Appendix Q

System Characterization Work Plan Part 1 (QAPP)
System Characterization Work Plan Part 2 (QAPP)
and
NJDEP approval letters dated October 20, 2016

State of New Jersey

CHRIS CHRISTIE
Governor

KIM
GUADAGNO
Lt. Governor

DEPARTMENT OF ENVIRONMENTAL PROTECTION
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Bureau of Surface Water Permitting
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BOB MARTIN
Commissioner

October 20, 2016

Brigite Goncalves, Town Clerk
Borough of East Newark
34 Sherman Avenue
East Newark, NJ 07029

Rocco Russomanno, Town Engineer
Town of Harrison
318 Harrison Avenue
Harrison, NJ 07102

Gerry Kerr, Superintendent DPW
Town of Kearny
357 Bergen Avenue
Kearny, NJ 07032

Mike Gelin, Assistant Director Water and Sewer
City of Newark, City Hall, Room B31F
920 Broad Street
Newark, NJ 07102

Fred Margron, Town Engineer
City of Paterson
111 Broadway
Paterson, NJ 07505

Bridget M. McKenna, Chief Operating Officer
Passaic Valley Sewerage Commission (PVSC)
600 Wilson Avenue
Newark, NJ 07105

Re: Receipt of Amended Sewer System Characterization Work Plan Part 1
PVSC, NJPDES Permit No. NJ0021016
Paterson City, NJPDES Permit No. NJ0108880
Newark City, NJPDES Permit No. NJ0108758
Kearny Town, NJPDES Permit No. NJ0111244
Harrison Town, NJPDES Permit No. NJ0108871
East Newark Borough, NJPDES Permit No. NJ0117846

Dear Permittees:

This letter is written to acknowledge receipt of your revised submission dated October 12, 2016 entitled "System Characterization and Landside Modeling Program Quality Assurance Project Plan (QAPP) Part 1". This revised QAPP was submitted cooperatively for PVSC, the City of Paterson, the City of Newark, the Town of Kearny, the Town of Harrison and East Newark Borough. The Sewer System Characterization QAPP is a requirement of all NJPDES CSO permits as per CSM Part IV.D.3. This submission is an amended version of the QAPP dated December 29, 2015 and revised March 16, 2016. The October 12, 2016 revisions of the QAPP are outlined in SECTION A – PROJECT MANAGEMENT, A.0 SUMMARY OF CHANGES, page 3 of the amended QAPP.

The Department has reviewed your amended QAPP and has determined that we do not have any comments or objections. Please proceed with implementation.

Thank you for your continued cooperation.

Sincerely,

Susan Rosenwinkel
Section Chief
Bureau of Surface Water Permitting

C: Joseph Mannick, Bureau of Surface Water Permitting
Dwayne Kobesky, Bureau of Surface Water Permitting
Marzooq Alebus, Bureau of Surface Water Permitting
Marc Ferko, Office of Quality Assurance

SYSTEM CHARACTERIZATION AND LANDSIDE MODELING PROGRAM QUALITY ASSURANCE PROJECT PLAN (QAPP) PART 1

Submitted on behalf of the following participating Permittees By the Passaic Valley Sewerage Commission:

Passaic Valley Sewerage Commission (NJ0021016)
Borough of East Newark (NJ0117846)
Town of Harrison (NJ0108871)
Town of Kearny (NJ0111244)
City of Newark (NJ0108758)
City of Paterson (NJ0108880)

Passaic Valley Sewerage Commission
Essex County
600 Wilson Avenue
Newark, New Jersey

"Protecting Public Health and the Environment"

December 29, 2015
Revised 3/16/2016
Revised 10/12/2016

SECTION A – PROJECT MANAGEMENT

A.0 SUMMARY OF CHANGES

This Quality Assurance Project Plan (QAPP) is Part 1 for the System Characterization and Landside Modeling Program to be executed by the Passaic Valley Sewerage Commission (PVSC). The System Characterization and Landside Modeling Program includes the rainfall monitoring, wastewater sampling, collections system monitoring, modeling and other work necessary to characterize the CSO discharges from the participating municipalities and for development of a collections system model for the purposes of evaluating CSO control alternatives and developing a CSO Long Term Control Plan (LTCP). Future versions will include summaries of changes and when they were incorporated in this section. The history of this document and changes made to it are summarized below:

- December 29, 2015: Submitted QAPP in fulfillment of the LTCP Permit requirement.
- Revised March 15, 2016: Modified QAPP to address comments made by NJDEP in letter dated February 16, 2016. A copy of the February 16, 2016 letter is included as Attachment E of this document. The 12/29/15 submitted QAPP was 61 pages. This version includes updates that resulted in a page total of 66 pages. Page number updates are not reflected with redline-strikeout in this document. The following pages in this document have been changed to address NJDEP comments, with changes shown in redline-strikeout throughout the document:
    a. DEP Comment 2 – Page 34 Modified.
    b. DEP Comment 3 – Page 22 Included.
    c. DEP Comment 7 – Page 58 Modified.
    d. DEP Comment 8 – Page 11 Modified.
    e. DEP Comment 9 – Page 12 Modified.
    f. DEP Comment 10 – Page 14 Modified.
    g. DEP Comment 11 – Page 64 & 65 Modified.
    h. DEP Comment 12 – Page 15 Modified.
    i. DEP Comment 13 – Page 15 & 17 Modified.
    j. DEP Comment 15 – Page 19 Modified.
    k. DEP Comment 16 – Page 20 Included.
    l. DEP Comment 17 – Page 24 Modified.
    m. DEP Comment 18 – Page 25 Modified.
    n. DEP Comment 19 – Page 26 Modified.
    o. DEP Comment 20 – Page 26 Modified.
    p. DEP Comment 21 – Page 27 Included.
    q. DEP Comment 22 – Page 28 Included.
    r. DEP Comment 23 – Page 29 Modified.
    s. DEP Comment 24 – Page 32 Modified.
    t. DEP Comment 25 – Page 32 Modified.
    u. DEP Comment 26 – Page 35 Modified.
    v. DEP Comment 27 – Page 36 Modified.
    w. DEP Comment 30 – Page 41 Modified.
    x. DEP Comment 31 – Page 41 Modified.

y. DEP Comment 34 – Page 47 Modified.
z. DEP Comment 35 – Page 51 Modified.
aa. DEP Comment 37 – Page 57 Modified.
bb. DEP Comment 38 – Page 57 Modified.
cc. DEP Comment 39 – Page 60 Modified.

- Page 18 - Includes modification of Section A.5.2 to be consistent with the System Characterization QAPP Part 2
- Page 18 – Includes addition to Section A.6 to be consistent with the System Characterization QAPP Part 2

- Revised October 12, 2016: Modified QAPP to reflect revised sampling locations that changed after field visits due to traffic control or access issues. The 3/16/16 submitted QAPP was 66 pages plus the 8 page DEP comment letter for a total of 74 pages. This version includes updates that resulted in a page total of 75 pages plus the revised figures in Appendix F (20 pages) for a total of 95 pages. Page number updates are not reflected with redline-strikeout in this document. The following pages in this document have been changed to address the sampling location modifications with changes shown in redline-strikeout throughout the document:
    a. Page 37 – modified to indicate drawings in Appendix F
    b. Page 37 – modified Table 3 sampling location descriptions
    c. Page 41 – modified text to indicate drawings in Appendix F
    d. Page 41 – modified Table 4 sampling location descriptions

In future versions, this section will be further updated to include summaries of changes and when they were incorporated as appropriate.

A.1 Title of Plan and Approval

Title: Quality Assurance Project Plan, System Characterization and Landside Modeling Program for the Passaic Valley Sewerage Commission LTCP, Part 1

Approval:

Preparer:

Project Officer, Michael J. Hope, P.E., Greeley and Hansen — Date 12/18/2015

QA Officer, Timothy J. Dupuis, P.E., CDM Smith — Date 12/18/15

Passaic Valley Sewerage Commission:

Program Manager, Bridget McKenna — Date 12/18/2015

New Jersey Department of Environmental Protection

Office of Quality Assurance, Marc Ferko — Date 3/30/16

Division of Water Quality, Bureau of Surface Water Permitting, Joseph Mannick — Date 3/29/16

Participating Permittee Approvals are attached.

SYSTEM CHARACTERIZATION AND LANDSIDE MODELING PROGRAM
QUALITY ASSURANCE PROJECT PLAN (QAPP)
Part 1

Submitted by
Passaic Valley Sewerage Commission:

NJPDES Number NJ0021016 (PVSC)

Approval of QAPP:

Permittee: _____ 12/18/2015

Bridget McKenna
Chief Operating Officer, PVSC

Date

NJPDES Certification:

"Without prejudice to any objections timely made to permit conditions, I certify under penalty of law that this document and all attachments were prepared either: (a) under my direction or supervision; or (b) as part of a cooperative performed by members of the NJ CSO group effort in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for purposely, knowingly, recklessly, or negligently submitting false information."

Permittee: _____ 12/18/15

Bridget McKenna
Chief Operating Officer, PVSC

Date

SYSTEM CHARACTERIZATION AND LANDSIDE MODELING PROGRAM
QUALITY ASSURANCE PROJECT PLAN (QAPP)
Part 1

Submitted on behalf of the following participating Permittee by
Passaic Valley Sewerage Commission:

NJPDES Number NJ0117486 (East Newark)

Approval of QAPP:

Permittee: _____ 12/14/15

Frank Pestana — Date
Licensed Operator, Borough of East Newark

NJPDES Certification:

"Without prejudice to any objections timely made to permit conditions, I certify under penalty of law that this document and all attachments were prepared either: (a) under my direction or supervision; or (b) as part of a cooperative performed by members of the NJ CSO group effort in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for purposely, knowingly, recklessly, or negligently submitting false information."

Permittee: _____ 12/14/15

Frank Pestana — Date
Licensed Operator, Borough of East Newark

SYSTEM CHARACTERIZATION AND LANDSIDE MODELING PROGRAM
QUALITY ASSURANCE PROJECT PLAN (QAPP)
Part 1

Submitted on behalf of the following participating Permittee by
Passaic Valley Sewerage Commission:

NJPDES Number NJ0108871 (Harrison)

Approval of QAPP:

Permittee: _____ 12/29/15

Rocco Russomano — Date
Town Engineer, Town of Harrison

NJPDES Certification:

"Without prejudice to any objections timely made to permit conditions, I certify under penalty of law that this document and all attachments were prepared either: (a) under my direction or supervision; or (b) as part of a cooperative performed by members of the NJ CSO group effort in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for purposely, knowingly, recklessly, or negligently submitting false information."

Permittee: _____ 12/29/15

Rocco Russomano — Date
Town Engineer, Town of Harrison

SYSTEM CHARACTERIZATION AND LANDSIDE MODELING PROGRAM
QUALITY ASSURANCE PROJECT PLAN (QAPP)
Part 1

Submitted on behalf of the following participating Permittee by
Passaic Valley Sewerage Commission:

NJPDES Number NJ0111244 (Kearny)

Approval of QAPP:

Permittee: _____ 12/28/15

Gerry Kerr, CPWM — Date
Department of Public Works Supervisor, Town of Kearny

NJPDES Certification:

"Without prejudice to any objections timely made to permit conditions, I certify under penalty of law that this document and all attachments were prepared either: (a) under my direction or supervision; or (b) as part of a cooperative performed by members of the NJ CSO group effort in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for purposely, knowingly, recklessly, or negligently submitting false information."

Permittee: _____ 12/28/15

Gerry Kerr, CPWM — Date
Department of Public Works Supervisor, Town of Kearny

SYSTEM CHARACTERIZATION AND LANDSIDE MODELING PROGRAM
QUALITY ASSURANCE PROJECT PLAN (QAPP)
Part 1

Submitted on behalf of the following participating Permittee by
Passaic Valley Sewerage Commission:

NJPDES Number NJ0108758 (Newark)

Approval of QAPP:

Permittee: _____

Ras J. Baraka, Date
Mayor, City of Newark

NJPDES Certification:

"Without prejudice to any objections timely made to permit conditions, I certify under penalty of law that this document and all attachments were prepared either: (a) under my direction or supervision; or (b) as part of a cooperative performed by members of the NJ CSO group effort in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for purposely, knowingly, recklessly, or negligently submitting false information."

Permittee: _____

Ras J. Baraka Date
Mayor, City of Newark

SYSTEM CHARACTERIZATION AND LANDSIDE MODELING PROGRAM
QUALITY ASSURANCE PROJECT PLAN (QAPP)
Part 1

Submitted on behalf of the following participating Permittee by
Passaic Valley Sewerage Commission:

NJPDES Number NJ0108880 (Paterson)

Approval of QAPP:

Permittee: _____ 12/17/15.
Manny Ojeda Date
Director of Public Works, City of Paterson

NJPDES Certification:

"Without prejudice to any objections timely made to permit conditions, I certify under penalty of law that this document and all attachments were prepared either: (a) under my direction or supervision; or (b) as part of a cooperative performed by members of the NJ CSO group effort in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for purposely, knowingly, recklessly, or negligently submitting false information."

Permittee: _____ 12/17/15.
Manny Ojeda Date
Director of Public Works, City of Paterson

A.2 DISTRIBUTION LIST

Passaic Valley Sewerage Commission
Bridget McKenna, Chief Operating Officer
Patricia Lopes, Director of Process Control Engineering and Regulatory Compliance
Marques Eley, Process Control Engineer III, PE

Participating Permittees
East Newark: Frank Pestana, Licensed Operator
Harrison: Rocco Russomano, Town Engineer
Kearny: Gerry Kerr, CPWM, Department of Public Works Supervisor
Newark: Michel Gelin, P.E., Asst. Director Department of Water and Sewer
Paterson: Manny Ojeda, Director of Public Works

New Jersey Department of Environmental Protection
Dwayne Kobesky, Surface Water Permitting
Joseph Mannick, Surface Water Permitting
Marc Ferko, Office of Quality Assurance

PER EPA GUIDANCE DOCUMENT
- Project manager;
- Laboratory manager;
- Field team leader;
- Data processor or statistician;
- Modeler;
- QA officer;
- Data reviewers; and
- Essential contractor and subcontractor personnel.

A.3 PROGRAM CONTACT INFORMATION

Contact information for those parties involved in the System Characterization and Landside Modeling Program is as follows:

Michel Gelin, PE
Assistant Director
Department of Water and Sewer
City of Newark
Room B31F
920 Broad Street
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Process Control Engineer
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600 Wilson Avenue
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Office of Quality Assurance
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401 E. State St, 4th Floor
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Manny Ojeda
Director of Public Works
City of Paterson
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Paterson, NJ 07505-1414

Dwayne Kobesky
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Division of Water Quality
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Department of Public Works
Supervisor
Town of Kearny
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Kearny, NJ 07032

Frank Pestana
Licensed Operator
East Newark Borough
34 Sherman Avenue
East Newark, NJ 07029

Rocco Russomanno, PE
Town Engineer
Harrison Town
318 Harrison Avenue
Harrison, NJ 07029-1796

A.4 Table of Contents

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A.5 PROJECT ORGANIZATION

A.5.1 Key Individuals and Responsibilities

Portions of the System Characterization and Landside Modeling Program are anticipated to be executed by contractors to PVSC that may include multiple independent firms assigned for laboratory, field, QA/QC, and other roles. The work under this QAPP will thus be executed by entities other than the listed permittees. Ultimate responsibility for the implementation of the program is with the positions listed below:

Program Manager (PM) – Bridget McKenna - PVSC

The Program Manager is responsible for the implementation of the System Characterization and Landside Modeling Program and its associated Quality Assurance Project Plan (QAPP) on behalf of all signatories.

Project Officer (PO) – Michael J. Hope - Greeley and Hansen

The Project Officer is responsible for the implementation of the "System Characterization and Landside Modeling Program" and it's associated Quality Assurance Project Plan (QAPP). In addition, the PO is responsible for:

- Taking corrective actions for any quality control (QC) problems with personnel, technical content, or procedures;
- Presenting documents/products to the PVSC Quality Assurance Officer (QAO);
- Fiscal accountability to PVSC and the permittees;
- Tracking and maintaining compliance with applicable EPA and New Jersey Department of Environmental Protection (NJDEP) procedures; and
- Coordinating and confirming the availability of team resources.

Project and Field Coordinator (PFC) – Don Henshaw – HDR

The Project and Field Coordinator is responsible for verifying that the sample collection and transport activities are conducted in a manner that provides confidence that the samples are representative of the site from which they are collected. Specifically, the PFC is responsible for the following:

- Organizing equipment, staff and materials for field sampling;
- Confirming that all staff are correctly and safely operating the sampling equipment;
- Verifying that Standard Operating Procedures (SOPs) which describe current

practices are written, approved, and distributed to appropriate project personnel;

- Managing the day-to-day field sampling activities to verify that the field procedures and activities conform to the requirements of the applicable sampling and field procedures, SOPs, and the QAPP;

- Resolving day-to-day problems in the implementation of the field portion of the study;

- Reporting any quality problems to the QAO;

- Reviewing records, and field and laboratory data for accuracy, validity and completeness and adding appropriate data qualifiers to the data base;

- Maintaining primary contact with associated contributing field personnel and laboratories regarding the sampling schedule, field data, sample transport, and final data reports;

- Verifying that laboratory and method certifications and calculated method detection limits (MDLs) are up to date;

- Submission and review of field and laboratory data and QC data, including blanks results, calibration results, reference standard results, etc.;

- Authoring or co-authoring annual reports;

- Co-authoring the QAPP and annual addendums, and keeping the QAO up to date on program changes;

- Verifying that an adequate QAPP is developed, and that the QAPP is distributed to all appropriate project personnel;

- Confirming that all data products are reviewed and approved according to accepted policies and guidelines before being released; and

- Maintaining the official PVSC data files.

Quality Assurance Officer (QAO) – Timothy J. Dupuis - CDM Smith
The Quality Assurance Officer has the following responsibilities:

- Confirming that the requirements of the QAPP are implemented through effective organizing and planning to meet the program and quality objectives;

- Monitoring and auditing QC/QA processes and performance;
- Co-authoring and approving the QAPP;
- Verifying that all data products are reviewed and approved according to accepted policies and guidelines before being released;
- Conducting an independent QA review of data and completed draft documents;
- Authoring or co-authoring annual reports;
- Communicating any problems to the Project Officer; and
- Maintaining the official QAPP.

Contract Sampling and Laboratories - *Eurofins QC*
Each contract entity is responsible for:

- Adhering to the sampling design methods, and all associated field and laboratory Quality Control procedures necessary to accomplish the Program work;
- Confirming that their laboratories remain certified for the analyses being performed for the PVSC Program;
- Maintaining documentation of all procedures and current method detection levels and notifying the PVSC Project and Field Coordinator of changes to procedures and detection levels;
- Verifying that analytical results are generated using the appropriate operating procedures and quality control measures;
- Maintaining proper document control and traceability for procedures, samples, data, and training;
- Providing training and maintaining training documentation for all field samplers and laboratory analysts;
- Assigning and completing internal reviews of the data, including data transcriptions, and the associated sampling and testing documentation; and

- Reporting any anomalies or out-of-compliance results to the PVSC Project and Field Coordinator.

A.5.2 Principal Data Users

The principal users of the data will be PVSC, PVSC member municipalities, LTCP engineering consultants supporting PVSC, NJDEP, and other CSO municipalities who elect to rely on the program, including but not limited to those specified by PVSC as cooperating in their November 18, 2014 letter to NJDEP (Borough of East Newark, Town of Harrison, City of Newark, Town of Kearny, and City of Paterson). While PVSC will collect and review the data, these other parties may use the data to satisfy certain NJPDES permit requirements related to the requirements of their NJPDES Permits.

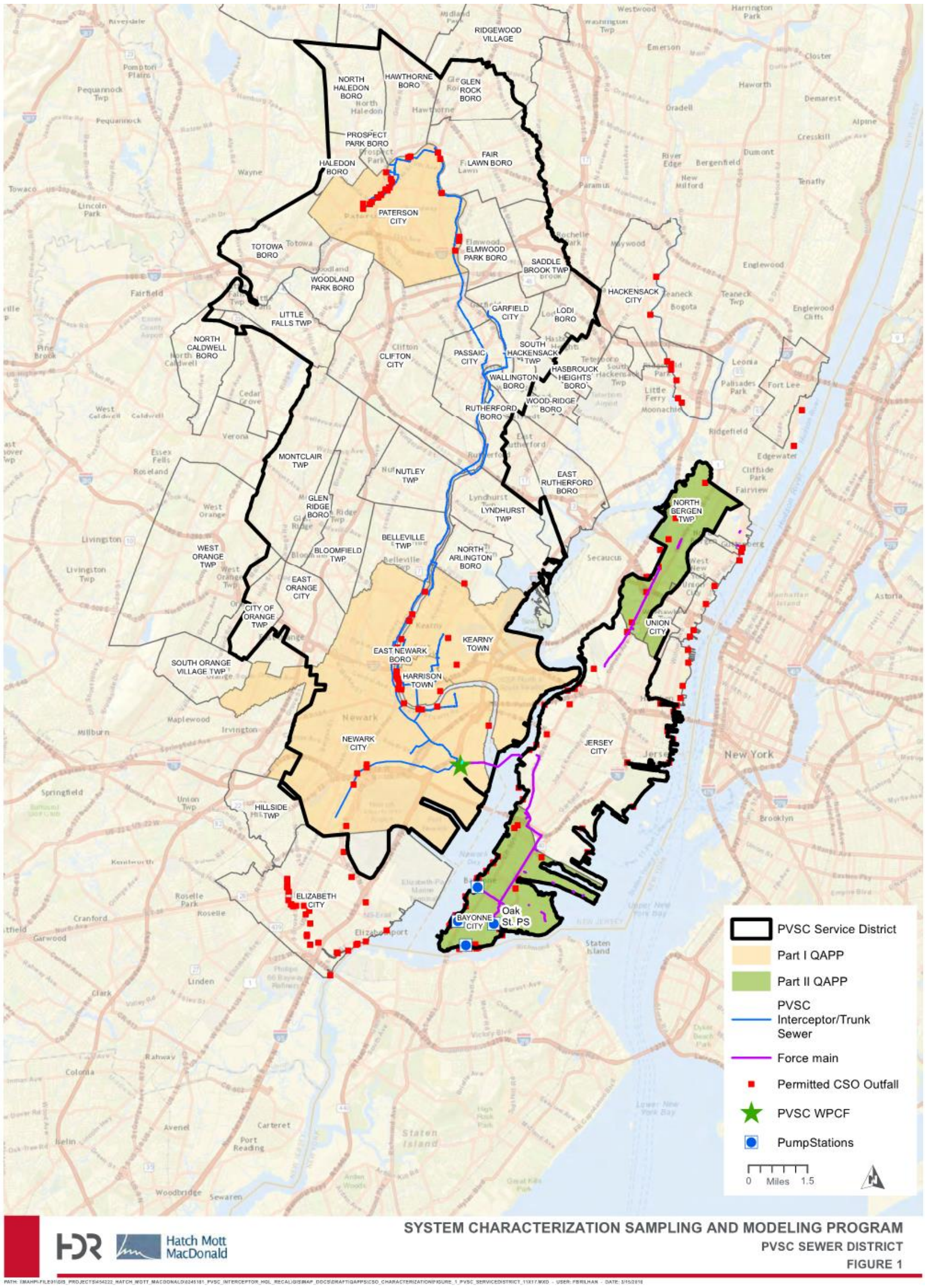
A.5.3 Decision Makers

PVSC has decision-making authority for the System Characterization and Landside Modeling Program. The Program Manager at PVSC is ultimately responsible for all technical, financial, and resource related elements of the program, and is the main contact for interagency communications. Any changes made to the program as outlined in this QAPP will be reported in writing for signatory approval and associated amendments to the QAPP will be submitted as necessary.

A.6 Problem Definition and Background

PVSC provides wastewater treatment service to forty-seven (47) municipalities within their northeast New Jersey service area. The PVSC District covers approximately 150 square miles from Newark Bay to regions of the Passaic River Basin upstream of the Great Falls in Paterson. PVSC's main interceptor sewer begins at Prospect Street in Paterson and generally follows the alignment of the Passaic River to the PVSC Water Pollution Control Facility (WPCF) in the City of Newark. The extent of the PVSC Service District and the combined sewer areas within the study area are illustrated in **Figure 1**.

Eight (8) of the municipalities within the PVSC District have combined sewer systems and have received authorization to discharge under their respective NJPDES Permits for Combined Sewer Management. Two of the combined sewer municipalities, the Cities of Bayonne and Jersey City, own and operate their own combined sewer systems, interceptors, CSO control facilities, and pumping stations. In addition they jointly own the force main used to transport wastewater to the primary clarifiers at the PVSC WPCF in Newark. The PVSC does not own or operate any of the combined sewer overflow control or transportation facilities which service this section of the District. Finally, the North Bergen MUA connects to PVSC through the Hudson County Force Main, owns CSOs, but does not own the collection system. The North Bergen MUA owns and operates the CSO outfalls, but does not own the collection system.


RIDGEWOOD VILLAGE
NORTH HALEDON BORO
HAWTHORNE BORO
GLEN ROCK BORO
PROSPECT PARK BORO
HALEDON BORO
FAIR LAWN BORO
PATERSON CITY
TOTOWA BORO
ELMWOOD PARK BORO
SADDLE BROOK TWP
WOODLAND PARK BORO
HACKENSACK CITY
GARFIELD CITY
LODI BORO
LITTLE FALLS TWP
NORTH CALDWELL BORO
CLIFTON CITY
PASSAIC CITY
SOUTH HACKENSACK TWP
WALLINGTON BORO
HASBROUCK HEIGHTS BORO
RUTHERFORD BORO
WOOD-RIDGE BORO
MONTCLAIR TWP
NUTLEY TWP
EAST RUTHERFORD BORO
GLEN RIDGE BORO
LYNDHURST TWP
NORTH BERGEN TWP
BELLEVILLE TWP
NORTH ARLINGTON BORO
WEST ORANGE TWP
BLOOMFIELD TWP
EAST ORANGE CITY
CITY OF ORANGE TWP
UNION CITY
KEARNY TOWN
EAST NEWARK BORO
HARRISON TOWN
SOUTH ORANGE VILLAGE TWP
NEWARK CITY
JERSEY CITY
HILLSIDE TWP
ELIZABETH CITY
BAYONNE CITY
Oak St. PS
PVSC Service District
Part I QAPP
Part II QAPP
PVSC Interceptor/Trunk Sewer
Force main
Permitted CSO Outfall
PVSC WPCF
PumpStations
0 Miles 1.5
Hatch Mott MacDonald
SYSTEM CHARACTERIZATION SAMPLING AND MODELING PROGRAM
PVSC SEWER DISTRICT
FIGURE 1

The other municipalities with combined sewer systems include the Borough of East Newark, the Towns of Harrison and Kearny, and the Cities of Newark and Paterson. A general schematic of the PVSC system is included in **Figure 2**. All of these municipalities are tributary to PVSC main interceptor and most of their combined sewer systems are tributary to CSO control facilities owned and/or operated by PVSC. In addition, the NJPDES permits issued to each party include requirements for PVSC and the CSO communities to cooperatively develop a CSO Long Term Control Plan (LTCP). To facilitate the CSO LTCP development, PVSC has offered to undertake the development of the System Characterization and Landside Modeling Program on behalf of these permittees.

Between 1998 and 2003, PVSC conducted a Combined Sewer Overflow Discharge Characterization Study for all regulators and interceptor sewers owned and operated by the PVSC. This study developed background information on the combined sewer systems tributary to each regulator as well as the analysis of historical rainfall patterns, overflow volumes and pollutants contained in the CSO discharges. This study was prepared by PVSC on behalf of the Borough of East Newark, the Towns of Harrison and Kearny and the City of Paterson. Jersey City, North Bergen MUA, and the Cities of Newark and Bayonne prepared their own separate reports in response to these NJPDES General Permit requirements. The following four reports were developed under this study:

- *Rainfall Monitoring Study Report* (December 1998) – This study was conducted to develop and understanding of the rainfall characteristics in the combined communities in the PVSC service area, develop a correlation between rainfall characteristics and frequency of occurrence that causes a discharge, and develop a real time rainfall monitoring for use in monitoring and modeling of CSO drainage basins.

- *CSO Monitoring Report* (December 1998) – This effort was intended to quantify and qualify dry weather and wet weather wastewater flow and pollutant concentration variations at key CSO drainage basins so that this information can be used to calibrate and verify hydrologic and hydraulic models of the combined sewer systems for the combined communities within the PVSC service area.

- *CSO Characterization Study Modeling Report* (December 2003) – This study developed a refined US EPA approved Storm Water Management Model of the PVSC interceptor sewer system and tributary collections systems. This report presents the data collection efforts, describes the model, discusses characterization of CSOs and presents and approach for estimating pollutant loads from drainage areas that were not monitored within the study area.

- *Combined Sewer System Modeling Study* (February 2004) – This study succeeded the 2003 Characterization and was intended to calibrate and verify the combined sewer overflow model to represent the response of the PVSC combined sewer system to

historical precipitation events using a US EPA approved Storm Water Management Model.

The information collected and the modeling tools developed under these previous studies will be supplemented and updated as part of this System Characterization and Landside Modeling Program Quality Assurance Project Plan Part 1. Each section of this QAPP summarizes the data collected under previous studies (performed under past QAPPS) and outlines the supplemental data to be collected under this QAPP.

Baseline Compliance Monitoring and Receiving Water Quality Modeling of the receiving waters will also be addressed under separate Quality Assurance Project Plans.

A.7 Project Description

In accordance with consultation with NJDEP as NJPDES permitting authority, multiple QAPPs will need to be developed to cover different aspects of the LTCP work activities. The QAPPs for the Baseline Compliance Monitoring and Receiving Water Quality Modeling Reports will be submitted separately. The project goals and objectives for the System Characterization and Modeling Program presented herein include:

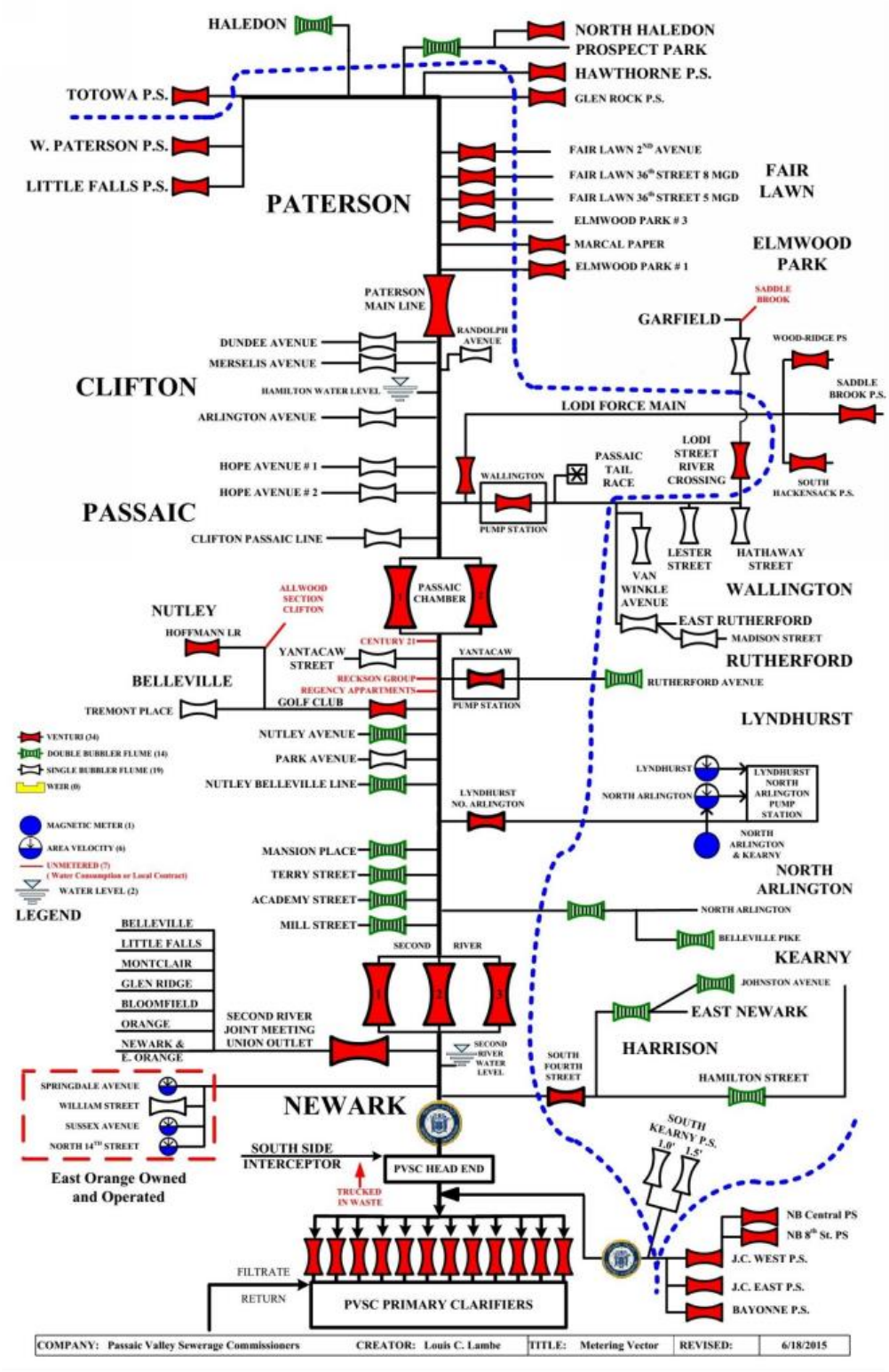


Figure 2 – PVSC Service Area Schematic

- Supplement and update, as appropriate, the site specific dry and wet weather data to be used to recalibrate and verify the InfoWorks collections system model of those collections systems tributary to the PVSC WPCF.
- Define the combined sewer systems' hydraulic response to rainfall.
- Supplement the existing dry weather water quality and quantity data to be used in the representation of each CSO drainage basin.
- Determine the CSO flows and pathogen concentrations/loadings being discharged to the receiving streams as a result of varied rainfall events.
- Supplement the stormwater quality data for various land use applications.

Regional Approach

The NJDEP, PVSC and the leadership of the CSO permittees all agree that a cooperative or regional approach to the development of a Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP) and requisite work tasks will be an optimal and cost-effective means of providing meaningful data and analyses. PVSC and the CSO communities have, with NJDEP approval, undertaken coordination of a CSO LTCP and this System Characterization and Landside Modeling QAPP for all permittees tributary to its conveyance facilities.

Several coordination meetings have been held with representatives of the CSO permittees tributary to PVSC's conveyance and treatment facilities. PVSC has agreed to lead the Combined Sewer System Characterization and Landside Modeling Tasks on behalf of the participating permittees.

The following outlines the owner/operators of the CSSs and control facilities from the CSO permittees who have committed to this regional approach.

Borough of East Newark

Owner/Operator of CSS:	East Newark
Owner/Operator of Regulators to PVSC Interceptor:	PVSC

Town of Harrison

Owner/Operator of CSS:	Harrison
Owner/Operator of Regulators to PVSC Interceptor:	PVSC

Town of Kearny

Owner/Operator of CSS:	Kearny
Owner/Operator of Regulators to PVSC Interceptor:	PVSC

City of Newark

Owner/Operator of CSS:	Newark
Owner/Operator of Internal Regulators:	Newark
Owner/Operator of Regulators to PVSC Interceptor:	PVSC
Owner/Operator of Regulators and Southside Interceptor:	Newark

City of Paterson

Owner/Operator of CSS:	Paterson
Owner/Operator of Internal Regulators:	Paterson
Owner/Operator of Regulators to PVSC Interceptor:	PVSC

Amendments to this QAPP will be performed, as appropriate, to reflect the changes in the scope of work associated with the commitment from other CSO permittees to join in this regional initiative.

Purpose

The purpose of the proposed monitoring program is to quantify and qualify dry weather and wet weather wastewater flow and pathogen concentration variations at key CSO and stormwater drainage basins to calibrate and verify hydrologic and hydraulic models (InfoWorks) of the combined sewer systems within the Borough of East Newark, the Towns of Harrison and Kearny, and the Cities of Newark and Paterson. This work will be used to update the mathematical tool (sewer system model) that will be used to assess residual storage and maximum hydraulic conveyance capacity in the PVSC interceptor system, pathogen concentrations and loading distributions during storm events and among CSO discharge points, calculate pathogen loads from CSOs and stormwater to the receiving water, and for the development and evaluation of long term control alternatives and/or modifications to the water quality standards (WQS) during wet weather events.

This QAPP is being submitted as required by the NJPDES Permits for Combined Sewer Management for PVSC, the Borough of East Newark, the Towns of Kearny and Harrison, and the Cities of Newark and Paterson. Similar to this QAPP, PVSC, on behalf of the Cities of Bayonne and Jersey City, and the North Bergen MUA will submit Part 2 of the QAPP covering those permittees.

Data Usage

Data collected under this QAPP will be used to supplement the data used from the 2003 CSO Characterization Study Modeling Report and the CSO Modeling Study dated February 2004. The measurements of rainfall duration and intensity, wastewater flow metering and CSO laboratory analytics will have several different uses, and will be utilized in performing the following LTCP development tasks:

Rainfall-Overflow Correlation Analysis – An analysis will be performed using the monitored hydrological events and the results of the precipitation statistical analysis, to develop the correlation between the characteristics and frequency of rainfall events that cause a discharge. This analysis was performed as part of past studies to identify the amount of rain that triggers an overflow event. New data collected as part of the work associated with this QAPP will be combined with historical data within the CSO Alert System to increase the data volume used to correlate the occurrence of CSO with rainfall properties and thus improve the performance of the CSO Alert System. The relationships between rainfall volume and intensity, and CSO events were developed for each of the permittees to allow them to estimate the frequency of overflow

for the purposes of completing their monthly Discharge Monitoring Reports. It was also performed for development of the CSO Alert System and will be further updated for the purposes of the CSO LTCP.

This data will be useful for conducting screening analyses for a variety of purposes, for example, to approximate the frequency of overflow events for selected/critical rainfall periods and evaluate the relative pathogen loading, peak flows, duration and volumes associated with the discharge from the various control facilities within the sewer district.

