 2008	---	
N605	Pike St: Repair broken house service.	---	----	
N606	Sewer system monitor in Pike St. area.	$25,000	$0	$25,000
N703	Separate catch basin at intersection of Brown and Reserve Streets	$168,000	$0	$168,000

N707	Private inflow removal in areas flowing to the Brown Street CSO	$15,000	$0	$15,000
N803	Flow monitor incoming pipes to better quantify CSO peak flows and volumes.	$25,000	$0	$25,000
N804	Private inflow removal in areas flowing to the King Street CSO	$25,000	$0	$25,000
	Total	**$3,414,000**	**$1,597,000**	**$5,011,000**

Table A2.2 - Potential Infiltration Reduction Projects

No.	Project Name (or Brief Description)	Base Cost	Extra Road Work Cost	Total Cost
N201B	Replace sewers on Rochester St., etc.	$1,950,000	$4,767,000	$6,717,000
N204	Replace stone sewer on Seavey Street.	$362,000	$0	$362,000
N310	Replace leaky sewers on Mason St., etc.	$1,149,000	$1,385,000	$2,534,000
N311	Line leaky sewer on Main St.	$209,000	$0	$209,000
N312	Replace leaky sewers on Berkley and Clifford Streets	$410,000	$899,000	$1,309,000
N313	Replace sewers on Spiers & Stevens	$500,000	$500,000	$1,000,000
N406	Replace sewers on Cloudman St., etc.	$611,000	$1,166,000	$1,777,000
N407	Line leaky sewer on Stroudwater St., etc.	$243,000	$0	$243,000
N408	Line or replace leaky sewer on Sunset Court	$865,000	$0	$865,000
N502	McKinley St: Replace section of broken pipe.	Pipe is on private land	---	---
N505	Replace leaky sewers on New Gorham Road & Longfellow St.	$904,000	$1,356,000	$2,260,000
N506	Replace leaky sewers on Conant St. and Route 25	$1,088,000	$730,000	$1,818,000
N602	Replace sewers on Mitchell St., etc.	$800,000	$1,502,000	$2,302,000

N603	Replace sewer on Chestnut St.	Included in N602	---	
N604	Line leaky sewer on Kennard St.	Included in N602	---	
N702A	Cole St. Gully Sewer: Redirect sanitary services and convert pipe to a storm drain.	Need to define scope of work	---	
N702B	Connect upper part of Cole St. Gully sewer to storm drain	$200,000	$0	$200,000
N805	Replace sewers on Roy Ave., etc.	$485,000	$636,000	$1,121,000
N806	Replace sewer on Everett St.	$90,000	$127,000	$217,000
N807	Replace sewer on Myrtle St.	???	???	$1,200,000
	Total	**$9,866,000**	**$13,068,000**	**$22,934,000**

Table A2.3 - Potential Optimization Projects

No.	Project Name (or Brief Description)	Base Cost	Extra Road Work Cost	Total Cost
N202A	Enlarge sewer pipe form Warren Ave. regulator to Interceptor	$57,000	$0	$57,000
N202B	Enlarge sewer pipe form Interceptor (see Project N202A) to Siphon Inlet	$418,000	$0	$418,000
N203A	Raise overflow weir	$5,000	$0	$5,000
N306	Storage Facility (0.50 Mgal)	$3,460,000	$0	$3,460,000
N402	Seal off overflow flap gate	$1000	$0	$1000
N403A	Raise overflow weir and install static screen for floatables control.	$50,000	$0	$50,000
N404	Decrease plugging by enlarging sewer connection to interceptor.	$66,000	$0	$66,000
N701B	Increase capacity of Dana Court PS to 5 MGD	$600,000	$0	$600,000
N704	Enlarge pipe from CSO 007 to Dana Court PS	$512,000	$0	$512,000

N705A	Raise overflow weir and install underflow baffle	$12,000	$0	$12,000
N708	Storage at DCPS	$600,000	$0	$600,000
N801	Enlarge pipe from CSO 008 to Dana Court PS	$359,000	$101,000	$460,000
N802A	Raise overflow weir and install underflow baffle	$12,000	$0	$12,000
	Total	**$6,152,000**	**$101,000**	**$6,253,000**

