DEVELOPMENT AND EVALUATION OF ALTERNATIVES FOR LONG TERM CONTROL PLANNING FOR COMBINED SEWER SYSTEMS - REGIONAL REPORT

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

Passaic Valley Sewerage Commission (NJ 0021016)
City of Bayonne (NJ0109240)
Borough of East Newark (NJ0117846)
Town of Harrison (NJ0108871)
Jersey City Municipal Utilities Authority (JCMUA) (NJ0108723)
Town of Kearny (NJ0111244)
City of Newark (NJ0108758)
North Bergen Municipal Utilities Authority (NBMUA) (NJ0108898)
City of Paterson (NJ0108880)

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

"Protecting Public Health and the Environment"

June 2019

SECTION A - INTRODUCTION AND BACKGROUND

A.0 SUMMARY OF CHANGES

This is the Regional Report for the Development and Evaluation of Alternatives for Long Term Control Planning for Combined Sewers to be utilized by the Passaic Valley Sewerage Commission ("**PVSC**"), later referred to as "this Report," and the entities who own and operate combined sewer collection systems within the PVSC Treatment District. This Report describes the receiving water characterization including water quality results, technology screening process, and the evaluation of combined sewer overflow ("CSO") control alternatives for the PVSC Treatment District. This Report compiles the results of the nine (9) individual Development and Evaluation of Alternatives Reports for the PVSC Treatment District. In future versions, this section will include summaries of changes and when they were incorporated as appropriate.

A.1 TITLE OF PLAN AND APPROVAL

Title: Development and Evaluation of Alternatives Regional Report

Preparer:

Project Officer: ______________________________ 6/25/19
Michael J. Hope, P.E., Greeley and Hansen LLC — Date

QA Officer: ______________________________ 6/25/2019
Timothy J. Dupuis, P.E., CDM Smith — Date

Passaic Valley Sewerage Commission:

PVSC
Program Manager: ______________________________ 06/25/2019
Bridget McKenna, Chief Operating Officer, PVSC — Date

PVSC
QA Officer: Marques Eley 6/25/2019
Marques Eley, Senior Engineer, PVSC — Date

New Jersey Department of Environmental Protection

DEP Permits: ______________________________
Joseph Mannick, CSO Coordinator — Date

DEP QA: ______________________________
Marc Ferko, Office of Quality Assurance — Date

Development and Evaluation of Alternatives Regional Report

Submitted by
Passaic Valley Sewerage Commission:

NJPDES Number NJ0021016 (Passaic Valley Sewerage Commission)

Approval of this submittal:

Permittee: ______________________ 06/25/2019
Bridget McKenna — Date
Chief Operating Officer, Passaic Valley Sewage Commission

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: ______________________ 06/25/2019
Bridget McKenna — Date
Chief Operating Officer, Passaic Valley Sewage Commission

Development and Evaluation of Alternatives Regional Report

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

NJPDES Number NJ0109240 (Bayonne City)

Approval of this submittal:

Permittee: ______________________ 6.25.19
Timothy Boyle — Date
Superintendent, City of Bayonne Department of Public Works

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: ______________________ 6.25/19
Timothy Boyle — Date
Superintendent, City of Bayonne Department of Public Works

Development and Evaluation of Alternatives Regional Report

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

NJPDES Number NJ0117486 (East Newark)

Approval of this submittal:

Permittee: ______________________________ 6/24/19
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: ______________________________ 6/24/19
Frank Pestana Date
Licensed Operator, Borough of East Newark

Development and Evaluation of Alternatives Regional Report

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

NJPDES Number NJ0108871 (Harrison)

Approval of this submittal:

Permittee: ______________________________ 6/25/19
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: ______________________________ 6/25/19.
Rocco Russomano Date
Town Engineer, Town of Harrison

Development and Evaluation of Alternatives Regional Report

Submitted on behalf of the following participating Permittee by Passaic Valley Sewerage Commission on behalf of the NJ CSO Group

