Rochester Area
Joint Sewer Authority
395 Adams Street, 1st Floor
Rochester, PA 15074

Rochester Area Joint Sewer Authority

Beaver County, Pennsylvania

Long Term Control Plan

for CSO and SSO Control

FINAL DRAFT

SUBMISSION TO PADEP

East Rochester Borough
Freedom Borough
Rochester Borough
Rochester Township

December 16, 2011

THE BAKER TEAM

Baker

Lennon, Smith, Souleret Engineering, Inc.

FRYE ENGINEERING

SHOUP ENGINEERING
ENGINEERS - PLANNERS - SURVEYORS

Rochester Area Joint Sewer Authority
FINAL DRAFT **- Long Term Control Plan**
December 16, 2011 - Submission to PaDEP

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List of Acronyms

3RWW	Three Rivers Wet Weather
ALCOSAN	Allegheny County Sanitary Authority
BMP	Best Management Practices
BOD	Biochemical Oxygen Demand
BOD5	5-Day Biological Oxygen Demand
cBOD5	Carbonaceous 5-Day Biochemical Oxygen Demand

CADD	Computer Aided Drafting and Design
CCTV	Closed-Circuit Television
COA	Consent Order Agreement
CPAC	CSO Plan Advisory Committee
CSO	Combined Sewer Overflow
CSOTF	CSO Treatment Facility
DE	Drnach Environmental, Inc.
DO	Dissolved Oxygen
EDT	Eastern Daylight Time
ENR	*Engineering News Record*
USEPA	U.S. Environmental Protection Agency
EST	Eastern Standard Time
FBD	Freedom Business District
FC	Fecal Coliform
FE	Frye Engineering
FS	Feasibility Study
FBCCA	Freedom Borough Collection and Conveyance Authority
GIS	Geographic Information System
GPM	Gallons per Minute
GPS	Global Positioning System
H&H	Hydraulic and Hydrologic
HGL	Hydraulic Grade Line
HRA	Highest Ranked Alternative
HREOP	High Rate End of Pipe
I/I	Infiltration/Inflow
LFP	Longest Flow Path
LSSE	Lennon, Smith, Souleret Engineering, Inc.
LTCP	Long-Term Control Plan
MGD	Million Gallons Per Day
MHI	Median Household Income
NBBSA	New Brighton Borough Sanitary Authority
NEXRAD	Next Generation Radar
NMC	Nine Minimum Controls
NPDES	National Pollution Discharge Elimination System

NPW	Net Present Worth
NST	New Sewickley Township
NSTMA	New Sewickley Township Municipal Authority
NWS	National Weather Service
O&M	Operation and Maintenance
PaDEP	Pennsylvania Department of Environmental Protection
PCCMP	Post Construction Compliance Monitoring Plan
PHF	Peak Hourly Flow
POTW	Publically Owned Treatment Works
PPB	Parts Per Billion
PPM	Parts Per Million
PW	Present Worth
QA/QC	Quality Assurance/Quality Control
QMS	Quality Management System
RAJSA	Rochester Area Joint Sewer Authority
RBSMA	Rochester Borough Sewer and Maintenance Authority
RDII	Rainfall-Derived Inflow and Infiltration
RTB	Retention Treatment Basin
RTSA	Rochester Township Sewer Authority
SCADA	Supervisory Control and Data Acquisition
SDH	Storm Deconstruction Hydrograph
SE	Shoup Engineering
SMP	Stormwater Management Practices
SSO	Sanitary Sewer Overflow
SWMM	Stormwater Management Model
TDH	Total Dynamic Head
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
TPW	Total Present Worth
TRC	Total Residual Chlorine
TSF	Trout Stocked Fisheries
TSS	Total Suspended Solids
UAA	Use Attainability Analysis
USACE	United States Army Corps of Engineers

USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UV	Ultraviolet Disinfection
WaPUG	Wastewater Users Planning Group
WQS	Water Quality Standards
WWF	Warm Water Fisheries
WWP	Wet Weather Plan
WWTP	Wastewater Treatment Plant

ES - Executive Summary

ES.1 Goals and Objectives

The objective of the RAJSA Long Term Control Plan (LTCP) is to identify and present technology, cost, and non-economic analyses that will allow the Rochester Area Joint Sewer Authority (RAJSA), the Rochester Borough Sewer and Maintenance Authority (RBSMA), Freedom Borough Collection and Conveyance Authority (FBCCA), East Rochester Borough and the Rochester Township Sewer Authority (RTSA) [RAJSA Communities] to select appropriate CSO and SSO control alternatives that best meet the environmental requirements set forth in the Commonwealth of Pennsylvania, Department of Environmental Protection's (PaDEP) Consent Order Agreement (COA), as amended, as issued on June 6, 2008. A copy of the COA is in Appendix A of this report.

ES.2 Background

The Long Term Control Plan (LTCP) development project is based upon the requirements set forth in Section 12 of the COA, as amended, which states the following:

"*By December 31, 2011, East Rochester, FBCCA, RBSMA, Rochester Township Authority, and RAJSA shall submit to the Department a single, coordinated LTCP. The LTCP shall be developed to comply with the CSO Control Policy. In addition the LTCP shall, if necessary, include provisions to expand the Plant to treat the appropriate amount of flows required to be conveyed to the Plant by the CSO Control Policy. The LTCP shall be based on sufficient and valid flow monitoring data necessary to determine the need for additional facilities. The implementation schedule contained in the LTCP shall have an end date no later than December 31, 2017.*

Although specific requirements relating to the LTCP were not detailed in the COA, it was clear that the LTCP needed to be prepared in accordance with the National CSO Policy. The Baker Team took a proactive approach, on behalf of the RAJSA Communities, prior to the project award and met with PaDEP to discuss the minimum content and technical approach that the Department required in the Plan. A scope of work for development of a LTCP was prepared and forwarded to PaDEP for review and comment. Months of planning resulted in the culmination of the award of the project to the Baker Team on March 25, 2010. The Baker Team consists of Michael Baker Jr., Inc. (Baker) of Beaver, PA as the prime consultant with Lennon, Smith, Souleret Engineering (LSSE) of Coraopolis, PA, Shoup Engineering of Baden, PA and Frye Engineering of Beaver, PA as subconsultants. Baker is the current engineering representative for Rochester Township and New Sewickley Township. LSSE is the current engineering consultant of the RBSMA, Shoup Engineering is the current engineering representative for the RAJSA, and Frye Engineering is the current engineering consultant for East Rochester Borough and the FBCCA. The extensive knowledge of the RAJSA treatment plant and respective collection systems made the Baker Team a natural fit to successfully complete this project.

ES.3 LTCP Approach

The basic approach to developing the LTCP is not substantively different from the development of any wet weather control plan or feasibility study for abatement of CSOs and SSOs. The basic steps are similar. For the RAJSA Project, the basic steps are outlined below:

- Perform adequate sewer system investigation to understand the existing collection system of the RAJSA and the member municipalities. This involved the compilation of GIS information from all entities relating to their respective combined and separate sewered systems. Field data was obtained to fill gaps in the data, and converted to GIS format. A system-wide GIS map was created by the Team that detailed the type, size and location of interceptor sewers, collection system sewers, CSO diversion structures, outfall pipes and pumping stations. This effort resulted in better understanding of the sewer system.

- Perform flow monitoring, QA/QC of the data, and data "deconstruction" for use in model calibration. Flow monitoring was conducted outside of the scope of this project by LSSE and Drnach Environmental in 2009 on behalf of the member municipalities. The flow monitoring and data processing is documented in a separate flow monitoring report.

- Develop and calibrate a hydrologic and hydraulic model of the "critical sewers" within the interceptor and collection system. This resulted in a fully-calibrated continuous simulation model that was used in subsequent phases of the project.

- Perform a cursory investigation and obtain an understanding of the existing water quality in the receiving streams. The investigation was cursory in nature because the LTCP was prepared using the "presumptive approach".

- The preceding steps culminated in the development of appropriate CSO and SSO control alternatives for RAJSA's and the member municipalities' outfalls. The result of the alternative development, cost estimation, evaluation and identification of the “selected” alternative is contained in this LTCP. Alternative selection was based on the "presumptive approach".

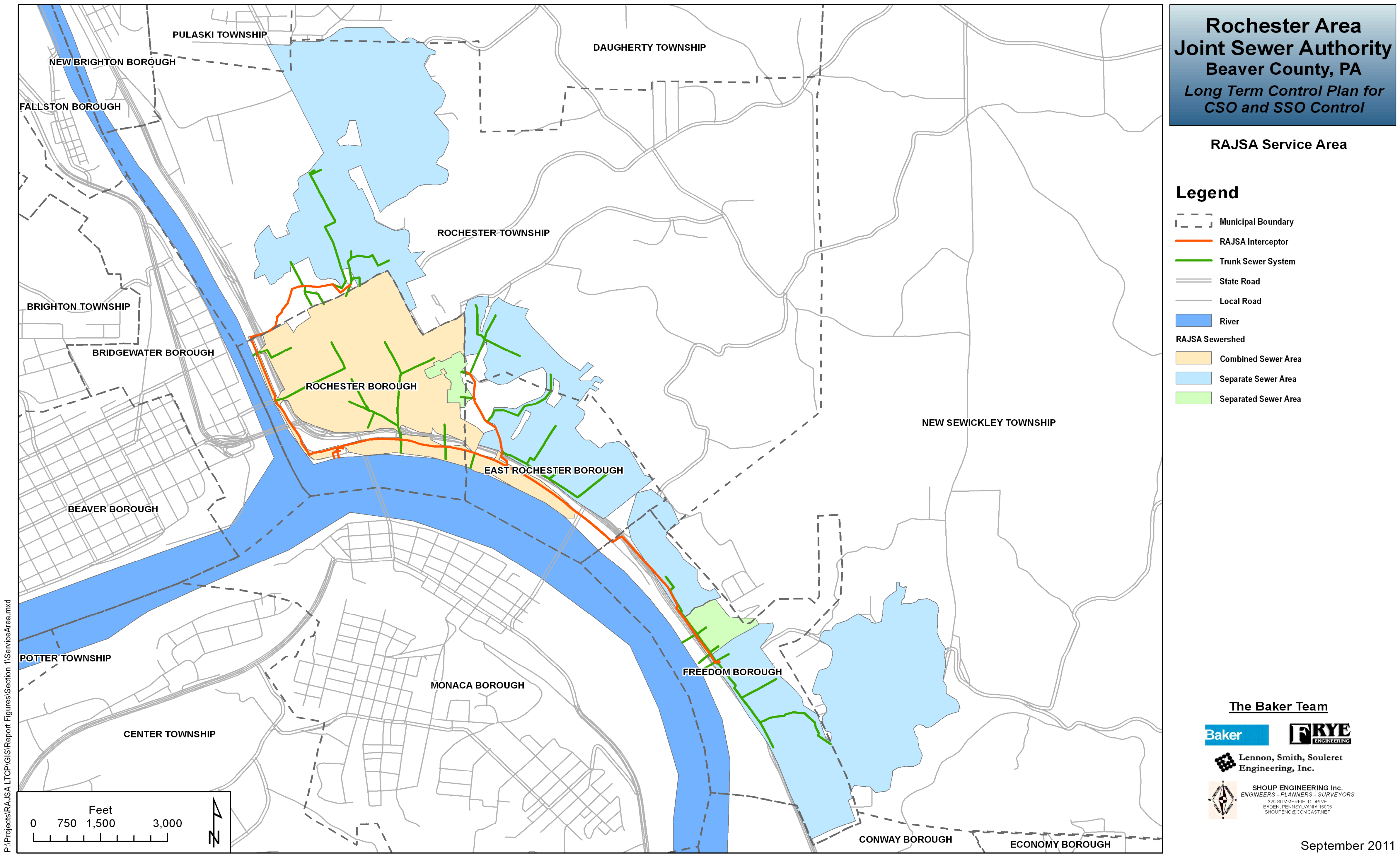
- The LTCP also addresses some potential next steps that RAJSA and the member municipalities will need to take in order to meet the requirements of the COA in the future.

ES.4 Existing RAJSA Interceptor System

The RAJSA owns and operates a WWTP and interceptor system that treats and conveys wastewater flows from Rochester Borough, East Rochester Borough, Freedom Borough, New Sewickley Township and Rochester Township within Beaver County, Pennsylvania. New Sewickley Township is considered a customer of Freedom Borough and the RAJSA and is not a member municipality of the RAJSA. The RAJSA interceptor system, located along the Ohio and Beaver Rivers, consists of approximately 3.2 miles of sewers ranging in size from 10 inches to 24 inches. The Rochester Borough sewer system, which is partially combined, consists of approximately 14.5 miles of sewers ranging in size from 6 inches to 54 inches. The East Rochester Borough sewer system, which is largely separate, consists of approximately 3.47 miles of sewers ranging in size from 4 inches to 24 inches. The Freedom Borough sewer system, which is 100% separate, consists of approximately 8.31 miles of sewers ranging in size from 4 inches to 24 inches. The Rochester Township sewer system, which is 100% separate, consists of approximately 13 miles of sewers ranging in size from 8 inches to 10 inches. The RAJSA Service Area is shown on Figure ES-1.

At the present time, there are six (6) active CSOs and two (2) active SSOs in the RAJSA sewer system. During the area's 75 wet weather events in a “typical” year, these discharge structures allow an estimated 35 million gallons of untreated sewage and storm water to flow into the Ohio

Figure ES-1: Rochester Area Joint Sewer Authority (RAJSA) Service Area *(base mapping source: Pennsylvania Spatial Data Access)*



and Beaver Rivers through over 450 overflow events. The CSOs and SSOs cause a variety of adverse impacts on the receiving waters, including impairing aquatic habitats, posing a threat to drinking water supplies, and affecting the recreational components of the receiving waters. As early as 2002, the USEPA and the PaDEP began negotiations with the RAJSA and its member municipalities to mitigate these discharges. This process culminated with the issuance of a COA in 2003, and subsequent amendments to RAJSA and the municipalities that required the preparation of a LTCP by December 31, 2011, and implementation of controls to minimize the frequency and duration of CSOs (Nine Minimum Controls or NMCs) until planned improvements to eliminate CSOs can be implemented. Previously, the service area contained ten (10) CSOs. Rochester Borough and Freedom Borough have successfully eliminated four (4) of the CSOs (2 each in their respective municipalities). Rochester Borough has eliminated the East Washington Street CSO and the Hull Street CSO. FBCCA has eliminated the 6th and 7th Street CSOs.

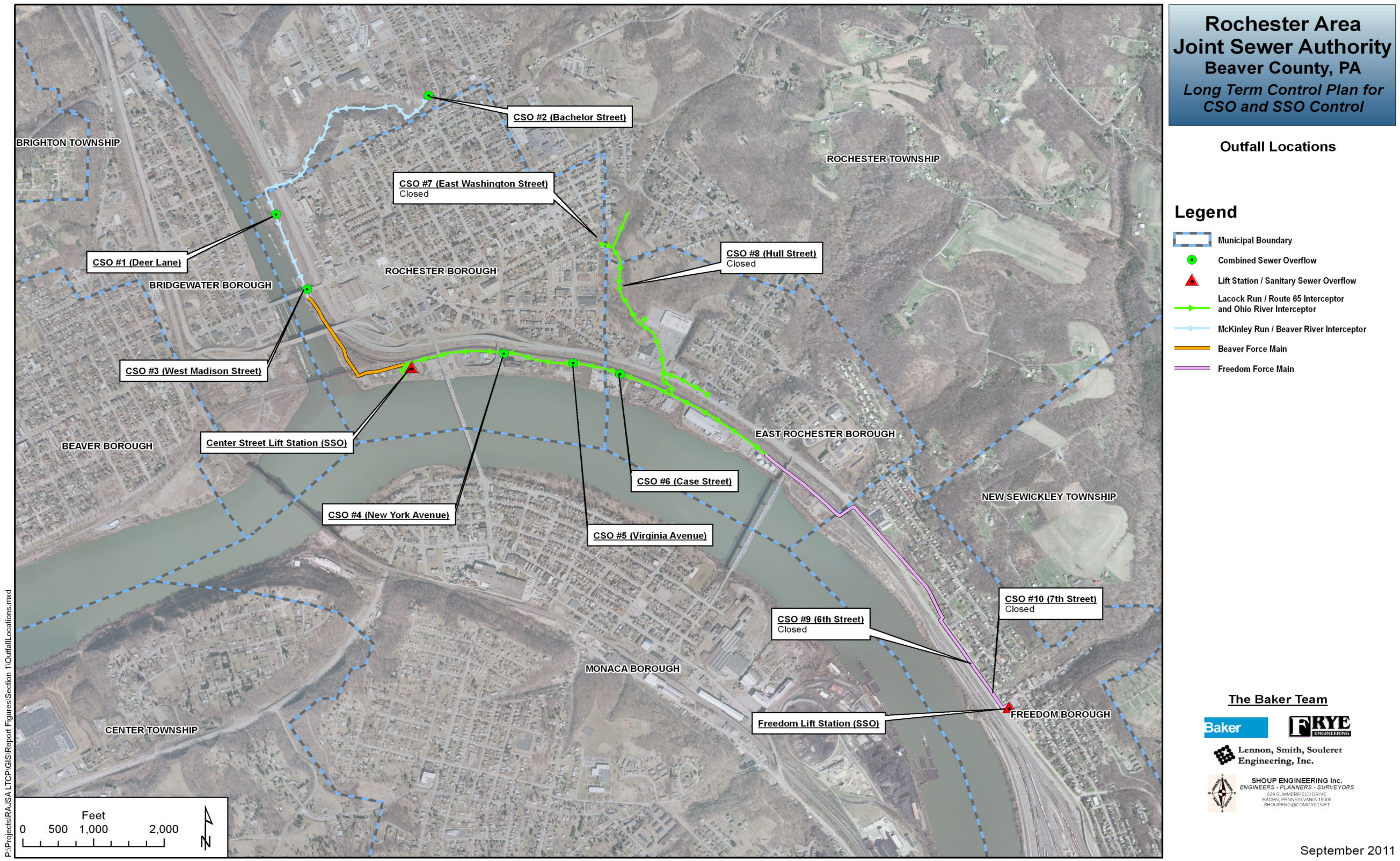
The RAJSA and its municipalities are currently authorized by the PaDEP to discharge combined sewage during wet weather events from the 6 permitted CSO outfall structures in the service area. The current NPDES permit that authorizes the RAJSA and the municipalities to discharge combined sewage requires the maintenance of these facilities in accordance with technology-based NMCs in order to minimize the duration and frequency of CSO discharges. The locations of the outfalls are illustrated in Figure ES-2.

ES.5 Flow Monitoring Program and Data Deconstruction

Outside of the scope of this project, but necessary for the LTCP, a flow monitoring program was developed and conducted for the RAJSA service area. The purpose of this program was to collect sewer flow data for the RAJSA interceptor system, including inputs from the municipalities. This information, combined with rainfall data, provided the foundation for the development and calibration of a comprehensive Hydraulic and Hydrologic (H&H) computer based model of the RAJSA service area.

The flow monitoring program was developed to meet the following objectives:

Figure ES-2: Outfall Locations *(base mapping source: Pennsylvania Spatial Data Access and AirPhoto USA Imagery 2007)*



- Evaluate the operational characteristics of key combined and separate sewer system components;
- Collect accurate and synoptic sewershed data to support collection system modeling;
- Collect system data to determine flow characteristics for areas outside the influence of downstream hydraulic control elements;
- Develop flow balances for as many monitored locations as feasible; and
- Determine the relationship between rainfall and system response for each monitoring location.

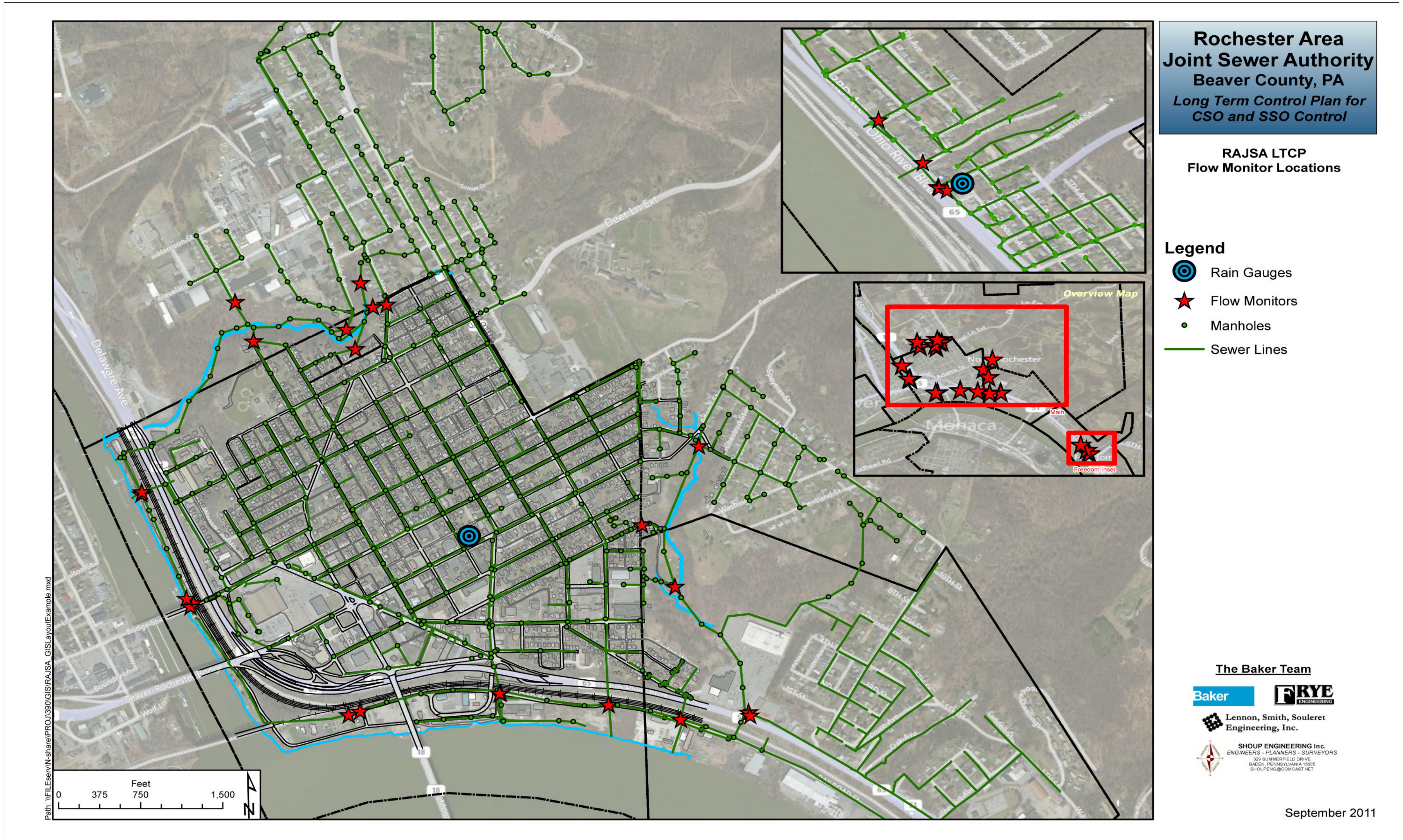
Based on the objectives, the 25 monitor locations shown on Figure ES-3 were identified. The 25 monitoring locations had a total of 38 sensors. The flow monitors were installed from March to October 2009; data was collected in fifteen-minute intervals during this time period.

As part of this project, the flow monitoring data was "deconstructed". The following activities were conducted during this process:

- Quality control / quality assurance was performed in accordance with accepted PaDEP standards; and
- Identification and quantification of the various components of the sewage flow, including the base wastewater flow, groundwater infiltration, and rainfall-dependent inflow and infiltration (RDII).

The intent of the deconstruction process was to produce a database to statistically correlate rainfall and RDII parameters, produce a time series hydrograph that enabled dry and wet weather evaluation for the development of the model, and develop synthetic unit hydrograph parameters (RTK) for the separate sanitary sewer system monitors that assisted in the model development.

Figure ES-3: Flow Monitoring Locations *(base mapping source: Pennsylvania Spatial Data Access and AirPhoto USA Imagery 2007)*



ES.6 Model Development and Calibration

The primary purpose of the development of a H&H model of the RAJSA service area is to characterize the hydraulic response of the sewer system during a variety of precipitation events. In addition, the system-wide model is used to predict pollutant loadings to the receiving waters and for numerous applications that support CSO abatement planning efforts, including:

- Evaluating the performance of CSOs for rain events other than those that occurred during the monitoring program.

- Developing annual CSO statistics such as frequency, volume, and duration to meet NPDES reporting requirements.

- Developing SSO statistics such as frequency, volume, and duration.

- Optimizing the collection system performance as part of NMC implementation. Specifically, modeling can assist in locating hydraulic bottlenecks and demonstrate that system storage and flow to the WWTP are maximized.

- Evaluating and optimizing CSO and SSO control alternatives for more complex controls that will be part of the LTCP.

- Becoming an operational and planning tool that will guide ongoing maintenance activities and assisting in the preliminary design of facilities recommended in the LTCP.

The RAJSA model was calibrated on a sewershed/submodel basis to facilitate network management and to minimize model run times during the calibration process. Generally, the calibration process began at the most upstream metering basin and progressed downstream. Each submodel was calibrated for dry weather flow and then for wet weather flow. Data from all meters were used for model calibration to the fullest extent possible.

The model was used to identify the capacity of the existing sewers by simulating different design storms and reviewing the resulting system performance. For each model run, the maximum hydraulic grade lines for the modeled sewers were examined in order to quantify the depth of surcharge above the crown of the sewer. The model was also used to quantify the flow discharges and volumes from the various CSO and SSO outfalls for the "typical year" and 2, 5 and 10-year design storms, respectively. The simulation indicates that the New York Avenue and West Madison Street CSOs have the highest overflow discharges and volumes during the "typical year".

ES.7 Existing Conditions

One of the early steps in the development of a feasibility study for wet weather control was to obtain a understanding of the existing collection system performance. This was accomplished through the development and calibration of the H&H model as described above. The calibrated model was then used to simulate the performance of the collection system. This was accomplished by identifying various rainfall events. For this project, 2003 was selected (and approved by PaDEP) as a "typical year" for the combined system. The rainfall events recorded in 2003 were simulated to determine how the existing collection system reacts. The 2, 5 and 10-year design storms were utilized for the separate sewered areas. The model was used to gain an understanding of the volume, frequency, and duration of overflows, and determine the ability of the collection system to transport the flow associated with various storms. A summary of the CSO and SSO statistics for the 12 outfalls (10 CSOs and 2 SSOs) is shown in Table ES-1. Please note that the East Washington Street, Hull Street, 6th Street and 7th Street CSOs have been closed as of the date of this report.

Table ES-1: Summary of CSO and SSO Statistics for Existing Conditions

Outfall	Number of Overflow Events	Total CSO Volume (MG)	Duration (hrs)
Bachelor St. CSO	44	0.885	275
Deer Lane CSO	76	1.75	559
West Madison St. CSO	51	7.34	299
New York Ave. CSO	47	23.18	396
Virginia Ave. CSO	44	0.49	330
East Washington St. CSO	87	0.58	355
Hull St. CSO	66	0.23	290
6th St. CSO	28	0.17	241
7th St. CSO	36	0.23	270
Case St. CSO	8	0.12	64
Totals for CSOs	**487**	**34.98**	**3,079**

Outfall	2-Year Flow (mgd) / Volume (MG)	5-Year Flow (mgd) / Volume (MG)	10-Year Flow (mgd) / Volume (MG)
Freedom Lift Station SSO	2.07/0.405	2.33/0.525	2.54/0.709
Center Street Lift Station SSO	2.70/0.72	2.87/0.89	3.44/1.02

ES.8 RAJSA LTCP CSO Control Levels

This LTCP was developed using the "presumptive approach" of the National CSO Policy. The presumptive approach operates under the premise that it is presumed that the RAJSA could meet water quality standards (WQSs) by implementing CSO controls that will not allow more than an average of four overflow events per year or provide an 85% capture rate during wet weather on an *annual average system-wide basis*.

Based on the RAJSA system model, CSO statistics (volume and peak flow) were generated for every outfall as well as a selection of outfall groupings for control levels of 0, 4, 8, 12, and 20 overflow events per year based on a "typical year" storm. CSO statistics were also generated based on the 85% capture of wet weather during the "typical year". Highest ranked alternatives were developed for the various CSOs using the overflows per year criteria, and they were advanced to the 85% capture analysis to develop the final alternatives. The approach was discussed with PaDEP, prior to and during the development of this LTCP. Results of the 85% capture analysis is included in Appendix D of this report.

ES.9 CSO Control Alternatives

CSO control alternatives for RAJSA's six (6) outfalls were sequentially developed. The Project Team listed over 70 potential CSO control technologies that are currently being utilized throughout the country. The Team also developed a list of applicable screening criteria that could be used to eliminate control technologies that were considered "non feasible". This process resulted in "surviving" technologies for CSO control – for use in forming alternatives; these technologies were used to develop CSO Control Alternatives for the following categories:

- Outfall Specific – Technologies that can be applied at every single outfall.
- Consolidated Alternatives – Technologies that can be applied to several outfalls (such as a large storage basin).
- System Wide Alternatives – Technologies that can be applied to the overall system. Storage tunnels were selected as the major technology that can be applied system-wide.
- 85% Capture Alternatives - Technologies that result in the capture of at least 85% of the wet weather flow on an average annual, system-wide basis.

ES.10 SSO Control Alternatives

SSO control alternatives for RAJSA's two (2) outfalls were sequentially developed. Since SSOs are illegal, control is limited to conveyance to the WWTP or storage. These two technologies were used in forming alternatives for the following categories:

- Outfall Specific – Technologies that can be applied at every single outfall.
- Consolidated Alternatives – Technologies that can be applied to several outfalls (such as a large storage basin).

ES.11 Alternative Evaluation Process

The different categories of alternatives were formed and evaluated. Prior to the evaluation, the Project Team presented the evaluation factors to the RAJSA, various municipal and authority boards and the CPAC. Initial evaluation factors and weighting criteria were obtained from the ALCOSAN wet weather planning study. Parties were provided the evaluation factors and weighting criteria and given the opportunity to comment. A summary of the major categories and weighting factors is shown in Table ES-2.

The Project Team utilized existing cost curves and a costing tool spreadsheet to develop planning-level present worth, capital and operation and maintenance costs of the alternatives. The cost curves were obtained from recent regional and national wet weather projects and supplemented with local cost data.

Table ES-2: Weighting Factors

Criteria Group	Criterion	Weight Factor
Economic Factors	Present Worth Cost	30%
Water Quality, Public Health & Environmental Impacts	Overflow volume reduction, bacteria discharge reduction, solids & floatable capture, pollutant control	25%
Public Factors	Community disruption, potential for nuisances (odor, noise), multiple benefit opportunities, environmental justice	20%
Operational Impacts	Ease of operation and maintenance, reliability, O&M consistency	15%
Implementation Impacts	Constructability, ability for expansion, land acquisition	10%
	Total:	**100%**

Outfall Specific: The resulting CSO control technologies were used to develop various levels of control for the evaluation. The various technologies were then evaluated, using economic and non-economic factors, to determine the highest scoring control technology for each outfall for the predetermined control levels (0 overflows, 4, 8, 12, 16 & 20). At 4 of the 6 CSO outfalls, complete sewer separation was the highest scoring alternatives, and at the other 2 subsurface storage facilities were the highest scoring alternatives. The 4 sewersheds that received the highest score for sewer separation were not evaluated further and were subsequently considered final alternatives. The 2 sewersheds that received the highest score for subsurface storage were carried forward to the consolidated and 85% capture analysis. The highest ranking outfall-specific CSO control technologies for various control levels are presented on Table ES-3. The 2 SSOs were evaluated in a similar manner, however, controls were limited to storage facilities.

Table ES-3: Highest Ranked Alternative for CSOs for Outfall-Specific Evaluation

	Level of Control - # of Untreated CSOs/year				
Location/CSO	**0**	**4**	**8**	**12**	**20**
Bachelor Street CSO	Complete Sewer Separation*	Complete Sewer Separation	Complete Sewer Separation	Complete Sewer Separation	Complete Sewer Separation
Deer Lane CSO	Complete Sewer Separation*	Complete Sewer Separation	Complete Sewer Separation	Complete Sewer Separation	Complete Sewer Separation
West Madison St. CSO	Storage Tank	Storage Tank	Storage Tank	Storage Tank	Storage Tank
New York Avenue CSO	Storage Tank	Storage Tank	Storage Tank	Storage Tank	Storage Tank
Virginia Avenue CSO	Complete Sewer Separation	Complete Sewer Separation	Complete Sewer Separation	Complete Sewer Separation	Complete Sewer Separation
Case Street CSO	Complete Sewer Separation	Complete Sewer Separation	Complete Sewer Separation	N/A	N/A

*** required by PaDEP for all control levels**

Consolidated: Consolidated alternatives were also formed and evaluated. A consolidated alternatives evaluation consists of combining the highest ranking alternatives from the outfall-specific evaluation into larger (consolidated) facilities and re-scored in the same process. As a result of the outfall-specific analysis with the majority of the sewersheds scoring high in the sewer separation category, consolidating the remaining storage facilities did not prove to be economically feasible. As such, no consolidated alternatives were carried forward to the final recommendation.

85% Capture: The highest ranked alternatives from the outfall-specific evaluation were carried forward to the 85% capture analysis. The 85% capture analysis was used to determine the final sizing of the two CSO storage facilities, in order to allow 15% wet weather discharge in the whole combined sewer system, based on an annual average volume.

WWTP Upgrade: Once the 85% capture analysis was complete, the 4 separated areas and the 4 subsurface storage facilities were carried forward to the WWTP upgrade alternative evaluation. This evaluation consisted of running the hydraulic model to determine the resultant wet weather flow and volume to the WWTP as a result of these system improvements. The analysis compared storing the wet weather volume at the WWTP or upgrading the WWTP to treat the additional wet weather flow.

Final Alternative Selection: The Project Team identified the highest scoring Outfall Specific Alternatives, Consolidated Alternatives, 85% Capture Alternatives and WWTP Upgrade alternatives for final recommendations.

ES.12 Recommended Plan Assumptions

The recommended plan described in this section was selected based on the screening and scoring process described in the previous sections. This process included numerous steps: screening of technologies to arrive at a short list of CSO and SSO control technologies that are applicable and appropriate for the RAJSA system and the existing municipal infrastructure in the service area; prioritization of evaluation factors by the RAJSA, CPAC and municipal boards which were incorporated into the alternative scoring process; development of control technology costs; generating hydraulic and hydrologic model results for sizing and costing of control technology facilities and evaluation of CSO volume reduction; and selection of CSO control levels to be evaluated. Main assumptions for the recommended plan are as follows (others are detailed in the LTCP):

- For CSOs, the evaluation is based on the 85% capture criteria, which is the *elimination or capture for treatment of no less than 85% by volume of the combined sewage collected during precipitation events on a system-wide annual average basis*.

- For SSOs, the evaluation is based on storage and/or conveyance of the 2, 5 and 10-year design storms or the "knee-of-the-curve" approach. Recommendations were based on the cost-effective solution and available space for a facility.

- The process used in the development of this LTCP is based on criteria established by the National CSO Policy, USEPA, PaDEP and standard engineering practice. Guidance and procedures were also adopted from 3 Rivers Wet Weather, Inc., a quasi-governmental agency working with ALCOSAN and its 82 municipalities. Many of the same procedures, processes, estimates, means and methods used in Allegheny County also apply and were utilized for the RAJSA project.

- Analysis on proposed and recently separated sewered areas was accomplished by providing a wet weather component to the separated flow based on similar sewersheds in the service area and an analysis of ALCOSAN flow monitoring data for "dry" systems.

- Cost estimates are based on 2010 cost data.

The recommended alternative is based on the 1994 USEPA CSO Policy presumptive remedy approach. Under the presumptive approach, compliance with WQS is presumed if one of several performance criteria is met. For this LTCP, CSO Control Alternatives were sized to capture no less than 85% of wet weather volume. This meets the second criteria in the 1994 CSO Policy which states that " the elimination or the capture for treatment of no less than 85% by volume of the combined sewage collected during precipitation events on a system-wide annual average basis." SSO Control Alternatives were developed based on the 2, 5, and 10-year design storms and presented to the RAJSA for consideration. A determination will need to be made by the PaDEP on the appropriate control level.

ES.13 Plan Description

The highest ranking alternative for each subsystem includes a mixture of complete sewer separation, subsurface storage facilities and a WWTP upgrade to treat the additional flow as a result of the requirements of the CSO Control Policy.

A summary of the highest ranked alternatives for the entire RAJSA service area is presented in Table ES-4 below.

Table ES-4: Summary of Highest Ranked Alternatives

Subsystem	Recommended Alternative Description
Bachelor Street CSO	Complete sewer separation of 26 acres of sewershed area
Deer Lane CSO	Complete sewer separation of 14 acres of sewershed area
West Madison Street CSO	600,000 gallon subsurface concrete storage tank complete with dewatering pumping, screening, connector piping, site preparation and ancillary functions; located adjacent to the existing West Madison Street pumping station along the Beaver River
New York Avenue CSO	600,000 gallon subsurface concrete storage tank complete with dewatering pumping, screening, connector piping, site preparation and ancillary functions; located adjacent to the existing Beaver Valley Bowl along the Ohio River
Virginia Avenue CSO	Complete sewer separation of 5 acres of sewershed area
Case Street CSO	Complete sewer separation of 7 acres of sewershed area
Freedom Lift Station SSO	530,000 gallon subsurface concrete storage tank complete with dewatering pumping, screening, connector piping, site preparation and ancillary functions; located adjacent to the existing Freedom lift Station (*this will control the 5-year design storm*)
Center Street SSO / WWTP Upgrade	Upgrade the existing WWTP, which includes improvements to the existing Center Street, West Madison and Freedom lift stations, clarifiers, and disinfection facilities. The WWTP capacity would increase from 1.4 MGD to approximately 2.78 MGD (5.88 MGD PHF) to accommodate the additional wet weather flow. The WWTP upgrade would also eliminate the Center Street SSO up to the 10-year design storm. Enhancements include two new clarifiers, a new UV disinfection system, new sludge dewatering system, upgrade of the grit removal system to include screening and demolition of the existing chlorine contact tank. Pumping station improvements consists of new pumps, controls, piping re-routing, etc.

A summary of the total project cost for the entire RAJSA service area is presented in Table ES-5 below. Costs are presented in current year values and have been rounded to the nearest hundred dollars. Figure ES-4 presents an overview map of the selected alternative.

Figure ES-4: Map of Selected Alternatives *(base mapping source: Pennsylvania Spatial Data Access and AirPhoto USA Imagery 2007)*

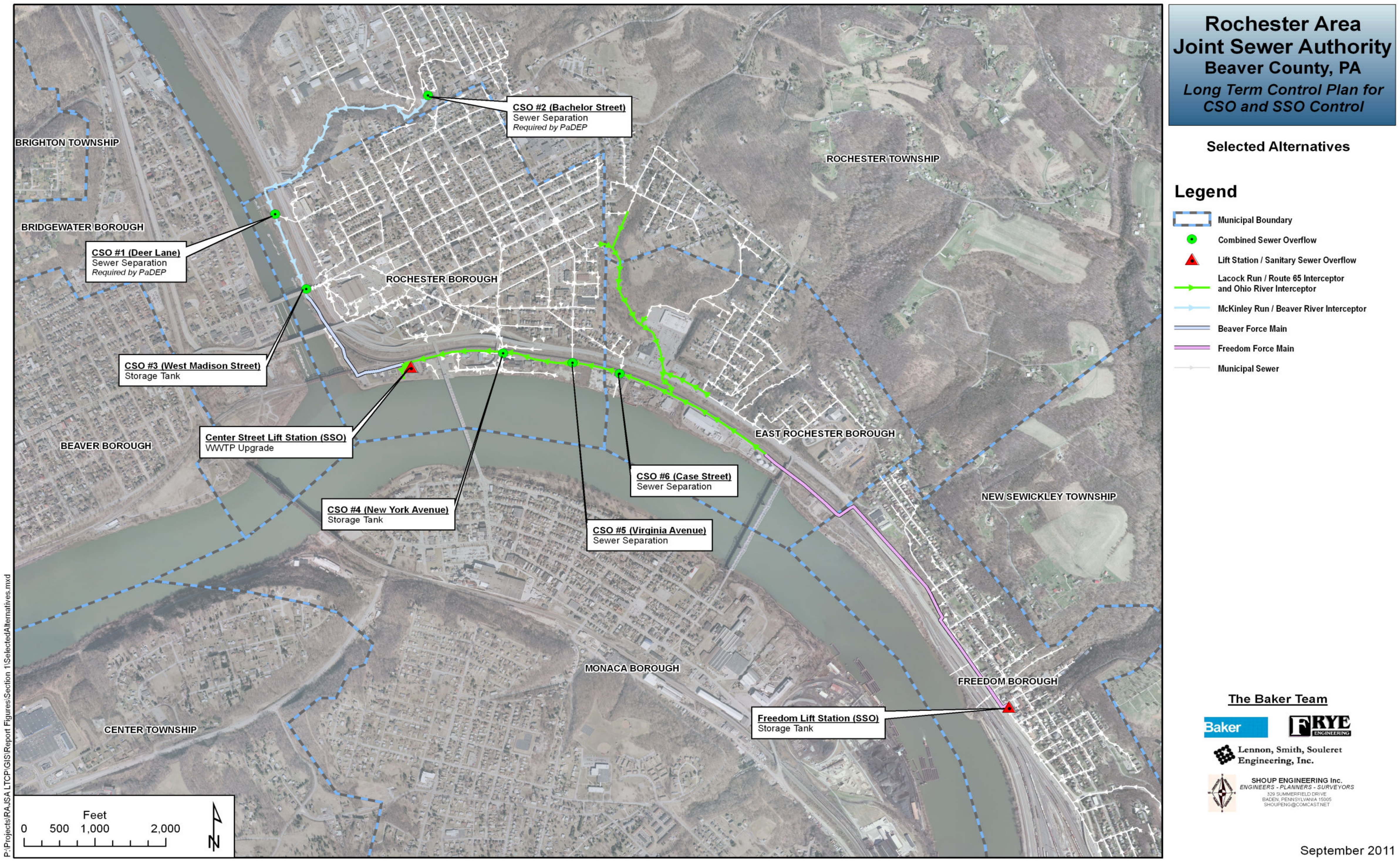


Table ES-5: Summary of Total Project Costs

Subsystem	Recommended Alternative	Total Capital Costs ($)	Total Annual O&M Costs ($)
Bachelor Street CSO	Complete Sewer Separation	$1,517,000	$0.00
Deer Lane CSO	Complete Sewer Separation	$1,327,000	$0.00
West Madison Street CSO	Storage Tank	$3,873,200	$60,600
New York Avenue CSO	Storage Tank	$3,873,200	$60,600
Virginia Avenue CSO	Complete Sewer Separation	$474,000	$0.00
Case Street CSO	Complete Sewer Separation	$664,000	$0.00
Freedom Lift Station SSO	Storage Tank	$3,491,500	$60,000
Center Street SSO / WWTP	WWTP and Lift Station Upgrades	$6,000,000	$25,000
	TOTAL SYSTEM	**$21,220,000**	**$206,200**

ES.14 User Cost Analysis / Affordability Analysis

The purpose of the affordability analysis and user cost analysis is to determine the financial impacts on the users of the RAJSA system based upon the recommendations provided in this LTCP using CSO Guidance for Financial Capability and Assessment and Schedule Development. It is important to note that the calculated user rates contained in this LTCP are based upon the existing Service Agreement between the RAJSA and the municipalities, which provides for a uniform rate throughout the service area. It is beyond the scope of this study to review and/or recommend other payment structures or rates. A community's median household income is an important piece of data utilized in determining funding options. Based on the CSO Guidance for Financial Capability Assessment and Schedule Development, an annual sewer bill of less than 1% of the median household income (MHI) constitutes a low financial impact to the community, between 1% and 2% is a medium impact and greater than 2% is a high financial impact. Table ES-6 below identifies the current sewer rate structure and 2000 Census data for the MHI. A median range of 1.5% of the MHI is utilized for comparison purposes. Based on the table, the current system users have a low financial impact with respect to sewer rates. Funding agencies will generally expect that rates increase to 1.5% of MHI before grant funding and low interest loans are awarded to projects.

Table ES-6: Current Sewer Rate Structure for RAJSA Municipalities

COMMUNITY	QUATERLY RATE STRUCTURE	Current Annual BILL	MHI[1]	1.5% of MHI[1]
ROCHESTER TOWNSHIP	$23.00 base plus $1.50 per 1,000 gallons over first 10,000 gallons per quarter	$290	$37,284	$559
ROCHESTER BOROUGH	$30.00 base plus $2.00 per 1,000 gallons over first 5,000 gallons per quarter	$368	$30,970	$465
EAST ROCHESTER BOROUGH	$45.00 flat base rate	$351	$25,625	$384
FREEDOM BOROUGH	$45.00 flat base rate	$351	$30,741	$461

[1] According to the 2000 census

The Project Team evaluated resultant user costs as a result of implementing the LTCP and obtaining funding from several agencies, including Pennvest and RUS as well as a traditional bond issue. Table ES-7 presents the various options evaluated by the Project Team. Based on current conditions and funding availability, Pennvest is the recommended funding source for the project. A likely funding scenario including a 30-year 1% loan is suggested with $1,000,000 in grant funding. Although based on the expected user rates, additional grant funding is warranted, it is not likely to be available. Supplemental grant funding should be sought to further lower user rates.

ES.15 Funding Responsibility

The LTCP recommends several capital projects to control overflows from CSOs and SSOs. Primarily, these projects involve both sewer separation and storage facilities. At the time the

LTCP was being developed, both Rochester Borough and East Rochester Borough were planning separation projects at Bachelor Street, Deer Lane, Virginia Avenue and Case Street. It was decided by the respective municipalities that these projects would be funded by the individual municipalities/authorities that were responsible for the outfalls. Namely, Rochester Borough for Bachelor Street, Deer Lane and Virginia Avenue and East Rochester for Case Street separation projects. At the present time, both Rochester Borough and East Rochester Borough are moving forward with the separation projects using a combination of grant and public funds. It is expected that this funding will continue through the implementation of this LTCP. At a regular meeting of the RAJSA Board held on October 13, 2011, the Board agreed that funding for the remaining projects in the LTCP (West Madison CSO, New York Avenue CSO, Freedom Lift Station SSO, Center Street SSO and the WWTP Expansion) should be borne by the RAJSA, in accordance with the existing Service Agreement. Table ES-7 reflects a uniform payment for these projects.