Table A2.4 - Potential Non-CSO System Upgrades and Repairs

No.	Project Name (or Brief Description)	Base Cost	Extra Road Work Cost	Total Cost
N301	Increase reliability of Cottage Place pump station	$3,997,000	$0	$3,997,000
N206	Rebuild outfall pipe and extend outfall to new low water mark (after dam is removed)	Unable to inspect outfall pipe, therefore it was not possible to determine likely cost.		
N309	Extend outfall pipe to new low water mark (after dam is removed).	Cost by others		
N403C	Extend outfall pipe to new low water mark (after dam is removed)	Cost by others		
N706	Rebuild outfall pipe and extend outfall to new low water mark (after dam is removed)	Unable to inspect outfall pipe, therefore it was not possible to determine likely cost.		
N802C	Extend outfall pipe to new low water mark (after dam is removed).	Cost by others		

Table A2.5 - Potential Floatable Controls Projects

No.	Project Name (or Brief Description)	Base Cost	Extra Road Work Cost	Total Cost
N203B	Install static screen for floatables control at Warren Ave.	$29,000	$0	$29,000
N308	Install static screen for floatables control at Siphon Inlet	$44,000	$0	$44,000
N403B	Install static screen for floatables control at Dunn St.	$34,000	$0	$34,000

N705B	Install static screen for floatable control at Brown St.	$45,000	$0	$45,000
N802B	Install static screen for floatable control at King St.	$45,000	$0	$45,000
	Total	**$197,000**	**$0**	**$197,000**