Rainfall Event Characterization - The statistical analysis of area rainfall will be made shortly after the QAPP is approved. While the analysis will be based upon information obtained for Newark Liberty International Airport (Newark Airport), NOAA records for other gages in the area (e.g., Rahway, Little Falls, Springfield, and Essex Fells) will be incorporated into the analysis to establish rainfall statistics for the overall study area. Storm event characteristics (volume, intensity, duration) for the individual storms associated with CSO monitoring events, and for the aggregate of all monitored storms, will be compared with long term statistics for area rainfall to determine the return period for the monitored storms and the anticipated probability of occurrence within the region.

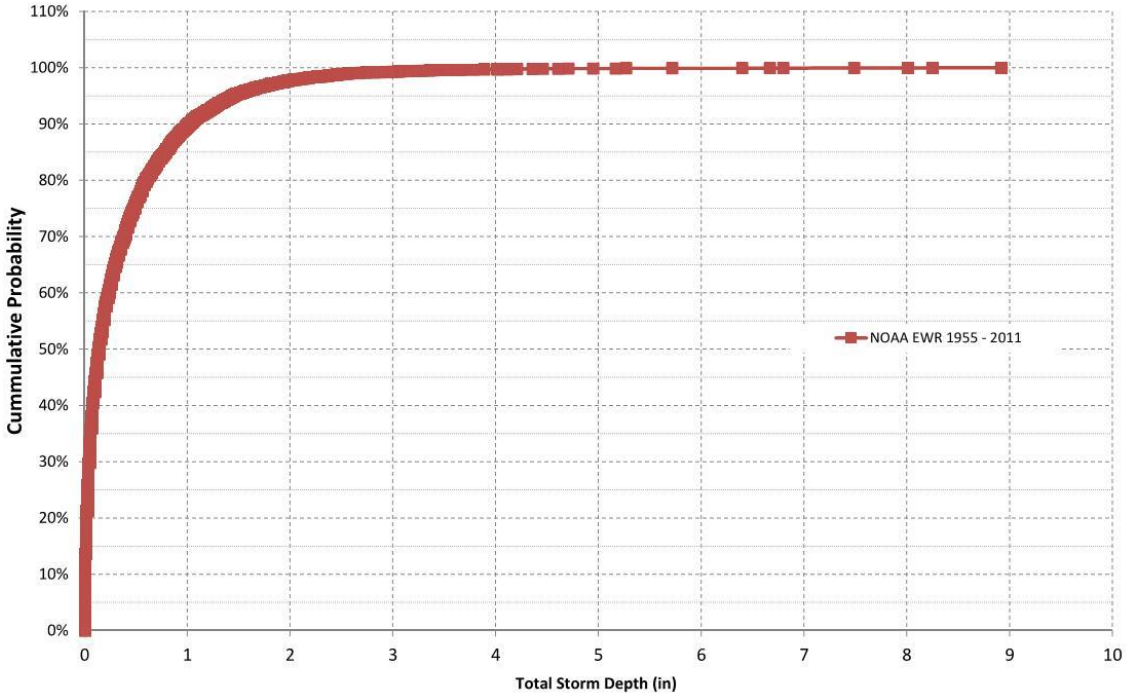
For the purposes of defining a wet weather event and for identifying the minimum size rain event to be sampled, a preliminary analysis of historical precipitation data was performed and summarized in a memorandum prepared by William Leo of HDR dated December 1, 2015 (attached as Appendix A). The correlation between rainfall and CSO events indicates that for a storm event of 0.2 inches, 40% of the CSOs are activated in the municipalities tributary to the main interceptor and 25% of the CSO s in the City of Bayonne are activated. As a result, 0.2 inches of total rainfall volume provides a conservative metric for defining a wet weather event.

Figure 3 provides insight on the size storms in weather forecasts that provide a strong probability of capturing a CSO event. Based upon the memo, the plan is to mobilize for wet weather monitoring for storms predicted to be 0.5 to 1.0 inches in volume since these storms events are more likely to result in combined sewer overflows. The preliminary statistical analysis of rainfall at Newark Airport indicates that approximately 75 percent of storms have rainfall volumes equal or less than 0.5 inches, while 90 percent of storms have rainfall volumes equal or less than 1.0 inches. While the monitoring program will be designed to capture a variety of storm volumes, durations and intensities to facilitate robust model calibration, individual storms can be expected to have varying characteristics across the study area. Storm events that fall outside of the target range are still relevant, and therefore data collected from all rainfall events will be presented in the monitoring report. The elimination of an overflow event because it does not fit within artificially established guidelines could introduce a bias to the data and result in the model not being truly representative of the area. The intent is to sample within the parameters established, however, the use of smaller or larger storms for the purposes of model calibration and validation will be considered acceptable, given that a sufficient number of storm events causing a discharge have been captured. A minimum of three (3) events will be collected for a model calibration and model verification. The Model Evaluation Group will be asked to provide input regarding the number of

events used and their overall distribution.

Since rainfall radar was not available at the time the past studies were performed, temporary precipitation gages were installed throughout the district to classify return periods and spatial variability. A statistical analysis was completed using data from the Newark NOAA Weather Station. That analysis will be revisited using the historical data that has been recorded since completion of the past studies. The statistical analysis will be updated with data from 2012 to present, to identify return frequencies of storms and to identify the "typical year" for the purposes of performing the alternatives evaluations. For the previous study, 1988 was specified by NJDEP as the "typical year. Upon reviewing and updating this past analysis, the "typical year" will be identified.

Figure 3 – Rainfall Volume Probability Plot



Collection System Model Validation - A primary use of the monitoring, metering, and sampling data will be for further validating the collections system model that was calibrated under the 2003 permitted required characterization work. Adjustment of model coefficients will be made so that the mathematical model provides an adequate representation of the combined sewer areas and their response to wet weather conditions. Principal model calibration parameters will be sanitary flow rates, contributing imperviousness and hydrograph shape factor for each subcatchment, Manning's pipe roughness coefficient, and the concentration of each simulated water quality parameter in wastewater and stormwater. Coefficients will be adjusted to develop a representative match between the flows and pathogen concentrations computed by the model, and the recorded rainfall, metered wastewater flows and the lab analyses of pathogen concentrations for each of the storm

events examined. The Sewer System Characterization Report that is due July 1, 2018, will include all of the model input parameters as well as the basis for each parameter, including identification of which parameters were adjusted to calibrate the model. The electronic InfoWorks input file and output files of the model as well a summary of input parameters and results will be included in the Sewer System Characterization Report. Section E of this document provides additional details.

Characterization of Sanitary, Stormwater and CSO Wastewater Quality - Characterization of Sanitary, Stormwater and CSO Wastewater Quality - Suitable statistical and other analyses and appropriate data tabulations will be developed so that bacteria concentrations in sanitary wastewater during dry weather and CSO quality during wet weather can be characterized. At selected stations with various land uses, stormwater quality will be sampled. Comparison of these results with similar data for other locations, as well as regional and national data sources will serve several purposes. These characterizations will provide a basis to calibrate the proposed mass balance approach. The mass balance approach estimates bacteria concentration in CSO through mixing fixed concentrations of bacteria assigned to sewage and stormwater respectively. The analysis will also help quantify CSO quality among different land uses or sewersheds within the PVSC service area.

If, during subsequent receiving water model calibration, the mass balance approach is found to yield a poor fit between observed and calculated receiving water bacteria concentrations, the water quality component of the landside model will be reconfigured to improve its value for receiving water quality analysis. Alternative water quality approaches for the landside modeling could include options such as implementation of a buildup-washoff component for stormwater bacteria loads, or definition of more refined bacteria source categories, such as sanitary sewer inflow, and infiltration flows in sanitary sewers, combined sewers, and separate drainage systems.

If the mass balance approach is not used, this QAPP and the Receiving Water Quality Modeling QAPP will be amended to include the modified approach.

Project/Task Description

Precipitation monitoring, wastewater quality sampling and flow metering will be conducted so that combined sewer overflow quantity and quality can be characterized for each of the combined sewer drainage areas, including determination of relationships between rainfall, runoff/overflow volume and pathogen loads. The data obtained will be used in the validation of the InfoWorks Collections System Model for all the combined sewer drainage basins tributary to the PVSC control facilities and main interceptor sewer. Monitoring will include rainfall intensities, volumes, and duration as well as receiving water stage to determine any backwater effects upon tide gates and discharge volumes.

The scope of work includes precipitation monitoring, metering of wastewater flows, and wastewater quality monitoring of CSO discharges. Each of these tasks is summarized separately within this QAPP. The task summaries reference the work performed under previous studies,

provide support for the use of the data collected during the past studies, and identify the proposed work to be performed under this QAPP. The proposed work will supplement the available data and be used to update the landside model. Information collected will be used to verify the maximum conveyance capacity of the collection system and to demonstrate under the alternatives evaluation task for the CSO LTCP development the relationship between PVSC accepting additional wet weather flows and the associated impacts on CSO discharges as well as other required alternative evaluations for the LTCP: green infrastructure; increased storage capacity in the collection system; STP expansion and/or storage at the plant; I/I reduction; sewer separation; and treatment of the CSO discharge and CSO related bypass of the secondary treatment portion of the STP.

Scope for Precipitation Monitoring

Historical precipitation data collected over a 22 month period was used in the analyses performed for the December 1998 Rainfall Monitoring Study. The 2003 CSO Characterization Study Modeling Report utilized this data in developing the relationship between rainfall and the conditions which produce combined sewer overflows within the sewer district. The previous studies undertaken by PVSC in the region showed a marked difference between the rainfall duration, intensities, and volumes in Paterson and Newark. Long term rainfall characterizations and statistical analyses were performed using historical rainfall data from the Little Falls and Newark United States Weather Service (USWS) gages to determine if consistent spatial differences in rainfall patterns could be identified throughout the PVSC sewer district. The analysis concluded that the northern end of the project area (near Paterson) experiences larger storm events with somewhat shorter durations and hence higher average intensities.

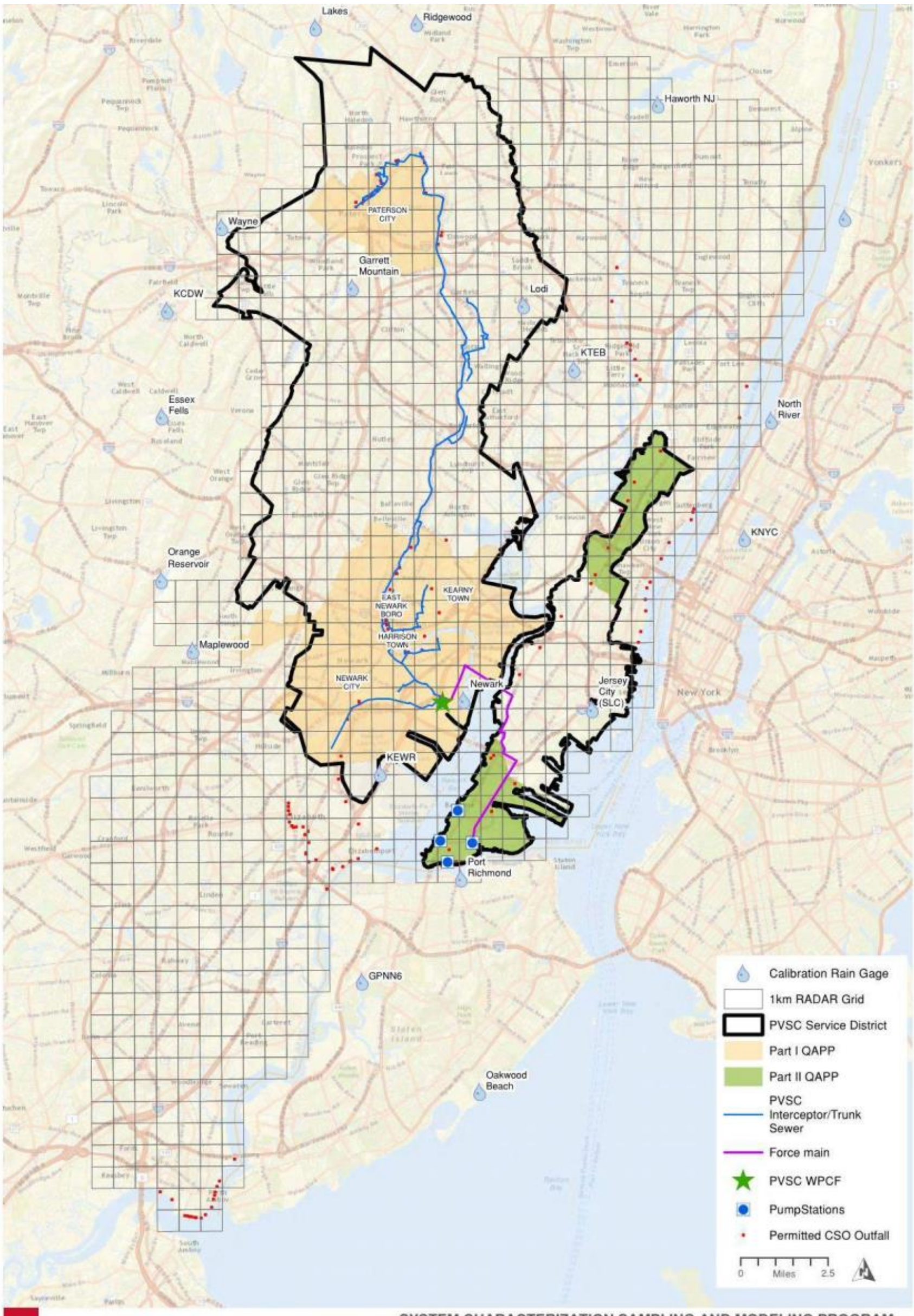
The first task to be completed under this QAPP will be to reevaluate and update the relationship between rainfall and the conditions which produce CSOs within the sewer district. More recent historical precipitation data will be used to supplement the data used in the historical precipitation analyses performed for the December 1998 Rainfall Monitoring Study. The past analyses will be revisited and will include the reevaluation of more recent climatological records for the purposes of updating historic and measured rainfall event statistics to consider changes in precipitation trends over the past 15 years.

To cost-effectively address spatial variation of precipitation and in consideration of technological advances since the performance of the past characterization studies, rainfall radar will be used for calibration of the receiving water and landside models as discussed in Section E.

A rainfall radar network has been developed for the CSO Alert and Discharge Monitoring Report (DMR) System. This network has been calibrated using existing rain gages located throughout the study area. It is common industry practice to use reliable rainfall data from outside the domain of interest to inform calibration of the radar-rainfall model. Additionally, there is a need to determine a method for estimating flows from the Passaic and Hackensack rivers that are not accounted for by the USGS gauges on the Passaic at Paterson (01389890) and the Hackensack at New Milford (01378500). If streamflow is modeled from ungaged areas using a hydrologic model, there will be a need for robust rainfall data for these areas. Most of Alpine drains either east directly to the Hudson, or west toward Oradell Reservoir and thus the USGS Hackensack River gauge. However, the southernmost part of the town drains southwest to the Hackensack River via Overpeck Creek, and may thus need rainfall data for use in simulating streamflow. The actual grid would however focus on the model domain. **Table 1** provides a listing of the gages used in the calibration while **Figure 4** identifies the location of each of the gages. Data from these gages will also be used to perform the Rainfall-Overflow Correlation Analysis and the Rainfall Event Characterization.

Table 1 – Existing Rain Gages Used in Rainfall Radar Calibration

Name	Network
Central Park	NOAA/NCDC
Essex County AP	NOAA/NCDC
Newark Liberty IAP	NOAA/NCDC
Teterboro AP	NOAA/NCDC
Essex Fells	USGS
Franklin Lakes	USGS
Garrett Mountain	USGS
Lodi	USGS
Maplewood	USGS
Newark	USGS
Orange Reservoir	USGS
Ridgewood	USGS
Wayne	USGS
New Brunswick	NJ Mesonet


Lakes
Ridgewood
Haworth NJ
Wayne
PATERSON CITY
Garrett Mountain
KCDW
Lodi
KTEB
Essex Fells
North River
KNYC
Orange Reservoir
EAST NEWARK BORO
KEARNY TOWN
HARRISON TOWN
Maplewood
NEWARK CITY
Newark
Jersey City (SLC)
KEWR
Port Richmond
GPNN6
Oakwood Beach
Calibration Rain Gage
1km RADAR Grid
PVSC Service District
Part I QAPP
Part II QAPP
PVSC Interceptor/Trunk Sewer
Force main
PVSC WPCF
PumpStations
Permitted CSO Outfall
0
Miles
2.5
Hatch Mott MacDonald
SYSTEM CHARACTERIZATION SAMPLING AND MODELING PROGRAM
LOCATION OF EXISTING GAGES USED IN RADAR CALIBRATION
Figure 4

Scope for Collections System Metering

The past system characterization and modeling reports utilized data from several sources as follows:

1. Existing PVSC In-System Flow Meters – These existing permanent meter sites provided either flow or level data that was used in the past model calibration tasks. Current data can be used from these meters to calibrate dry weather and wet weather conditions and establish boundary conditions. Per Louis Lambe, PVSC Superintendent of Line Operations, these meters are calibrated at a minimum of every two months.
2. Past Temporary PVSC In-System Flow Meters – Installed from January 1997 through March of 1999, the flow and level data from these meters were used to better characterize surface runoff characteristics within the CSO drainage basins.
3. Past PVSC CSO Meters – These temporary meters were installed at rotating outfall and regulator sites between 1999 and 2001. Five Paterson sites were metered in 2000-2001 and four sites located in East Newark, Kearny and Harrison were metered in 1999. The CSO data was used to calibrate and validate the modeled CSO discharge predictions.
4. Past PVSC Sewershed Metering - Each of the 42 sewersheds outside of Newark were metered for 30 days on a rotating basis between April 1997 and August 1998. The data collected during this period was used to calibrate the model for dry weather conditions.
5. Past Temporary Newark Flow Meters – Regulator and Outfall flow data was collected for eight CSO sites. In addition, the City metered flows entering from the City of E. Orange at two locations. The data was collected from May 1998 through January 2000 and used to calibrate and validate the city's collections system model.
6. Past PVSC In-System Water Level Monitoring – Seventeen (17) water level meters and one (1) flow meter were installed along the main interceptor sewer and select branch sewers to improve the calibration of the PVSC interceptor model during larger intensity wet weather events. Monitoring was conducted using meters with redundant level sensors, typically a pressure sensor and a sonic meter. All meters are tested for flow and/or level accuracy and stability before installation and were calibrated on installation for velocity and/or level. Data from each sensor was downloaded electronically to a central data collection center approximately every four hours, and all metering sites were viewed online two or three times per week. If an issue or inconsistent data was detected, a field crew was dispatched for a maintenance visit. Each site was visited at least monthly for maintenance including: a visual inspection of all meter and sensor components; a review of previous period's data to search for anomalies in the meter performance; physical calibration of velocity and/or level; and replacement of any questionable equipment. A preliminary and final QA/QC of the data included checking the validity of each data point, flow balance, comparison of observed flow to expected flow (pipe rating curve), etc. These meters were spread throughout the main interceptor so that water surface elevation data could be captured throughout the system to allow for recalibration of the IW model that would result in more reliable calculations of water depths in the pipes during high flow events. This data was collected from April of 2015 through October of 2015.

Based upon a review of the extensive metering performed for the past studies, no additional

metering is necessary along PVSC's main interceptor sewer. However, data will be collected at combined sewer overflow regulator inflow and overflow locations to include monitoring for a period of twelve (12) weeks at eight (8) regulator sites. These sites generally consist of the larger CSO basins that introduce the greatest volume of CSO to the collection system and contribute the highest volume of CSO discharge. Past metering sites were selected as these sites are known to be accessible and suitable for meter installation. These sites also overlap with the sites selected for representative CSO sampling, providing for a consistent source of data for the system characterization. This data will be used to confirm any variations in overflow characteristics due to modifications made to the collection and interceptor systems since the past studies. The supplemental flow data will be collected at some of the past metering sites and used in the update of the landside model.

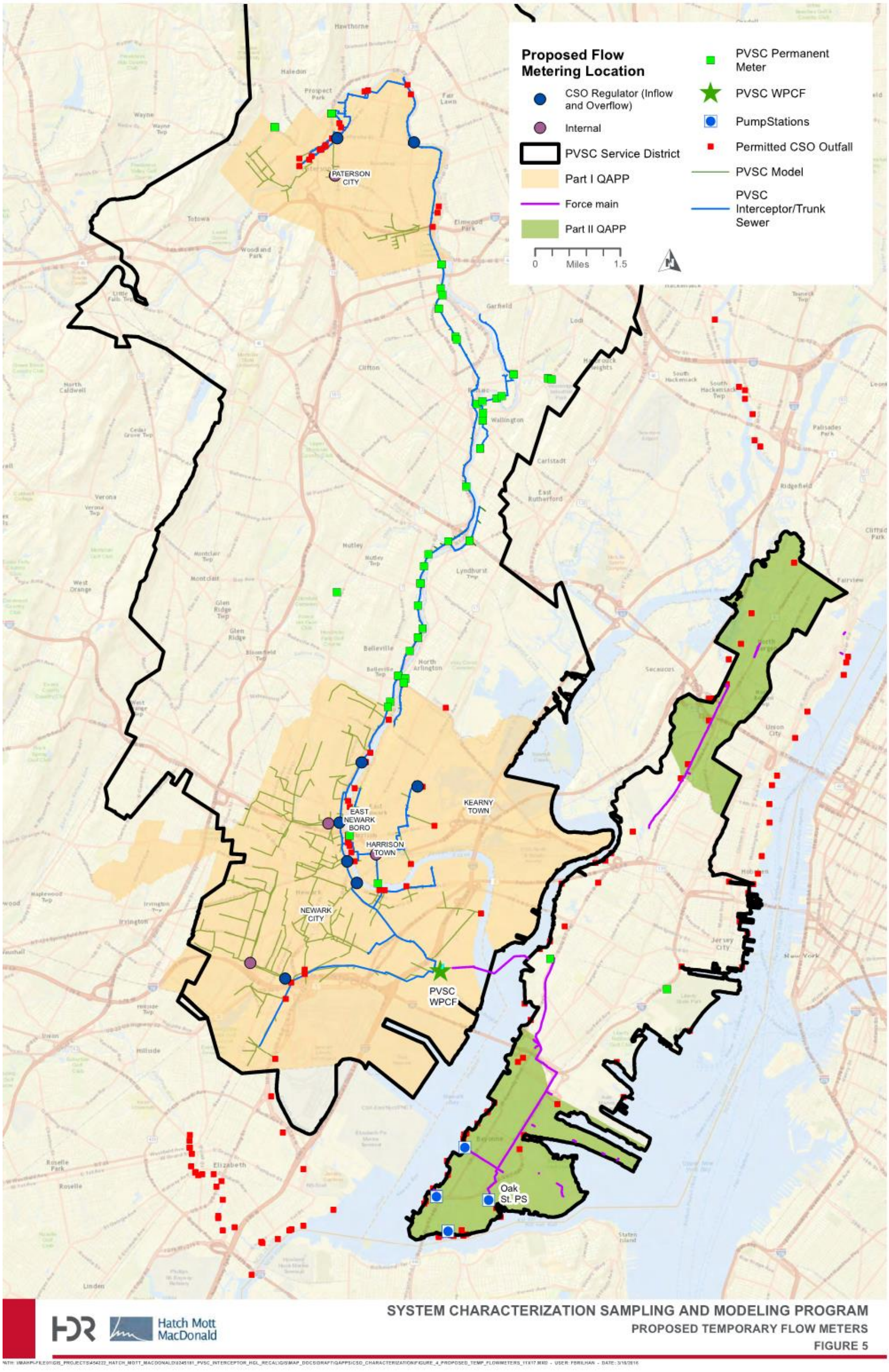
The flow monitoring equipment will be installed in the combined trunk sewer upstream of the overflow chamber or within the overflow chamber (sandcatcher compartment) of the control facility. The flow monitoring equipment will be installed and maintained by a specialty company who has the expert knowledge in the science of flow measurements. The flow data reports from the flow monitoring company are accompanied with QA/QC data that demonstrates validity of the results or flags results that are questionable. Calibration and maintenance procedures will be requested from the specialty flow monitoring company and shared with NJDEP upon request. Sensors will be installed within the incoming sewer and/or overflow chamber to measure depth of flow and velocity. The precise location of the sensors will be determined during the field visit with the flow monitoring company since logistical and practical considerations unique to each site (such as access, proximity to changes in flow patterns, depth of flow initially observed, sediment deposition, etc.) affect the final location for the sensor. Figures showing metering locations and configuration of sensors, with photos of installed flow monitors will be provided in the Sewer System Characterization Report. The depth measurements will be used to determine the overflow rate by using the height of flow over the weir adjusted for tidal or high water influences. Weir formulas established in previous studies and/or scattergraph methodologies will also be used as appropriate based upon the individual site conditions. More detail on the type of flow meters and sensors to be used, final locations and SOPs will be provided after the metering subcontractors have completed their site evaluations and provided their proposals for performance of the work. The SOPs provided will address the specific meters, sensors and other equipment installed, as well as the site characteristics that may influence meter performance and accuracy.

In addition to the eight regulator sites, four additional meters will be placed in large CSO drainage basins in Newark, Harrison, Kearny and Paterson over the same twelve (12) week monitoring period. The meters will be located along free flowing portions of trunk or collector sewers to provide additional data for characterizing runoff conditions in each of the sewersheds.

Table 2 summarizes the proposed temporary flow metering locations while **Figure 5** illustrates the location of the proposed metering locations.

Table 2 – Location of Proposed Temporary Flow Meters

Municipality	NJPDES Permit No.	Name	Monitoring Location
Paterson	025A	Morlot Avenue	Overflow Chamber
Paterson	006A	Montgomery	Overflow Chamber
Paterson	N/A	Market Street	Internal Collector
Harrison	N/A	Franklin Rodgers Blvd.	Internal Collector
Kearny	007A	Ivy Street	Overflow Chamber
Newark	004/005A	Herbert Pl	Overflow Chamber
Newark	009/010A	Clay Street	Overflow Chamber
Newark	009/010A	Clay Street	Internal Collector
Newark	014A	Saybrook	Overflow Chamber
Newark	015A	City Dock	Overflow Chamber
Newark	025A	Peddie	Overflow Chamber
Newark	025A	Peddie	Internal Collector


Proposed Flow Metering Location
CSO Regulator (Inflow and Overflow)
Internal
PVSC Service District
Part I QAPP
Force main
Part II QAPP
0 Miles 1.5
PVSC Permanent Meter
PVSC WPCF
PumpStations
Permitted CSO Outfall
PVSC Model
PVSC Interceptor/Trunk Sewer
PATERSON CITY
EAST NEWARK BORO
HARRISON TOWN
KEARNY TOWN
NEWARK CITY
PVSC WPCF
Oak St. PS
SYSTEM CHARACTERIZATION SAMPLING AND MODELING PROGRAM
PROPOSED TEMPORARY FLOW METERS
FIGURE 5

Sanitary Wastewater Quality Monitoring

Wastewater sampling data collected during dry and wet weather conditions for the December 1998 CSO Discharge Characterization Study and the December 2003 CSO Characterization Study Modeling Report and February 2004 CSO Modeling Study will be utilized in the collection system model development. Specifically, this data will be used to define sanitary sewage pathogen quality for use in the mass balance approach to calculate CSO overflow quality. These PVSC led studies covered the Towns of Kearny and Harrison, the Borough of East Newark and the City of Paterson. Data developed in preparation of a separate study performed by the City of Newark entitled *Monitoring Data Report Newark CSO Discharge Characterization Study* March 2000 will also be utilized in development of the System Characterization. This 2000 study included chemical and biological sampling at CSO sites to measure the concentrations of pollutants being discharged at CSOs in Newark. Data from this sampling was used to calibrate and verify a storm water management model for the Newark combined sewer system.

While such parameters as biochemical oxygen demand, chemical oxygen demand and total suspended solids may be influenced by loss of industry since performance of the past studies, pathogens (the focus of this study) are not expected to be impacted. The collection of fecal coliform data, as part of this study, will be used to verify this concern. The fecal coliform data will be supplemented with the analysis of E. coli and enterococcus, as site appropriate, for assessment of the proposed USEPA Recommended Recreational Water Quality Criteria.

The sampling data presented in each of these past studies was performed under approved QAPPs and evaluated the following pollutant parameters.

Lab Analyzed Composite Samples

- Total Suspended Solids (TSS)
- Total Dissolved Solids (TDS)
- Settleable Solids
- 5-Day Biochemical Oxygen Demand (BOD_5)
- Chemical Oxygen Demand (COD)
- Total Kjeldahl Nitrogen (TKN)
- Ammonia-Nitrogen (NH_3-N)
- Nitrate-Nitrogen (NO_3-N)
- Nitrite-Nitrogen (NO_2-N)
- Total Phosphorus (TP)
- Orthophosphate (OP)
- Hardness (Newark Only)

Field Analyzed Grab Samples

- Temperature
- pH
- Dissolved Oxygen (PVSC only)
- Conductivity (PVSC only)

Lab Analyzed Grab Samples

- Fecal Coliform Bacteria

The data collected under the past PVSC led studies will be supplemented with data collected under this QAPP.

Water quality monitoring under this QAPP will be limited to pathogen sampling during dry and wet weather conditions. In consideration of pending action by NJDEP in response to the Recreational Water Quality Criteria recommended by USEPA for the protection of public health and welfare for those waterbodies designated for water contact recreational activities, the work under this QAPP will supplement pollutant parameter information collected under past studies with new pathogen indicators identified in the USEPA criteria. Dry weather samples will be taken just prior to each rain event sampled and utilized in verifying the current baseline conditions versus the past dry weather sampling data. Dry weather samples will be collected once the sampling teams are mobilized and site set up is complete, and prior to the start of the anticipated rain event, and will be contingent on observing flow at the time approximating dry weather conditions. Discrete grab samples will be collected and analyzed for fecal coliform and enterococcus for outfalls that discharge to saline and fresh waters. E. coli will also be analyzed for those outfalls that discharge to fresh waters.

In consideration of the cost and logistical issues of performing event sampling for fifty-four (54) CSOs over a large planning area, the wastewater quality sampling will be limited to a select set of sampling stations. This process is consistent with the past studies and will utilize most of the past sampling stations. The wastewater quality sampling conducted under this QAPP will include twelve (12) of the fifty-four (54) CSO drainage basins tributary to the Passaic Valley Sewerage Commission's main interceptor sewer from the municipalities of Kearny, East Newark, Harrison, Newark and Paterson. The twelve CSO drainage basins cover a total area of approximately 4,600 acres, or over three-quarters of the land area within the study area. These areas provide for a sufficient range of land uses to allow for the data to be applied to the remaining forty-two 42 CSO basins based upon similarities in land use characteristics. The data collected from these twelve (12) sampling stations will thereby serve as "representative" data for the other 42 CSO outfalls.

Land use changes from 1995 to 2012 will be reviewed using available aerial photography and GIS database information. Land uses will be simplified and broken down into the following categories: low and high density residential, open space, commercial and industrial. The data collected from the twelve representative monitoring stations will be applied to each of the 42 un-monitored stations as appropriate based on similarities in land use distributions within the CSO drainage basins.

CSO Wastewater Quality Monitoring

Water quality sampling at each of the twelve (12) proposed monitoring stations will be limited to the collection of grab samples and analysis for fecal coliform and enterococcus. Grab samples for analysis of E. coli will also be collected at those monitoring sites where the outfall discharges to a fresh water receiving waterbody.

The goal of the event sampling protocol is to obtain three wet-weather events of sufficient depth, intensity, and duration for valid model calibration. Sampling crews will mobilize in advance of a

rain event and conduct a round of dry weather sampling prior to each event and commencement of wet weather monitoring. Wet weather sampling will commence upon activation of an overflow event and continue through the cessation of the CSO event. After activation of the CSO event, sampling will continue to be performed at the following intervals throughout the duration of the CSO event: 0.5 hour, 1 hour, 2 hours, 4 hours, and 8 hours. CSO sampling will end upon collection of the sample at the 8 hour interval or upon cessation of the CSO discharge, whichever occurs first. Only a single sampling point will be established at each sampling station since adequate in-system mixing should occur during rainfall events. Monitoring will be conducted in the sandcatcher of the regulator. The sandcatcher is a standard part of the PVSC regulator design, and essentially all PVSC regulators have them. Should safe accessibility to the sandcatcher be an issue, a manhole upstream of the regulator chamber will be utilized as an alternate sampling location.

Table 3 provides a summary of each of the twelve sampling locations, the associated permit identification number, permittee and location. **Figures 6, 7 and 8** (and the detailed site drawings contained in Appendix F) illustrate the location of each of the wastewater quality sampling stations in Paterson, Kearny/Harrison and Newark respectively.

Table 3 - PVSC System Characterization Wastewater Quality Sampling Stations

NJPDES Permit No.	Permittee	Location of Sampling Stations
006A	Paterson	River Street & Montgomery Street
025A	Paterson	~~10th Avenue & 33rd Street~~ E 36th btwn Mclean Blvd & 11th Ave.
027A	Paterson	~~Market Street~~ McLean Blvd @ Ramp
029A	Paterson	Loop Road
030A	Paterson	~~19th Avenue~~ E. 41st btwn 19th & 20th
007A	Kearny	Ivy Street near King St.
006A	Harrison	Bergen Street
007A	Harrison	~~Worthington Avenue~~ Supor Blvd @ Bergen St
004/005A	Newark	Herbert Place
009/010A	Newark	Clay Street
014A	Newark	Saybrook Place
025A	Newark	Peddie

Figure 6 – Location of Proposed Supplemental System Characterization Wastewater Quality Sampling Stations – City of Paterson

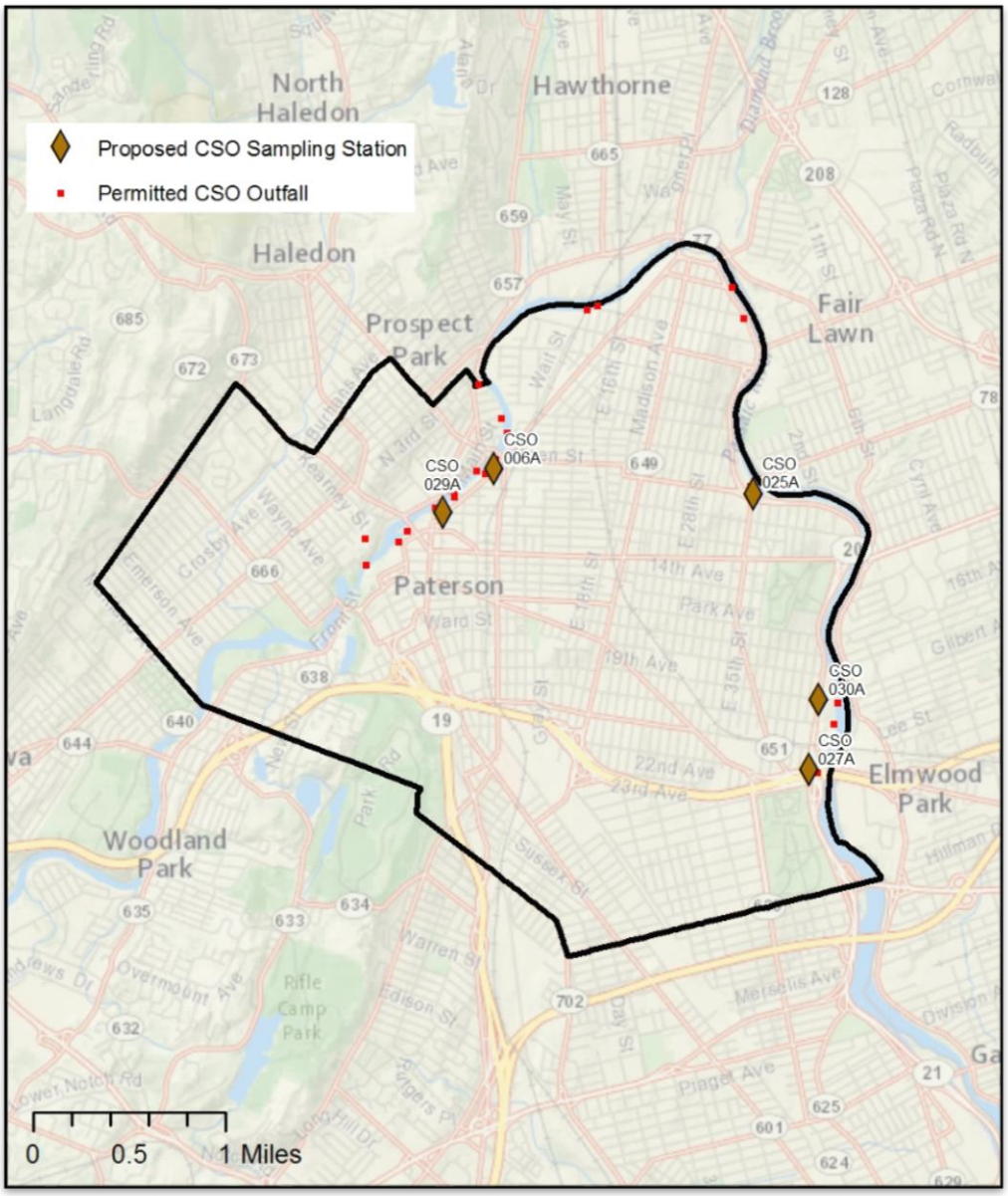


Figure 7 – Location of Proposed Supplemental System Characterization Wastewater Quality Sampling Stations – Towns of Kearny and Harrison