ES.16 CPAC and Public Participation

RAJSA and the member municipalities entered into a COA that, among other items, requires the development of a unified LTCP. According to the National CSO Policy, public participation and agency interaction are recommended. A Public Participation Program (PPP) was initiated as part of this project. The goals of the PPP was to involve citizens in the LTCP process, especially in the areas of alternative development and financial impacts to the service area. RAJSA's PPP included the formation of a CSO Plan Advisory Committee (CPAC) that met two times during the development of the LTCP, and will meet a final time after the LTCP is submitted to the PaDEP. The meetings were used to review and discuss the status and coordination of the LTCP, educate the public on CSO matters, and present the process, findings and recommendations of the LTCP. The meetings were advertised in the local newspaper, the Beaver County Times. Flyers were also sent to customers of the RAJSA with their bills and prominently placed in the municipal offices. The Project Team also developed a website www.rajsa-cso.org that informed the public of the LTCP project, provided CSO information, maps, useful links and public education. Important documents, such as the draft LTCP, was posted on the website and were made available for download, review and comment. Joint and separate presentations were also made to the municipal boards prior to and during the LTCP development. All public involvement, activities and public meetings were well documented.

Table ES-7: User Rate Analysis with Various Funding Options

USER RATE ANALYSIS
RAJSA Storage and WWTP Recommended Alternative

	PENNVEST $0 Grant with 20 Year Loan at County Cap [4]		PENNVEST $1,000,000 Grant with 30 Year Loan at 1%		PENNVEST $10,000,000 Grant with 30 Year Loan at 1%		USDA RUS 0% Grant with 40 Year Loan at 2.5%		USDA RUS 75% Grant with 40 Year Loan at 2.5%		Bond Issue $0 Grant with 30 Year Term at 5.5%	
Project Costs												
West Madison CSO Storage	$3,873,200		$3,873,200		$3,873,200		$3,873,200		$3,873,200		$3,873,200	
New York Avenue CSO Storage	$3,873,200		$3,873,200		$3,873,200		$3,873,200		$3,873,200		$3,873,200	
Freedom Lift Station Storage	$3,491,500		$3,491,500		$3,491,500		$3,491,500		$3,491,500		$3,491,500	
WWTP Upgrade	$6,000,000		$6,000,000		$6,000,000		$6,000,000		$6,000,000		$6,000,000	
Total Project Cost	**$17,237,900**		**$17,237,900**		**$17,237,900**		**$17,237,900**		**$17,237,900**		**$17,237,900**	
Customer Count												
Rochester Borough	1,578		1,578		1,578		1,578		1,578		1,578	
Rochester Township	942		942		942		942		942		942	
Freedom [1]	888		888		888		888		888		888	
East Rochester	313		313		313		313		313		313	
Total Customer	**3,721**		**3,721**		**3,721**		**3,721**		**3,721**		**3,721**	
Project Financing												
Grant Amount (Assumed)	$0		$1,000,000		$10,000,000		$0		$12,928,425		$0	
Total Amount Financed	**$17,237,900**		**$16,237,900**		**$7,237,900**		**$17,237,900**		**$4,309,475**		**$17,237,900**	
Annual Costs [2]												
Annual Project Debt Service	$1,187,773		$629,188		$280,455		$686,693		$171,673		$1,186,060	
Additional Annual Operation Costs - West Madison	$60,600		$60,600		$60,600		$60,600		$60,600		$60,600	
Additional Annual Operation Costs - Freedom	$60,000		$60,000		$60,000		$60,000		$60,000		$60,000	
Additional Annual Operation Costs - New York	$60,600		$60,600		$60,600		$60,600		$60,600		$60,600	
Additional Annual Operation Costs - WWTP	$25,000		$25,000		$25,000		$25,000		$25,000		$25,000	
Total Projected Annual Cost	**$1,393,973**		**$835,388**		**$486,655**		**$892,893**		**$377,873**		**$1,392,260**	
Monthy User Rates [5]												
Additional Monthly Cost per Customer [2]	$31.22		$18.71		$10.90		$20.00		$8.46		$31.18	
Current Average Monthly User Rate - RAJSA	$14.23		$14.23		$14.23		$14.23		$14.23		$14.23	
Total Monthly User Rate - RAJSA	$45.45		$32.94		$25.13		$34.23		$22.69		$45.41	
Current Average Monthly User Rate - Rochester Boro	$23.18		$23.18		$23.18		$23.18		$23.18		$23.18	
Current Average Monthly User Rate - Rochester Twp	$9.97		$9.97		$9.97		$9.97		$9.97		$9.97	
Current Average Monthly User Rate - East Rochester	$15.00		$15.00		$15.00		$15.00		$15.00		$15.00	
Current Average Monthly User Rate - Freedom	$15.00		$15.00		$15.00		$15.00		$15.00		$15.00	
		% of MHI		**% of MHI**		**% of MHI**		**% of MHI**		**% of MHI**		**% of MHI**
Total Monthly User Rate - Rochester Boro [3]	$68.63	2.7%	$56.12	2.2%	$48.31	1.9%	$57.41	2.2%	$45.88	1.8%	$68.59	2.7%
Total Monthly User Rate - Rochester Twp [3]	$55.42	1.8%	$42.91	1.4%	$35.10	1.1%	$44.20	1.4%	$32.66	1.1%	$55.38	1.8%
Total Monthly User Rate - East Rochester [3]	$60.45	2.8%	$47.94	2.2%	$40.13	1.9%	$49.23	2.3%	$37.69	1.8%	$60.41	2.8%
Total Monthly User Rate - Freedom [3]	$60.45	2.4%	$47.94	1.9%	$40.13	1.6%	$49.23	1.9%	$37.69	1.5%	$60.41	2.4%
	2.0% MHI	**1.5% MHI**										
Rochester Borough	$51.62	$38.71										
Rochester Township	$62.14	$46.61										
East Rochester	$42.71	$32.03										
Freedom	$51.24	$38.43										

1 Freedom customers include New Sewickley customers.
2 Additional annual cost for LTCP recommendations
3 Total Monthly User Rate includes RAJSA fee and Tributary Community fee.
4 County Cap Blended Rate = 3.27%
5 Current Average Monthly User Rate based on 160gpd/EDU average water use per Beaver Falls records.

ES.17 Next Steps

Section 12 of the COA requires the RAJSA to implement the CSO abatement recommendations of the LTCP by December 31, 2017. SSO discharges are required to cease by January 1, 2015 or a civil penalty will be levied by PaDEP. It is expected that the RAJSA will request a schedule extension from PaDEP relating to remediating the Center Street SSO (accomplished by the WWTP expansion). As such, it has been extended to December 31, 2017 with the remainder of the CSO abatement measures. At the time this report was being drafted, there was on-going discussion with PaDEP on whether the RAJSA would be required to complete an Act 537 Update for the WWTP expansion portion of the plan. It is expected that this will be clarified by the final draft of the LTCP. If an Act 537 Update is required, it should be accounted for in the schedule below. Listed below and illustrated in Figure ES-5 is important key milestones that should be considered, and are a result of the implementation schedule put forth by the PaDEP in the COA. The schedule below assumes that the RAJSA and the municipalities will adopt the LTCP during their respective Board meetings in October or November 2011.

Submit the draft LTCP to PaDEP .... December 31, 2011
PaDEP Comment Period... January to October 2012
Final PaDEP Approval of LTCP.. December 31, 2012
Design and Permitting of the Freedom Lift Station Storage Tank ...October 2012 to October 2013
Act 537 Plan Update (if required by PaDEP) ....October 2012 to October 2013
Construction of the Freedom Lift Station Storage Tank..... November 2013 to December 31, 2014
Design and Permitting of CSO Remediation Projects ....January 2014 to December 2015
Design and Permitting of Center St. and WWTP Upgrade .... January 2015 to July 2016
Construction of Remaining Projects ....January 2016 to December 31, 2017*

** it is expected that the separation projects of Bachelor Street, Deer Lane, Virginia Avenue and Case Street will be under construction from 2011 to 2014. As such, they have not been included in the schedule above.*

Some other considerations of the RAJSA and municipalities should be:

- Determine the awarding agency(ies) for the various wet weather projects included in this LTCP.
- Determine how the implementation of joint projects (if required) and ongoing operation and maintenance are going to be performed.

ES.18 LTCP Review by COA Signatories

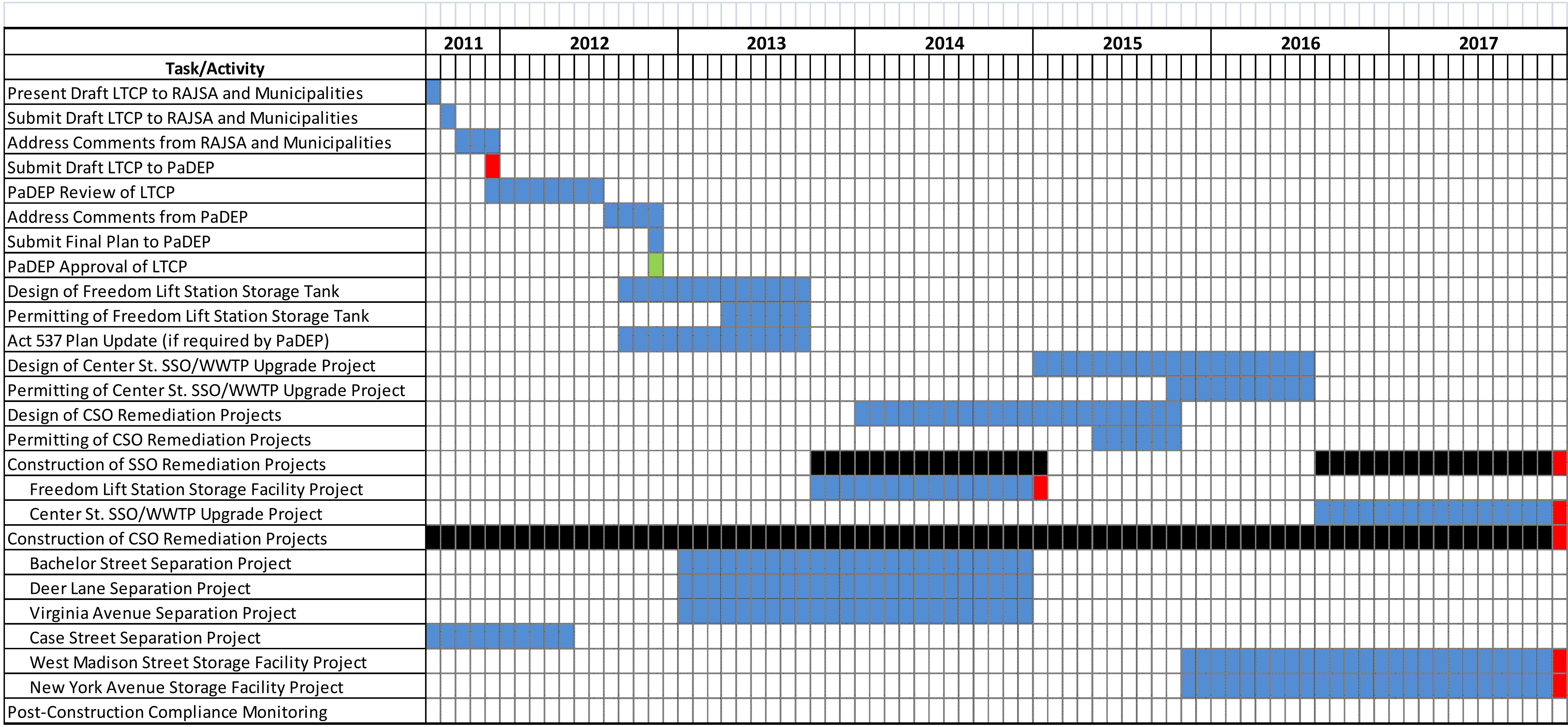
The draft LTCP was submitted to the RAJSA and other signatories of the COA, namely the RBSMA, FBCCA, RTSA and East Rochester Borough, on October 21, 2011 for review and comment. The recipients were provided a six-week period to review the plan and provide comments to the Project Team. Since section 12 of the COA required the development of a "single, coordinated" LTCP, the Project Team wanted to provide the opportunity for the municipalities to accept or "adopt" the plan during either their November or December 2011 public meetings.

The Project Team participated in an informational meeting held on November 30, 2011 at 6:30 PM at the Rochester Township Municipal Building. The Rochester Township Commissioners requested the RAJSA to participate in this meeting with the municipal officials. Discussions were held regarding the plan recommendations, costs, implementation schedule and future customer rates. The sign-in sheet of attendees is included in Appendix J of this report. It was decided among the municipal officials that a series of informational meetings would need to be scheduled within the respective municipalities to inform the public of the LTCP projects and the impacts of the projects with respect to customer rates.

East Rochester Borough requested a meeting with their residents to discuss the LTCP. A meeting was scheduled by the Project Team for January 24, 2012. It is expected that this meeting will serve as the 3rd and final CPAC meeting.

In all, the draft LTCP was accepted by all the municipalities and the RAJSA. Plan approval documentation is included in Appendix L.

Figure ES-5: Draft Implementation Schedule



1.0 Introduction

1.1 Goals and Objectives

The goals and objectives of the Long Term Control Plan (LTCP) is to develop and present the valuation of alternatives, cost analysis, screening of alternatives, to present the highest ranked and recommended solutions and an implementation schedule that will allow Rochester Area Joint Sewer Authority (RAJSA) and the member municipalities to select appropriate control alternatives that will best meet the environmental requirements set forth in the Commonwealth of Pennsylvania, Department of Environmental Protection's (PaDEP) Consent Order Agreement (COA), 2^{nd} Amendment, as issued on June 6, 2008 (included in Appendix A).

The LTCP will also include information regarding existing sewer system characteristics, flow monitoring results, hydraulic and hydrologic system characteristics, receiving-water quality, and end-of-pipe water quality. Existing collection system information obtained from the municipal records, GIS mapping and flow monitoring of the individual sewer systems were used in the screening of technologies, the analysis of CSO control alternatives, and the development of opinions of probable costs for each alternative evaluated. Evaluation criteria were weighted and scored to facilitate ranking of the control alternatives. In addition, recommendations for the RAJSA long-term CSO controls are being coordinated with the PaDEP to ensure that a comprehensive solution for combined sanitary sewer overflows is developed. The LTCP includes a summary of the possible alternatives and how these alternatives can be implemented.

1.1 Background

1.1.1 Present Wastewater Facilities

The RAJSA owns and operates a WWTP and interceptor system that treats and conveys wastewater flows from Rochester Borough, East Rochester Borough, Freedom Borough, New Sewickley Township and Rochester Township within Beaver County, Pennsylvania. New Sewickley Township is considered a customer of Freedom Borough and the RAJSA and is not a member municipality of the RAJSA. Each of the municipalities are responsible for the operation and maintenance of their respective collection systems and the RAJSA is responsible for operation and maintenance of the RAJSA interceptors, pumping stations and WWTP. Each of these systems are described in further detail in the next chapter.

The RAJSA is organized under the Pennsylvania Municipal Authorities Act of 1945. A service agreement exists between the RAJSA and the municipalities that was last renewed in 2009. The service agreement outlines terms and conditions for the RAJSA and the municipalities with respect to operation and maintenance, service charges, capital additions, bonds, records, audits, budgets, reports, etc. Typically, the service agreement is reviewed and amended periodically by the RAJSA and the municipalities.

1.1.2 Institutional History

The regulation of CSOs in Western Pennsylvania falls under the authority of the PaDEP with oversight from USEPA. The PaDEP has authority to administer and enforce The Clean Streams Law, Act of June 22, 1937, P. L. 1987, as amended. The PaDEP also recognizes the Combined Sewer Overflow Control Policy signed by USEPA on April 11, 1994 and codified in the Water Quality Act of 2000. By recognizing the CSO Control Policy, RAJSA can utilize information contained in the associated USEPA and Pennsylvania CSO Guidance documents to devise and implement measures to control CSO.

The USEPA CSO Control Policy and the accompanying guidance documents provide assistance to CSO communities in preparing cost-effective CSO control alternatives. These cost-effective CSO control alternatives are evaluated based on the reduction or elimination of water quality impacts from CSO discharges and on adequate input by stakeholders. A major part of the LTCP development process is the need to adequately characterize the collection system, which includes, *"…analysis of existing data, monitoring and modeling of the combined sewer system and the receiving water."[USEPA CSO – Guidance for Long-Term Control Plan]*.
The CSO Control Policy allows for a "Demonstration Approach," where the permittee demonstrates the adequacy of its CSO control program to meet water quality-based requirements, or a "Presumptive Approach", where the permittee is presumed to have met water quality standards when certain performance-based criteria are met.

The LTCP development project is based upon the requirements set forth in Section 12 of the aforementioned COA, as amended, which states the following:

> "*By December 31, 2011, East Rochester, FBCCA, RBSMA, Rochester Township Authority, and RAJSA shall submit to the Department a single, coordinated LTCP. The LTCP shall be developed to comply with the CSO Control Policy. In addition the LTCP shall, if necessary, include provisions to expand the Plant to treat the appropriate amount of flows required to be conveyed to the Plant by the CSO Control Policy. The LTCP shall be based on sufficient and valid flow monitoring data necessary to determine the need for additional facilities. The implementation schedule contained in the LTCP shall have an end date on later than December 31, 2017.*

Although specific requirements relating to the LTCP was not detailed in the COA, it was clear that it needed to be prepared in accordance with the National CSO Policy. The Baker Team took a proactive approach, on behalf of RAJSA, prior to the project award and met with PaDEP to discuss the content and technical approach that the Department required in the Plan. A scope of work for development of a LTCP was prepared and forwarded to PaDEP for review and comment. Months of planning resulted in the culmination of the award of the project to the Baker Team on March 25, 2010.

1.2 Project Team

The Baker Team consists of Michael Baker Jr., Inc. (Baker) of Beaver, PA as the prime consultant with Lennon, Smith, Souleret Engineering (LSSE) of Coraopolis, PA, Shoup Engineering of Baden, PA and Frye Engineering of Beaver, PA as subconsultants. Baker is the current engineering representative for Rochester Township and New Sewickley Township. LSSE is the current engineering consultant of the RBSMA, Shoup Engineering is the current engineering representative for the RAJSA, and Frye Engineering is the current engineering consultant for East Rochester Borough and the FBCCA. The extensive knowledge of the RAJSA treatment plant and respective collection systems made the Baker Team a natural fit to successfully complete this project.

1.3 Report Contents

Table 1-1: Report Contents

Section	Contents
Section 1—Introduction	Background information and report approaches, goals and objectives
Section 2—Existing Facilities	Overview of existing wastewater collection system
Section 3—Flow Monitoring Program	Overview of the flow monitoring program and results
Section 4—Model Development & Calibration	Development and calibration of the collection system model used for the H&H characterization
Section 5—Existing Water Quality and Sensitive Area Analysis	Overview of existing water quality regulatory limits and designated sensitive areas
Section 6—Collection System Performance	Description of existing conditions and baseline conditions of the collection system, and level of service analysis results
Section 7—CSO and SSO Control Levels	Description of CSO and SSO control levels
Section 8 —CSO and SSO Control Technologies	Development of CSO and SSO control technology inventory and screening
Section 9 —Development and Evaluation of CSO and SSO Controls	CSO and SSO control technology alternative development and selection and preliminary facility siting
Section 10—Affordability Analysis	Description of the affordability analysis and its impact on LTCP implementation
Section 11—Recommended Project Plan Summaries	Description of the most economically feasible, highest ranked combination of outfall-specific, consolidated, system-wide and 85% capture alternatives
Section 12 - Public Participation	Description of community outreach avenues and meetings (CPACs) and regulatory agency meetings during LTCP development
Section 13 - Schedule and Implementation	Development of the implementation strategy and description of required tasks and services
Section 14—Post Construction Compliance Monitoring Plan	Description and recommendations for post-construction monitoring of remaining CSO outfalls

2.0 Existing Facilities

2.1 RAJSA Wastewater Treatment Plant

The RAJSA Wastewater Treatment Plant (WWTP) is located in Rochester Borough on the north shore of the Ohio River, at the confluence of the Ohio River and Beaver River. The WWTP was originally placed into operation in 1960.

The original WWTP constructed in 1960 initially provided only primary treatment. The original treatment plant included two primary settling tanks, two anaerobic sludge digestion tanks, a sludge vacuum filter, and chlorination facilities.

In 1974, the original WWTP was modified and expanded into a secondary biological treatment system. The secondary treatment plant project included construction of an extended aeration system utilizing two aeration tanks (with surface aeration), conversion of the two primary settling tanks into final settling tanks, conversion of one of the sludge digester tanks from anaerobic to aerobic (the second anaerobic digester was no longer to be used), and demolition and construction of a new chlorine contact tank.

Since the WWTP was upgraded to a biological treatment system in 1974, additional modifications or additions to the WWTP occurred, most notably being:

- 1987 - A belt filter press was installed to improve sludge dewatering.

- 1991 - A polymer feed system was installed to improve solids removal in the final settling tanks during high flow conditions.

- 1995-1996 - The surface aeration of the aeration tanks was replaced with a fine bubble diffused air system.

The secondary treatment WWTP was designed and permitted for an average monthly flow of 1.40 MGD. In 2003, PaDEP, in the issuance of the RAJSA NPDES permit, added a monthly average wet weather flow limit of 2.25 MGD and a peak hourly flow limit of 4.70 MGD. These wet weather flow limits were added since the WWTP had historically proved its ability to accommodate wet weather flows to these levels without effluent degradation. The wet weather flow limits allow the WWTP to maximize flow to the WWTP for treatment during wet weather.

From 2008 through 2010, the WWTP has processed an average flow of 1.33 MGD (based on average monthly flows) from its service area of Rochester Borough, Freedom Borough, Rochester Township, East Rochester Borough, and New Sewickley Township.

2.2 RAJSA Interceptor System

RAJSA currently maintains approximately 3.2 miles of interceptor sewer with gravity sewers ranging from 10 inches to 24 inches, along with 3 pump stations and associated force mains ranging from 10 inches to 12 inches. The RAJSA interceptor system is shown on Figures 2-1 and 2-2.

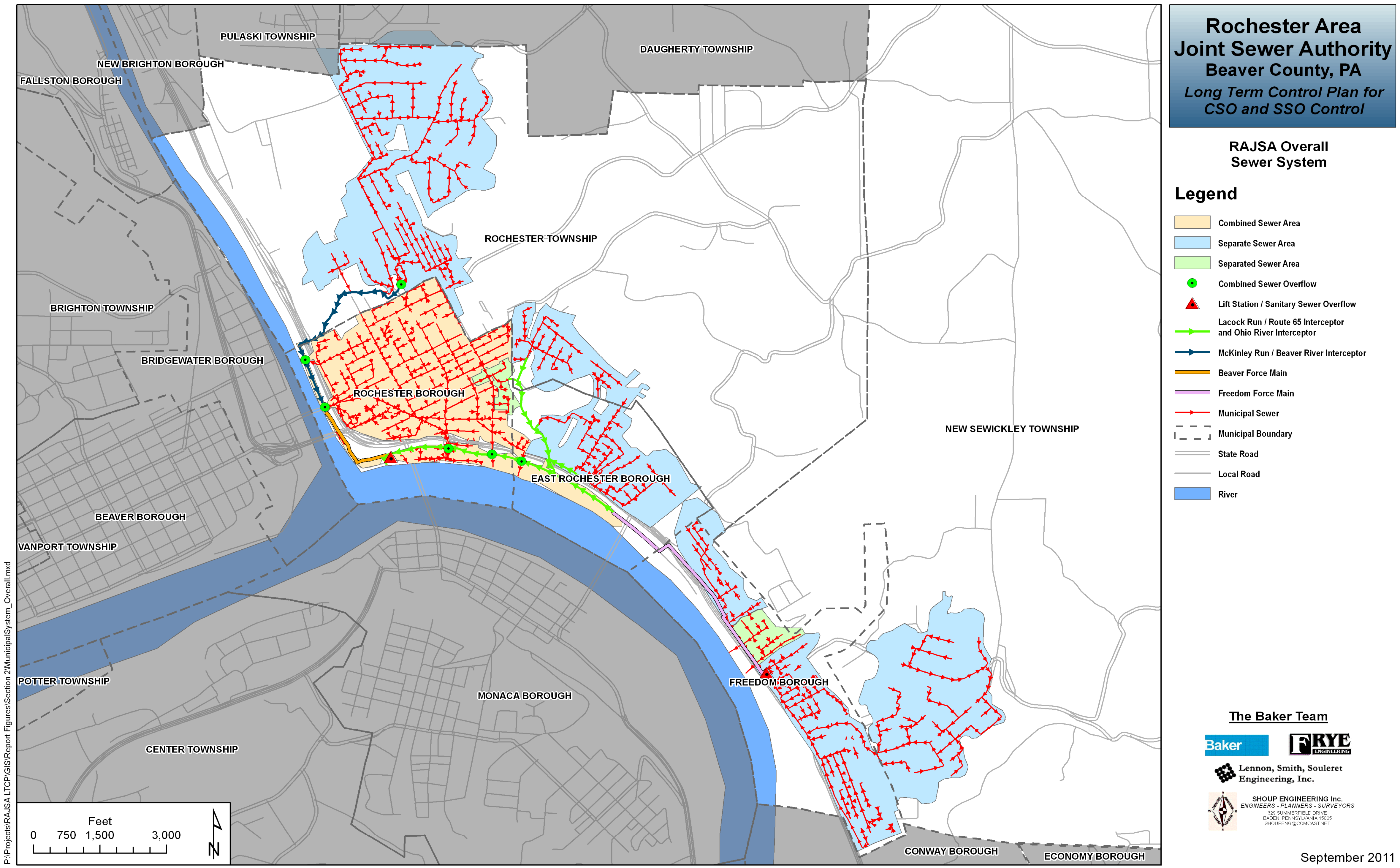
The gravity interceptor sewer system has historically been divided into 6 different portions, as follows:

- <u>Ohio River Interceptor</u> - This interceptor generally parallels the Ohio River and commences at the Center Street Pump Station adjacent to the WWTP. The interceptor conveys wastewater from each of the 5 municipalities serviced by RAJSA. The interceptor ranges from 15 inches to 24 inches and has a total length of approximately 5,425 feet.

- <u>Beaver River Interceptor</u> - This interceptor generally parallels the Beaver River and commences at the West Madison Pump Station along the east shore of the Beaver River. The interceptor conveys wastewater from Rochester Borough and Rochester Township. The interceptor ranges from 12 inches to 18 inches and has a total length of approximately 1,720 feet.

- <u>McKinley Run Interceptor</u> - This interceptor generally parallels McKinley Run and commences at the upstream terminus of the Beaver River Interceptor. The interceptor

Figure 2-1: RAJSA Service Area *(base mapping source: Pennsylvania Spatial Data Access)*



conveys wastewater from Rochester Borough and Rochester Township. The interceptor ranges from 10 inches to 12 inches and has a total length of approximately 2,800 feet.

- Lacock Run Interceptor - This interceptor generally parallels Lacock Run and commences at the Ohio River Interceptor. The interceptor conveys wastewater from Rochester Borough, Rochester Township, and East Rochester Borough. The interceptor ranges from 8 inches to 15 inches and has a total length of approximately 2,705 feet.

- Ohio River Boulevard Interceptor - This interceptor generally parallels the Ohio River Boulevard in East Rochester Borough and commences at the Lacock Run Interceptor. The interceptor conveys wastewater from East Rochester Borough. The interceptor sewer is a 10-inch sewer and has a total length of approximately 790 feet.

- Freedom Interceptor - This interceptor generally parallels Third Avenue in Freedom Borough and commences at the Freedom Borough Pump Station. The interceptor conveys wastewater from Freedom Borough and New Sewickley Township. The interceptor ranges from 10 inches to 15 inches and has a total length of approximately 2,100 feet.

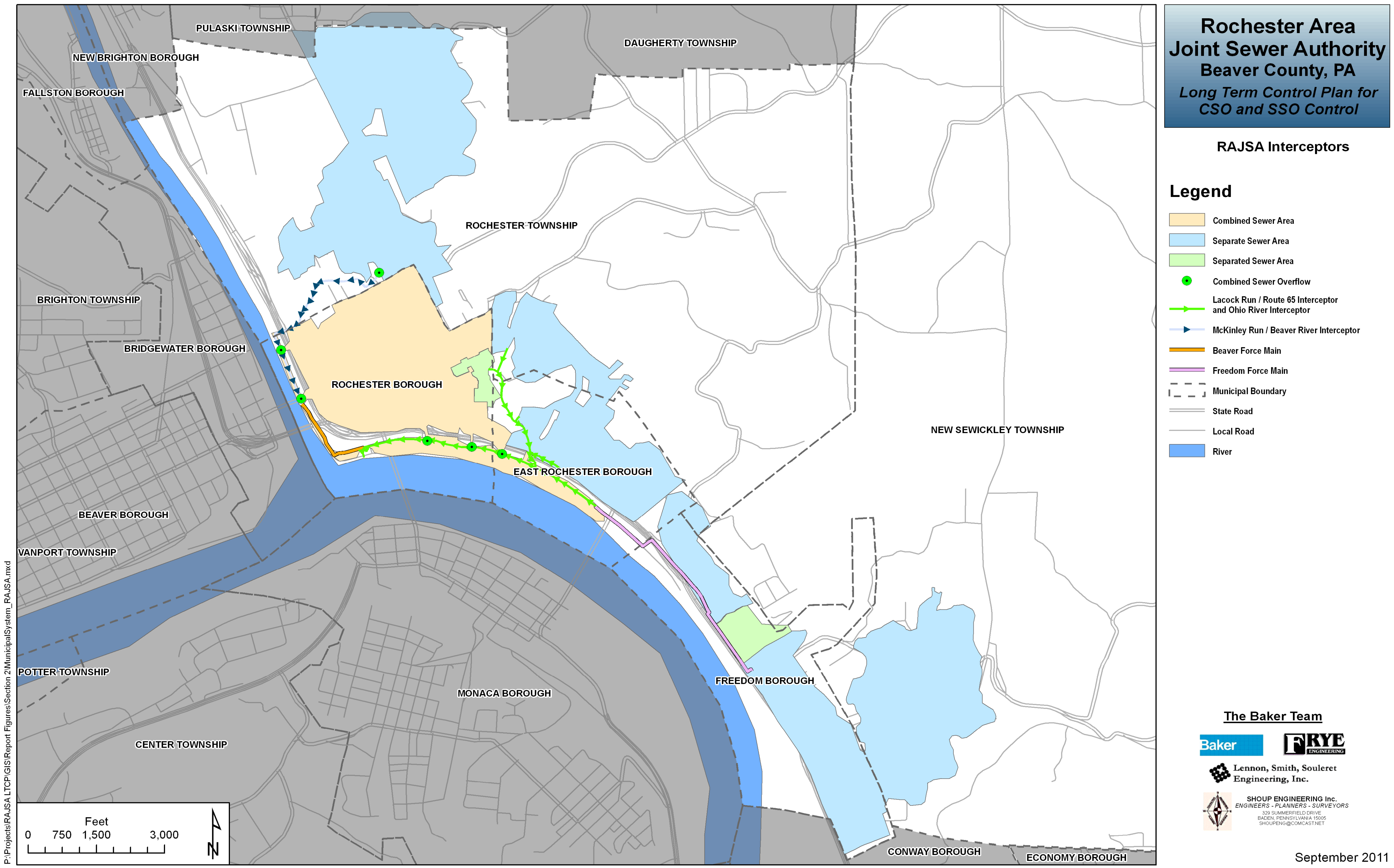
RAJSA also owns and operates 3 pump stations and their associated force mains, as follows:

- Center Street Pump Station - This pump station is located adjacent to the WWTP and accepts wastewater flows from the Ohio River Interceptor. The flows are lifted to the WWTP via a 12-inch force main. The pump station also conveys return sludge from the WWTP's final settling tanks to the head of the WWTP. Centrifugal pumps generate a maximum capacity of 4.9 MGD at the pump station.

- West Madison Pump Station - This pump station is located along the east shore of the Beaver River and accepts wastewater flows from the Beaver River Interceptor. The flows are lifted to the WWTP via a 12-inch force main. Centrifugal pumps generate a maximum capacity of 1.8 MGD at the pump station.

- Freedom Pump Station - This pump station is located adjacent to the intersection of Third Avenue and Eighth Street in Freedom Borough and accepts wastewater flows from the

Figure 2-2: RAJSA Interceptor System *(base mapping source: Pennsylvania Spatial Data Access)*



Freedom Interceptor. The flows are lifted to the Ohio River Interceptor via a 10-inch force main. Centrifugal pumps generate a maximum capacity of 1.0 MGD at the pump station.

Each of the RAJSA pump stations contain a grit removal system and comminutor. Likewise, each of the pump stations have 3 pumps that operate in a sequential order to accommodate the flow rates experienced at the pump stations.

2.3 Rochester Borough Collection System

Rochester Borough is a riverfront municipality located along the Ohio River in east-central Beaver County and was incorporated in 1908. According to the 2000 census, it has a population of 4,014. It has a land area of approximately 0.5 square miles. It has a water area of 0.1 square miles. The population density is approximately 6,862 people per square mile. In 2000, it had a median household income of $30,790. The Rochester Borough collection system is shown in Figure 2-3.

The Rochester Borough Sewer and Maintenance Authority (RBSMA) owns, operates, and maintains the collection sewer system within Rochester Borough. The collection system includes approximately 41,300 feet of combined sewers and approximately 34,500 feet of separate sanitary sewers. Sewers range in diameter from 6 inches to 54 inches. A total of approximately 247 manholes are located within the sewer system.

In 2010, the RBSMA performed a sewer separation project for a portion of the combined sewer system that led to the closure of two CSOs known as the East Washington Street CSO and the Hull Street (manhole 8) CSO which previously discharged to Lacock Run.

There are five active CSOs present within Rochester Borough. These CSOs and their discharge locations are as follows:

1. Bachelor Street CSO - discharges to McKinley Run
2. Deer Lane CSO - discharges to the Beaver River
3. West Madison Street CSO - discharges to the Beaver River
4. New York Avenue CSO - discharges to the Ohio River

5. Virginia Avenue CSO - discharges to the Ohio River

The RBSMA also owns and operates a small pump station located near the bank of the Ohio River in the vicinity of the Beaver Valley Bowl. This pump station services a small portion of the overall RBSMA system.

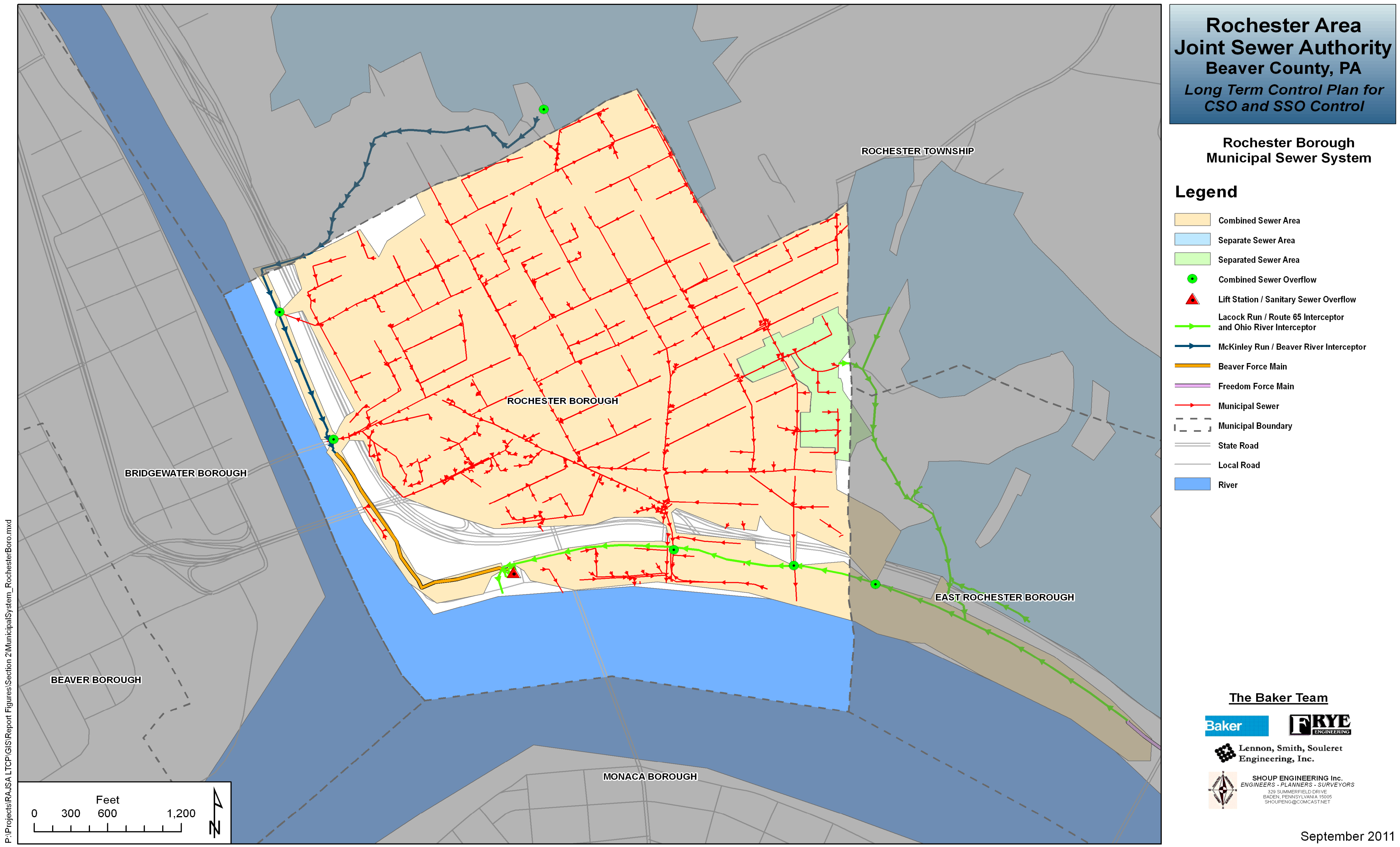
All sewage generated within Rochester Borough is collected and conveyed to either the McKinley Run interceptor sewer, Beaver River interceptor sewer, Ohio River interceptor sewer, or the Lacock Run interceptor sewer. All of these are owned and operated by RAJSA.

2.4 East Rochester Borough Collection System

East Rochester Borough is a riverfront municipality located along the Ohio River and Beaver River in central Beaver County and was incorporated in 1849. According to the 2000 census, it has a population of 623. It has a land area of approximately 0.6 square miles. It has a water area of 0.1 square miles. The population density is approximately 1,568 people per square mile. In 2000, it had a median household income of $25,625. The East Rochester Borough collection system is shown in Figure 2-4.

East Rochester Borough owns, operates, and maintains the collection sewer system within East Rochester Borough. The collection system includes approximately 12,000 feet of sewer. With the exception of a portion of the system which is combined sewer in the vicinity of Case Street, the sewers are 6 inches and 8 inches in diameter. The system also includes approximately 94 manholes.

Figure 2-3: Rochester Borough Sewer System *(base mapping source: Pennsylvania Spatial Data Access)*



East Rochester Borough has prepared design plans to separate the portion of combined sewers in the vicinity of Case Street. It is anticipated that the sewer separation project will be completed in 2012. Following the sewer separation project, all sewers within East Rochester Borough should be separate sanitary sewers. Upon completion of the sewer separation project, the Case Street CSO will be closed.

East Rochester Borough also owns and operates a small pump station known as the Oak Avenue Pump Station. This pump station services a small portion of the Borough's overall system.

Upon completion of the above described sewer separation project, all sewage generation within East Rochester Borough will be collected and conveyed to either the Ohio River Boulevard interceptor sewer or the Lacock Run interceptor sewer, both of which are owned and operated by RAJSA.

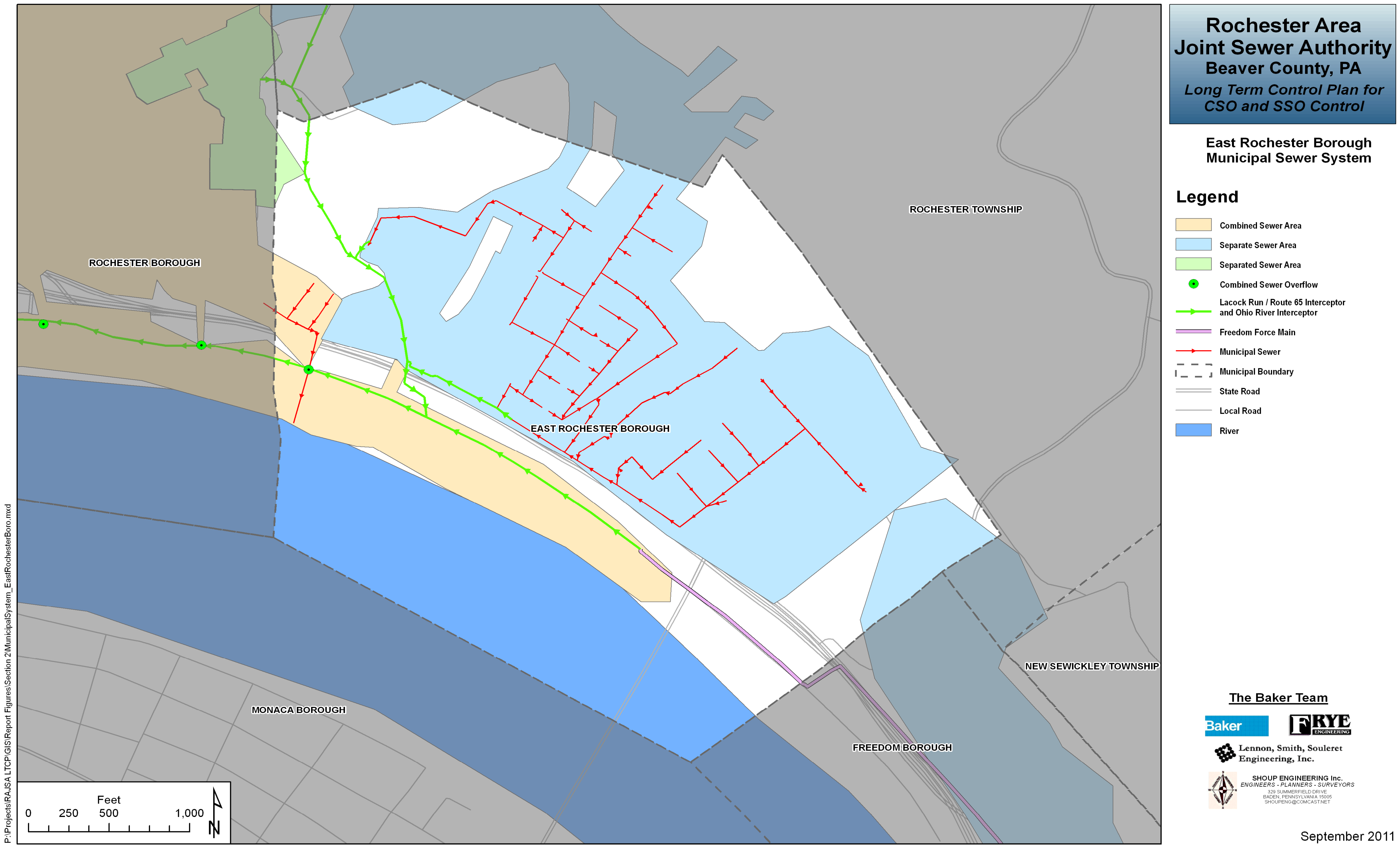
2.5 Freedom Borough Collection System

Freedom Borough is a riverfront municipality located along the Ohio River east-central Beaver County and was incorporated in 1838. According to the 2000 census, it has a population of 1,763. It has a land area of approximately 0.6 square miles. It has a water area of 0.1 square miles. The population density is approximately 2,984 people per square mile. In 2000, it had a median household income of $30,741. As of 2009, the Freedom Borough sewer system is a 100% separate system. The Freedom Borough collection system is shown in Figure 2-5.

The Freedom Borough Collection and Conveyance Authority (FBCCA) owns, operates, and maintains the collection sewer system within Freedom Borough. The system includes approximately 45,000 feet of sewer. The vast majority of sewer is 8 inches in diameter with small portions of 6-inch diameter sewer also present. The system also includes approximately 198 manholes.

In 2009, FBCCA performed a sewer separation project for the combined sewer system portion of the system. This separation project resulted in the closure of two CSOs in the Borough. One of the CSOs was located at the intersection of Sixth Street and Third Avenue and the other CSO

Figure 2-4: East Rochester Borough Sewer System *(base mapping source: Pennsylvania Spatial Data Access)*



was located at the intersection of Seventh Street and Third Avenue. All sewers within Freedom Borough are now believed to be separate sanitary sewers.

All sewage generated within Freedom Borough is collected and conveyed to the Freedom Pump Station which is owned and operated by RAJSA.