APPENDIX C BACKGROUND INFORMATION FOR SIPHON INLET STORAGE FACILITY

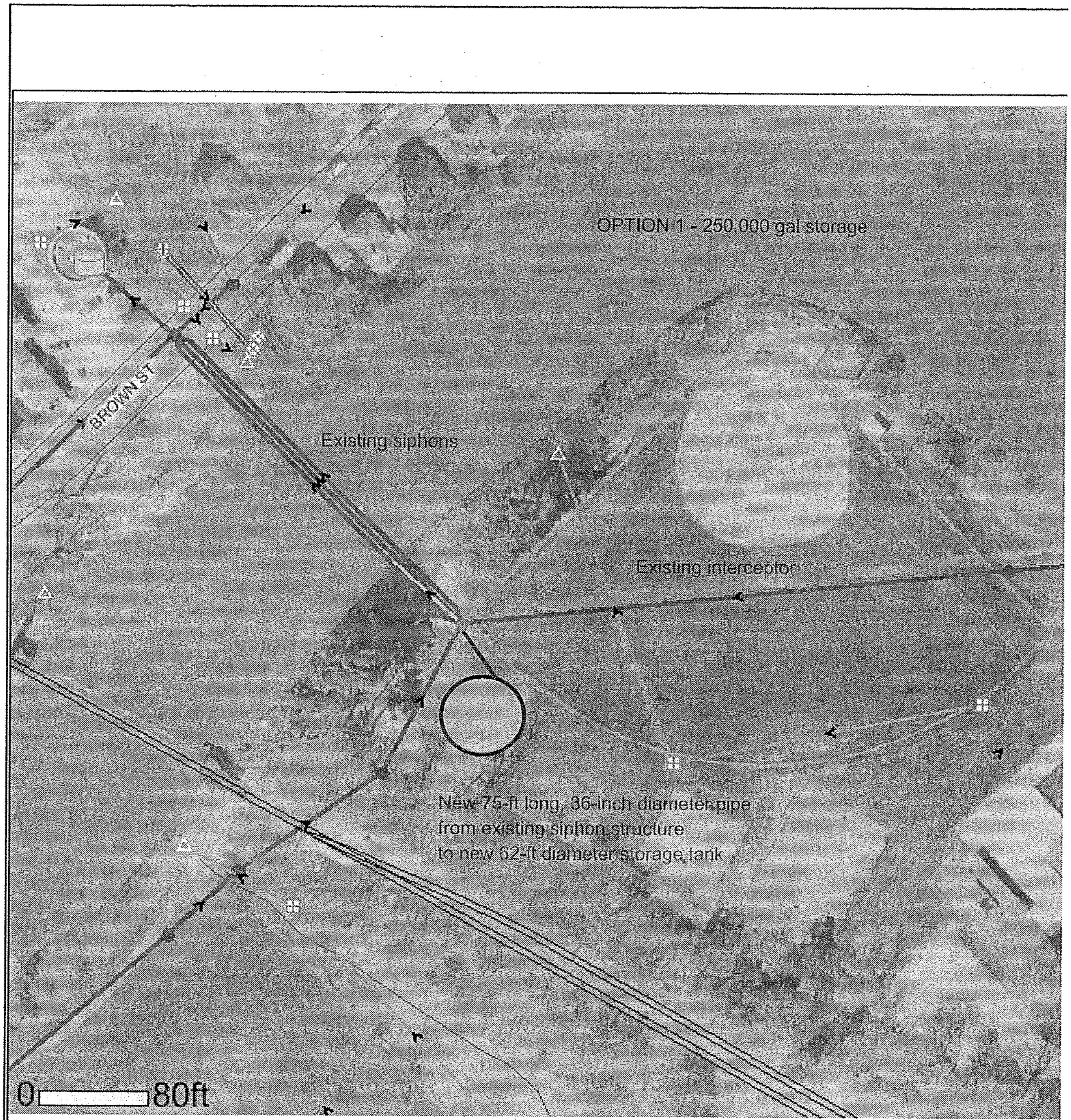
Westbrook, ME
CSO 003 Storage Options

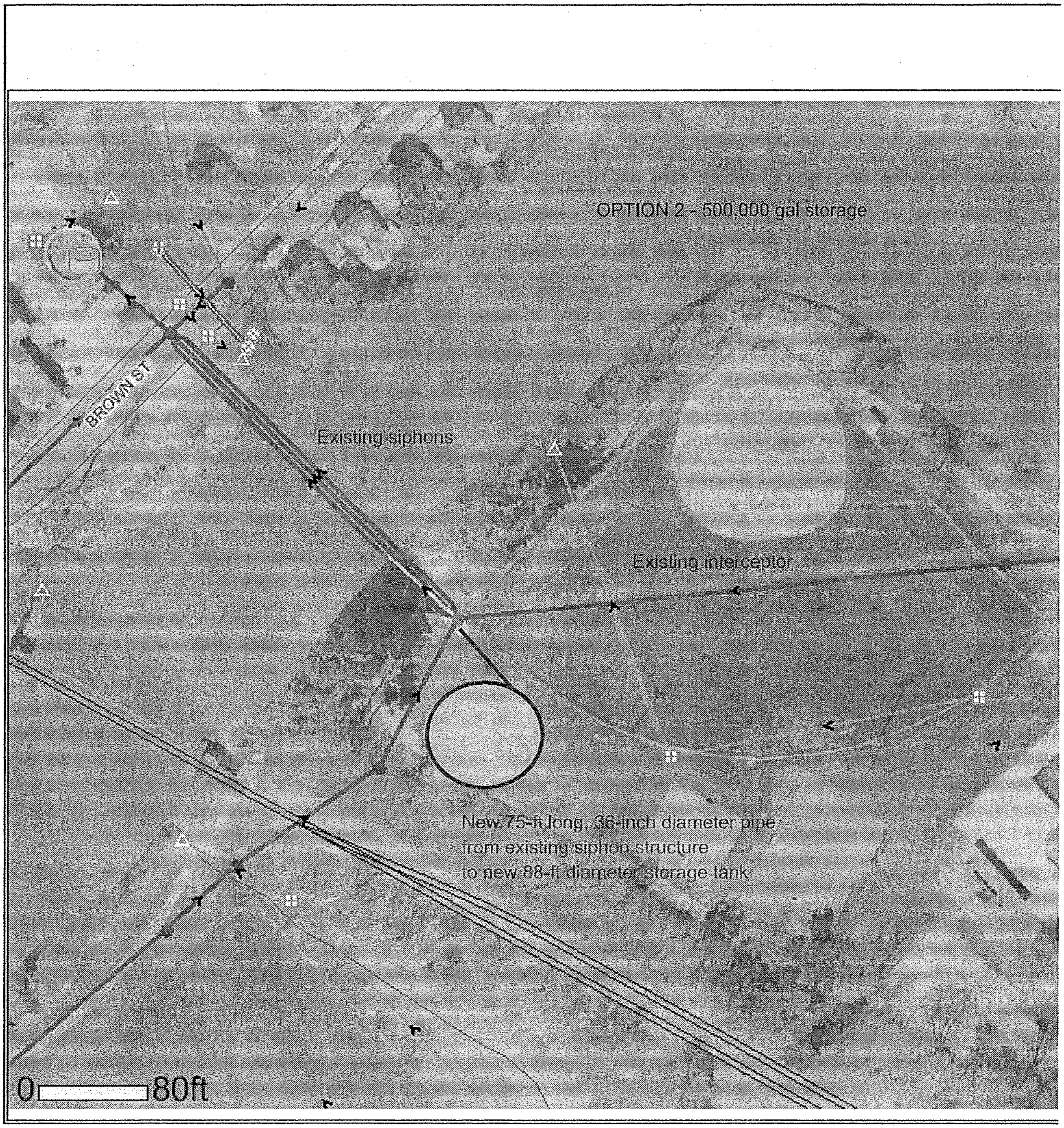
OPTION 1

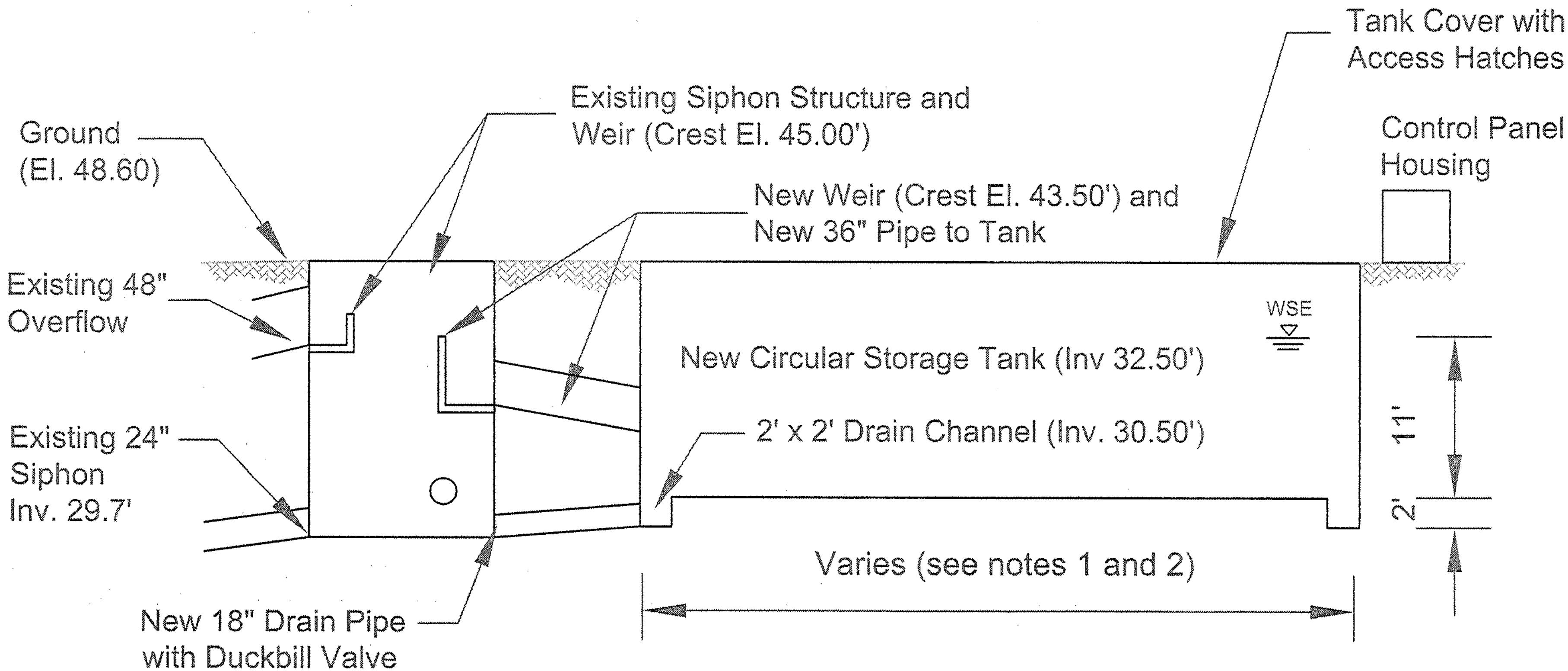
- Underground storage.
- **62' diameter (250,000 gal) concrete storage tank.**
- **62' diamater tank cover with four (4) access hatches.**
- Total depth of excavation is approximately 20'.
- Assume dewatering is needed, but no rock excavation
- 75' long, 3' diamter pipe from existing structure to tank.
- 50' long, 1.5' diamter drain pipe from tank.
- Duckbill valve on 1.5' diamter drain pipe.
- **Hydroself Round Flusher in tank ($140,000 from GNA)**
- Control Panel for Flusher (included in GNA cost)