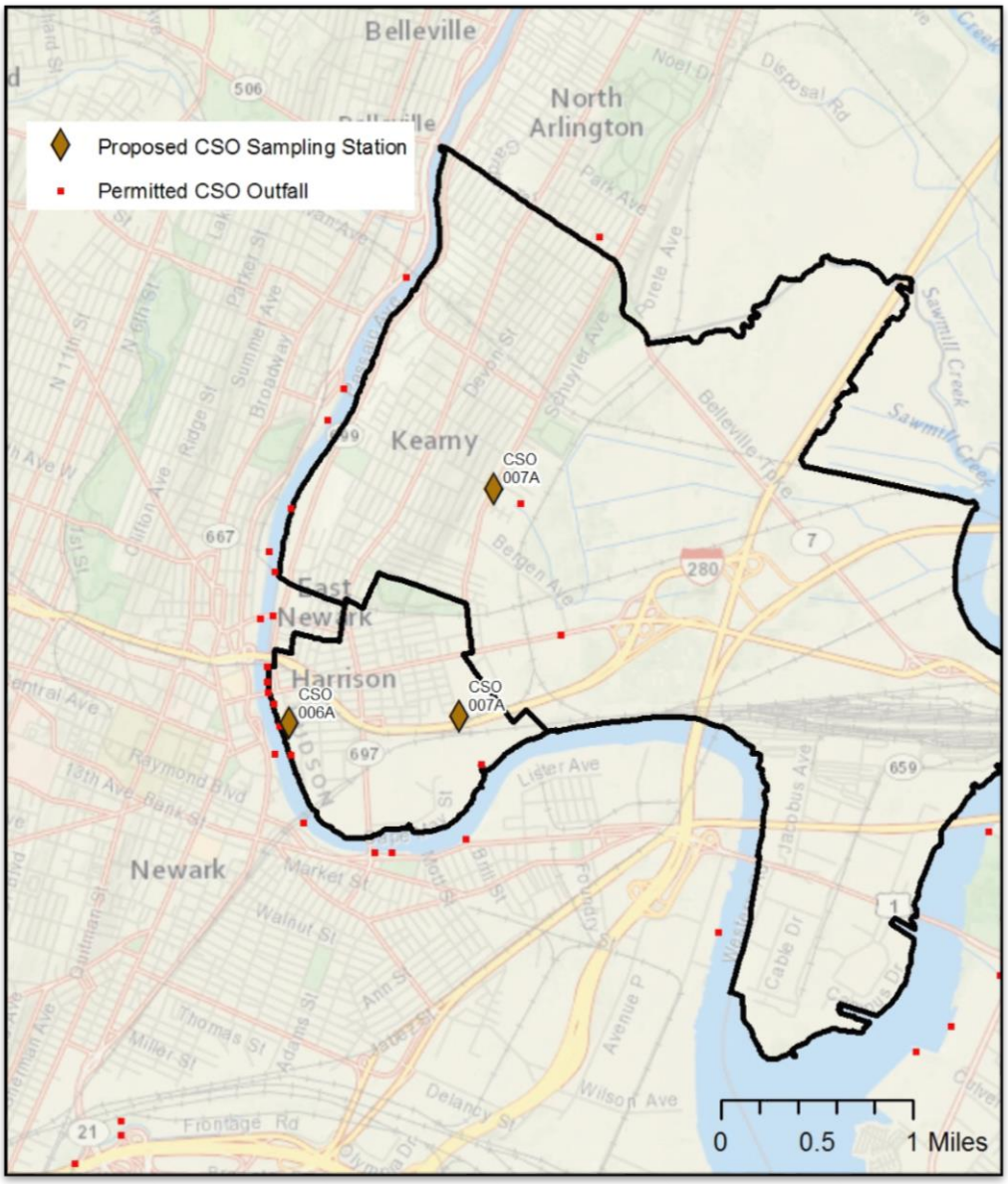
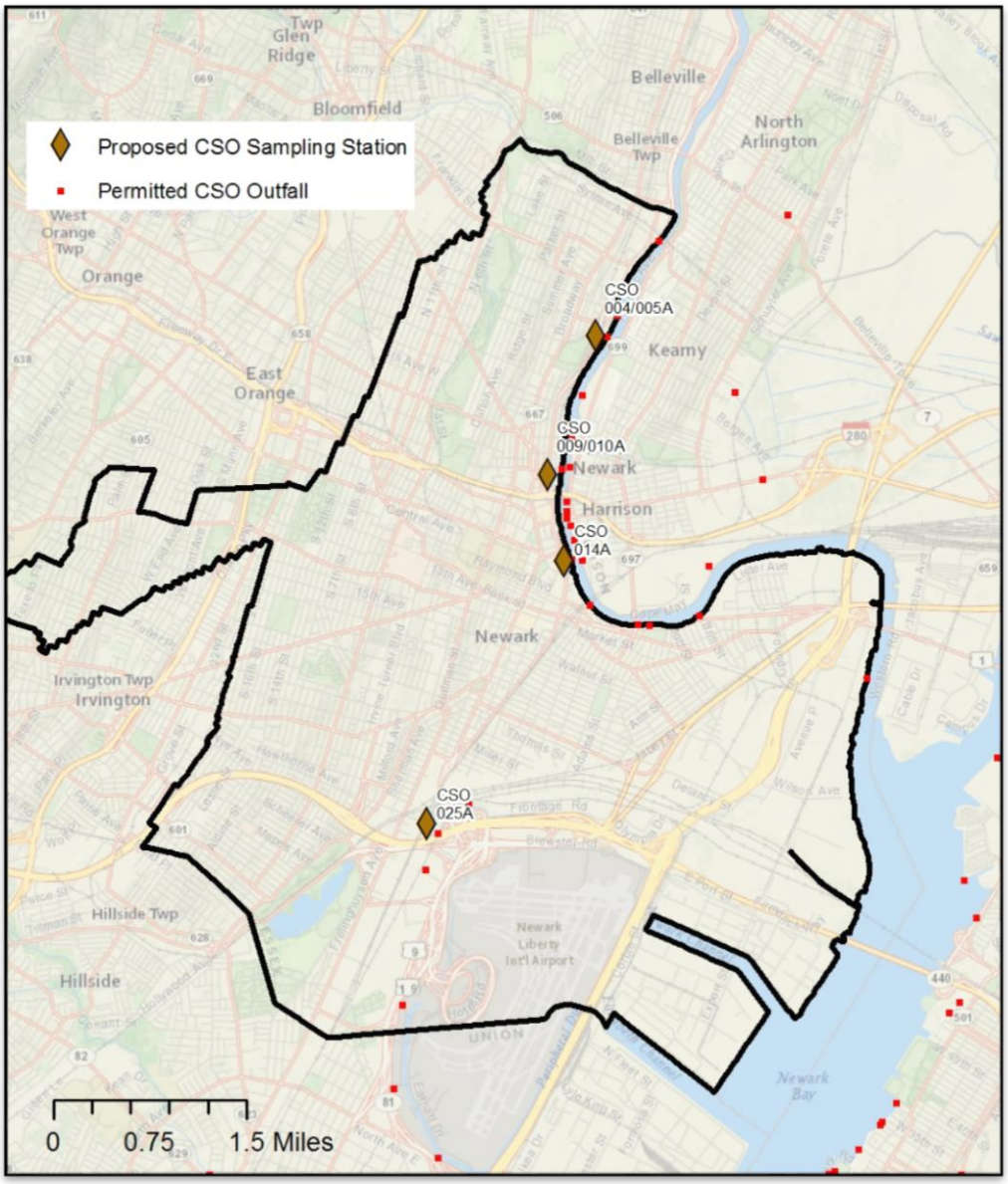


Figure 8 – Location of Proposed Supplemental System Characterization Wastewater Quality Sampling Stations – City of Newark



Stormwater Quality Monitoring

A stormwater sampling program will be performed to characterize pathogen concentrations in runoff from various land uses in the PVSC District. However, identification of ideal stormwater sampling sites is difficult because the availability of separate storm sewer systems maps is limited. While stormwater outfalls for separate sewer systems can be identified, the lack of mapping prevents delineation of tributary drainage areas with specific land use characteristics. However, as a number of the CSO permittees tributary to the PVSC main interceptor have performed separation projects and in some cases have eliminated CSO outfalls, the storm sewers in these areas should provide representative stormwater sampling locations of typical land-uses in the study area.

A total of eight (8) sampling stations are proposed with sampling to be performed for three (3) wet weather events. Four (4) samples will be collected per station for each wet weather event. Time intervals between samples will vary by event and likely by location as well, based upon the expected duration of the event and the size of the outfall. Storm sewers in combined municipalities that serve areas made up of a single predominant land use have been identified. Two (2) stations covering each of the following land uses for a total of six (6) sites have been identified in Paterson and Newark: high density residential, low-medium density residential, and commercial/industrial. The locations of these sites are identified in **Table 4** and **Figures 9, 10 and 11** (and the detailed site drawings contained in Appendix F). In addition, two (2) low-medium density residential drainage basins have been identified in the separately sewered municipalities of Hawthorne and Oakland.

Table 4 - PVSC System Characterization Stormwater Quality Sampling Stations

Land Use	Permittee	Location of Sampling Stations (nearest intersection)
LDR-1	**Paterson**	**Short and Goffle Streets**
LDR-2	**Newark**	**Kerrigan Boulevard and Ivy Street**
LDR-3	**Hawthorne**	**Westervelt Avenue and North 7 Street**
LDR-4	**Oakland**	**Oswego Ave between Hiawatha Blvd and Calumet Ave**
HDR-1	**Newark**	**North ~~10th~~ 9th Street and 3rd Avenue**
HDR-2	**Newark**	**Goldsmith Avenue and Aldine Street**
CI-1	**Paterson**	**~~6th Avenue and~~ Shady Street btwn 6th and Peel St**
CI-2	**Newark**	**NJ Railroad Avenue and Vanderpool Street**

LDR - Low-Medium Density Residential
HDR – High Density Residential
CI - Commercial/Industrial

The pathogen data from each of the representative sites will be used for comparison with literature values and adjusted accordingly for use in the respective landside model for the characterization of CSO and stormwater discharges. Literature values for pathogen concentrations will be used for open space. In addition to the permittees identified in this QAPP, the stormwater pathogen concentrations will also be used as representative data for the Part 2 QAPP for Bayonne, and North Bergen and the North Bergen/Guttenberg QAPP.

Figure 9 – Location of Proposed Stormwater Sampling Stations – City of Paterson and the Township of Hawthorne

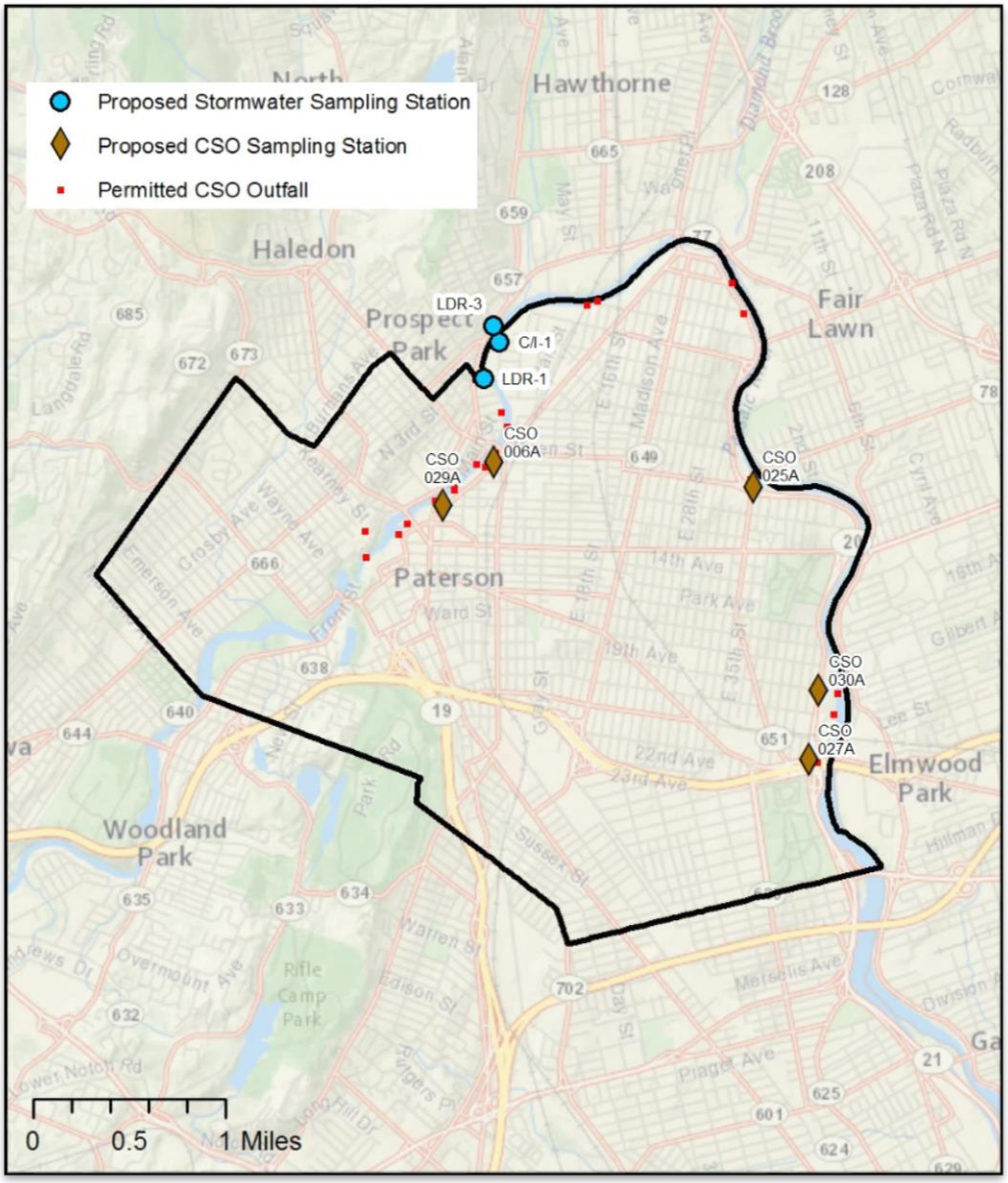


Figure 10 – Location of Proposed Stormwater Sampling Stations – City of Newark

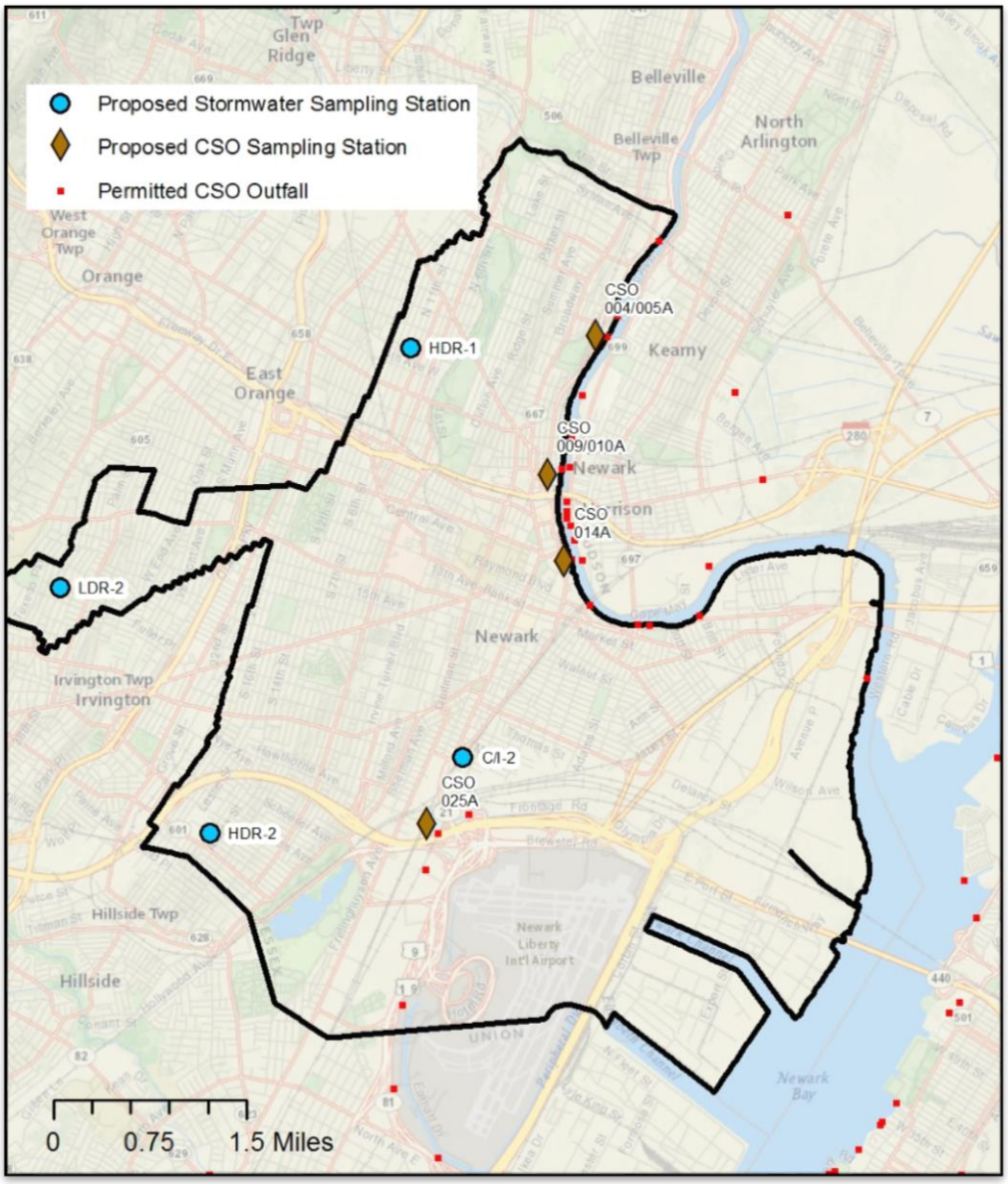
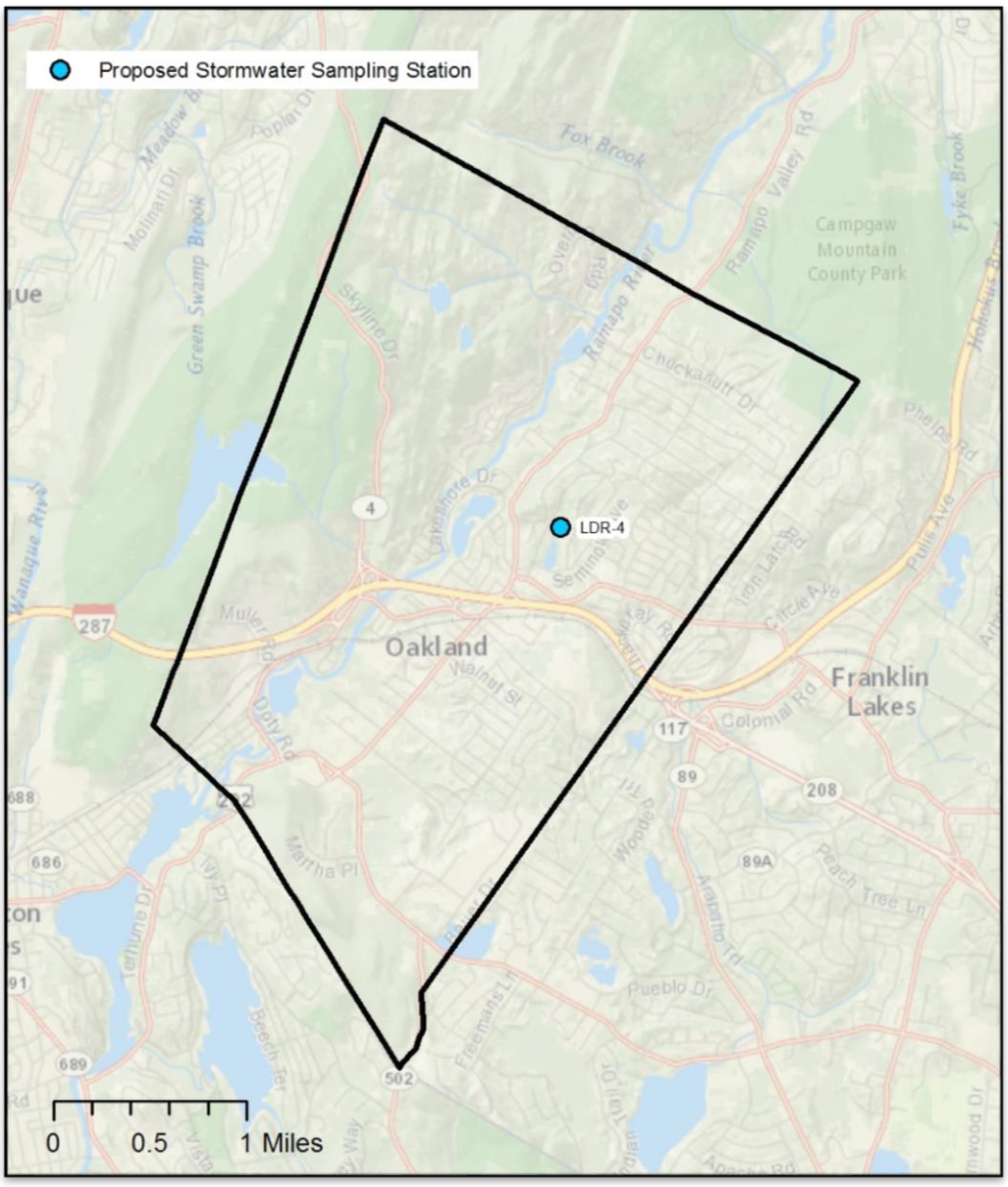


Figure 11 – Location of Proposed Stormwater Sampling Stations – Borough of Oakland



Consideration of Sensitive Areas
Paragraph G.3 of the Combined Sewer Management Section of PVSC's NJPDES Permit requires CSO permittees to "give the highest priority to controlling overflows to sensitive areas". The permit identifies a separate report deliverable for this evaluation due on July 1, 2018. As the system characterization will provide information necessary to evaluate the potential impact of CSOs on sensitive areas, it will be necessary to perform the evaluations and report development in parallel.

A preliminary evaluation indicates that the receiving waters within the influence of the CSOs are not designated Outstanding National Resource Waters or National Marine Sanctuaries. Upon calibration and validation of the receiving water quality model, further evaluation of the influence of CSOs on waters used for primary contact recreation, public drinking water intakes (or their designated protection areas) and shellfish beds can be further evaluated. The presence of threatened or endangered species and their habitats will be investigated and the potential impacts evaluated. Once the sensitive areas have been identified, the results of the landside and receiving water models will be reviewed for those CSOs potentially impacting these areas, to characterize the impacts and to develop strategies for controls to be considered during the alternatives evaluation phase of the CSO LTCP development.

Surface Flooding and Basement Backups
Paragraph G.1.b of the Combined Sewer Management Section of PVSC's NJPDES Permit requires the system characterization to "include a thorough review of the entire collections system that conveys flows to the treatment works, including areas of sewage overflows, including to basements, streets and other public and private areas, to adequately address the response of the CSS to various precipitation events." As this information is specific to the operation and maintenance of the individual municipal systems, each permittee is documenting these areas through NJPDES Permit requirements F.1.e.iii and F.1.f.viii "system spreadsheet". This document will be used in the evaluation process for the LTCP. PVSC anticipates that these historic operations issues will be addressed by each individual permittee in their operations and maintenance manuals, which are required to be completed by July 1, 2016.

A.8 Quality Objectives and Criteria
Quality control (QC) procedures will be applied in the field and the laboratory to assess data quality criteria of precision, accuracy, sensitivity, completeness, comparability, and representativeness (**Table 5**).

Table 5 - Data Quality Criteria

Data Quality Indicator (DQI)	Measurement Performance Criterion	Measurement Performance Assessment Activity	S: Sampling A: Analysis
Precision	RPD[1] <30% for field duplicates; RPD[1] <40% for lab duplicates	1 field dup/event 10% lab dups	S & A
Bias/Accuracy	80%-120% Recovery	Reference material	A
Sensitivity	MDL[2] and RL[3]	Daily calibration curve	A
Completeness	Valid data from 90% of collected samples	Percentage of valid measurements	S & A
Comparability	Acceptable PT[4] samples; use of certified laboratories and approved sampling and testing methods	PT[4] samples and recertification of methods and/or laboratories by NJDEP	A
Representativeness	1 equipment blank per sampler per crew per event; Adherence to sampling/handling procedures and program SOPs; Routine equipment maintenance with each event	Equipment blanks < each MDL; documentation of equipment calibration and maintenance	S & A

[1] Relative Percent Difference. RPD values are non-representative when (a) both the original and duplicate results are less than 5x the reporting limit or not detected at the reporting limit or (b) either result is estimated, rejected, or suspected of contamination.
[2] Method Detection Limits are calculated where applicable. For numerical values for each parameter, refer to Tables 5 and 6 herein.
[3] Reporting Limit or Reporting Level: For numerical values for each parameter, refer to Tables 5 and 6 herein.
[4] Performance Test. Part of annual laboratory & method certification for the laboratory performing the analysis.

Precision assesses the variability associated with sample collection, handling, and storage in the field, as well as variability associated with the analytical processes. To address this variability, one sample from each sampling event and sampling group will be collected in duplicate. As an additional assessment of analytical precision, every 20th sample, or at least one sample per batch, will be split in the laboratory for duplicate analysis.

Accuracy, or the closeness of a result to the true value, will be assessed by analyzing a second source QC sample of known concentration with each batch of samples for methods where this is applicable. Those QC samples can be in the form of Laboratory Fortified Blanks or Matrix Spikes, depending on the analytical method.

Sensitivity of the methods will be assessed using predetermined method detection limits (calculated annually as necessary) and reporting limits or levels.

Completeness is a measure of the amount of valid data obtained from a measurement system. It should be expected that at least 90% of data collected will be valid, usable data meeting all quality objectives.

Comparability is a measure of confidence with which one data set (or method) can be considered equivalent to another. Comparability is assessed using Performance Test (PT) samples as part of annual laboratory & method certification for each laboratory participating in the analysis of Program samples. Additionally, comparability is built into the program by using only EPA approved methods and NJDEP Certified Laboratories.

Representativeness is a measure of the degree to which data accurately and precisely represent, in this case, the parameter or environmental condition at the sampling point. Representativeness is established by adhering to sampling and sample handling procedures, equipment maintenance, calibration, and use procedures, and by uniform implementation of all program SOPs. In addition equipment blanks, using laboratory de-ionized water, will be generated each day that samples are collected and for each sampler to be used during that event (includes all sampling groups within each sampling event). Enough equipment blanks will be collected to be analyzed with each parameter of interest.

The objective of the duplicate is to document field equipment cleanliness, field method consistency and the possibility of ambient condition contamination of the samples. The collection apparatus will be lowered a second time to collect a sample at the same time and depth. The duplicate set of sample containers will then be handled in accordance with all sample handling procedures and placed in a cooler on ice to maintain the samples at 4^{o} C. The duplicate samples will be analyzed for all laboratory parameters for which each sample is analyzed.

A.9 Special Training Needs / Certification

A clear understanding of project objectives and data quality criteria is necessary for project personnel to successfully participate in this project. Field personnel are trained in routine field water sampling and in-situ testing techniques. Lab personnel are trained in quality laboratory techniques and in the tests that they will be performing. Each laboratory performing testing for this project will be certified annually by the NJDEP for each parameter.

This QAPP will be appended with the names and certification information of the sampling firm and analytical laboratories when such information becomes available.

A.10 Data Documentation and Review

All data generated in the field and laboratory will be recorded in the appropriate logbook or standardized data form. The information that will be recorded includes: sampling location and date, time, field conditions, raw analytical data and date of testing, sampling and testing personnel, daily sample processing procedures and any corrective actions or deviations from procedures, as necessary. *Primary* data for this project, recorded on data sheets or in laboratory notebooks, will be retained according to each participating laboratory's procedures. The contractor responsible for the sampling efforts will maintain *copies* of the primary data, and/or summary data reports for at least seven years. Other project documentation such as sample chain

of custody records and instrument maintenance and calibration information is maintained on file at each laboratory within their normal documentation systems.

An electronic Excel file will be used to compile data into a single file. The entry of this data into the electronic file is 100% second checked for correctness to eliminate typographical errors. These electronic files are kept by the Field Coordinator. The electronic files of compiled data will be retained for the life of the project.

Routine QC testing is a part of normal procedure at each laboratory collecting data throughout the course of the program. Additional quality assurance reviews of the data are conducted by the project's Field Coordinator (100% of the data) and by the QA Officer (10% of the data) before releasing data in the final report and to secondary data users.

A.11 Corrective Action

If corrective action is required during this project, the QAPP will be revised and redistributed to all project signatories, including the NJDEP Office of Quality Assurance for review and approval.

SECTION B - DATA GENERATION AND ACQUISITION

B.1 Sampling Process Design

The System Characterization Sampling Program is a sixteen (16) week effort of wastewater sample collection/analysis and flow metering for PVSC and the participating permittees. The study design is based on knowledge of the past system characterization efforts, the current conditions of these CSO drainage basins and professional judgment. The study has been designed to provide a means of characterizing the quality and quantity of existing CSO discharges and supporting surface water modeling efforts that will project the success of pollution abatement alternatives to be evaluated under future LTCP tasks. The sampling sites were selected for consistency with the past system characterization efforts and for the purposes of supplementing the past data set. The sampling design also considered the logistical limits of collecting data from multiple stations during wet weather conditions. An effort has been made to prevent unnecessary cost and logistical problems while still meeting the program's objectives.

The data collected in this program should provide an adequate characterization of the pathogen concentrations of CSO discharges in the project area. All sampling methods will conform to the applicable requirements of the *NJDEP Field Sampling Procedures Manual (FSPM, 2005).* Relevant section numbers are provided where applicable.

B.2 Sampling Methods

Sampling Procedures

All samples will be collected in accordance with the NJDEP's Field Sampling Procedures Manual (2005 – Chapter 2: Quality Assurance, Chapter 5: Sampling Equipment, Chapter 6: Sample Collection, and Chapter 10: Documentation). Grab samples for fecal coliform, enterococcus, and E. coli will be collected directly into new sterile HDPE containers and preserved. Field blanks for pathogens will not be conducted.

Sample bottles will be prepared prior to initiating sampling at each site. All sample bottles will be marked with the site ID and location, parameter and date of collection. Time of collection will be listed on the chain of custody. Pre-sterilized disposable bottles will be purchased for bacteria analysis. *(NJDEP FSPM 2005: 2.3 Sample Containers, 10.5.1 Sample Labels, 10.5.2 Chain of Custody).*

Sample Collection and Schedule

The goal of the event sampling protocol is to obtain three wet-weather events of sufficient depth, intensity, and duration for valid model calibration. Event–based sampling is responsive by nature: weather forecasts are checked and crews are mobilized in anticipation of the predicted precipitation event. Due to false starts, insufficient event sizes, and other limitations of event-based sampling, it is anticipated that there will be more than three event-based sampling occurrences. Regardless, no prior authorization is needed for each sampling crew leader, in coordination with the field leader, to change sampling schedule based on unsafe weather, holiday schedules, laboratory logistics, and equipment failure/availability.

Sample Preservation and Transfer Procedure
All samples for laboratory analysis will be preserved per laboratory methods and transferred to the appropriate contracted laboratory for analysis under standard chain-of-custody (COC) protocol. Analysis will be performed by a certified NJ Laboratory for all laboratory parameters reported. All sample bottles used for laboratory analysis will be new and provided by the sampling contractor or the contracted laboratory.

Field Equipment
Prior to the first deployment, each field crew will be provided all equipment necessary to safely and efficiently collect the Event-based wastewater quality samples. The following list includes the items anticipated to be required for each field sampling event, but as the program progresses adaptation and enhancements may be possible:

- *Vehicle*: A cargo van or vehicle with similar capacity to transport the sampling equipment and materials will be used.

- *Sampling equipment*: Coolers with ice, thermometer, de-ionized water, sample bottles with appropriate preservative and sampling pole.

- *Safety equipment*: Traffic cones, hazard lights, flashlights, personal protective equipment safety vests, nitrile gloves, safety glasses, cold and wet weather gear as appropriate.

- *Documentation*: Work plan, field data sheets, COC forms, clipboards.

B.3 Sample Handling and Custody
Samples will be collected and immediately stored on wet ice in a cooler. The temperature of the first sample taken by each sampling crew will be measured upon delivery of samples to the contractor laboratory and will be recorded on chain of custody forms. Note that the last samples taken, depending on the temperature of the sampling waters, may not have time to reach the cooling temperature required by the analytical methodology before delivery to the laboratory.

Chain of custody (COC) documentation tracks the progress of samples from their collection in the field through laboratory analysis. The forms will be completed by field personnel, and will accompany the samples to the laboratory. Each time the samples change hands, the COC form will be signed by the person relinquishing the samples, then by the person receiving them. The Field Coordinator will be responsible for establishing and distributing COC forms to each of the sampling crews *(FSPM 10.5.2).*

B.4 Analytical Methods
Because the data collected is intended to be used in conjunction with the ongoing NJHDG sampling and the Baseline Compliance Monitoring Sampling Program, it is preferable to use the same laboratory methodology as the PVSC laboratory currently employs on the NJHDG's behalf. However, given the large quantity of samples to be analyzed and the use of contractor laboratories, it may be necessary to rely on laboratory results produced using alternate analyses. **Table 6** summarizes the sample preservation and holding times for the methods specific to

PVSC and preferred for this QAPP. **Table 7** lists alternate analyses approved by NJDEP and EPA, along with preservation and holding times. The preference is to use the analytical methods noted in **Table 6.** Should it be necessary, because of laboratory capacity or other such issues, to utilize an alternative analytical technique from **Table 7**, NJDEP will be notified and if necessary this QAPP will be modified for any additional quality control testing that is required.

Table 6 - PVSC Laboratory Analytical Chemistry Analyses

Parameter	Laboratory Method	Preservation	Holding Time	Reporting Limit*
Fecal Coliform	EPA Micro Manual p. 124 (1978), Single Step Membrane Filtration	Cool ≤ 4°C	6 hrs	1, 2, 4, 10 CFU/100 mL
Enterococcus	EPA 1600 (Dec 2009), Membrane Filtration	Cool ≤ 4°C	6 hrs	1, 2, 4, 10 PE/100 mL
E. coli	EPA 1603 (Dec 2009), Membrane Filtration	Cool ≤ 4°C	6 hrs	1, 2, 4, 10 CFU/100 mL

* Values are current as of issuance of this QAPP and are based on dilutions, i.e., lower dilutions yield lower reporting limits and vice versa. CFU: colony forming units; PE: presumptive enterococci.

Table 7 - Alternate Analytical Chemistry Analyses Approved by NJDEP and USEPA

Parameter	Laboratory Method[1]	Preservation	Holding Time	Reporting Limit[4]
Fecal Coliform	Standard Methods MF: 9222 D (1997) MF MPN: 9221 C&E EPA MPN: Micro Manual p. 132 (1978)	Cool ≤ 4°C	6 hrs	1, 2, 4, 10 CFU/100 mL 1.8 MPN/100 mL
Enterococcus	Standard Methods MF: 9230 C (2007)[2] MPN: 9230 B (2007)[2] Other MF: IDEXX labs MPN: Enterolert[3], IDEXX labs	Cool ≤ 4°C	6 hrs	1, 2, 4, 10 PE/100 mL
E. coli	Standard Methods MF: 9213 D (2007)[2] MPN: 9223 B (2013), 9223 B (1997), 9221 B.2 (2006), 9221 F (2006) EPA MF:, 1603-09 Other MF: mColiBlue-24, Hach MPN: Colilert-04[3], Colilert-18-04[3]	Cool ≤ 4°C	6 hrs	1, 2, 4, 10 CFU/100 mL

1. MF = membrane filtration analyses, MPN = most probable number analyses.
2. Although approved, rapid MPN methods have been discouraged by NJDEP.
3. Values are current as of issuance of this QAPP and are based on dilutions, i.e., lower dilutions yield lower reporting limits and vice versa. CFU: colony forming units; PE: presumptive enterococci.

Sample preservation is done in the field following sample collection. Any deviations from the analytical procedures, preservation methods, and/or holding times are recorded in the laboratory notebook or data sheets.

The contractor laboratory selected must be certified annually by the NJDEP for each parameter and must conform to the procedures outlined in N.J.A.C. 7:18, "Regulations Governing Laboratory Certification and Standards of Performance" *(NJDEP FSPM 2005: 2.1.1 Laboratory Certification).* Equipment and supplies utilized in the analytical procedures are specified in each laboratory's SOPs. Instructions for data controls (equipment calibrations, blanks, reference standards, positive controls, etc.) are included in both the SOPs and lab manuals. Minimum detection levels and minimum reporting levels are specified and, if required, calculated annually.

B.5 Quality Assurance and Quality Control

In addition to the Quality Objectives and Criteria listed in Section A.8, additional QA/QC methods will be adhered to. Primary data records (forms, notebooks, or electronically generated data) will be checked for completeness and accuracy. All data that will be electronically entered into the study records (Excel file) will be checked by someone other than the person entering the data. An electronic Excel file will be used to compile data into a single file. The entry of this data into the electronic file will be 100% second checked for correctness to eliminate the possibility of typographical errors. These electronic files will be kept by the Field Coordinator.

Routine QC testing is an integral part of routine laboratory procedure. The contract laboratory will be responsible for the testing of all routine QC samples associated with each method and for evaluating the QC results for each batch of samples (e.g., laboratory blanks, spiked samples, split samples, positive and negative controls). All QC results that fail the appropriate quality control criteria will be documented as part of the data packet, reviewed by the laboratory's Manager and QA Officer, and then communicated to the PVSC Field Coordinator as soon as possible. Additional quality assurance reviews of the data will be conducted by the QA Officer before release of the data to primary and secondary users.

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

Routine preventive maintenance will be conducted to minimize the occurrence of field and laboratory instrument failure and other system malfunctions. All maintenance will be documented in instrument maintenance logbooks.

B.7 Instrument/Equipment Calibration and Frequency

Laboratory equipment used in this project will be maintained, calibrated and operated according to the guidelines in *Regulations Governing the Certification of Laboratories and Environmental Measurements (NJAC 7:18),* and applicable project SOPs. Calibrations for laboratory equipment and instrumentation will be performed prior to sample analysis according to NJAC 7:18 (Subchapters 3, 4, 5, 8, and 9). Field Equipment will be maintained, calibrated and operated according to the specific equipment manuals, and *NJDEP FSPM 2005*. Calibrations for field equipment will be performed prior to sample analysis on each day of use. Routine preventive maintenance will be performed at the frequency as recommended by equipment manuals to minimize instrument failure and other system malfunctions. Instruments will be recalibrated after

conducting any maintenance activity. All maintenance performed will be documented in the appropriate instrument operating record books *(FSPM 10.2).*

Field equipment will be cleaned with mild detergent and rinsed with DI water and inspected for cleanliness and usability before each use in the field *(FSPM 2.4).* Meters for field data parameters will be calibrated at the start of each sampling event. Documentation for each calibration will be recorded on the field data sheets or in field calibration log books.

B.8 Inspection/Acceptance for Supplies and Consumables

Supplies will be inspected to insure they will meet the needs of the project. Any specialized replacement equipment will be tested prior to use.

B.9 Data Management

Primary data for this project will be recorded on data sheets or in laboratory notebooks, and will be retained according to the participating laboratory's procedures. The sampling contractor will maintain *copies* of the primary data, and/or summary data reports for at least seven years in an organized and easily retrievable manner. Other project documentation such as sample chain-of-custody records and instrument maintenance and calibration information will be maintained on file at each laboratory within their normal documentation systems.