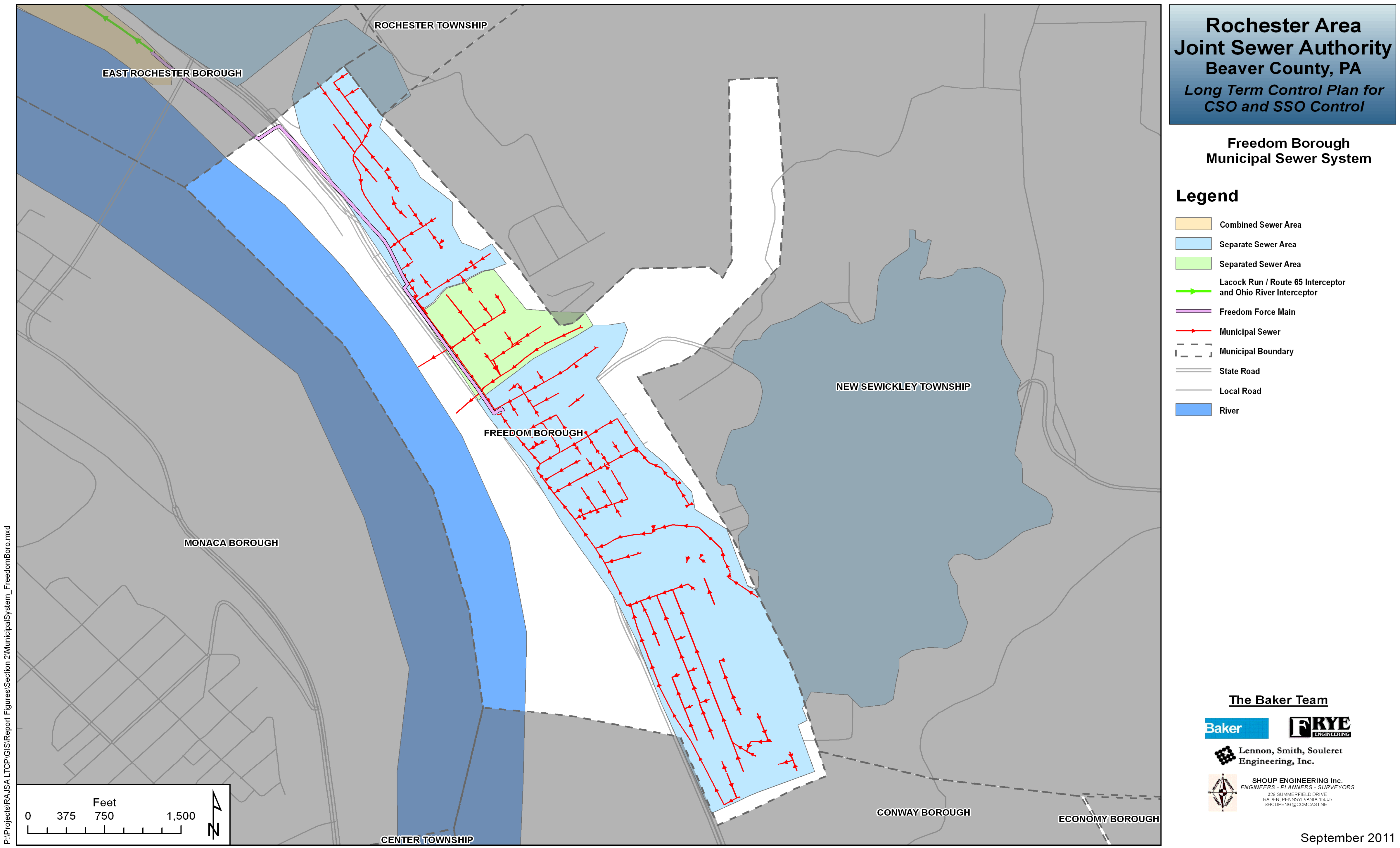
2.6 Rochester Township Collection System

Rochester Township is located north of Rochester Borough in north-central Beaver County and was incorporated in 1840. According to the 2000 census, it has a population of 3,129, with 80% being urban and 20% being rural. It has a land area of approximately 3.8 square miles. It has a water area of 0.1 square miles. The population density is approximately 820 people per square mile. In 2000, it had a median household income of $37,284. The Rochester Township Sewer Authority (RTSA) is responsible for the operation and maintenance of the Township sewer system, which was constructed in the 1950's.

The RTSA system is a completely separate collection system that serves the urban portion of the Township. The rural portion of the Township is currently served by on-lot treatment systems. The majority of the sewage flow in the Township connected to the public system is conveyed to the RAJSA WWTP. There is a small portion of the Township, located along the western border that conveys sewage flow to the New Brighton Borough Sanitary Authority collection system and WWTP. This service area is not part of the COA or the LTCP. The RTSA serves 932 residential and commercial customers. Although potential exists for future growth in the Township, its population has remained fairly constant, and the RTSA has no immediate plans for expansion of their collection system.

The interceptor portion of the system consists of approximately 9,400 lineal feet of 8" pipe, approximately 4,500 lineal feet of 10" pipe, and 70 manholes. The collection portion of the system consists of approximately 55,000 lineal feet of 8" pipe and 204 manholes. The pipe is primarily vitrified clay except for some of the more recent modifications which are PVC pipe. For the most part, the collection system and interceptor system are in good operating condition.

Figure 2-5: Freedom Borough Sewer System *(base mapping source: Pennsylvania Spatial Data Access)*



The eastern drainage area of the Township is a gravity system. The western drainage area of the system flows to the Grant Street Lift Station which then discharges via an 8” force main to the gravity system at the intersection of Pennsylvania Avenue and Harrison Street. The Grant Street Lift Station was constructed in the 1950s and was rehabilitated in 1992. The lift station is a wet well-dry well system with two pumps, each rated for 320 GPM at 47’ TDH. There are no known basement backups, problematic areas, SSOs or CSOs in the Township.

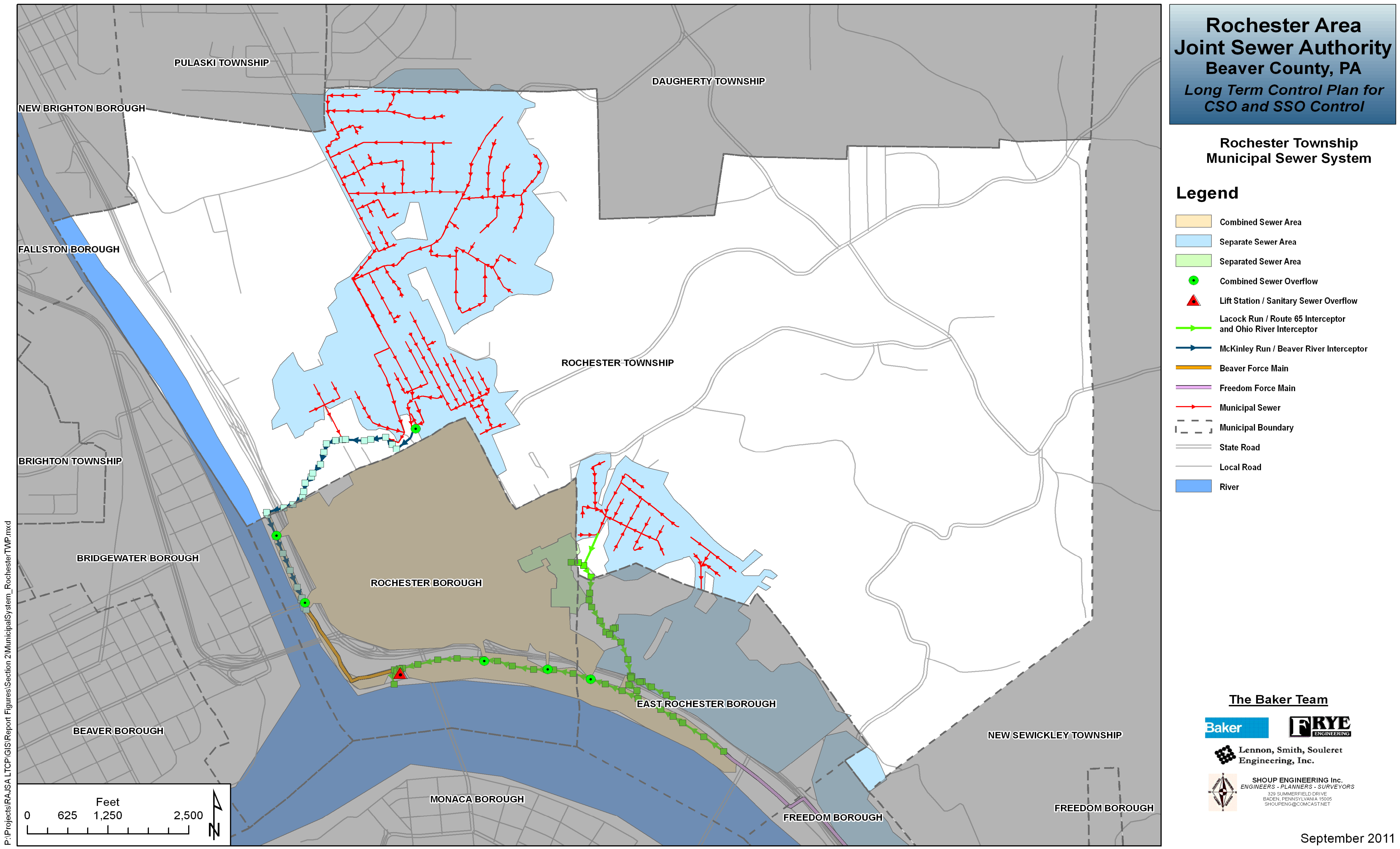
Flows from Rochester Township connect to the RAJSA system at two locations - via the McKinley Run and Lacock Run Interceptors. There are no portions of the Township that are conveyed through another municipalities sewage collection system. The RAJSA owns the interceptors up to the points of connections of the RTSA system. The McKinley Run Interceptor conveys flows to RAJSA's Beaver River Interceptor and the Lacock Run Interceptor conveys flows to RAJSA's Ohio River Interceptor.

RTSA has been proactive since the mid-1990s identifying and correcting defects within their system. RTSA performed a system inventory and mapping study from 1996 to 1998. Smoke testing was performed at this time. RTSA used the conclusions of the 1996 to 1998 system inventory and mapping studies as a framework to begin repairing identified defects. RTSA has completed several I/I removal projects in the Sunflower Road and Beaver Street area, Charlotte Avenue, Irvin Street and Valley Drive area. In October of 2004, the RTSA completed a sanitary sewer replacement project on Charlotte Avenue from Elm Street to Pentland Avenue. The project included replacement of approximately 290' of 8" VCP sewer with new PVC pipe and two new precast manholes. In accordance with the requirements of the COA, RTSA has also performed dye testing, a system-wide manhole characterization project, and flow monitored at several key locations in the Township for a 12-month period. In 2007, the RTSA removed seventeen homes from Rochester Borough’s Bachelor Street CSO, which was a requirement of the COA.

Two other projects have recently been completed to repair identified defects, these projects included:

Rudzik Excavating Inc. completed a project to replace 1,003 feet of 10” sanitary sewer and seven manholes on the RTSA-owned portion of the McKinley Run interceptor in December of 2009.

Figure 2-6: Rochester Township Sewer System *(base mapping source: Pennsylvania Spatial Data Access)*



Meyer Excavating Inc. completed a project in 2011 to replace the manhole covers on 30 of the existing manholes in state road right of ways, and to replace two manholes that were in poor condition and to replace a 75 foot section of pipe.

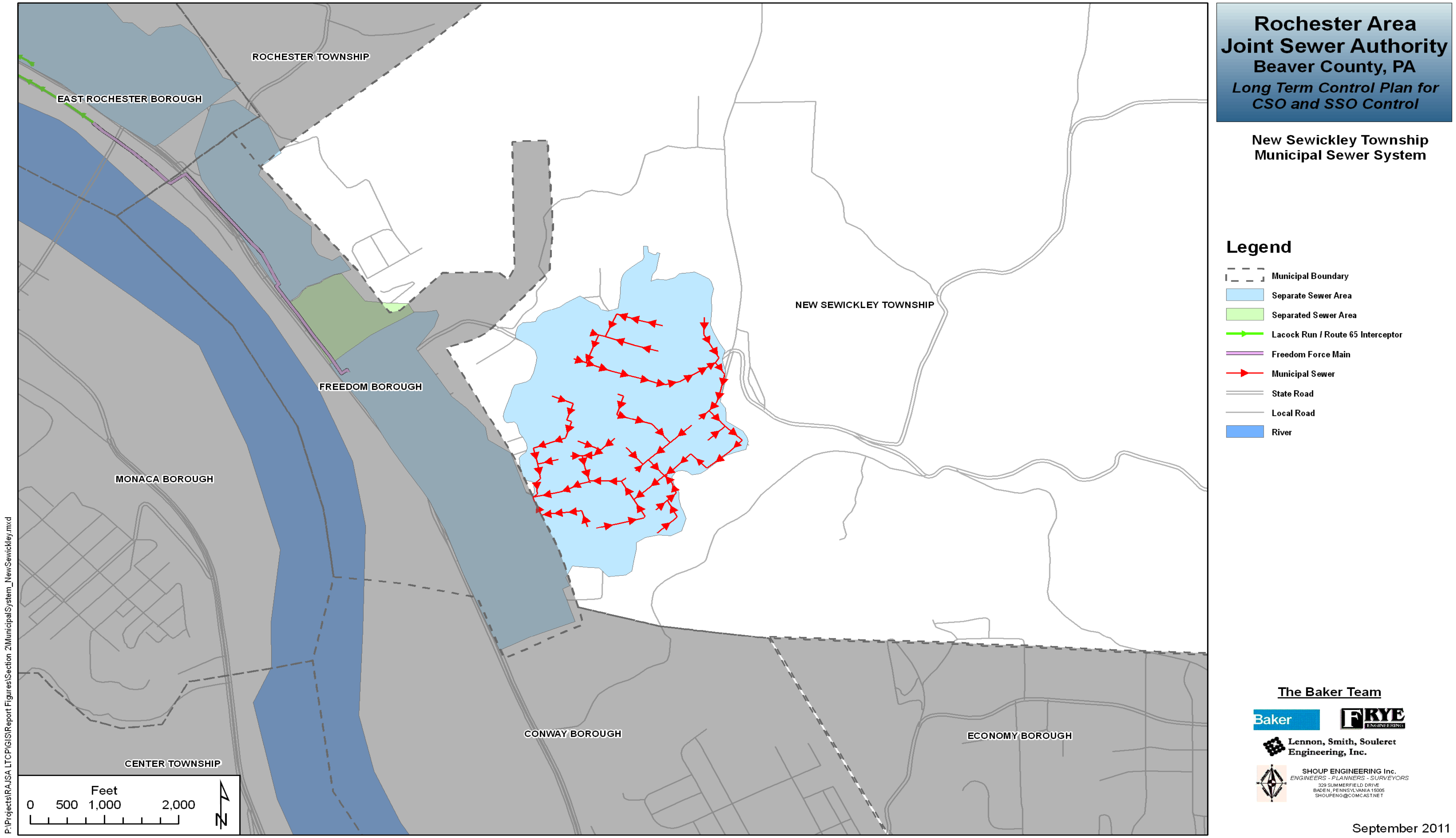
2.7 New Sewickley Township Collection System

New Sewickley Township is a municipality located along the eastern border of Beaver County and is bounded by Economy Borough to the south, Marion Township to the north, New Brighton Borough and Rochester Borough to the west, and Cranberry Township in Butler County to the east. It was incorporated in 1801. According to the 2000 census, it has a population of 7,076. It has a land area of approximately 32.7 square miles. It has a water area of 0.0 square miles. The population density is approximately 217 people per square mile. In 2000, it had a median household income of $42,614. The Township has two main areas of concentrated residential / commercial development; namely, at the intersections of Freedom Crossing / Lovi Roads near Cranberry Township and just east of Freedom Borough along 9th St. Ext. and Harvey Run Roads.

The New Sewickley Township Municipal Authority (NSTMA) is responsible for the operation and maintenance of the Township sewer system, which is 100% separate. New Sewickley Township is not a member of the RAJSA, but conveys sewage to the RAJSA system and WWTP through its connection in Freedom Borough. For this, New Sewickley Township is considered a "customer" of the RAJSA and Freedom Borough. NSTMA basically has two separate and distinct utility systems servicing these two developed areas of the Township. NSTMA provides potable sanitary sewage service to its customers at / near the intersection of Freedom Crider / Lovi Roads (referred to as the Tri-County Commerce Park (TCCP) system). This area does not contribute flow to the RAJSA system. NSTMA also provides sanitary sewage service to its approximately 200 residential customers at / near the Freedom Borough portion of the Township (also known as the Harvey Run Road service area).

The sanitary sewer system within the Harvey Run Road service area system was constructed between 1987 and 2003, and consists of approximately 5 miles of 8” and 10” PVC collection and conveyance lines (with about 120 manholes) and one (1) 400 GPM @ 76’ TDH sewage pump station. The sewage pump station discharges through a 4” force main into the NSTMA's gravity sewage system along Harvey Avenue. All collected sewage from the service area is conveyed

Figure 2-7: New Sewickley Township Sewer System *(base mapping source: Pennsylvania Spatial Data Access)*



to Freedom Borough's sewage conveyance system (at an interconnection point in Freedom Borough near Sixth Avenue along Harvey Run Road) for eventual transfer to the RAJSA's system and WWTP for treatment and disposal.

2.8 Existing Combined Sewer Overflows

Table 2-1 lists the six active CSOs in the RAJSA service area along with their location and receiving water. Figure 2-8 graphically shows the location of the CSOs.

Table 2-1: List of CSOs in the RAJSA Service Area

CSO	Location	Municipality/Owner	Receiving Water	NPDES No.
1	Bachelor Street	Rochester Borough	McKinley Run	PAG066133
2	Deer Lane	Rochester Borough	Beaver River	PAG066133
3	West Madison Street	Rochester Borough/RAJSA	Beaver River	PAG066133 / PA0026140
4	New York Avenue	Rochester Borough	Ohio River	PAG066133
5	Virginia Avenue	Rochester Borough	Ohio River	PAG066133
6	Case Street & Railroad Street	East Rochester Borough	Ohio River	PAG0166132

2.9 Existing Sanitary Sewer Overflows

Table 2-2 lists the two active SSOs in the RAJSA service area along with their location and receiving water. Figure 2-8 graphically shows the location of the SSOs.

Table 2-2: List of SSOs in the RAJSA Service Area

SSO	Location	Municipality	Receiving Water
1	Freedom Lift Station	Freedom Borough	Ohio River
2	Center Street Lift Station	Rochester Borough	Ohio River

2.10 Implementation of the Nine Minimum Controls

The CSO Control Policy identifies the Nine Minimum Controls which, when properly implemented, are intended to maximize flow to the treatment plant and reduce overflows. RBSMA has focused on implementation of the NMC's since its creation. Progress is reported to the Department twice a year as required by the Consent Order and Agreement. The table below summarized each control, how RBSMA is implementing the control and the status.

NMC No.	Description
NMC 1 Proper Operation and Regular Maintenance Program	RBSMA has established a program for regular Operation and Maintenance of the CSS. Inlets and catch basins are cleaned on a routine basis. CSOs are inspected weekly and after each rainfall event. Inspection, operations and maintenance and record keeping procedures were modified as necessary to ensure adoption of inspection, maintenance and record keeping standards necessary for NMC compliance. RBSMA has implemented an improvement program where inlets within the combined sewer system are converted to catch basins by various physical modifications to the specific inlet. This task is largely complete with final completion scheduled for December 31, 2011. RBSMA has completed an extensive base mapping program which include aerial photography and mapping of their service area, review of existing mapping, and field verification. The base map is updated regularly as new information is obtained about the sewer system. This mapping includes a GIS database which assists in

	record keeping.
NMC 2 Maximum Use of the Collection System for Storage	RBSMA has completed separation projects for two sewersheds, the East Washington CSO, and the Hull Street CSO. Defect repair is ongoing. RBSMA is currently in the design phase of separation of three additional combined sewer areas.
NMC 3 Review and Modification of Pretreatment Requirements	The Borough adopted a Grease Trap Ordinance to limit the amount of fat/oil/grease (FOG) contribution by commercial customers to 100 ppm.
NMC 4 Maximization of Flow to the POTW for Treatment	As part of the LTCP process and the attendant flow monitoring program, confirmation that 350% of the average flow is conveyed to the treatment plant has been completed.
NMC 5 Elimination of CSOs During Dry Weather Flow	The RBSMA currently inspects and maintains the diversion structures weekly and after wet weather events. Blockages are removed immediately to prevent DWO's.
NMC 6 Control of Solid and Floatable Materials	RBSMA has proactively taken measures to reduce the amount of solid and floatable materials entering the CSS. As reported under NMC 1, catch basins/inlets are cleaned regularly and street sweeping occurs weekly. RBSMA evaluated outfall screening devices in a 2009 memorandum which ultimately deferred further evaluation to the LTCP process. Due to the physical nature and location of the outfalls, no screening devices are proposed for the CSOs to remain.

NMC 7 Pollution Prevention Program	RBSMA maintains source controls for the minimization of pollution/pollution prevention as described previous NMC.
NMC 8 Public Notification of Overflow Occurrences and their Impacts	RBSMA has installed visual identification signage at each of the diversion structures. Each sign is individually labeled with the diversion structure number. A website has been established as a result of the LTCP process at www.rajsa-cso.org that provides various CSO information including CSO descriptions, CSO location maps, LTCP meeting dates, contact information, links to related material and a Sewage Overflow Brochure.
NMC 9 Monitoring to Characterize CSO Impacts and the Efficacy of Controls	RBSMA currently maintains a regular CSO maintenance/visual inspection program as described in the NMC Report. RBSMA regularly inspects, cleans and maintains CSOs to minimize the impacts of wet weather flows.

3.0 Flow Monitoring Program

3.1 Background

Outside of the scope of this project, but necessary for the LTCP, a flow monitoring program was developed and conducted for the RAJSA service area. The purpose of this program was to collect sewer flow data for the RAJSA interceptor system, including inputs from the municipalities. This information, combined with rainfall data, provided the foundation for the development and calibration of a comprehensive Hydraulic and Hydrologic (H&H) computer based model of the RAJSA service area.

3.2 Flow Monitoring Program

The flow monitoring program was developed to meet the following objectives:

- Evaluate the operational characteristics of key combined sewer system components;
- Collect accurate and synoptic sewershed data to support collection system modeling;
- Collect system data to determine flow characteristics for areas outside the influence of downstream hydraulic control elements;
- Develop flow balances for as many monitored locations as feasible; and
- Determine the relationship between rainfall and system response for each monitoring location.

RAJSA initiated a 6 month flow monitoring program in 2009. A total of twenty-five (25) flow monitors were installed with thirty-eight (38) sensors. Flow monitors were installed on either February 26, 2009 or March 1, 2009. Most monitors were removed on September 3, 2009, however five monitors capturing flow from Freedom remained in place to document post construction flows from the 6th and 7th Street Sewer Separation projects. Seven monitors remained installed until October 6 or 7, 2009 to obtain additional flow data.

3.3 Site Evaluations

Flow monitoring sites were selected to characterize subunits within the tributary community sewer systems as shown on Figure 3-1. Prior to monitor installation, each manhole was inspected to determine the suitability of each flow monitoring location. The flow monitoring locations are described in Table 3-1.

3.4 Flow Monitoring Equipment

The system was monitored using ISCO 2100 Series flow monitors. Area-Velocity (AV) probes were utilized to measure flow rates within the sewer system and combined sewer overflows.

3.5 Monitor Maintenance

Bi-weekly maintenance and interrogation site visits were performed which consisted of data upload from monitor to computer, sensor cleaning and calibration adjustments as required.

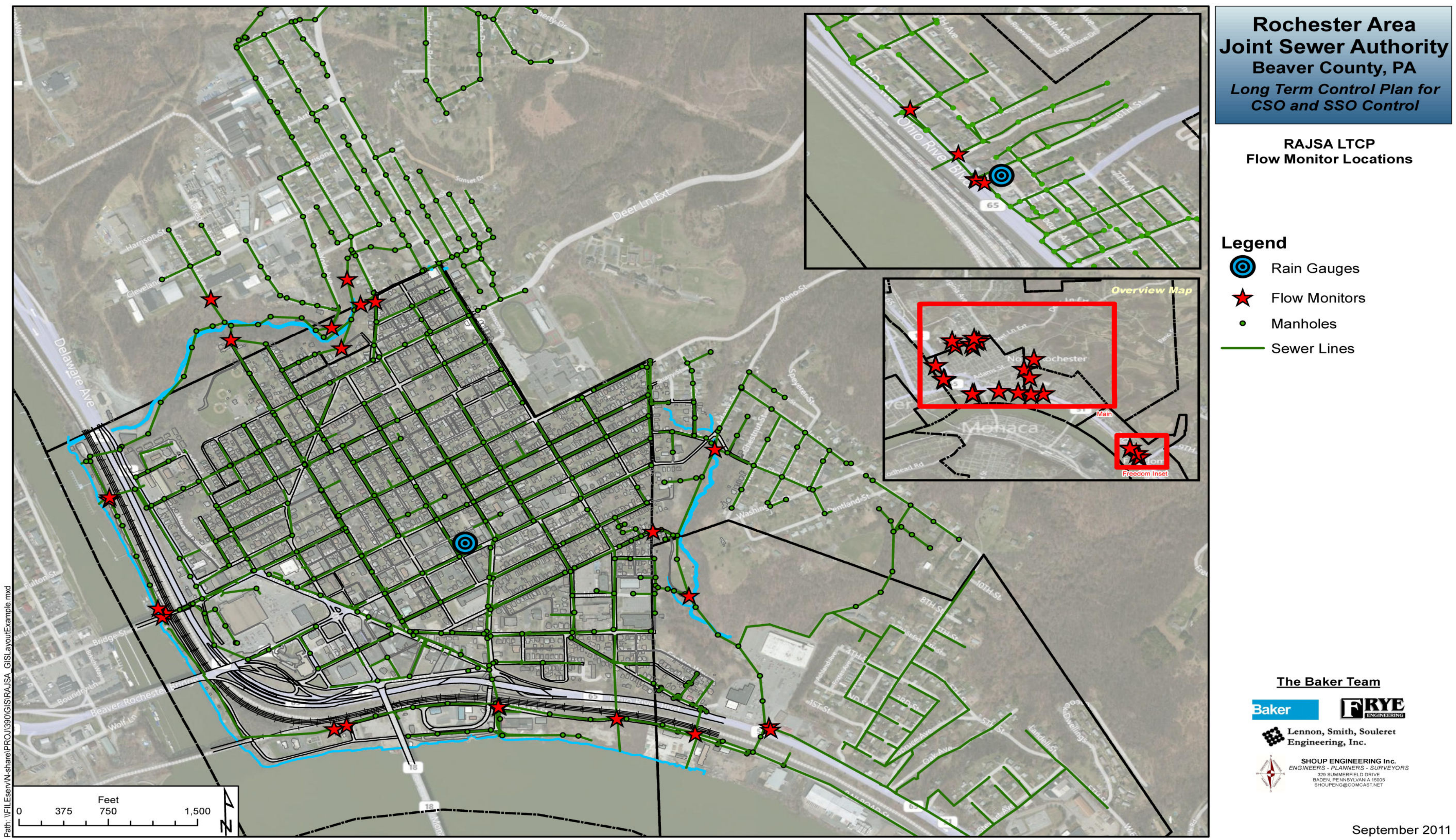
3.6 Raw Data QA/QC

The raw data quality review process was performed during the bi-weekly flow data collection sessions. The raw data was reviewed in the field providing a “first cut” screening of the data on a laptop computer an included a review of the repeatability and consistency of the raw data. Once the raw data was uploaded to the server in the office a flow data quality was graded with the methodology developed by the 3 River Wet Weather Demonstration Program (3RWWDP) during the development of the regional flow monitoring plan for the 83 communities within the ALCOSAN service area (Allegheny County). The level vs. velocity scatterplot (d/v), flow vs. level scatterplot (d/q) and time series plot (hydrographs) for each site were reviewed after each download. Primary emphasis was placed on the d/v and d/q scatterplots and if any hydraulic issues existed within the scatterplots, the field technicians were notified and the appropriate adjustments were made to the monitors out in the field. Flow data quality was characterized and characterized as follows:

Table 3-1: Flow Monitoring Location Descriptions

Monitor Number	Number of Sensors	Key Number	Monitor Name	Sensor Location	Line size	Flow Contribution Pecentage					Line Operated/Owned By
						Rochester Borough	Rochester Township	East Rochester Borough	Freedom Borough	RAJSA	
1	1	20	Freedom 3rd Ave and 8th (Lift Station Side line)	(A) 3:00 In	15"	0%	0%	0%	100%	0%	RAJSA
2	2	21	Freedom 3rd Ave and 8th (Lift Station Overflow) B	(A) Overflow (B) Effluent	16" 15"	0%	0%	0%	100%	0%	RAJSA
3	2	21	Freedom 3rd Ave and 8th (Lift Station Overflow) A	(A) Overflow (B) Main In	18" 8"	0%	0%	0%	100%	0%	RAJSA
4	2	19	Freedom 3rd Ave and 7th (CSO)	(A) Overflow (B) Main In	18" 24"	0%	0%	0%	100%	0%	Freedom
5	2	18	Freedom 3rd Ave and 6th (CSO)	(A) Overflow (B) Main In	18" 18"	0%	0%	0%	100%	0%	Freedom
6	1	17	Lacock B Hollywood	(A) Main Interceptor In	14"	0%	0%	0%	0%	100%	RAJSA
7	1	17	Lacock B Hollywood Side Line	(A) 3:00 In	10"	0%	0%	100%	0%	0%	East Rochester
8	2	9	Case Street (CSO)	(A) Overflow (B) Main In	18" 24"	0%	0%	100%	0%	East Rochester, Rochester	East Rochester
10	2	11	East Washington (CSO)	(A) Overflow (B) Main In	30" 24"	100%	0%	0%	0%	0%	Rochester Borough
11	2	10	MH-8 (CSO)	(A) Overflow (B) Main In	15" 15"	100%	0%	0%	0%	0%	Rochester Borough
12	2	8	Virginia Avenue (CSO)	(A) Overflow (B) Main In	30" 36"	100%	0%	0%	0%	0%	Rochester Borough
13	2	7	New York Avenue (CSO)	(A) Overflow (B) Main In	54" 15"	100%	0%	0%	0%	0%	Rochester Borough
14	1	2	Center Street Lift Station	(A) Effluent	24"	0%	0%	0%	0%	100%	RAJSA
15	1	16	Center Street (CSO)	(A) Overflow	16"	0%	0%	0%	0%	100%	RAJSA
16	1	1	West Madison Lift Station	(A) Main Interceptor In	18"	0%	0%	0%	0%	100%	RAJSA
17	2	3	West Madison (CSO)	(A) Overflow (B) Main In	24" 24"	100%	0%	0%	0%	0%	Rochester Borough
18	1	5	McKinley Run	(A) Main Interceptor In	18"	0%	0%	0%	0%	100%	RAJSA
19	2	4	Deer Lane (CSO) (aka Delaware)	(A) Overflow (B) Effluent	24" 10"	100%	0%	0%	0%	0%	Rochester Borough
20	2	12	Connecticut Ave	(A) 12:00 In (B) 3:00 In	8" 8"	100%	0%	0%	0%	0%	Rochester Borough
23	1	13	New York Avenue @ McKinley Run	(A) Effluent	8"	100%	0%	0%	0%	0%	Rochester Borough
24	2	6	Bachelor Street (CSO)	(A) Overflow (B) Main In	24" 18"	15%	85%	0%	0%	0%	Rochester Borough
MH 3 (Dmach)	1	-	New York Ave and Vermont Ave	(A) Effluent	10"	0%	100%	0%	0%	0%	Rochester Township
MH 12 (Dmach)	1	-	Connecticut Avenue and Cleveland St	(A) Effluent	8"	0%	100%	0%	0%	0%	Rochester Township
MH 263 (Dmach)	1	-	Adams St and Charlotte Ave	(A) Effluent	10"	0%	100%	0%	0%	0%	Rochester Township
MH 293 (Dmach)	1	-	Harmony Ave	(A) Effluent	8"	0%	100%	0%	0%	0%	Rochester Township

Figure 3-1: Flow Monitoring Locations *(base mapping source: Pennsylvania Spatial Data Access and AirPhoto USA Imagery 2007)*



- Type 1 – Generally considered to be acceptable for use "As Is".

  Typically the hydrograph/scatterplot indicates:
  - Consistent, repeatable pattern for velocity and depth time series plots,
  - Consistent base infiltration (not associated with seasonal groundwater variations),
  - No evidence of velocity or depth drift,
  - Valid calibration points reasonably approximate the monitored data.

With the exception of minimal random error modifications (i.e. fill-in of lost single observation point etc.) the time series plots (i.e. hydrograph) is used as generated from the raw data "unaltered or unadjusted".

- Type 2 – Data set containing alternate hydraulic conditions or defined periods of "Adjusted" data for random or systematic error. Data is usable in terms of quality and utility.

  Typically the hydrograph/scatterplot indicates:
  - Reasonably consistent, repeatable pattern for velocity and depth time series plots,
  - Reasonably consistent base infiltration (not associated with seasonal groundwater variations),
  - May include calculated trendline-based flow rates as a result of systematic velocity sensor error,
  - Valid calibration points reasonably approximate the monitored data,
  - Repeatable pattern for velocity and depth time series plots that may deviate from the typical patterns observed at the site.

  The dataset may have corrected systematic errors including;
  - Flow rate computations on loss of velocity based on a rating curve method, or
  - Random loss of depth that was corrected/adjusted using simple averaging.

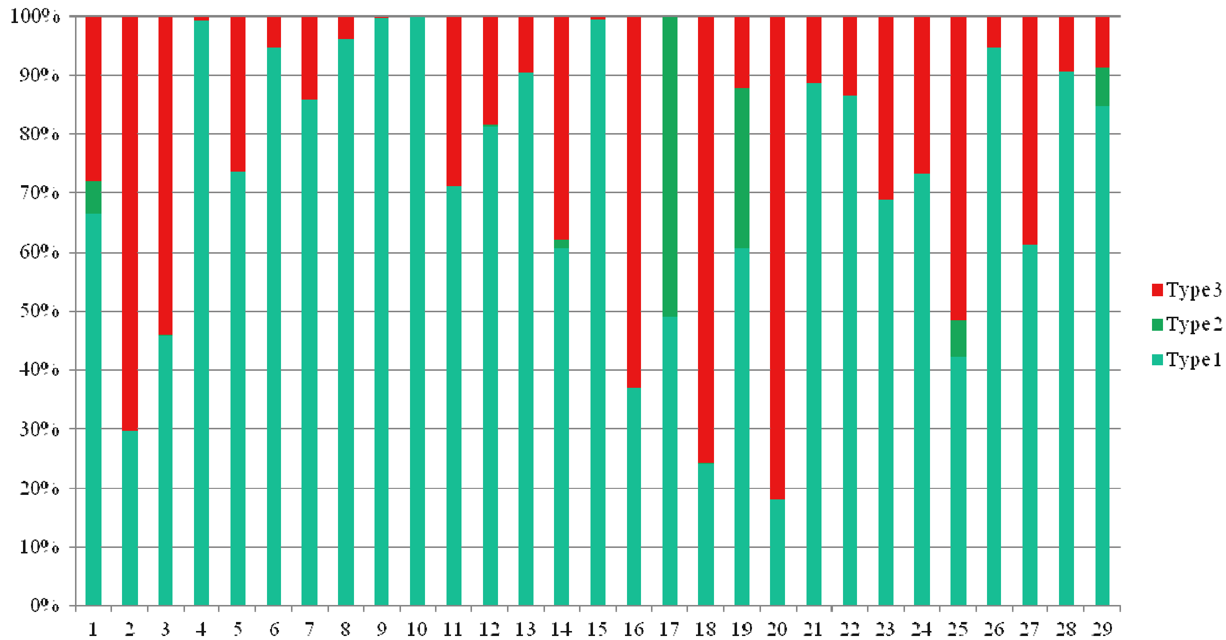
- Type 3 – Data is suspect in terms of quality and utility and should not be considered for use.

  Typically the hydrograph/scatterplot should indicate:
  - Inconsistent, non-repeatable pattern for velocity and depth time series plots,
  - Inconsistent base infiltration (not associated with seasonal groundwater variations)
  - Evidence of significant and uncorrectable velocity or depth drift
  - Calibration points generally have a random pattern and do not generally fall within the limits of scatter and are offset from the time series plots.

It is acknowledged that there will likely be certain flow monitoring sites in which data utility may not necessarily coincide with data quality. As an example, certain sites that may have Type 3 quality in terms of scatterplot analysis (flow depth v. flow rate relationship), however may contain repeatable/reliable depth data that will be desirable for hydrologic/hydraulic model calibration/assessment. It is understood that in certain circumstances, engineering judgment will need applied to the Data Typing process. In these instances, the data set will be "Typed" as Type 2, however will be annotated appropriately with respect to Type 3 flow rate quality.

Figure 3-2 summarizes the data collected from the flow monitoring program and the Type classification. There were a total of 260 monitor months of flow monitoring data from February 26, 2009 to October 6, 2009 obtained from the 25 monitoring locations (38 sensors) for the RAJSA LTCP Flow Monitoring Program. There were approximately 148 months of Type 1 data, 5 months of Type 2 data, and 108 months of Type 3 data. These statistics include the overflow monitors.

Figure 3-2: Data Types Collected During the Flow Monitoring Program



3.7 Rainfall Data

Digital rainfall data was obtained and evaluated on a bi-weekly basis along with the QA/QC review of the flow data. The precipitation data was obtained in 15-minute increments with two ISCO 676 Rainfall Logging System Rain gauges. One rain gauge was installed on the Freedom Lift Station and the second was installed at the Rochester Borough building. The locations are shown on Figure 3-1.

3.8 Flow Database Preparation

This task included generating calendar time versus flow rate hydrographs for each monitor location. Hydrographs were sorted and de-constructed to identify and characterize flow parameters including; Sewage Flow, Base Infiltration, and Storm Flow. Hydrographs from each monitor location were annotated as “suitable” and “unsuitable” data based on the final QA/QC analysis. Scatterplot analysis in accordance with the final QA/AC review was performed on “suitable” data. Precipitation data obtained was used to establish flow volume for precipitation events.

3.9 Flow Monitoring Findings

3.9.1 Final QA/QC

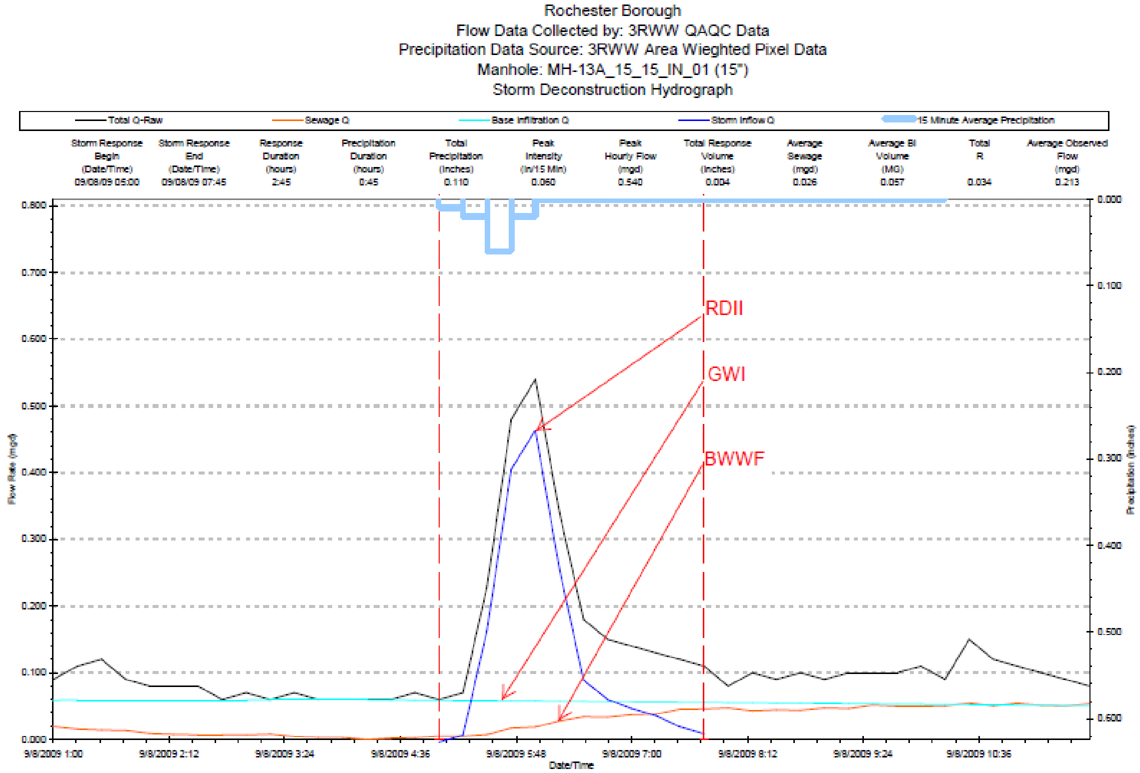
The scope of the work for the LTCP included QA/QC analysis of the flow monitor data collected within the RAJSA sewer system for the period of monitoring for each flow monitor. Cursory analysis of the data include review of pre and post storm event diurnal cycles (i.e. magnitude of flow and hydrograph shape) to qualitatively assess the suitability of the flow data. Sensor cutouts periods were synthetically generated or excluded from any further analysis.

Periods of unsuitable flow data were identified where debris was present of systematic error cutouts occurred, or where monitors were pulled for maintenance. After the raw data QA/QC analysis was completed and exported from LSSE's Flow Data Software Program (FDS), QA/QC flow time series consisting of data categorized as Type 1 and Type 2 was copied into individual spreadsheets in uniform format. To determine the continuity within the collection system and individual subsystem contributions, "meter math" was used. "Meter math" is simply subtracting the tributary monitors from the downstream monitor to determine net sewershed readings. These net readings can also determine if a meter is reading suitably based on net demographics which will be described below. Final QA/QC plots are presented in Appendix E.

3.9.2 Storm Deconstructions

Precipitation event data and QA/QC flow data were loaded into an Access database and correlated to match time. The RTK SHAPE program was used to sort and deconstruct total flow hydrographs in order to identify component flow parameters - base wastewater flow (BWWF), groundwater infiltration (GWI), and rainfall dependent inflow and infiltration (RDII) which are shown in Figure 3-3.

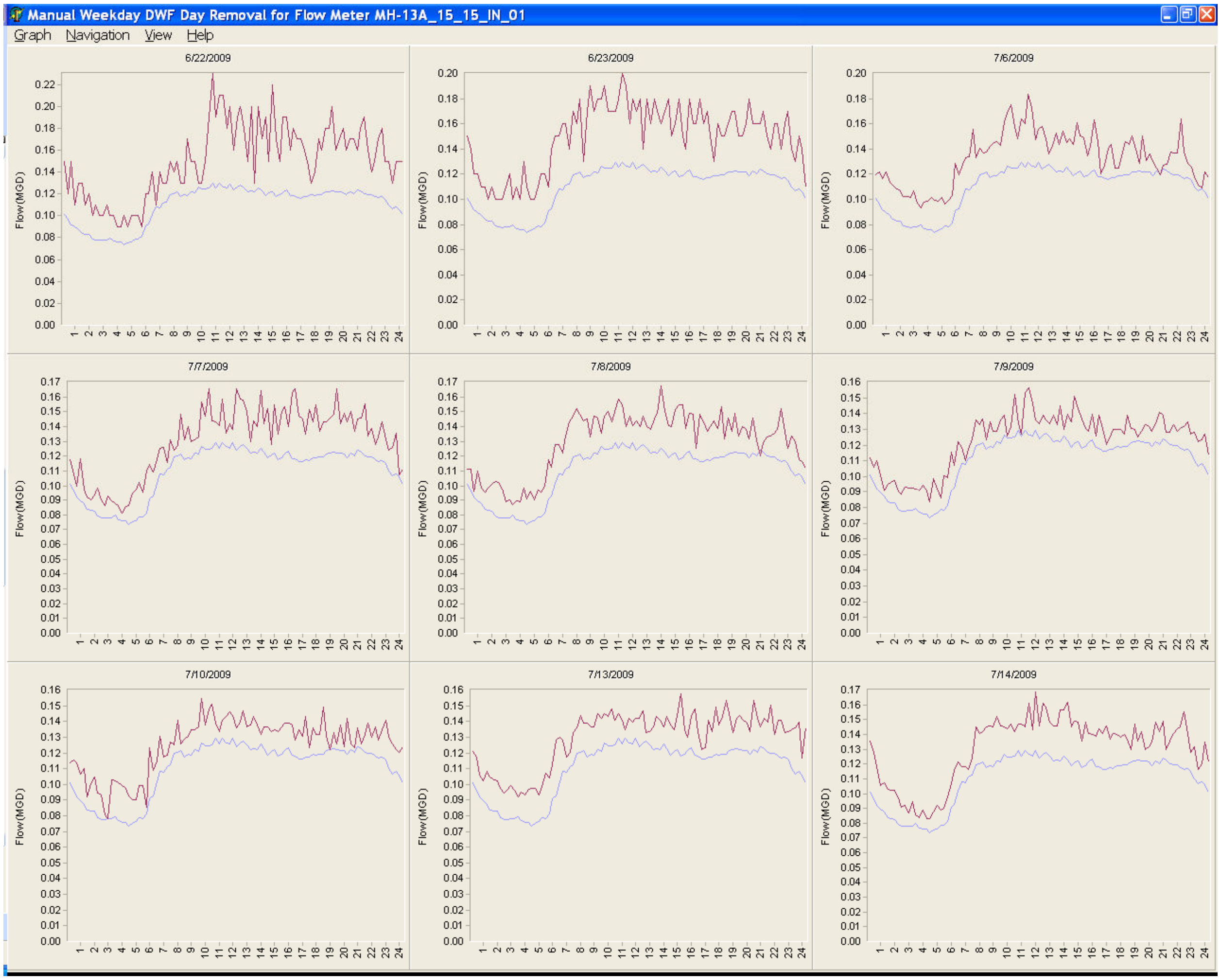
Figure 3-3: Example Storm Deconstruction Hydrograph



Dry Weather Flow (DWF; includes both GWI and BWWF components) patterns were then developed using the RTK SHAPE program. The RTK SHAPE tool programmatically selected dry weather days and plotted individual daily DWF patterns for weekends and weekdays against the overall average DWF pattern as shown in Figure 3-4. Individual days were reviewed for correlation with the average daily pattern. Daily patterns selected by the program were removed if major inconsistencies in the diurnal pattern were determined. The tool was then used to combine the remaining days to develop a single weekday and weekend dry weather time series.

The GWI flow component fluctuates on a seasonal basis relative to the rising or falling ground water table. As a result, manual adjustments were made to the DWF time series to correlate GWI with QAQC flow data as shown in Figure 3-5. Programmatic subtraction between the DWF and QAQC time series developed the RDII time series.

Figure 3-4: Dry Weather Flow Review



The RDII events are defined as the increase in flow rate above DWF during a precipitation event. The events typically coincide with the start of rainfall and end when the flow pattern returns back to the pre-rainfall DWF conditions. RDII is determined by subtracting the DWF (turquoise) from the QAQC (green) flow as indicated by the red time series in Figure 3-6.