OPTION 2

- Underground storage.
- **88' diameter (500,000 gal) concrete storage tank.**
- **88' diameter tank cover with four (4) access hatches.**
- Total depth of excavation is approximately 20'.
- Assume dewatering is needed, but no rock excavation
- 75' long, 3' diamter pipe from existing structure to tank.
- 50' long, 1.5' diamter drain pipe from tank.
- Duckbill valve on 1.5' diamter drain pipe.
- **Hydroself Round Flusher in tank ($165,000 from GNA)**
- Control Panel for Flusher (included in GNA cost)


OPTION 1 - 250,000 gal storage
BROWN ST
Existing siphons
Existing interceptor
New 75-ft long, 36-inch diameter pipe
from existing siphon structure
to new 62-ft diameter storage tank
0
80ft


OPTION 2 - 500,000 gal storage
BROWN ST
Existing siphons
Existing interceptor
New 75-ft long, 36-inch diameter pipe
from existing siphon structure
to new 88-ft diameter storage tank
0
80ft



Notes:
1. Option 1 (250,000 gal) - Diameter is 62'.
2. Option 2 (500,000 gal) - Diameter is 88'.
3. Tanks include circular flushing unit (see vendor info).

SECTION	1
NOT TO SCALE	-

BROWN AND CALDWELL

WESTBROOK STORAGE TANK CONCEPTUAL DESIGN
SECTION 1

GNA®
Gabriel Novac & Associates Inc.
Engineering solutions for all your Wet Weather needs

Design Criteria's for the HydroSelf Round Flushing System

1. When possible the HydroSelf Round system flushing cylinder should be filled before filling the tank itself. There are a couple ways to achieve this:

   a) A filling pipe from the CSO influent to the HS flushing cylinder (pipe can be placed anywhere in the flushwater storage area (FWSA) cylinder)
   b) Influent water supply for the tank itself preferably filling the FWSA first.
   c) One-way check valves on the wall of the flushing cylinder can be used to fill the flush water storage area during the actual tank filling.

   Note: If the filling system used is either a) or b) above then the one-way check valve in the flushing cylinder can be omitted.

2. A one-way check valve for early filling of the flushing cylinder needs to be installed if there is no possibility for installing the filling pipe (early filling of cylinder at partial filling of tank). For an exception see point 4.

3. The required bottom surface quality, where the water storage cylinder makes contact with the surface of the tank, must be observed closely and is subject to close checking by GNA Inc.. The vertical deviation (tolerance) may not exceed 1mm (1/32") in a measuring distance of 1000mm (3.3 ft.). This means that the surface must be done absolutely clean and even. This precision applies for the 500mm (1.64) ft.) wide circle which is in direct contact with seal of the flushing cylinder. Another option is a stainless steel plate which can be installed on the tank concrete floor, in order to provide a proper sealing.