Data records for this project will be kept using basic laboratory practices; such as: the writing of corrections in ink, and the use of a single-line to cross out incorrect information, and the labeling of documents with sample ID, date, and signature of analyst. Data records will be stored in each laboratory's normal data files using either data sheets or laboratory notebooks.

Data will be compiled for use using Excel. Excel functions will be used to calculate basic mathematical values (e.g., monthly or seasonal averages, geometric means) for each analytical parameter from each sampling site.

The entry of this data into the electronic Excel file will be 100% second checked for correctness to eliminate the possibility of typographical errors. These electronic files will be kept by the Field Coordinator. The electronic files of compiled data will be retained for seven years past the life of the project.

SECTION C – ASSESSMENT AND OVERSIGHT

C.1 Assessments and Response Actions

Performance and Systems Audits

Only certified laboratories will be permitted to perform the tests specified in this report. To maintain certification, the contract laboratory is required to participate successfully in a performance testing program and is subject to periodic audits.

Performance Audits: All certified laboratories participate in the US EPA's Performance Evaluation (PE) studies for each category of certification. Laboratories are required to pass each of these PE studies in order to maintain certification.

System Audits: As part of certification, each laboratory periodically receives an onsite audit. The findings of these audits, together with the USEPA PE results, are used to update certification status.

Although sampling activities will be executed by a contractor, PVSC has ultimate responsibility for oversight and coordination of these activities. Therefore, although the contractor performing the sample collection and field measurements will provide information to PVSC relative to the program, it will be PVSC, or its designee, that will certify that each sample is collected according to standard procedures. To address this, a trained PVSC employee, or a designee, will periodically review field activities to verify that appropriate protocols are being observed and that each sampling crew is trained on the standard procedures for sample collection, preservation, transportation and chain of custody.

C.2 Reports to Management

Reports

A report will be generated by the contractor or PVSC or both. The following information will be included in the report:

- a description of the program;
- the methods used for sample collection and chemical analysis;
- summary of results;
- anything unusual about the sampling or analysis, including deviations from specific protocols and any other relevant information; and
- the implications of the results as they relate to current and past conditions in the harbor, as relevant.

SECTION D - DATA VALIDATION AND USABILITY

D.1 Data Quality Control

Quality Control procedures are performed throughout each step of the System Characterization and Landside Modeling Program to evaluate Data Quality Criteria based on indicators of precision, accuracy/bias, sensitivity, completeness, comparability and representativeness (see **Table 2**). To gather the information necessary to evaluate these criteria, the following QC samples will be analyzed along with the wastewater quality monitoring samples:

Sampling Quality Control

A collection batch is a set of samples collected by a sampling team during a single sampling event. A duplicate of one field sample is taken for every 20 collected, or at least one per collection batch, if there are fewer than 20 samples. The field duplicate QC requirement for chemical analyses is a relative percent difference (RPD) of < 30%. The field duplicate requirement is a RPD of <40% for *fecal coliform*, *Enterococcus*, and *E.coli*. The laboratory will receive and process the field duplicates and equipment blank samples in the same manner as all investigative samples. The Project and Field Coordinator is responsible for calculating field sample duplicate RPDs.

A one hundred percent Quality Assurance review of Field Sampling QC controls will be conducted by the Project and Field Coordinator and an additional 10% review of the QC controls will be conducted by the Project Quality Assurance Officer, who is independent of any of the actual sampling and testing for this program. The Project and Field Coordinator is responsible for qualifying (flagging) data on the data sheets and in the Excel data file if the data fails any QC requirements.

Laboratory Quality Control

As specified for individual laboratory methods, the following QC samples will be analyzed as necessary and reviewed against QC requirements/limits for that sample and method:

Method Blank: A method blank will be analyzed during each sample batch. The parameter of interest cannot be detected in the method blank above the reported detection limit. If blank concerns are identified, analysis of the sample batch should not continue until the source of the problem is corrected.

Laboratory Fortified Blank (LFB): A LFB will be analyzed during each sample batch. Where appropriate, the results (percent recovery) must fall within the laboratory's control limits. If the LFB is found to be outside the limits, the following corrective actions should be taken:

- check the data and recovery calculations, and;
- check a reference QC standard.

QC Matrix Spike: A QC Matrix Spike will be analyzed during each sample batch. The results should fall within the laboratory's control limits established for each methodology (percent recovery). If a problem is identified, the corrective actions should be as follows:

- check the data and recovery calculations;
- check to determine if the blank spike reference standard is acceptable;
- if only the matrix spike is not within control limits, check the other analytes present for possible sample matrix interference, as detailed in the specific method. If the sample matrix is identified as the problem, this should be noted. If the matrix spike is consistently outside of acceptable limits for a particular parameter, another methodology should be considered for that analyte;
- check the reference QC standard if one has been performed in that batch;
- check for the presence of the analyte at a high value (more than four times the spike level), which suggests invalid spike recovery.

Laboratory Duplicates: 10% of samples from each sampling event, or at least one sample per sampling event, will be split into laboratory duplicate samples and run within the same batch. The QC requirement for laboratory duplicates is a relative percent difference (RPD) of <40%.

Positive and Negative Control Blanks: For bacteriological tests, these blanks will be used with the bacterial tests. A negative control (or blank) will be run with each batch. Positive controls will be run with each new set of agar plates.

D.2 Verification and Validation Methods

Each SOP or laboratory control manual contains the quality control requirements for each test, including, where applicable: method blanks, matrix spikes, precision criteria for field duplicates, minimum detection limits, minimum reporting limits, and maximum reporting limits (for biological tests).

Since all laboratories will be certified for the test methods they will be using for this project, each laboratory will use their standard Quality Control criteria for accepting, rejecting or qualifying data.

A Quality Assurance verification of data will be conducted by the Project and Field Coordinator, and an additional 10% of data verification will be conducted by the Project Quality Assurance Officer, who is independent of any of the actual sampling and testing for this program.

SECTION E – COLLECTIONS SYSTEM MODELING

E.1 Collections System Modeling

The monitoring and modeling study addressed by this QAPP is designed to update an InfoWorks collections system model for the collection system that serves each of the participating CSO permittees. It will also be used to develop, calibrate and verify the InfoWorks portions of the model upstream of the interceptors, which will be built-out as discussed herein. The InfoWorks model of the combined sewered areas will produce the hydraulic flow and quality information that will be the basis for projecting wet weather, combined sewage flows, volumes and pathogen loadings to the PVSC interceptor and water pollution control facility (WPCF), and ultimately, via the regulator overflows, to the receiving water. The model will permit the evaluation of the interceptor/overflow system's response to a range of hydrologic events, as well as any that would result from actions proposed by the municipalities for improving CSO management or capture.

The overall, comprehensive landside model will provide an essential analysis tool for addressing the NJPDES Permit requirements for maximization of combined sewer flows to the PVSC WPCF in Newark as well as other required alternative evaluations for the LTCP. The landside model will also provide the hydraulic and water quality data that will provide the necessary inputs for a water quality model of the receiving waters. Although a receiving water model is not a specific requirement of the NJPDES Permit, it is anticipated that a suitable model will be required to allow for utilization of the Demonstration Approach for evaluation of CSO controls and to support the CSO control recommendations for achieving water quality standards and supporting use designations as required by the NJPDES permits and USEPA CSO Control Policy. Separate QAPPs for the Baseline Compliance Monitoring Program and the Receiving Water Quality Model will be developed concurrently with this project plan.

The collections system and receiving water models may serve a multitude of purposes that may include, but not be limited to:

1) Establishing the baseline conditions for the collections systems and receiving waters;
2) Identifying the impacts of non-CSO point and non-point pathogen sources in relation to CSO impacts;
3) Developing integrated watershed management strategies based upon the pathogen sources identified as causing impairments preventing compliance with water quality standards;
4) Evaluating the CSO capture benefits of best management practices, changes in operations procedures and other low-cost system improvements;
5) Assessing the benefits of stormwater source controls using green infrastructure and other sustainable stormwater management practices;
6) Performing cost-effective evaluations of the water quality benefits associated with the implementation of a wide range of CSO controls, including the evaluation of whether the elimination of CSOs alone will not preclude the attainment of water quality standards;
7) Developing an adaptive management strategy for implementation of recommended CSO controls;
8) Supporting analyses as may be required for establishing the knee of the curve, assessing use attainability, investigating the benefits of establishing total maximum daily loads or other methods of supporting the recommended plan;

9) Addressing reporting requirements throughout the course of the CSO LTCP development and following implementation;
10) Evaluating the performance of implemented controls in relation to the baseline conditions established at the outset of the project.

Flow monitoring, rainfall, sanitary and stormwater quality data collected as described previously in this QAPP will be used to refine the calibration of the sewer system IW models after they are modified and updated as discussed below. Flow component analysis will be achieved through commonly used methods, as well as through calibration of the collection system model. For instance, sanitary flow can be identified based on total system flow during a dry period with low infiltration (typically early fall), with an appropriate allowance for base infiltration. Annual infiltration can be estimated through application of mathematical filtering (e.g. Lyne-Hollick method) such as is used to partition quickflow and baseflow in rivers. Inflow is the remainder after sanitary and infiltration flows are subtracted from total flow, and is confirmed via calibration of the wet-weather component of the collection system model.

Existing Sewer System Model: The PVSC sewer system model contains the entire stretch of the PVSC Main Interceptor Sewer, from Curtis Street in the City of Paterson to the Main pumping station at the PVSC WPCF. This model also included the 11 major branch interceptor sewers connecting to the Main Interceptor Sewer. The model represents all PVSC-owned/operated regulators along the main interceptor and their tributary drainage areas, as well as the CSO outfalls and internal overflow reliefs in its combined sewered municipalities. Dry-weather, sanitary contributions from the forty-three (43) separately sewered municipalities and large industrial and commercial dischargers are also characterized as inflows to the interceptors. The model currently does not include any Hudson County community sewers but will be included as part of the LTCP effort (discussed herein). The existing model was originally developed and calibrated as two individual SWMM based models consisting of the following as part of the 2003 characterization study work:

- PVSC Model – This model included Paterson, Kearny, Harrison, East Newark and the complete PVSC interceptor system.

- Newark Model – This was a detailed model of the Newark combined sewer system.

Subsequent to the 2003 characterization work, the two models were converted to InfoWorks, linked into one model for the five PVSC connected communities and validated.

Updated Collections System Model: The model is currently being recalibrated to improve its ability to calculate the maximum flows that can be delivered to PVSC. The work efforts focus on the hydraulic gradeline in the Main Interceptor, especially at higher flow rates that exceed the current operating range of about 350 to 400 MGD. Key to the efforts is the collection of water-elevation data within the interceptor under a range of flows that exceed 400 MGD and that fill

the interceptor. With this data, the model is being recalibrated to further understand the hydraulic gradeline during the delivery of high wet weather flows.

Other changes being made to the model are as follows:

- Geo-referencing modeled interceptor sewers upstream of Newark,
- Updating the model of the PVSC Main Interceptor so that all manholes are represented,
- Incorporating recently available ground elevation updates into the model, and
- Adding the relevant features of the Newark Screening facilities so any inflows are accounted for.

The PVSC InfoWorks model does not include the Hudson County CSO communities listed below whose flows are conveyed to the PVSC treatment plant through the Hudson County force main.

- Bayonne
- Jersey City
- North Bergen

These municipalities however also developed and calibrated collection system models as part of the 2003 characterization work. As part of this LTCP effort, the Hudson County collection system models will be incorporated in to the PVSC InfoWorks model.

With the exception of the City of Newark and a very small portion of Paterson, the model does not include any of the combined sewer pipes within the connected CSO communities. For each of these connected CSO communities, land areas upstream of the regulator structures are divided into a number of runoff producing catchments that direct their runoff to the regulator structures; not to local combined sewer trunk lines.

For completing the Long Term Control Plan, additional combined sewers can be added to the model for each of the connected CSO municipalities, with the exception of Newark, where sufficient definition of the combined sewer system already exists. The Newark portion of the model is fully built out and includes combined sewers as small as 24 inches in diameter. If requested by the connected CSO municipalities for the purposes of evaluating green infrastructure, the current model can be expanded to include combined sewers, likely down to a size of 24-inches, for the Kearny, Harrison, East Newark and Paterson sewer systems. The ability to accomplish this task and the modeling approach will depend on the availability of existing information, which is under development by most of the permittees as they prepare GIS mapping of their collection systems to satisfy the permit deadline of July 1, 2016. If requested, a review

of the GIS mapping prepared by the connected CSO communities and expansion of the model can be considered to facilitate their LTCP efforts. The Part II System Characterization and Landside Modeling Program QAPP will address the efforts for North Bergen and Bayonne.

Once that effort is completed, the full PVSC InfoWorks model will be validated against relevant portions of the historical flow data discussed above as well as the flow data to be collected as part of this QAPP. Validation will consist of comparison of flow versus time for the monitoring data and the model calculations. Validation will also employ goodness of fit procedures developed by the "Wastewater Planning Users Group (WaPUG), Code of Practice for the Hydraulic Modelling of Sewer Systems, November 2002 as amended December 2002). In particular, relevant model verification and testing procedures in Section 6 of that document will be applied.

Validation will consist of first identifying a range of large and small rainfall events and separating the flow monitoring data into hydrographs of sewer flow with time during those events. For each event, the amount of wet weather flow present within the system during the storm event will be calculated for comparison to the model calculated volume of flow in the validation analysis. The next step in the model validation process will be to isolate the spatially varying radar rainfall data for that period and impose the hourly radar rainfall on the IW model subcatchments so that runoff entering the combined sewers can be calculated. Validation will then proceed to comparisons of model calculated and observed sewer flow hydrographs and WaPUG comparisons of calculated event volumes and peak flows.

Model assessments will also be performed to assess the ability of the models to calculate combined sewer overflow concentrations and mass loading that will be used to drive the receiving water quality model. This analysis will involve using the IW model to calculate the CSO overflow concentrations by mixing the mass of runoff pathogens entering the combined sewers with the mass of sanitary pathogens within the combined sewers. The resultant calculated overflow concentrations will be compared to the observed site event mean pathogen concentrations.

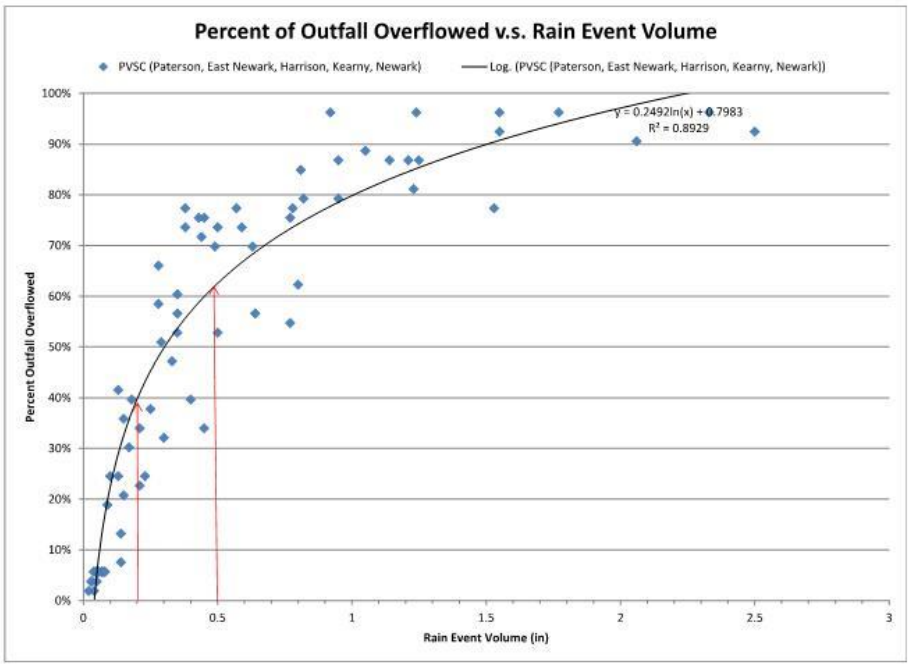
Once these exercises are completed, the previously calibrated models, updated for LTCP purposes, will be assumed to be ready to be used to evaluate CSO control alternatives and ready to be used to develop mass loadings to the receiving water quality model.

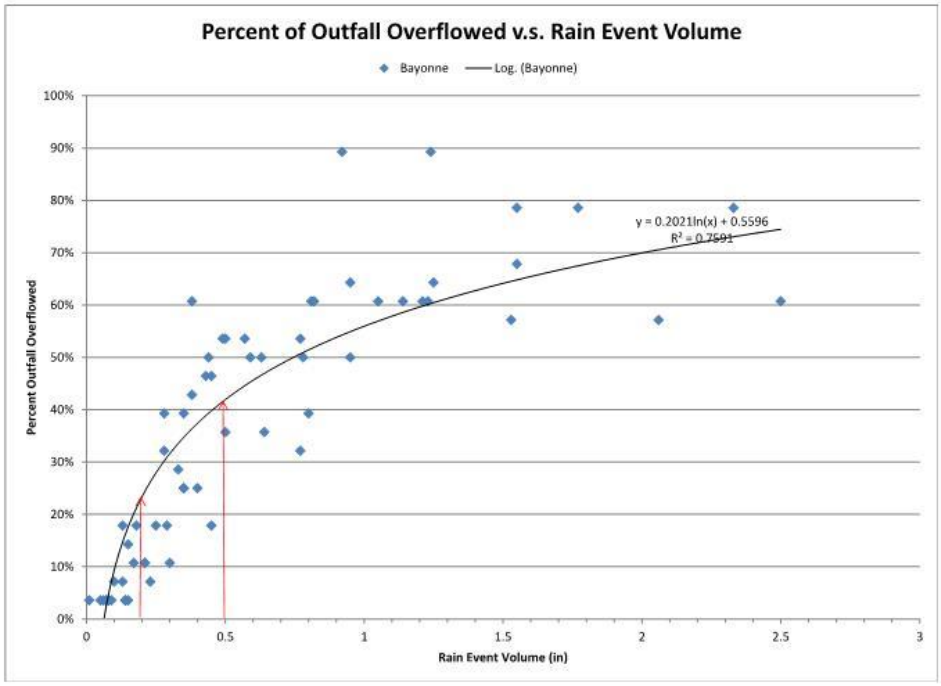
APPENDIX A - Rainfall Event Characterization Memorandum December 1, 2015

Memo

Date:	Tuesday, December 01, 2015
Project:	PVSC LTCP
To:	Bridget McKenna
From:	William Leo
Subject:	Modeled CSOs versus Rainfall

HDR conducted an analysis to determine how CSO overflows occurred as a function of rainfall volumes. HDR used the existing sewer system models to simulate overflows from rainfall events using the 1988 rainfall records. The results are shown below for the PVSC main interceptor outfalls and are abstracted from the PVSC IW model simulation. The next page summarizes the results for the Bayonne model.





The graphics show the fraction of the outfalls which overflow in each drainage area (y-axis) as a function of total storm event rainfall. Each solid blue diamond is the result for an individual storm. The solid line represents the line of best fit of the results.

The analyses show that depending on the collection system, between 40 and 60 percent of the CSOs overflow during rainfalls of 0.5 inches or greater. For rainfalls of 0.2 inches or greater, between about 25 and 40 percent of the outfalls are calculated to overflow. As noted by the spread of the results above and below the trend line, the results will vary based on storm characteristics, antecedent conditions, time of the event, etc.

APPENDIX B - REFERENCES

APHA, AWWA, and WEF. 2005. *Standard methods for the examination of water and wastewater*. American Public Health Association, American Water Works Association, and Water Pollution Control Federation. 21st edition, Washington, D.C.

EPA. (2015). 5.5 Turbidity. In Water: Monitoring & Assessment. Retrieved from http://water.epa.gov/type/rsl/monitoring/vms55.cfm, September 2015.

EPA Method 1103.1: Escherichia coli (E. coli) in Water by Membrane Filtration Using membrane-Thermotolerant Escherichia coli Agar (mTEC) EPA Number 821R10002, March 2010.

EPA Method 1600: Enterococci in Water by Membrane Filtration Using membrane-Enterococcus Indoxyl-B-D-Glucoside Agar (mEI); EPA Number 821R06009, December 2009.

EPA Method 1603: Escherichia coli (E. coli) in Water by Membrane Filtration Using Modified membrane-Thermotolerant Escherichia coli Agar (Modified mTEC); EPA Number 821R09007, December 2009.

EPA Method 1680: Fecal Coliforms in Sewage Sludge (Biosolids) by Multiple-Tube Fermentation using Lauryl Tryptose Broth (LTB) and EC Medium; EPA Number 821R10003, April 2010.

EPA Method 1681: Fecal Coliforms in Sewage Sludge (Biosolids) by MultipleTube Fermentation using A-1 medium , EPA Number 821R06013, July 2006.

EPA Microbiological Methods for Monitoring the Environment, Water, and Wastes, EPA/600/8-78/017.1978. US EPA (EPA Micro Manual p. 124, Membrane Filtration Method; p. 132, Most Probable Number Method).

New Jersey Administrative Code (NJAC) 7:18, Regulations Governing the Certification of Laboratories and Environmental Measurements. November 22, 2006.

New Jersey Department of Environmental Protection (NJDEP) Field Sampling Procedures Manual (FSPM). August 2005.

APPENDIX C - SOPS

Standard Operating Procedure (SOP) Reference Documents for Analytical Chemistry
for Laboratories and Flow Metering Subcontractors participating in the System Characterization and Landside Modeling Program

SOP Title	NJDEP Method Code	Laboratory	Analytical Method
Fecal Coliform (Membrane Filtration, Single Step Method)	WPP01.02000	Eurofins QC	EPA SM 9220D or SM 9222D
Enterococcus (Membrane Filtration Technique)	WPP01.09010	Eurofins QC	EPA SM 1600
Escherichia Coli (E.coli) (Membrane Filtration Technique)	WPP01.16100	Eurofins QC	EPA SM 1603

APPENDIX D – CHAIN OF CUSTODY FORM

eurofins | QC

CHAIN OF CUSTODY
Page ____ of ____

Lab LIMS No:

MATRIX CODES
DW: DRINKING WATER
GW: GROUND WATER
WW: WASTEWATER
SO: SOIL
SL: SLUDGE
OIL: OIL
SOL: NON SOIL SOLID
MI: MISCELLANEOUS
X: OTHER

1205 Industrial Blvd. Phone: 215-355-3900
Southampton, PA 18966-0514 Fax: 215-355-7231

Bill to/Report to (if different)

Sampling Site Address (if different) Include State

Client/Acct. No.
Address
City/State/Zip
Phone/Fax
Client Contact:

P.O. No. PWSID #:
Quote #
e-mail:

LAB USE ONLY:
____ Ascorbic/HCL Vials # ____ HCl Vials
____ $Na_2S_2O_3$ _____
____ Na OH/Zn acetate pH _____
____ NHO_3 pH _____
____ H_2SO_4 pH _____
____ NaOH pH _____
____ Unpreserved
____ HCl # ____NH4Cl # ____MeOH
____ DI Water

LAB USE ONLY	PROJECT / FIELD ID	Collection Date	Collection Military Time	GRAB	COMP	Matrix Code	Number of Containers Total	H_2SO_4	HCl	Vials	HNO_3	NaOH	ZnAc	UNPRE	BACT	ANALYSIS REQUESTED	Field pH, Temp (°C), DO, Cl2, Cond. etc.

SAMPLED BY: (Name/Company)

TAT: ☐ STANDARD (10 DAY)
or DUE DATE ____/____/____

Report Format: ☐ Standard ☐ NJ-RDD ☐ SRP-RDD
☐ Standard + QC ☐ Forms ☐ EDD

Please call for pricing and availability for rush (<10 day) turnaround and for all but standard reporting format.

Field Parameters Analyzed By:
Initials | Date/Time:

SAMPLE CUSTODY EXCHANGES MUST BE DOCUMENTED BELOW. USE FULL LEGAL SIGNATURE, DATE AND MILITARY TIME (24 HOUR CLOCK, I.E. 8AM IS 0800, 4 PM IS 1600)

	DATE	TIME		DATE	TIME
RELINQUISHED BY SAMPLER 1.			RECEIVED BY 1.		
RELINQUISHED BY 2.	DATE	TIME	RECEIVED BY 2.	DATE	TIME
RELINQUISHED BY 3.	DATE	TIME	RECEIVED BY 3.	DATE	TIME
RELINQUISHED BY 4.	DATE	TIME	RECEIVED BY 4.	DATE	TIME
RELINQUISHED BY 5.	DATE	TIME	RECEIVED BY 5.	DATE	TIME

DELIVERY: ☐ EQC COURIER ☐ CLIENT ☐UPS ☐FEDEX ☐OTHER _____

Custody Seal Number

Rec'd Temp.: _____ Initials: _____ Ice Y / N Location:____
COMMENTS:

Hazardous: yes / no

APPENDIX E – February 16, 2016 NJDEP Comment Letter on December 29, 2015 QAPP

(NJDEP Letter Consists of 8 Pages)

State of New Jersey

CHRIS CHRISTIE
Governor

KIM
GUADAGNO
Lt. Governor

DEPARTMENT OF ENVIRONMENTAL PROTECTION
Mail Code – 401-02B
Division of Water Quality
Bureau of Surface Water Permitting
P.O. Box 420 – 401 E State St
Trenton, NJ 08625-0420
Phone: (609) 292-4860 / Fax: (609) 984-7938

BOB MARTIN
Commissioner

February 16, 2016

Brigite Goncalves, Town Clerk
Borough of East Newark
34 Sherman Avenue
East Newark, NJ 07029

Rocco Russomanno, Town Engineer
Town of Harrison
318 Harrison Avenue
Harrison, NJ 07102

Gerry Kerr, Superintendent DPW
Town of Kearny
357 Bergen Avenue
Kearny, NJ 07032

Mike Gelin, Assistant Director Water and Sewer
City of Newark, City Hall, Room B31F
920 Broad Street
Newark, NJ 07102

Fred Margron, Town Engineer
City of Paterson
111 Broadway
Paterson, NJ 07505

Bridget M. McKenna, Chief Operating Officer
Passaic Valley Sewerage Commission (PVSC)
600 Wilson Avenue
Newark, NJ 07105

Re: Technical Comments on the Sewer System Characterization Work Plan Part 1
Borough of East Newark, NJPDES Permit No. NJ0117846
Town of Harrison, NJPDES Permit No. NJ0108871
Town of Kearny, NJPDES Permit No. NJ0111244
City of Newark, NJPDES Permit No. NJ0108758
City of Paterson, NJPDES Permit No. NJ0108880
PVSC, NJPDES Permit No. NJ0021016

Dear Permittees:

Thank you for your submission dated December 30, 2015 that was submitted in accordance with Part IV.D.3.b.i of your NJPDES CSO permit. This study is entitled "System Characterization and Landside Modeling Program Quality Assurance Project Plan (QAPP) Part 1" and was submitted cooperatively by the Borough of East Newark, the Town of Harrison, the Town of Kearny, the City of Newark, the City of Paterson and PVSC. While PVSC and its eight member municipalities have submitted a letter of intent to complete a single, coordinated long term control plan, the Department acknowledges that Part 1 of the Sewer System Characterization Work Plan includes the five municipalities identified above that discharge to PVSC's main interceptor sewer that generally follows the alignment of the Passaic River to the PVSC facility. A separate work plan entitled "System Characterization and Landside Modeling Program Quality Assurance Project Plan (QAPP) Part 2" includes the remaining two PVSC member municipalities (North Bergen MUA and Bayonne MUA) that connect to PVSC through force mains as well as Jersey City MUA who has submitted a separate work plan and discharges to the force main.

The Department recognizes that details of this system characterization have been discussed at meetings between the Department and PVSC and its consultants where meeting dates include July 22, 2015,

August 12, 2015, September 16, 2015, September 30, 2015, October 21, 2015, November 20, 2015 and December 2, 2015. This letter is written to provide the Department's technical comments on "System Characterization and Landside Modeling Program Quality Assurance Project Plan (QAPP) Part 1."

Overall Objectives of the Sewer System Characterization

The required information for the Sewer System Characterization is included in the NJPDES CSO permit at CSM Part IV.G.1. In order to provide a backdrop to some of the technical issues identified in this letter, the Department would like to note the objectives of modeling in relation to the Sewer System Characterization as contained in EPA's Guidance for Long-Term Control Plans (EPA 832-B-95-002). Specifically, once the model is calibrated and verified, the primary objectives of CSS modeling applications include:

- To predict overflow occurrence, volume, and, in some cases, quality for rain events other than those which occurred during the monitoring phase. These can include a storm event of large magnitude (long recurrence period) or numerous storm events over an extended period of time.

- To predict the performance of portions of the combined sewer system (CSS) that have not been extensively monitored.

- To develop CSO statistics, such as annual number of overflows and percent of combined sewerage captured as described in the CSO Control Policy.

- To optimize CSS performance as part of Nine Minimum Control (NMC) implementation. In particular, modeling can assist in locating storage opportunities and hydraulic bottlenecks and demonstrate that system storage and flow to the POTW are maximized.

- To evaluate and optimize control alternatives, from simple controls described under the NMC to more complex controls proposed in a municipality's LTCP. An example of a simple control would be to raise weir heights to increase in-line storage. The model can be used to evaluate the resulting reductions in CSO volume and frequency.

In light of the above objectives, the Department's comments are as follows:

General Comments on the Work Plan

Comment 1: While the work plan contains a narrative discussion on the PVSC service area and combined sewer system as well as maps depicting the PVSC sewer district; locations of existing gages used in radar calibration; and the locations of proposed temporary flow meters, visual representations of additional information would be useful to support the narrative descriptions. Therefore, please provide sewer system maps with the following labeled on the map of sufficient scale to adequately depict these items:

- Regulators
- Pump stations (Existing and Proposed)
- Flow metering locations from past studies if proposed to be utilized for characterization
- Subcatchments and drainage areas with names or identification numbers
- Identification of any elements that are referenced in the narrative discussion. For example, the Hudson County Force Main referenced on Section A.6, Curtis Street in the City of Paterson or notable sites that are described in the discussion.

While some regulators are shown on Figure 4, this does not appear to show all of the regulators for Part 1.

Comment 1: Figure 4 indicates that certain pipes will be modeled (shown in green). Please clarify whether each pipe shown will be modeled individually. If not, please indicate on the map the portion of the CSS to be modeled. For example, some permittees establish a pipe diameter threshold size for their model.

Comment 3: The work plan must include a schematic of the CSS, including the subcatchments, outfalls, regulators, pump stations and wastewater treatment plant. Considering the size and complexity of the PVSC Part 1 System, this may be represented through one or several schematics provided all information requested above is included.

Comment 4: The alternatives analysis due on July 1, 2019 (CSM Part IV.G.4.d and e) must include an evaluation of green infrastructure. The Sewer System Characterization work plan should acknowledge that additional characterization and subcatchment discretization will likely be necessary to establish and model the locations and parameters associated with the implementation of green infrastructure within the CSS service or drainage areas.

Comment 5: A schedule or Gantt chart with a breakdown of tasks and target time frames should be provided in the work plan. Such a schedule should include the milestones, general categories, and specific tasks necessary for the timely submission of the Sewer System Characterization Report.

Comment 6: The work plan must indicate the date of the most recent evaluation of the CSS and that the System Characterization Report and associated model will be based a review of the entire collection system, in accordance with CSM Part IV.G.1.b.

Comment 7: The work plan should discuss the methodology for disaggregating raw flow data into its dry weather and wet weather components based upon observed rainfall. Components shall include, but are not limited to, infiltration, inflow (including stormwater flow) and wastewater flow.

Specific Comments

A.2. Distribution List

Comment 8: On page 10 under New Jersey Department of Environmental Protection please add Marc Ferko, Office of Quality Assurance.

A.3. Program Contact Information

Comment 9: On page 11 please add:

Marc Ferko
NJDEP
Office of Quality Assurance
P.O. Box 420
401 E. State St., 4th Floor
Trenton, NJ 08625-0420

A.4. Table of Contents

Comment 10: Under the list of figures on page 13, Figure 2 should be listed as "Rainfall Volume Probability Plot" as is indicated on Figure 2.

Comment 11: On page 13 regarding Appendix C (SOPs) and Appendix D (Chain of Custody Forms), it is noted that this information will be provided after lab selection is finalized. Please acknowledge that this information will be provided within thirty days of sampling.

A.5. Project Organization

Comment 12: Under Program Manager on page 14 there is reference to the "Baseline Compliance Monitoring Program." It is unclear if this was intended since the subject document concerns the System Characterization and Landside Modeling Program. Please change if needed.

Comment 13: The Project and Field Coordinator is listed on page 14 as "To be determined." Please confirm that the name of the Project and Field Coordinator will be provided to the Department prior to the initiation of sampling. The Contract Sampling and Laboratories on page 16 is also listed as "To be determined." Please provide the names of the laboratories thirty days prior to the commencement of sampling along with the New Jersey certification numbers. In the event that there are alternate certified laboratories that may be utilized, please provide certification status of those laboratories prior to QAPP approval.

A.6. Problem Definition and Background

Comment 14: On page 17 the following statement is included:

> "Two of the combined sewer municipalities, the Cities of Bayonne and Jersey City, own and operate their own combined sewer systems, interceptors, CSO control facilities, and pumping stations. In addition they jointly own the force main used to transport wastewater to the primary clarifiers at the PVSC WPCF in Newark."

Please clarify the point of intersection between this force main and the PVSC's treatment facility.

Comment 15: Figure 1 is included on page 18. While force mains are included in the legend, it does not appear that the North Bergen MUA force main is included. Please confirm.

Comment 16: On page 19 four studies are referenced. It is acceptable to rely upon previous studies as identified in this section; however, please provide copies of these studies as attachments. In addition, please provide a brief description of each study.

A.7. Project Description

Comment 17: On page 21 under *Rainfall-Overflow Correlation Analysis* you state:

> "An analysis will be performed using the monitored hydrological events and the results of the precipitation statistical analysis, to develop the correlation between the characteristics and frequency of rainfall events that cause a discharge. This analysis was performed as part of past studies to identify the amount of rain that triggers an overflow event."

It is unclear as to how past studies and/or historical data relates to the proposed rainfall-overflow correlation analysis. Please clarify. In addition, if the previous study will be utilized as a

foundation for this current work, provide a copy of the study as well as a brief description of the study in the work plan.

Comment 18: On page 22, you state that a "representative set of monitored events should ideally include a variety of storm volumes, durations and intensities to provide for a more robust model calibration." Please clarify the minimum number of storm events recommended for model calibration and for model verification. Indicate what parameters will determine that a particular event can be used to calibrate and verify the model. Provide additional detail regarding how the size of the event is determined (i.e., rainfall intensity, daily rainfall amount, comparative analysis both intensity and daily rainfall volume). For example, will the storms be classified based on magnitude or duration or both? Storm events chosen for the calibration and validation of the models must address different rainfall intensities, distributions and volumes.

Comment 19: The following excerpt is included on page 15:

> "Since rainfall radar was not available at the time the past studies were performed, temporary precipitation gages were installed throughout the district to classify return periods and spatial variability. A statistical analysis was completed using data from the Newark NOAA Weather Station. That analysis will be revisited using the historical data that has been recorded since completion of the past studies. The statistical analysis will be updated to identify return frequencies of storm and to identify the "typical year" for the purposes of performing the alternatives evaluation. For the previous study, 1988 was specified by NJDEP as the "typical year." Upon reviewing and updating this past analysis, the "typical year" will be identified."

This section is confusing. Please clarify what years of data were previously used for the statistical analysis from the Newark NOAA Weather Station and what it means to revisit the "historical data." Describe any relationship of the temporary precipitation gages to the NOAA Weather data used in the previous study. Please clarify when temporary precipitation gages were installed and whether those gages are still operational. As per a previous comment, please provide the locations of the rain gages on a map. The selection of a specific weather station(s) that will be used to establish the "typical year" must be justified including a description of the proximity of such gages to the PVSC District.

Comment 20: Please provide additional information regarding the following excerpt on page 23:

> "A primary use of the monitoring data will be for further validation the collections system models that was calibrated under the 2003 permitted required characterization work. Adjustment of model coefficients will be made so that the mathematical model provides an adequate representation of the combined sewer areas and their response to wet weather conditions."

This section should be clarified to include additional detail. Please describe how calibration will be proposed associated with the monitoring, metering and sampling proposed under this work plan. In addition, the work plan must indicate that the Sewer System Characterization report will include all of the model input parameters as well as the basis for each parameter, including identification of which parameters were adjusted to calibrate the model. As part of the Sewer System Characterization report that is due July 1, 2018, please include the electronic InfoWorks input file and output files of the model as well as a hard copy of the summary of parameters and results. A hard copy of the model input and output data shall be made available upon the Department's request.

Comment 21: Also within *Characterization of Sanitary, Stormwater and CSO Wastewater Quality* on page 24 you state "Should the mass balance approach fall short of providing reasonable comparisons between observed and calculated CSO quality and observed and calculated receiving

water pathogen concentrations, alternate approaches will be pursued during the receiving water model calibration process." Please provide additional detail regarding alternative approaches and indicate that changes in the approach are subject to Department review and approval. In addition, the Department neither recommends nor approves adjusting the CSO loading to enhance the receiving water model predictability once the landside model has been calibrated and validated.

Comment 22: On page 24 under *Project/Task Description*, please make the following change in order to ensure that it is clear that Maximization of Flow to the Treatment Plant is not the only alternative:

> "The proposed work will supplement the available data and be used to update the landside model. Information collected will be used to verify maximum conveyance capacity of the collection system and to demonstrate under the alternatives evaluation task for the CSO LTCP development the relationship between PVSC accepting additional wet weather flows and the associated impacts on CSO discharges as well as other required alternative evaluations for the LTCP: green infrastructure; increased storage capacity in the collection system; STP expansion and/or storage at the plant; I/I reduction; sewer separation; and treatment of the CSO discharge and CSO related bypass of the secondary treatment portion of the STP."

Comment 23: On page 25 under *Scope for Precipitation Monitoring* you state that "rainfall radar will be used for calibration of the receiving water and landside models as discussed in Section E." However, based on Table 1 (page 25) and Figure 3 (page 26), certain rain gages that will be used in rainfall radar calibration are a considerable distance from the PVSC district. Most notably, on Figure 3 the rainfall radar grid extends to Alpine, NJ which is considerably northeast of PVSC. Provide additional detail and/or justification as to why this is appropriate.