Figure 3-5: Before and After GWI Adjustment

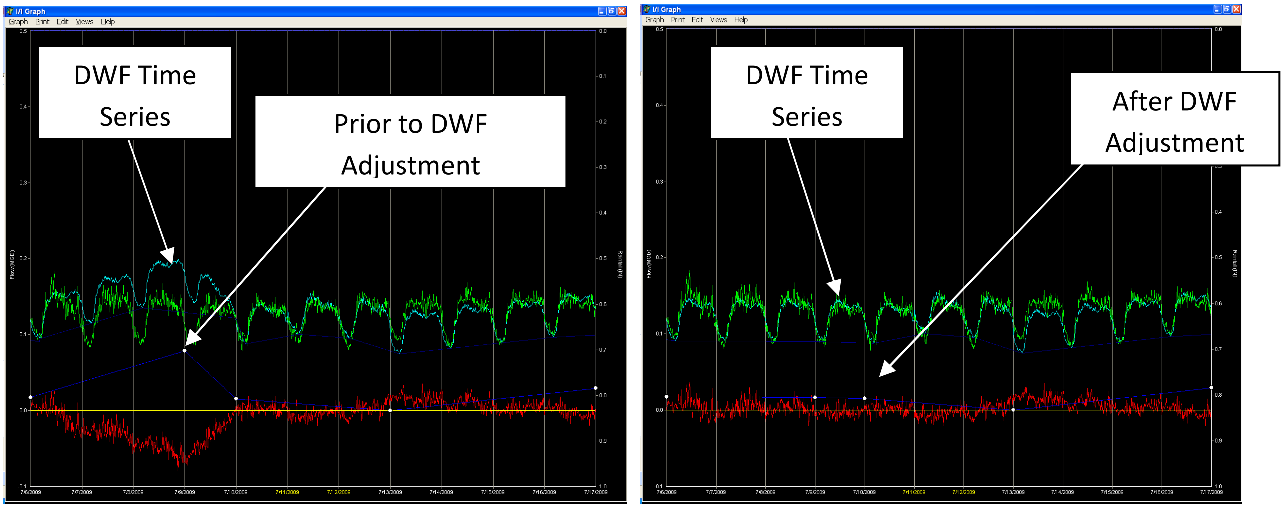
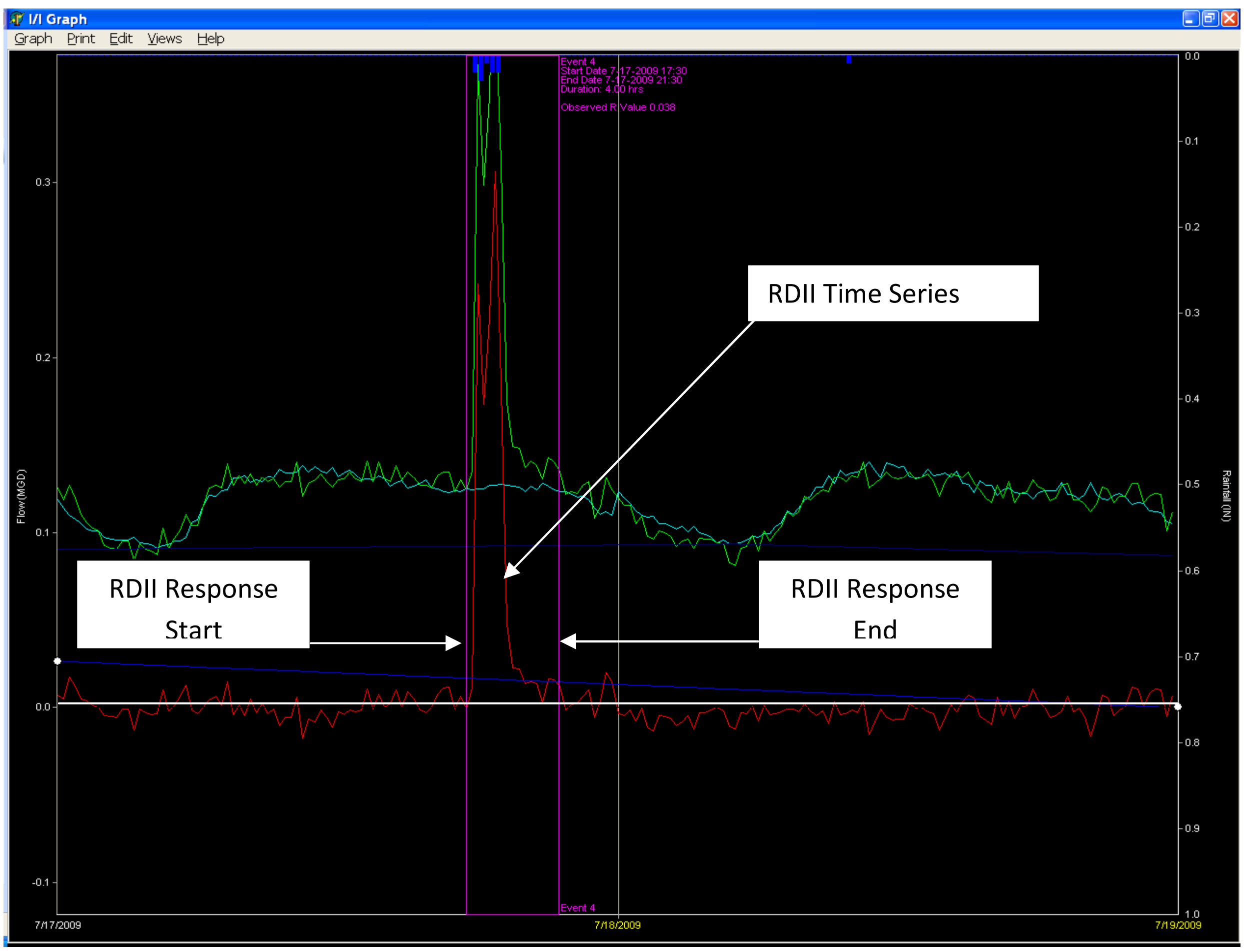


Figure 3-6: RDII Time Series



The initial RDII analysis included only storms with precipitation exceeding 0.2 inches. If the selected precipitation events developed a significant and discernable RDII response, they were deconstructed by manually identifying the start and end of the event as shown in Figure 3-6. The analysis was extended to storms with precipitation less than 0.2 inches where discernable responses were identified. The number of deconstructed storms for each monitor location is summarized below in Table 3-2.

Table 3-2: Number of Deconstructed Storms for Each Monitor

Monitor Name	Number of Deconstructed Storms	Monitor Name	Number of Deconstructed Storms
MH-1_15_15_IN_01	23	MH-20B_8_8_IN_01	15
MH-10_24_24_IN_01	11	MH-23_8_8_EF_01	0
MH-11_15_15_IN_01	20	MH-24_16_16_IN_01	0
MH-12_36_36_IN_01	0	MH-24A_18_18_IN_01	20
MH-12_8_8_IN_01	28	MH-3_8_8_IN_01	11
MH-13_54_54_IN_01	6	MH-4_24_24_IN_01	16
MH-13A_15_15_IN_01	22	MH-4A_8_8_IN_01	2
MH-14_24_24_IN_01	9	MH-5_18_18_IN_01	24
MH-14A_24_24_IN_01	23	MH-5A_8_8_IN_01	2
MH-16_18_18_IN_01	2	MH-6_14_14_IN_01	32
MH-16A_18_18_EF_01	23	MH-7_10_10_IN_01	27
MH-17_24_24_IN_01	34	MH-8_24_24_IN_01	28
MH-18_18_18_IN_01	17	MH-263-DR_99_99_IN_01	29
MH-19_10_10_EF_01	18	MH-293-DR_99_99_IN_01	34
MH-19_24_24_IN_01	0	MH-12-DR_99_99_IN_01	19
MH-2_15_15_EF_01	14	MH-3-DR_99_99_IN_01	32
MH-20A_8_8_IN_01	1		

Deconstructed storm events were further processed to develop the precipitation and inflow response database as shown in the example Table 3-3. Total Precipitation (inches) versus Total Inflow Volume (inches) for each flow monitor location was plotted on an X-Y scatterplot to define inflow v. precipitation volumetric relationships segregated based on intensity. Figure 3-7 presents an example Total Precipitation (inches) Vs. Total Inflow Volume (inches) produced for each flow monitor. Statistics generated for each flow monitoring location are provided in Appendix E.

Table 3-3: Example Storm Deconstruction Schedule Statistics

Flow Data Collected by: LSSE															
Precipitation Data Source: Rochester Borough Raingauge															
MH-12-DR_99_99_IN_01(1")															
Storm Deconstruction Statistics by Storm Number															
Storm #	Storm Begin Date/Time	Storm End Date/Time	Response Begin Date/Time	Response End Date/Time	Response Duration (hours)	Precipitation Duration (hours)	Total Precipitation (inches)	Peak Precipitation Intensity (in/15 min)	Peak Total Flow (mgd)	Peak I/I Flow (mgd)	Total Response Volume (inches)	Average BWWF (mgd)	Average GWI (mgd)	Average Observed Flow (mgd)	Total R Value R Value
1	3/26/2009 11:00	3/26/2009 17:15	3/26/2009 10:00	3/27/2009 5:30	19.5	6.25	0.500	0.040	0.126	0.035	0.015	0.050	0.008	0.067	0.030
2	3/29/2009 5:00	3/29/2009 10:00	3/29/2009 3:45	3/29/2009 15:00	11.25	5	0.380	0.100	0.059	0.045	0.010	0.009	0.010	0.029	0.026
3	4/3/2009 0:00	4/3/2009 8:45	4/3/2009 0:00	4/3/2009 9:15	9.25	8.75	0.340	0.060	0.066	0.034	0.007	0.009	0.011	0.030	0.022
4	4/20/2009 7:00	4/20/2009 19:15	4/20/2009 6:00	4/20/2009 21:15	15.25	12.25	0.630	0.080	0.120	0.034	0.011	0.063	0.010	0.081	0.018
5	5/16/2009 18:00	5/16/2009 20:15	5/16/2009 17:00	5/17/2009 4:30	11.5	2.25	0.340	0.200	0.106	0.087	0.008	0.007	0.007	0.023	0.025
6	6/2/2009 1:00	6/2/2009 4:00	6/2/2009 0:00	6/2/2009 4:30	4.5	3	0.220	0.070	0.050	0.039	0.004	0.003	0.007	0.021	0.019
7	6/3/2009 4:15	6/3/2009 5:00	6/3/2009 3:00	6/3/2009 6:30	3.5	0.75	0.070	0.030	0.059	0.051	0.003	0.005	0.005	0.021	0.046
8	6/17/2009 4:15	6/17/2009 12:00	6/17/2009 3:45	6/17/2009 12:30	8.75	7.75	0.460	0.120	0.113	0.055	0.005	0.032	0.007	0.046	0.010
9	6/17/2009 18:30	6/18/2009 8:00	6/17/2009 17:45	6/18/2009 9:00	15.25	13.5	1.810	0.550	0.234	0.157	0.050	0.027	0.007	0.074	0.028
10	6/28/2009 18:30	6/28/2009 18:30	6/28/2009 17:30	6/28/2009 20:00	2.5	0	0.170	0.170	0.058	0.040	0.003	0.013	0.003	0.028	0.016
11	7/23/2009 0:00	7/23/2009 19:00	7/23/2009 0:00	7/23/2009 23:00	23	19	1.050	0.170	0.148	0.130	0.030	0.046	0.006	0.068	0.028
12	7/23/2009 23:30	7/24/2009 0:15	7/23/2009 23:15	7/24/2009 4:30	5.25	0.75	0.150	0.080	0.065	0.049	0.006	0.004	0.006	0.024	0.038
13	7/25/2009 15:30	7/25/2009 15:30	7/25/2009 14:45	7/25/2009 17:30	2.75	0	0.180	0.180	0.065	0.045	0.002	0.010	0.008	0.027	0.012
14	7/31/2009 3:30	7/31/2009 7:45	7/31/2009 3:30	7/31/2009 8:00	4.5	4.25	0.180	0.020	0.058	0.038	0.005	0.009	0.008	0.030	0.027
15	8/2/2009 6:00	8/2/2009 14:15	8/2/2009 5:15	8/2/2009 17:00	11.75	8.25	0.340	0.200	0.131	0.117	0.010	0.011	0.009	0.030	0.030
16	8/28/2009 2:15	8/28/2009 4:00	8/28/2009 1:45	8/28/2009 5:15	3.5	1.75	0.230	0.110	0.063	0.054	0.005	0.003	0.006	0.026	0.022
17	8/29/2009 9:45	8/29/2009 9:45	8/29/2009 9:30	8/29/2009 14:15	4.75	0	0.090	0.090	0.116	0.096	0.009	0.011	0.009	0.043	0.101
18	9/26/2009 12:15	9/27/2009 10:45	9/26/2009 11:30	9/27/2009 14:45	27.25	22.5	0.970	0.120	0.076	0.061	0.021	0.008	0.009	0.027	0.022
19	9/28/2009 6:15	9/28/2009 8:45	9/28/2009 5:45	9/28/2009 9:45	4	2.5	0.250	0.100	0.056	0.023	0.003	0.019	0.009	0.038	0.012
Precipitation Type / Data Source: Rochester Borough Raingauge															
Sewershed Area = 19.14 acres															

Table 3-4 represents statistical trendline analysis for data over the entire period of record. The trendline equation slope and R^2 values indicate the approximate percent capture and statistical correlation of the data set for each monitor location respectively.

In terms of the regression analysis, a perfect correlation (i.e. the x and y data points land on the trend line) exhibits an R^2 value of 1. Values less than 1 indicate less than exact correlation. The closer the R^2 value is to 1, the better the regression relationship.

<u>Storm Deconstruction Schedule</u>

A summary schedule of storm deconstructions for each monitor location is provided in Appendix E to indicate the relative continuity between flow monitor sites and storm events. This information can be applied to subsequent analysis including model development and calibration.

Figure 3-7: Example SDH Total Precipitation vs. Storm Inflow Volume Plot

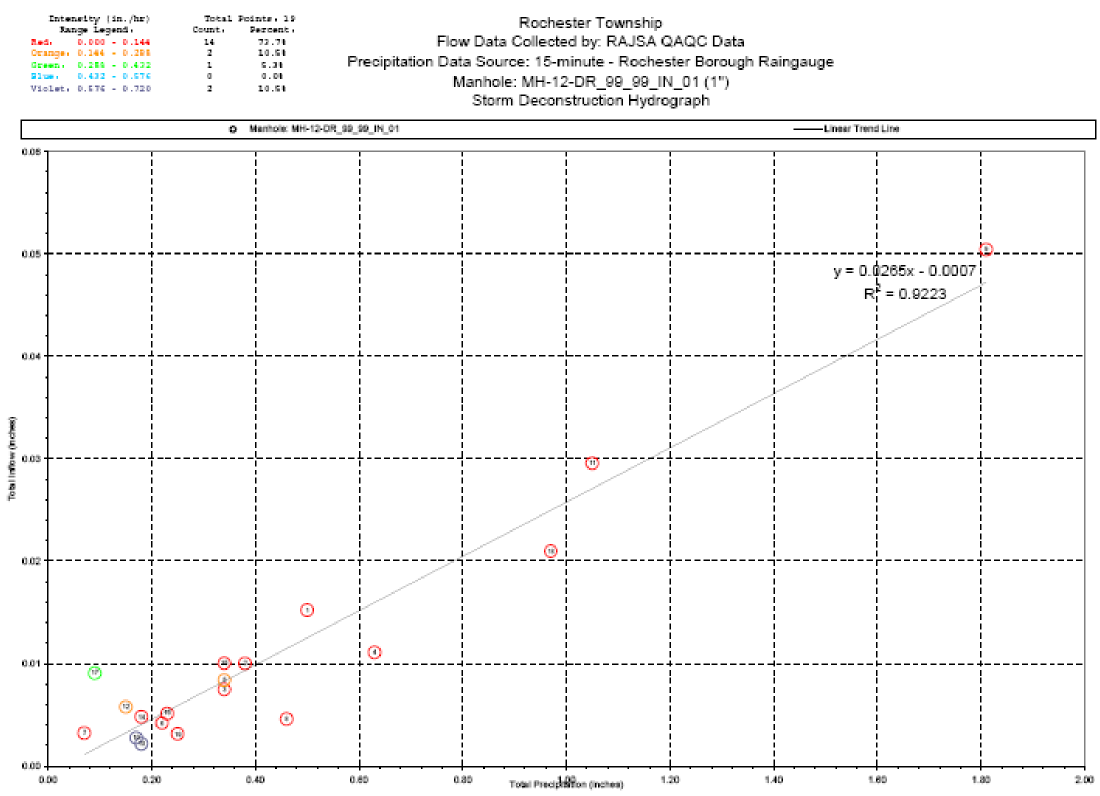


Table 3-4: Capture Percentages and Correlation Factors

RAJSA LTCP Flow Monitoring Program Capture Percentages and Correlation Factors		
Monitor	**Slope**	**R^2**
MH-1_15_15_IN_01	0.1588	0.3743
MH-10_24_24_IN_01	0.2979	0.952
MH-11_15_15_IN_01	0.0855	0.233
MH-12_8_8_IN_01	0.1123	0.3193
MH-13_54_54_IN_01	0.2081	0.6733
MH-13A_15_15_IN_01	0.068	0.8975
MH-14_24_24_IN_01	0.0645	0.9732
MH-14A_24_24_IN_01	0.0423	0.8412
MH-16_18_18_IN_01	0.0936	1
MH-16A_18_18_EF_01	0.0296	0.9176
MH-17_24_24_IN_01	0.4396	0.4784
MH-18_18_18_IN_01	0.0175	0.823
MH-19_10_10_EF_01	0.0806	0.5065
MH-2_15_15_EF_01	0.0845	0.7855
MH-20B_8_8_IN_01	0.0209	0.6288
MH-24A_18_18_IN_01	0.2304	0.838
MH-3_8_8_IN_01	0.0144	0.0033
MH-4_24_24_IN_01	0.462	0.7365
MH-4A_8_8_IN_01	0.0068	1
MH-5_18_18_IN_01	0.1582	0.2406
MH-5A_8_8_IN_01	0.8384	1
MH-6_14_14_IN_01	0.0693	0.7979
MH-7_10_10_IN_01	0.018	0.8702
MH-8_24_24_IN_01	0.5357	0.8872
MH-3-DR_99_99_IN_01	0.0167	0.5927
MH-12-DR_99_99_IN_01	0.0265	0.9223
MH-263-DR_99_99_IN_01	0.1263	0.7649
MH-293-DR_99_99_IN_01	0.0896	0.8613

4.0 Model Development and Calibration

4.1 Modeling Approach Overview

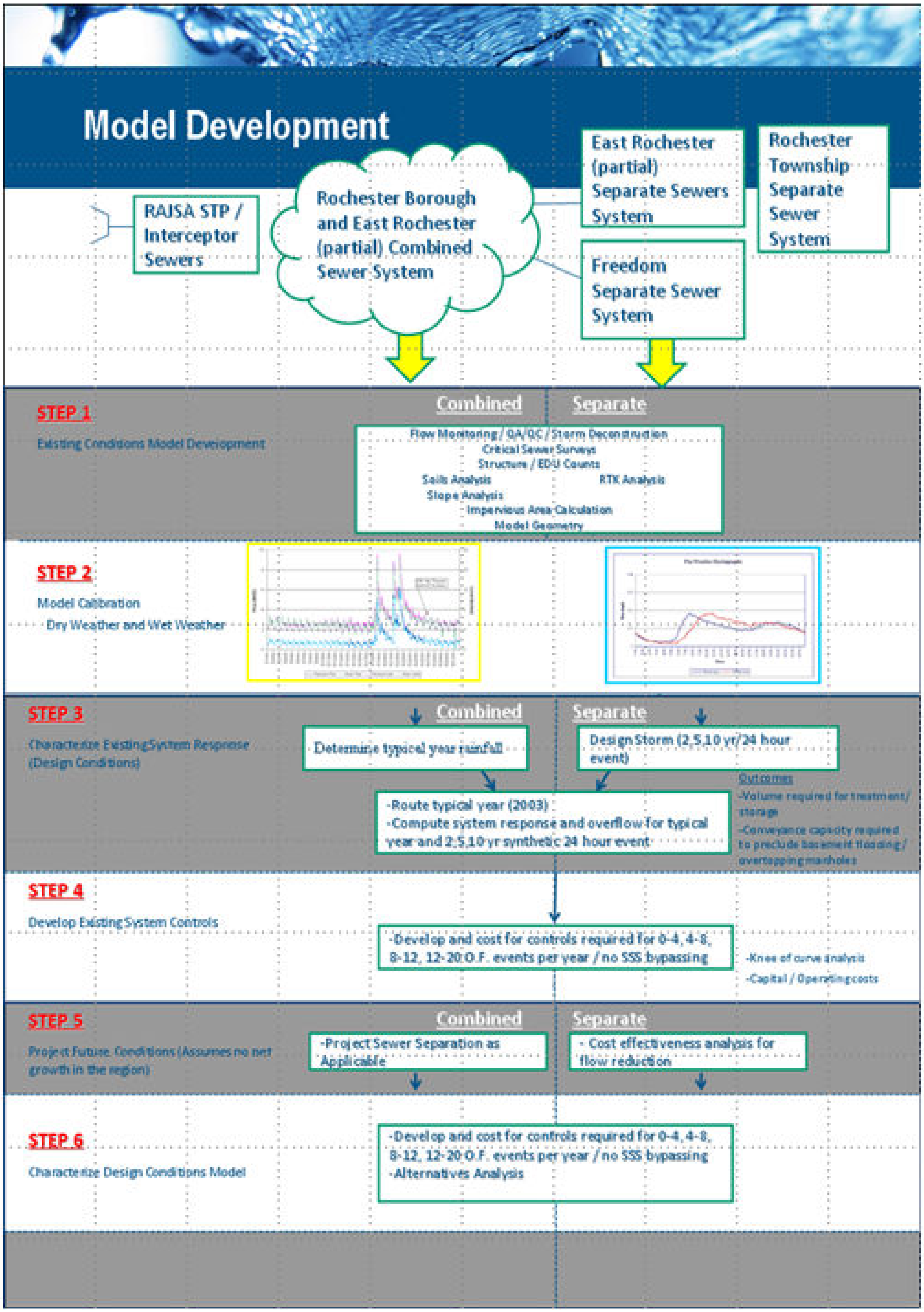
A Hydraulic and Hydrologic (H & H) model was created as part of the LTCP process as required by the Federal CSO Policy. The LTCP modeling program utilized was EPA Storm Water Management Model (SWMM). The program is widely used throughout the world for analysis and planning of combined and sanitary sewers in urban environments. SWMM is also the primary program utilized by multiple engineering firms for Allegheny County Sanitary Authority's (ALCOSAN) Alternative Analysis.

The SWMM program is a dynamic rainfall-runoff simulation model used for long term and single event simulation of runoff and RDII quantity for primarily urban areas. The routing portion of SWMM transports this RDII and runoff through a system of pipes, storage, treatment devices, pumps and regulators to determine the flow rate and flow depth during a simulation period in time series format.

To provide input data for the H & H model, the RAJSA LTCP team collected data, including GIS information, flow monitoring data, precipitation data, surveying inspection information and field investigation data. The programs described in earlier sections, such as Diurnal Curve Calculator and RTK SHAPE programs were used to produce the flow input into the model based on the collected suitable flow monitoring data. For storm response within sanitary subcatchments, an RTK Calculator was used to derive RTK parameters to simulate RDII during wet weather events. GIS information was used to develop hydrologic parameters for each tributary subcatchment including, area, slope and soil characteristics to create the runoff associated with the H & H model.

Figure 4-1 provides a brief summary of the modeling process showing the difference in modeling of Combined Sewer Systems and Separate Sanitary Sewer Systems.

Figure 4-1: Model Development Process



4.2 Model Extents

To determine the H & H model extents, the RAJSA Regional system was evaluated for specific collection and conveyance system elements:

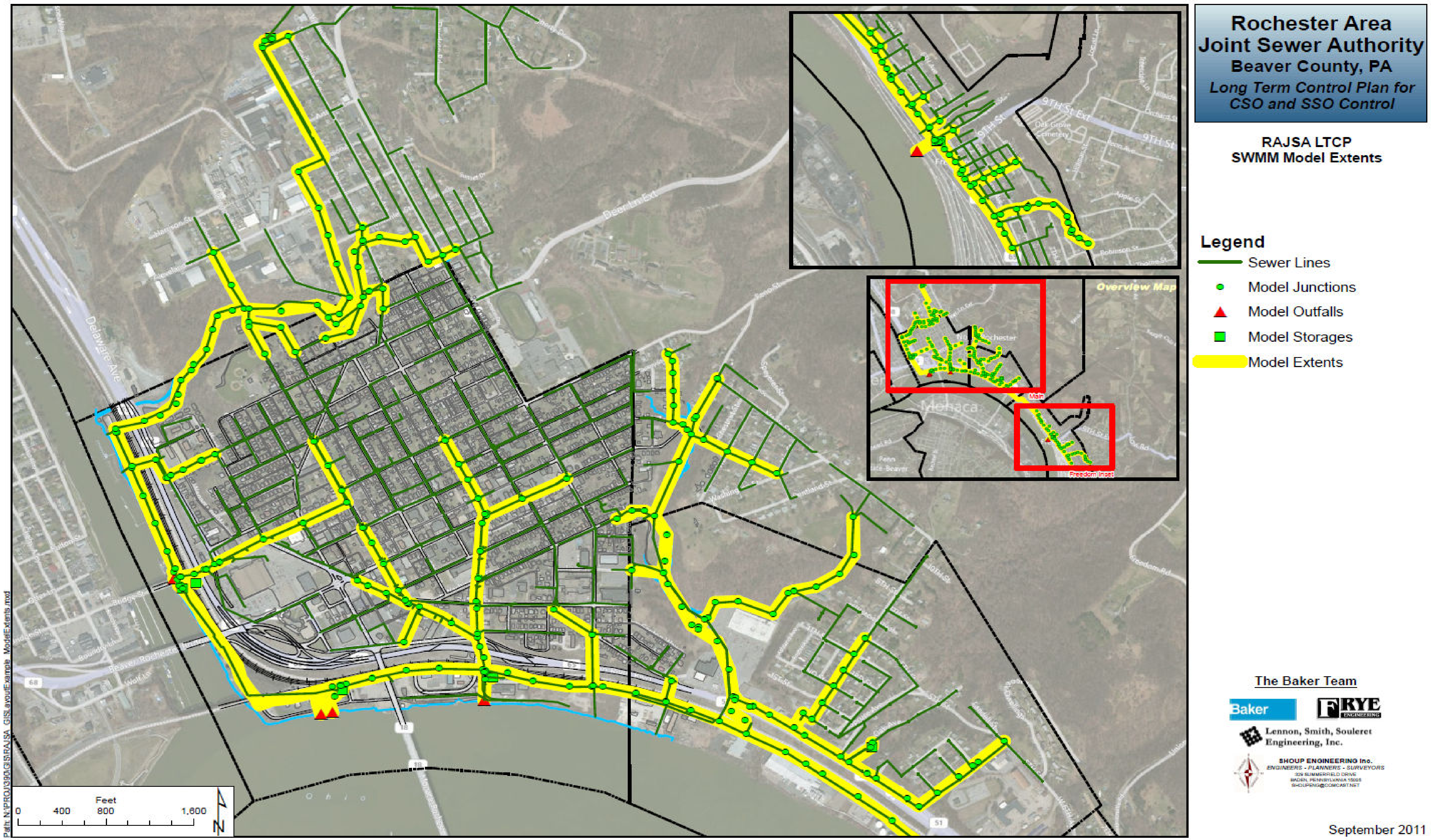
- All known municipal CSO and SSO structures in the system including their corresponding outfalls
- The portions of the collection systems downstream of the municipal SSO or CSO structure
- Those collection system elements where sewer surcharge may be causing manhole bypassing or localized basement backups
- Any other collection system elements to further detail the system and produce a suitable H & H model such that rainfall responses can be adequately represented for the provided storm events with a reasonable predictive capability

Sewersheds were delineated to determine the tributary area to each flow monitor and structure along the RAJSA Interceptor. These sewersheds were further divided into subcatchments based on sewer connectivity, sewer type (combined or separate sanitary), etc. Each subcatchment was designated a unique loading point within the system that in many cases would serve as furthest upstream point of the modeling extents.

To provide input for the model extents, dye testing, field surveys, inspection and field investigation information was utilized. Dye testing and manhole physical surveys (MHPS) were completed within the scope of the model. The dye testing enabled the field technicians to confirm connectivity throughout the system. The MHPS sheets provide the required data to physically build the model. This includes influent, and effluent line dimensions and measure downs, material of pipe, dam distance, and miscellaneous notes (surcharged manhole, etc.).

The modeling scope was built in to SWMM as a model skeleton. A soils analysis, impervious area analysis, flow length analysis, and structure counts were performed using the GIS database. A drawing showing the modeling extents is provided as Figure 4-2.

Figure 4-2: Model Extents *(base mapping source: Pennsylvania Spatial Data Access and AirPhoto USA Imagery 2007)*



4.3 Dry Weather Calibration

The dry weather flow (DWF) pattern includes two components, Base Wastewater Flow (BWWF) and Groundwater Infiltration (GWI). Rainfall Dependent Inflow and Infiltration (RDII) is the key component within the study, however RDII does not contribute to DWF because RDII is produced during rainfall events. BWWF and GWI are broken up to understand what is contributing to the collection system.

GWI consists of groundwater entering a sewer system, including through service connections, through means as defective pipes, pipe joints, connections or manhole walls. The base GWI flow rate can simply be the rate of flow at the minimum sewage rate, normally between 3 AM and 5 AM. Wastewater flow rates can include infiltration however BWWF subtracts out the GWI to obtain the daily sewage flow, BWWF. BWWF is normally broken up as weekend and weekday flow.

The DWF time series that was developed as part of the storm deconstruction task was then loaded into the SWMM model. A DWF time series needed to be developed for each loading point. If a flow monitor only had one subcatchment (one loading point) assigned to it, then the DWF time series developed for that monitor was directly loaded to that loading point. In cases where many subcatchments loaded into a flow monitoring location, i.e. New York Avenue, the DWF time series was divided amongst the loading points. The BWWF was split based on EDU counts and GWI was split based on area.

Once all loading points are assigned to a GWI and BWWF time series, a model simulation can be run. The model results are then compared to the flow monitoring data. To correctly calibrate to DWF, depths should be similar and minimal adjustments should be made to obtain and percent error of 10% for the timing of the peak flow rates, maximum depth, average depth, and minimum depth. The timing of the peaks and troughs should be within one hour.

Adjustments might need to be made as a result of inadequate upstream manhole invert elevations, Manning's coefficient, entry and exit loss coefficients and discharge coefficients within conduits, orifices and weirs. All of these node and conduit characteristics can be adjusted within a range of tolerances, Manning's Roughness Coefficient range of values shown in Table

4-1. For modeled conduits with high depth and low velocity readings, the roughness coefficient should be decreased to increase the velocity values resulting in a low depth reading. When the range of roughness coefficient is reached and depth values still need to be increased, entry, exit and average loss coefficients can be added. If the velocity reading is matching, however gaining depth is becoming difficult, downstream debris can be added to increase depth while keeping velocity consistent.

Table 4-1: Typical Manning's Roughness Coefficients

Pipe Material	Manning's Roughness Coeff.
Concrete	0.013
Asbestos Cement	0.011
Brick	0.015
Terra-Cotta	0.014
Vitrified Clay	0.014
Cast Iron	0.013
PVC	0.009

Discrepancies may exist when comparing the modeled vs. monitored data. The weekday and weekend diurnal BWWF should be consistent throughout the period of record, however since the Diurnal Calculator outputs the average diurnal curve there may be discrepancies depending on the quality of the monitored data.

The validation of the DWF calibration was completed using an Integral Square Error (ISE) (et al Marsalek 1975) calibration tool provided by Baker. This analysis applies a "goodness of fit" rating to the data. By comparing the modeled and monitored wet weather event data characteristics of peak flow, flow volume and time to peak, a rating factor was determined by using the following equation:

$$ISE = \frac{\left[\sum_{i=1}^{N}(O_i - M_i)^2\right]^{1/2}}{\sum_{i=1}^{N} M_i} \times 100$$

Where: O_i = Observed parameter value at time i

M_i = Modeled parameter value at time i

N = the number of data points

Table 4-2: ISE Rating Factors

Goodness of Fit Ratings for Model Calibration	
ISE Range	**Rating**
0 to 3	Excellent
3.1 to 6	Very Good
6.1 to 10	Good
10.1 to 25	Fair
Greater Than 25	Poor

The Integral Square Error (ISE) was calculated for each monitor to compare modeled flow and depth to monitored flow and depth during dry weather. The scatterplot analysis provided a visual and mathematical means for data set comparison, and the ISE calculations provided a gauge for model calibration. DWF calibration plots for each flow monitor used in RAJSA system are provided in Appendix F.

4.4 Wet Weather Calibration

This section summarizes the procedure and findings of the wet-weather calibration performed on the SWMM collection system model for the RAJSA System. The scope of this section is to describe the procedure and adjustments made to "calibrate" the modeled flow data to the monitored flow data during wet-weather events.

Once the modeled depth and flow data is within 10% of the monitored values during dry-weather, hydrologic characteristics can be looked at in order to calibrate to wet-weather events. The Hydraulic and Hydrologic modeling program simulated applying rainfall (2009 Rain Gauge Data) to a landmass or subcatchment upstream to each monitoring location, manhole or regulator structure, and generating an inflow component adding sewage flow and base infiltration components and routing this input through a numerical hydraulic model of the sewer system. The Rainfall Dependent Inflow and Infiltration (RDII) component of the SWMM RUNOFF was used to develop the hydrologic model. RDII uses known precipitation data as an input which is applied to subcatchments representing each of the upstream tributary area to each manhole or diversion structure. Landmass area has a series of unitless parameters that determine the shape and the magnitude of the storm response flows and depths from each subcatchment which will be described later. The hydrologic model was then adjusted or "calibrated" as required to reasonably reproduce observed hydrograph conditions during certain rainfall events. Model calibration consisted of sensitivity and statistical analysis based adjustment of key parameters as necessary to replicate as closely as possible the shape, peak flow rates and flow volume for a series of full capture.

The calibration/verification criteria for wet-weather are based upon the approved Wastewater User Group (WaPUG) Code of Practice for the Hydraulic Modeling of Sewer Systems. This criterion was established for wet-weather storm volume, peak flow and depth.

Table 4-3: WaPUG Wet Weather Calibration/Verification Criteria

Shape	The shape of predicted hydrographs should closely follow the observed one
Timing	The timing of the peaks and troughs should be similar
Flooding	Predicted flooding locations with large spilled volumes should correlate with field observations or other historical records if available
Peak Flow Rate	-15% to +25% of observed
Flow Volume	-10% to +20% of observed
Maximum, Average and Minimum Depth	-0.33 ft to +1.67 ft at surcharge locations +/-0.33 ft at non-surcharge locations

Hydraulic adjustments are mainly completed during the dry-weather process therefore the model's conduit, nodes, orifices, etc characteristics should not be adjusted. For portions of the RAJSA Regional system that are combined, subcatchment characteristics are adjusted to gain peak flow, minimize volume, etc during storm events. For areas within the system that are known to be separate, RTK values are assigned to each inlet node to simulate the appropriate RDII response.

For the combined subcatchments within the model, the area of each subcatchment, derived from the GIS delineations, cannot be adjusted. Area affects the total storm runoff because a larger area yields a larger runoff volume. There are multiple subcatchment attributes that affect a storm response in a different way, therefore some have more of an effect on storm response than another. Of the characteristics that may be adjusted, percent impervious land cover and subcatchment width were the two main parameter adjustments. These two parameters typically have the greatest effect on the storm response. A subcatchment with a large width has a shorter flow path, therefore creating a faster response in the system contributing to a high peak flow rate. Increasing impervious area will yield more volume to the storm response and depending on the width and slope of the subcatchment, will most likely increase the peak flow rate of the storm response.

To simulate the most reasonable storm response in a separately sewered area a RTK unit hydrograph is used. R, T and K all represent a key component for each of the three unit hydrographs that are made to resemble a storm:

- R: The fraction of rainfall that enters the sewer system
- T: The time from the onset of rainfall to the peak of the Unit Hydrograph in hours
- K: The ratio of time to recession of the Unit Hydrograph in hours

The WaPUG program outputs three monitored versus modeled scatter plots graphically illustrating Maximum Depth, Event Volume and Peak Flow for the calibration storms as shown in Figures 4-3, 4-4, and 4-5. Each scatter plot graphs a 1 to 1 ratio line, which would indicate if the storm's modeled peak flow, for example, matched the monitored peak flow. The scatter also illustrates the upper and lower WaPUG limit and a data trendline. A slope of 1 based off the trendline equation represents a 1 to 1 ratio between modeled and monitored storm responses for depth, peak flow and storm volume. The R^2 value represents the storm response correlation. A perfect correlation within the calibration storms is 1, therefore a value closer to 1 would result in a greater confidence in calibration. WaPUG calibration plots for all monitors in are provided in Appendix E.

Figure 4-3: Monitored vs. Model Maximum Depth

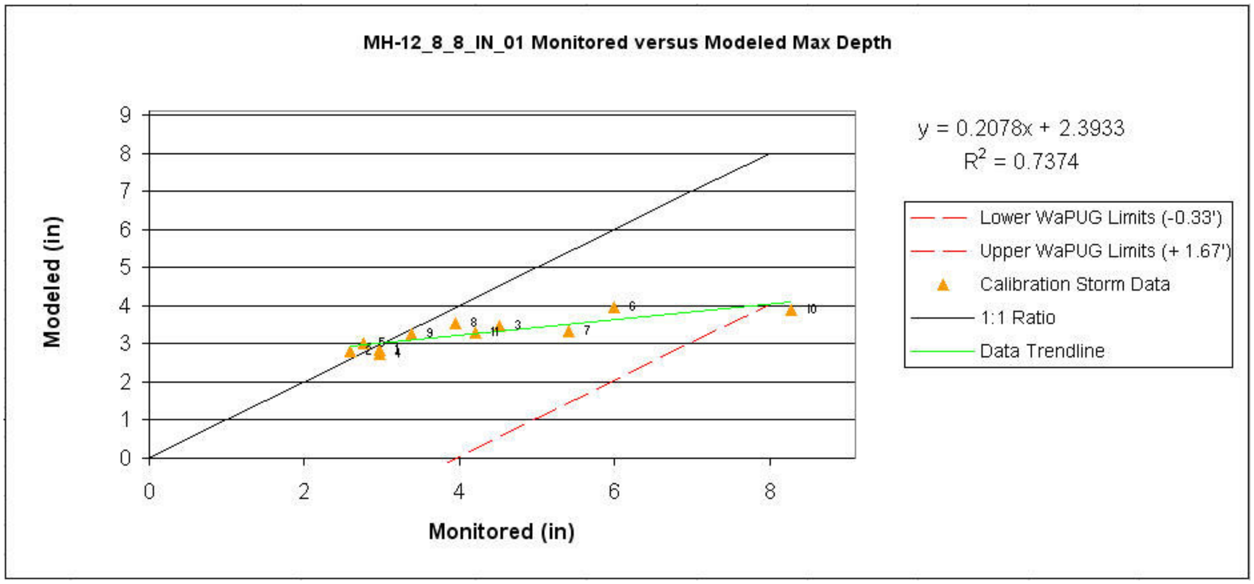


Figure 4-4: Monitored vs. Modeled Event Volume

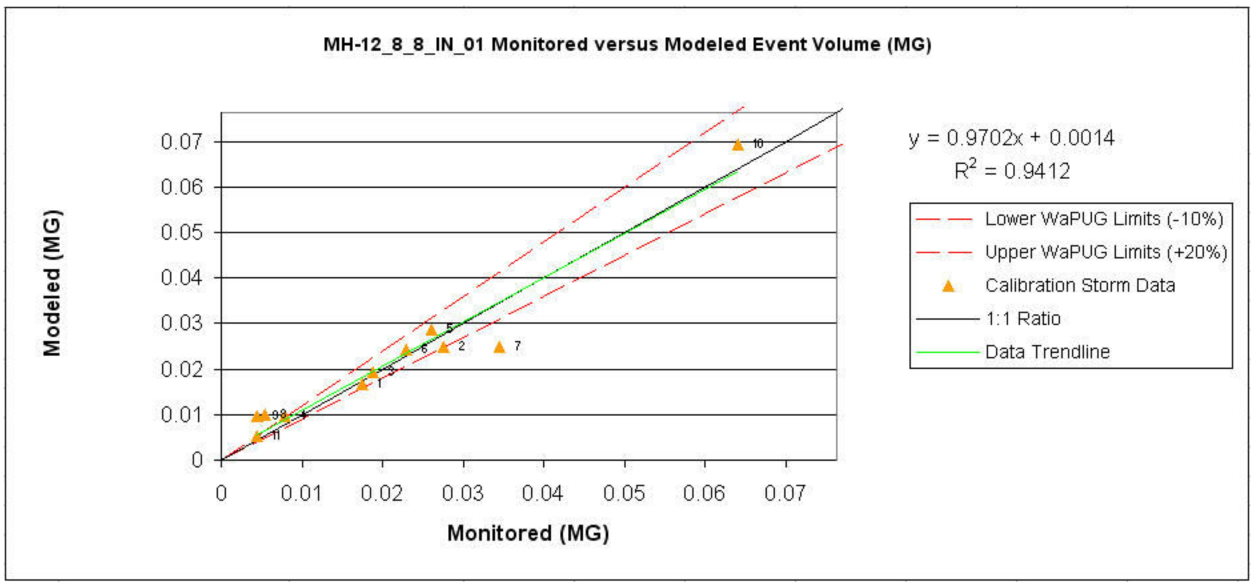
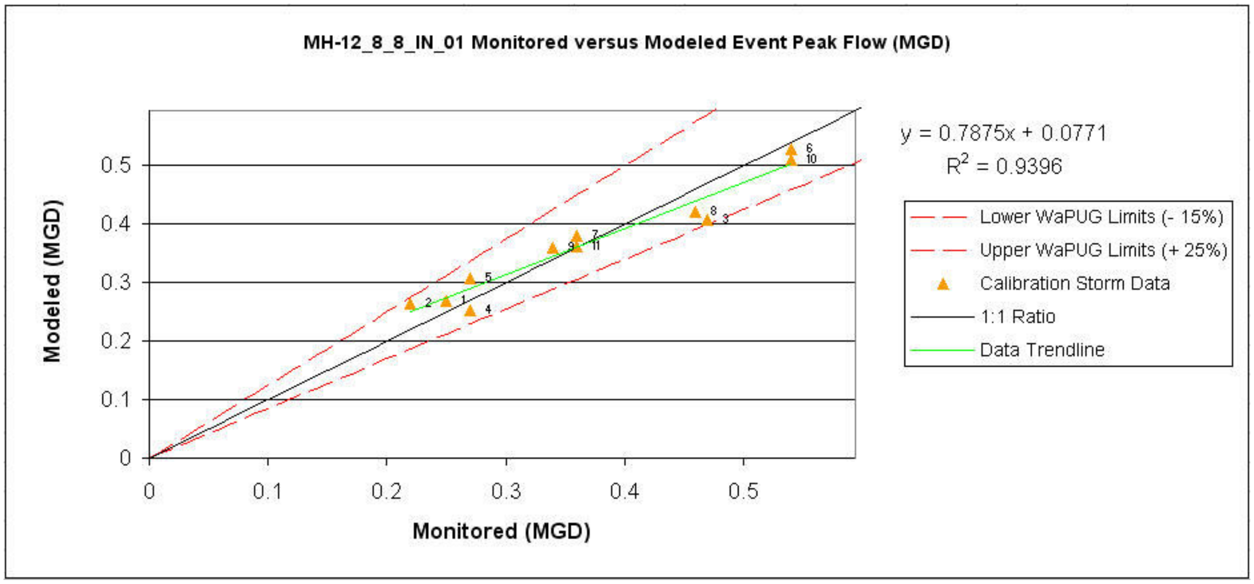


Figure 4-5: Monitored vs. Modeled Event Peak Flow



Separation projects were completed in the East Washington and Hull Street sewersheds after the initial flow monitoring program. To further validate the model, Rochester Borough installed flow meters to monitor the flow in each of these systems for a short period from May 19, 2011 through August 5, 2011.

4.5 Typical Year/Design Storm Evaluation

To determine the average precipitation volume and storm intensities throughout the year, a Typical Year of rainfall was acquired for the next step of the H & H model evaluation, alternative analysis. 2003 was selected as the typical year based on an analysis completed by the 3RWW Project Management (PM) Team for the ALCOSAN H & H model simulations. The analysis concluded that calendar year 2003 matched the historical hydrological conditions better than any other year within high resolution, spatially distributed precipitation record.

In order to develop a fully typical year model, BWWF, GWI, and RDII inputs in the model needed to be created for a full year. This was accomplished by extrapolating the inputs from the inputs already developed. BWWF was a 7 day repeatable pattern. This pattern was extended to a full year. GWI patterns and RTK values were extrapolated from adjacent months.

This typical year model was the basis for the Alternatives Analysis. Combined areas were evaluated using typical year rainfall, while separate areas were evaluated using the 2, 5, and 10 year, 24-hour design storms. During Winter months, a precipitation distribution developed by 3RWW was used. During Summer months, a 24-hr SCS Type II distribution was used.

The regional model was also simulated with a combination of typical year rainfall and design storm rainfall. This was accomplished by syncing the peak flow produced by the typical year rainfall (from combined sewer areas) and the peak flow produced by the Summer or Winter design storm (from separate sewer areas). This simulation was required for Alternatives Analysis for the RAJSA Interceptor and Treatment Plant.

Many of the areas in Rochester Borough were proposed to be separated. These areas required new inputs for RDII flow development in the Alternatives model. At the time, there was a few months of post-separation flow monitoring data at East Washington and Hull Street. However, this time period experienced minimal precipitation and no storms during this period could be deconstructed. Post-separation flow monitoring was also undertaken in Freedom Borough following the separation of the 6th and 7th sewersheds. However, like the case in the East Washington and Hull Street sewersheds, there was minimal precipitation and no significant storm events that could be deconstructed.

With no reliable nearby areas with post-separation RTK values, the project team decided to use an analysis completed by LSSE that focused on dry and wet separate sanitary sewer systems in the ALCOSAN service area. Dry system RTK values from this analysis were used as input for all areas proposed to by separated as part of the Alternatives Analysis. A technical memorandum documenting the procedure and findings of this analysis is provided in Appendix F.

5.0 Existing Water Quality and Sensitive Areas

5.1 Water Quality Criteria

The following represents the current use designations from PA Code Chapter 93 for which the receiving streams are protected (where CSOs exist):

- McKinley Run - Warm Water Fishery (WWF)
- Beaver River - WWF, Navigation
- Ohio River - WWF, Navigation
- Lacock Run - WWF

The regulatory limits below are those determined by the designated stream uses as defined by PA Code Chapter 93.9a through 93.9z.

- Alkalinity (WWF) - ALK - Minimum 20 mg/l as $CaCO_3$, except where natural conditions are less. Where discharges are to waters with 20 mg/l or less alkalinity, the discharge should not further reduce the alkalinity of the receiving waters.

- Dissolved Oxygen (WWF) - DO - Maximum daily average 5.0 mg/l; minimum 4.0 mg/l.

- Iron (WWF) - Fe - 30 day average - 1.5 mg/l as total recoverable.

- Osmotic Pressure (WWF) - OP - Maximum 50 milliosmoles per kilogram.

- pH (WWF) - from 6.0 to 9.0 inclusive.