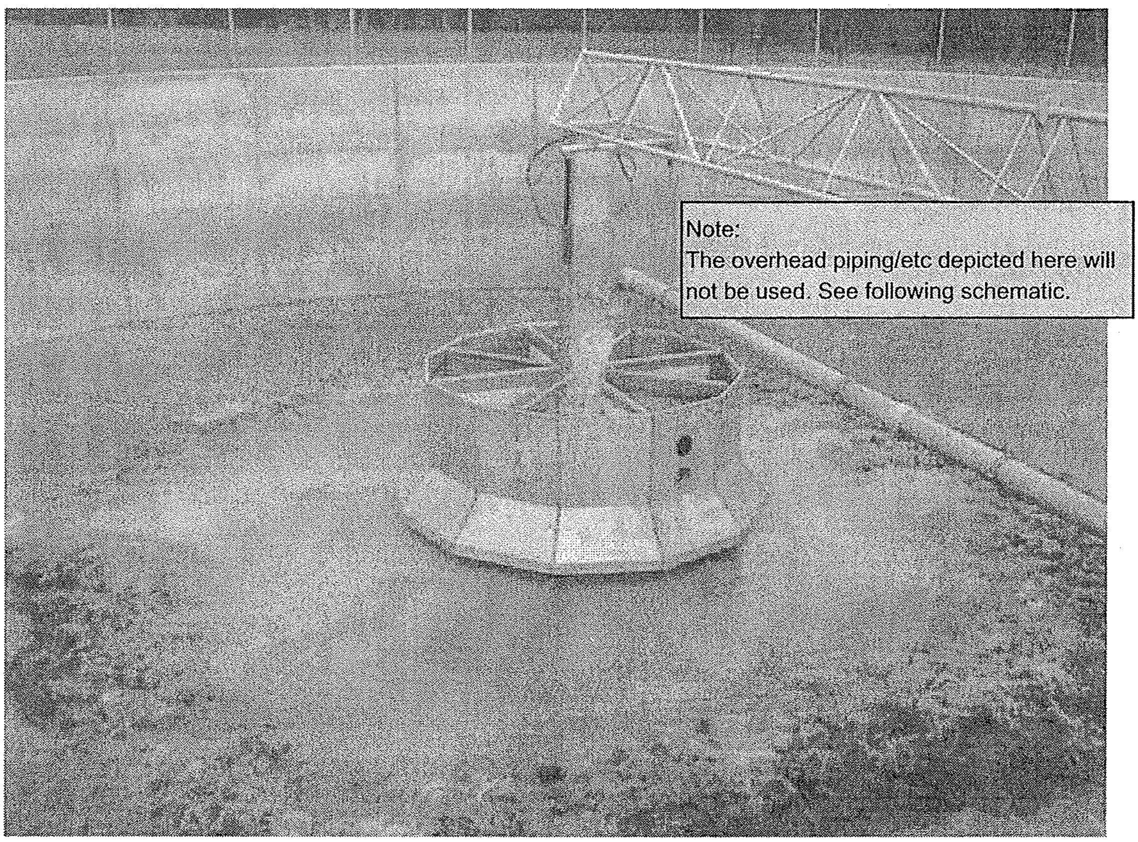
4. The influent pipe flow must not be hit the flushing cylinder directly. The inflow needs to be designed to provide a tangential and circular water stream. If the inflow points directly towards the flushing cylinder, deflection plates need to be installed in order to avoid a direct hit.

3532 Ashby, Montréal, Québec, Canada H4R 2C1
Tel.: (514) 336-5454 • Fax.: (514) 336-2882

HYDROSELF

RADIAL TANK FLUSHING

WAVE FLUSH FOR CIRCULAR AND SMALL RECTANGULAR TANKS!
THE FIRST RADIAL FLUSH WITHOUT EXTERNAL POWER



The Challenge

Most flushing systems available on the market for circular and small rectangular tanks are uneconomical in comparison with the construction costs. These tanks have to be cleaned manually especially when there is no electric power at hand. Circulation power units, which can only be powered electrically, counteract the sedimentation process, for which the tank is designed.

The Solution

The HydroSelf for circular and small rectangular tanks is a container flush. It is placed on a base plate with central guide rod, to which the container guide and the closure are positioned. The circular or rectangular outer wall is at the same time the storage reservoir separating wall. The filling occurs by means of a backwater gate near the ground or above the overspill crest of the container itself. After impounding, the detained combined water is situated in the flush container.