NJPDES Number NJ0108723 (Jersey City MUA)

Approval of Report:

Permittee: ______________________ 6/26/19
Rich Haytas Date
Senior Engineer, Jersey City MUA

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 cooperation 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: ______________________ 6/26/19.
Rich Haytas Date
Senior Engineer, Jersey City MUA

Development and Evaluation of Alternatives Regional Report

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

NJPDES Number NJ0111244 (Kearny)

Approval of this submittal:

Permittee: [signature] 9/25/19

Robert J. Smith Date
Town Administrator, 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: [signature] 9/25/19

Robert J. Smith, Date
Town Administrator, Town of Kearny

Disclaimer: The Town of Kearny has completed and participated in the production of this document as required by the Town's individual New Jersey Pollutant Discharge Elimination System (NJPDES) permit (NJPDES Permit No. NJ0111244). At this time, the Town of Kearny is not committing the current governing body of the Town, or future governing bodies, to the allocation of funds based on the costs presented in this report to complete projects related to the control of combined sewer overflows (CSOs).

Development and Evaluation of Alternatives Regional Report

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

NJPDES Number NJ0108758 (Newark)

Approval of this submittal:

Permittee: ______________________ 6-25-19
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: ______________________ 6-25-19
Ras J. Baraka Date
Mayor, City of Newark

Development and Evaluation of Alternatives Regional Report

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

NJPDES Number NJ0108988 (North Bergen Municipal Utilities Authority)

Approval of this submittal:

Permittee: ______________________ 6/24/19
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: ______________________ 6/24/19
Frank Pestana — Date
Executive Director, North Bergen Municipal Utilities Authority

Development and Evaluation of Alternatives Regional Report

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

NJPDES Number NJ0108880 (Paterson)

Approval of this submittal:

Permittee: ______________________________ 6/28/19
William Rodriguez — 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: ______________________________ 6/28/19
William Rodriguez — 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, PE, Senior Engineer

Participating Permittees:

Bayonne:	Timothy Boyle, Superintendent of Public Works
East Newark:	Frank Pestana, Licensed Operator
Harrison:	Rocco Russomano, Town Engineer
Jersey City:	Rich Haytas, Senior Engineer
Kearny:	Robert J. Smith, Town Administrator
Newark:	Ras J. Baraka, Mayor of Newark
North Bergen:	Frank Pestana, Executive Director
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

A.3 PROGRAM CONTACT INFORMATION

Contact information for those parties involved in the System Characterization Report is as follows:

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

Marques Eley
Senior Engineer
PVSC
600 Wilson Avenue
Newark, NJ 07105

Patricia Lopes
Director of Process Control and Regulatory Compliance
PVSC
600 Wilson Avenue
Newark, NJ 07105

Michael J. Hope
Greeley and Hansen LLC
1700 Market Street
Suite 2130
Philadelphia, PA 19103

Timothy J. Dupuis
CDM Smith
77 Hartland Street
Suite 201
East Hartford, CT 06108

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

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

Marc Ferko
NJDEP Office of Quality Assurance
PO Box 420
401 E. State St., 2nd Floor
Trenton, NJ 08625-0420

Timothy Boyle
Superintendent Public Works
City of Bayonne
630 Avenue C
Bayonne, NJ 07002

Rocco Russomano
Town Engineer
Harrison Town
318 Harrison Avenue
Harrison, NJ 07029

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

Robert J. Smith
Town Administrator
Town of Kearny
357 Bergen Avenue
Kearny, NJ 07302

Kareem Adeem
Asst. Director Dept. of Water and Sewer
City of Newark
239 Central Avenue
Newark, NJ 07103

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

Manny Ojeda
Director of Public Works
City of Paterson
111 Broadway, 4th Floor
Paterson, NJ 07505