Comment 24: On page 27 under *Scope for Collection System Metering* you state "The flow monitoring equipment will be installed in the combined trunk sewer upstream of the overflow chamber or within the overflow chamber (sandcatcher compartment) of the control facility." Please describe the calibration and maintenance process for operation of the flow meters.

Comment 25: On page 28 you state that the "flow monitoring equipment will be installed in the combined trunk sewer upstream of the overflow chamber…" However, based on Figure 1 there is no differentiation between PVSC Interceptor and the Trunk Sewer. Please clarify.

Comment 26: On page 31 under *Sanitary Wastewater Quality Monitoring* the study entitled Monitoring Data Report Newark CSO Discharge Characterization Study March 2000 is referenced. Please provide a brief description of this study as well as a copy as an attachment.

Comment 27: On page 32 under *Sanitary Wastewater Quality Monitoring* you state "Dry weather samples will be taken just prior to each rain event sampled and utilized in verifying the current baseline conditions versus the past dry weather sampling data." Please describe how this will be performed and how dry weather sampling will be defined.

Comment 28: On page 32 under *Sanitary Wastewater Quality Monitoring* you indicate that a comparison of changes in Land Use Land Cover (LULC) from 1995 to 2012 will be performed. The comparison should be provided in the work plan, including a comparison of impervious covers (percentage and/or area) in addition to LULC, and should be provided for each subcatchment.

Comment 29: On page 32 under *CSO Wastewater Quality Monitoring* you state "The goal of the event sampling protocol is to obtain three wet-weather events of sufficient depth, intensity, and duration for valid model calibration." Please indicate what will occur in the event that three events are not able to be obtained. Note that the Department will not entertain any time extensions for Sewer System Characterization report submission that is due on July 1, 2018.

Comment 30: On page 37 under *Stormwater Quality Monitoring* states that "Four (4) samples will be collected per station for each wet weather event." Please indicate the time intervals between each sample.

Comment 31: On page 37 under *Stormwater Quality Monitoring* please remove the reference to Jersey City as being included in the Part 2 QAPP.

Comment 32: Flooding is addressed on page 41 under *Surface Flooding and Basement Backups*. Assessment of CSO-related flooding areas is a critical part of the sewer system characterization. While the Department does not expect that every area that has experienced flooding be modeled, special attention should be paid to areas of combined sewage backup, including to basements and other public and private areas. Areas of sewage overflows during wet weather periods typically represent bottlenecks and problem areas in the CSS which is important in understanding the flow dynamics in the CSS during wet weather. In addition, existing drainage features (such as areas of surface ponding) may also provide attenuation of flows and impact the response of the CSS to storm events. Please indicate that these issues will be addressed as part of the system characterization and associated model.

Comment 33: The Department acknowledges that you reference on page 41 that the Operations and Maintenance Manuals will be updated via a system spreadsheet to include the information required by Part IV.F.1.e.iii and Part IV.F.1.f.iiii of your permit. However, for the purposes of the work plan, please provide discussion as to any avenues that are available to the public to notify the permittee of flooding areas (i.e. hotline).

A.10. Data Documentation and Review

Comment 34: On page 43, narrative information is included regarding a sample field reporting data sheet. The parameters "time" and "field conditions" should be included. Therefore, modify this language as follows:

> "The information that will be recorded includes: sampling location and date, <u>time, field conditions,</u> raw analytical data and date of testing, sampling and testing personnel, daily sample processing procedures and any corrective actions or deviations from procedures, as necessary."

B.4. Analytical Methods

Comment 35: On page 47, please remove references to footnote 2 for EPA Method 9213 and 9230 as well as footnote 2 which states "For ambient water only."

C.1. Assessments and Response Actions

Comment 36: On page 50, you state that "a trained PVSC employee, or a designee, will periodically review field activities to verify that appropriate protocols are being observed and that each sampling

crew is trained on the standard procedures for sample collection, preservation, transportation and chain of custody." Please develop a standardized checklist that shall be used for these reviews.

E. Collection System Modeling

Comment 37: Similar to a previous comment, please be sure to characterize the model as evaluating all required CSO control alternatives and not limit the alternatives evaluation to maximization of combined sewer flows to the treatment plant. This statement should be modified on page 53 as follows:

> "The overall, comprehensive landside model will provide an essential analysis tool for addressing the NJPDES Permit requirements for maximization of combined sewer flows to the PVSC WPCF in Newark as well as other required alternative evaluations for the LTCP."

Comment 38: On page 53, please delete the reference to the "CSO General Permit" since the current permit is an individual NJPDES permit.

Comment 39: On page 55 please remove the reference to Jersey City as being included in the Part 2 QAPP.

Please provide a revised work plan addressing the issues discussed above within 30 days from the date of this letter as required under Part IV CSM Section D.1.a. Thank you for your continued cooperation. Questions or comments should be addressed to me via e-mail at Dwayne.kobesky@dep.nj.gov or phone at (609) 292-4860.

Sincerely,

Dwayne Kobesky
CSO Team Leader
Bureau of Surface Water Permitting

c: Chief Pilar Patterson, Bureau of Surface Water Permitting
Sandra Blick, Bureau of Surface Water Permitting
Marzooq Alebus, Bureau of Surface Water Permitting
Joseph Mannick, Bureau of Surface Water Permitting
Susan Rosenwinkel, Bureau of Surface Water Permitting
Corey Anen, Bureau of Nonpoint Pollution Control
Marc Ferko, Office of Quality Assurance

APPENDIX F – Revised Wastewater & Stormwater Quality Sampling Locations

(Revised Sampling Location Plans Consists of 20 Pages)

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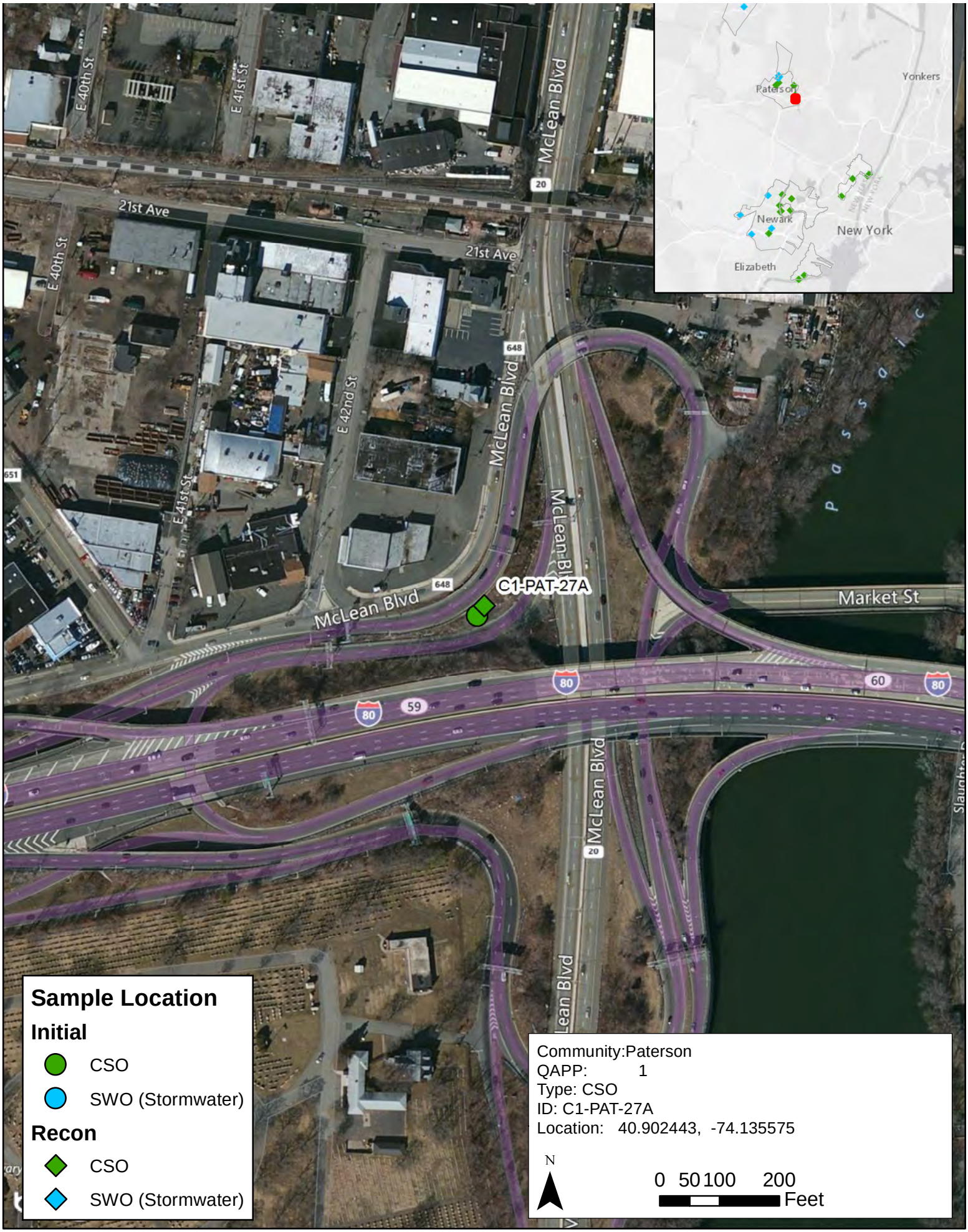

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Jersey St
Warren St
Manor Ave
Supor Blvd
Wilhelm St
Sussex St
Bergen St
McGuigan Pl
C1-HAR-07A
280
Yonkers
Paterson
Newark
New York
Elizabeth
Sample Location
Initial
CSO
SWO (Stormwater)
Recon
CSO
SWO (Stormwater)
Community:Harrison
QAPP: 1
Type: CSO
ID: C1-HAR-07A
Location: 40.743817, -74.146446
N
0 50 100 200
Feet

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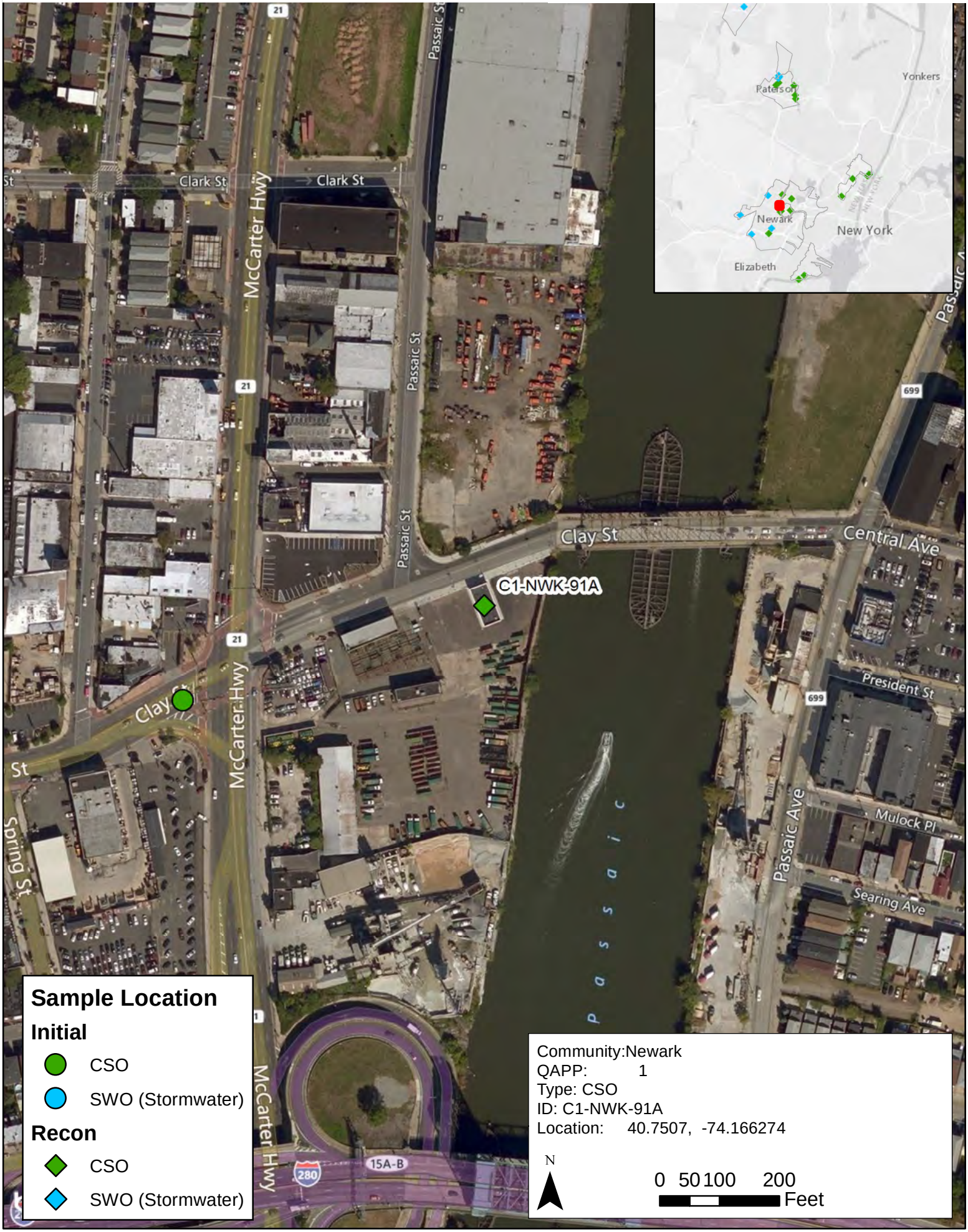

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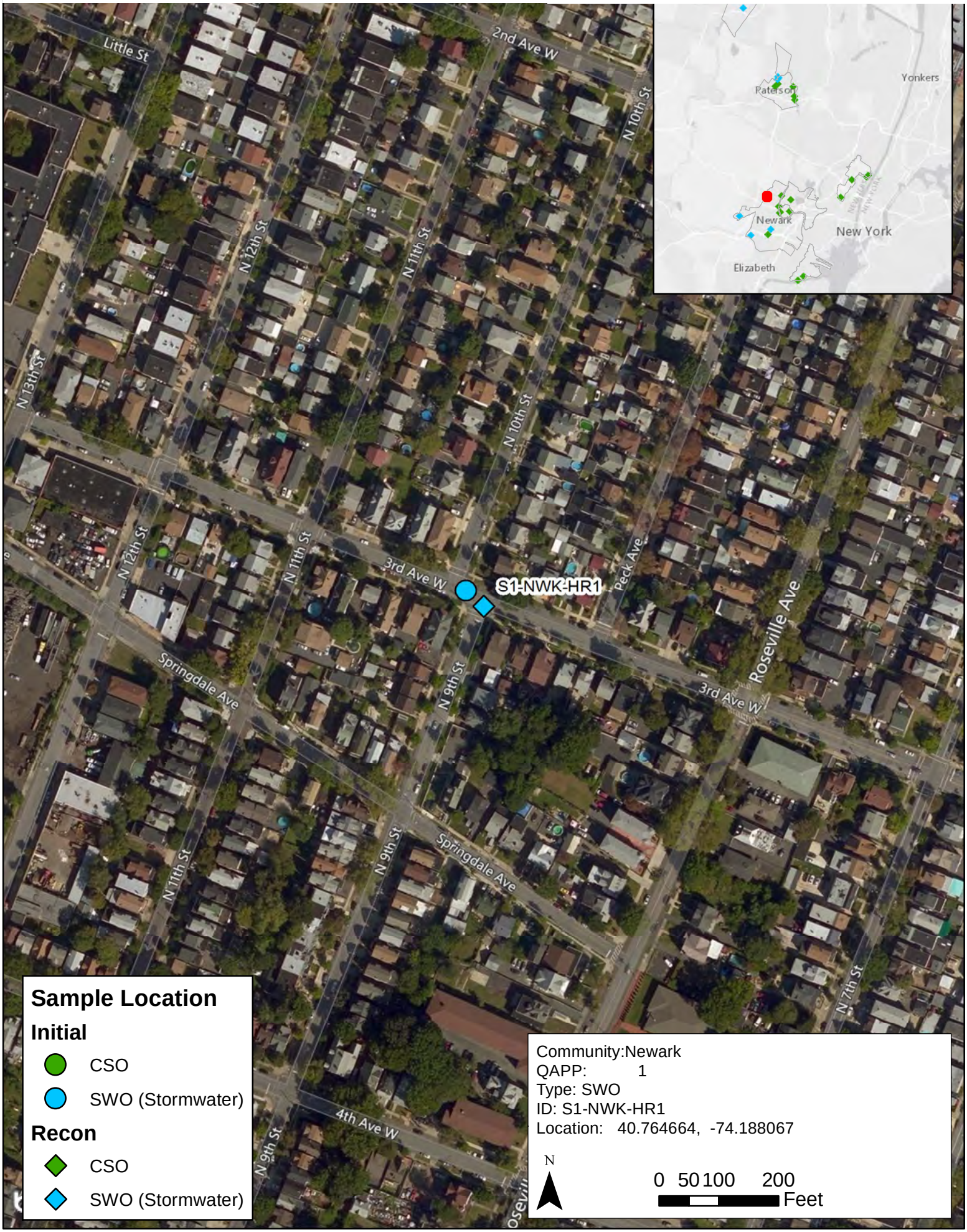

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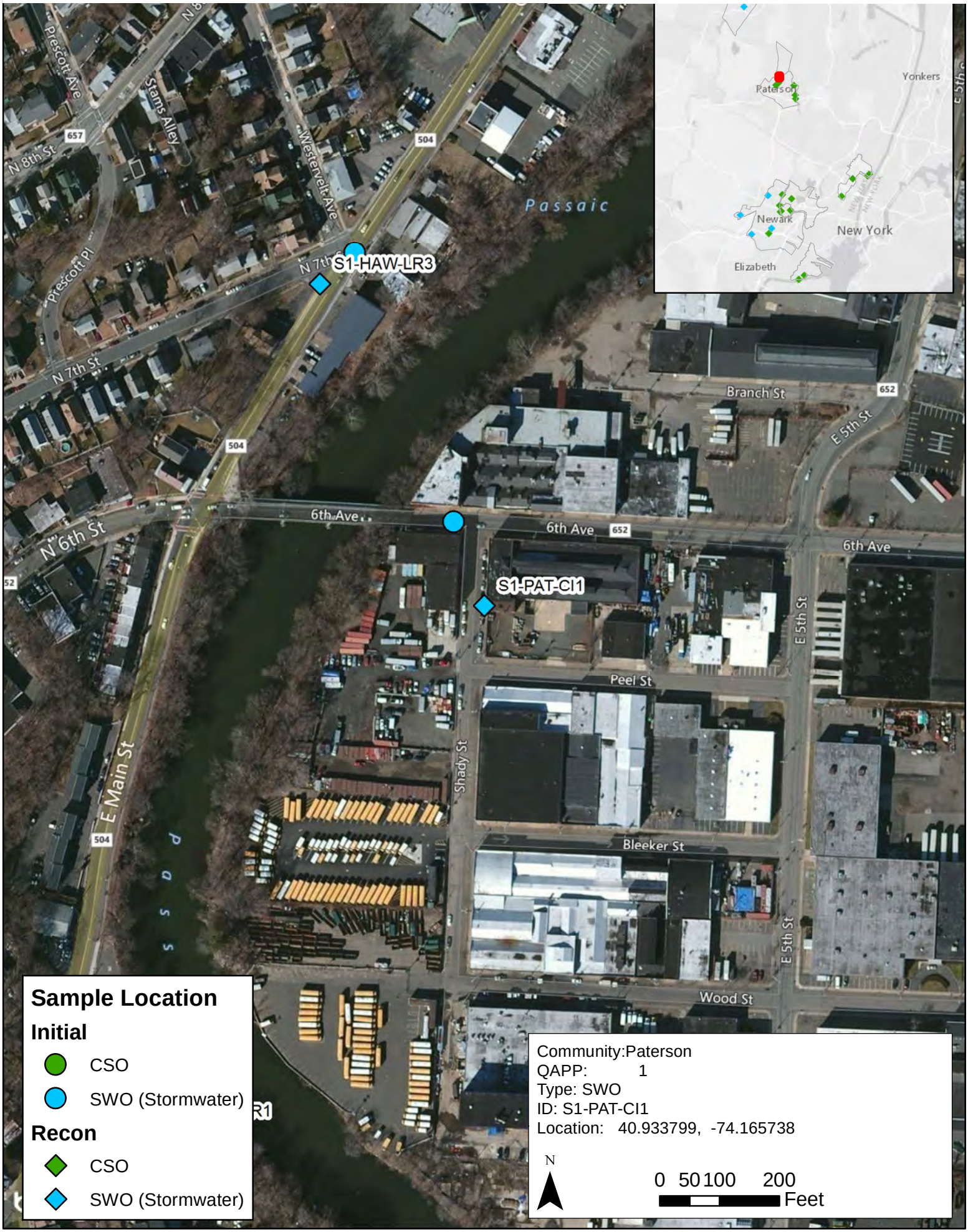

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State of New Jersey

CHRIS CHRISTIE
Governor

KIM
GUADAGNO
Lt. Governor

DEPARTMENT OF ENVIRONMENTAL PROTECTION
Mail Code – 401-02B
Division of Water Quality
Bureau of Surface Water Permitting
P.O. Box 420 – 401 E State St
Trenton, NJ 08625-0420
Phone: (609) 292-4860 / Fax: (609) 984-7938

BOB MARTIN
Commissioner

October 20, 2016

Tim Boyle, Executive Director
Bayonne MUA
Bayonne Municipal Building
960 Avenue C, Room 11
Bayonne, NJ 07002

Frank Pestana, Executive Director
North Bergen MUA
6200 Tonnelle Avenue
North Bergen, NJ 07047

Bridget M. McKenna, Chief Operating Officer
Passaic Valley Sewerage Commission (PVSC)
600 Wilson Avenue
Newark, NJ 07105

Re: Receipt of Amended Sewer System Characterization Work Plan Part 2
Bayonne Municipal Utilities Authority (MUA), NJPDES Permit No. NJ0109240
North Bergen MUA, NJPDES Permit No. NJ0108898
PVSC, NJPDES Permit No. NJ0021016

Dear Permittees:

This letter is written to acknowledge receipt of your revised submission dated October 12, 2016 entitled "System Characterization and Landside Modeling Program Quality Assurance Project Plan (QAPP) Part 2". This revised QAPP was submitted cooperatively for Bayonne MUA, North Bergen MUA and PVSC. The Sewer System Characterization QAPP is a requirement of all NJPDES CSO permits as per CSM Part IV.D.3. This submission is an amended version of the QAPP dated December 28, 2015 and revised March 17, 2016. The October 12, 2016 revisions of the QAPP are outlined in SECTION A – PROJECT MANAGEMENT, A.0 SUMMARY OF CHANGES, page 3 of the amended QAPP.

The Department has reviewed your amended QAPP and has determined that we do not have any comments or objections. Please proceed with implementation.

Thank you for your continued cooperation.

Sincerely,

Susan Rosenwinkel

Susan Rosenwinkel
Section Chief
Bureau of Surface Water Permitting

C: Joseph Mannick, Bureau of Surface Water Permitting
Dwayne Kobesky, Bureau of Surface Water Permitting
Marzooq Alebus, Bureau of Surface Water Permitting
Marc Ferko, Office of Quality Assurance

SYSTEM CHARACTERIZATION AND LANDSIDE MODELING PROGRAM QUALITY ASSURANCE PROJECT PLAN (QAPP) PART 2

Submitted on behalf of the following participating Permittees
By Passaic Valley Sewerage Commission on behalf of:

Bayonne MUA (NJ0109240)
North Bergen MUA (NJ0108898)

Passaic Valley Sewerage Commission
Essex County
600 Wilson Avenue
Newark, New Jersey

"Protecting Public Health and the Environment"

December 28, 2015
Revised 3/17/2016
Revised 10/12/2016

SECTION A – PROJECT MANAGEMENT

A.0 Summary of Changes

This Quality Assurance Project Plan (QAPP) is PART 2 for the System Characterization and Landside Modeling Program to be performed by the Passaic Valley Sewerage Commission (PVSC). The System Characterization and Landside Modeling Program includes the rainfall monitoring, wastewater sampling, collections system monitoring, modeling and other work necessary to characterize the CSO discharges from the participating municipalities and for development of a collections system model for the purposes of evaluating CSO control alternatives and developing a CSO Long Term Control Plan (LTCP). Future versions will include summaries of changes made and when they were incorporated. The history of this document and changes made to it are summarized below:

- December 28, 2015: Submitted QAPP in fulfillment of the LTCP Permit requirement.
- Revised March 17, 2016: Modified QAPP to address comments made by NJDEP in letter dated February 17, 2016. A copy of the February 17, 2016 letter is included as Attachment E of this document (9 pages). The 12/28/15 submitted QAPP was 49 pages. This version includes updates that resulted in a page total of 53 pages. Page number updates are not reflected with redline-strikeout in this document. The following pages in this document have been changed to address NJDEP comments and the changes are either summarized below or shown in redline-strikeout.
    a. DEP Comment 4 - Page 17 & 18 Modified
    b. DEP Comment 8 - Page 47 Modified
    c. DEP Comment 9 – New Page 5 Inserted
    d. DEP Comment 10 - Page 8 Modified
    e. DEP Comment 11 - Page 9 Modified
    f. DEP Comment 12 - Page 51 & 52 Modified
    g. DEP Comment 13 - Page 11 & 14 Modified
    h. DEP Comment 14 - Page 12 Modified
    i. DEP Comment 15 - Page 12 Modified
    j. DEP Comment 16 - Page 15 Modified
    k. DEP Comment 18 - Page 16 Modified
    l. DEP Comment 19 - Page 17 & 31 Modified
    m. DEP Comment 21 - Page 20 Modified
    n. DEP Comment 22 - Page 20 Modified
    o. DEP Comment 23 - Page 21 Modified
    p. DEP Comment 24 - Page 21 & 22 Modified
    q. DEP Comment 25 - Page 22&23 Modified
    r. DEP Comment 26 - Page 23 Modified
    s. DEP Comment 27 - Page 23 Modified
    t. DEP Comment 28 - Page 24 Modified
    u. DEP Comment 29 - Page 24 & 25 Modified
    v. DEP Comment 30 - Page 27 Modified`
    w. DEP Comment 32 - Page 27 Modified

x. DEP Comment 34 - Page 31 Modified
y. DEP Comment 39 - Page 35 & 45 Modified
z. DEP Comment 40 - Page 36 Modified
aa. DEP Comment 41 - Page 41 Modified
bb. DEP Comment 42 - Page 41 Modified
cc. DEP Comment 44 - Page 46 Modified
dd. DEP Comment 45 - Page 46 Modified

- Revised October 12, 2016: Modified QAPP to reflect revised sampling locations that changed after field visits due to traffic control or access issues. The 3/17/2016 submitted QAPP was 53 pages plus the 9 page DEP letter for a total of 62 pages. This version includes updates that resulted in a page total of 63 pages plus the revised figures in Appendix F (4 pages) for a total of 67 pages. Page number updates are not reflected with redline-strikeout in this document. The following pages in this document have been changed to address the sampling location modifications with changes shown in redline-strikeout throughout the document:
    a. Page 32 – modified to indicate drawings in Appendix F
    b. Page 32 – modified Table 3 sampling location descriptions

In future versions, this section will be further updated to include summaries of changes and when they were incorporated as appropriate.

A.1 Title of Plan and Approval

Title: Quality Assurance Project Plan, System Characterization and Landside Modeling Program for the Passaic Valley Sewerage Commission LTCP, PART 2

Preparer:

Project Officer: _____ 12/17/2015
Michael J. Hope, P.E., Greeley & Hansen — Date

QA Officer: _____ 12/17/15
Timothy J. Dupuis, P.E., CDM Smith — Date

Passaic Valley Sewerage Commission:

Program Manager: _____ 12/17/2015
Bridget McKenna, Chief Operating Officer, PVSC — Date

New Jersey Department of Environmental Protection

DEP Permits: _____ 4/5/16
Joseph Mannick, CSO Coordinator — Date

DEP QA: _____ 4/5/16
Marc Ferko, Office of Quality Assurance — Date

Participating Permittee Approvals are attached.

SYSTEM CHARACTERIZATION AND LANDSIDE MODELING PROGRAM
QUALITY ASSURANCE PROJECT PLAN (QAPP)
Part 2

Submitted by
Passaic Valley Sewerage Commission:

NJPDES Number NJ0021016 (PVSC)

Approval of QAPP:

Permittee: _____ 03/17/2016

Bridget McKenna
Chief Operating Officer, PVSC

Date

NJPDES Certification:

"Without prejudice to any objections timely made to permit conditions, I certify under penalty of law that this document and all attachments were prepared either: (a) under my direction or supervision; or (b) as part of a cooperative performed by members of the NJ CSO group effort in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for purposely, knowingly, recklessly, or negligently submitting false information."

Permittee: _____ 03/17/2016

Bridget McKenna
Chief Operating Officer, PVSC

Date

SYSTEM CHARACTERIZATION AND LANDSIDE MODELING PROGRAM
QUALITY ASSURANCE PROJECT PLAN (QAPP)
PART 2

Submitted on behalf of the following participating Permittee by
Passaic Valley Sewerage Commission:

NJPDES Number NJ0109240 (Bayonne Municipal Utilities Authority)

Approval of QAPP:

Permittee: _____ 12.28.2015

Tim Boyle Date

Executive Director, Bayonne Municipal Utilities Authority

NJPDES Certification:

"Without prejudice to any objections timely made to permit conditions, I certify under penalty of law that this document and all attachments were prepared either: (a) under my direction or supervision; or (b) as part of a cooperative performed by members of the NJ CSO group effort in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for purposely, knowingly, recklessly, or negligently submitting false information."

Permittee: _____ 12.28.2015

Tim Boyle Date

Executive Director, Bayonne Municipal Utilities Authority

SYSTEM CHARACTERIZATION AND LANDSIDE MODELING PROGRAM
QUALITY ASSURANCE PROJECT PLAN (QAPP)
PART 2

Submitted on behalf of the following participating Permittee by
Passaic Valley Sewerage Commission:

NJPDES Number NJ0108988 (North Bergen Municipal Utilities Authority)

Approval of QAPP:

Permittee: _____ 12/18/15

Frank Pestana Date
Executive Director, North Bergen Municipal Utilities Authority

NJPDES Certification:

"Without prejudice to any objections timely made to permit conditions, I certify under penalty of law that this document and all attachments were prepared either: (a) under my direction or supervision; or (b) as part of a cooperative performed by members of the NJ CSO group effort in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for purposely, knowingly, recklessly, or negligently submitting false information."

Permittee: _____ 12/18/15

Frank Pestana Date
Executive Director, North Bergen Municipal Utilities Authority

A.2 Distribution List

Passaic Valley Sewerage Commission
Bridget McKenna, Chief Operating Officer
Patricia Lopes, Director of Process Control Engineering and Regulatory Compliance
Marques Eley, Process Control Engineer III, P.E.

Participating Permittees
Bayonne MUA: Timothy Boyle, Executive Director
North Bergen MUA: Frank Pestana, Executive Director

New Jersey Department of Environmental Protection
Dwayne Kobesky, Surface Water Permitting
Joseph Mannick, Surface Water Permitting
Marc Ferko, Office of Quality Assurance

PER EPA GUIDANCE DOCUMENT
- Project manager;
- Laboratory manager;
- Field team leader;
- Data processor or statistician;
- Modeler;
- QA officer;
- Data reviewers; and
- Essential contractor and subcontractor personnel.

A.3 Program Contact Information

Contact information for those parties involved in the System Characterization and Landside Modeling Program is as follows:

Timothy Boyle
Executive Director
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630 Avenue C
Bayonne, NJ 07002

Bridget McKenna
Chief Operating Officer
PVSC
600 Wilson Avenue
Newark, NJ 07105

Marques Eley, P.E.
Process Control Engineer
PVSC
600 Wilson Avenue
Newark, NJ 07105

Frank Pestana
Executive Director
North Bergen MUA
6200 Tonnelle Avenue
North Bergen, NJ 07047

Mark Ferko
NJDEP
Office of Quality
Assurance
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Trenton, NJ 08625-0420

Rich Haytas
Senior Engineer
Jersey City MUA
555 Route 440
Jersey City, NJ 07305

Dwayne Kobesky
NJDEP Water Quality
Surface Water Permitting
PO Box 420
401 E. State St., 2nd Floor
Trenton, NJ 08625-0420

Patricia Lopes
Regulatory Compliance
PVSC
600 Wilson Avenue
Newark, NJ 07105

Joseph Mannick
NJDEP Water Quality
Surface Water Permitting
PO Box 420
401 E. State St., 2nd Floor
Trenton, NJ 08625-0420

A.4 Table of Contents

A.4 Table of Contents (continued)

LIST OF TABLES

LIST OF FIGURES

A.5 Project Organization

A.5.1 Key Individuals and Responsibilities

Portions of the System Characterization and Landside Modeling Program are anticipated to be executed by contractors to PVSC that may include multiple independent firms assigned for laboratory, field, QA/QC, and other roles. The work under this QAPP will thus be executed by entities other than the listed permittees. Ultimate responsibility for the implementation of the program is with the positions listed below:

Program Manager (PM) – Bridget McKenna - PVSC

The Program Manager is responsible for the implementation of the System Characterization and Landside Modeling Program and its associated Quality Assurance Project Plan (QAPP) on behalf of all signatories.

Program Officer (PO) – Michael J. Hope – Greeley and Hansen

The Program Officer is responsible for the implementation of the "System Characterization and Landside Modeling Program" and its associated QAPP. In addition, the PO is responsible for:

- Taking corrective actions for any quality control (QC) problems with personnel, technical content, or procedures;
- Presenting documents/products to the PVSC Quality Assurance (QA) Officer;
- Fiscal accountability to PVSC and the permittees;
- Tracking and maintaining compliance with applicable EPA and New Jersey Department of Environmental Protection (NJDEP) procedures; and
- Coordinating and confirming the availability of team resources.

Project and Field Coordinator (PFC) —Don Henshaw - HDR

The Project and Field Coordinator is responsible for verifying that the sample collection and transport activities are conducted in a manner that provides confidence that the samples are representative of the site from which they are collected. Specifically, the PFC is responsible for the following:

- Organizing equipment, staff and materials for field sampling;
- Confirming that all staff are correctly and safely operating the sampling equipment;
- Verifying that Standard Operating Procedures (SOPs) which describe current

practices are written, approved, and distributed to appropriate project personnel;

- Managing the day-to-day field sampling activities to verify that the field procedures and activities conform to the requirements of the applicable sampling and field procedures, SOPs, and the QAPP;

- Resolving day-to-day problems in the implementation of the field portion of the study;

- Reporting any quality problems to the Quality Assurance Officer (QAO);

- Reviewing records, and field and laboratory data for accuracy, validity and completeness and adding appropriate data qualifiers to the data base;

- Maintaining primary contact with associated contributing field personnel and laboratories regarding the sampling schedule, field data, sample transport, and final data reports;

- Verifying that laboratory and method certifications and calculated method detection limits (MDLs) are up to date;

- Submission and review of field and laboratory data and QC data, including blanks results, calibration results, reference standard results, etc.;

- Authoring or co-authoring annual reports;

- Co-authoring the QAPP and annual addendums, and keeping the QAO up to date on program changes;

- Verifying that an adequate QAPP is developed, and that the QAPP is distributed to all appropriate project personnel;

- Confirming that all data products are reviewed and approved according to accepted policies and guidelines before being released; and

- Maintaining the official PVSC data files.

Quality Assurance Officer (QAO) – Timothy J. Dupuis – CDM Smith
The QAO has the following responsibilities:

- Confirming that the requirements of the QAPP are implemented through effective organizing and planning to meet the program and quality objectives;

- Monitoring and auditing QC/QA processes and performance;
- Co-authoring and approving the QAPP;
- Verifying that all data products are reviewed and approved according to accepted policies and guidelines before being released;
- Conducting an independent QA review of data and completed draft documents;
- Authoring or co-authoring annual reports;
- Communicating any problems to the Program Manager; and
- Maintaining the official QAPP.

Contract Sampling and Laboratories *– Eurofins QC*

Each contract entity is responsible for:

- Adhering to the sampling design methods, and all associated field and laboratory Quality Control procedures necessary to accomplish the Program work;
- Confirming that their laboratories remain certified for the analyses being performed for the PVSC Program;
- Maintaining documentation of all procedures and current method detection levels and notifying the PVSC Project and Field Coordinator of changes to procedures and detection levels;
- Verifying that analytical results are generated using the appropriate operating procedures and quality control measures;
- Maintaining proper document control and traceability for procedures, samples, data, and training;
- Providing training and maintaining training documentation for all field samplers and laboratory analysts;
- Assigning and completing internal reviews of the data, including data transcriptions, and the associated sampling and testing documentation; and

- Reporting any anomalies or out-of-compliance results to the PVSC Project and Field Coordinator.

A.5.2 Principal Data Users

The principal users of the data will be PVSC, PVSC member municipalities, LTCP engineering consultants supporting PVSC, NJDEP, and other CSO municipalities who elect to rely on the program, including but not limited to those specified by PVSC as cooperating in their November 18, 2014 letter to NJDEP (Bayonne MUA, and North Bergen MUA). While PVSC will collect and review the data, these other parties may use the data to satisfy certain NJPDES permit requirements related to the requirements of their NJPDES Permits.