- Temperature (WWF) - TEMP - Varies by time of year (see Table 3 PA Code Chapter 93).

- Total Residual Chlorine (WWF) - TRC - 4 day average - 0.011 mg/l; 1 hour average - 0.019 mg/l.

5.2 Sensitive Areas

Based on the EPA CSO Control Policy and other EPA guidance, sensitive use areas include the following:

- Drinking water intakes
- Swimming beaches, designated as such by the appropriate state, or local health department or other agency.
- Existence of threatened or endangered species

The EPA CSO Control Policy also requires the identification of Outstanding National Resource Waters, National Marine Sanctuaries, and shellfish beds. None of these three types of waters is found in the study area.

The nearest public water intake is located in Midland Borough on the Ohio River. The public water intake is located approximately 10.5 miles downstream of the confluence of the Beaver River and Ohio River (WWTP location). The existing CSOs are all located by varying distances up river from the confluence of the Beaver River and Ohio River.

There are no swimming beaches that have been designated by the State of Pennsylvania or local municipalities in the vicinity of the CSO outfalls to rivers or stream within the study limits of this document.

A boat marina does exist along the east bank of the Beaver River in Rochester Borough. It should be noted that the discharge of the Deer Lane CSO at the Beaver River is within the confines of the boat marina. A meeting was held with PaDEP on July 17, 2009, and it was agreed that the Deer Lane sewershed would be separated, and the CSO eliminated to accommodate the nearby marina.

For the purpose of this study, the following areas within the service area are considered "sensitive areas".

- McKinley Run;
- Lacock Run; and the
- Beaver River Boat Docks

PaDEP stipulated that the combined sewersheds upstream of these areas be fully separated. The LTCP provides for the full separation of the two CSO areas upstream of these sensitive areas.
To determine the existence of federal or state listed threatened or endangered species, a search of the Pennsylvania Natural Diversity Inventory (PNDI) records was performed for the areas in the vicinity of the existing CSOs. A copy of the PNDI record review can be found in Appendix K. The PNDI review found that a potential impact of threatened or endangered species was identified by the U.S. Fish and Wildlife Service in the vicinity of five of the existing CSOs. As of the date of submission of this LTCP to the RAJSA and municipalities, comments were not received from US Fish and Wildlife.

6.0 Existing Collection System Performance

6.1 Introduction

One of the early steps in the development of a LTCP is the understanding of the existing collection system performance. This is accomplished through the development and calibration of a collection systems hydrologic and hydraulic model. This model would represent the Project Team's understanding of the existing collection system. The calibration of the model helps the Team confirm this understanding and verify that it matches reality as demonstrated by the flow monitoring data. The model development and calibration was presented in Chapter 4.

The calibrated model is then used to simulate the performance of the collection system. This is accomplished by identifying various rainfall events. For this project, 2003 was selected as a typical year. The rainfall events recorded in 2003 were simulated to determine how the existing collection system reacts. This section of the report summarizes the results of the calibrated model simulations and sets the stage for the development of alternatives to control the overflows. In addition to understanding the volume, frequency, and duration of overflows, the ability of the collection system to transport the flow associated with various design storms was also investigated.

6.2 Existing Collection System Condition

The RAJSA system model was calibrated to 2009 flow monitoring data. Thus, the existing collection system condition represented by the model resembles the year 2009. Performance data for the CSO structures within the RAJSA system under existing conditions were obtained by running the calibrated RAJSA model for the typical year as a continuous simulation. Statistics were developed for the annual frequency, volume, and duration of overflows at each outfall. A summary of the CSO statistics for the RAJSA system outfalls under existing conditions is shown in Table 6-1. The 2, 5 and 10-year design storms were used to generate the SSO statistics for the Center Street SSO and Freedom Lift Station SSO. These statistics are provided in Table 6-2. Full statistics for the CSOs and SSOs are included in Appendix G of this report.

Table 6-1: Overflow Statistics for the RAJSA System CSOs During a Typical Year

Outfall	Number of Overflow Events	Total CSO Volume (MG)	Duration (hrs)
Bachelor St. CSO	44	0.885	275
Deer Lane CSO	76	1.75	559
West Madison St. CSO	51	7.34	299
New York Ave. CSO	47	23.18	396
Virginia Ave. CSO	44	0.49	330
East Washington St. CSO	87	0.58	355
Hull St. CSO	66	0.23	290
6th St. CSO	28	0.17	241
7th St. CSO	36	0.23	270
Case St. CSO	8	0.12	64
Totals for CSOs	**487**	**34.98**	**3,079**

Table 6-2: Overflow Statistics for the RAJSA System SSOs During Various Design Storms

Outfall	2-Year Flow (mgd) / Volume (MG)	5-Year Flow (mgd) / Volume (MG)	10-Year Flow (mgd) / Volume (MG)
Freedom Lift Station SSO	2.07/0.405	2.33/0.525	2.54/0.709
Center Street Lift Station SSO	2.70/0.72	2.87/0.89	3.44/1.02

7.0 CSO and SSO Control Goals

7.1 Purpose

This section of the report presents the requirements for CSO control as put forth by the PaDEP and the USEPA. It discusses the background information needed to understand the project and outlines the RAJSA's approach to meeting these control level requirements.

7.2 Background

The COA was amended and re-issued on June 5, 2008 by PaDEP. It contained various requirements for repair, maintenance and operation of the collection systems as well as requirements for the operation of the WWTP. These are summarized in general below:

- Physical Survey/Visual Inspection of Prescribed Portions of the Collection System;
- Sewer Line CCTV Internal Inspection of the Sewer System;
- Sewer System Mapping;
- Sewer System Dye Testing and Enforcement;
- Sewer System Deficiency Corrections;
- Transfer of various NPDES permits;
- Nine Minimum Controls; and
- Flow Monitoring

Section 12 of the COA required that the RAJSA and its member municipalities prepare and submit a single, coordinated LTCP to comply with the CSO Control Policy. Specific CSO control goals were not stated in the COA, other than to generally comply with the National CSO Control Policy.

Each municipality/authority was responsible for complying with their requirements of the COA. Separately, the municipalities worked to perform their sewer system characterizations, dye testing, implementation of the NMCs, cleaning and televising of the sewer system, inspections, repairs of sewer system defects, separation of certain combined sewer areas, and other tasks to comply with the Order.

Sewer system mapping was completed by the individual municipalities, and supplemented for this project. Existing computer-aided drafting and design (CADD) mapping was compiled, standardized, and converted to a GIS platform. The development of an accurate, system-wide GIS map was considered a priority for the Project Team because the mapping forms the foundation for the hydraulic computer model that was created as part of the LTCP project.

Flow monitoring was conducted previously in the service area by RTSA, as part of their COA requirements. However, it was not performed synoptically with other municipalities. From March to October 2009, the RAJSA implemented a flow monitoring program within their entire service area. The flow monitoring data collected was checked for quality, processed and utilized for dry and wet-weather calibration of the system-wide hydraulic model.

Compliance with USEPA CSO Policy

The USEPA, with extensive input from numerous state, municipal, and environmental stakeholder organizations in an open participatory process, published its final CSO Control Policy in April 1994. The policy implements a national strategy to ensure that permittees, regulators, and the public engage in a comprehensive and coordinated planning effort to achieve cost-effective CSO controls that meet appropriate health and environmental objectives. It provides for flexibility in developing long-term CSO control plans and allows CSO controls to be tailored to address site-specific impacts of CSOs. The policy requires implementation of the NMC technologies and establishes a planning and implementation process for developing the LTCP by evaluating a range of CSO control alternatives that comply with Water Quality Standards (WQS) and protect designated uses.

The nine (9) general requirements for developing an LTCP in conformance with the federal policy are listed below.

- Characterizing, monitoring, and modeling the combined sewer system;
- Promoting public participation;
- Ensuring that the protection of sensitive receiving waters is a priority;
- Evaluating alternatives that achieve a range of CSO control levels;
- Considering cost/performance factors;

- Developing operational plans to maximize use of facilities for CSO control;
- Maximizing wet weather flow treatment at the WWTP;
- Phasing the implementation of projects; and
- Performing post-construction compliance monitoring.

Implementation of the plan may be phased, such that projects impacting the most sensitive areas supporting critical uses are given priority. The financial capability of a permittee to implement CSO control projects may also be considered when prioritizing projects.

Presumptive Approach

Under the 1994 National CSO Policy, plans for long-term CSO control and compliance with WQS may be developed by using either a "presumptive" or "demonstrative" approach. Under the presumptive approach, compliance with WQS is presumed if one of the following performance criteria is met:

1. No more than an average of four overflow events occur per year on an annual average basis, with up to two additional overflow events per year (six total) possibly being allowed by the permitting authority.
2. Elimination of, or capture for treatment of no less than 85 percent (by volume) of the combined sewage collected in the combined sewer system on a system-wide annual average basis.
3. Elimination or reduction of no less than the mass of pollutants that would be eliminated or captured for treatment in No. 2 above.

The minimum level of treatment applicable to the presumptive criteria is defined in the policy as primary clarification and disinfection of the effluent, if necessary, to meet WQS and protect designated uses. This includes the removal of harmful disinfection chemical residuals, if necessary.

Selection of the presumptive approach does not release the permittee from the overall requirement of meeting applicable WQS. If the permitting authority determines that the LTCP would not result in attainment of WQS, more stringent controls may be required. The performance criteria of the presumptive approach may be evaluated using a receiving water quality model.

Demonstrative Approach

Under the demonstrative approach, compliance with WQS is confirmed through the CSO control planning process. Controls that may not necessarily satisfy the performance criteria of the presumptive approach may be shown to meet WQS by assessing the impacts of those CSO discharges on the receiving water(s).

Under the definition of a successful demonstrative approach, an LTCP must meet the following criteria:

1. The planned control program is adequate to meet WQS and protect designated uses, unless standards or uses cannot be met as a result of natural background conditions or pollution sources other than CSOs.
2. The CSO discharges remaining after implementation of the planned control program would not preclude the attainment of WQS or designated uses, or contribute to their impairment. Where standards and uses are not met in part because of natural background conditions or pollution sources other than CSOs, a total maximum daily load (TMDL) allocation should be used to apportion pollution loads.
3. The planned control program would provide the maximum pollution reduction benefits reasonably attainable.
4. The planned control program is designed to allow cost-effective expansion or cost-effective retrofitting if additional controls are subsequently determined to be necessary to meet WQS or designated uses.

It should be noted that both the "Presumptive" and "Demonstrative" approaches require that WQS be met in the receiving streams. The Presumptive approach presumes that WQS will be met by the control alternatives, while the Demonstrative approach requires that the LTCP demonstrate that WQS will be met. In either case, the requirement to meet WQS still applies.

The next section provides some background on WQS as well as an approach to CSO control alternative development that will ensure that remaining overflows do not contribute to any WQS violations.

Compliance with PADEP CSO Control Policy

The Commonwealth of Pennsylvania published the *Pennsylvania Combined Sewer Overflow (CSO) Policy* in March 2002.

The key elements of an LTCP, as defined by PaDEP, are listed below.

- Continued implementation of the nine minimum controls;
- Protection of sensitive areas (recreation areas, public water supply, unique ecological habitat, etc.);
- Public participation in developing the LTCP and implementation;
- Characterization, monitoring, and modeling of overflows and assessment of water quality impacts;
- Evaluation and selection of control alternative – presumptive or demonstrative approach;
- Development of an implementation schedule and financing plan for selected control options;
- Maximization of treatment at the WWTP;
- Development and implementation of a post-construction monitoring plan; and
- Development and implementation of a CSO System Operational Plan.

7.3 Water Quality Issues

During the July 17, 2009 meeting, PaDEP identified several areas within the RAJSA service area as "sensitive areas". They include:

- McKinley Run;
- Lacock Run; and the
- Beaver River Boat Docks

PaDEP stipulated that the combined sewersheds upstream of these areas be fully separated. The LTCP provides for the full separation of the two CSO areas upstream of these sensitive areas.

The scope of work for the LTCP did not include a detailed water quality analysis or extensive examination of water quality issues in the service area since the use of the presumptive approach presumes that WQS will be achieved by implementation of CSO controls. As mentioned, a post-construction compliance monitoring plan (PCCMP) will be developed to ensure WQS are being achieved.

7.4 USEPA CSO Control Levels

The USEPA CSO Control Guidance manual allows for the evaluation of the effectiveness of CSO control alternatives at various levels of control, based upon a "typical year" of rainfall or other rainfall design conditions. The control levels are described below.

For the purposes of this project, the following definitions and rationale are provided for each of the CSO control levels, starting with the highest level of CSO control.

CSO Control Level I: The goal of CSO Control Level I is to eliminate untreated overflows. CSO may be totally eliminated by sewer separation or a full range of CSO storage and treatment options. Storage and/or treatment alternatives will be sized and evaluated based on the capture and/or treatment of the largest volume (storage) or highest peak flow rate (treatment) determined via a "typical year" hydraulic model simulation. Control Level I provides an "upper limit" of potential costs for CSO control and exceeds the presumptive approach criteria detailed in the CSO Policy.

It should be noted that sewer separation may not result in an overall environmental benefit, since sewer separation may result in increased stormwater pollution loading to the receiving waters. In such cases, it would be necessary to address stormwater sources, which is beyond the scope of this study.

CSO Control Level II: The goal of this control level is to allow four untreated CSO discharge, as determined using the "typical year" hydraulic model simulation. This may be accomplished by a full range of CSO storage and treatment options, sized and evaluated based on the capture and/or treatment of the volume (storage) and/or peak flow rate (treatment) generated from all but four untreated CSO discharge during the "typical year" simulated flow condition.

This CSO control level is consistent with one of the presumptive approach criteria detailed in the CSO Policy.

CSO Control Level III: The goal of this CSO control level is to allow eight untreated CSO discharges, as determined using the "typical year" hydraulic model simulation. This may be accomplished by a full range of CSO storage and treatment options, sized and evaluated based on the capture and/or treatment of the volume (storage) and/or peak flow rate (treatment) from all flows in excess of eight untreated CSO discharges per year during the "typical year" simulated flow condition. This does not meet the 4 overflow/year presumptive approach criteria detailed in the CSO Policy.

CSO Control Level IV: The goal of this CSO control level is to allow twelve untreated CSO discharges, as determined using the "typical year" hydraulic model simulation. This may be accomplished by a full range of CSO storage and treatment options, sized and evaluated based on the capture and/or treatment of the volume (storage) and/or peak flow rate (treatment) from all flows in excess of twelve untreated CSO discharges per year during the "typical year" simulated flow condition. This does not meet the 4 overflow/year presumptive approach criteria detailed in the CSO Policy.

CSO Control Level V: The goal of this CSO control level is to allow twenty untreated CSO discharges, as determined using the "typical year" hydraulic model simulation. Again, this may be accomplished by a full range of CSO storage and treatment options, sized and evaluated based on the capture and/or treatment of the volume (storage) or peak flow rate (treatment) from all flows in excess of twenty untreated CSO discharges per year during the "typical year" simulated flow condition. This does not meet the 4 overflow/year presumptive approach criteria detailed in the CSO Policy.

7.5 RAJSA LTCP CSO and SSO Control Levels

During a meeting held on July 17, 2009 with PaDEP, the Project Team presented its approach to CSO control. It was agreed that the RAJSA LTCP would be prepared using the Presumptive Approach. It was also agreed that post-construction compliance monitoring would be required to assure that the CSO controls were achieving their intended purpose. As stated above, the presumptive approach requires that controls adopted in the LTCP should meet at least one of three criteria (i.e. 4 overflows per year, 85% capture, or elimination of mass pollutants causing water quality impairment).

It was decided by the Project Team to pursue criteria #2 of the presumptive approach, which is the elimination or capture of 85% by volume of the combined sewage collected during precipitation events on a system-wide annual average basis. As recommended in the CSO Policy, CSO alternatives were evaluated, costed and ranked based on a range of overflow events per year, and the recommended alternative for 4 overflow events per year was carried forward to the 85% capture analysis for facility sizing.

For the purposes of sizing the final CSO alternatives, the Project Team performed an 85% capture analysis. The analysis was based on the criteria of a maximum of 15% of the total flow collected in the combined sewer system during precipitation events would be discharged without treatment. Specifics regarding this analysis is detailed later in this report.

Based on the presumptive approach, the RAJSA could meet water quality standards by implementing CSO controls that will not allow more than 15% untreated discharge from CSOs during precipitation events per year on an annual average basis.

Using the RAJSA system model, CSO statistics (volume and peak flow) were generated for every outfall as well as for a selection of outfall groupings for control levels of zero, four, eight, twelve, and twenty overflow events per year, based on a “typical year” storm. As will be described in the following sections of this report, the costs for constructing and maintaining CSO control technology alternatives for each outfall and/or group of outfalls were developed based on these volumes and peak flow rates. The detailed results for these five control levels are included in the appendices. However, in the body of this report, it is assumed that the ultimate control level that the RAJSA will be required to meet is 85% capture of wet weather flows.

7.6 RAJSA SSO Control Levels and Approach

There are two SSOs in the RAJSA system at the following locations:

- Freedom Lift Station SSO; and
- Center Street SSO

Historically, sanitary sewer overflows (SSOs) have and continue to be considered illegal. As a practical matter, and for a substantial number of separate systems, SSOs will occur given sufficient precipitation. Across the nation, EPA has documented more than 19,500 municipal sanitary sewer systems serving an estimated 150 million people with about 40,000 SSO events per year (Lai, 2008). A common statement from various states can be summarized as follows; "…State and Federal Regulations for SSOs require either the elimination of all SSOs or treatment of SSOs to the Federal categorical secondary wastewater treatment standard. The (state) acknowledges that total elimination or secondary treatment of all SSOs is not practical or economically feasible. The (state) does not authorize the discharge of raw or partially treated SSOs. However, enforcement discretion will be considered for communities experiencing SSOs that are implementing a corrective action program…."

In practice, an argument could be made for the use of a cost-effectiveness analysis to determine a "knee-of-the-curve" for SSO control. The "knee-of-the-curve" approach typically compares the performance of a SSO technology with the costs and identifies the point of diminishing returns. For the RAJSA LTCP project, the approach was to develop a "knee-of-the-curve" analysis utilizing the 2-yr, 5-yr and 10-yr, 24-hour storms. The costs have been presented to the RAJSA for the various control levels in this LTCP. It is important to note that the Center Street SSO and WWTP expansion was recommended for the 10-year control level and the Freedom Lift Station SSO Storage Tank was recommended for the 5-year control due to space limitations in the vicinity of the lift station.

8.0 CSO and SSO Control Technologies

8.1 Overview

There are numerous known technologies that can be used to control CSOs. Some of the known technologies (for one reason or another) may not be suitable for application within the RAJSA's system. This section of the report presents the approach used by the Project Team to screen the control technologies that are not applicable to the RAJSA's system. This section also presents an inventory of CSO control technologies, discusses the screening process used, and provides a detailed description of the "surviving technologies." The results of this section form the basic building blocks of the CSO control alternatives that are developed and evaluated in the next section.

8.2 CSO Control Technology Inventory

As part of the development of the RAJSA LTCP, a cursory technology review, initial analysis, and screening was performed to identify and categorize feasible wet-weather management technologies for use in developing CSO control alternatives.

More than 70 individual wet-weather management technologies were reviewed for potential use as CSO controls in the combined portions of the RAJSA service area. The review was based on experience with CSO control activities in other communities, technical literature, processes identified by the 3 Rivers Wet Weather Program Management Team, and information provided by manufacturers, vendors, and other industry sources. Table 8-1 summarizes the technologies that were identified and categorized for screening. The wet-weather management technologies (CSO controls) were grouped into four functional categories, including:

- Source Control
- Collection System Optimization
- Storage
- Treatment

Table 8-1 - Technologies Reviewed for CSO Control

<table>
<tr><th colspan="2">Source Control</th></tr>
<tr><td>Best Management Practices:
• Catch basin cleaning
• Street cleaning
• Litter control
• Deicer control
• Fertilizer and pesticide control
• Hazardous material control
• Industrial runoff control
• Water conservation
• Public education
• Sewer use bylaws
• Spills emergency program

Infiltration/Inflow Control:
• Sewer and Manhole Rehabilitation
• Roof Leader and Footing Drain disconnection
• Cross connection removal</td><td>Stormwater Management Practices:
• Upstream stormwater storage
• Porous pavement
• Infiltration trenches and basins
• Erosion and sedimentation control
• Overland flow slippage and catch basin restriction
• Storm sewer exfiltration and infiltration systems
• Water quality inlets (stormtreat system, stormceptor system, downstream defender, csf stormwater treatment systems)
• Private property storage (rain harvesting)
• Stormwater permitting
• Urban forest structure</td></tr>
<tr><th colspan="2">Collection System Control</th></tr>
<tr><td>Sewer System Optimization:
• Remove Bottlenecks (Pipe Capacity and Connection Hydraulic Improvements)
• Sewer Cleaning and Maintenance
• Polymer Injection (Lining and Coating)

Regulator Optimization:
• Static Regulator Device Improvements
• Swirl/Helical, Plunge, and Vortex Energy Dissipaters</td><td>Regulator Optimization cont:
• Bending Weir (GNA Hydrobend)
• Drop Structure Optimization

Inter-Basin Flow Balancing/Relief:
• Inter-Basin Flow Transfer
• Relief Sewers

Sewer Separation: Complete or Partial Separation</td></tr>
</table>

<table>
<tr><th colspan="2">Storage</th></tr>
<tr><td>In-line Storage:
• Inflatable Dams
• Manual and Automatic Gates
• Existing Unused Conduits
• Static Flow Control Strategies
• Variable Flow Control Strategies
• Real-Time Control Strategies</td><td>Subsurface Storage:
• Tunnel Storage
• Closed Concrete Tanks
• Storage and Conveyance Conduits

Surface Storage:
• Open Concrete Tanks
• Earthen Basins</td></tr>
<tr><th colspan="2">Treatment</th></tr>
<tr><td>Suspended Solids Control:
• Microscreens
• Gravity Sedimentation
• Flocculation and Sedimentation
• Dissolved Air Flotation
• High-Rate Filtration
• Sand and Organic Filters (Buffer Strips, Sand and Peat Filters, Bioretention Areas)
• High-Rate Sedimentation (vortex sep.)
• Coarse Sand Filters

Floatable and Coarse Solids Control:
• Static Screens
• Mechanical Screens
• In-line Netting
• Containment Booms
• Regulator Underflow Baffles
• Catch Basin Inserts and Modifications
• Brush Screens
• Continuous Deflective Separation (CDS)</td><td>Disinfection:
• Chlorination
• Bromination
• Ozonation
• Microfiltration
• Ultraviolet Disinfection (UV)

High-Rate End-of-Pipe Treatment (HREOP):
• Ballasted Flocculation
• Clarification
• CoMag

CSO Treatment Facilities (CSOTF)
• Storage & Sedimentation
• Detention & Treatment (RTB)

“Other” Technologies
• Sidestream Elevated Pool Aeration
• Carbon Adsorption
• High-Gradient Magnetic Separation (HGMS)
• Constructed Wetlands
• Existing Treatment Plant Expansion
• Enclose Beach Area</td></tr>
</table>

8.3 CSO Control Technology Screening

Technology Screening Criteria

The technology screening process provided a way of eliminating technologies from consideration that did not meet the basic criterion for consideration and would therefore not likely achieve the program goals of this LTCP. In general, there were four main categories of criteria used for overall evaluation purposes in this project. These were:

- Economic Impact
- Environmental Impact
- Implementation Impact
- Operational Impact

Table 8-2 summarizes the subdivisions of each of these criteria as used in the evaluation of CSO control alternatives.

Table 8-2: CSO Control Technology Screening Criteria

Economic Impact • Present Worth Cost (Capital, Operations and Maintenance (O&M))
Environmental Impact • Pollution Reduction • Impact on habitat, stream flooding, etc.
Implementation Impacts • Constructability • Permanent Land Requirements • Public Acceptance • Institutional Constraints • Siting Restrictions
Operational Impact • Operating Complexity • Flexibility • Reliability • Compatibility with existing RAJSA Facilities and Operations

These evaluation criteria are described in detail in the next section where all of the factors were used to evaluate alternatives. However, for technology screening purposes, a set of modified statements was used (see Table 8-3 below.)

Technology Screening Approach

The screening criteria were used to develop screening-level queries to determine whether a particular CSO control technology should be used to develop short- and long-term control alternatives. The technology screening queries were directed towards the non-cost criteria because it was difficult to assess the impacts of cost prior to the development of control alternatives. Therefore, the Economic Impact criteria were not used to screen CSO control technologies.

The screening queries for the Environmental, Implementation, and Operational Impact criteria are summarized in Table 8-3.

Table 8-3: Technology Screening Queries

Criteria	Screening Level Queries
Environmental Impact	1. Does the technology reduce or capture the water quality pollutants of concern? 2. Does the technology reduce the number of untreated overflow events and volume? 3. Does technology effectively capture CSO floatables? 4. Does implementation of the technology avoid adverse impacts to sensitive areas, habitat, river, etc.?
Implementation Impact	1. Is the technology feasible (public acceptance, construction impact, etc.) in urban, residential, or commercial areas? 2. Can the technology be physically constructed in the service area given its land requirements, site restrictions, etc.?
Operational Impact	1. Is the technology compatible with current operating systems with respect to specialized staff or new staff requirements? 2. Is the technology a proven, reliable, and flexible system? 3. Does the technology avoid negative impacts to downstream facilities? 4. Does the technology have minimal remote O&M needs?

The above queries were formulated to obtain consistent responses relative to positive and negative impacts. For example, a “yes” answer would always be positive and a “no” answer would always be negative. However, instead of using “yes” or “no” answers, a rating scale of “+”, “0”, and “–“ was employed to address positive, neutral, and negative responses to the questions. To that end, the responses to the screening questions were established as follows:

“+” indicated a Positive Impact / Improvement
“0” indicated a Neutral Impact / No Improvement
“-” indicated a Negative Impact / Deterioration

After each CSO control technology was subjected to the screening questions, an assessment was made of its future use in the RAJSA service area, as defined below.

- **System-Wide Technology**–The technology scored reasonably well over the range of evaluation criteria and is a logical CSO control technology to be applied system-wide in the RAJSA service area. That is, the technology will be evaluated and/or applied to all CSO outfalls (or tributary areas).

- **Region-Wide (Consolidated) Technology–**The technology scored reasonably well over a range of criteria and may best be applied to the development of regional or consolidated CSO control alternatives.

- **Site-Specific Technology–**The technology scored reasonably well over a range of criteria and may best be applied to the development of site-specific CSO control alternatives. These were termed "Outfall-Specific" alternatives.

- **Remote Locations and Low Flow Technology**–The technology scored reasonably well over a range of criteria, but may best be implemented independently as part of a "Remote & Low Flow Solution" program.

- **Non-Feasible Technology**–The technology consistently scored poorly over a range of criteria and will not be a logical choice for inclusion in the detailed evaluation phase.

A detailed record of the screening process is included in Appendix M —Technology Screening Matrix.

Technology Screening Results

The results of the screening process for each of the technology categories, source control, collection system controls, storage, and treatment, are described below.

Source Control. This category included the following subcategories of technologies:

Best Management Practices (BMP)
Infiltration / Inflow (I/I) Control
Stormwater Management Practices (SMP)

Table 8-4 presents the screening results of the source control technologies.

Table 8-4: Source Control Technology Screening Results

Feasible Technologies	Non-Feasible Technologies
BMP	
• None	• Catch basin cleaning • Street cleaning • Litter control • Deicer control • Fertilizer and pesticide control • Hazardous material control • Industrial runoff control • Water conservation • Public education • Sewer use bylaws • Spills emergency program
I / I Control	
• None	• Sewer & Manhole Rehabilitation • Roof Leader / Footing Drain Disconnection • Cross Connection Removal
SMP	
• None	• Upstream Stormwater Storage • Porous Pavement • Infiltration Trenches & Basins • Erosion & Sedimentation Control • Storm Sewer Exfiltration & Infiltration Systems • Water Quality Inlets • Private Property Storage • Stormwater Permitting • Urban Forest Structure • Overland Flow Slippage & Catch Basin Restriction

The BMP technologies were screened as a group. The applicability and effectiveness of BMPs as part of the RAJSA LTCP project was discussed at length by the Project Team. BMPs were considered to be Non-Feasible with the following rationale:

- The technologies do not significantly reduce pollutant and/or hydraulic loadings.

- Many of the technologies are already included in the Nine NMC measures.

- The effectiveness of the technologies is limited when upstream flows are significant.

The I/I Control technologies were screened individually. Of the three technologies, all were considered Non-Feasible because they have limited effectiveness in a combined sewer area.

The applicability and effectiveness of SMPs as part of the RAJSA project was discussed at length by the Project Team. The SMP technologies were screened as a group, and all considered to be Non-Feasible with the following rationale:

- Implementation and Operational “negatives” outweighed the Environmental “positives”.

- The overall scores indicated that all of the technologies are Non-Feasible.

- Many of these technologies are already included in the NMC measures.

- The effectiveness of these technologies is limited when upstream flow are significant.

SMPs have currently been grouped into “Green Solutions” and have become very popular as part of overall wet weather management/control programs. These Green Solutions are seen as enhancements, but cannot serve as replacements for end-of-pipe CSO control approaches. These items were seen as “good” practices to include with new and redevelopment projects, but with some drawbacks, which include the following:

- Typical controls would require maintenance and buy-in by other municipal departments.

- Some of the Green Solutions infrastructure (such as tree planting) require years to become established and provide benefits.

- The impact of Green Solutions would not be realized at larger storms (corresponding to 85% capture or 4 overflows per year).

- Full implementation of Green Solutions will not replace the need to build end-of-pipe controls, such as treatment facilities and storage basins.

- Extensive time frame to get to a point of full implementation which would not meet the requirement to comply with the schedules contained in the COA.

If needed, in the future, the RAJSA can opt to investigate and implement Green Solutions such that they could reduce the cost of the end-of-pipe treatment facilities.

Collection System Controls. This category included the following subcategories of technologies:

- Sewer System Optimization

- Regulator Optimization

- Inter-Basin Flow Balance / Relief

- Sewer Separation

Table 8-5 presents the results of the Collection System Controls screening process.

Table 8-5: Collection System Control Technology Screening Results

Feasible Technologies	Non-Feasible Technologies
Sewer System Optimization	
• None	• Removal of bottlenecks • Sewer cleaning & maintenance • Polymer injection (lining & coating)
Regulator Optimization	
• Regulator optimization	• Swirl / helical, plunge, and vortex energy dissipaters • Bending weirs • Drop structure optimization
Inter-basin Flow Balance/Relief	
• Relief Sewer(s)	• Inter-basin flow transfer
Sewer Separation	
• Complete separation • Partial separation	• None

The Sewer System Optimization technologies were screened as a group. They were considered to be Non-Feasible for use as Regional, Site-Specific, and/or Remote/Low Flow technology because their impacts on CSOs are minimal.

The Regulator Optimization technologies were screened as a group, and as such, they were considered to be feasible for use as Site-Specific and/or Remote/Low Flow technology. These technologies are similar to collection system controls and cause greater environmental impacts. However, they require more O&M. Swirl / helical, plunge, and vortex energy dissipaters and bending weirs do not exist in the RAJSA service area.

The Inter-basin Flow Balance/Relief technologies were screened individually. Of the two technologies, only relief sewer(s) technology was deemed to be feasible for use as Regional, Site-Specific, and/or Remote/Low Flow technology, despite the reasoning that a relief sewer may simply transfer problems downstream where they may arise again. Inter-basin flow transfer was deemed to be Non-Feasible because of potential difficulties presented by the terrain, municipal boundaries and because implementation of these technologies may simply transfer problems elsewhere, where they may arise again.

The Sewer Separation technologies were screened individually. Complete separation was deemed to be feasible for use as System-Wide, Regional, Site-Specific, and/or Remote/Low Flow technology, while partial separation was deemed to be feasible for use as Regional, Site-Specific, and/or Remote/Low Flow technology. The following rationale applies:

- Partial and total separation are judged to be effective.

- Partial separation is feasible for Site-Specific or Remote/Low Flow plans. It will not provide a full level of control in most instances during System-Wide applications.

Storage. This category included the following subcategories of technologies:

- In-Line Storage

- Sub-Surface Storage

- Surface Storage

Table 8-6 presents the results of the Storage technology screening process.

Table 8-6: Storage Technology Screening Results

Feasible Technologies	Non-Feasible Technologies
In-Line Storage	
• None	• Existing Unused Conduits • Inflatable Dams • Manual & Automatic Gates • Static Flow Control Strategies • Variable Flow Control Strategies • Real-Time Control Strategies
Sub-Surface Storage	
• Tunnel Storage • Closed Concrete tanks	• Storage & Conveyance Conduits
Surface Storage	
• None	• Open Concrete Tanks / Earthen Basins

In-Line Storage technologies were screened as a group, and as such, many were considered to be Non-Feasible for use as Regional, Site-Specific, and/or Remote/Low Flow technology with the following rationale:

- There are no existing unused conduits in the RAJSA system.
- Steep local terrain would make it difficult to monitor and control flows.
- Large diameter conduits do not exist in the RAJSA system.

The Sub-Surface Storage technologies were screened individually. Tunnel Storage was deemed to be feasible for System-Wide and Regional use, while each of the others was deemed to be feasible for Regional and Site-Specific use. The following rationale applies:

- Tunnel storage rated high on a System-Wide and Regional basis, but not for Site- Specific areas. RAJSA does not currently operate similar systems, and such a system would require extensive O&M.

- Closed concrete tanks and storage conduits were judged to be Non-Feasible for System-Wide use due to the pumping required to consolidate overflows from different drainage basins.

Surface Storage (open concrete tanks / earthen basin storage) was deemed to be Non-Feasible for use as Site-Specific technology with the following rationale:

- Environmental concerns along the riverfront
- High O&M requirements

Treatment. This category included the following sub-categories of technologies:

- Suspended Solids Control
- Floatables & Coarse Solids Control
- Disinfection
- High Rate End-of-Pipe (HREOP)
- CSO Treatment Facilities (CSOTF)

- “Other” Treatment Technologies

Table 8-7 presents the results of the Treatment technology screening process.

Table 8-7: Treatment Technology Screening Results

Feasible Technologies	Non-Feasible Technologies
Suspended Solids Control	
Region-Wide and/or Site-Specific: • High Rate Sedimentation (vortex separator)	• Microscreens • Gravity Sedimentation • Flocculation & Sedimentation • Dissolved Air Floatation • High Rate Filtration • Sand & Organic Filters
Floatables & Coarse Solids Control	
• Screens, including Static, Mechanical and In-Line Netting	• Containment Booms • Catch Basin Inserts & Modifications • Brush Screens • Regulator Underflow Baffles
Disinfection	
• Chlorination	• Bromination • Ozonation • Microfiltration • Ultraviolet Radiation
HREOP	
• Ballasted Flocculation	• Clarification (DensaDeg 4D) • CoMag
CSOTF	
• Storage & Sedimentation • Detention & Treatment (RTB)	• None
Other Technologies	
• Existing Treatment Plant Expansion	• Carbon Absorption • HGMS • Constructed Wetlands • Enclose Beach Area • Sidestream Elevated Pool Aeration

The Suspended Solids Control technologies were screened individually. All were considered Non-Feasible with the exception of vortex separators for use as Regional and/or Site-Specific technology with the following rationale:

- Less "proven" technologies.

The Floatables & Course Solids Control technologies were screened individually. Screens were deemed to be feasible for Regional and/or Site-Specific use. The following rationale applies:

- Technology may require implementation in conjunction with Disinfection and other treatment.
- In-receiving water methods were not considered feasible in the area's rivers and streams.

Containment booms, catch basin inserts and modifications, and brush screens were deemed to be Non-Feasible due to consistently poor scores on the Operational Impact criteria.

Disinfection technologies were screened individually. All were considered to be Non-Feasible with the exception of chlorination for use as Regional and/or Site-Specific technology with the following rationale:

- RAJSA does not have experience with other types of disinfection.

The HREOP technologies were screened individually, and ballasted flocculation was considered to be feasible for use as Regional and/or Site-Specific technology. The others were considered to be Non-Feasible with the following rationale:

- DensaDeg and CoMag are less "proven" technologies than ballasted flocculation.

The CSOTF technologies were screened individually, and each was considered to be feasible for use as Regional and/or Site-Specific technology with the following rationale:

- Both are accepted CSO control technologies.

- Detention and treatment basins would generally be smaller than those for storage and sedimentation, thus raising its "implementation impact" score.

"Other" technologies were screened individually, and the only feasible option was the expansion of the existing WWTP. All others were considered to be Non-Feasible, with the following rationale:

- All technologies must be implemented in conjunction with Floatables & Coarse Solids Control.
- None of these technologies have been "proven" to be effective at CSO control.
- Relatively high land requirements or inappropriate land uses limit possible implementation.

Technologies that were considered feasible for use were carried forward in the development of CSO control alternatives to be applied to remote/low flow, outfall-specific, consolidated, and/or system-wide controls.

Table 8-8 summarizes the CSO control technologies that have been recommended for use in the development of RAJSA's CSO control alternatives at the system-wide, regional, individual outfall, or remote and low flow levels.

Table 8-8: Technology Screening–Summary of Recommended Uses

Source Control Technologies				
System-Wide	**Region-Wide**	**Site-Specific**	**Remote and Low Flow**	**Non-Feasible**
• None	• None	• None	• None	• BMP (all) • Roof Leader / Footing Drain Disconnection • Cross Connection Removal • SMP (all) • Sewer & Manhole Rehabilitation

Collection System Control Technologies				
System-Wide	**Region-Wide**	**Site-Specific**	**Remote and Low Flow**	**Non-Feasible**
• Complete Separation	• Relief Sewer(s) • Complete separation • Partial Separation	• Regulator optimization • Relief Sewer(s) • Complete separation • Partial separation	• Regulator optimization • Relief Sewer(s) • Complete separation • Partial separation	• Inter-basin flow transfer • Removal of bottlenecks • Sewer cleaning & maintenance • Polymer injection (lining & coating) • Swirl / helical, plunge, and vortex energy dissipaters • Bending weirs • Sewer system optimization

Storage Technologies				
System-Wide	**Region-Wide**	**Site-Specific**	**Remote and Low Flow**	**Non-Feasible**
• Tunnel	• Tunnel • Closed Concrete tanks	• Closed Concrete tanks	• None	• Inflatable Dams • Manual & Automatic Gates • Static Flow Control Strategies • Variable Flow Control Strategies • Real-Time Control Strategies • Storage & Conveyance Conduits
Treatment Technologies				
System-Wide	**Region-Wide**	**Site-Specific**	**Remote and Low Flow**	**Non-Feasible**
• Existing Treatment Plant Expansion	• Suspended Solids removal • Screening and disinfection • HREOP (BF) • CSOTF	• Suspended Solids removal • Screening and disinfection • Disinfection • HREOP (BF) • CSOTF	• None	• Containment Booms • Catch Basin Inserts & Mods • Brush Screens • Carbon Absorption • HGMS • Constructed Wetlands • Enclose Beach Area • Sidestream Elevated Pool Aeration • Underflow baffles

8.4 Screened CSO Technology Descriptions

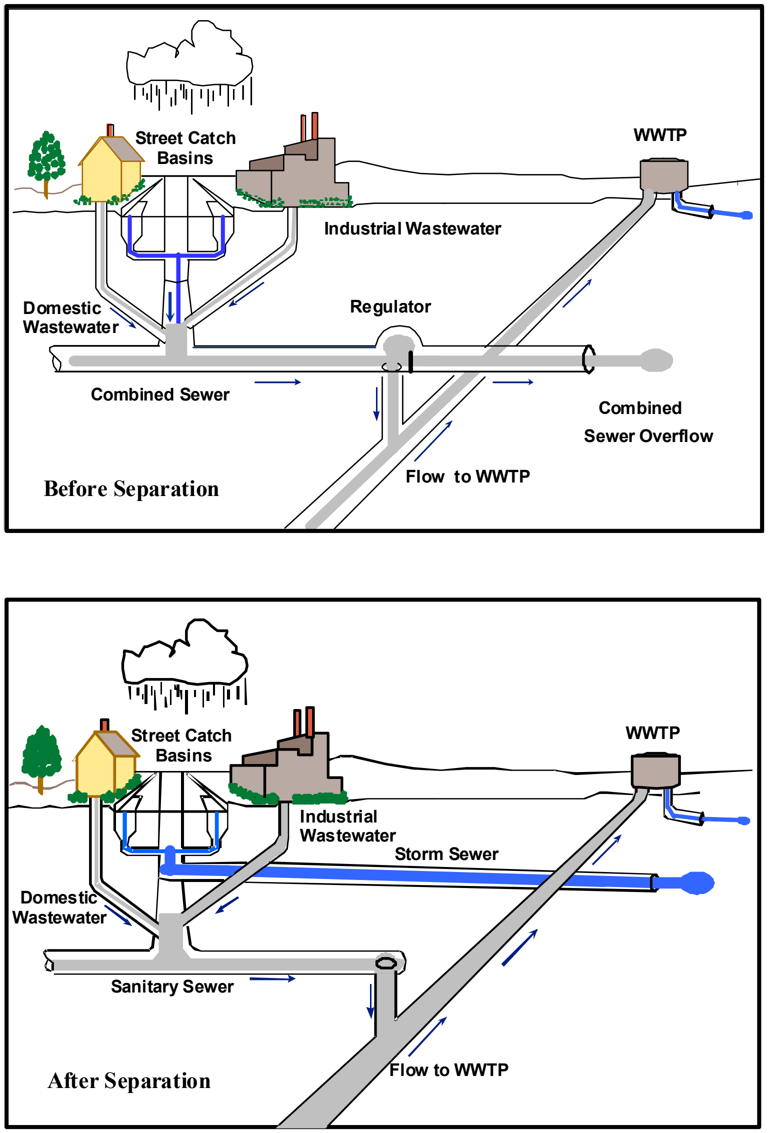
CSO control alternatives are essentially "packages" containing a number of technology components based upon a specific CSO control technology. Brief descriptions of the recommended CSO control technology alternatives are presented below.

- *Regulator Optimization:* Often, regulators can be modified or even eliminated to better manage CSO volumes and frequencies. Regulated flows entering the interceptor system could be increased in wet weather conditions to reduce CSO volume and / or frequency if available interceptor capacity exists to receive and convey these flows. Regulator optimization methods include static regulator device improvements (gates or weirs); swirl / helical, plunge, and vortex energy dissipaters; bending weirs; or drop structure optimization. *Static regulator device improvements* may be made to fixed and adjustable weir regulators. However, without moving parts, no opportunity exists for additional control once the weir elevation is set. There are numerous fixed weir regulators in operation within the RAJSA system.

- *Relief sewer(s),* with the following associated components: regulator modification / repair / replacement.

- *Sewer separation*, with the following associated components: regulator modification / repair / replacement and land easements. In a combined sewer system, stormwater and sanitary sewage are collected in the same pipe and then conveyed to the WWTP. The combined sewer may not have sufficient capacity to convey stormwater runoff from storms of all sizes, often causing the mixture of stormwater and sanitary sewage to overflow at certain points within the combined system. These overflows are called "Combined Sewer Overflows," or "CSOs." In a separate sewer system, pipes that convey sanitary sewage to the WWTP are independent of pipes that convey stormwater to nearby water bodies, which eliminates the opportunity for sanitary sewage to overflow to receiving waters. Figure 8-1 illustrates the typical configurations of combined and separate sewer systems. Complete or partial sewer separation could be accomplished by constructing new storm drains, and allowing the existing combined sewer to function as a separate sanitary sewer. Separation could also be achieved by constructing new sanitary sewers, allowing the existing combined sewer to function as a storm drain. Using the existing combined sewer as the sanitary sewer allows separate sanitary building connections to remain connected to the "converted" combined sewer. Complete sewer separation involves the complete removal of stormwater inputs to a newly constructed sanitary sewer system. This includes the removal of catch basins, roof drains, footing drains, and all other sources of stormwater. Partial separation could also be implemented to lower the stormwater flows into the remaining combined sewer pipe. This may include separating only the catch basins in a true combined area.

Figure 8-1. Sewer Separation



- **Subsurface storage**, with the following associated components: influent pump station and piping, consolidation and/or outfall piping, odor control, screening, regulator modification / repair / replacement, and land acquisition.

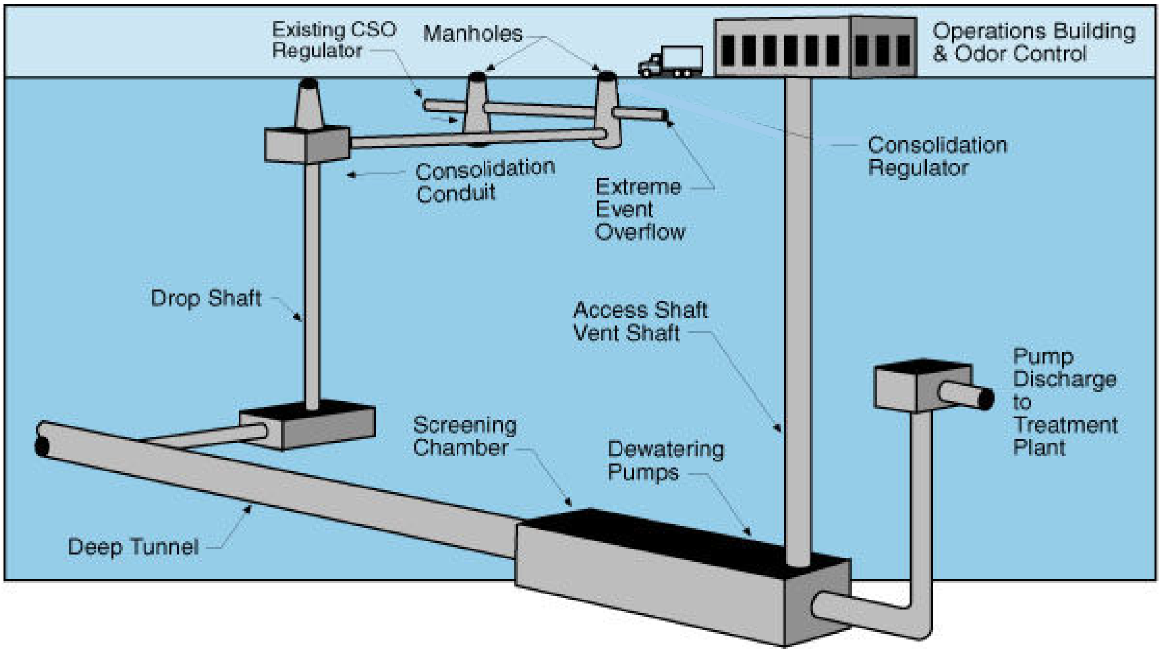
  Closed concrete tanks are constructed at depths sufficient to bury the structure so that the covered surface can possibly be used for other desired purposes. Subsurface tanks perform the same function as surface tanks, but often include pumping facilities due to their required depths.