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

A.4 TABLE OF CONTENTS

SECTION A - INTRODUCTION AND BACKGROUND 1
A.0 SUMMARY OF CHANGES 1
A.1 TITLE OF PLAN AND APPROVAL 2
A.2 DISTRIBUTION LIST 12
A.3 PROGRAM CONTACT INFORMATION 13
A.4 TABLE OF CONTENTS 14
A.5 INTRODUCTION 20
A.6 PURPOSE OF REPORT 23
A.7 REGULATORY SETTING 24
A.7.1 Introduction 24
A.7.2 NJPDES Permit Requirements 24
A.7.3 USEPA's CSO Policy 27
A.7.3.1 Presumption Approach from USEPA's CSO Policy 27
A.7.3.2 Demonstration Approach from USEPA's CSO Policy 28
A.7.4 USEPA's Guidance for Long-Term Control Plan Requirements 29
A.7.4.1 Presumption Approach from USEPA's CSO Guidance for LTCP 30
A.7.4.2 Demonstration Approach from USEPA's CSO Guidance for LTCP 30
A.7.5 Comparison of the Two Approaches 31
A.7.6 NJPDES LTCP Permittees Approach and CSO Discharge Locations 32
A.8 EXISTING CONDITIONS 35
A.8.1 System Characterization Report Summary 36
A.9 SENSITIVE AREAS 37
A.9.1 Sensitive Areas Report Summary 38

SECTION B - RECEIVING WATERS CHARACTERIZATION 39
B.1 RECEIVING WATERS OVERVIEW 39
B.1.1 CSO Receiving Waters 39
B.1.2 Summary of Impacted Drainage Basins 39
B.2 POLLUTANTS OF CONCERN IN THE RECEIVING WATERS 41
B.2.1 Summary of the Identified POCs for Each Receiving Water 41
B.3 APPLICABLE WATER QUALITY STANDARDS 41
B.3.1 NJ Integrated Water Quality Monitoring and Assessment Report (303(d) list) 41

B.3.2 Interstate Environmental Commission Requirements 42
B.3.3 New Jersey Administrative Code.. 45

SECTION C - DESCRIPTION OF CSO CONTROL TECHNOLOGIES 48
C.1 INTRODUCTION 48
C.1.1 Water Quality and CSO Control Goals... 48
C.1.2 Evaluation Methodology Used for this Study... 50
C.2 SOURCE CONTROL.. 52
C.2.1 Stormwater Management 52
C.2.1.1 Street/Parking Lot Storage (Catch Basin Control)... 52
C.2.1.2 Catch Basin Modification (Floatables Control) 52
C.2.1.3 Catch Basin Modifications (Leaching) 52
C.2.2 Public Outreach Program.. 53
C.2.2.1 Water Conservation... 54
C.2.2.2 Catch Basin Stenciling 54
C.2.2.3 Community Cleanup Program.. 54
C.2.2.4 Public Outreach (Public Meetings) 54
C.2.2.5 FOG Program 54
C.2.2.6 Garbage Disposal Restrictions 55
C.2.2.7 Pet Waste Management.. 55
C.2.2.8 Lawn and Garden Maintenance.. 55
C.2.2.9 Hazardous Waste Collection 55
C.2.3 Ordinance Enforcement 55
C.2.3.1 Construction Site Erosion and Sediment Control 55
C.2.3.2 Illegal Dumping Control 56
C.2.3.3 Pet Waste Control... 56
C.2.3.4 Litter Control.. 56
C.2.3.5 Illicit Connection Control... 56
C.2.4 Good Housekeeping... 56
C.2.4.1 Street Sweeping/Flushing.. 56
C.2.4.2 Leaf Collection.. 57
C.2.4.3 Recycling Programs 57
C.2.4.4 Storage/Loading/Unloading Areas.. 57