A.5.3 Decision Makers

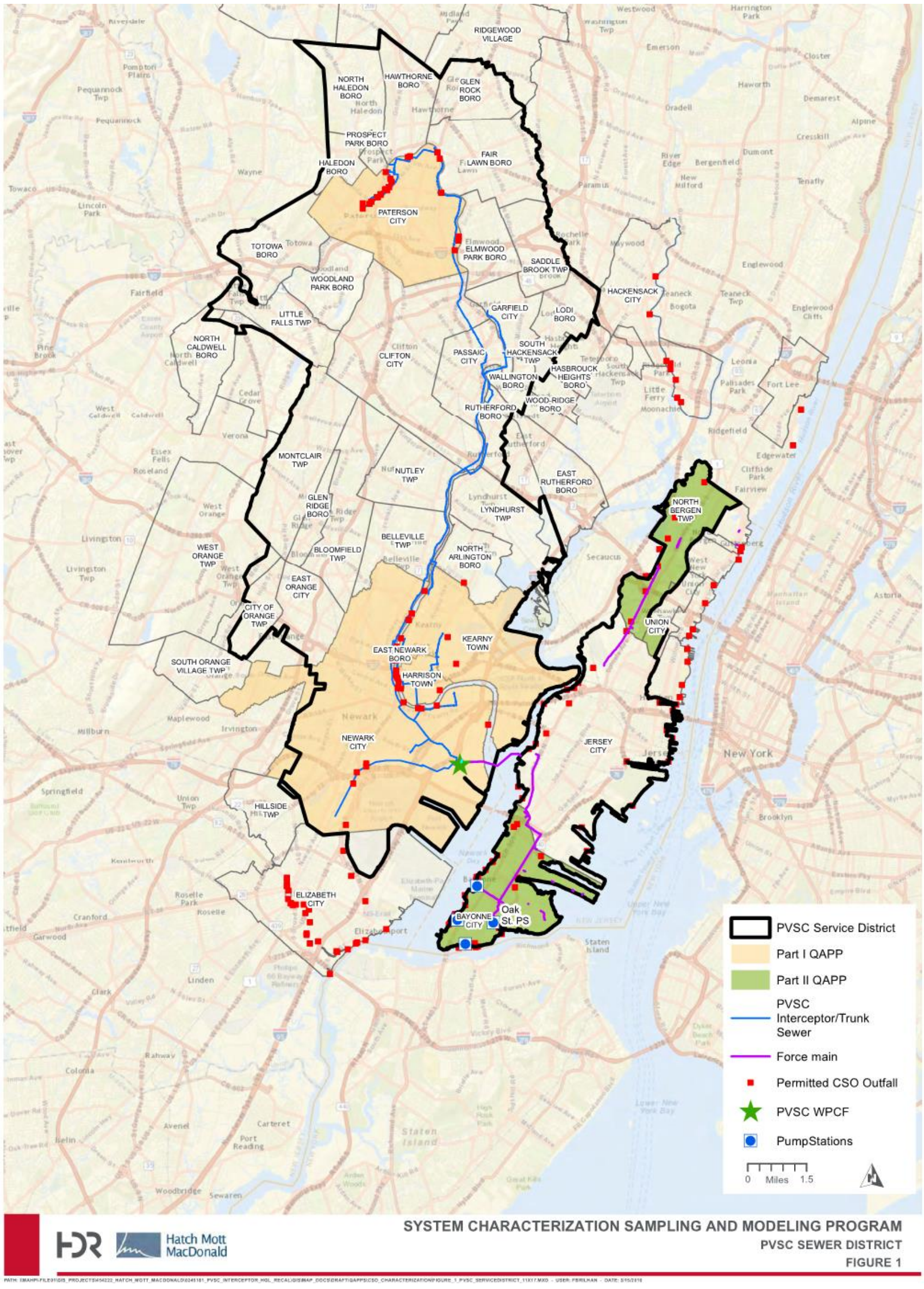
PVSC has decision-making authority for the System Characterization and Landside Modeling Program. The Program Manager at PVSC is ultimately responsible for all technical, financial, and resource related elements of the program, and is the main contact for interagency communications. Any changes made to the program as outlined in this QAPP will be reported in writing for signatory approval and associated amendments to the QAPP will be submitted as necessary.

A.6 Problem Definition and Background

PVSC provides wastewater treatment service to 47 municipalities within its northeast New Jersey service area. The PVSC district covers 150 square miles from Newark Bay to the Passaic River Basin upstream of the Great Falls in Paterson. PVSC's main interceptor sewer begins at Prospect Street in Paterson and follows the alignment of the Passaic River to the PVSC Water Pollution Control Facility (WPCF) in the City of Newark. The extent of the PVSC Service District and the combined sewer areas within the study area are illustrated in **Figure 1**.

Eight municipalities within the PVSC District have combined sewer systems and have received authorization to discharge under their respective NJPDES Permits for Combined Sewer Management. Two combined sewer municipalities, Bayonne MUA and Jersey City MUA, own and operate their own combined sewer systems, interceptors, CSO control facilities, and pumping stations. In addition they jointly own the force main used to transport wastewater to the primary clarifiers at the PVSC WPCF. PVSC does not own or operate any of the combined sewer overflow control or transportation facilities which service this section of the District. Finally, the North Bergen MUA discharges flow to the Jersey City Westside Interceptor and ultimately connects to PVSC through the Hudson County Force Main. The North Bergen MUA owns and operates the CSO outfalls, but does not own the collection system.

Figure 1 – PVSC Sewer District



The other municipalities with combined sewer systems include the Borough of East Newark, the Towns of Harrison and Kearny, and the Cities of Newark and Paterson. A general schematic of the PVSC system is included in **Figure 2**. All of these municipalities are tributary to PVSC main interceptor and most of their combined sewer systems are tributary to CSO control facilities owned and/or operated by PVSC. In addition, the NJPDES permits issued to each party include requirements for PVSC and the CSO communities to cooperatively develop a CSO LTCP. To facilitate the CSO LTCP development, PVSC has offered to undertake the development of the System Characterization and Landside Modeling Program on behalf of these permittees.

Between 2003 and 2007, the Bayonne MUA and North Bergen MUA conducted individual Combined Sewer Overflow Discharge Characterization Studies for all regulators and interceptor sewers owned and operated within their respective systems. This study developed background information on the combined sewer systems tributary to each regulator as well as the analysis of historical rainfall patterns, overflow volumes and pollutants contained in the CSO discharges. The reports were developed under the following studies:

Bayonne Municipal Utilities Authority

- *CSO Characterization Study Final Modeling Report Volumes I and II (November 2005);* Bayonne MUA performed continuous rainfall monitoring; long-term flow monitoring at 8 stations both in-stream and at outfalls; and performed dry and wet weather monitoring and overflow water quality sampling at 3 locations. This effort informed the current sampling and modeling program effort by providing suitable locations to characterize the Bayonne MUA system and will aid in calibration and verification of previously developed SWMM models of each Bayonne CSO drainage basin. It will also provide a baseline to compare dry and wet weather quality and quantity as well as a comparison of CSO flows and pollutant concentrations/loadings since the 2005 study.

- *CSO Discharge Characterization Study - Rainfall Monitoring Study Report (August 2006);*
  Bayonne conducted its rainfall monitoring program to develop an understanding of the rainfall characteristics of its service area, determine any correlation between rainfall characteristics and frequency of occurrence of CSO discharges, and establish a rainfall monitoring network. This information will supplement other rainfall data collected in as part of this characterization study to correlate the hydraulic and hydrologic response to rainfall of the combined sewer system.

North Bergen Municipal Utilities Authority

- *CSO Characterization Study Group 2 Dry Weather Quality and Quantity Monitoring Report (June 2003);*
- *CSO Characterization Study Water Quality and Quantity Monitoring Report (March 2005)*

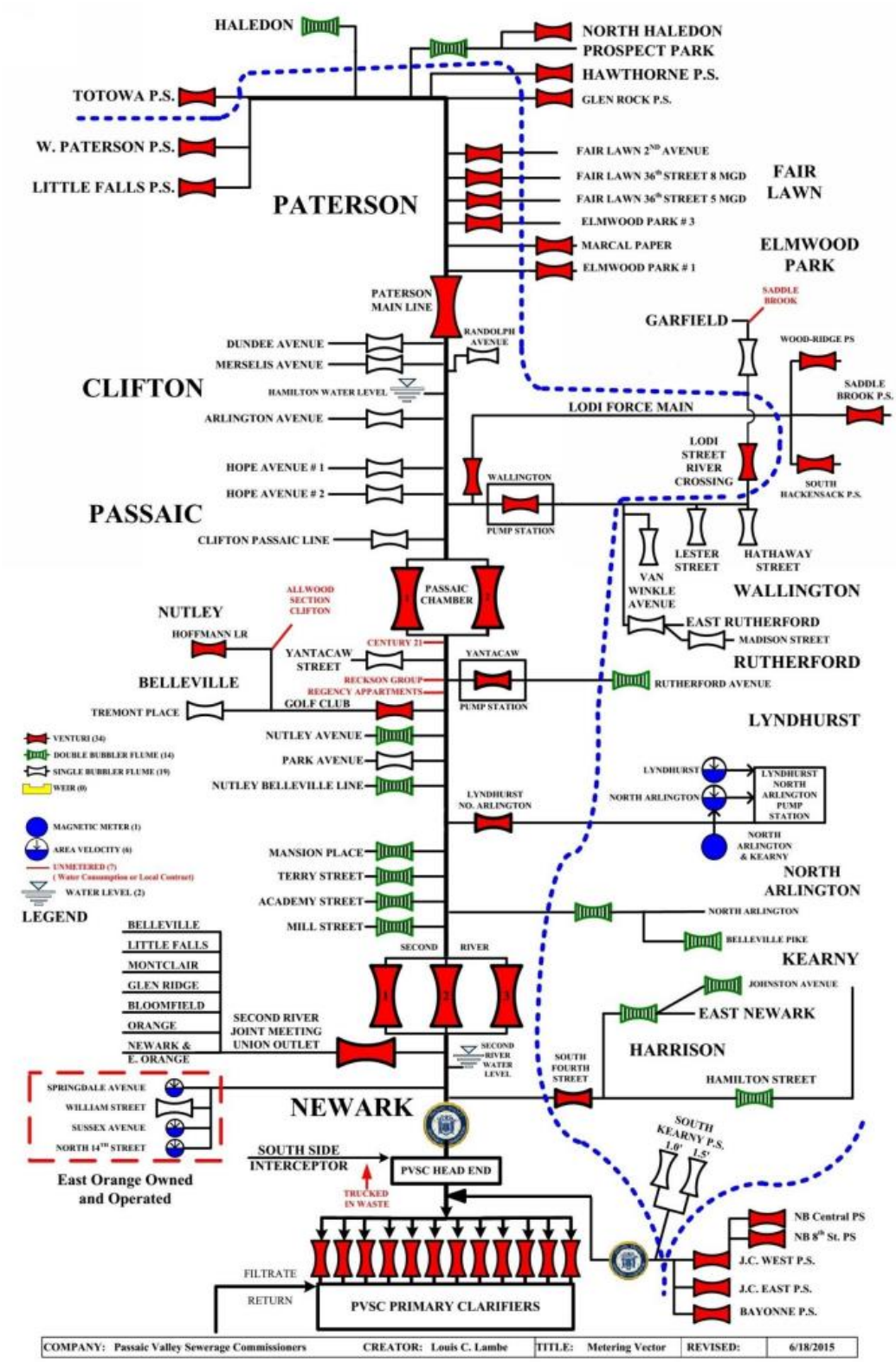


Figure 2 – PVSC Service Area Schematic

North Bergen MUA developed a monitoring program that collected specific dry and wet weather data that was used to calibrate and verify its hydraulic model for each CSO basin that discharges to the PVSC collection system. This data also defined the combined sewer system response to rainfall and determined the quality and quantity of dry weather flow in the system as well as determine CSO flow quantities and pollutant concentrations/loadings discharged to receiving streams. NBMUA collected information from 2 rain gauge stations, 10 baseline flow monitoring stations for dry weather, 4 flow monitoring stations for wet weather, and three combined sewer overflow water quality sampling stations. This effort informed the current sampling and modeling program effort by providing suitable locations to characterize the North Bergen MUA system and will aid in calibration and verification of previously developed SWMM models of each CSO drainage basin. It will also provide a baseline to compare dry and wet weather quality and quantity as well as a comparison of CSO flows and pollutant concentrations/loadings since the 2005 study.

The information collected and the modeling tools developed under these previous studies will be supplemented and updated as part of this System Characterization and Landside Modeling Program QAPP PART 2. Baseline Compliance Monitoring and Receiving Water Quality Modeling of the receiving waters will also be addressed under separate QAPPs.

A.7 Project Description

In accordance with consultation with NJDEP as NJPDES permitting authority, the multiple QAPPs will need to be developed to cover different aspects of the LTCP work activities. Also in accordance with consultation with NJDEP (as NJPDES permitting authority), the QAPPs for the Baseline Compliance Monitoring and Receiving Water Quality Modeling Reports will be submitted separately.

The project goals and objectives for the System Characterization and Landside Modeling Program presented herein include:

- Supplement and update to Innovyze InfoWorks, as appropriate, the site specific dry and wet weather data to be used to recalibrate and verify the collections system model of those collections systems tributary to the PVSC WPCF.
- Define the combined sewer systems' hydrologic and hydraulic response to rainfall.
- Supplement the existing dry weather water quality and quantity data to be used in the representation of each CSO drainage basin.
- Determine the CSO flows and pathogen concentrations/loadings being discharged to the receiving streams.
- Supplement the stormwater quality data for various land use applications.

Regional Approach

The NJDEP, PVSC and the leadership of the CSO permittees all agree that a cooperative or regional approach to the development of a CSO LTCP and requisite work tasks will be an optimal and cost/effective means of providing meaningful data and analyses. PVSC and the CSO

permittees have, with NJDEP approval, undertaken coordination of a CSO LTCP and this System Characterization and Landside Modeling QAPP for all permittees tributary to its conveyance facilities.

Several coordination meetings have been held with representatives of the CSO permittees tributary to PVSC's conveyance and treatment facilities. PVSC has agreed to lead the Combined Sewer System Characterization and Landside Modeling Tasks on behalf of the participating permittees.

The following outlines the owner/operators of the CSSs and control facilities from the CSO permittees who have committed to this regional approach.

City of Bayonne
Owner/Operator of CSS: Bayonne Municipal Utilities Authority
Owner/Operator of Regulators: Bayonne Municipal Utilities Authority

North Bergen Township
Owner of CSS: North Bergen Township
Operator of CSS: North Bergen Municipal Utilities Authority
Owner/Operator of Regulators: North Bergen Municipal Utilities Authority

Purpose
The purpose of the proposed monitoring program is to quantify and qualify dry weather and wet weather wastewater flow and pathogen concentration variations at key CSO and stormwater drainage basins to calibrate and verify hydrologic and hydraulic models of the combined sewer systems within the City of Bayonne and North Bergen Township. This work will be used to update the mathematical tool (sewer system model) that will be used to assess residual storage and maximum hydraulic conveyance capacity in the collection system, pathogen concentrations and loading distributions during storm events and among CSO discharge points, calculate pathogen loads to the receiving water, and for the development and evaluation of possible long term control alternatives and/or modifications to the water quality standards (WQS) during wet weather events.

This QAPP is being submitted as required by the NJPDES Permits for Combined Sewer Management for Bayonne MUA and North Bergen MUA. PVSC owns and operates the wastewater treatment plant that accepts flow from the Bayonne MUA and North Bergen MUA combined sewer systems.

Data Usage
Data collected under this QAPP will be used to supplement the data used to complete the 2003 CSO Characterization Study Modeling Report. The measurements of rainfall duration and intensity, wastewater flow metering and CSO laboratory analytics will have several different uses, and will be utilized in performing the following LTCP development tasks:

Rainfall-Overflow Correlation Analysis – An analysis will be performed using the monitored hydrological events and the results of the precipitation statistical analysis, to develop the correlation between the characteristics and frequency of rainfall events that cause a discharge. This analysis was performed as part of past studies to identify the amount of rain that triggers an overflow event. New data collected as part of the work associated with this QAPP will be combined with historical data within the CSO Alert System to increase the data volume used to correlate the occurrence of CSO with rainfall properties and thus improve the performance of the CSO Alert System. The relationships between rainfall volume and intensity, and CSO overflow events were developed for each of the permittees to allow them to estimate the frequency of overflow for the purposes of completing their monthly Discharge Monitoring Reports. It was also performed for development of the CSO Alert System and will be further updated for the purposes of the CSO LTCP.

This data will be useful for conducting screening analyses for a variety of purposes, for example, to approximate the frequency of overflow events for selected/critical rainfall periods and evaluate the relative pathogen loading, peak flows, duration and volumes associated with the discharge from the various control facilities within the sewer district.

Rainfall Event Characterization - The statistical analysis of area rainfall will be made shortly after the QAPP is approved. While the analysis will be based upon information obtained for Newark Liberty International Airport (Newark Airport), NOAA records for other gages in the area (e.g., Rahway, Little Falls, Springfield, and Essex Fells) will be incorporated into the analysis to establish rainfall statistics for the overall study area. Storm event characteristics (volume, intensity, duration) for the individual storms associated with CSO monitoring events, and for the aggregate of all monitored storms, will be compared with long term statistics for area rainfall to determine the return period for the monitored storms and the anticipated probability of occurrence within the region.

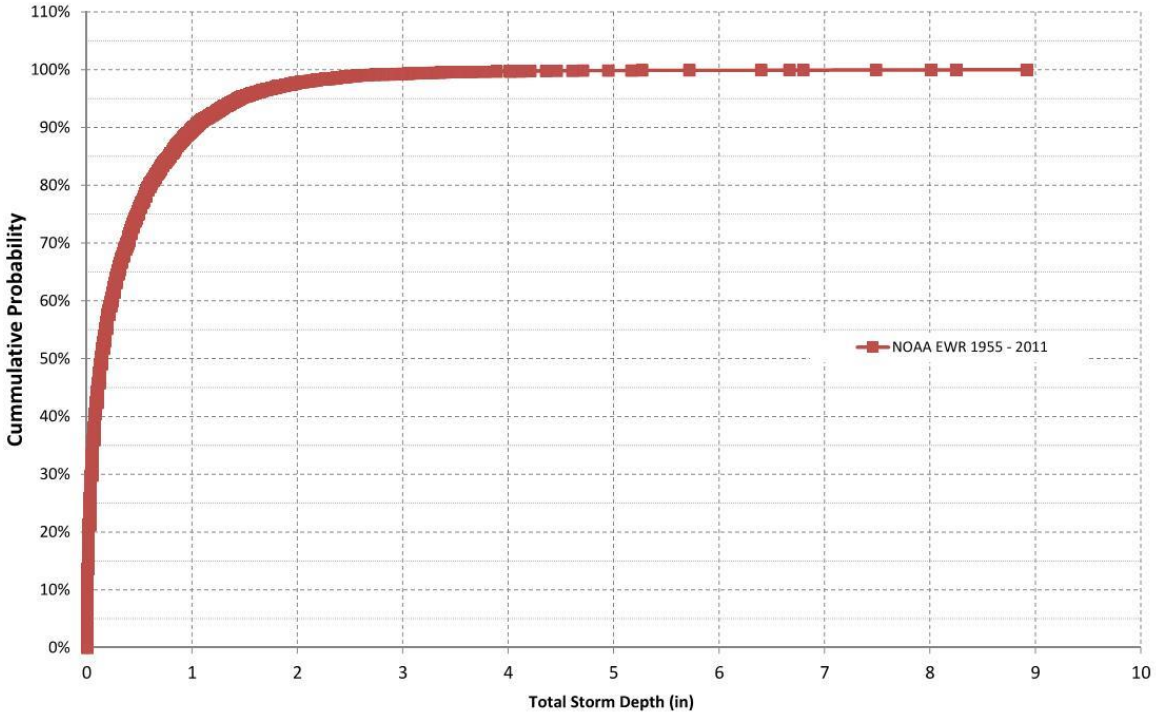
For the purposes of defining a wet weather event and for identifying the minimum size rain event to be sampled, a preliminary analysis of historical precipitation data was performed and summarized in a memorandum prepared by William Leo of HDR dated December 1, 2015 (attached as Appendix A). The correlation between rainfall and CSO events indicates that for a storm event of 0.2 inches, 40% of the CSOs are activated in the municipalities tributary to the main interceptor and 25% of the CSOs in the City of Bayonne are activated. As a result, 0.2 inches of total rainfall volume provides a conservative metric for defining a wet weather event.

Figure 3 provides insight on the size storms in weather forecasts that provide a strong probability of capturing a CSO event. Based upon the memo, the plan is to mobilize for wet weather monitoring for storms predicted to be 0.5 to 1.0 inches in volume since these storms events are more likely to result in combined sewer overflows. The preliminary statistical analysis of rainfall at Newark Airport indicates that approximately 75 percent of storms have rainfall volumes equal or less than 0.5 inches, while 90 percent of storms have rainfall volumes equal or less than 1.0 inches. While the monitoring program will be designed to capture a variety of storm volumes, durations and intensities to facilitate robust model calibration, individual

storms can be expected to have varying characteristics across the study area. Storm events that fall outside of the target range are still relevant, and therefore data collected from all rainfall events will be presented in the monitoring report. The elimination of an overflow event because it does not fit within artificially established guidelines could introduce a bias to the data and result in the model not being truly representative of the area. The intent is to sample within the parameters established, however, the use of smaller or larger storms for the purposes of model calibration and validation will be considered acceptable, given that a sufficient number of storm events causing a discharge have been captured. A minimum of three (3) events will be collected for a model calibration and model verification. The Model Evaluation Group will be asked to provide input regarding the number of events used and their overall distribution.

Since rainfall radar was not available at the time the past studies were performed, temporary precipitation gages were installed throughout the district to classify return periods and spatial variability. A statistical analysis was completed using data from the Newark NOAA Weather Station. That analysis will be revisited using the historical data that has been recorded since completion of the past studies. The statistical analysis will be updated to identify return frequencies of storms and to identify the "typical year" for the purposes of performing the alternatives evaluations. For the previous study, 1988 was specified by NJDEP as the "typical year". Upon reviewing and updating this past analysis, the "typical year" will be identified.

Figure 3 – Rainfall Volume Probability Plot



Collection System Model Validation – A primary use of the monitoring, metering, and sampling

data will be for further validating the collection system models that were calibrated under the 2003 permitted required characterization work. Adjustment of model coefficients will be made so that the mathematical model provides an adequate representation of the combined sewer areas and their response to wet weather conditions. Principal model calibration parameters will be sanitary flow rates, contributing imperviousness and hydrograph shape factor for each subcatchment, Manning's pipe roughness coefficient, and the concentration of each simulated water quality parameter in wastewater and stormwater. Coefficients will be adjusted to develop a representative match between the flows and pathogen concentrations computed by the model, and the recorded rainfall, metered wastewater flows and the lab analyses of pathogen concentrations for each of the storm events examined. The Sewer System Characterization Report that is due July 1, 2018, will include all of the model input parameters as well as the basis for each parameter, including identification of which parameters were adjusted to calibrate the model. The electronic InfoWorks input file and output files of the model as well a summary of input parameters and results will be included in the Sewer System Characterization Report. Section E of this document provides additional details.

Characterization of Sanitary, Stormwater and CSO Wastewater Quality – Characterization of Sanitary, Stormwater and CSO Wastewater Quality - Suitable statistical and other analyses and appropriate data tabulations will be developed so that bacteria concentrations in sanitary wastewater during dry weather and CSO quality during wet weather can be characterized. At selected stations with various land uses, stormwater quality will be sampled. Comparison of these results with similar data for other locations, as well as regional and national data sources will serve several purposes. These characterizations will provide a basis to calibrate the proposed mass balance approach. The mass balance approach estimates bacteria concentration in CSO through mixing fixed concentrations of bacteria assigned to sewage and stormwater respectively. The analysis will also help quantify CSO quality among different land uses or sewersheds within the PVSC service area.

If, during subsequent receiving water model calibration, the mass balance approach is found to yield a poor fit between observed and calculated receiving water bacteria concentrations, the water quality component of the landside model will be reconfigured to improve its value for receiving water quality analysis. Alternative water quality approaches for the landside modeling could include options such as implementation of a buildup-washoff component for stormwater bacteria loads, or definition of more refined bacteria source categories, such as sanitary sewer inflow, and infiltration flows in sanitary sewers, combined sewers, and separate drainage systems.

If the mass balance approach is not used, this QAPP and the Receiving Water Quality Modeling QAPP will be amended to include the modified approach.

Project/Task Description

Precipitation monitoring, wastewater quality sampling and flow metering will be conducted so that combined sewer overflow quantity and quality can be characterized for each of the combined sewer drainage areas, including determination of relationships between rainfall,

runoff/overflow volume and pathogen loads. The data obtained will be used in the validation of the Hudson County Collection System Models for all the combined sewer drainage basins tributary to the Hudson County forcemain. Monitoring will include rainfall intensities, volumes, and duration as well as receiving water stage to determine any backwater effects upon tide gates and discharge volumes.

The scope of work includes precipitation monitoring, metering of wastewater flows, and wastewater quality monitoring of CSO discharges. Each of these tasks is summarized separately within this QAPP. The task summaries reference the work performed under previous studies, provide support for the use of the data collected during the past studies, and identify the proposed work to be performed under this QAPP. The proposed work will supplement the available data and be used to update the landside model. Information collected will be used to verify maximum conveyance capacity of the collection system and to demonstrate under the alternatives evaluation task for the CSO LTCP development the relationship between PVSC accepting additional wet weather flows and the associated impacts on CSO discharges as well as other required alternative evaluations for the LTCP: green infrastructure; increased storage capacity in the collection system; STP expansion and/or storage at the plant; I/I reduction; sewer separation; and treatment of the CSO discharge and CSO related bypass of the secondary treatment portion of the STP.

Scope for Precipitation Monitoring

Historical precipitation data collected by Bayonne and North Bergen was done independently by each municipality in rainfall monitoring studies developed between 2003 and 2006. These efforts paralleled a 1998 PVSC Rainfall Monitoring Study that represented their hydraulically connected municipalities. The information collected in the Bayonne and North Bergen rainfall monitoring studies was used by each municipality in establishing the relationship between precipitation and conditions which produce CSO within each of their sewer districts and presented in their independently-developed CSO Characterization Study Modeling Reports.

The first task to be completed under this QAPP will be to re-evaluate and update the relationship between precipitation and the conditions which produce CSOs within the sewer district. Recent precipitation data will be used to supplement the data used in the historical analyses performed for the rainfall monitoring studies developed by Bayonne and North Bergen. The past analyses will be revisited and will include reevaluation of more recent climatological records for the purposes of updating historic and measured rainfall event statistics to consider changes in precipitation patterns.

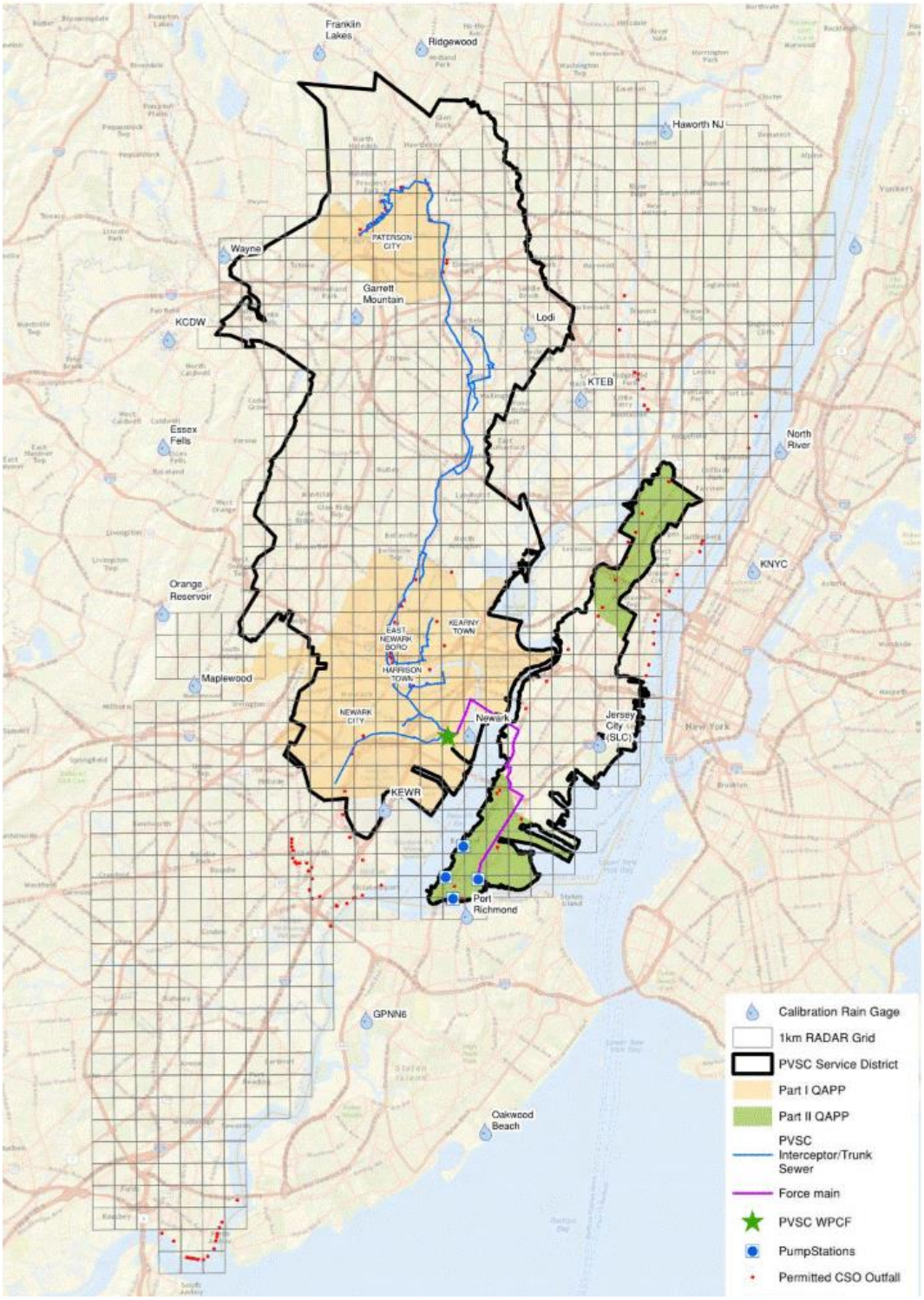
To cost-effectively address spatial variation of precipitation and in consideration of technological advances since the performance of the past characterization studies, rainfall radar will be used for calibration of the landside model. A rainfall radar network has been developed for the CSO Alert and Discharge Monitoring Report System. This network has been calibrated using existing rain gages located throughout the study area. It is common industry practice to use reliable rainfall data from outside the domain of interest to inform calibration of the radar-rainfall model.

Additionally, there is a need to determine a method for estimating flows from the Passaic and Hackensack rivers that are not accounted for by the USGS gauges on the Passaic at Paterson (01389890) and the Hackensack at New Milford (01378500). If streamflow is modeled from ungaged areas using a hydrologic model, there will be a need for robust rainfall data for these areas. Most of Alpine drains either east directly to the Hudson, or west toward Oradell Reservoir and thus the USGS Hackensack River gauge. However, the southernmost part of the town drains southwest to the Hackensack River via Overpeck Creek, and may thus need rainfall data for use in simulating streamflow. The actual grid would however focus on the model domain. **Table 1** provides a listing of the gages used in the calibration while **Figure 4** identifies the location of each gage. Data from these gages will also be used to perform a rainfall-overflow correlation analysis and rainfall event characterization.

Table 1 – Existing Rain Gages Used in Rainfall Radar Calibration

Name	Network
Central Park	NOAA/NCDC
Essex County AP	NOAA/NCDC
Newark Liberty IAP	NOAA/NCDC
Teterboro AP	NOAA/NCDC
Essex Fells	USGS
Franklin Lakes	USGS
Garrett Mountain	USGS
Lodi	USGS
Maplewood	USGS
Newark	USGS
Orange Reservoir	USGS
Ridgewood	USGS
Wayne	USGS
New Brunswick	NJ Mesonet

Figure 4 – Location of Existing Rain Gages Used in Rainfall Radar Calibration



Scope for Collections System Metering

The past system characterization and modeling reports utilized data from sources as follows:

1. Past Temporary Municipal In-System Flow Meters – Installed independently among Bayonne and North Bergen between 2002 and 2004 in support of their respective characterization studies, the flow and level data from these meters were used to better characterize surface runoff characteristics within the CSO drainage basins.
2. Past Municipal CSO Meters – These temporary meters were installed at rotating outfall and regulator sites between 2002 and 2004. Three Bayonne sites were metered in 2003-2004 and two sites in North Bergen in 2002. The CSO data was used to calibrate and validate the modeled CSO discharge predictions.
3. Two (2) flow meters presently exist on the South Kearny Pump Station's force main. Additionally, there is one (1) flow meter located on each force main of the NBMUA Central Pump Station and the NBMUA 8th Street Pump Station. A flow meter is also present on the JCMUA West Pump Station, as well as the JCMUA East Pump Station. The force main for the Bayonne Pump Station also has a flow meter. All flow meters are owned by the individual permittees and are shown on Figure 2. However, PVSC maintains and calibrates these flow meters and each flow meter is calibrated at least once per month.

Based upon a review of the extensive metering performed for the past studies, data will be collected at combined sewer overflow regulator inflow and overflow locations to include monitoring for 12 weeks at four regulator sites. This data will be used to confirm any variations in overflow characteristics due to modifications made to the collection and interceptor systems since the past studies. The supplemental data will be collected at 4 sites all of which were past metering sites in the update of the landside model. These four sites were chosen as they correlate to the prior characterization sampling stations and will provide enough flow data to check the prior calibrated model.

The flow monitoring equipment will be installed in the combined trunk sewer upstream of the overflow chamber or within the overflow chamber as field conditions dictate. The flow monitoring equipment will be installed and maintained by a specialty company who has the expert knowledge in the science of flow measurements. The flow data reports from the flow monitoring company are accompanied with QA/QC data that demonstrates validity of the results or flags results that are questionable. Calibration and maintenance procedures will be requested from the specialty flow monitoring company and shared with NJDEP upon request. Sensors will be installed within the incoming sewer and/or overflow chamber to measure depth of flow and velocity. The precise location of the sensors will be determined during the field visit with the flow monitoring company since logistical and practical considerations unique to each site (such as access, proximity to changes in flow patterns, depth of flow initially observed, sediment deposition, etc.) affect the final location for the sensor. Figures showing metering locations and configuration of sensors, with photos of installed flow monitors will be provided in the Sewer System Characterization Report. The depth measurements will be used to determine the overflow rate by using the height of flow over the weir adjusted for tidal or high water influences. Weir

formulas established in previous studies and/or scattergraph methodologies will also be used as appropriate based upon the individual site conditions.

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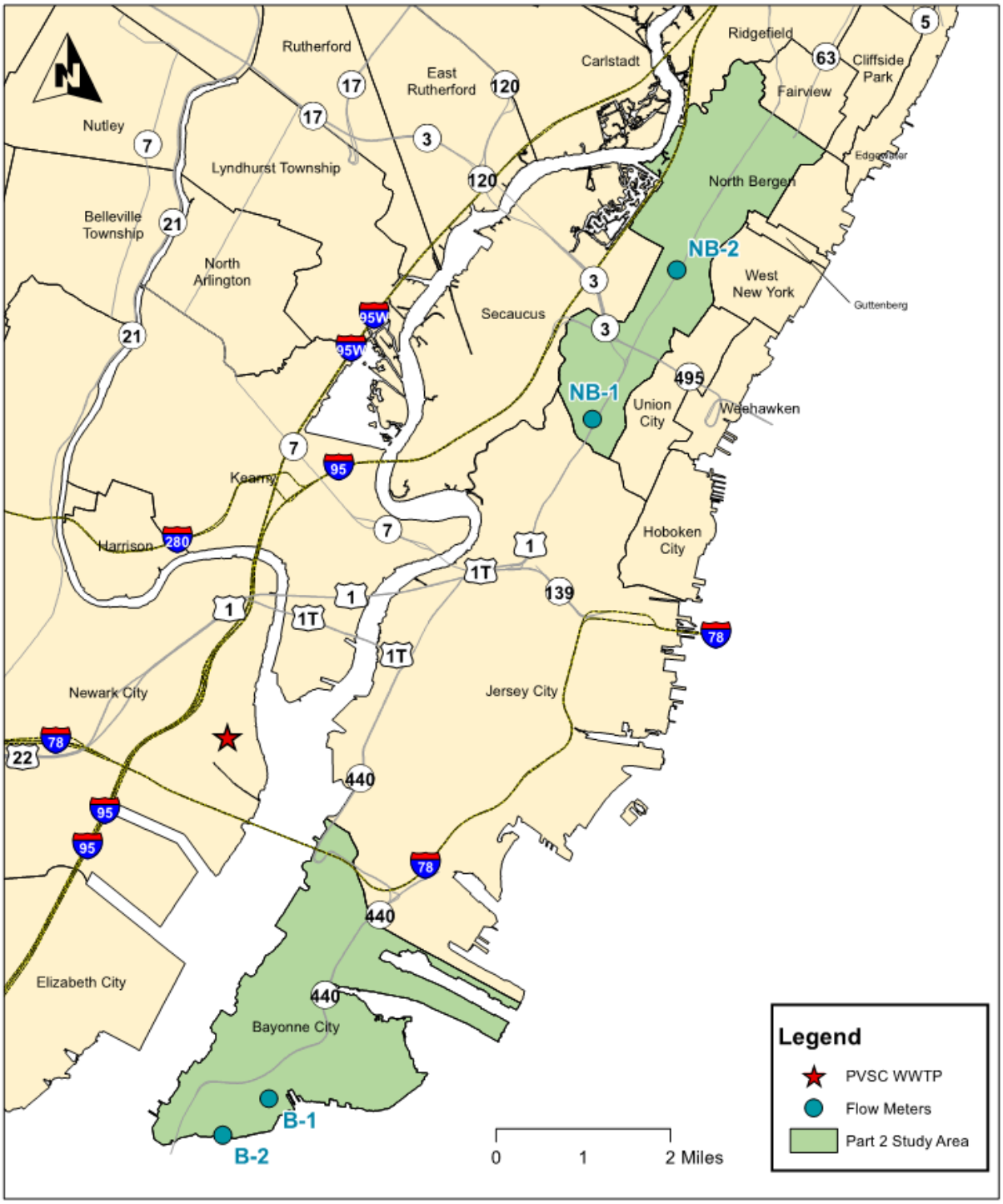
Table 2 summarizes the proposed temporary flow metering locations while **Figure 5** illustrates the location of the proposed metering locations.

Table 2 – Location of Proposed Temporary Flow Meters

Flow Meter ID	Municipality	NJPDES Permit No.	Name	Monitoring Location
B-1	Bayonne	008A	E. 5th Street & Ingham Avenue	Overflow Chamber
B-2	Bayonne	010A	W. 1st Street and Avenue C	Overflow Chamber
NB-1	North Bergen	007A	Regulator 5-2, Tonnelle Avenue	Overflow Chamber
NB-2	North Bergen	011A	Regulator 9-7, Tonnelle Avenue	Overflow Chamber



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LOCATION OF PROPOSED TEMPORARY FLOW METERS

FIGURE 5

Sanitary Wastewater Quality Monitoring

Wastewater sampling data collected during dry and wet weather conditions for the respective CSO Discharge Characterization Studies for Bayonne and North Bergen will be utilized in the collection system model development. Specifically, this data will be used to define sanitary sewage pathogen quality for use in the mass balance approach to calculate the CSO overflow quality for water quality modeling purposes.