GNA CSO

HYDROSELF

RADIAL TANK FLUSHING

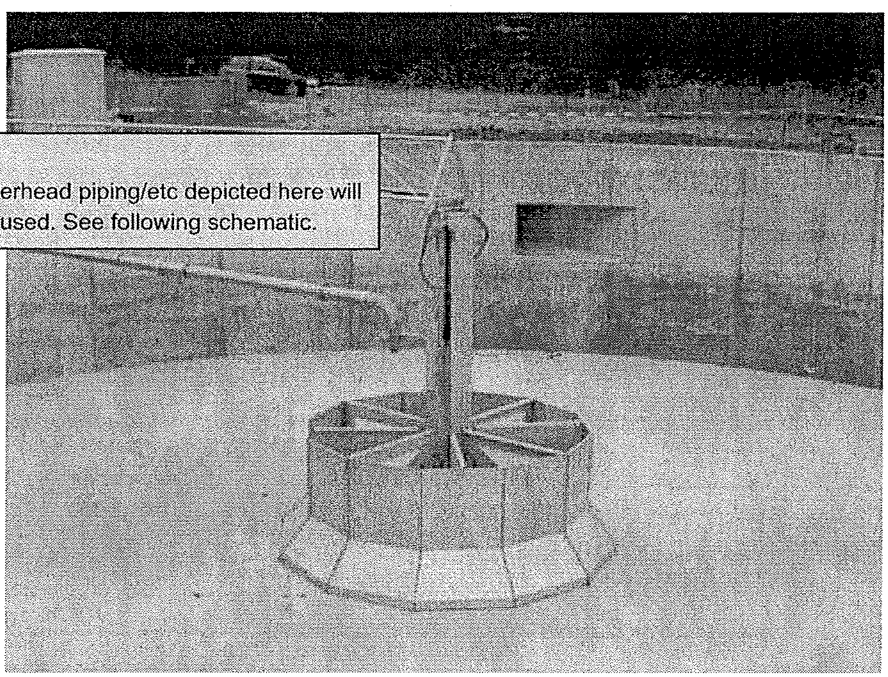
The container separating wall, sloping in the lower part, receives impetus from the water in the flushing container. When the closure in the container is opened by means of float technology or ultrasonic detector, then the whole container wall is raised and a radial flush wave occurs.

Cost effectiveness

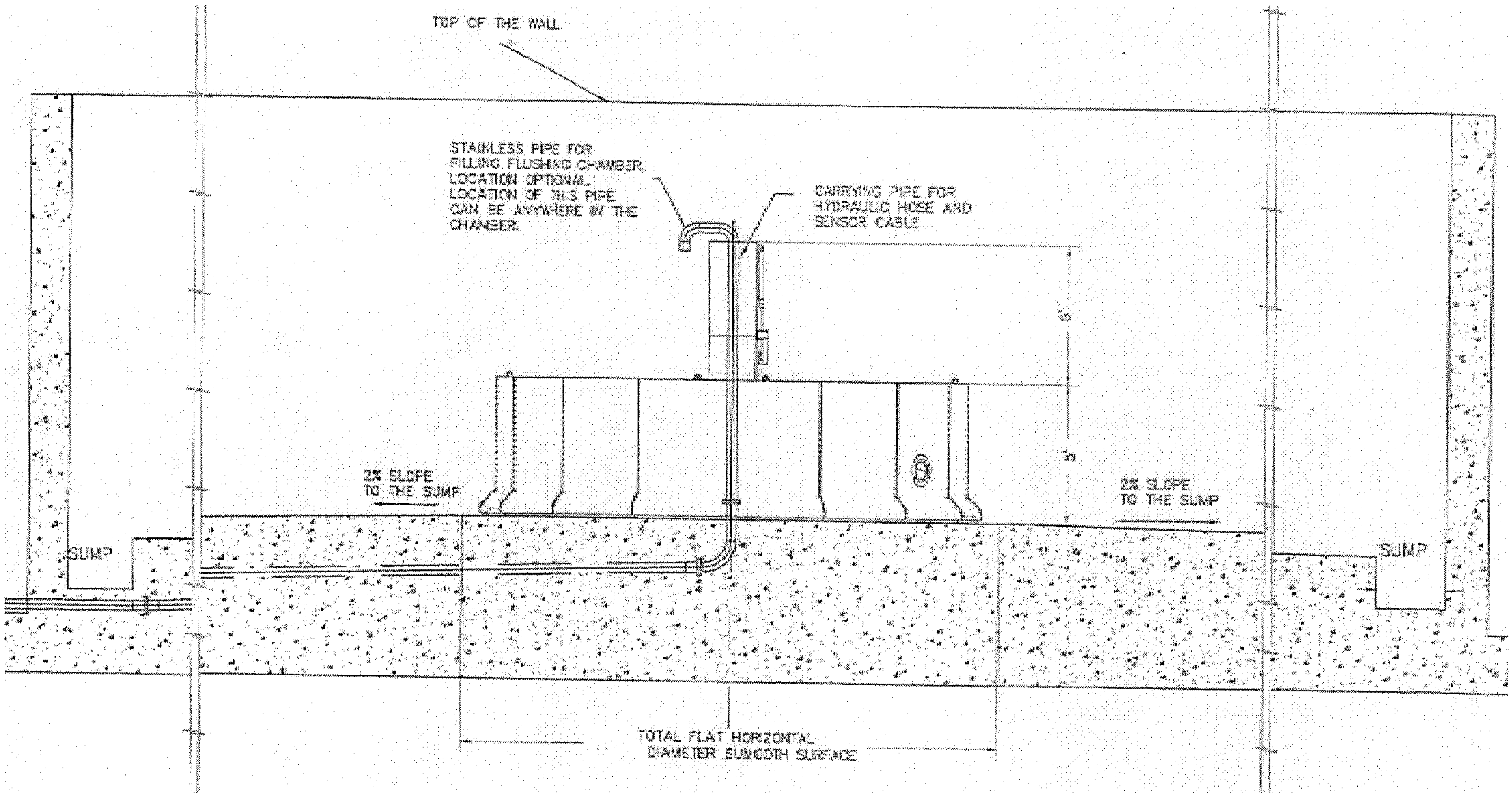
- Very inexpensive
- Operation without external power
- Retrofit possible
- Also through small manholes
- Easy maintenance
- Operationally safe