C.2.4.5 Industrial Spill Control 57
C.2.5 Green Infrastructure 57
C.2.5.1 Green Roofs 58
C.2.5.2 Blue Roofs 59
C.2.5.3 Rainwater Harvesting 60
C.2.5.4 Permeable Paving 60
C.2.5.5 Planter Boxes 62
C.2.5.6 Bioswales 63
C.2.5.7 Free-Form Rain Gardens 64
C.3 INFILTRATION AND INFLOW CONTROL 65
C.3.1 Infiltration Inflow (I/I) Reduction 65
C.3.2 Advanced System Inspection and Maintenance 65
C.3.3 Combined Sewer Flushing 65
C.3.4 Catch Basin Cleaning 65
C.4 SEWER SYSTEM OPTIMIZATION 66
C.4.1 Increased Storage Capacity in the Collection System 66
C.4.1.1 Additional Conveyance 66
C.4.1.2 Regulator Modifications 66
C.4.1.3 Outfall Consolidation/Relocation 66
C.4.1.4 Real Time Control 67
C.5 STORAGE 67
C.5.1 Linear Storage 67
C.5.1.1 Pipelines 67
C.5.1.2 Tunnels 68
C.5.2 Point Storage 68
C.5.2.1 Tanks 68
C.5.2.2 Industrial Discharge Detention 69
C.6 SEWAGE TREATMENT PLANT EXPANSION OR STORAGE AT THE PLANT 69
C.6.1 Additional Treatment Capacity 69
C.6.2 Wet Weather Blending 69
C.7 SEWER SEPARATION 69
C.7.1 Roof Leader Disconnection 69
C.7.2 Sump Pump Disconnection 69

C.7.3 Combined Sewer Separation ... 70
C.8 TREATMENT OF CSO DISCHARGE ... 70
C.8.1 Treatment – CSO Facility ... 70
C.8.1.1 Vortex Separators ... 70
C.8.1.2 Screens and Trash Racks ... 70
C.8.1.3 Netting ... 71
C.8.1.4 Containment Booms ... 71
C.8.1.5 Baffles ... 71
C.8.1.6 Disinfection and Satellite Treatment ... 71
C.8.1.7 High Rate Physical/Chemical Treatment (ActiFlo®) ... 72
C.8.1.8 High Rate Physical Treatment (Fuzzy Filters) ... 73
C.9 SCREENING OF CONTROL TECHNOLOGIES ... 73
SECTION D - SUMMARY OF ALTERNATIVES ANALYSIS ... 82
D.1 DEVELOPMENT AND EVALUATION OF ALTERNATIVES ... 82
D.1.1 Alternatives Evaluation Approach ... 82
D.1.2 Siting ... 83
D.1.3 Institutional Issues ... 83
D.1.4 Implementability ... 83
D.1.5 Public Input ... 84
D.1.6 Performance Considerations ... 84
D.1.7 Cost ... 84
D.2 CONTROL PROGRAM ALTERNATIVES ... 86
D.2.1 Regional Alternative 1 ... 87
D.2.2 Regional Alternative 2 ... 89
D.2.3 Regional Alternative 3 ... 91
D.2.4 Regional Alternative 4 ... 93
D.2.5 Summary of Cost Opinions ... 95
D.3 SELECTION OF ALTERNATIVES ... 95
D.3.1 Evaluation Factors ... 95
D.3.2 Regulatory Compliance ... 95
D.3.3 Selection of Regional Alternative ... 95