- **Tunnel storage**, with the following associated components: influent pump station and piping, consolidation and/or outfall piping, odor control, screening, regulator modification / repair / replacement, and land acquisition.

  Tunnel storage provides storage for large volumes of CSO in below-grade tunnels, as shown in Figure 8-2. Following a storm event, the stored CSO volume flows by gravity or is pumped back to the collection system for full treatment at the WWTP. If the tunnel storage capacity is exceeded, excess CSO volume is discharged directly to the receiving water(s). While the size, depth, and complexity of a tunnel system varies depending on the location and volume of CSO to be captured and the subsurface conditions, a tunnel system would generally include the following features:

  - Vertical drop shafts to deliver flow from CSOs or consolidation conduits near the surface to the deep tunnel
  - Coarse bar screens located at each drop shaft or just upstream of the pump system to protect pumps from large objects in the combined flow
  - Access shafts to provide tunnel access for personnel and equipment
  - Vent shafts constructed to allow air pressure balancing in the tunnel during tunnel filling or dewatering
  - Dewatering pumping system to pump stored combined flow from the tunnel to the collection system or WWTP
  - Odor control system located at vent shafts to eliminate odors from the vented air

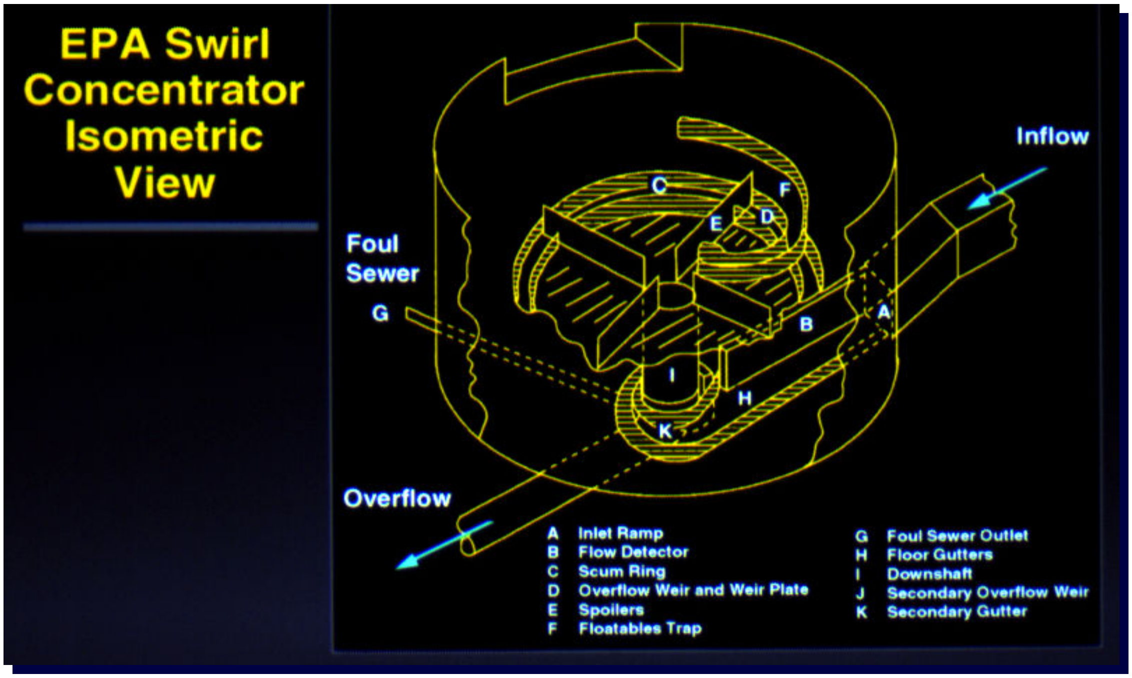
Figure 8-2. Subsurface Storage Using Deep Tunnels



- **Suspended Solids removal (swirl / vortex separator),** with the following associated components: effluent pump station and piping, consolidation and/or outfall piping, odor control, screening, disinfection, regulator modification / repair / replacement, and land acquisition. *High rate sedimentation systems*, such as swirl concentrators, vortex separators, and FluidSep, regulate both the quantity and quality of CSO at the point of overflow. These facilities use the inertial energy of the influent along with the annular geometry of a fixed inlet device to simultaneously regulate flow and separate materials of different densities from the influent. The result is a large volume of clear overflow and a concentrated low volume of waste (underflow) that is sent to the WWTP.

  These devices are designed to operate under extremely high flow conditions and have relatively small space requirements. In free-flowing applications, no pumping may be necessary. Prototype units have also been observed to provide effective floatables removal. Due to the minimization of moving parts and relatively low maintenance and space requirements, vortex technologies have been selected by many cities as potential alternatives for CSO control. They could be used as part of an overall treatment system for CSO control. Figure 8-3 illustrates the characteristics of a swirl concentrator system**.**

Figure 8-3. Characteristics of a Swirl Concentrator System



- **CSOTF**, with the following associated components: effluent pump station and piping, consolidation and/or outfall piping, odor control, screening, disinfection, regulator modification / repair / replacement, and land acquisition. CSOTFs are near-surface storage / primary treatment technologies used for wet-weather flows at CSO outfalls or at a treatment plant site, and include storage and sedimentation facilities, and detention and treatment facilities.

  Storage and sedimentation facilities have storage capacity to fully capture a certain volume that can be sent to a treatment plant after the storm subsides. Flows in excess of the storage tank volume pass through the tank and receive treatment for floatables control, solids removal, and disinfection (if desired). The degree of treatment depends on the rate of flow through the tank.

  Detention and treatment systems (RTBs) are similar to storage and sedimentation systems but have a smaller volume and surface area, providing less storage and a lower level of treatment.

While the size of each type of facility varies for a given overflow volume and peak flow rate, the features of each facility are generally similar. At a minimum, the facilities would include screening and a pump station. Influent bar screens (upstream of the tank) and disinfection facilities (if required) should be evaluated for inclusion with these technologies.

- **HREOP**, with the following associated components: effluent pump station and piping, consolidation and/or outfall piping, odor control, screening, disinfection, regulator modification / repair / replacement, and land acquisition. Ballasted flocculation is a physical / chemical treatment process that utilizes a continuously recycled media, a coagulant, and a polymer to improve floc formation and increase settling velocities of suspended solids. This allows clarification to occur at rates up to 10 times faster than can be achieved in conventional clarification units. The end result is greater treatment capacity in a smaller footprint, which can be ideal for high rate applications such as 0 overflow controls.

  Ballasted flocculation systems, such as the ACTIFLO system, are high-rate clarification processes that utilize microsand-enhanced flocculation along with a settling process. The coagulant used is a multivalent salt (ferric chloride or alum). It is mixed with a polymeric flocculent within the microsand. The system is capable of handling a large range of flows. Pilot project results show up to 85-95 percent removals of total suspended solids and 60-80 percent removals of BOD.

- **Screening and disinfection with the following associated components**: effluent pump station and piping, consolidation and/or outfall piping, odor control, regulator modification / repair / replacement, and land acquisition. Floatables / Coarse Solids Controls are implemented to manage the larger debris existing in combined sewage.

  Static screens are the simplest of all screening mechanisms. Static screens consist of a stationary bar rack or a fine screen placed at an incline perpendicular to the flow stream. With no moving parts, static screens enable the removal of large suspended and settleable solids from the flow stream as it passes through the screening mechanism. Typically, a hydraulic loading rate in the range of 100 to 180 gallons/minute/foot of width would provide the best removal results. The collected solids are manually removed from the screen for disposal.

Mechanical screens have been developed by a number of manufacturers specifically for CSO floatables control. These screens are intended for use at unmanned sites within sewer systems and are placed on the overflow or diversion weir. Traditional screens have vertical bars and clear spacing of 0.25 to 1.5 inches. Screens are cleaned with various types of rakes that pull trash captured on the front of the bars up along the face of the screen and deposit it into a dumpster or onto a conveyor. Screenings may be disposed of by returning them to the sanitary flow stream for final removal at the downstream sewage treatment facility or by sending them to a landfill.

Traditional mechanical screens generally require construction of a building to conceal the equipment and the solids collected before disposal. They also typically require a staff to maintain the screens and the building. Mechanical screens used for CSO applications typically are associated with other CSO controls. For example, vertical screens provide pretreatment of combined flow entering vortex separators or storage-treatment facilities. These screens are generally not used as stand-alone CSO treatment systems, although their application as an end-of-pipe treatment facility might be applicable on a site-specific basis.

Chlorine and chlorine compounds such as chlorine gas, sodium hypochlorite, chloramines, and chlorine dioxide are perhaps the most commonly used chemical disinfectants. All of these leave a chlorine "residual" in the waste stream, i.e., it takes time for them to dissipate once introduced. This residual can be quite useful in maintaining low levels of pathogens in transmission systems when required, but it may also combine with organic constituents in the receiving waters and become quite harmful to organisms in the waters. Depending upon receiving water quality, the effluent from the Control Facilities may require elimination of most, if not all, of its chlorine residual. If so, de-chlorination of the effluent may be accomplished via chemical neutralization using sulfur dioxide or sodium metabisulfite, or via adsorption by activated carbon.

- **Other Technologies**: *Existing Treatment Plant Expansion* is used to expand the capacity in the WWTP, and is typically achieved by increasing the size or adding new components such as screens, clarifiers, settling tanks, pumps, disinfection facilities, and other ancillary facilities of the plant.

8.5 SSO Control Technology Inventory

Similarly for SSOs, a cursory technology review, initial analysis, and screening was performed to identify and categorize feasible wet-weather management technologies for use in developing SSO control alternatives.

Table 8-9 summarizes the technologies that were identified and categorized for screening. The SSO technologies were grouped into four functional categories, including:

- Source Control
- Collection System Optimization
- Storage
- Treatment

Table 8-9 - Technologies Reviewed for SSO Control

Source Control	
Infiltration/Inflow Control: • Sewer rehabilitation/repair • Manhole rehabilitation/manhole inserts • Pipe replacement • Service lateral repair/replacement	**Stormwater Management Practices:** • Service lateral connection replacement • Sump pump discharge rerouting • Footing drain disconnection • Private drain removal
Collection System Control	
Sewer System Optimization • Remove bottlenecks (pipe capacity and connection hydraulic improvements) • Sewer cleaning and maintenance • Lining and coating	**Inter-Basin Flow Balancing/Relief:** • Inter-Basin Flow Transfer • Relief Sewers
Storage	
Subsurface Storage • Tunnel Storage • Closed Concrete Tanks	

Treatment	
End-of-Pipe: • Satellite Treatment Plant	

8.6 SSO Control Technology Screening

A similar process was used to screen the SSO technologies as described above. The following are the "surviving" SSO technologies:

Table 8-10: Source Control Technology Screening Results

Feasible Technologies	Non-Feasible Technologies
I / I Control	
• None	**Infiltration/Inflow Control:** • Sewer rehabilitation/repair • Manhole rehabilitation/manhole inserts • Pipe replacement • Service lateral repair/replacement
SMP	
• None	**Stormwater Management Practices:** • Service lateral connection replacement • Sump pump discharge rerouting • Footing drain disconnection • Private drain removal

All were considered to the Non-Feasible because they are out of the jurisdiction of the RAJSA, and the municipalities and customers would be responsible for their implementation.

Table 8-11: Collection System Control Technology Screening Results

Feasible Technologies	Non-Feasible Technologies
Sewer System Optimization	
• None	• Removal of bottlenecks • Sewer cleaning & maintenance • Polymer injection (lining & coating)
Inter-Basin Flow Balancing/Relief	
• Relief Sewers	• Inter-Basin Flow Balancing/Relief

Table 8-12: Storage Technology Screening Results

Feasible Technologies	Non-Feasible Technologies
Sub-Surface Storage	
• Tunnel Storage • Closed Concrete tanks	• None

Table 8-13: Treatment Technology Screening Results

Feasible Technologies	Non-Feasible Technologies
End-of-Pipe Treatment	
• None	• Satellite Treatment Plant

The new satellite treatment plant alternative was considered Non-Feasible due to the small system of RAJSA.

8.7 Screened SSO Technology Descriptions

Descriptions for surviving SSO technologies were discussed earlier in this section.

9.0 Development and Evaluation of CSO and SSO Control Alternatives

9.1 Overview

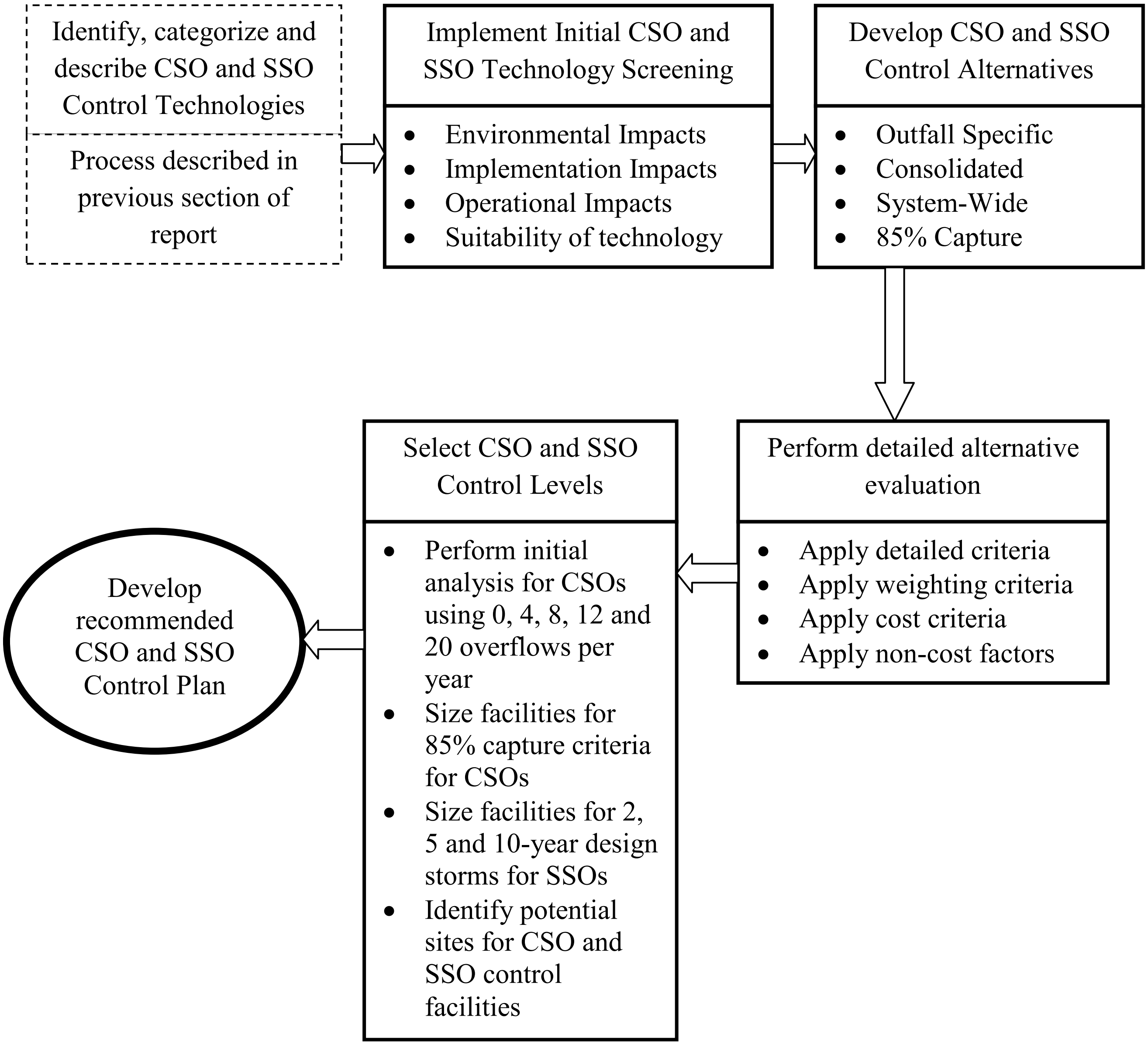
This section of the report describes the process by which CSO and SSO control alternatives were developed and evaluated for use in the RAJSA and municipalities' systems. The initial subsections focus on the alternative development process and the resulting alternatives. The later subsections describe the methods used to calculate planning-level cost estimates and the means by which the final evaluation (ranking) and comparison of alternatives was completed. The costs for the various alternatives are summarized near the end of this section. Finally, the Project Team performed a preliminary siting analysis to identify potential locations for the CSO and SSO controls. This is explained in detail in the final subsection of this chapter.

The conclusion of the alternative development and evaluation process was the identification of the highest-ranking CSO control alternatives for the RAJSA LTCP, sized for 85% capture of wet weather flows based on the system-wide annual average during the Typical Year Baseline Condition Simulation (2003). SSO controls have been sized for the 2, 5 and 10-year design storm. It is expected that final design criteria for SSOs will be decided by PaDEP, and more than likely will be based on many factors, including affordability, performance vs. cost and others.

9.2 CSO and SSO Control Alternative Development

The previous section presented a detailed description of the process used in determining the resulting (i.e., feasible) CSO and SSO Control Technologies that could be used as a basis for the development of CSO and SSO control alternatives. The Project Team decided to develop the alternatives in a stepwise fashion, starting with the outfall-specific analyses to obtain the highest ranked alternative for each CSO or SSO location, followed by a consolidated analyses to determine if there were benefits to consolidating CSO and SSO controls, followed by a system-wide evaluation to determine if there is any merit in controlling the system as a whole, and finally performed an 85% capture analysis to size determine the final cost of the alternatives. This process is shown schematically in Figure 9-1.

Figure 9-1: Process Flow Chart for CSO and SSO Control Alternative Development



The first step in the development of CSO and SSO control alternatives was to tabulate the results of the Technology Screening process described in the previous section. Table 9-1 summarizes the selected CSO and SSO Control Technologies and their recommended uses, respectively.

Table 9-1: Technology Screening–Summary of Recommended Uses for CSO Control

Source Control Technologies		
System-Wide Solutions	**Consolidated Solutions**	**Outfall-Specific Solutions**
• None	• None	• None
Collection System Control Technologies		
System-Wide Solutions	**Consolidated Solutions**	**Outfall-Specific Solutions**
• Complete Separation	• Relief sewer(s) • Complete separation • Partial Separation	• Regulator optimization • Relief sewer(s) • Complete separation • Partial separation
Storage Control Technologies		
System-Wide Solutions	**Consolidated Solutions**	**Outfall-Specific Solutions**
• Tunnel	• Closed concrete tanks	• Closed concrete tanks
Treatment Control Technologies		
System-Wide Solutions	**Consolidated Solutions**	**Outfall-Specific Solutions**
• None	• Vortex Separators • Screening and Disinfection • Ballasted Flocculation • RTB	• Vortex Separators • Screening and Disinfection • Ballasted Flocculation • RTB

Table 9-2: Technology Screening–Summary of Recommended Uses for SSO Control

Source Control Technologies		
System-Wide Solutions	**Consolidated Solutions**	**Outfall-Specific Solutions**
• None	• None	• None
Collection System Control Technologies		
System-Wide Solutions	**Consolidated Solutions**	**Outfall-Specific Solutions**
• None	• Relief sewer(s)	• Relief sewer(s)
Storage Control Technologies		
System-Wide Solutions	**Consolidated Solutions**	**Outfall-Specific Solutions**
• None	• Closed concrete tanks	• Closed concrete tanks
Treatment Control Technologies		
System-Wide Solutions	**Consolidated Solutions**	**Outfall-Specific Solutions**
• None	• None	• None

To estimate the required sizes, costs, and physical impacts of each technology component in a given CSO and SSO control alternative, planning-level design criteria were developed for each technology. These design criteria are detailed in a technical memorandum, *Technical Parameters for CSO and SSO Alternatives Analysis,* and a copy of is included in Appendix B. These parameters were used, on a planning-level basis, to size technologies (via flow rate or volume) and set tank side water depths (feet). The application of these design criteria resulted in the production of valuable and consistent planning-level information that was used in the alternative evaluation process. Sizing criteria included supplemental facilities such as pump stations, odor control facilities, tank flushing systems, etc.

For CSO areas, flow rates and volumes were determined from the results of the calibrated H&H Model, under the Typical Year Baseline Condition Simulation (2003). Exceedance summary graphs for each outfall were produced to illustrate the CSO volume, peak flow rate, and frequency of overflows. Typical Exceedance Summary graphs are shown below in Figures 9-2 and 9-3.

Figure 9-2: Exceedance Summary Graph; CSO Volume vs. No. of Exceedances

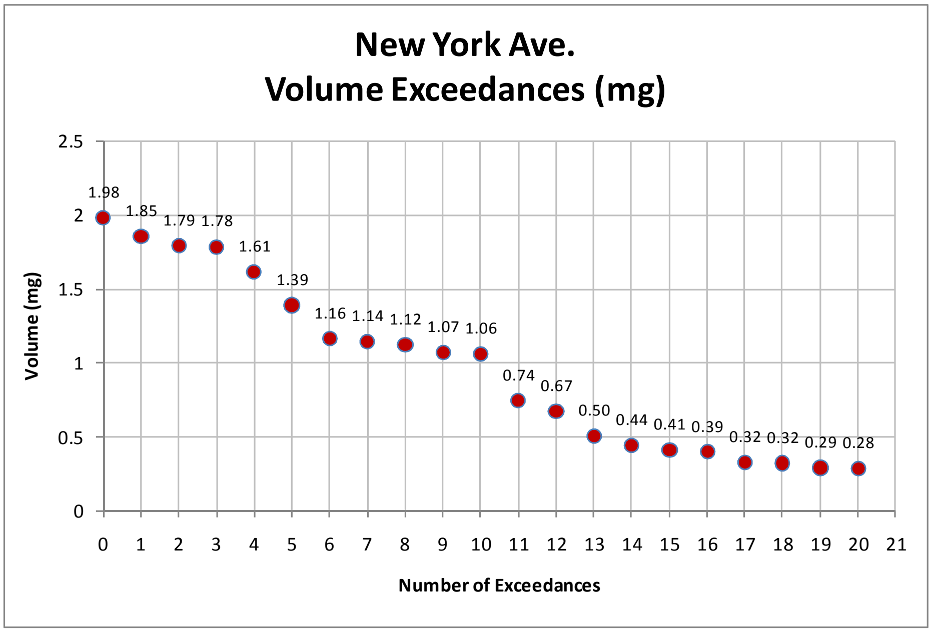
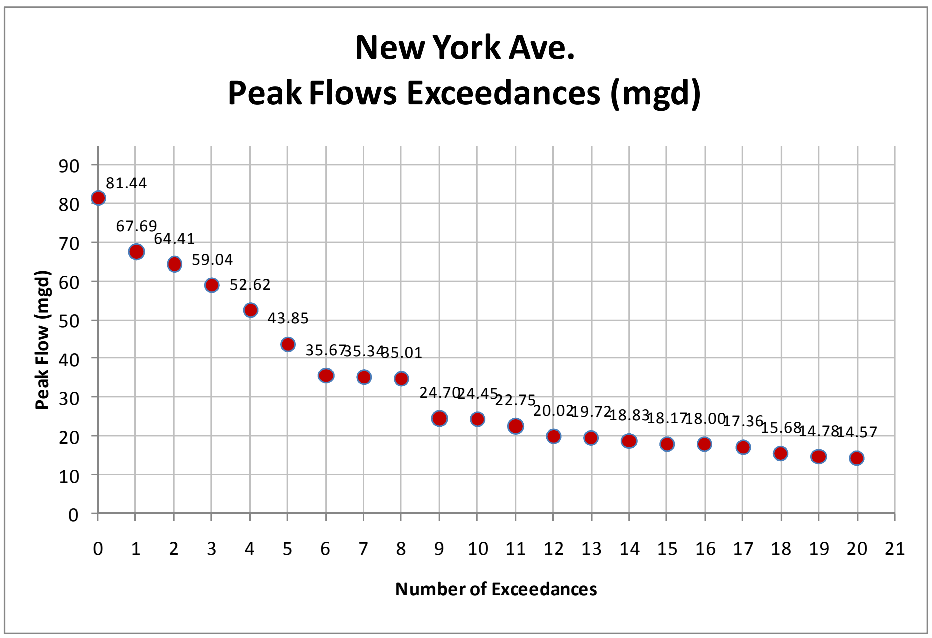


Figure 9-3: Exceedance Summary Graph; CSO Peak Flow vs. No. of Exceedances



The facilities were then sized based on the flow rate or volume corresponding to the following overflow frequencies:

- Zero untreated overflows per year
- Four untreated overflow per year
- Eight untreated overflows per year
- Twelve untreated overflows per year
- Twenty untreated overflows per year

For example, using Figures 9-2 and 9-3, CSO control alternatives for the New York Avenue outfall, if sized to control all but four overflow events per year, would be sized for 1.61 MG or 52.62 MGD, as appropriate. Storage-based technologies, such as a subsurface storage tank, would be sized to store 1.61 MG, while flow-rate-based technologies, such as screening and disinfection, would be sized to handle 52.62 MGD.

Similarly for SSO areas, flow rates and volumes were determined from the results of the calibrated H&H Model, under several design storms, namely the 2, 5 and 10-year, 24-hour events.

9.3 CSO and SSO Control Alternatives

Outfall-Specific Alternatives

The alternatives evaluated for each outfall included technologies that may reasonably be constructed for a single outfall. As illustrated above in Tables 9-1 and 9-2, the technologies considered were:

- Screening and disinfection (CSO)
- Vortex Separators (CSO)
- Ballasted Flocculation (CSO)
- RTB (CSO)
- Concrete storage tank (CSO and SSO)
- Sewer separation (CSO)

Consolidated Alternatives

The alternatives evaluated for a grouping of nearby outfalls included:

- Screening and disinfection (CSO)

- Vortex Separators (CSO)
- Ballasted Flocculation (CSO)
- RTB (CSO)
- Concrete storage tank (CSO and SSO)
- Sewer separation (CSO)
- Conveyance to WWTP (CSO and SSO)

System-Wide Alternatives

The alternatives evaluated for the entire system of CSO outfalls included:

- Tunnel storage along the Ohio and Beaver Rivers
- Sewer separation

9.4 CSO and SSO Control Alternative Evaluation Process

The CSO Control Alternative Evaluation Process detailed below was applied to the outfall-specific alternatives. The evaluation process utilized various economic, environmental, implementation, and operational "evaluation criteria" – as were used in the technology screening process – and applied "weighting" factors to each criteria. Weighting factors were used to represent the relative importance of each criterion amongst the overall group of criteria. For each outfall / level of control (0, 4, 8, 12 and 20 untreated overflows per year) scenario, the evaluation process consisted of:

- Determining the "Objective Score" of each alternative relative to each criterion, based upon that alternative's ability to meet defined quantitative or qualitative measures.
- Determining the "Weighted Subjective Score" of each alternative relative to each criterion, by applying a specific weighting factor vetted through the RAJSA, CPAC and municipalities.
- Determining the "Alternative Score" of each alternative by summing the "Weighted Subjective Scores" determined for each criterion.
- Determining the "Highest-Ranked Alternative" via a comparison of alternative scores. For each scenario, this was the alternative having the highest "Alternative Score".

This process was repeated for each level of control under which the alternative was to be considered for use. The highest-ranked outfall-specific alternative was accepted independently as the “winner”. If an outfall's highest ranked alternative was sewer separation, this solution was considered the recommended solution, and was not part of the consolidated analysis. Also, since PaDEP required several combined sewersheds to be separated because of their status as sensitive areas, their "highest ranked alternative" may have been discarded, if it was not sewer separation. A similar process was used for the consolidated grouping of outfalls.

Evaluation Criteria

Multiple criteria, divided into Economic, Environmental, Implementation, and Operational categories, were used for assigning “Objective Scores”. These criteria are explained in more detail below.

Economic Impact. The economic impact of each alternative was measured by calculating both the annual O&M cost and the present worth cost.

Annual O&M Cost calculations were based upon technology-specific cost curves obtained from historical cost data for similar projects.

Present worth cost calculations convert life-cycle costs into equivalent annual costs and provide consistent economic comparisons between alternatives. The parameters used in calculating life-cycle costs included:

- Planning interest rate
- Economic lifespan
- Capital costs
- Operation & Maintenance costs

Environmental Impact. The environmental impact of CSO technologies were measured by evaluating the following parameters:

Pollution Reduction for each CSO control alternative under consideration, pollutant removal efficiencies, and maximum possible removals by pollutant type were considered. Pollution indicators and pollutants of concern for this project included:

- CSO volume and frequency of overflow
- Pathogens and coliform bacteria
- Floatables (debris, scum, raw sewage)
- Total suspended solids (TSS)
- Coarse / settleable solids (sand, grit, debris)
- Oxygen demand components (BOD, COD)
- Nuisance components (odor, color)
- Nutrients (phosphates, nitrogen)
- Toxins (heavy metals, hydrocarbons, chlorinated hydrocarbons)

Impact on Habitat, Stream, River, etc. CSO control alternatives were also screened based on permanent operating impacts to the environment, including factors such as:

- Reduction of natural habitat from construction of new facilities in previously undisturbed areas.
- Increase in run-off pollutants and/or stream erosion from new facilities.
- Maximization of visual compatibility, i.e., new facilities blend in with surrounding area or are installed below grade.
- Minimization of visual nuisances, such as floating debris, scum, oil, and grease.
- Minimization of noise and odor.
- Minimization of unsafe conditions due to possible chemical leakage or flooding.
- Minimization of possible unauthorized access that may cause injuries or system failures.
- Discharge to sensitive areas.

Implementation Impact. The implementation impact of CSO control alternatives was measured by evaluating the following parameters:

Constructability parameters consisted of the level of design and construction sophistication of the CSO control technology. The constructability impacts to be minimized included:

- Time required for design and construction
- Level of disturbance to traffic patterns and business activity
- Soil erosion
- Excessive construction noise
- Site security and safety

Land Acquisition parameters were based on the following considerations:
- Availability of land
- Site requirements (relative area required)

Public Acceptance parameters consisted of the relative levels of probable public acceptance based on the following:

- Known / expected responses from community, neighborhood, and business groups
- Citizen responses at public meetings and other forms of media
- Community disruption

Operational Impact. The operational impact of CSO control alternatives was screened by reviewing the following parameters:

Ease of Operation and Maintenance parameters considered the relative operation and maintenance complexity of the control alternative, including safety and accessibility for operators and maintenance crews.

Reliability parameters involved the CSO control alternative's relative reliability, including its historical track record, known maintenance problems, and reported design shortcomings.

Weighting Factors

The scores and metrics described above established relative measures for each criterion with which to rate competing CSO control alternatives. However, the importance of each criterion, relative to all other criteria, varied as well. Some criteria were valued more in the decision-making process than others, and were thus "weighted". Weighting factors were proposed by the Project Team, based upon our experience with other LTCPs and the work being performed in the Pittsburgh area and region. The proposed weighting factors were subsequently vetted through the RAJSA, the CPAC and the municipal/authority boards via the municipal engineers on the Project Team. No comments were received, and the proposed weighting factors were issued as final. The final weighting factors are found below in Table 9-3.

Table 9-3: Weighting Factors

Criteria Group	Criterion	Weight Factor
Economic Factors	Present Worth Cost	30%
Water Quality, Public Health & Environmental Impacts	Overflow volume reduction, bacteria discharge reduction, solids & floatable capture, pollutant control	25%
Public Factors	Community disruption, potential for nuisances (odor, noise), multiple benefit opportunities, environmental justice	20%
Operational Impacts	Ease of operation and maintenance, reliability, O&M consistency	15%
Implementation Impacts	Constructability, ability for expansion, land acquisition	10%
	Total:	**100%**

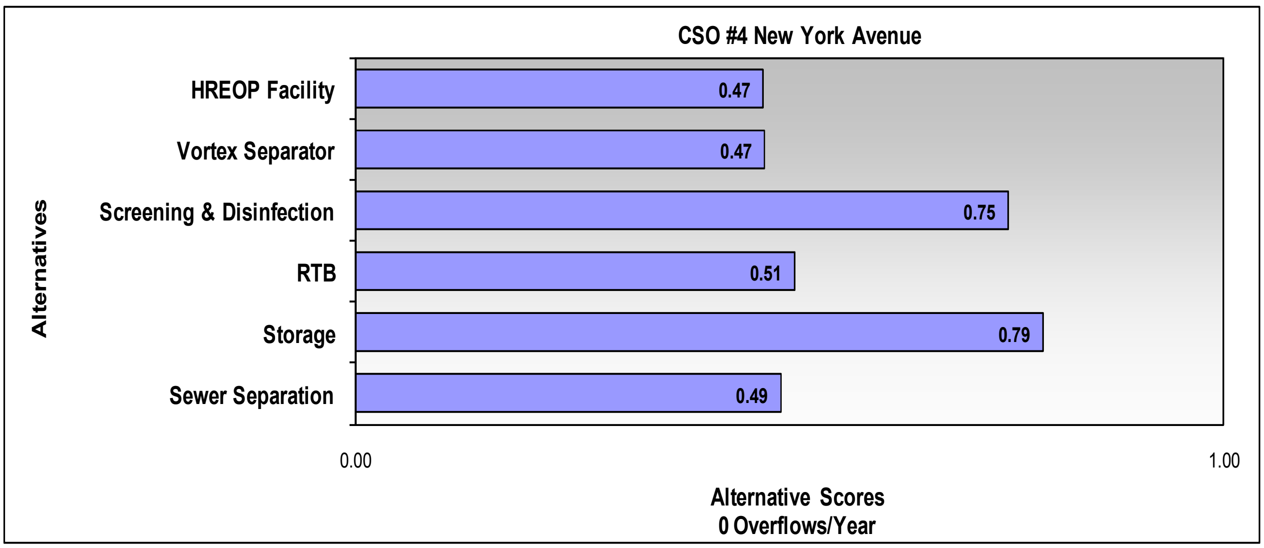
Weighted objective scores were then calculated for each criterion by multiplying them by the weighting criteria.

Alternative Scores / Highest-Ranked Alternative

Following the determination of weighted subjective scores for each CSO control alternative under each scenario, all weighted subjective scores (one for each criterion) were summed. The resulting score, ranging from 0.0 to 1.0, was termed the "Alternative Score". The CSO control alternative with the highest alternative score was deemed the "highest-ranked alternative" for a given outfall and control level.

The results of the comparisons of alternative scores were summarized via bar graphs on Alternative Scoring Sheets. The Alternative Scoring Sheet for the New York Avenue outfall, at a control level of zero untreated overflows per year is presented in Figure 9-4. As the graph shows, a storage facility was the highest ranked alternative for the zero overflow condition for this outfall.

Figure 9-4: Example Alternative Ranking Bar Graph



Similar alternative scoring sheets were generated for all outfalls. Complete sets of alternative scoring sheets may be found in Appendix C.

9.5 CSO and SSO Control Alternative Evaluation Costs

Costs for CSO Control Technologies were based upon local, regional and national planning-level costs.

Three primary cost calculations were used:

- Capital Costs
- Annual O & M Costs
- Present Worth Costs

Capital Costs

Capital costs, loosely defined, include all costs incurred during the complete design and construction of the component facilities. For the purposes of this study, they were further defined as the combination of construction costs, site restoration costs, land costs, and non-construction costs associated with construction permitting, engineering design, legal requirements, bonds, insurance, and contingencies.

Planning-level opinions of probable capital costs for CSO control alternative components were based on information obtained from completed projects, actual contractor bids, or engineer estimates obtained from the design and/or construction of similar control technologies by various municipal entities locally, regionally and nationally. The planning-level costs were considered accurate to -30% to +50%.

All capital costs were adjusted to the December 2010 ENR Cost Index to standardize the analysis. Cost information for each component was then summarized and plotted against a defining parameter, such as pipe diameter, maximum volume, peak flow rate, etc. The resulting equation of the “best fit line” for each component was then used to estimate the cost of that component whenever it was included in a CSO control alternative. Cost data were available for the following items:

- General construction activities
- Open-cut pipe construction activities
- Regulator modification / replacement activities
- Pump station construction activities
- Storage facility construction activities
- Treatment facility construction activities

Operations & Maintenance (O&M) Costs

Annual O&M costs are defined as the expenses related to labor, maintenance supplies, replacement equipment, and consumable materials in a given year. The calculated O&M costs for CSO control alternatives were adapted to account for periodic operations, such as facility inspections and clean-ups after storm events, but also included minimal full-time staffing between events. O&M costs were typically functions of the design flow rate (in MGD) or volume (MG) and the duration time (in hours per year) that the facility was in operation.

Planning-level opinions of probable O&M costs of CSO control alternatives were based on actual facility operating expenses, when available, for similar control alternatives. All costs included expenses for labor, maintenance, repairs, consumable materials, and ancillary expenses. Cost information for each alternative was then plotted against its associated flow rate (MGD), volume (MG) or hours of operation. The resulting equation of the "best fit line" for each alternative was then used to estimate the annual O&M cost of that alternative.

Costs were then adjusted to the December 2010 ENR Cost Index to standardize the analysis.

Present Worth Analysis

Total Present Worth (TPW) is defined as the sum of the present worth values of the capital and the O&M costs. Calculating the present worth of all values takes into account the time-value of money by applying the following economic factors:

- Planning Interest Rate – an interest rate of 6% was used.

- Economic Life of Capital Expenditures - The assigned service life for each component was based on EPA cost-effectiveness guidelines. They were:

Wastewater Conveyance Structures	70 years
Storage Structures	50 years
Other Structures	50 years
Process Equipment	20 years
Supplementary (mechanical, electrical, I&C, etc.) Equipment	20 years

For the purposes of this analysis, the planning period was 2017 to 2037 (20 years), so replacement costs were not factored into the present worth analysis.

Comparison of TPW between alternatives allowed for consistent economic comparisons to be made, with the alternative having the lowest TPW being the most “economic” alternative over its life span.

9.6 Alternative Evaluation Results

This section of the report summarizes the results of the alternative evaluations and presents the winning alternatives for each evaluation category.

Outfall-Specific Alternatives

The application of the process discussed above resulted in the identification of the "highest ranked alternative" for each of the outfalls in the RAJSA system. Tables 9-4 and 9-5 below lists the highest ranked alternatives corresponding to the various levels of control.

The outfall-specific analysis was performed for the following outfalls:

- Bachelor Street CSO
- Deer Lane CSO
- West Madison Street CSO
- New York Avenue CSO
- Virginia Avenue CSO

- Case Street CSO
- Freedom Lift Station SSO
- Center Street SSO

Table 9-4: Highest Ranked Alternative for CSOs for Outfall-Specific Evaluation

	Level of Control - # of Untreated CSOs/year				
Location/CSO	**0**	**4**	**8**	**12**	**20**
Bachelor Street CSO	Complete Sewer Separation	Complete Sewer Separation	Complete Sewer Separation	Complete Sewer Separation	Complete Sewer Separation
Deer Lane CSO	Complete Sewer Separation	Complete Sewer Separation	Complete Sewer Separation	Complete Sewer Separation	Complete Sewer Separation
West Madison St. CSO	Storage Tank	Storage Tank	Storage Tank	Storage Tank	Storage Tank
New York Avenue CSO	Storage Tank	Storage Tank	Storage Tank	Storage Tank	Storage Tank
Virginia Avenue CSO	Complete Sewer Separation	Complete Sewer Separation	Complete Sewer Separation	Complete Sewer Separation	Complete Sewer Separation
Case Street CSO	Complete Sewer Separation	Complete Sewer Separation	Complete Sewer Separation	N/A	N/A

Table 9-5: Highest Ranked Alternative for SSOs for Outfall-Specific Evaluation

Level of Control - Design Storm Return Period (yr.)			
Location/SSO	**2**	**5**	**10**
Freedom Lift Station	Storage Tank	Storage Tank	Storage Tank
Center Street Lift Station	Storage Tank	Storage Tank	Storage Tank

Evaluation reports for the outfall-specific alternatives are included in Appendix C of this report. As previously mentioned, the Bachelor Street CSO and the Deer Lane CSO were considered to be upstream of a sensitive area (Beaver River boat docks), and were required to be separated per PaDEP. As such, their highest ranked alternatives are sewer separation for all control levels.

The highest ranked alternatives for the outfall-specific evaluation are shown graphically in Figure 9-5.

Consolidated Alternatives

Following completion of the outfall-specific evaluation, the Project Team commenced the consolidated evaluation. The purpose of the consolidated evaluation was to determine if there was a cost savings or greater economies of scale by combining or "consolidating" more than one outfall. Consolidation of outfalls has various pros and cons. Pros include:

- Only 1 site required for the facility
- Potential cost savings from "economy of scale"
- O&M consolidated at one location or less locations

Cons include:

- Larger footprint required for the facility
- Additional piping and facilities upgrades may be required to convey the flow to consolidated facility
- Larger facility may be more difficult to operate and maintain
- Distance between outfalls may make it more expensive to consolidate

Following a review of the outfall-specific solutions and the layout of the RAJSA system, it became apparent that mass consolidation of outfalls was not possible or feasible. However, the following outfalls were consolidated for analysis:

- West Madison Street CSO and New York Avenue CSO at a site near the WWTP
- Freedom Lift Station SSO and Center Street SSO at a site near the WWTP

Using the same evaluation process, the highest ranked alternative was determined for the two consolidated outfalls. The results are presented in Tables 9-6 and 9-7 below:

Figure 9-5: Highest Ranked Outfall-Specific Alternatives *(base mapping source: Pennsylvania Spatial Data Access and AirPhoto USA Imagery 2007)*

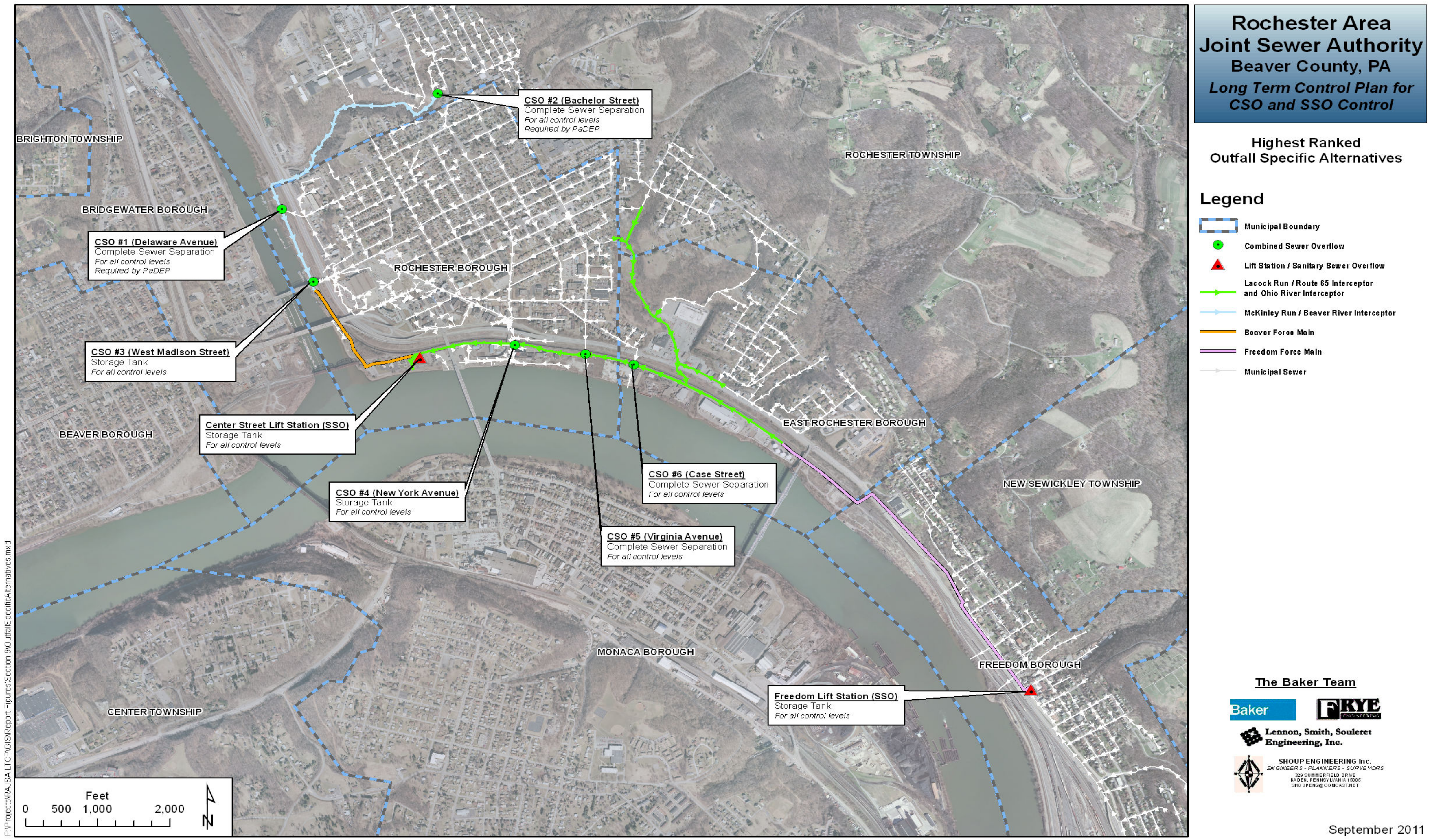


Table 9-6: Highest Ranked Alternative for CSOs for Consolidated Evaluation

	Level of Control - # of Untreated CSOs/year				
CSOs	0	4	8	12	20
West Madison St. CSO and New York Ave. CSO	Screening and Disinfection Facility	Screening and Disinfection Facility	Screening and Disinfection Facility	Storage Tank	Storage Tank
Freedom Lift Station and Center Street Lift Station	Storage Tank	Storage Tank	Storage Tank	Storage Tank	Storage Tank

Table 9-7: Highest Ranked Alternative for SSOs for Consolidated Evaluation

Level of Control - Design Storm Return Period (yr.)			
SSOs	2	5	10
Freedom Lift Station and Center Street Lift Station	Storage Tank	Storage Tank	Storage Tank

The highest ranked alternatives for the consolidated evaluation are shown graphically in Figure 9-6.