While such parameters as biochemical oxygen demand, chemical oxygen demand and total suspended solids may be influenced by loss of industry since performance of the past studies, pathogens (the focus of this study) are not expected to be impacted. The collection of fecal coliform data, as part of this study, will be used to verify this concern. The fecal coliform data will be supplemented with the analysis of E. coli and enterococcus, as site appropriate, for assessment of the proposed USEPA Recommended Recreational Water Quality Criteria.

The sampling data presented in each of these past studies was performed under approved QAPPs and evaluated the following parameters.

Lab Analyzed Composite Samples

- Total Suspended Solids (TSS)
- Total Dissolved Solids (TDS)
- Settleable Solids
- 5-Day Biochemical Oxygen Demand (BOD_5)
- Chemical Oxygen Demand (COD)
- Total Kjeldahl Nitrogen (TKN)
- Ammonia-Nitrogen (NH_3-N)
- Nitrate-Nitrogen (NO_3-N)
- Nitrite-Nitrogen (NO_2-N)
- Total Phosphorus (TP)
- Orthophosphate (OP)
- Hardness (Newark Only)

Field Analyzed Grab Samples

- Temperature
- pH
- Dissolved Oxygen (PVSC only)
- Conductivity (PVSC only)

Lab Analyzed Grab Samples

- Fecal Coliform Bacteria

The data collected under the past municipal-led studies will be supplemented with data collected under this QAPP.

Water quality monitoring under this QAPP will be limited to pathogen sampling during dry and wet weather. In consideration of pending action by NJDEP in response to the Recreational Water Quality Criteria recommended by EPA for the protection of public health and welfare for those

waterbodies designated for water contact recreational activities, the work under this QAPP will be limited to the new pathogen indicators identified in the EPA criteria. Dry weather samples will be taken just prior to each rain event sampled and utilized in verifying the current baseline conditions versus the past dry weather sampling data. Dry weather samples will be collected after a period of at least 48 hours without precipitation and prior to the start of the predicted rain event. The dry weather sample results will be compared to past dry weather sampling results to determine the validity of the historic baseline results. Discrete grab samples will be collected and analyzed for fecal coliform and enterococcus for outfalls that discharge to saline and fresh waters. E. coli will also be analyzed for those outfalls that discharge to fresh waters.

In consideration of the cost and logistical issues of performing event sampling for 38 CSOs over a large planning area, wastewater quality sampling will be limited to a select set of sampling stations. This process is consistent with past studies performed by the MUAs and will utilize most of the past sampling stations. Wastewater quality sampling conducted under this QAPP will include 4 of the 38 CSO drainage basins tributary to the Passaic Valley Sewerage Commission from the municipalities of Bayonne and North Bergen. These areas provide for a sufficient range of land uses to allow for the data to be applied to the remaining 34 CSO basins based upon similarities in land use characteristics. The data collected from these 6 sampling stations will thereby serve as surrogate data for the other 34 CSO outfalls.

Land use changes from 1995 to 2012 will be reviewed using available aerial photography and GIS database information. Land uses will be classified into the following categories: low and high density residential, open space, commercial and industrial. For the purposes of estimating pathogen loads, a surrogate from one of the 6 monitoring stations will be applied to each of the 34 un-monitored stations based on similarities in land use distribution within the CSO drainage basins.

CSO Wastewater Quality Monitoring

Water quality sampling at each proposed monitoring station will be limited to the collection of grab samples and analysis for fecal coliform and enterococcus. Grab samples for analysis of *E. coli* will also be collected at monitoring sites where the outfall discharges to a fresh water receiving waterbody.

The goal of the event sampling protocol is to obtain three wet-weather events of sufficient depth, intensity, and duration for valid model calibration. Sampling crews will mobilize in advance of a rain event and conduct a round of dry weather sampling prior to the each event and commencement of wet weather monitoring. Wet weather sampling will commence upon activation of an overflow event and continue through the cessation of the CSO event. After activation of the CSO event, sampling will continue to be performed at the following intervals throughout the duration of the CSO event: 0.5 hour, 1 hour, 2 hours, 4 hours, and 8 hours. CSO sampling will end upon collection of the sample at the 8 hour interval or upon cessation of the CSO discharge, whichever occurs first. Only a single sampling point will be established at each sampling station since adequate in-system mixing should occur during rainfall events. Monitoring will be conducted in an upstream manhole, the overflow or regulator chamber based on field conditions to monitor the loads that develop and overflow from the system as operated.

Table 3 provides a summary of each of the four sampling locations, the associated permit identification number, permittee and location. **Figures 6 and 7** (and the detailed site drawings contained in Appendix F) illustrate the location of each of the sampling stations in Bayonne and North Bergen respectively.

Table 3 - PVSC System Characterization Wastewater Quality Sampling Stations

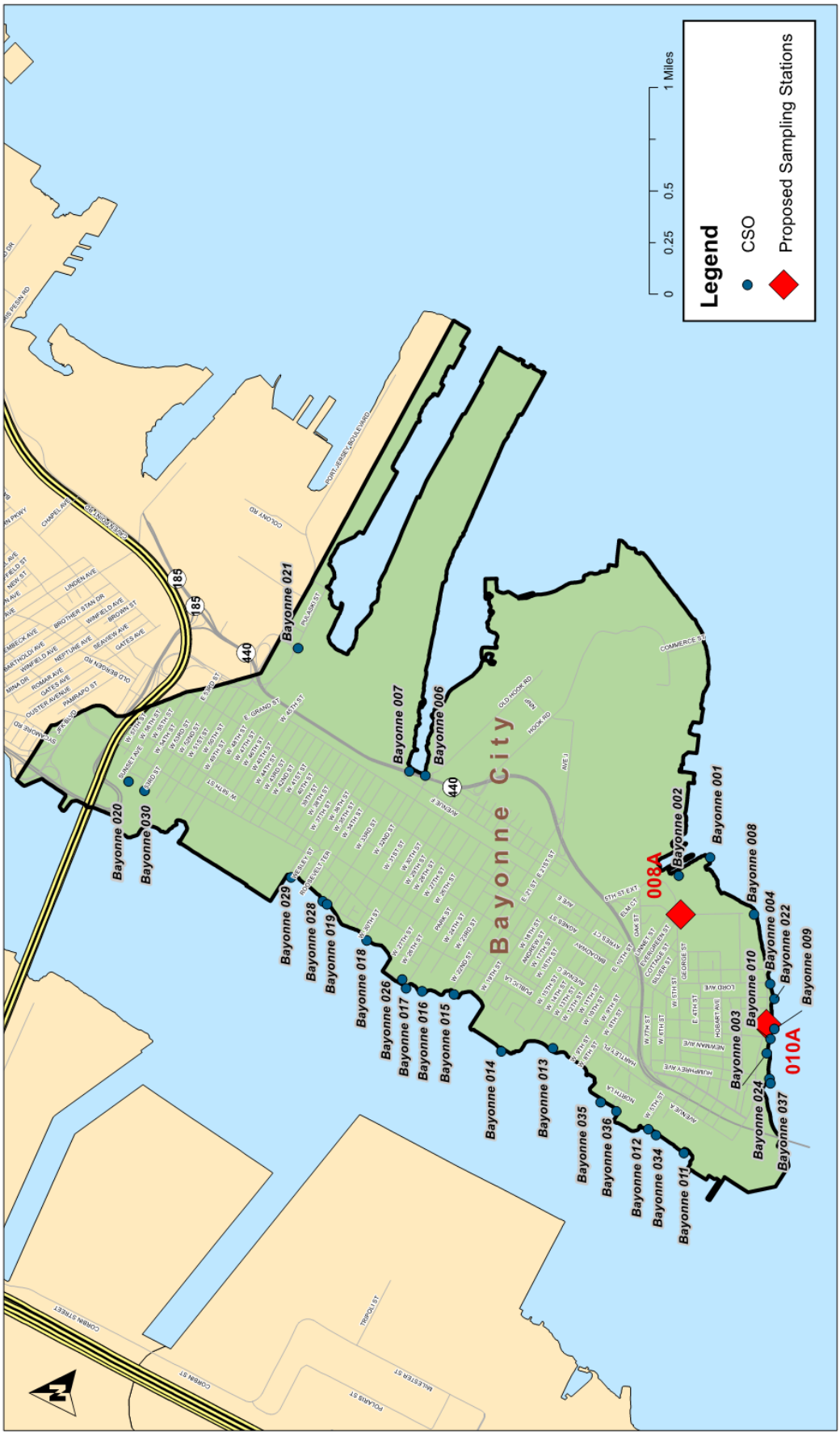
NJPDES Permit No.	Permittee	Location of Sampling Stations
008A	Bayonne	E. 5th Street & Ingham Avenue
010A	Bayonne	W. 1st Street and Avenue C
007A	North Bergen	~~Regulator 5-2, Tonnelle Avenue~~ Liberty Ave btwn 52nd & 53rd
011A	North Bergen	~~Regulator 9-7, Tonnelle Avenue~~ Dell Ave. across from 10th St.

Stormwater Quality Monitoring
A stormwater sampling program will be performed under the PART 1 QAPP and the results will be utilized for this PART 2 QAPP.

Consideration of Sensitive Areas
Paragraph G.3 of the Combined Sewer Management Section of PVSC's NJPDES Permit requires CSO permittees to "give the highest priority to controlling overflows to sensitive areas". The permit identifies a separate report deliverable for this evaluation due on July 1, 2018. As the system characterization will provide information necessary to evaluate the potential impact of CSOs on sensitive areas, it will be necessary to perform the evaluations and report development in parallel.

A preliminary evaluation indicates that the receiving waters within the influence of the CSOs are not designated Outstanding National Resource Waters or National Marine Sanctuaries. Upon calibration and validation of the receiving water quality model, further evaluation of the influence of CSOs on waters used for primary contact recreation, public drinking water intakes (or their designated protection areas) and shellfish beds can be further evaluated. The presence of threatened or endangered species and their habitats will be investigated and the potential impacts evaluated. Once the sensitive areas have been identified, the results of the landside and receiving water models will be reviewed for those CSOs potentially impacting these areas, to characterize the impacts and to develop strategies for controls to be considered during the alternatives evaluation phase of the CSO LTCP development.

Surface Flooding and Basement Backups
Paragraph G.1.b of the Combined Sewer Management Section of PVSC's NJPDES Permit requires the system characterization to "include a thorough review of the entire collections system that conveys flows to the treatment works, including areas of sewage overflows, including to basements, streets and other public and private areas, to adequately address the response of the CSS to various precipitation events." As this information is specific to the operation and maintenance of the individual municipal systems, each permittee is documenting these areas through NJPDES Permit requirements F.1.e.iii and F.1.f.viii "system spreadsheet". This document will be used in the evaluation process for the LTCP. PVSC anticipates that these historic operations issues will be addressed by each individual permittee in their operations and maintenance manuals, which are required to be completed by July 1, 2016.



LOCATION OF PROPOSED SUPPLEMENTAL SYSTEM CHARACTERIZATION WASTEWATER QUALITY SAMPLING STATIONS CITY OF BAYONNE

FIGURE 6

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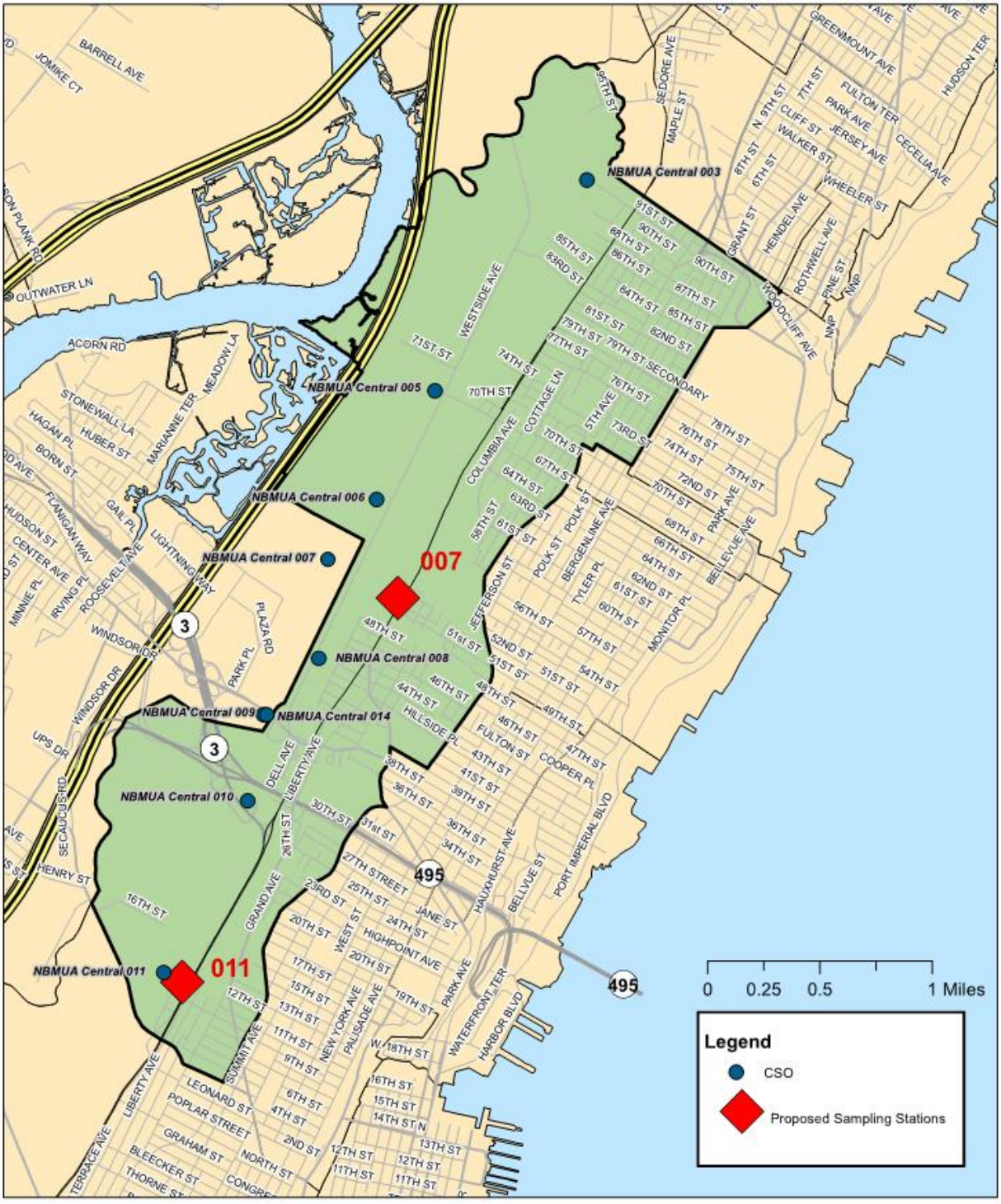

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LOCATION OF PROPOSED SUPPLEMENTAL SYSTEM CHARACTERIZATION
WASTEWATER QUALITY SAMPLING STATIONS
NORTH BERGEN (CENTRAL CITY)
FIGURE 7

A.8 Quality Objectives and Criteria

Quality control (QC) procedures will be applied in the field and the laboratory to assess data quality criteria of precision, accuracy, sensitivity, completeness, comparability, and representativeness (**Table 4**).

Table 4 - Data Quality Criteria

Data Quality Indicator (DQI)	Measurement Performance Criterion	Measurement Performance Assessment Activity	S: Sampling A: Analysis
Precision	RPD[1] <30% for field duplicates; RPD[1] <40% for lab duplicates	1 field dup/event 10% lab dups	S & A
Bias/Accuracy	80%-120% Recovery	Reference material	A
Sensitivity	MDL[2] and RL[3]	Daily calibration curve	A
Completeness	Valid data from 90% of collected samples	Percentage of valid measurements	S & A
Comparability	Acceptable PT[4] samples; use of certified laboratories and approved sampling and testing methods	PT[4] samples and recertification of methods and/or laboratories by NJDEP	A
Representativeness	1 equipment blank per sampler per crew per event; Adherence to sampling/handling procedures and program SOPs; Routine equipment maintenance with each event	Equipment blanks < each MDL; documentation of equipment calibration and maintenance	S & A

[1] Relative Percent Difference. RPD values are non-representative when (a) both the original and duplicate results are less than 5x the reporting limit or not detected at the reporting limit or (b) either result is estimated, rejected, or suspected of contamination.
[2] Method Detection Limit, calculated where applicable; refer to Tables 5 & 6 herein.
[3] Reporting Limit or Reporting Level; refer to Tables 5 & 6 herein.
[4] Performance Test. Part of annual laboratory & method certification for the laboratory performing the analysis.

Precision assesses the variability associated with sample collection, handling, and storage in the field, as well as variability associated with the analytical processes. To address this variability, one sample from each sampling event and sampling group will be collected in duplicate. As an additional assessment of analytical precision, every 20th sample, or at least one sample per batch, will be split in the laboratory for duplicate analysis.

Accuracy, or the closeness of a result to the true value, will be assessed by analyzing a second source QC sample of known concentration with each batch of samples for methods where this is applicable. Those QC samples can be in the form of Laboratory Fortified Blanks or Matrix Spikes, depending on the analytical method.

Sensitivity of the methods will be assessed using predetermined method detection limits (calculated annually as necessary) and reporting limits or levels.

Completeness is a measure of the amount of valid data obtained from a measurement system. It should be expected that at least 90% of data collected will be valid, usable data meeting all quality objectives.

Comparability is a measure of confidence with which one data set or method can be considered equivalent to another. Comparability is assessed using Performance Test samples as part of annual laboratory & method certification for each laboratory participating in the analysis of Program samples. Additionally, comparability is built into the program by using only EPA approved methods and NJDEP Certified Laboratories.

Representativeness is a measure of the degree to which data accurately and precisely represent, in this case, the parameter or environmental condition at the sampling point. Representativeness is established by adhering to sampling and sample handling procedures, equipment maintenance, calibration, and use procedures, and by uniform implementation of all program SOPs. In addition equipment blanks, using laboratory deionized water, will be generated each day that samples are collected and for each sampler to be used during that event (includes all sampling groups within each sampling event). Enough equipment blanks will be collected to be analyzed with each parameter of interest.

The objective of the duplicate is to document field equipment cleanliness, field method consistency and the possibility of ambient condition contamination of the samples. The collection apparatus will be lowered a second time to collect a sample at the same time and depth. The duplicate set of sample containers will then be handled in accordance with all sample handling procedures and placed in a cooler on ice to maintain the samples at 4º C. The duplicate samples will be analyzed for all laboratory parameters for which each sample is analyzed.

A.9 Special Training Needs / Certification

A clear understanding of project objectives and data quality criteria is necessary for project personnel to successfully participate in this project. Field personnel are trained in routine field water sampling and in-situ testing techniques. Lab personnel are trained in quality laboratory techniques and in the tests that they will be performing. Each laboratory performing testing for this project will be certified annually by the NJDEP for each parameter.

This QAPP will be appended with the names and certification information of the sampling firm and analytical laboratories when such information becomes available.

A.10 Data Documentation and Review

All data generated in the field and laboratory will be recorded in the appropriate logbook or standardized data form. The information that will be recorded includes: sampling location and date, time, field conditions, raw analytical data and date of testing, sampling and testing personnel, daily sample processing procedures and any corrective actions or deviations from procedures, as necessary. *Primary* data for this project, recorded on data sheets or in laboratory notebooks, will be retained according to each participating laboratory's procedures. The

contractor responsible for the sampling efforts will maintain *copies* of the primary data, and/or summary data reports for at least seven years. Other project documentation such as sample chain of custody records and instrument maintenance and calibration information is maintained on file at each laboratory within their normal documentation systems.

An electronic Excel file will be used to compile data into a single file. The entry of this data into the electronic file is 100% second checked for correctness to eliminate typographical errors. These electronic files are kept by the Field Coordinator. The electronic files of compiled data will be retained for the life of the project.

Routine QC testing is a part of normal procedure at each laboratory collecting data throughout the course of the program. Additional quality assurance reviews of the data are conducted by the project's Field Coordinator (100% of the data) and by the QA Officer (10% of the data) before releasing data in the final report and to secondary data users.

A.11 Corrective Action

If corrective action is required during this project, the QAPP will be revised and redistributed to all project signatories, including the NJDEP Office of Quality Assurance for review and approval.

SECTION B - DATA GENERATION AND ACQUISITION

B.1 Sampling Process Design

The System Characterization Sampling Program will occur over a 12 month period (coincident with other baseline compliance and event sampling) to collect the of wastewater samples for PVSC and the participating permittees. The study design is based on knowledge of the past system characterization efforts, the current conditions of these CSO drainage basins and professional judgment. The study has been designed to provide a means of characterizing the quality and quantity of existing CSO discharges and supporting surface water modeling efforts that will project the success of pollution abatement alternatives to be evaluated under future LTCP tasks. The sampling sites were selected for consistency with the past system characterization efforts and for the purposes of supplementing the past data set. The sampling design also considered the logistical limits of collecting data from multiple stations during wet weather conditions. An effort has been made to prevent unnecessary cost and logistical problems while still meeting the program's objectives.

The data collected in this program should provide an adequate characterization of the pathogen concentrations of CSO discharges in the project area. All sampling methods will conform to the applicable requirements of the *NJDEP Field Sampling Procedures Manual (FSPM, 2005).* Relevant section numbers are provided where applicable.

B.2 Sampling Methods

Sampling Procedures

All samples will be collected in accordance with the NJDEP's Field Sampling Procedures Manual (2005 – Chapter 2: Quality Assurance, Chapter 5: Sampling Equipment, Chapter 6: Sample Collection, and Chapter 10: Documentation). Grab samples for fecal coliform, enterococcus, and E. coli will be collected directly into new sterile HDPE containers and preserved. Field blanks for pathogens will not be conducted.

Sample bottles will be prepared prior to initiating sampling at each site. All sample bottles will be marked with the site ID and location, parameter and date of collection. Time of collection will be listed on the chain of custody. Pre-sterilized disposable bottles will be purchased for bacteria analysis. *(NJDEP FSPM 2005: 2.3 Sample Containers, 10.5.1 Sample Labels, 10.5.2 Chain of Custody).*

Sample Collection and Schedule

The goal of the Event sampling protocol is to obtain three wet-weather events of sufficient depth, intensity, and duration for valid model calibration. Event –based sampling is responsive by nature: weather forecasts are checked and crews are mobilized in anticipation of the predicted precipitation event. Due to false starts, insufficient event sizes, and other limitations of event-based sampling, it is anticipated that there will be more than three event-based sampling occurrences. Regardless, no prior authorization is needed for each sampling crew leader, in coordination with the field leader, to change sampling schedule based on unsafe weather, holiday schedules, laboratory logistics, and equipment failure/availability.

Sample Preservation and Transfer Procedure
All samples for laboratory analysis will be preserved per laboratory methods and transferred to the appropriate contracted laboratory for analysis under standard chain-of-custody (COC) protocol. Analysis will be performed by a NJDEP certified Laboratory for all laboratory parameters reported. All sample bottles used for laboratory analysis will be new and provided by the sampling contractor or the contracted laboratory.

Field Equipment
Prior to the first deployment, each field crew will be provided all equipment necessary to safely and efficiently collect the Event-based wastewater quality samples. The following list includes the items anticipated to be required for each field sampling event, but as the program progresses adaptation and enhancements may be possible:

- *Vehicle*: A cargo van or vehicle with similar capacity to transport the sampling equipment and materials will be used.

- *Sampling equipment*: Coolers with ice, thermometer, de-ionized water, sample bottles with appropriate preservative and sampling pole.

- *Safety equipment*: Traffic cones, hazard lights, flashlights, personal protective equipment safety vests, nitrile gloves, safety glasses, cold and wet weather gear as appropriate.

- *Documentation*: Work plan, field data sheets, COC forms, clipboards.

B.3 Sample Handling and Custody
Samples will be collected and immediately stored on wet ice in a cooler. The temperature of the first sample taken by each sampling crew will be measured upon delivery of samples to the contractor laboratory and will be recorded on chain of custody forms. Note that the last samples taken, depending on the temperature of the sampling waters, may not have time to reach the cooling temperature of approximately 4ºC or lower before delivery to the laboratory.

Chain of custody (COC) documentation tracks the progress of samples from their collection in the field through laboratory analysis. The forms will be completed by field personnel, and will accompany the samples to the laboratory. Each time the samples change hands, the COC form will be signed by the person relinquishing the samples, then by the person receiving them. The Field Coordinator will be responsible for establishing and distributing COC forms to each of the sampling crews *(FSPM 10.5.2).*

B.4 Analytical Methods
Because the data collected is intended to be used in conjunction with the ongoing NJHDG sampling and the Baseline Compliance Monitoring Sampling Program, it is preferable to use the same laboratory methodology as the PVSC laboratory currently employs on the NJHDG's behalf. However, given the large quantity of samples to be analyzed and the use of contractor laboratories, it may be necessary to rely on laboratory results produced using alternate analyses. **Table 5** summarizes the sample preservation and holding times for the methods specific to PVSC and preferred for this QAPP. **Table 6** lists alternate analyses approved by NJDEP and

EPA, along with preservation and holding times. The preference is to use the analytical methods noted in **Table 5.** Should it be necessary, because of laboratory capacity or other such issues, to utilize an alternative analytical technique from **Table 6**, NJDEP will be notified and if necessary this QAPP will be modified for any additional quality control testing that is required.

Table 5 - PVSC Laboratory Analytical Chemistry Analyses

Parameter	Laboratory Method	Preservation	Holding Time	Reporting Limit*
Fecal Coliform	EPA Micro Manual p. 124 (1978), Single Step Membrane Filtration	Cool $\leq$ 4°C	6 hrs	1, 2, 4, 10 CFU/100 mL
Enterococcus	EPA 1600 (Dec 2009), Membrane Filtration	Cool $\leq$ 4°C	6 hrs	1, 2, 4, 10 PE/100 mL
E. coli	EPA 1603 (Dec 2009), Membrane Filtration	Cool $\leq$ 4°C	6 hrs	1, 2, 4, 10 CFU/100 mL

* Values are current as of issuance of this QAPP and are based on dilutions, i.e., lower dilutions yield lower reporting limits and vice versa. CFU: colony forming units; PE: presumptive enterococci.

Sample preservation is done in the field following sample collection. Any deviations from the analytical procedures, preservation methods, and/or holding times are recorded in the laboratory notebook or data sheets.

The contractor laboratory selected must be certified annually by the NJDEP for each parameter and must conform to the procedures outlined in N.J.A.C. 7:18, *Regulations Governing Laboratory Certification and Standards of Performance (NJDEP FSPM 2005: 2.1.1 Laboratory Certification).* Equipment and supplies utilized in the analytical procedures are specified in each laboratory's SOPs. Instructions for data controls (equipment calibrations, blanks, reference standards, positive controls, etc.) are included in both the SOPs and lab manuals. Minimum detection levels and minimum reporting levels are specified and, if required, calculated annually.

B.5 Quality Assurance and Quality Control

In addition to the Quality Objectives and Criteria listed in A8, additional QA/QC methods will be adhered to. Primary data records (forms, notebooks, or electronically generated data) will be checked for completeness and accuracy. All data that will be electronically entered into the study records (Excel file) will be checked by someone other than the person entering the data. An electronic Excel file will be used to compile data into a single file. The entry of this data into the electronic file will be 100% second checked for correctness to eliminate the possibility of typographical errors. These electronic files will be kept by the Field Coordinator.

Routine QC testing is an integral part of routine laboratory procedure. The contract laboratory will be responsible for the testing of all routine QC samples associated with each method and for evaluating the QC results for each batch of samples (e.g., laboratory blanks, spiked samples, split samples, positive and negative controls). All QC results that fail the appropriate quality control criteria will be documented as part of the data packet, reviewed by the laboratory's Manager and QA Officer, and then communicated to the PVSC Field Coordinator as soon as possible. Additional quality assurance reviews of the data will be conducted by the QA Officer before release of the data to primary and secondary users.

Table 6 - Alternate Analytical Chemistry Analyses Approved by NJDEP and EPA

Parameter	Laboratory Method[1]	Preservation	Holding Time	Reporting Limit[4]
Fecal Coliform	Standard Methods MF: 9222 D (1997) MF MPN: 9221 C&E EPA MPN: Micro Manual p. 132 (1978)	Cool ≤ 4°C	6 hrs	1, 2, 4, 10 CFU/100 mL 1.8 MPN/100 mL
Enterococcus	Standard Methods MF: 9230 C (2007) MPN: 9230 B (2007) Other MF: IDEXX labs MPN: Enterolert[3], IDEXX labs	Cool ≤ 4°C	6 hrs	1, 2, 4, 10 PE/100 mL
E. coli	Standard Methods MF: 9213 D (2007) MPN: 9223 B (2013), 9223 B (1997), 9221 B.2 (2006), 9221 F (2006) EPA MF: 1603-09 Other MF: mColiBlue-24, Hach MPN: Colilert-04[3], Colilert-18-04[3]	Cool ≤ 4°C	6 hrs	1, 2, 4, 10 CFU/100 mL

1. MF = membrane filtration analyses, MPN = most probable number analyses.
3. Although approved, rapid MPN methods have been discouraged by NJDEP.
4. Values are current as of issuance of this QAPP and are based on dilutions, i.e., lower dilutions yield lower reporting limits and vice versa. CFU: colony forming units; PE: presumptive enterococci.

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

Routine preventive maintenance will be conducted to minimize the occurrence of field and laboratory instrument failure and other system malfunctions. All maintenance will be documented in instrument maintenance logbooks.

B.7 Instrument/Equipment Calibration and Frequency

Laboratory equipment used in this project will be maintained, calibrated and operated according to the guidelines in *Regulations Governing the Certification of Laboratories and Environmental Measurements (NJAC 7:18)*, and applicable project SOPs. Calibrations for laboratory equipment and instrumentation will be performed prior to sample analysis according to NJAC 7:18 (Subchapters 3, 4, 5, 8, and 9). Field Equipment will be maintained, calibrated and operated according to the specific equipment manuals, and *NJDEP FSPM 2005*. Calibrations for field equipment will be performed prior to sample analysis on each day of use. Routine preventive maintenance will be performed at the frequency as recommended by equipment manuals to minimize instrument failure and other system malfunctions. Instruments will be recalibrated after conducting any maintenance activity. All maintenance performed will be documented in the appropriate instrument operating record books *(FSPM 10.2).*

Field equipment will be cleaned with mild detergent and rinsed with deionized water and inspected for cleanliness and usability before each use in the field *(FSPM 2.4).* Meters for field data parameters will be calibrated at the start of each sampling event. Documentation for each calibration will be recorded on the field data sheets or in field calibration log books.

B.8 Inspection/Acceptance for Supplies and Consumables

Supplies will be inspected to insure they will meet the needs of the project. Any specialized replacement equipment will be tested prior to use.

B.9 Data Management

Primary data for this project will be recorded on data sheets or in laboratory notebooks, and will be retained according to the participating laboratory's procedures. The sampling contractor will maintain *copies* of the primary data, and/or summary data reports for at least seven years in an organized and easily retrievable manner. Other project documentation such as sample chain-of-custody records and instrument maintenance and calibration information will be maintained on file at each laboratory within their normal documentation systems.

Data records for this project will be kept using basic laboratory practices; such as: the writing of corrections in ink, and the use of a single-line to cross out incorrect information, and the labeling of documents with sample ID, date, and signature of analyst. Data records will be stored in each laboratory's normal data files using either data sheets or laboratory notebooks.

Data will be compiled for use using Excel. Excel functions will be used to calculate basic mathematical values (e.g., monthly or seasonal averages, geometric means) for each analytical parameter from each sampling site.

The entry of this data into the electronic Excel file will be 100% second checked for correctness to eliminate the possibility of typographical errors. These electronic files will be kept by the Field Coordinator. The electronic files of compiled data will be retained for seven years past the life of the project.

SECTION C – ASSESSMENT AND OVERSIGHT

C.1 Assessments and Response Actions

Performance and Systems Audits
Only certified laboratories will be permitted to perform the tests specified in this report. To maintain certification, the contract laboratory is required to participate successfully in a performance testing program and is subject to periodic audits.

Performance Audits: All certified laboratories participate in the US EPA's Performance Evaluation (PE) studies for each category of certification. Laboratories are required to pass each of these PE studies in order to maintain certification.

System Audits: As part of certification, each laboratory periodically receives an onsite audit. The findings of these audits, together with the EPA PE results, are used to update certification status.

Although sampling activities will be executed by a contractor, PVSC has ultimate responsibility for oversight and coordination of these activities. Therefore, although the contractor performing the sample collection and field measurements will provide information to PVSC relative to the program, it will be PVSC, or its designee, that will certify that each sample is collected according to standard procedures. To address this, a trained PVSC employee, or a designee, will periodically review field activities to verify that appropriate protocols are being observed and that each sampling crew is trained on the standard procedures for sample collection, preservation, transportation and chain of custody.

C.2 Reports to Management

Reports
A report will be generated by the contractor or PVSC or both. The following information will be included in the report:

- a description of the program;
- the methods used for sample collection and chemical analysis;
- summary of results;
- anything unusual about the sampling or analysis, including deviations from specific protocols and any other relevant information; and
- the implications of the results as they relate to current and past conditions in the harbor, as relevant.

SECTION D - DATA VALIDATION AND USABILITY

D.1 Data Quality Control

Quality Control procedures are performed throughout each step of the System Characterization and Landside Modeling Program to evaluate Data Quality Criteria based on indicators of precision, accuracy/bias, sensitivity, completeness, comparability and representativeness (see **Table 2**). To gather the information necessary to evaluate these criteria, the following QC samples will be analyzed along with the wastewater quality monitoring samples:

Sampling Quality Control
A collection batch is a set of samples collected by a sampling team during a single sampling event. A duplicate of one field sample is taken for every 20 collected, or at least one per collection batch, if there are fewer than 20 samples. The field duplicate QC requirement for chemical analyses is a relative percent difference (RPD) less than 30%. The field duplicate requirement is a RPD less than 40% for fecal coliform, enterococcus, and E.coli. The laboratory will receive and process the field duplicates and equipment blank samples in the same manner as all investigative samples. The Project and Field Coordinators are responsible for calculating field sample duplicate RPDs.

A one hundred percent Quality Assurance review of Field Sampling QC controls will be conducted by the Project and Field Coordinator and an additional 10% review of the QC controls will be conducted by the Quality Assurance Officer, who is independent of any of the actual sampling and testing for this program. The Project and Field Coordinator is responsible for qualifying (flagging) data on the data sheets and in the Excel data file if the data fails any QC requirements.

Laboratory Quality Control
As specified for individual laboratory methods, the following QC samples will be analyzed as necessary and reviewed against QC requirements/limits for that sample and method:

Method Blank: A method blank will be analyzed during each sample batch. The parameter of interest cannot be detected in the method blank above the reported detection limit. If blank concerns are identified, analysis of the sample batch should not continue until the source of the problem is corrected.

Laboratory Fortified Blank (LFB): A LFB will be analyzed during each sample batch. Where appropriate, the results (percent recovery) must fall within the laboratory's control limits. If the LFB is found to be outside the limits, the following corrective actions should be taken:

- check the data and recovery calculations, and;
- check a reference QC standard.

QC Matrix Spike: A QC Matrix Spike will be analyzed during each sample batch. The results should fall within the laboratory's control limits established for each methodology (percent recovery). If a problem is identified, the corrective actions should be as follows:

- check the data and recovery calculations;
- check to determine if the blank spike reference standard is acceptable;
- if only the matrix spike is not within control limits, check the other analytes present for possible sample matrix interference, as detailed in the specific method. If the sample matrix is identified as the problem, this should be noted. If the matrix spike is consistently outside of acceptable limits for a particular parameter, another methodology should be considered for that analyte;
- check the reference QC standard if one has been performed in that batch;
- check for the presence of the analyte at a high value (more than four times the spike level), which suggests invalid spike recovery.

Laboratory Duplicates: 10% of samples from each sampling event, or at least one sample per sampling event, will be split into laboratory duplicate samples and run within the same batch. The QC requirement for laboratory duplicates is a RPD less than 40%.

Positive and Negative Control Blanks: For bacteriological tests, these blanks will be used with the bacterial tests. A negative control (or blank) will be run with each batch. Positive controls will be run with each new set of agar plates.

D.2 Verification and Validation Methods

Each SOP or laboratory control manual contains the quality control requirements for each test, including, where applicable: method blanks, matrix spikes, precision criteria for field duplicates, minimum detection limits, minimum reporting limits, and maximum reporting limits (for biological tests).

Since all laboratories will be certified for the test methods they will be using for this project, each laboratory will use their standard Quality Control criteria for accepting, rejecting or qualifying data.

A Quality Assurance verification of data will be conducted by the Project and Field Coordinator, and an additional 10% of data verification will be conducted by the Quality Assurance Officer, who is independent of any of the actual sampling and testing for this program.

SECTION E – COLLECTIONS SYSTEM MODELING

E.1 Collections System Modeling

The monitoring and modeling study addressed by this QAPP is designed to update the existing collections system models for the collection system that serves the participating CSO permittees and convert them to InfoWorks. It will also be used to develop, calibrate and verify the s portions of the model as needed. The updated model will produce the hydraulic flow and quality information that will be the basis for projecting wet weather, combined sewage flows, volumes and pathogen loadings to the Hudson County forcemain, WPCF, and ultimately, via the regulator overflows, to the receiving water. The model will permit evaluation of the collection system's response to a range of hydrologic events, as well as any that would result from actions proposed by the municipalities for improving CSO management or capture.

The overall, comprehensive landside model will provide an essential analysis tool for addressing the NJPDES Permit requirements for maximization of combined sewer flows to the PVSC WPCF in Newark as well as other required alternative evaluations for the LTCP. The landside model will also provide the hydraulic and water quality data that will provide the necessary inputs for a water quality model of the receiving waters. Although a receiving water model is not a specific requirement of the NJDPES permit, it is anticipated that a suitable model will be required to allow for utilization of the Demonstration Approach for evaluation of CSO controls and to support the CSO control recommendations for achieving water quality standards and supporting use designations as required by the NJPDES permits and USEPA CSO Control Policy. Separate QAPPs for the Baseline Compliance Monitoring Program and the Receiving Water Quality Model will be developed concurrently with this project plan.