The Advantages

- very favourable cost effectiveness
- automatic filling, even with partial inflow
- float technology with no external power, therefore no operational costs
- optimal cleaning results even with heavier deposits
- can be retrofitted
- no additional construction technology
- durable
- manual flushing
- flexible adjustment
- optional: electro-hydraulic control



Note:
The overhead piping/etc depicted here will not be used. See following schematic.


TOP OF THE WALL
STAINLESS PIPE FOR FILLING FLUSHING CHAMBER. LOCATION OPTIONAL. LOCATION OF THIS PIPE CAN BE ANYWHERE IN THE CHAMBER.
CARRYING PIPE FOR HYDRAULIC HOSE AND SENSOR CABLE
2% SLOPE TO THE SUMP
2% SLOPE TO THE SUMP
SUMP
SUMP
TOTAL FLAT HORIZONTAL DIAMETER SMOOTH SURFACE

SECTION A

PRELIMINARY COST ESTIMATE
OFF-LINE STORAGE TANK
CSO 003
CITY OF WESTBROOK, MAINE
(Prepared by Brown & Caldwell, 4/22/08)

ENR 20 City Construction Cost Index = 8140 [6]

ITEM[1,2]	TANK VOLUME			
	250,000 Gallons (62-ft. diameter)		500,000 Gallons (88-ft. diameter)	
01 - GENERAL REQUIREMENTS	$	14,000	$	16,000
02 - SITE CONSTRUCTION	$	373,100	$	581,900
02 - LEDGE[5]	$	100,000	$	200,000
03 - CONCRETE	$	458,100	$	764,200
05 - METALS	$	331,300	$	606,700
07 - THERMAL/MOIST PROTECTION	$	13,100	$	13,100
09 - FINISHES	$	9,100	$	19,900
11 - EQUIPMENT	$	307,300	$	348,100
15 - MECHANICAL	$	165,300	$	165,300
16 - ELECTRICAL	$	48,700	$	48,700
SUBTOTAL - CONSTRUCTION[3]	$	1,820,000	$	2,763,900
PROJECT SERVICES (25%)[4]	$	455,000	$	690,975
TOTAL PROJECT COST	$	2,275,000	$	3,454,875

1. Assumes no land acquisition costs.
2. Assumes no odor control.
3. Includes contingencies.
4. Includes design- and construction-phase engineering and legal/fiscal fees.
5. Ledge cost added by Mark Jordan, costs are best guess and will need to be refined by borings once conceptual design has been completed and location finalized.
6. ENR Construction Cost Index estimated by Mark Jordan

APPENDIX D SEWER SYSTEM MAP