System-Wide Alternatives

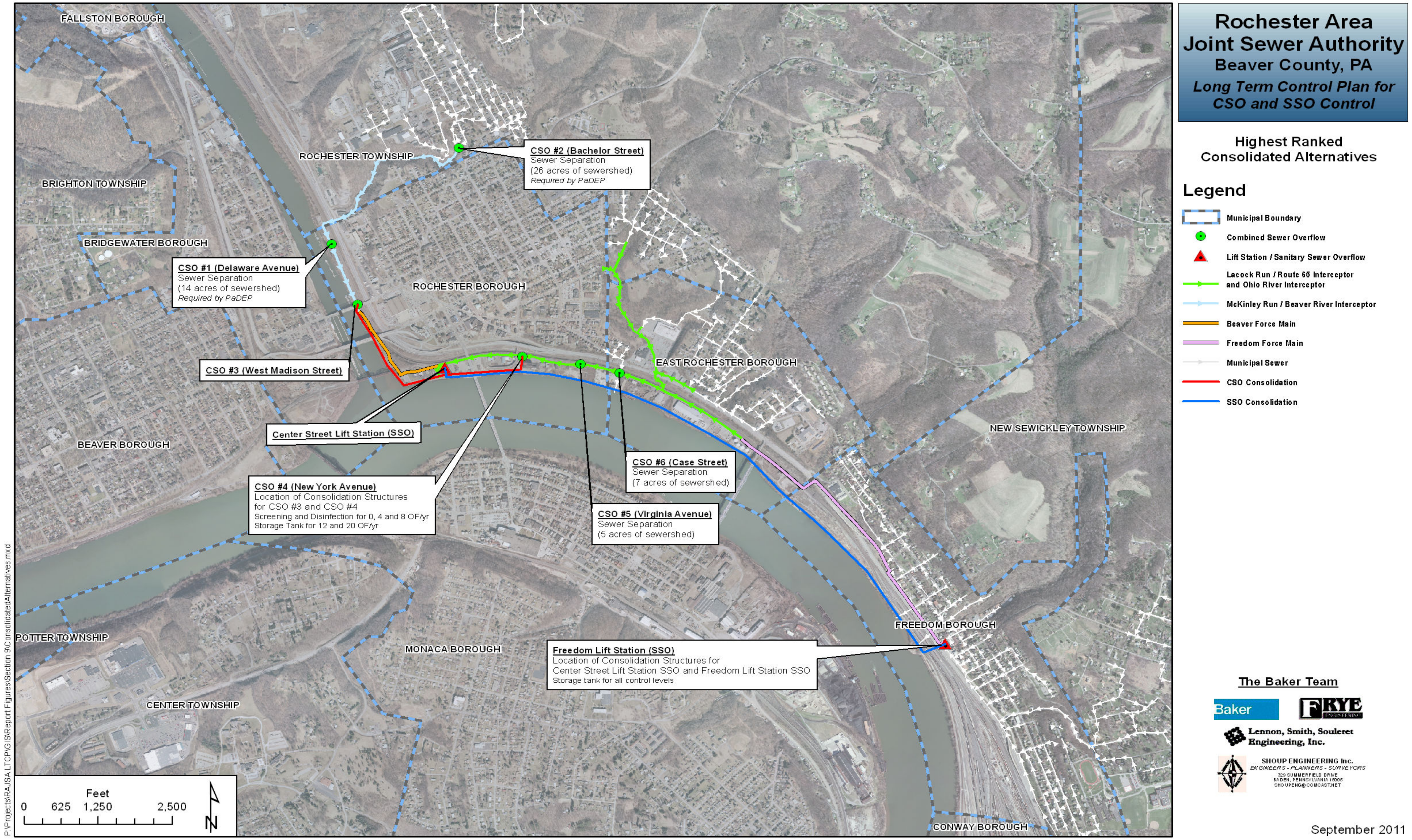
Following completion of the consolidated alternatives evaluation, the Project Team commenced the system-wide evaluation. The two surviving technologies for a system-wide application included:

- Tunnel storage; and
- Sewer Separation

Table 9-8: Highest Ranked Alternative for CSOs for System-Wide Evaluation

	Level of Control - # of Untreated CSOs/year				
CSOs	0	4	8	12	20
System-Wide	Sewer Separation	Sewer Separation	Sewer Separation	Sewer Separation	Sewer Separation

Figure 9-6: Highest Ranked Consolidated Alternatives *(base mapping source: Pennsylvania Spatial Data Access and AirPhoto USA Imagery 2007)*



The highest ranked alternatives for the system-wide evaluation are shown graphically in Figure 9-7.

Listed below is the costs associated with each of the evaluations for the CSOs based on the scenario of 4 untreated overflows per year. Note that costs were developed for all control levels and are available in Appendix C of this report.

Table 9-9: Capital, O&M and Present Worth Costs for CSO Outfall-Specific Evaluation (4 OF/yr)

	Outfall-Specific Highest Ranked Alternative (4 ov/yr)			
Location	Technology	Capital Cost	Annual O&M Cost	Present Worth Cost
Bachelor Street CSO	Sewer Separation	$1,517,000	$0	$1,517,000
Deer Lane CSO	Sewer Separation	$1,327,000	$0	$1,327,000
West Madison CSO	Storage Tank	$3,131,400	$683,300	$3,814,700
NY Avenue CSO	Storage Tank	$8,724,200	$768,600	$9,492,800
Virginia Ave. CSO	Sewer Separation	$474,000	$0	$474,000
Case Street CSO	Sewer Separation	$664,000	$0	$664,000
	Totals	**$15,837,600**	**$1,451,900**	**$17,289,500**

Figure 9-7: Highest Ranked System-Wide Alternatives *(base mapping source: Pennsylvania Spatial Data Access and AirPhoto USA Imagery 2007)*

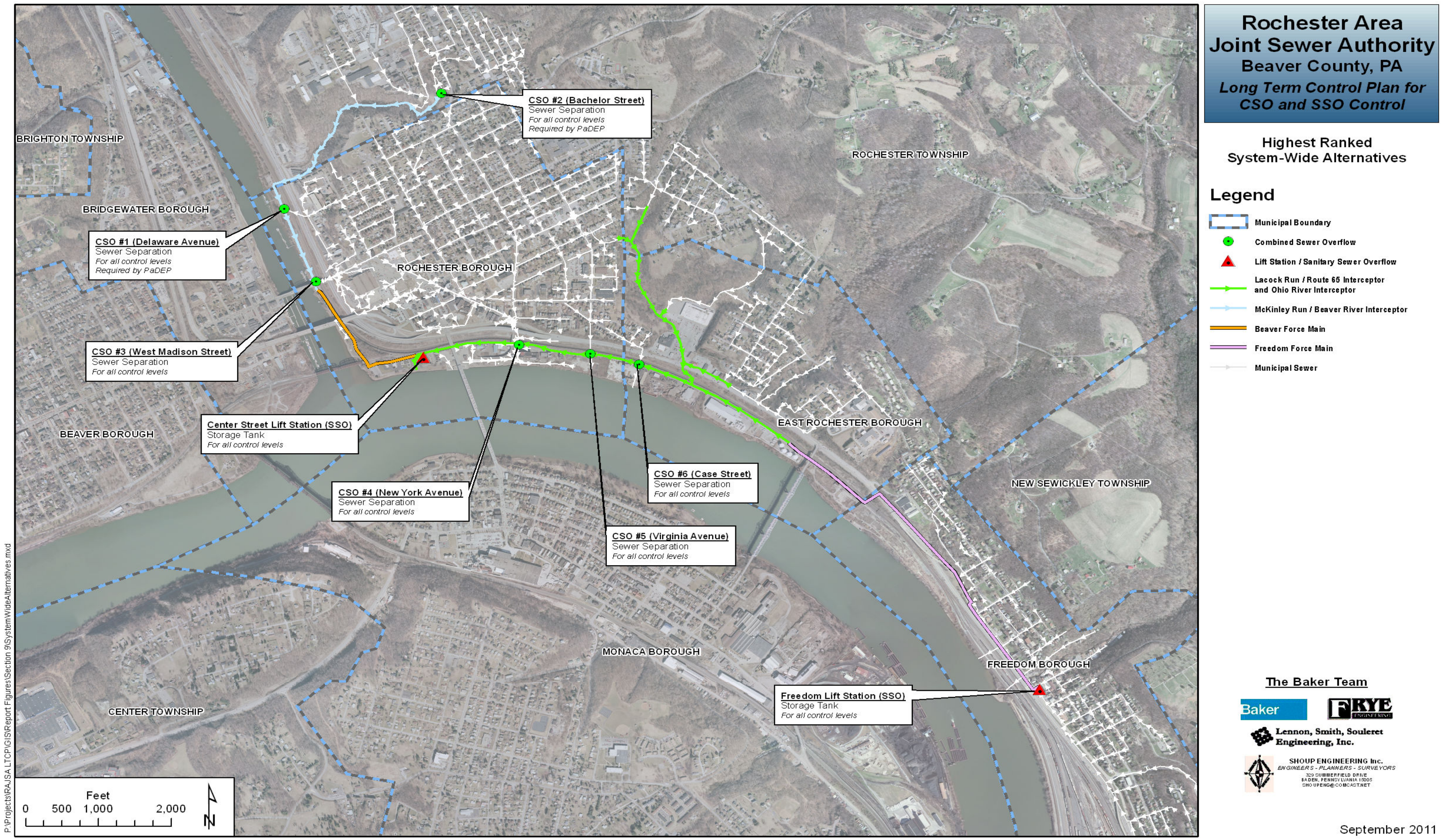


Table 9-10: Capital, O&M and Present Worth Costs for CSO Consolidated Evaluation (4 OF/yr)

	Consolidated Highest Ranked Alternative (4 ov/yr)			
Location	Winning Alternative	Capital Cost	Annual O&M Cost	Present Worth Cost
Bachelor Street CSO	Sewer Separation	$1,517,000	$0	$1,517,000
Deer Lane CSO	Sewer Separation	$1,327,000	$0	$1,327,000
West Madison CSO and NY Avenue CSO	Screening and Disinfection Facility	$15,209,794	$2,133,043	$17,342,837
Virginia Ave. CSO	Sewer Separation	$474,000	$0	$474,000
Case Street CSO	Sewer Separation	$664,000	$0	$664,000
	Totals	**$19,191,794**	**$2,133,043**	**$21,324,837**

Costs generally increased for the consolidated alternative evaluation due to the significant expenditures that would be required to convey the flow to a common facility at the WWTP. Additional large diameter piping and pumps would be required in this scenario.

Table 9-11: Capital, O&M and Present Worth Costs for CSO System-Wide Evaluation (4 OF/yr)

System-Wide Highest Ranked Alternative (4 ov/yr)			
Winning Alternative	Capital Cost	Annual O&M Cost	Present Worth Cost
All - Sewer Separation	$23,224,320	$0	$23,224,320
Totals	**$23,224,320**	**$0**	**$23,224,320**

Table 9-12: Capital, O&M and Present Worth Costs for SSO Outfall-Specific Evaluation for 2, 5 and 10-Year Design Storms

	2-Year Design Storm			
Location	Winning Alternative	Capital Cost	Annual O&M Cost	Present Worth Cost
Freedom Lift Station	Storage Tank	$2,840,000	$680,000	$3,520,000
Center Street Lift Station	Storage Tank	$4,459,200	$702,000	$5,161,200
	Totals	**$7,299,200**	**$1,382,000**	**$8,681,200**

	5-Year Design Storm			
Location	Winning Alternative	Capital Cost	Annual O&M Cost	Present Worth Cost
Freedom Lift Station	Storage Tank	$3,491,500	$688,400	$4,179,900
Center Street Lift Station	Storage Tank	$5,319,700	$714,200	$6,033,900
	Totals	**$8,811,200**	**$1,402,600**	**$10,213,800**

	10-Year Design Storm			
Location	Winning Alternative	Capital Cost	Annual O&M Cost	Present Worth Cost
Freedom Lift Station	Storage Tank	$4,455,400	$702,000	$5,157,400
Center Street Lift Station	Storage Tank	$5,990,000	$724,400	$6,714,400
	Totals	**$10,445,400**	**$1,426,400**	**$11,871,800**

Table 9-13: Capital, O&M and Present Worth Costs for SSO Consolidated Evaluation for 2, 5 and 10-Year Design Storms

	2-Year Design Storm			
Location	Winning Alternative	Capital Cost	Annual O&M Cost	Present Worth Cost
Center Street Lift Station and Freedom Lift Station Consolidated	Storage Tank	$10,307,000	$1,124,200	$11,431,200
	Totals	**$10,307,000**	**$1,124,200**	**$11,431,200**

	5-Year Design Storm			
Location	Winning Alternative	Capital Cost	Annual O&M Cost	Present Worth Cost
Center Street Lift Station and Freedom Lift Station Consolidated	Storage Tank	$11,667,800	$1,146,000	$12,813,800
	Totals	**$11,667,800**	**$1,146,000**	**$12,813,800**

	10-Year Design Storm			
Location	Winning Alternative	Capital Cost	Annual O&M Cost	Present Worth Cost
Center Street Lift Station and Freedom Lift Station Consolidated	Storage Tank	$13,109,200	$1,169,000	$14,278,200
	Totals	**$13,109,200**	**$1,169,000**	**$14,278,200**

Costs generally increased for the consolidated alternative evaluation due to the significant expenditures that would be required to convey the flow to a common facility at the WWTP. Additional large diameter piping and pumping station upgrades would be required in this scenario.

9.7 85% Capture Evaluation and Results

Following the analysis of the outfall-specific, consolidated and system-wide alternatives, the Project Team proceeded with the 85% capture analysis, which was the final analysis performed as part of the alternatives development. It had been determined through earlier analysis that storage tanks would be required at the West Madison Avenue CSO, New York Avenue CSO and the Freedom Lift Station SSO. The final step was to use the concept of 85% capture to size the storage facilities at the two CSO locations.

One of three possible criteria within the "Presumption Approach" in EPA's CSO Policy is to provide "…the capture for treatment of no less than 85% by volume of the combined sewage collected in the combined sewer system during precipitation events on a system-wide annual average basis."

The criteria refers specifically to the volume captured during "precipitation periods". This includes the dry weather flow during the wet-weather period as part of the captured flow. The Project Team used the Typical Year (2003) hydraulic model to identify periods of wet-weather. The analysis focused only on the combined sewer systems within the RAJSA system. In general, the approach used by the Project Team for the 85% capture analysis included:

- Review of time series of flows into the CSO structure and from the CSO into the interceptor for a 1-year period;
- Review of the time series of precipitation for the same 1-year period; this was used to identify the wet weather days;
- The flow to the interceptor represented "Flow Captured During Wet Weather". This flow divided by the total flow to each CSO resulted in the "Capture Percentage".

The above analysis yielded a capture percentage for the existing system for the Typical Year Model (2003) of 52.19%. Results of the 85% capture analysis is included in Appendix D.

During the project planning meeting held with PaDEP on July 17, 2009, it was agreed that the RAJSA could take credit in their 85% capture analysis for the completed sewer separation projects at East Washington Street and Hull Street in Rochester Borough and 6th and 7th Streets in Freedom Borough. The assumption is that the total flows tributary to these CSOs were considered to be 100% captured as a result of the separation. The proposed separation projects at Bachelor Street, Deer Lane, Virginia Avenue and Case Street were also considered separated in the final analysis. Taking credit for the past and proposed separation projects caused the capture percentage to marginally increase from 52.19% to 58.83%, which was expected because the sewersheds of the separated areas were small in relation to the entire combined sewer system sewershed.

In order to obtain the 85% capture requirement, the Project Team, by trial and error using the hydraulic model, developed several scenarios of capturing additional wet weather flow at the West Madison Street and New York Avenue storage facilities. Scenarios considered were providing full capture at the West Madison CSO and the separated areas and no control at the New York Avenue CSO. This resulted in an overall capture of 69%, which was well below the requirement. Conversely, another scenario considered was providing full capture at the New

York Avenue CSO and the separated areas and no control at the West Madison Street CSO. This resulted in an overall capture of 90%, which exceeded the 85% requirement. It became clear that reducing the size of the facilities at the New York Avenue and/or West Madison Street would provide the required capture. The Project Team calculated the resultant capture percentage of various combinations of storage tank sizes at these locations using the hydraulic model. Several factors were considered during this iterative process. First, there was more available facility space near the West Madison CSO than the New York Avenue CSO, and second, the flow and volume at the New York Avenue CSO was significantly higher than the West Madison CSO during the typical year.

The final analysis resulted in the West Madison storage tank being sized to allow zero (0) untreated overflows per year. The New York Avenue storage tank was subsequently designed to provide the required 85% system-wide capture rate. Table 9-14 below summarizes the results of the 85% capture analysis for the two combined sewersheds:

Table 9-14: 85% Capture Analysis Results and Costs

Location	CSO Control Alternative	Control Level for 85% Cap.	Size	Capital Cost	Annual O&M Cost	Present Worth Cost
West Madison Street CSO	Storage Tank	0 overflows per year	600,000 gal	$3,873,200	$695,000	$4,568,200
New York Avenue CSO	Storage Tank	Approx. 22 overflows per year (by vol.)	600,000 gal	$3,873,200	$695,000	$4,568,200

9.8 WWTP Upgrade Alternative

The final component of the RAJSA system that needed to be addressed was the resultant flow and volume as a result of the controls proposed in the 85% capture analysis. With the sewer separation at Bachelor Street, Deer Lane, Virginia Avenue, Case Street, East Washington Street, Hull Street, 6th and 7th Streets, and storage facilities at West Madison Street and New York Avenue, there was additional wet weather flow and volume being contributed to the RAJSA interceptor system and WWTP. This is flow that would have existed the system through the CSOs. It is understood that sewer separation does not result in a leak-proof system and that RDII will still occur. The Project Team used post-separation monitoring information as well as RTK information from the ALCOSAN service area to simulate the resultant flow from the separated areas (both existing and proposed). Currently, the WWTP has a capacity of approximately 1.4 MGD and a maximum permitted wet weather flow of 2.25 MGD. It was expected that enhancements to both the WWTP and Center Street Lift Station would be required to handle this additional wet weather flow. Also, the Center Street SSO, located at the Center Street Lift Station, required a substantial storage facility as determined during the outfall-specific alternative analysis. It was expected that any improvements at the WWTP and lift station would be sized sufficiently to eliminate the Center Street SSO.

The hydraulic model was utilized to determine the flow and volume at the WWTP with the final alternatives in place. Time series hydrographs were developed for the 2, 5 and 10-year summer design storms (24-hour maximum) occurring in the separate portions of the system and the typical year in the combined portion of the system at the WWTP. These hydrographs are shown below in Figures 9-6, 9-7 and 9-8.

Figure 9-8: 2-Year Hydrograph at the RAJSA WWTP

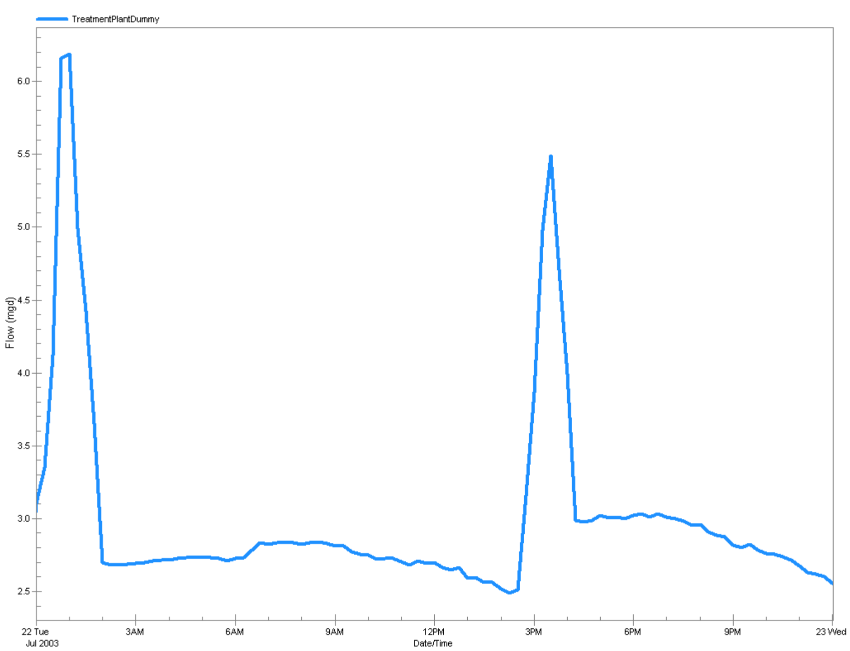


Figure 9-9: 5-Year Hydrograph at the RAJSA WWTP

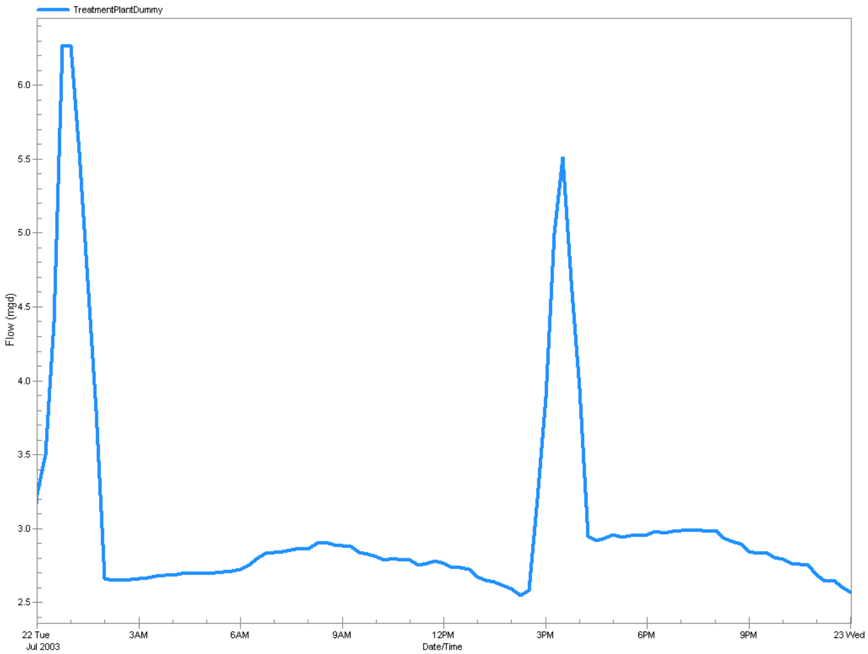
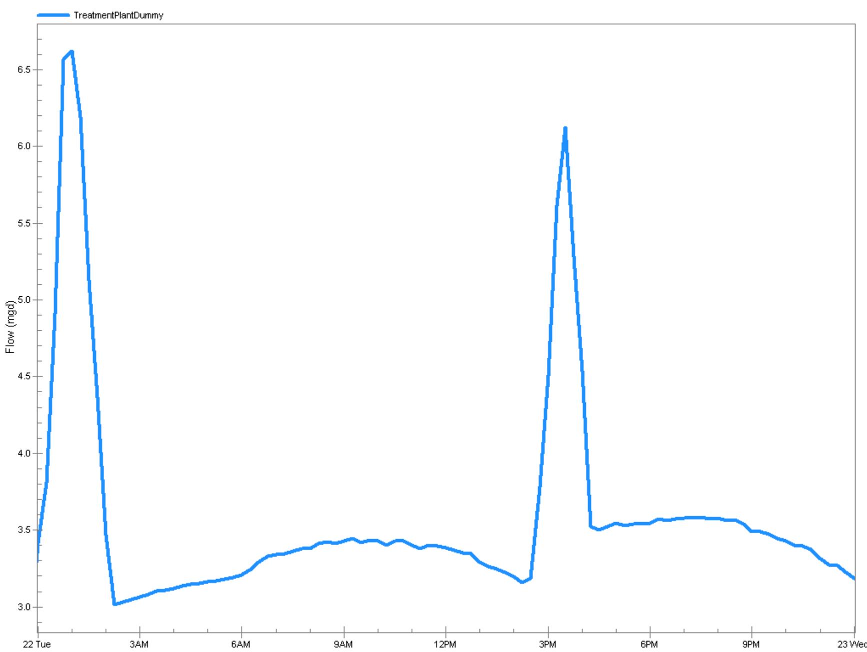


Figure 9-10: 10-Year Hydrograph at the RAJSA WWTP



As shown on the hydrographs, the following are the resultant flows and volumes to the WWTP from the model:

Table 9-15: Resultant Flow and Volume to WWTP

	2-Year	5-Year	10-Year
Max. Flow	6.19 MGD	6.27 MGD	6.62 MGD
Total Volume	3.02 MG	3.05 MG	3.6 MG

The final alternative evaluation involved the comparison of upgrading the existing WWTP to treat the flow or store the volume from the various storms and release it back into the WWTP after the event recedes. As shown in Table 9-15, the storage tanks required a significant volume for the various design storms.

The Project Team reviewed the existing WWTP components and treatment processes and determined that the following enhancements would be required at the plant to accommodate the increased flows.

- Construction of two (2) new clarifiers;
- Demolition of the existing chlorine contact tank;
- Installation of UV disinfection;
- Installation of air lift pumps with blowers for use in the existing and proposed clarifiers;
- Upgrade the pumping capacity at the Center Street Lift Station; and the
- Replacement of the existing belt filter press

The costs of the WWTP upgrade alternative are included in Table 9-16 below. As shown, it is significantly less expensive to upgrade the WWTP as opposed to constructing a storage tank. The highest ranked alternatives for the 85% capture evaluation are shown graphically in Figure 9-11.

Figure 9-11: Highest Ranked 85% Capture Alternatives *(base mapping source: Pennsylvania Spatial Data Access and AirPhoto USA Imagery 2007)*

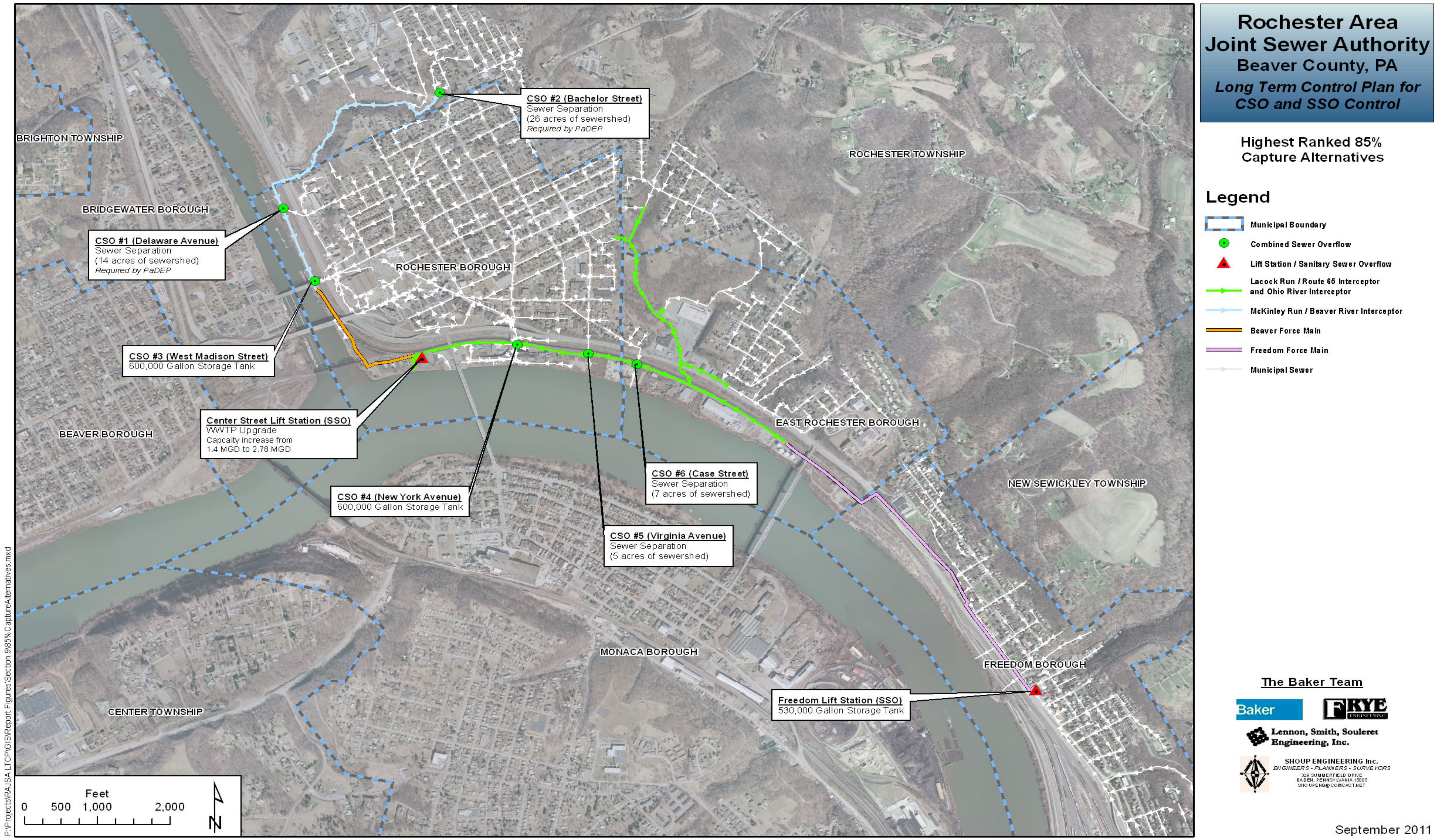


Table 9-16: Costs for the WWTP Alternative

	2-Year			5-Year			10-Year		
	Capital Cost ($)	O&M Cost ($)	Present Worth Cost ($)	Capital Cost ($)	O&M Cost ($)	Present Worth Cost ($)	Capital Cost ($)	O&M Cost ($)	Present Worth Cost ($)
Storage Tank	14,716,800	910,400	15,627,200	14,884,400	915,200	15,799,600	17,099,500	985,000	18,084,500
WWTP Upgrade	$5,290,000	$20,900	$5,310,900	$5,330,000	$21,000	$5,351,000	$6,000,000	$25,000	$6,025,000

9.9 Preliminary Siting Analysis

One of the key considerations in assessing the overall feasibility of a CSO or SSO control alternative is the identification of an appropriate site. The objective of the preliminary siting analysis was to identify potential locations for the various facilities identified based on sizing procedures.

The Project Team utilized the following criteria to screen potential sites:

- Availability of sufficient space for the facility on the site
- Distance of the site from CSO and SSO outfalls to be controlled

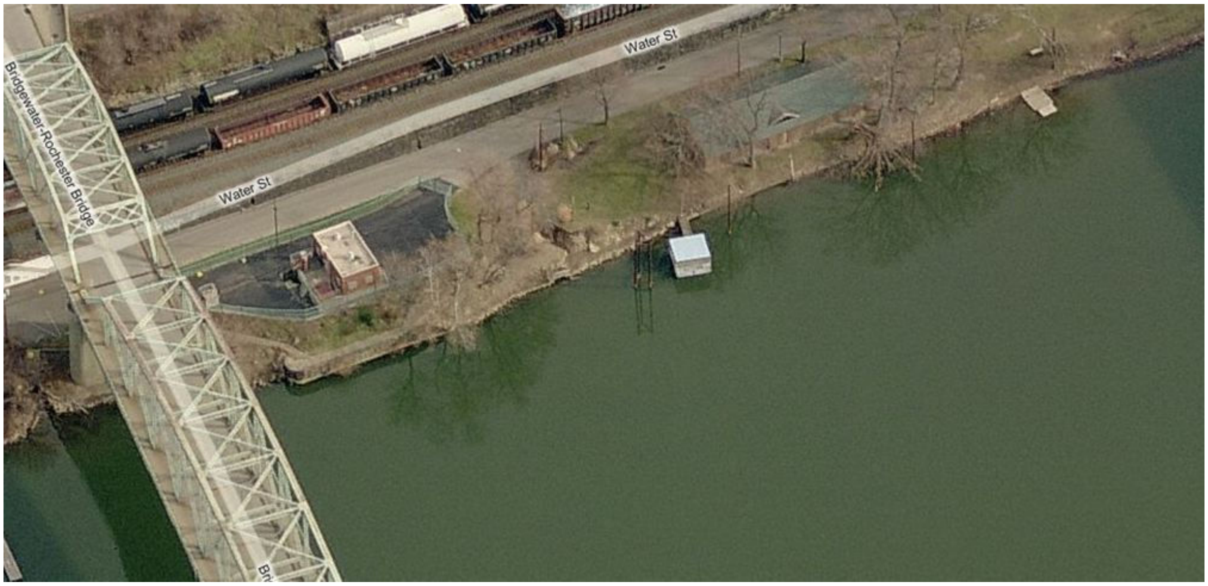
The Project Team utilized available mapping, aerial photographs and local knowledge of the area surrounding the outfalls to identify potential sites for facilities. Sizing of the facilities was determined via procedures detailed in the *Technical Parameters for CSO and SSO Alternatives*

Analysis Technical Memorandum located in Appendix B of this report. For the various treatment and storage facilities, algorithms were developed to provide the area for tanks, screens, disinfection, control buildings, dewatering, pumping stations, etc.. The algorithms used flow rates to size the treatment facilities and volumes to size the storage facilities, in accordance with standard practice. The Project Team performed cursory field investigations to verify the accuracy of the available mapping.

The preliminary siting analysis resulted in the identification of the following sites for CSO and SSO control:

- West Madison CSO storage facility - there appears to be sufficient space located to the south of the existing West Madison Lift Station along the Beaver River. The property is owned by RAJSA and Rochester Borough. The parcel numbers are 46-001-2118.001 and 46-001-2118.000 respectively. The RAJSA parcel is 0.33 acres and has an assessed market value of $10,900, according to the Beaver County Assessment records. The Rochester Borough parcel is 0.67 acres and has an assessed market value of $2,900. The site is bounded by Water Street to the east, the West Madison Lift Station to the north, vacant property to the south and the Beaver River to the west. It appears that the control facility would be span the property boundary between these two parcels or may be able to be placed on either parcel. Figure 9-9 below shows the two parcels investigated for this CSO facility.

Figure 9-12: West Madison Street CSO Facility Siting *(source: Bing Mapping)*

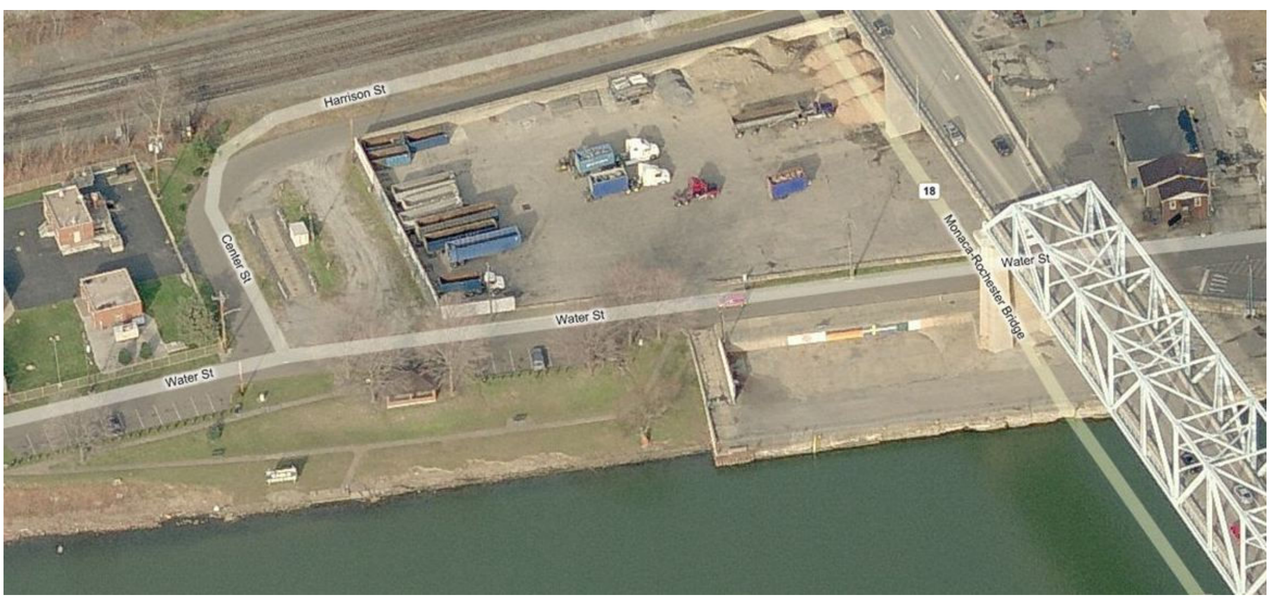


RAJSA/Rochester Borough Property Adjacent to W. Madison St. Lift Station

- New York Avenue CSO storage facility - there appears to be sufficient space located to the south of New York Avenue near the existing Beaver Valley Bowl along the Ohio River. The property is owned by Rochester Borough. The parcel number is 49-001-1908.001. The parcel is 0.90 acres and has an assessed market value of $19,600. The site is bounded by existing buildings to the east, the Beaver Valley Bowl Building to the north, the Ohio River to the south and the Rochester Riverfront Park to the west. The Project Team also investigated an alternate site located to the east of the RAJSA WWTP site, west of Lewis Way on property owned by Rochester Borough. The parcel number is 49-002-1029.000. The parcel is 0.76 acres and has an assessed market value of $37,600. This site would require consolidated piping to convey the flow from the New York Avenue CSO to the site. Approximately 1,200 feet of sewer along Harrison Street would be required. Figure 9-10 below shows the two parcels investigated for this CSO facility.

Figure 9-13: New York Avenue CSO Facility Siting *(source: Bing Mapping)*

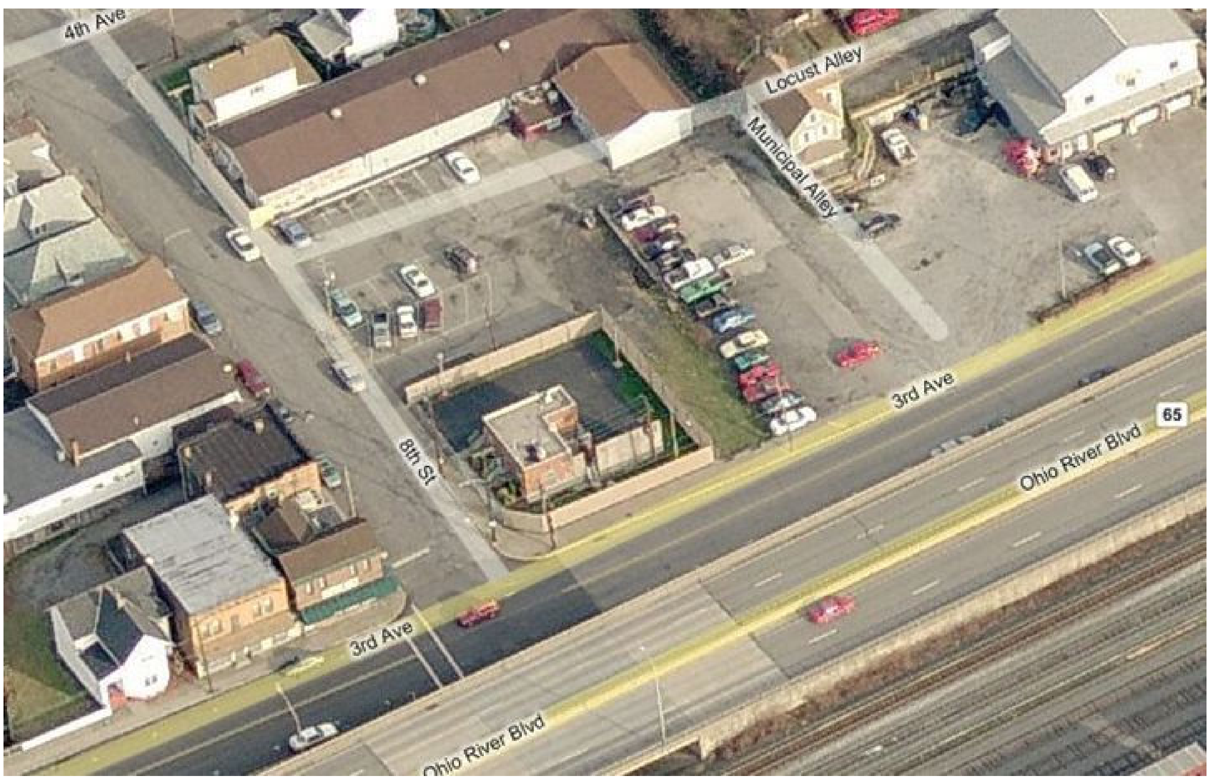
Beaver Valley Bowl Site Adjacent to the New York Avenue CSO



Harrison Street Site Adjacent to the RAJSA WWTP

- Freedom Lift Station SSO storage facility - there appears to be sufficient space located to the northeast or east of the existing Freedom Lift Station, upstream of the lift station. There are several owners of the property in this location. They include Freedom Borough, RAJSA and the Freedom Business District. The parcel numbers are 26-001-0601.000, 26-001-0602.000 and 26-001-0603.000 respectively. The Freedom Borough parcel is 0.04 acres and has an assessed market value of $3,500. The RAJSA parcel is 0.15 acres and has an assessed market value of $67,700. The Freedom Business District parcel is 0.07 acres and has an assessed market value of $4,600. The site is bounded by existing parking to the east and north, 3rd Avenue to the south and the 8th Street to the west. Figure 9-11 below shows the three parcels investigated for this SSO facility. It is important to note that due to site constraints at this location, it does not appear that it will be feasible to construct a storage facility to capture the 10-year design storm. This would require acquisition of private property to the south of the lift station. As such, further analysis will focus on the 5-year design storm.

Figure 9-14: Freedom Lift Station SSO Facility Siting *(source: Bing Mapping)*



Freedom Lift Station Site Adjacent to the Freedom Lift Station

- WWTP Upgrade Alternative - there appears to be sufficient space located on the site of the existing WWTP to accommodate the proposed enhancements required for wet weather control. The existing WWTP is located on property owned by the RAJSA on parcel 49-002-1001.000. The parcel is 2.21 acres and has an assessed market value of $1,750,400. The site is bounded by Center Street to the east, railroad tracks to the north, Water Street and the Ohio River to the south and the Rochester Riverfront Park to the west. Figure 9-12 below shows the RAJSA WWTP parcel investigated for this upgrade.

Figure 9-15: WWTP Upgrade Facility Siting *(source: Bing Mapping)*

RAJSA WWTP Site Adjacent to the Ohio River

9.10 Final Alternatives

Based upon the analysis above, the recommended alternatives and the estimated capital costs for the RAJSA LTCP include:

Separate the Bachelor Street Sewershed	$1,517,000
Separate the Deer Lane Sewershed	$1,327,000
Separate the Virginia Avenue Sewershed	$474,000
Separate the Case Street Sewershed	$664,000
Construct a 0.60 MG storage tank near the W. Madison St. CSO	$3,873,200
Construct a 0.60 MG storage tank near the NY Avenue CSO	$3,873,200
Construct a 0.53 MG storage tank near the Freedom Lift Station SSO (5-yr control*)	$3,491,500
Upgrade the existing WWTP to accommodate additional wet weather flow	$6,000,000
Total Capital Cost	**$21,220,000**

* based upon available space at the Freedom Lift Station site (if control level is permitted by PaDEP)

10.0 Affordability Analysis and User Rate Analysis

10.1 Purpose

The purpose of the affordability analysis and user cost analysis is to determine the financial impacts on the users of the RAJSA system based upon the recommendations provided in this LTCP using CSO Guidance for Financial Capability and Assessment and Schedule Development. The User Cost Analysis contained in this section is based upon several funding sources, anticipated project costs, existing RAJSA customer counts and anticipated annual operation and maintenance costs. It is important to note that the calculated user rates are based upon the existing Service Agreement between the RAJSA and the municipalities, which provides for a uniform rate throughout the service area. It is beyond the scope of this study to review and/or recommend other payment structures or rates.

10.2 Background

As discussed in Chapter 9, the selected alternative consists of several components. Sewer separation projects are proposed for three of the combined sewer overflows (CSOs) in Rochester Borough and East Rochester. These projects are underway at this writing. The user rate analysis will assume that these separation projects are complete and reflect the same. The remaining projects including three storage tanks and treatment plant upgrades have a total project cost of $17,237,900 and associated additional annual operation and maintenance costs. There are several funding sources available for consideration of funding of these costs discussed below.

The Pennsylvania Infrastructure Investment Authority (Pennvest) offers low interest loans and grants through a state revolving fund. Source of funding includes both state and federal funds. Projects are awarded based a ranking system and funding offers are made based on financial need. Terms include interest rates are generally either 1% or county cap rates (currently a blended 3.27% rate for Beaver County), loan term of 20 or 30 years. Limited grant funds are awarded based financial need utilizing an annual sewer bill target rate of 1.5% of the median household income (MHI).

The United States Department of Agriculture Rural Utilities Service (RUS) offers a grant and loan program for water and wastewater projects. Based on 2000 Census data, the region would qualify for the poverty level which offers the lowest interest rate available (2.5% at this writing, revised quarterly) and up to 75% grant funding. The term on RUS loans is 40 years. Although the project qualifies for 75% grant funding, this value is more than the annual grant allocation to RUS for the entire state. Further RUS grant allocations are generally committed to projects for the next five to seven years. This varies and could be as short as two years, however, due to the current finite schedule set forth in the Consent Order and Agreement (COA), waiting for grant funding to become available does not appear to be an option.

An additional option for funding would be a traditional bond issue. Although this option does not have the same requirements associated with utilization of state and federal funds, the terms do not compare as well. A 30 year term and 5.5% interest rate is utilized in this analysis based on recent information, however, rates and terms are highly volatile in the current economy and tied directly with the bond rating of the issuer.

As discussed above, a community's median household income is an important piece of data utilized in determining funding options. Based on the CSO Guidance for Financial Capability Assessment and Schedule Development, an annual sewer bill of less than 1% of the MHI constitutes a low financial impact to the community, between 1% and 2% is a medium impact and greater than 2% is a high financial impact. Table 10-1 below identifies the current sewer rate structure and 2000 Census data for the MHI. A median range of 1.5% of the MHI is utilized for comparison purposes. Based on the table, the current system users have a low financial impact with respect to sewer rates. Funding agencies will generally expect that rates increase to 1.5% of MHI before grant funding and low interest loans are awarded to projects.

Table 10-1: Current Sewer Rate Structure for RAJSA Municipalities

COMMUNITY	QUATERLY RATE STRUCTURE	Current Annual BILL	MHI[1]	1.5% of MHI[1]
ROCHESTER TOWNSHIP	$23.00 base plus $1.50 per 1,000 gallons over first 10,000 gallons per quarter	$290	$37,284	$559
ROCHESTER BOROUGH	$30.00 base plus $2.00 per 1,000 gallons over first 5,000 gallons per quarter	$368	$30,970	$465
EAST ROCHESTER BOROUGH	$45.00 flat base rate	$351	$25,625	$384
FREEDOM BOROUGH	$45.00 flat base rate	$351	$30,741	$461

[1] According to the 2000 census

10.3 Results

Based on the available funding sources and current sewer rates, several funding scenarios were reviewed. Table 10-2 presents these options.