SECTION E - REFERENCES 96

SECTION F - Abbreviations 98

List of Tables

Table A-1: Permittees Covered Under this Development and Regional Alternatives Report..... 24
Table A-2: Review of Requirements of the Development and Evaluation of Regional Alternatives Report........ 25
Table A-3: Comparison of the Presumption Approach and Demonstration Approach........ 31
Table A-4: Summary of CSO Discharge Locations 32
Table A-5: Municipality and Associated QAPP Submissions........ 35
Table A-6: System Characterization Report Contents and Organization 36
Table B-1: Watersheds Affected by CSO Discharges 39
Table B-2: Components of New Jersey's Integrated List of Water (Integrated List)........ 42
Table B-3: IEC Water Quality Standards for IEC Class B Waters........ 44
Table B-4: The NJ Administrative Code Classifications of PVSC Treatment District........ 45
Table C-1: NJPDES Permit Numbers........ 48
Table C-2: NJ Administrative Code Regarding the Passaic River 49
Table C-3: NJ Administrative Code regarding the Newark Bay 49
Table C-4: NJ Administrative Code regarding the Upper New York Bay 49
Table C-5: NJ Administrative Code regarding the Kill Van Kull 49
Table C-6: NJ Administrative Code regarding the Hudson River........ 49
Table C-7: NJ Administrative Code regarding the Hackensack River........ 50
Table C-8: Typical Year % Capture 50
Table C-9: Source Control Technologies Screening Table 75
Table C-10: Collection System Technologies Screening Table 79
Table C-11: Storage and Treatment Technologies Screening Table 80
Table D-1: Regional Alternatives 82
Table D-2: Regional Alternative 1 – Life Cycle Cost vs. # CSO/CSO Capture 87
Table D-3: Regional Alternative 1 – CSO Volume Captured vs. # CSO/CSO Capture 87
Table D-4: Regional Alternative 2 – Summary of Life Cycle Cost, CSO Volume Discharged and Captured, and Life Cycle Cost Efficiency........ 89
Table D-5: Regional Alternative 4 – Summary of Life Cycle Cost, CSO Volume Discharged and Captured, and Life Cycle Cost Efficiency........ 93

List of Figures

Figure A-1: The PVSC Treatment District 21
Figure A-2: The PVSC Sewer System Schematic 22
Figure B-1: PVSC Treatment District Watersheds........ 40
Figure B-2: Interstate Environmental Commission Water Quality Classifications........ 43
Figure B-3: Administrative Classifications of PVSC Treatment District Waterbodies 47

Figure C-1: Example Green Roof Section ... 59
Figure C-2: Example Rain Barrels ... 60
Figure C-3: Example Permeable Pavement Design near Existing Buildings ... 61
Figure C-4: Example Permeable Pavement Design near Existing Roadway and Surface ... 61
Figure C-5: Example Permeable Pavement Design near Existing Roadway and Sidewalk ... 62
Figure C-6: Example Planter Bumpout Section ... 62
Figure C-7: Example Bioswale Design ... 63
Figure C-8: Example Free-Form Rain Garden Design ... 64
Figure D-1: Map of Regional Tunnels Locations NJ440 ... 90
Figure D-2: Regional Alternative 3 ... 92
Figure D-3: Regional Alternative 4 ... 94

Appendices

Appendix A Evaluation of Alternatives Report for PVSC
Appendix B Evaluation of Alternatives Report for City of Bayonne
Appendix C Evaluation of Alternatives Report for Borough of East Newark
Appendix D Evaluation of Alternatives Report for Town of Harrison
Appendix E Evaluation of Alternatives Report for Jersey City MUA
Appendix F Evaluation of Alternatives Report for Town of Kearny
Appendix G Evaluation of Alternatives Report for City of Newark
Appendix H Evaluation of Alternatives Report for North Bergen MUA
Appendix I Evaluation of Alternatives Report for City of Paterson
Appendix J PVSC LTCP Technical Guidance Manual

A.5 INTRODUCTION

The Passaic Valley Sewerage Commission ("PVSC") provides wastewater treatment service to 48 municipalities within Bergen, Hudson, Essex, Union and Passaic counties in the Passaic Valley Treatment District located in Northeast New Jersey. In total, PVSC services approximately 1.5 million people, 198 significant industrial users and 5,000 commercial customers. The PVSC Treatment 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 Resource Recovery Facility ("WRRF") in the City of Newark. The WRRF receives flow from three sources: the Main Interceptor Sewer, the South Side Interceptor, and the Hudson County Force Main ("HCFM").