The collections system and receiving water models will serve a multitude of purposes that will include, but not be limited to:

1) Establishing baseline conditions for the collections systems and receiving waters,
2) Identifying impacts of non-CSO point and non-point pathogen sources in relation to CSO impacts,
3) Developing Integrated Watershed Management strategies based upon the pathogen sources identified as causing impairments preventing compliance with water quality standards,
4) Evaluating CSO capture benefits of best management practices, changes in operations procedures and other low-cost system improvements,
5) Assessing the benefits of stormwater source controls using green infrastructure and other sustainable stormwater management practices,
6) Performing cost-effective evaluations of the water quality benefits associated with implementation of a wide range of CSO controls,
7) Developing an adaptive management strategy for implementation of recommended CSO controls,
8) Supporting analyses as may be required for establishing the knee of the curve, assessing use attainability, investigating the benefits of establishing total maximum daily loads or other methods of supporting the recommended plan,
9) Addressing reporting requirements throughout the course of CSO LTCP development and following implementation,

10) Evaluating the performance of implemented controls in relation to baseline conditions established at the outset of the project.

Flow monitoring, rainfall, sanitary and stormwater quality data collected as described previously in this QAPP will be used to refine the calibration of the sewer system IW models after they are modified and updated as discussed below. Flow component analysis will be achieved through commonly used methods, as well as through calibration of the collection system model. For instance, sanitary flow can be identified based on total system flow during a dry period with low infiltration (typically early fall), with an appropriate allowance for base infiltration. Annual infiltration can be estimated through application of mathematical filtering (e.g. Lyne-Hollick method) such as is used to partition quickflow and baseflow in rivers. Inflow is the remainder after sanitary and infiltration flows are subtracted from total flow, and is confirmed via calibration of the wet-weather component of the collection system model.

Existing Sewer System Model: The PVSC InfoWorks model (subject of PART 1 QAPP) does not include the Hudson County CSO communities of Bayonne, Jersey City, and North Bergen. Flows from these communities are conveyed to the PVSC WPCF through the Hudson County force main. These municipalities however, also developed and calibrated collection system models as part of the 2003 characterization work. As part of this LTCP, all three of these systems will be incorporated into the PVSC InfoWorks model. These existing models include a SWMM model of Bayonne, an XP-SWMM model of Jersey City and a SWMM model of North Bergen (Central Service Area). These models will be combined into one contiguous model to facilitate analyses amongst all 8 CSO communities. Jersey City will be performing their own Sewer System Characterization QAPP but they have agreed to provide PVSC their existing model to facilitate the contiguous analysis.

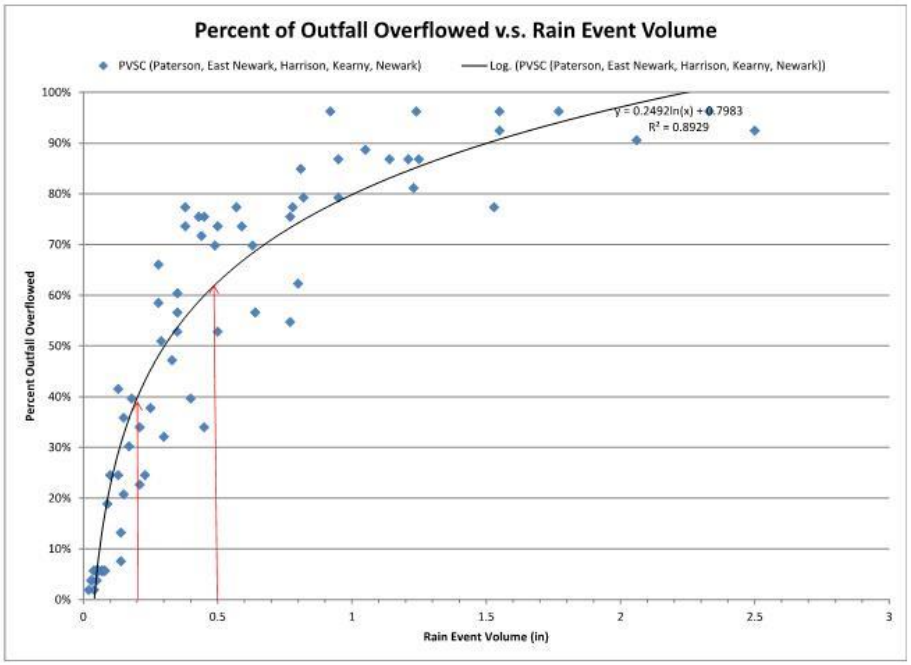
Once that effort is completed, the Hudson County CSO model will be validated against relevant historical flow data discussed above as well as flow data to be collected as described in this QAPP. Validation will consist of comparison of flow versus time for the monitoring data and the model calculations. Validation will also employ goodness of fit procedures described in the *Wastewater Planning Users Group Code of Practice for the Hydraulic Modelling of Sewer Systems* (CIWEM, 2002). Model verification and testing procedures in that document will be applied.

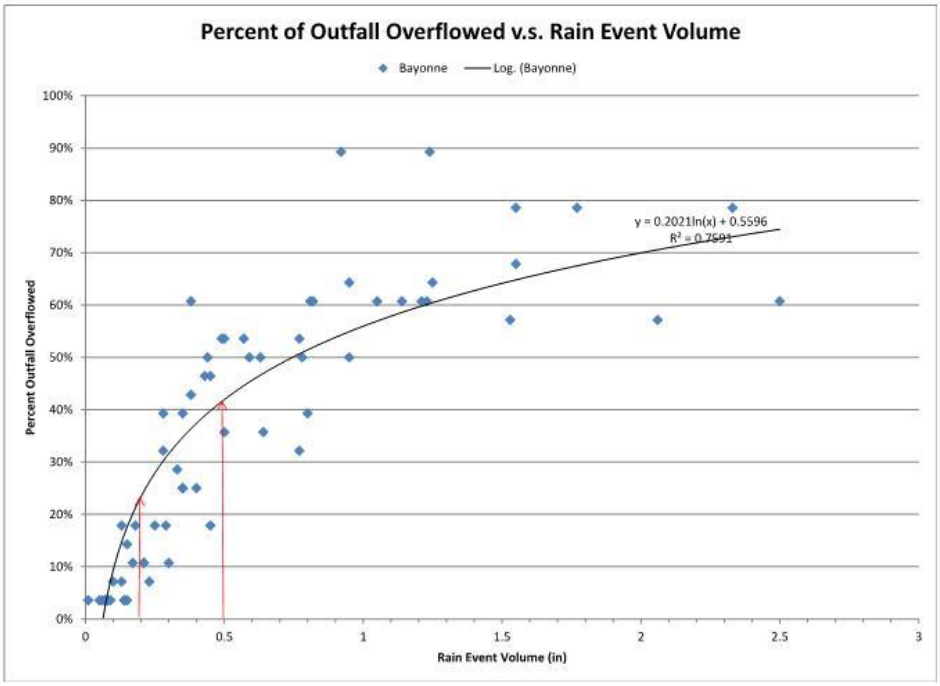
APPENDIX A – Rainfall Event Characterization Memorandum Dated December 1, 2015

Memo

Date:	Tuesday, December 01, 2015
Project:	PVSC LTCP
To:	Bridget McKenna
From:	William Leo
Subject:	Modeled CSOs versus Rainfall

HDR conducted an analysis to determine how CSO overflows occurred as a function of rainfall volumes. HDR used the existing sewer system models to simulate overflows from rainfall events using the 1988 rainfall records. The results are shown below for the PVSC main interceptor outfalls and are abstracted from the PVSC IW model simulation. The next page summarizes the results for the Bayonne model.





The graphics show the fraction of the outfalls which overflow in each drainage area (y-axis) as a function of total storm event rainfall. Each solid blue diamond is the result for an individual storm. The solid line represents the line of best fit of the results.

The analyses show that depending on the collection system, between 40 and 60 percent of the CSOs overflow during rainfalls of 0.5 inches or greater. For rainfalls of 0.2 inches or greater, between about 25 and 40 percent of the outfalls are calculated to overflow. As noted by the spread of the results above and below the trend line, the results will vary based on storm characteristics, antecedent conditions, time of the event, etc.

APPENDIX B - REFERENCES

APHA, AWWA, and WEF. 2005. *Standard methods for the examination of water and wastewater*. American Public Health Association, American Water Works Association, and Water Pollution Control Federation. 21st edition, Washington, D.C.

EPA. (2015). 5.5 Turbidity. In Water: Monitoring & Assessment. Retrieved from http://water.epa.gov/type/rsl/monitoring/vms55.cfm, September 2015.

EPA Method 1103.1: Escherichia coli (E. coli) in Water by Membrane Filtration Using membrane-Thermotolerant *Escherichia coli* Agar (mTEC) EPA Number 821R10002, March 2010.

EPA Method 1600: Enterococci in Water by Membrane Filtration Using membrane-Enterococcus Indoxyl-B-D-Glucoside Agar (mEI); EPA Number 821R06009, December 2009.

EPA Method 1603: Escherichia coli (E. coli) in Water by Membrane Filtration Using Modified membrane-Thermotolerant *Escherichia coli* Agar (Modified mTEC); EPA Number 821R09007, December 2009.

EPA Method 1680: Fecal Coliforms in Sewage Sludge (Biosolids) by Multiple-Tube Fermentation using Lauryl Tryptose Broth (LTB) and EC Medium; EPA Number 821R10003, April 2010.

EPA Method 1681: Fecal Coliforms in Sewage Sludge (Biosolids) by MultipleTube Fermentation using A-1 medium , EPA Number 821R06013, July 2006.

EPA Microbiological Methods for Monitoring the Environment, Water, and Wastes, EPA/600/8-78/017.1978. US EPA (EPA Micro Manual p. 124, Membrane Filtration Method; p. 132, Most Probable Number Method).

New Jersey Administrative Code (NJAC) 7:18, Regulations Governing the Certification of Laboratories and Environmental Measurements. November 22, 2006.

New Jersey Department of Environmental Protection (NJDEP) Field Sampling Procedures Manual (FSPM). August 2005.

APPENDIX C - SOPS

Standard Operating Procedure (SOP) Reference Documents for Analytical Chemistry for Laboratories Participating in the Baseline Compliance Monitoring Program

SOP Title	NJDEP Method Code	Laboratory	Analytical Method
Fecal coliform (Membrane Filtration, Single Step Method)	WPP01.02000	Eurofins QC	EPA SM 9220D or SM 9222D
Enterococcus (Membrane Filtration Technique)	WPP01.09010	Eurofins QC	EPA SM 1600
Escherichia Coli (E.coli) (Membrane Filtration Technique)	WPP01.16100	Eurofins QC	EPA SM 1603

APPENDIX D – CHAIN OF CUSTODY FORM

eurofins | QC

CHAIN OF CUSTODY
Page ____ of ____

1205 Industrial Blvd. Phone: 215-355-3900
Southampton, PA 18966-0514 Fax: 215-355-7231

Client/Acct. No.
Address
City/State/Zip
Phone/Fax
Client Contact:

Bill to/Report to (if different)
Sampling Site Address (if different) Include State
P.O. No. PWSID #:
Quote #
e-mail:

Lab LIMS No:

LAB USE ONLY:

____ Ascorbic/HCL Vials # ____ HCl Vials
____ $Na_2S_2O_3$ _____
____ Na OH/Zn acetate pH _____
____ NHO_3 pH _____
____ H_2SO_4 pH _____
____ NaOH pH _____
____ Unpreserved
____ HCl # ____NH4Cl # ____MeOH
____ DI Water

MATRIX CODES
DW: DRINKING WATER
GW: GROUND WATER
WW: WASTEWATER
SO: SOIL
SL: SLUDGE
OIL: OIL
SOL: NON SOIL SOLID
MI: MISCELLANEOUS
X: OTHER

LAB USE ONLY	PROJECT / FIELD ID	Collection Date	Collection Military Time	GRAB	COMP	Matrix Code	Number of Containers Total	H_2SO_4	HCl	Vials	HNO_3	NaOH	Znac	UNPRE	BACT	ANALYSIS REQUESTED	Field pH, Temp (°C), DO, Cl2, Cond. etc.

SAMPLED BY: (Name/Company)

TAT: ☐ STANDARD (10 DAY)
or DUE DATE____/____/____
Please call for pricing and availability for rush (<10 day) turnaround and for all but standard reporting format.

Report Format: ☐ Standard ☐ NJ-RDD ☐ SRP-RDD
☐ Standard + QC ☐ Forms ☐ EDD

Field Parameters Analyzed By:
Initials | Date/Time:

SAMPLE CUSTODY EXCHANGES MUST BE DOCUMENTED BELOW. USE FULL LEGAL SIGNATURE, DATE AND MILITARY TIME (24 HOUR CLOCK, I.E. 8AM IS 0800, 4 PM IS 1600)

RELINQUISHED BY SAMPLER	DATE	TIME	RECEIVED BY	DATE	TIME
1.			1.		
RELINQUISHED BY 2.	DATE	TIME	RECEIVED BY 2.	DATE	TIME
RELINQUISHED BY 3.	DATE	TIME	RECEIVED BY 3.	DATE	TIME
RELINQUISHED BY 4.	DATE	TIME	RECEIVED BY 4.	DATE	TIME
RELINQUISHED BY 5.	DATE	TIME	RECEIVED BY 5.	DATE	TIME

DELIVERY: ☐ EQC COURIER ☐ CLIENT
☐UPS ☐FEDEX ☐OTHER _____

Custody Seal Number

Rec'd Temp.: _____ Initials: _____ Ice Y / N Location:____
COMMENTS:

Hazardous: yes / no

APPENDIX E - February 17, 2016 NJDEP Comment Letter on December 29, 2015 QAPP (9 Pages)

State of New Jersey

CHRIS CHRISTIE
Governor

KIM
GUADAGNO
Lt. Governor

DEPARTMENT OF ENVIRONMENTAL PROTECTION
Mail Code – 401-02B
Division of Water Quality
Bureau of Surface Water Permitting
P.O. Box 420 – 401 E State St
Trenton, NJ 08625-0420
Phone: (609) 292-4860 / Fax: (609) 984-7938

BOB MARTIN
Commissioner

February 17, 2016

Tim Boyle, Executive Director
Bayonne Municipal Building
960 Avenue C, Room 11
Bayonne, NJ 07002

Frank Pestana, Executive Director
North Bergen MUA
6200 Tonnelle Avenue
North Bergen, NJ 07047

Bridget M. McKenna, Chief Operating Officer
Passaic Valley Sewerage Commission (PVSC)
600 Wilson Avenue
Newark, NJ 07105

Re: Technical Comments on Sewer System Characterization Work Plan Part 2
Bayonne Municipal Utilities Authority (MUA), NJPDES Permit No. NJ0109240
North Bergen MUA, NJPDES Permit No. NJ0108898
PVSC, NJPDES Permit No. NJ0021016

Dear Permittees:

Thank you for your submission dated December 30, 2015 that was submitted in accordance with Part IV.D.3.b.i of your NJPDES CSO permit. This study is entitled "System Characterization and Landside Modeling Program Quality Assurance Project Plan (QAPP) Part 2" and was submitted cooperatively by Bayonne MUA, North Bergen MUA and PVSC. While PVSC and its eight member municipalities have submitted a letter of intent to complete a single, coordinated long term control plan, the Department acknowledges that Part 2 of the Sewer System Characterization Work Plan includes the two municipalities identified above that connect to PVSC through force mains. Jersey City MUA is also within the same hydraulically connected system and discharges through the same force main but has elected to submit a separate Sewer System Characterization Work Plan. Regarding the remaining five PVSC member municipalities (Borough of East Newark, the Town of Harrison, the Town of Kearny, the City of Newark, the City of Paterson and PVSC) that connect to PVSC through PVSC's main interceptor sewer, a separate work plan entitled "System Characterization and Landside Modeling Program Quality Assurance Project Plan (QAPP) Part 1" was submitted.

The Department recognizes that details of this system characterization have been discussed at meetings between the Department and PVSC and its consultants where meeting dates include July 22, 2015, August 12, 2015, September 16, 2015, September 30, 2015, October 21, 2015, November 20, 2015 and December 2, 2015. This letter is written to provide the Department's technical comments on "System Characterization and Landside Modeling Program Quality Assurance Project Plan (QAPP) Part 2."

Overall Objectives of the Sewer System Characterization

The required information for the Sewer System Characterization is included in the NJPDES CSO permit at CSM Part IV.G.1. In order to provide a backdrop to some of the technical issues identified in this

letter, the Department would like to note the objectives of modeling in relation to the Sewer System Characterization as contained in EPA's Guidance for Long-Term Control Plans (EPA 832-B-95-002). Specifically, once the model is calibrated and verified, the primary objectives of CSS modeling applications include:

- To predict overflow occurrence, volume, and, in some cases, quality for rain events other than those which occurred during the monitoring phase. These can include a storm event of large magnitude (long recurrence period) or numerous storm events over an extended period of time.

- To predict the performance of portions of the combined sewer system (CSS) that have not been extensively monitored.

- To develop CSO statistics, such as annual number of overflows and percent of combined sewerage captured as described in the CSO Control Policy.

- To optimize CSS performance as part of Nine Minimum Control (NMC) implementation. In particular, modeling can assist in locating storage opportunities and hydraulic bottlenecks and demonstrate that system storage and flow to the POTW are maximized.

- To evaluate and optimize control alternatives, from simple controls described under the NMC to more complex controls proposed in a municipality's LTCP. An example of a simple control would be to raise weir heights to increase in-line storage. The model can be used to evaluate the resulting reductions in CSO volume and frequency.

In light of the above objectives, the Department's comments are as follows:

General Comments on the Work Plan

Comment 1: As described above, the Department acknowledges that two separate system characterization work plans were submitted: one for Bayonne, North Bergen MUA, and PVSC, and a second one for Jersey City which are all part of one hydraulically connected system that discharges to PVSC. This is acceptable for the purposes of the work plan and Sewer System Characterization Report (as due on July 1, 2018); however, it is expected that all permittees will submit a single, coordinated long term control plan (LTCP).

Comment 2: The Department acknowledges that PVSC is proposing to undertake the monitoring and modeling needed for Bayonne MUA and North Bergen MUA in the development of a regional LTCP to characterize the discharge that is pumped through the force main. As acknowledged in the work plan, this also includes the modeling outputs from the Jersey City collection systems model. However, while PVSC is proposing the use of InfoWorks modeling software, Jersey City MUA is proposing the use of PCSWMM.
Given that all four permittees have agreed to work to submit a single LTCP, please provide discussion and justification as to how these models will successfully be linked together. More specifically, confirm that the models will link together in that the output from one permittee's model will be able to work as the input to another permittee's model. Second, confirm that the models will use the same parameters and are able to address the same typical rainfall year and parameter assumptions. Third, verify that the models can function cooperatively so that an alternatives analysis and the subsequent selection of alternatives for the LTCP can be generated.

Comment 3: While the work plan contains a narrative discussion on the PVSC service area and combined sewer system as well as maps depicting the PVSC sewer district; locations of existing gages used in radar calibration; and the locations of proposed temporary flow meters, visual representations of additional information would be useful to support the narrative descriptions. Therefore, please provide sewer system maps with the following labeled on the map of sufficient scale to adequately depict these items:

- Regulators
- Pump stations (Existing and Proposed)
- Flow metering locations from past studies if proposed to be utilized for characterization
- Subcatchments and drainage areas with names or identification numbers
- Areas and/or portions of the CSS proposed to be modeled
- Identification of any elements that are referenced in the narrative discussion. For example, Great Falls and Prospect Street discussed in Section A.6 and other notable sites that are described in the discussion.

Comment 4: The work plan must include a schematic of the CSS, including the subcatchments, outfalls, regulators, pump stations and wastewater treatment plant. Considering the size and complexity of the PVSC Part 2 System, this may be represented through one or several schematics provided all information requested above is included.

Comment 5: The alternatives analysis due on July 1, 2019 (CSM Part IV.G.4.d and e) must include an evaluation of green infrastructure. The Sewer System Characterization work plan should acknowledge that additional characterization and subcatchment discretization will likely be necessary to establish and model the locations and parameters associated with the implementation of green infrastructure within the CSS service or drainage areas.

Comment 6: A schedule or Gantt chart with a breakdown of tasks and target time frames should be provided in the work plan. Such a schedule should include the milestones, general categories, and specific tasks necessary for the timely submission of the Sewer System Characterization Report.

Comment 7: The work plan must indicate the date of the most recent evaluation of the CSS and that the System Characterization Report and associated model will be based a review of the entire collection system, in accordance to CSM Part IV.G.1.b.

Comment 8: The work plan should discuss the methodology for disaggregating raw flow data into its dry weather and wet weather components based upon observed rainfall. Components shall include, but are not limited to, infiltration, inflow (including stormwater flow) and wastewater flow.

Specific Comments

A.1. Title of Plan and Approval

Comment 9: As indicated in my letter dated January 26, 2016, please provide a certification statement for Jersey City MUA.

A.2. Distribution List

Comment 10: On page 6 under New Jersey Department of Environmental Protection please add Marc Ferko, Office of Quality Assurance.

A.3. Program Contact Information

Comment 11: On page 7 please add:

Marc Ferko
NJDEP
Office of Quality Assurance
P.O. Box 420
401 E. State St., 4th Floor
Trenton, NJ 08625-0420

A.4. Table of Contents

Comment 12: On page 9 regarding Appendix C (SOPs) and Appendix D (Chain of Custody Forms), it is noted that this information will be provided after lab selection is finalized. Please acknowledge that this information will be provided within 30 days of sampling.

Comment 13: Under the list of figures on page 9, Figure 2 should be listed as "Rainfall Volume Probability Plot" as is indicated on Figure 2.

A.5. Project Organization

Comment 14: Under Program Manager on page 10 there is reference to the "Baseline Compliance Monitoring Program." It is unclear if this was intended since the subject document concerns the System Characterization and Landside Modeling Program. Please change if needed.

Comment 15: The Project and Field Coordinator is listed on page 10 as "To be determined." Please confirm that the name of the Project and Field Coordinator will be provided to the Department prior to the initiation of sampling. The Contract Sampling and Laboratories on page 12 is also listed as "To be determined." Please provide the names of the laboratories thirty days prior to the commencement of sampling along with the New Jersey Certification numbers. In the event that there are alternate certified laboratories that may be utilized, please provide certification status of those laboratories prior to QAPP approval.

Comment 16: Under *Principal Data Users* on page 13, it does not indicate that Jersey City MUA is a principal data user. Please clarify whether the "cooperating municipality" indicated is Jersey City MUA.

A.6. Problem Definition and Background

Comment 17: On page 13 the following statement is included:

> "Two combined sewer municipalities, Bayonne MUA and Jersey City MUA, own and operate their own combined sewer systems, interceptors, CSO control facilities, and pumping stations. In addition they jointly own the force main used to transport wastewater to the primary clarifiers at the PVSC WPCF in Newark."

Please clarify the point of intersection between this force main and the PVSC's treatment facility.

Comment 18: Figure 1 is included on page 14. While force mains are included in the legend, it appears that neither the force mains jointly owned by Bayonne MUA and Jersey City MUA nor the Hudson County force main is shown. Please revise the figure accordingly.

Comment 19: On page 15 the following is included:

> "Between 2003 and 2007, the communities of Bayonne and North Bergen conducted Combined Sewer Overflow Discharge Characterization Studies..."

Please clarify whether the studies were performed by the municipality, the MUA, or by a joint effort of the municipality and MUA. This clarification should also be provided on page 27 where it speaks about past municipal-led studies.

Comment 20: **P**lease provide copies of the studies referenced on page 15 as attachments.

A.7. Project Description

Comment 21: Under ***Purpose*** on page 17, the wording is as follows:

> "The purpose of the proposed monitoring program is to quantify and qualify dry weather and wet weather wastewater flow and pathogen concentrations variations at key CSO drainage basins to calibrate and verify hydrologic and hydraulic models…"

In the PVSC Part 1 QAPP the phrase states "…at key CSO and stormwater drainage basins…" Please discuss the difference in sewershed areas and surface (stormwater-based) drainage between PVSC QAPP Part 1 as compared to PVSC QAPP Part 2 which resulted in this change.

Comment 22: On page 17, under *Purpose*, you state that this QAPP is being submitted as required by the NJPDES Permits for Combined Sewer Management for Bayonne MUA and North Bergen MUA. Please clarify that this QAPP is also being submitted for PVSC.

Comment 23: On page 17 and 18 under *Rainfall-Overflow Correlation Analysis* you state:

> "An analysis will be performed using the monitored hydrological events and the results of the precipitation statistical analysis, to develop the correlation between the characteristics and frequency of rainfall events that cause a discharge. This analysis was performed as part of past studies to identify the amount of rain that triggers an overflow event."

It is unclear as to how past studies and/or historical data relates to the proposed rainfall-overflow correlation analysis. Please clarify. In addition, if the previous study will be utilized as a foundation for this current work, provide a copy of the study as well as a brief description of the study in the work plan.

Comment 24: On page 18, it states that a "representative set of monitored events should ideally include a variety of storm volumes, durations and intensities to provide for a more robust model calibration." Please clarify the minimum number of storm events recommended for model calibration and for model verification. Indicate what parameters will determine that a particular event can be used to calibrate and verify the model. Provide additional detail regarding how the size of the event is determined (i.e., rainfall intensity, daily rainfall amount, comparative analysis both intensity and daily rainfall volume). For example, will the storms be classified based on magnitude

or duration or both? Storm events chosen for the calibration and validation of the models must address different rainfall intensities, distributions and volumes.

Comment 25: Please provide additional information regarding the following excerpt from page 19:

> "A primary use of the monitoring data will be for further validation the collections system models that was calibrated under the 2003 permitted required characterization work. Adjustment of model coefficients will be made so that the mathematical model provides an adequate representation of the combined sewer areas and their response to wet weather conditions."

This section should be clarified to include additional detail. Please describe how calibration will be performed as associated with the monitoring, metering and sampling proposed under this work plan. In addition, the work plan must indicate that the Sewer System Characterization report will include all of the model input parameters as well as the basis for each parameter, including identification of which parameters were adjusted to calibrate the model. As part of the Sewer System Characterization report that is due July 1, 2018, please include the electronic InfoWorks input file and output files of the model as well as a hard copy of the summary of parameters and results. A hard copy of the model input and output data shall be made available upon the Department's request.

Comment 26: On page 19 under *Collection System Model Validation*, the wording is as follows:

> "The coefficients will be adjusted to develop a representative match between the flows computed by the models, and the recorded rainfall, metered wastewater flows and the lab analyses of pathogen concentrations…"

In the PVSC Part 1 QAPP the phrase states "…between the flows and pathogen concentrations computed by the models…" Please discuss the implications of this change and whether it is the intent that different coefficients will be targeted for adjustment between PVSC Part 1 and Part 2.

Comment 27: Also within *Characterization of Sanitary, Stormwater and CSO Wastewater Quality* on page 20 you state "Should the mass balance approach fall short of providing reasonable comparisons between observed and calculated CSO quality and observed and calculated receiving water pathogen concentrations, alternate approaches will be pursued during the receiving water model calibration process." Please provide additional detail regarding alternative approaches and indicate that changes in the approach are subject to Department review and approval. In addition, the Department neither recommends nor approves adjusting the CSO loading to enhance the receiving water model predictability once the landside model has been calibrated and validated.

Comment 28: On page 20 under *Project/Task Description*, additional information is needed to better describe the *Project/Task Description* similar to language as included in PVSC Part 1. Please incorporate the following change:

> "The proposed work will supplement the available data and be used to update the landside model. <u>Information collected will be used to verify maximum conveyance capacity of the collection system and to demonstrate under the alternatives evaluation task for the CSO LTCP development the relationship between PVSC accepting additional wet weather flows and the associated impacts on CSO discharges as well as other required alternative evaluations for the LTCP: green infrastructure; increased storage capacity in the collection system; STP expansion and/or storage at the plant; I/I reduction; sewer separation; and treatment of the CSO discharge and CSO related bypass of the secondary treatment portion of the STP."</u>

Comment 29: On page 21 under *Scope for Precipitation Monitoring* you state that "rainfall radar will be used for calibration of the landside model." However, based on Table 1 (page 22) and Figure 3 (page 23), certain rain gages that will be used in rainfall radar calibration are a considerable distance from the PVSC district. Most notably, on Figure 3 the rainfall radar grid extends to Alpine, NJ which is considerably northeast of PVSC. Provide additional detail and/or justification as to why this is appropriate.

Comment 30: On page 24 under *Scope for Collections Systems Metering* you state "The flow monitoring equipment will be installed in the combined trunk sewer upstream of the overflow chamber or within the overflow chamber as field conditions dictate." Please describe the calibration and maintenance process for operation of the flow meters.

Comment 31: On page 24 under *Scope for Collections Systems Metering* you note that past temporary municipal in-system flow meter data from between 2002 and 2004 will be used along with past municipal CSO meter data from rotating outfall and regulator sites between 2002 and 2004. Please justify why this data is appropriate for comparison purposes.

Comment 32: On page 24 under *Scope for Collections Systems Metering* the Department acknowledges that you are metering flow within the collection system. However, what is missing is a discussion of monitoring at the Hudson County Force Main or any other force mains that pump flow to PVSC. Please provide a separate discussion regarding any flow metering at these locations as well as a discussion of the frequency of calibration for those flow meters.

Comment 33: On page 27 under *Sanitary Wastewater Quality Monitoring*, CSO discharge Characterizations studies for Bayonne and North Bergen are referenced. While some of these studies were discussed on pages 15 and 16, it appears that additional studies are being referenced in this section. Please provide brief descriptions of studies not previously discussed and a copy as an attachment.

Comment 34: On page 28 under *Sanitary Wastewater Quality Monitoring* you state "Dry weather samples will be taken just prior to each rain event sampled and utilized in verifying the current baseline conditions versus the past dry weather sampling data." Please describe how this will be performed and how dry weather sampling will be defined.

Comment 35: On page 28 under *Sanitary Wastewater Quality Monitoring* you indicate that a comparison of changes in Land Use Land Cover (LULC) from 1995 to 2012 will be performed. The comparison must be provided in the work plan, including a comparison of impervious covers (percentage and/or area) in addition to LULC, and should be provided for each subcatchment.

Comment 36: On page 28 under *CSO Wastewater Quality Monitoring* you state "The goal of the event sampling protocol is to obtain three wet-weather events of sufficient depth, intensity, and duration for valid model calibration." Please indicate what will occur in the event that three events are not able to be obtained. Note that the Department will not entertain any time extensions for Sewer System Characterization report submission that is due on July 1, 2018.

Comment 37: Flooding is addressed on page 29 under *Surface Flooding and Basement Backups*. Assessment of CSO-related flooding areas is a critical part of the sewer system characterization. While the Department does not expect that every area that has experienced flooding be modeled, special attention should be paid to areas of combined sewage backup, including to basements and other public and private areas. Areas of sewage overflows during wet weather periods typically

represent bottlenecks and problem areas in the CSS which is important in understanding the flow dynamics in the CSS during wet weather. In addition, existing drainage features (such as areas of surface ponding) may also provide attenuation of flows and impact the response of the CSS to storm events. Please indicate that these issues will be addressed as part of the system characterization and associated model.

Comment 38: The Department acknowledges that you reference on page 29 that the Operations and Maintenance Manuals will be updated via a system spreadsheet to include the information required by Part IV.F.1.e.iii and Part IV.F.1.f.iiii of your permit. However, for the purposes of the work plan, please provide discussion as to any avenues that are available to the public to notify the permittee of flooding areas (i.e. hot line).

A.8. Quality Objectives and Criteria

Comment 39: In Table 4 – Data Quality Criteria, there is a reference to "5% lab dups" in the precision row whereas this value should be "10% lab dups." This correction must also be made on page 42 under "*Laboratory Duplicates*" where it should say "10% of samples from each sampling event,…"

A.10. Data Documentation and Review

Comment 40: On page 34, narrative information is included regarding a sample field reporting data sheet. The parameters "time" and "field conditions" should be included. Therefore, modify this language as follows:

> "The information that will be recorded includes: sampling location and date, <u>time, field conditions,</u> raw analytical data and date of testing, sampling and testing personnel, daily sample processing procedures and any corrective actions or deviations from procedures, as necessary."

B.4. Analytical Methods

Comment 41: On page 36, please remove references to footnote 2 for EPA Method 9213 and 9230 as well as footnote 2 which states "For ambient water only."

Comment 42: On page 38, please remove standard methods MF 9222B (1997), 9222G (1997) and MF: 1103.1-10 as these are not approved methods for NJPDES permits. Additionally, please remove references to footnote 2 for EPA Method 9213 and 9230 as well as footnote 2 which states "For ambient water only."

C.1 Assessments and Response Actions

Comment 43: On page 40 you state that "a trained PVSC employee, or a designee, will periodically review field activities to verify that appropriate protocols are being observed and that each sampling crew is trained on the standard procedures for sample collection, preservation, transportation and chain of custody." Please develop a standardized checklist that shall be used for these reviews.

E. Collection System Modeling

Comment 44: Please be sure to characterize the model as evaluating all required CSO control alternatives and not limit the alternatives evaluation to maximization of combined sewer flows to the treatment plant. This statement should be modified on page 43, as follows:

> "The overall, comprehensive landside model will provide an essential analysis tool for addressing the NJPDES Permit requirements for maximization of combined sewer flows to the PVSC WPCF in Newark as well as other required alternative evaluations for the LTCP."

Comment 45: On page 43, please delete the reference to the "CSO General Permit" since the current permit is an individual NJPDES permit.

Comment 46: On page 44 you state that "Jersey City will be performing their own Sewer System Characterization QAPP but they have agreed to provide PVSC their existing model to facilitate the contiguous analysis." Information sharing for a hydraulically connected system is key to the success of the system characterization and is a requirement for a single, coordinated LTCP. As you know, the permit submission timeframes where extended for those members of a hydraulically connected system that agreed to a single, coordinated LTCP. The Department anticipates cooperation in this regard and needs to be notified if this does not occur.

Please provide a revised work plan addressing the issues discussed above within 30 days from the date of this letter as required under Part IV CSM Section D.1.a. Thank you for your continued cooperation. Questions or comments should be addressed to me via e-mail at Dwayne.kobesky@dep.nj.gov or phone at (609) 292-4860.

Sincerely,

Dwayne Kobesky
CSO Team Leader
Bureau of Surface Water Permitting

c: Daniel F. Becht, Jersey City MUA
Chief Pilar Patterson, Bureau of Surface Water Permitting
Sandra Blick, Bureau of Surface Water Permitting
Marzooq Alebus, Bureau of Surface Water Permitting
Joseph Mannick, Bureau of Surface Water Permitting
Susan Rosenwinkel, Bureau of Surface Water Permitting
Corey Anen, Bureau of Nonpoint Pollution Control
Marc Ferko, Office of Quality Assurance

APPENDIX F – Revised Wastewater Sampling Locations

(Revised Sampling Location Plans Consists of 4 Pages)

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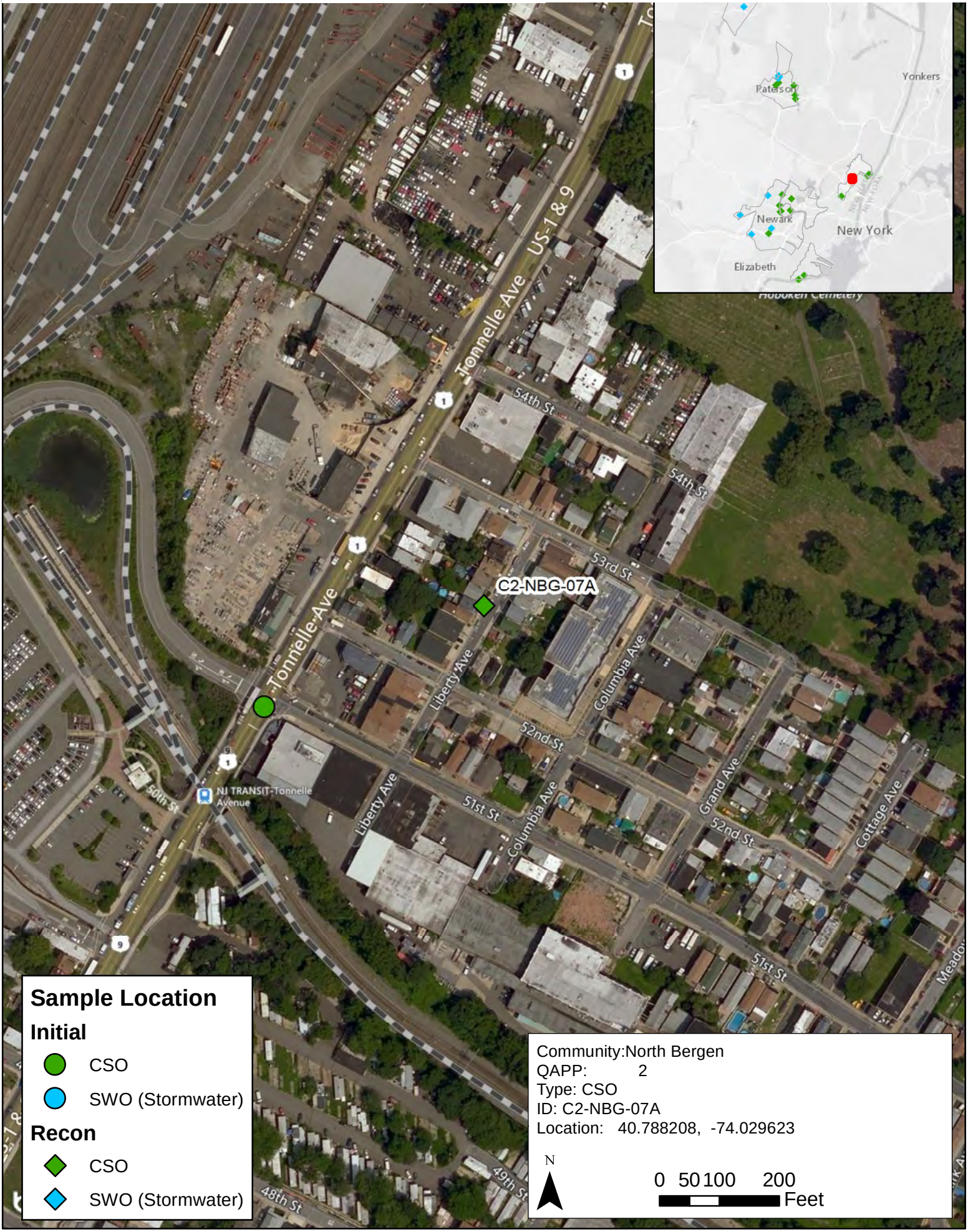

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