Several Pennvest funding scenarios are presented with the purpose of showing a range of funding offers and attendant user rates. A scenario showing $10,000,000 in grant funding is presented with the purpose of showing the order of magnitude of grant funding necessary to achieve user rates in the vicinity of 1.5% of MHI. This grant award is not likely based on expected available grant funds through Pennvest.

Two scenarios are provided for RUS funding. Again, although the project may be eligible for 75% grant funding, this scenario is not likely due to expected available grant funds. Although a 40 year term is available through RUS, Pennvest's 30 year term and 1% interest rate offers a slightly lower interest rate.

The user rate analysis makes several assumptions. The first assumption is that per existing service agreements with RAJSA, the costs for these upgrades will be split equally among all customers. Another assumption made is that the all of the currently collected sewer revenues are utilized for existing expenses. Additional operating costs associate with the projects are shown in Table 10-2. These costs in additional to the debt service payment will essentially equate to the net increase in the user rates.

Based on current conditions and funding availability, Pennvest is the recommended funding source for the project. A likely funding scenario including a 30-year 1% loan is suggested with $1,000,000 in grant funding. Although based on the expected user rates, additional grant funding is warranted, it is not likely to be available. Supplemental grant funding should be sought to further lower user rates.

The Environmental Protection Agency's CSO Guidance for Financial Capability Assessment and Schedule Development also provides for an analysis of other financial, socioeconomic, and borrowing factors. This analysis would ultimately be combined with the cost per household compared to MHI previously discussed to identify a suggested implementation schedule end date. The COA provides for an end date of December 31, 2017, therefore, this analysis was not completed.

10.4 Funding Responsibility

The LTCP recommends several capital projects to control overflows from CSOs and SSOs. Primarily, these projects involve both sewer separation and storage facilities. At the time the LTCP was being developed, both Rochester Borough and East Rochester Borough were planning separation projects at Bachelor Street, Deer Lane, Virginia Avenue and Case Street. It was decided by the respective municipalities that these projects would be funded by the individual municipalities/authorities that were responsible for the outfalls. Namely, Rochester Borough for Bachelor Street, Deer Lane and Virginia Avenue and East Rochester for Case Street separation projects. At the present time, both Rochester Borough and East Rochester Borough are moving forward with the separation projects using a combination of grant and public funds. It is expected that this funding will continue through the implementation of this LTCP. At a regular meeting of the RAJSA Board held on October 13, 2011, the Board agreed that funding for the remaining projects in the LTCP (West Madison CSO, New York Avenue CSO, Freedom Lift Station SSO, Center Street SSO and the WWTP Expansion) should be borne by the RAJSA, in accordance with the existing Service Agreement.

Table 10-2: User Rate Analysis with Various Funding Options

USER RATE ANALYSIS
RAJSA Storage and WWTP Recommended Alternative

	PENNVEST $0 Grant with 20 Year Loan at County Cap [4]		PENNVEST $1,000,000 Grant with 30 Year Loan at 1%		PENNVEST $10,000,000 Grant with 30 Year Loan at 1%		USDA RUS 0% Grant with 40 Year Loan at 2.5%		USDA RUS 75% Grant with 40 Year Loan at 2.5%		Bond Issue $0 Grant with 30 Year Term at 5.5%	
Project Costs												
West Madison CSO Storage	$3,873,200		$3,873,200		$3,873,200		$3,873,200		$3,873,200		$3,873,200	
New York Avenue CSO Storage	$3,873,200		$3,873,200		$3,873,200		$3,873,200		$3,873,200		$3,873,200	
Freedom Lift Station Storage	$3,491,500		$3,491,500		$3,491,500		$3,491,500		$3,491,500		$3,491,500	
WWTP Upgrade	$6,000,000		$6,000,000		$6,000,000		$6,000,000		$6,000,000		$6,000,000	
Total Project Cost	**$17,237,900**		**$17,237,900**		**$17,237,900**		**$17,237,900**		**$17,237,900**		**$17,237,900**	
Customer Count												
Rochester Borough	1,578		1,578		1,578		1,578		1,578		1,578	
Rochester Township	942		942		942		942		942		942	
Freedom [1]	888		888		888		888		888		888	
East Rochester	313		313		313		313		313		313	
Total Customer	**3,721**		**3,721**		**3,721**		**3,721**		**3,721**		**3,721**	
Project Financing												
Grant Amount (Assumed)	$0		$1,000,000		$10,000,000		$0		$12,928,425		$0	
Total Amount Financed	**$17,237,900**		**$16,237,900**		**$7,237,900**		**$17,237,900**		**$4,309,475**		**$17,237,900**	
Annual Costs [2]												
Annual Project Debt Service	$1,187,773		$629,188		$280,455		$686,693		$171,673		$1,186,060	
Additional Annual Operation Costs - West Madison	$60,600		$60,600		$60,600		$60,600		$60,600		$60,600	
Additional Annual Operation Costs - Freedom	$60,000		$60,000		$60,000		$60,000		$60,000		$60,000	
Additional Annual Operation Costs - New York	$60,600		$60,600		$60,600		$60,600		$60,600		$60,600	
Additional Annual Operation Costs - WWTP	$25,000		$25,000		$25,000		$25,000		$25,000		$25,000	
Total Projected Annual Costs	**$1,393,973**		**$835,388**		**$486,655**		**$892,893**		**$377,873**		**$1,392,260**	
Monthy User Rates [5]												
Additional Monthly Cost per Customer [2]	$31.22		$18.71		$10.90		$20.00		$8.46		$31.18	
Current Average Monthly User Rate - RAJSA	$14.23		$14.23		$14.23		$14.23		$14.23		$14.23	
Total Monthly User Rate - RAJSA	$45.45		$32.94		$25.13		$34.23		$22.69		$45.41	
Current Average Monthly User Rate - Rochester Boro	$23.18		$23.18		$23.18		$23.18		$23.18		$23.18	
Current Average Monthly User Rate - Rochester Twp	$9.97		$9.97		$9.97		$9.97		$9.97		$9.97	
Current Average Monthly User Rate - East Rochester	$15.00		$15.00		$15.00		$15.00		$15.00		$15.00	
Current Average Monthly User Rate - Freedom	$15.00		$15.00		$15.00		$15.00		$15.00		$15.00	
		% of MHI		**% of MHI**		**% of MHI**		**% of MHI**		**% of MHI**		**% of MHI**
Total Monthly User Rate - Rochester Boro [3]	$68.63	2.7%	$56.12	2.2%	$48.31	1.9%	$57.41	2.2%	$45.88	1.8%	$68.59	2.7%
Total Monthly User Rate - Rochester Twp [3]	$55.42	1.8%	$42.91	1.4%	$35.10	1.1%	$44.20	1.4%	$32.66	1.1%	$55.38	1.8%
Total Monthly User Rate - East Rochester [3]	$60.45	2.8%	$47.94	2.2%	$40.13	1.9%	$49.23	2.3%	$37.69	1.8%	$60.41	2.8%
Total Monthly User Rate - Freedom [3]	$60.45	2.4%	$47.94	1.9%	$40.13	1.6%	$49.23	1.9%	$37.69	1.5%	$60.41	2.4%
	2.0% MHI	**1.5% MHI**										
Rochester Borough	$51.62	$38.71										
Rochester Township	$62.14	$46.61										
East Rochester	$42.71	$32.03										
Freedom	$51.24	$38.43										

1 Freedom customers include New Sewickley customers.
2 Additional annual cost for LTCP recommendations
3 Total Monthly User Rate includes RAJSA fee and Tributary Community fee.
4 County Cap Blended Rate = 3.27%
5 Current Average Monthly User Rate based on 160gpd/EDU average water use per Beaver Falls records.

11.0 Recommended Plan Project Summaries

11.1 Overview

The recommended alternatives described in this section was selected based on the screening and scoring process described in the previous sections. This process included numerous steps: screening of technologies to arrive at a short list of CSO and SSO control technologies that are applicable and appropriate for the RAJSA system; prioritization of evaluation factors by the RAJSA, municipalities and CPAC, which was incorporated into the alternative scoring process; development of control technology costs; generating hydraulic and hydrologic model results for sizing and costing of control technology facilities and evaluation of CSO volume reduction; and selection of CSO control levels to be evaluated. Finally, the highest ranked outfall specific alternatives, consolidated alternatives and system-wide alternatives were compared in order to determine the "winning" or best alternative. Basic assumptions for the final alternative consist of the following:

- For CSO sewersheds, the final alternatives are based on 85% capture of wet weather events on a system-wide, average annual basis.
- For SSO sewersheds, the WWTP upgrade/Center Street SSO alternative is based on a 10-year design storm control level. The Freedom Lift Station SSO alternative is based upon a 5-year design storm control level. This was due to limited space available to construct a storage facility. Ultimately, the USEPA and the PaDEP will need to decide on the appropriate control level for SSOs. Costs have been developed and provided for the 2, 5 and 10-year events for RAJSA's use.
- According to PaDEP, the Bachelor Street and Deer Lane combined sewersheds were required to be separated since they are considered to be located upstream of the Beaver River boat dock facilities, which are defined as "sensitive areas".

The selected CSO alternatives are based on the 1994 USEPA CSO Policy presumptive remedy approach.

11.2 Plan Description

Project #1 - Bachelor Street Sewershed

This project involves the separation of 26 acres of combined sewers in the Bachelor Street sewershed within Rochester Borough. The separation of sewers includes the installation of new sanitary sewer piping and manholes and connection of customer laterals upstream of this CSO. The existing combined sewer piping and manholes would be converted to a dedicated storm sewer system and the CSO would be converted to a storm sewer outfall structure. It is anticipated that the majority of this system could be constructed in existing right-of-way.

Project #2 - Deer Lane Sewershed

This project involves the separation of 14 acres of combined sewers in the Deer Lane sewershed within Rochester Borough. The separation of sewers includes the installation of new sanitary sewer piping and manholes and connection of customer laterals upstream of this CSO. The existing combined sewer piping and manholes would be converted to a dedicated storm sewer system and the CSO would be converted to a storm sewer outfall structure. It is anticipated that the majority of this system could be constructed in existing right-of-way.

Project #3 - West Madison Street Sewershed

This project involves the construction of a 600,000 gallon below-grade, concrete storage tank to capture the wet weather flows from the West Madison Street CSO. The location of the tank would be near the existing CSO structure in Rochester Borough along the Beaver River on property owned by Rochester Borough and RAJSA (south of the existing West Madison Street Lift Station). The maximum depth of the storage facility should be 20'. The approximate footprint of the tank is 90' x 45'. The storage facility would include dewatering pumping, screening and appropriate space for ancillary functions. Following wet weather events, the tank would be dewatered back into the existing system, when flows recede. With this tank volume, it is not anticipated the existing CSO would be active during the typical year, but it should remain open to allow discharges for precipitation events greater than the largest storm in the typical year. O&M would be required following each storm event to ensure the tank's function remains as designed. The project also includes the upgrade of the pumps and controls in the West Madison Lift Station.

Project #4 - New York Avenue Sewershed

This project involves the construction of a 600,000 gallon below-grade, concrete storage tank to capture the wet weather flows from the New York Avenue CSO. The location of the tank would be south of the existing Beaver Valley Bowl in Rochester Borough along the Ohio River on property owned by Rochester Borough. The maximum depth of the storage facility should be 20'. The approximate footprint of the tank is 90' x 45'. The storage facility would include dewatering pumping, screening and appropriate space for ancillary functions. Following wet weather events, the tank would be dewatered back into the existing system, when flows recede. With this tank volume, it is anticipated the existing CSO would be active during the typical year, discharging approximately 22 times. O&M would be required following each storm event to ensure the tank's function remains as designed.

Project #5 - Virginia Avenue Sewershed

This project involves the separation of 5 acres of combined sewers in the Virginia Avenue sewershed within Rochester Borough. The separation of sewers includes the installation of new sanitary sewer piping and manholes and connection of customer laterals upstream of this CSO. The existing combined sewer piping and manholes would be converted to a dedicated storm sewer system and the CSO would be converted to a storm sewer outfall structure. It is anticipated that the majority of this system could be constructed in existing right-of-way.

Project #6 - Case Street Sewershed

This project involves the separation of 7 acres of combined sewers in the Case Street sewershed within East Rochester Borough. The separation of sewers includes the installation of new sanitary sewer piping and manholes and connection of customer laterals upstream of this CSO. The existing combined sewer piping and manholes would be converted to a dedicated storm sewer system and the CSO would be converted to a storm sewer outfall structure. It is anticipated that the majority of this system could be constructed in existing right-of-way. As of the date of this report, this project has been awarded for construction by East Rochester Borough.

Project #7 - Freedom Lift Station Sewershed

This project involves the construction of a 530,000 gallon below-grade, concrete storage tank to capture the sanitary sewer overflows from the Freedom Lift Station SSO. The location of the tank would be north of the existing Freedom Lift Station in Freedom Borough on property owned by Freedom Borough. The maximum depth of the storage facility should be 20'. The approximate footprint of the tank is 84' x 42'. The storage facility would include dewatering pumping, screening and appropriate space for ancillary functions. Following wet weather events, the tank would be dewatered back into the existing system, when flows recede. With this tank volume, it is anticipated the existing SSO would not be active up to the 5-year storm (i.e. overflow on average once every 5 years). The 5-year design storm is the desired control level at this location due to site constraints at the lift station. O&M would be required to ensure the tank's function remains as designed. The project also includes the upgrade of the pumps and controls in the Freedom Lift Station.

Project #8 - Existing WWTP Upgrade

This project involves the expansion of the existing RAJSA WWTP to accommodate the additional wet weather flows as a result of implementation of this LTCP. Details of the recommended expansion include:

- Construction of two (2) new clarifiers;
- Demolition of the existing chlorine contact tank;
- Installation of UV disinfection;
- Installation of air lift pumps with blowers for use in the existing and proposed clarifiers;
- Upgrade the pumping capacity at the Center Street Lift Station; and the
- Replacement of the existing belt filter press

11.3 Plan Costs and Considerations

A summary of the total project cost for the highest ranked alternatives for addressing the entire RAJSA sewer system (CSOs and SSOs) is presented in Table 11-1 below. The costs for controlling the SSOs are shown for the 5-year design storm control level for presentation purposes. It is anticipated that the PaDEP and/or USEPA will have the ultimate discretion in determining the control level of SSOs in the system.

Table 11-1: Summary of Total Project Costs

Sewershed	Alternative	Total Capital Costs	Total Annual O&M Costs
Bachelor Street CSO	Separation	$1,517,000	$0
Deer Lane CSO	Separation	$1,327,000	$0
West Madison St. CSO	Storage	$3,873,200	$60,600
New York Avenue CSO	Storage	$3,873,200	$60,600
Virginia Avenue CSO	Separation	$474,000	$0
Case Street CSO	Separation	$664,000	$0
Freedom Lift Station SSO	Storage	$3,491,500	$60,000
Center Street SSO	WWTP Upgrade	$6,000,000	$25,000
	TOTAL SYSTEM	**$21,220,000**	**$206,200**

11.4 Comparison with Water Quality Objectives

By implementing the LTCP described above, the total CSO volume and number of CSO events per year will be significantly reduced. Figure 10-1 shows the CSO volumes by sewershed after being controlled with these CSO control technologies compared to the baseline conditions. Figure 10-2 shows the number of untreated discharges from the CSOs by sewershed after being controlled with the CSO control technologies compared to the baseline conditions. There is an overall reduction in CSO volume of 68% and an overall reduction in overflow events of 95.5% for the entire RAJSA system. Also, by implementing this LTCP, the RAJSA may achieve the goal of the 1994 National CSO Policy presumptive remedy approach of reducing CSO overflow events to 85% capture of wet weather flow on an average annual basis. The total storage volume provided by the selected alternatives is approximately 24,010,000 gallons.

Figure 11-1: Overflow Volumes from CSOs for Existing and Proposed Conditions

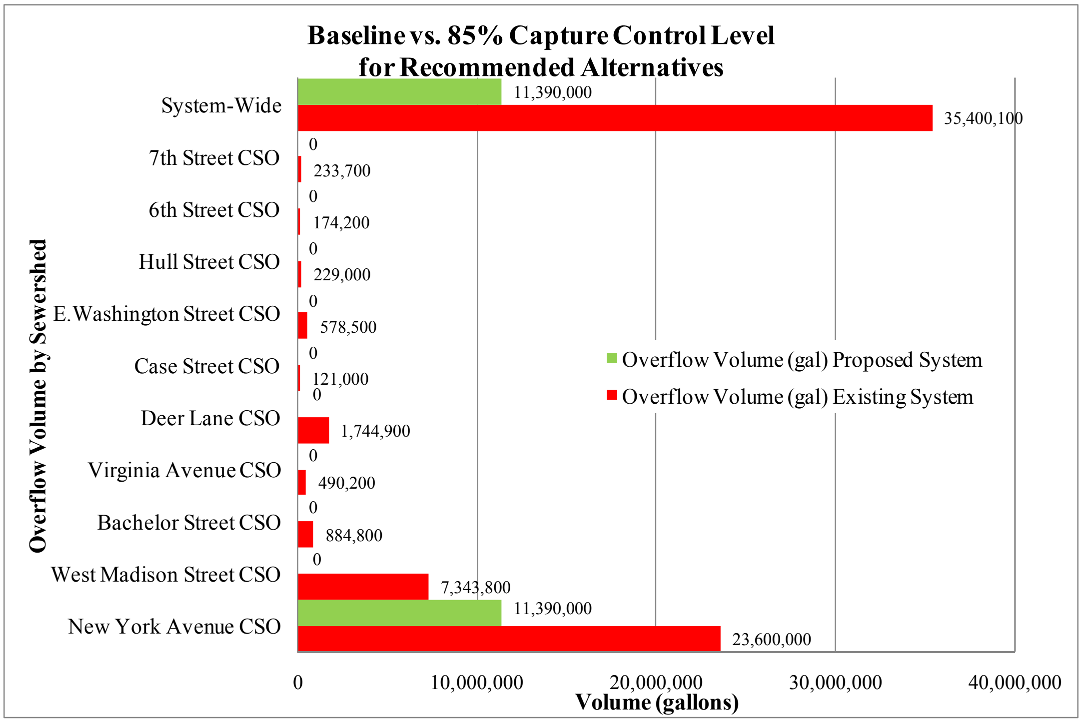
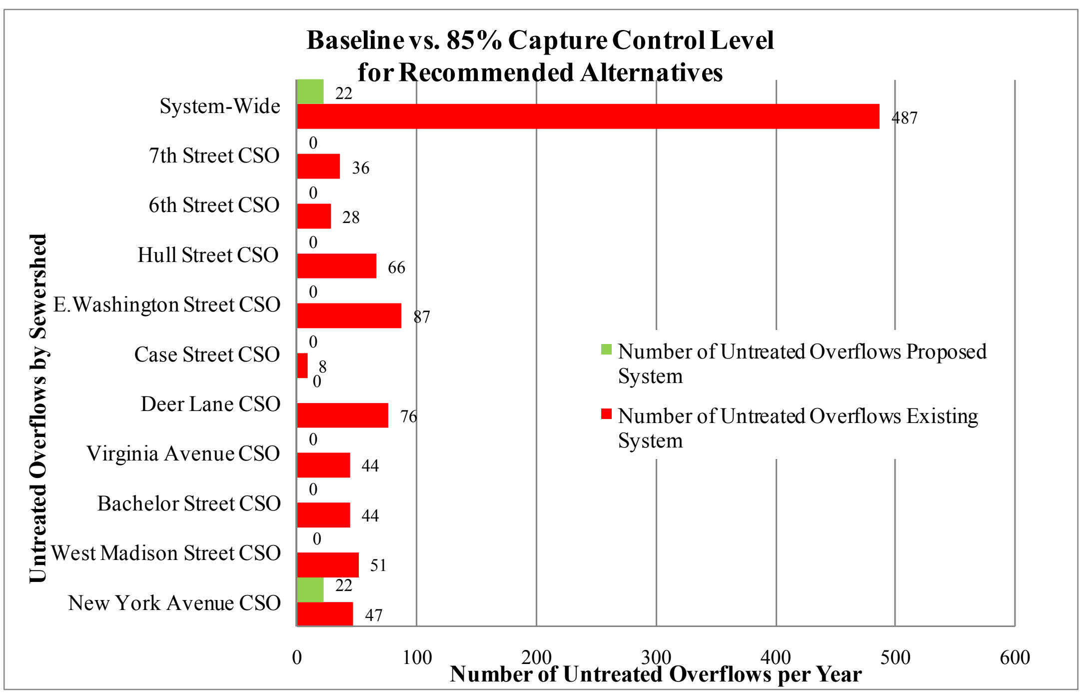


Figure 11-2: No. of Untreated Overflows from CSOs for Existing and Proposed Conditions



12.0 Public Participation

12.1 Introduction

For the most part, sewer system infrastructure is invisible; most sewer system customers do not give any thought to the sewer infrastructure that lies beneath the ground as long as the water and waste drains away. It is important to raise public awareness of the RAJSA and member communities sewer infrastructure needs so that public support of selected capital improvement alternatives can be achieved. Stakeholder involvement and public awareness also provide a mechanism for ensuring that the affected public, rate payers, and system users fully understand the regulatory and environmental "drivers" for undertaking the chosen plan as well as the economic impact that the implementation of the chosen plan will have on the region overall. Continuing goals of the RAJSA and the member communities are to promote stakeholder involvement and undertake a public awareness plan to ensure that all federal, state, and local regulatory requirements for public participation are met, develop an understanding within the customer base of the need to implement a capital plan, and foster support for the implementation of the chosen plan.

All stakeholder involvement and public awareness initiatives to date have been closely coordinated with the engineering committee and future coordination will be within the stakeholder groups being formulated as part of the RAJSA and the member communities public outreach. Coordination of these efforts will complement and support any and all public information and education activities that may be required by COA. Such coordination will capitalize on opportunities to share resources and provide a consistent approach for implementing a cost-effective public awareness program across the affected region.

12.2 Regulatory Requirements

Federal and state regulations require public participation in the development, selection, and implementation of a long-term control plan for controlling combined sewer overflow structures. The CSO Control Policy discusses the public participation requirements for LTCP development. In the "Guidance for Long-Term Control Plan" published by USEPA in 1995, specific outlines for public participation/awareness are discussed. The guidance outlines public participation and agency interactions for each major step of the program. These include public participation and agency involvement during system characterization, development and evaluation of control alternatives, and selection and implementation of the resulting Long-Term Plan.

12.3 Public Involvement Overview

While municipal involvement and public awareness are mandated at the federal, state, and local levels, it is vitally important to convey a clear and concise message to the public through the public awareness process. In keeping with this idea, the RAJSA and the individual municipal entities used a robust public awareness process that included presentations to the citizens of the various municipalities through public meetings, websites and informational flyers. These programs were designed to inform as well as solicit input from stakeholders. The RAJSA developed a website, www.rajsa-cso.org, that was used to post information on CSOs, meeting notices and documents that were developed during the project. An excerpt from the website in included below in Figure 12-1.

Also, it is important to recognize that moving forward, the RAJSA and the member municipal entities have engaged the public as part of the process in developing and implementing this long term control plan. Close cooperation and coordination between all parties has helped to ensure that a consistent and concise message is conveyed to the public. Cooperation and involvement has permitted the RAJSA and all municipal entities to capitalize on opportunities to share public information and resources, thereby containing and limiting costs in preparing a single unified long term control plan as required under the Consent Order and Agreement.

12.4 CPAC

RAJSA and the member municipalities entered into a COA that, among other things, requires the development of a unified LTCP. According to the National CSO Policy, public participation and agency interaction are recommended. A Public Participation Program (PPP) was initiated as part of this project. The goals of the PPP is to involve citizens in the LTCP process, especially in the areas of alternative development and financial impacts to the service area. RAJSA's PPP included the formation of a CSO Plan Advisory Committee (CPAC) that met two times during the development of the LTCP, and will meet a final time after the LTCP is submitted to the PaDEP. In addition to the public being present at the CPAC meetings, the committee had at least one representative from each municipality. The first meeting was held on June 28, 2010 and the second meeting was held on September 27, 2011. The meetings were used to review and discuss the status and coordination of the LTCP, educate the public on CSO matters, and present the process, findings and recommendations of the LTCP. The meetings were advertised in the local newspaper, the Beaver County Times. Flyers were also sent to customers of the RAJSA with their bills and prominently placed in the municipal offices. Joint and separate presentations were also made to the municipal boards prior to and during the LTCP development. All public involvement, activities and public meetings were well documented and all CPAC correspondence as been resented in Appendix J.

Figure 12-1: Excerpt from RAJSA Website

The Project Team participated in an informational meeting held on November 30, 2011 at 6:30 PM at the Rochester Township Municipal Building. The Rochester Township Commissioners requested the RAJSA to participate in this meeting with the municipal officials. Discussions were held regarding the overall plan recommendations, costs, implementation schedule and future customer rates. The sign-in sheet of attendees is included in Appendix J of this report. It was decided among the municipal officials that a series of informational meetings would need to be scheduled within the respective municipalities to inform the public of the LTCP projects and the impacts of the projects with respect to customer rates.

East Rochester Borough requested a meeting with their residents to discuss the LTCP. A meeting was scheduled by the Project Team for January 24, 2012. It is expected that this meeting will serve as the 3rd and final CPAC meeting.

12.5 Summary and Recommendations

Federal, state and local regulations as well as consent orders and agreements mandate that RAJSA and member municipalities to solicit involvement and undertake a public awareness campaign as they move forward with the planning and development the LTCP.

Section 12 of the COA requires the RAJSA to implement the recommendations of the LTCP by December 31, 2017. SSO discharges are required to cease by January 1, 2015 or a civil penalty will be levied by PaDEP. At a minimum, the following recommendations should be implemented by RAJSA:

- Review the existing Service Agreement of the RAJSA and municipalities to identify cost sharing clauses and requirements. Outline the process on how the various governmental agencies will work together from both a technical and institutional perspective.

- Determine how costs (capital and O&M) will be shared between municipalities.

- Determine the awarding agency(ies) for the various wet weather projects included in this LTCP.

13.0 Schedule and Implementation

13.1 Overview

This section of the report provides a conceptual implementation plan and schedule for the highest ranked alternatives as previously analyzed and described in Section 9. A review of typical planning, design, construction and commissioning phases for a major project of this magnitude is provided along with other tasks that should be considered once a final LTCP is formalized and agreed upon by RAJSA and the member communities. Therefore a detailed implementation schedule cannot be developed until the regional LTCP is formalized; however, given basic assumptions for the type, complexity and magnitude of construction anticipated, a conceptual project timeline can be developed for planning purposes which have been presented herein. Refinements to sequencing, schedule and construction methods would be necessary after final planning and during preliminary and final design engineering.

13.2 Typical Project Parameters to be Considered

The highest ranked alternative, as described within Section 9 of this report, identified complete separation as the primary CSO control strategy for Bachelor Street, Deer Lane, Virginia Avenue and Case Street CSO's while the West Madison Street and New York Avenue CSO's primary control alternatives were identified as storage tanks. In addition the primary control alternative for the Freedom Lift Station SSO was determined to be a storage tank along with WWTP and Lift Station upgrades to control the Center Street SSO. A summary of these highest ranked alternatives can be found in Table ES-4.

In addition to the major components noted within Section 9, typical project parameters to be considered for each selected alternative would be the following project phases typically undertaken on any major public infrastructure project:

- Funding and Public Coordination;
- Preliminary Design (includes siting and property acquisition);
- Final Design;
- Permitting;

- Public Bid / Contract Award;
- Construction Phase; and,
- Commissioning and Project Closeout.

13.3 Funding and Public Coordination

Table ES-5 and Table 11-1 identify the summary of estimated project cost associated with the highest ranked alternatives as being $21,220,000 which will require non-traditional as well as traditional funding sources and alternatives be explored. The affordability analysis and user rate analysis discussed in Chapter 10 investigated the following funding alternatives that are available and could be considered for this project:

- The **Pennsylvania Infrastructure Investment Authority (Pennvest)** offers low interest loans and grants through a state revolving fund. Source of funding includes both state and federal funds. Projects are awarded based a ranking system and funding offers are made based on financial need. Terms include interest rates are generally either 1% or county cap rates (currently a blended 3.27% rate for Beaver County), loan term of 20 or 30 years. Limited grant funds are awarded based financial need utilizing an annual sewer bill target rate of 1.5% of the median household income (MHI).

- The **United States Department of Agriculture Rural Utilities Service (RUS)** offers a grant and loan program for water and wastewater projects. Based on 2000 Census data, the region would qualify for the poverty level which offers the lowest interest rate available (2.5% at this writing, revised quarterly) and up to 75% grant funding. The term on RUS loans is 40 years. Although the project qualifies for 75% grant funding, this value is more than the annual grant allocation to RUS for the entire state. Further RUS grant allocations are generally committed to projects for the next five to seven years. This varies and could be as short as two years, however, due to the current finite schedule set forth in the Consent Order and Agreement (COA), waiting for grant funding to become available does not appear to be an option.

- Traditional funding of public infrastructure projects involving the issuance of revenue backed **Municipal Bonds**. Although this option does not have the same requirements associated with utilization of state and federal funds, the terms do not compare as well. A 30 year term and 5.5% interest rate is utilized in this analysis based on recent information, however, rates and terms are highly volatile in the current economy and tied directly with the bond rating of the issuer.

Although funding options for the selected alternative may be limited, all available options should be investigated. For this reason, it is not unusual to allocate time within the project schedule for investigating funding alternatives in order to develop an acceptable financing program or strategy so that the project can be implemented. The funding phase of the project has been incorporated into the preliminary design phase of this study. In the event that the funding phase overlaps other project phases, consideration should given to interim financing in order to fund on a short term basis the early development phases of the project.

Public coordination is an important step in the selection of improvements for the study area. Opportunities should be provided for public comment through a proactive outreach program consisting of meetings and information distribution through newsletters and published documents. This coordination would be performed in conjunction for all phases of the project.

13.4 Preliminary Design/Siting/Property Acquisition

Preliminary design typically involves the sizing, layout, siting and design of facilities to a level of completion approximately thirty (30) percent. The preliminary design phase allows the Project Team to investigate, discuss and finalize locations for major project components as well as identify potential utility conflicts resulting in the need for possible utility relocations. Other major design factors that may be considered during the preliminary design phase would include the availability power, potential noise pollution associated with construction activities, construction impacts to neighborhoods, and an evaluation of environmental factors in order to minimize project impact to the environment. The preliminary design should also result in a project cost estimate that consists of a higher level of accuracy then any project estimate contained within a conceptual study.

During the preliminary design phase, the availability of property required for easements and acquisitions for the separation and storage tank construction projects should be investigated. The time required for easements and acquisition of selected sites is a variable that is difficult to predict; however, during the preliminary design phase, options for the purchase of properties should be secured so that access to the properties can be obtained. Final acquisition of properties can proceed and overlap other project phases such as final design.

13.5 Final Design

The final design phase typically involves the completion of construction plans and specifications, development of public bid and contract documents, final utility coordination, and the identification and development of required permits. Figure ES-5 Draft Implementation Schedule has allotted thirteen months and twenty-two months respectively for the design of the SSO and CSO remediation projects.

13.6 Permitting

The Project Design Team will contact with the Pennsylvania Department of Conservation and Natural Resources (DCNR) is required to determine if plant or animal species of special concern, such as endangered species, are located within the study area. Additional permits that may be needed include, but are not necessarily limited to, highway occupancy permits for work associated with any consolidation sewers, soil erosion and sedimentation control plan approvals through County and State regulatory agencies, railroad crossing permits and construction permits from the Commonwealth of Pennsylvania Department of Environmental Protection. The development of permit applications can be performed during the final design phase; however, submission of permit applications to regulatory agencies may not occur until or near the final stages of the final design phase. Therefore, permit application review, comment and approval time must be taken into account. The aforementioned Draft Implementation Schedule identifies six months to be allocated near the end of each final design phase for the submission, review and approval of permits.

13.7 Public Bid/Contract Award Phase

Typically, the public bidding period for public works projects can be as short as ten calendar days (minimum); however, consideration should be given to as much as a three month public bidding period for each phase of this project. Compliance with the Commonwealth of Pennsylvania separations of trades regulations may result in a number of Construction Contracts that will extend the time required for detailed review of bids received, analysis of bidder qualifications to perform the work for which they are bidding on, and financial analysis of low bidders in order to assure that they have the financial ability to complete the anticipated work. Therefore, it may be necessary to allow for an additional three months to be added to each public bid/award phase thereby resulting in a total of six months for public bidding and award of construction contracts for each major phase of this project.

13.8 Construction Phase

Many variables must be considered when selecting an appropriate time period for construction of the anticipated facilities. The following factors are examples of typical factors that would need to be considered for the construction phase of the selected alternatives:

- Clearing and grubbing operations. Some sewer separation projects may be constructed within wooded or densely vegetated areas or on steep slopes.
- Weather/Time of year of construction. Cold, snow and rain may slow production of work forces and hamper the equipment.
- Traffic/Obstructions
- Production rate for sewer line construction.
- Availability of materials.
- Utility relocations (i.e. sewer, water, telephone, cable, electric, natural gas).
- Environmental Impacts/Soils/Testing/Disposal. Excavated material may need to be tested in accordance with guidance from the U.S. Environmental Protection Agency. This material cannot be placed in sensitive areas such as wetlands, floodplains, parklands or historic sites.

Several construction staging areas will be necessary to store materials and equipment through the construction period. The final locations of the construction staging areas will be determined by the construction contractors before construction commences and will be coordinated with the appropriate local, state and federal agencies.

Based on the parameters noted herein, basic assumptions for production rates, a review of current projects and the COA, more than six years allocated for the construction phase as shown on Figure ES-5.

13.9 Commissioning and Project Closeout

This phase of a project typically involves final inspection of the completed work, testing of mechanical systems, review of project documentation (record drawings), project audit (if required) and official acceptance and transfer of the completed work to the Owner. Portions of the commissioning and project closeout phase can commence during the final construction stages; however, it is customary to allocate time after all construction activities have ended for project closeout. It is recommended that six months be allocated after construction is completed for project closeout.

13.10 Project Schedule and Phasing

Section 12 of the COA requires the RAJSA to implement the recommendations of the LTCP by December 31, 2017. SSO discharges are required to cease by January 1, 2015 or a civil penalty will be levied by PaDEP. Listed below and illustrated in Figure ES-5 is important key milestones that should be considered, and are a result of the implementation schedule put forth by the PaDEP in the COA. The schedule below assumes that the RAJSA and the municipalities will adopt the LTCP during their respective Board meetings in October 2011. Figure 13-1 presents the draft schedule in graphical form.

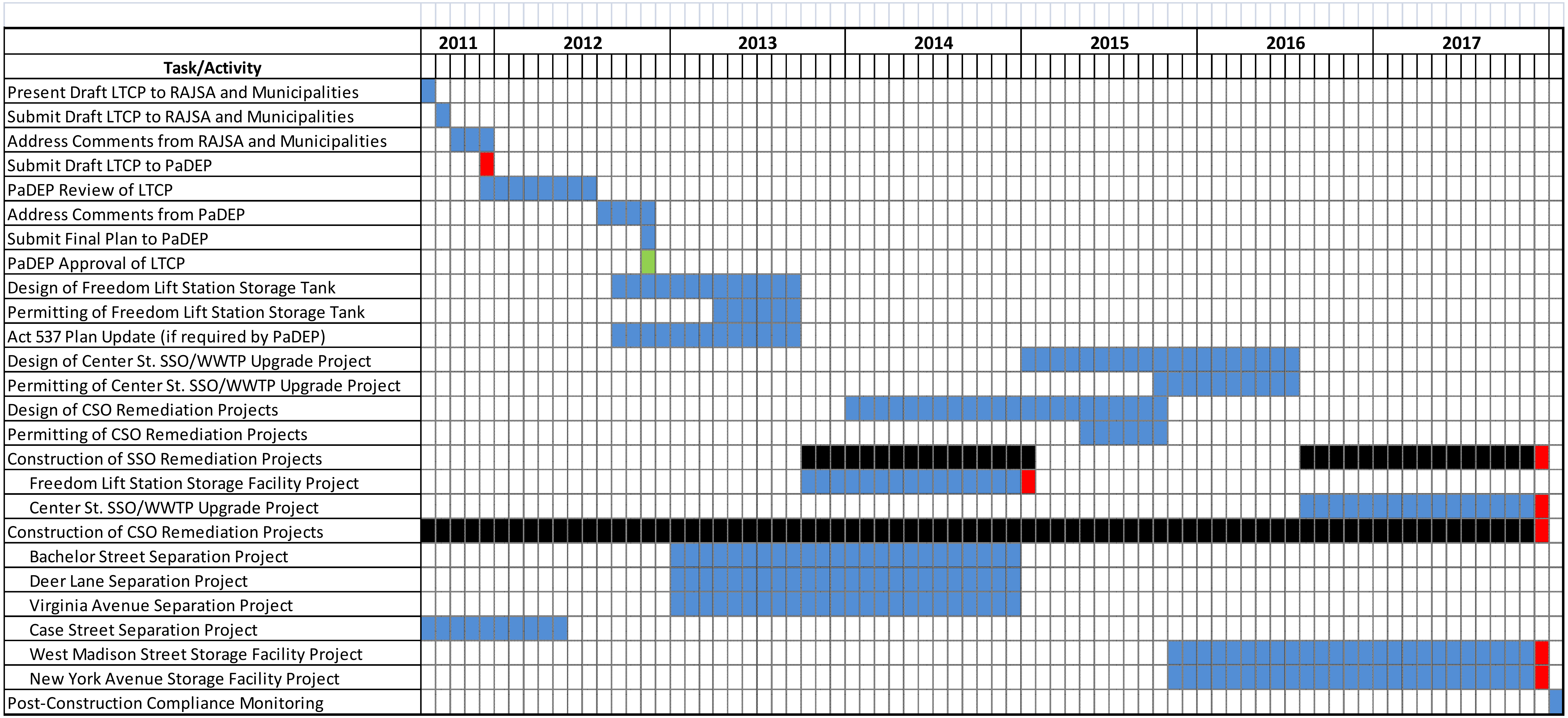
Submit the draft LTCP to PaDEP .... December 31, 2011
PaDEP Comment Period.. January to October 2012
Final PaDEP Approval of LTCP.. December 31, 2012
Design and Permitting of the Freedom Lift Station Storage Tank ...October 2012 to October 2013
Act 537 Plan Update (if required by PaDEP) ....October 2012 to October 2013
Construction of the Freedom Lift Station Storage Tank..... November 2013 to December 31, 2014
Design and Permitting of CSO Remediation Projects ....January 2014 to December 2015
Design and Permitting of Center St. and WWTP Upgrade .... January 2015 to July 2016
Construction of Remaining Projects ....January 2016 to December 31, 2017*

* it is expected that the separation projects of Bachelor Street, Deer Lane, Virginia Avenue and Case Street will be under construction from 2011 to 2014. As such, they have not been included in the schedule above.

Some other considerations of the RAJSA and municipalities should be:

- Determine the awarding agency(ies) for the various wet weather projects included in this LTCP.
- Determine how the implementation of joint projects (if required) and ongoing operation and maintenance are going to be performed.

Figure 13-1: Draft Implementation Schedule



14.0 Post Construction Compliance Monitoring Plan

14.1 Overview

The 1994 CSO Policy, Section II.C.9 states "*the selected CSO controls should include a post-construction water quality monitoring program adequate to verify compliance with water quality standards and protection of designated uses as well as to ascertain the effectiveness of CSO controls. This water quality compliance monitoring program should include a plan to be approved by the NPDES authority that details the monitoring protocols to be followed, including the necessary effluent and ambient monitoring and, where appropriate, other monitoring protocols such as biological assessments, whole effluent toxicity testing, and sediment sampling.*"

The Post Construction Compliance Monitoring Plan (PCCMP) contained in this section is intended to comply with the above requirement to verify compliance with water quality standards in the Beaver and Ohio Rivers and determine the effectiveness of the CSO controls proposed in this LTCP.

14.2 Plan Summary and Recommendations

The PCCMP for RAJSA is comprised of the following:

1. CSO flow monitoring;
2. QA/QC; and
3. Record keeping and reporting

CSO Flow Monitoring

To determine the effectiveness of the CSO controls proposed in the LTCP, recording-type, area-velocity flow monitors should be installed at all remaining CSO discharge points to measure the amounts of overflows during rainfall events. It is expected that flow sensors would be installed on the influent line from the trunk sewer, the effluent line to the interceptor and the overflow pipe. Data from this flow monitoring program should be compared to that which was previously completed to ascertain the reduction in the volume, frequency and duration of CSO events as a result of implementation of the LTCP. The overflow data should be tabulated along with the rainfall data and analyzed. The following findings are expected from the analysis:

- Rainfall and overflow relationships for each CSO;
- Number of overflow events reduced for each CSO, as a result of each CSO control measure implemented;
- Duration of each overflow event, as a result of each CSO control measure implemented; and
- Volume of overflow reduced for each CSO, as a result of each CSO control measure implemented.

Flow monitors should be installed at the following locations:

- New York Avenue CSO
- West Madison Street CSO
- Furthest downstream location in the Bachelor Street sewershed
- Furthest downstream location in the Deer Lane sewershed
- Furthest downstream location in the Virginia Avenue sewershed
- Furthest downstream location in the Case Street sewershed
- Furthest downstream location in the East Washington Street sewershed
- Furthest downstream location in the Hull Street sewershed
- Furthest downstream location in the 6th Street sewershed
- Furthest downstream location in the 7th Street sewershed
- Freedom Lift Station

It is recommended that a flow monitor also be installed at the WWTP to monitor the influent dry and wet weather flows and a monitor be installed at the Center Street overflow to monitor any discharges from this structure. Figure 14-1 contains the recommended flow monitoring locations.

CSO and Stream Sampling

No sampling is proposed for this PCCMP.

QA/QC

Quality assurance and quality control (QA/QC) procedures are important in a monitoring program to ensure that collected data is of known quality, useful, and reliable. It is important that QA/QC procedures are followed both in the field during monitoring and the office during data analysis. The RAJSA staff/contractors complying with the PCCMP should follow the following QA/QC procedures:

- Field instrument maintenance and calibration - The field instruments used in the monitoring program shall be calibrated and maintained in accordance with the manufacturer's specifications.

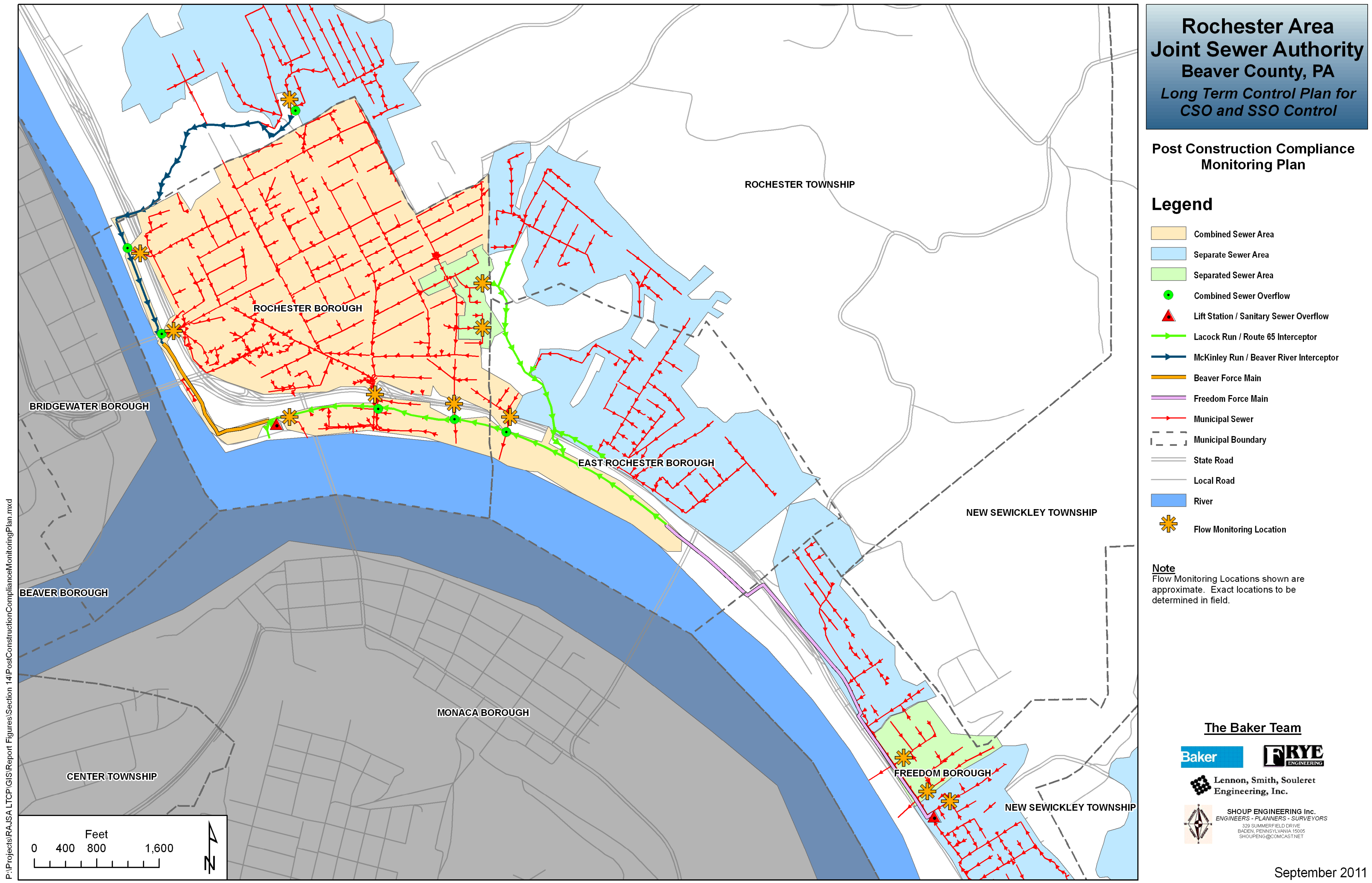
- Flow data obtained from the flow meters should be reviewed and subjected to a QA/QC procedure. The flow data QA/QC procedures were discussed in detail earlier in this LTCP.

Record Keeping and Reporting

Good record keeping is imperative to the success of the PCCMP. The RAJSA should maintain a file (both hard copy and electronic) with the protocol, flow monitoring data, recording forms, etc. that is associated with the PCCMP.

The RAJSA or its consultant should develop sample log sheets and other QA/QC forms to record field data or other activities conducted during the PCCMP.

Figure 14-1: Recommended PCCMP Flow Monitoring Locations *(base mapping source: Pennsylvania Spatial Data Access)*



15.0 References

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16.0 Appendices

Appendices are attached in electronic form.