PVSC does not own or operate any of the combined sewer overflow ("CSO") outfalls but has assumed a lead role in coordinating the Development and Evaluation of Alternatives Regional Report on behalf of the permittees within the PVSC Treatment District. However, each of the individual CSO Permittees have performed an analysis and prepared their own Development of Evaluation of Alternatives Reports, which have been included as Appendices A through I of this Report. The extent of the PVSC Treatment District and the combined sewer areas within the study area are illustrated in **Figure A-1**.

Eight (8) of the municipalities within the PVSC Treatment District have combined sewer systems ("CSSs") and have received authorization to discharge under their respective New Jersey Pollutant Discharge Elimination System ("NJPDES") Permits for Combined Sewer Management. The eight (8) PVSC CSO Permittees are listed below:

- City of Paterson
- City of Newark
- Town of Kearny
- Town of Harrison
- Borough of East Newark
- City of Bayonne (Bayonne Municipal Utilities Authority was dissolved in 2016 and the City of Bayonne now own its CSS)
- Jersey City Municipal Utilities Authority ("JCMUA")
- North Bergen Municipal Utilities Authority ("NBMUA")

A general schematic of the PVSC sewer system is included in **Figure A-2**.

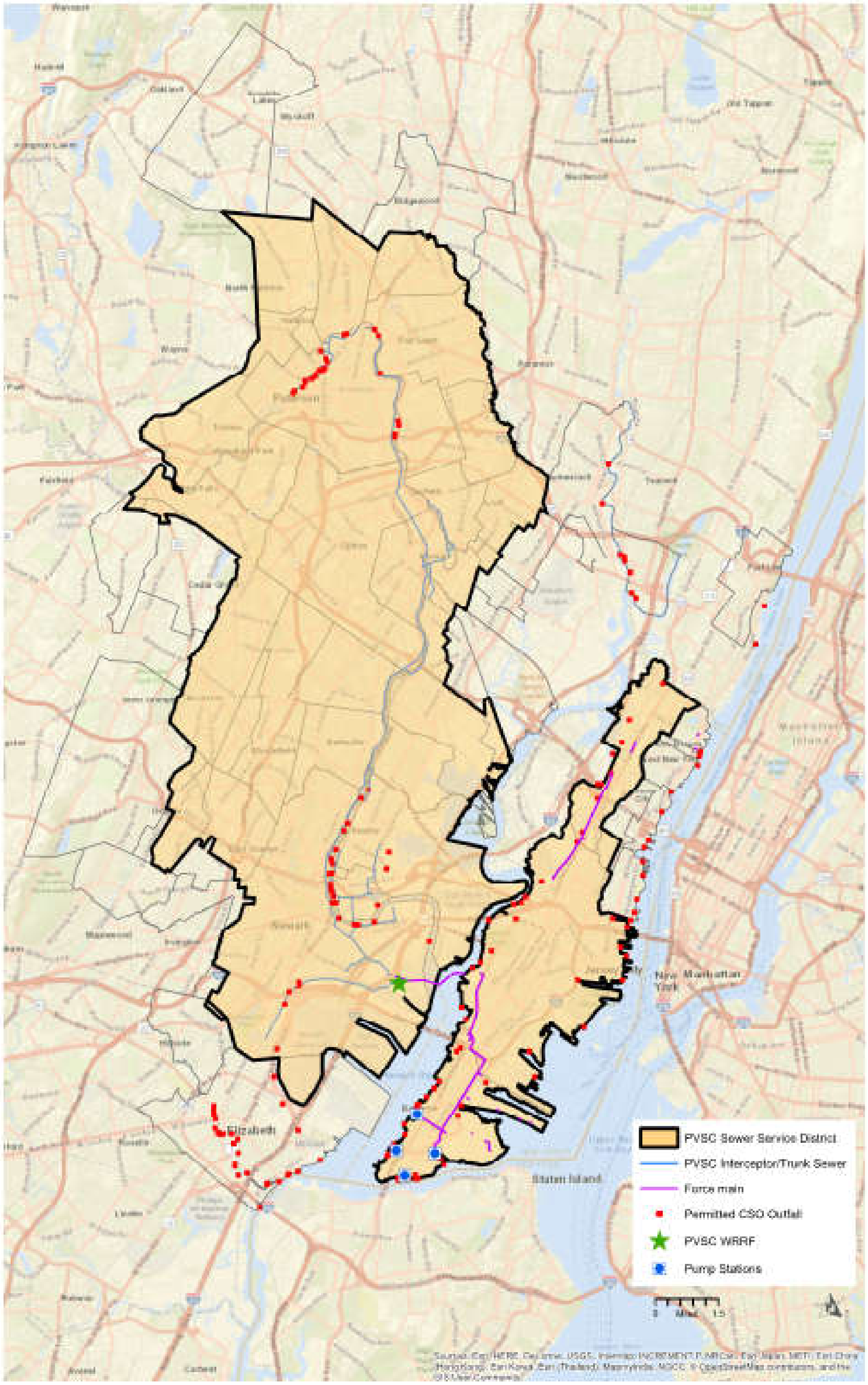

Figure A-1: The PVSC Treatment District

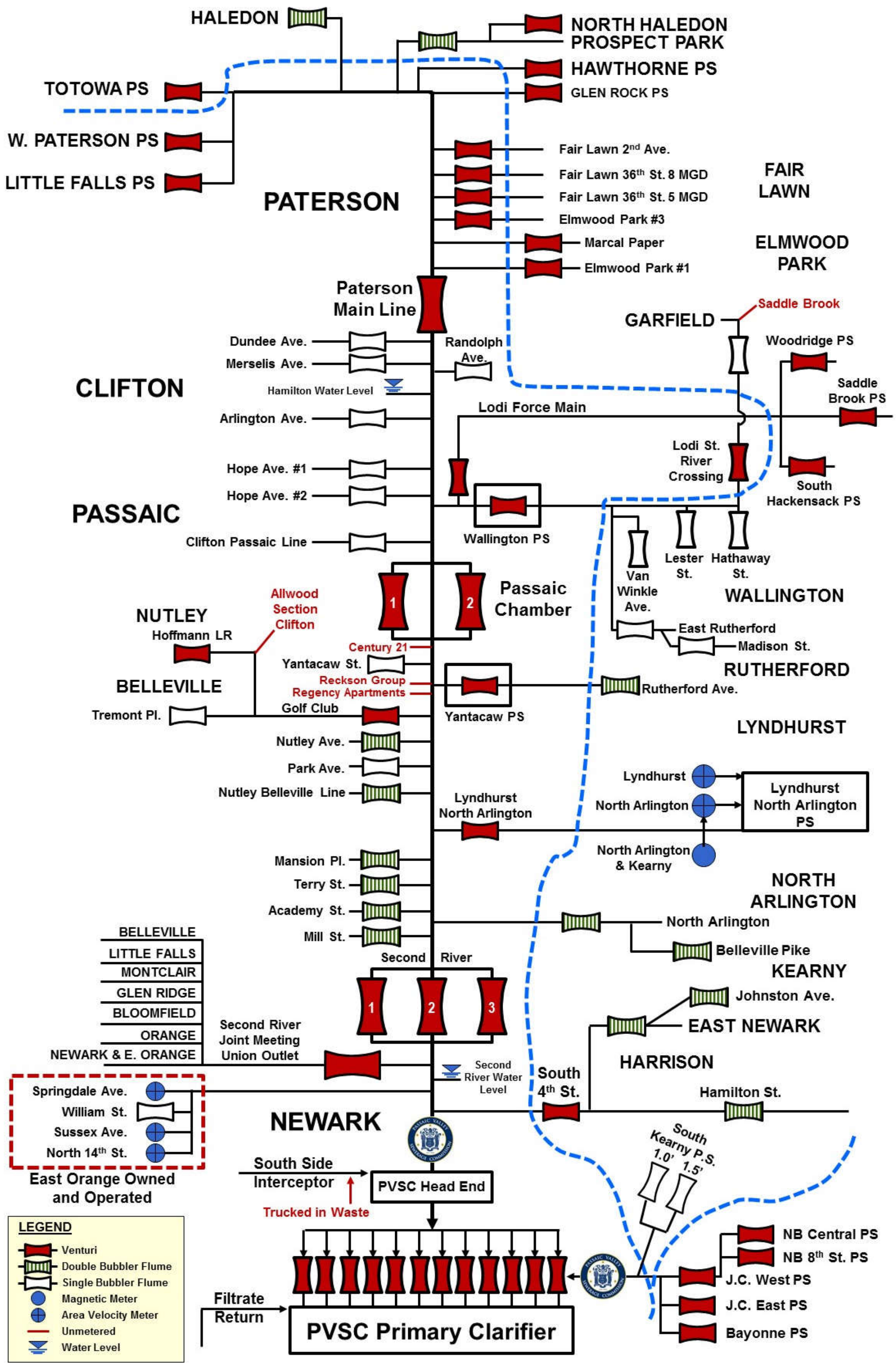

Figure A-2: The PVSC Sewer System Schematic

A.6 PURPOSE OF REPORT

The NJDPES Permit for each of the Permittees outlines the Long Term Control Plan (the "LTCP") Submittal requirements in Part IV (entitled Specific Requirement: Narrative), Section D.3. Subsection D.3.b.v states:

> *Step 2 - Development and Evaluation of Alternatives for the LTCP - In accordance with Sections G.2. through G.5. and G.9., the permittee shall submit an approvable Development and Evaluation of Alternatives Report: within 48 months from the effective date of the permit (EDP).*

In accordance with the NJPDES Permits' LTCP requirements, a Development and Evaluation of Alternatives Report shall be submitted by July 1, 2019.

To meet this requirement, of the CSO Permittees and PVSC developed their own individual Development and Evaluation of Alternatives Report. This *Development and Evaluation of Alternatives Regional Report* (the "Regional Alternatives Report") compiles and summarizes the results of the nine (9) individual Development and Evaluation of Alternatives Reports for the PVSC Treatment District, which includes PVSC's Report and the Development and Evaluation of Alternatives Reports developed by the CSO Permittees listed in Subsection A.5.

All nine (9) of the individual reports are included in their full version at the end of this Regional Alternatives Report as Appendices.

Section G.4 of the NJDPES Permit for each of the Permittees outlines the requirements of the Development and Evaluation of Alternatives Report. The objective of this Regional Alternatives Report is to enable the Permittees to evaluate the alternatives of CSO controls that will meet the water quality-based requirements of the Federal Water Pollution Control Act of 1972 (the "Clean Water Act" or the "CWA"), will be protective of the existing designated uses of the receiving waters, give priority to controlling CSOs to sensitive areas and address minimizing impacts from significant indirect user ("SIU") discharges. The Regional Alternatives Report also evaluates, compares, and incorporates the specific local alternatives developed by the eight (8) municipalities to the regional alternatives developed by PVSC as part of this Report.

A.7 REGULATORY SETTING

A.7.1 Introduction

This document constitutes the Regional Alternatives Report developed by PVSC and the municipalities and municipal authorities served by PVSC that are listed below in **Table A-1.**

Table A-1: Permittees Covered Under this Development and Regional Alternatives Report

Municipality	NJPDES #
PVSC	NJ0021016
Borough of East Newark	NJ0117846
Town of Harrison	NJ0108871
Town of Kearny	NJ0111244
City of Newark	NJ0108758
City of Paterson	NJ0108880
City of Bayonne	NJ0209240
North Bergen MUA	NJ0108898
Jersey City MUA	NJ0108723

A.7.2 NJPDES Permit Requirements

Under Section 402 of the CWA, all point source discharges to the waters of the United States must be permitted. The United States Environmental Protection Agency ("USEPA") Region II has delegated permitting authority in New Jersey to the New Jersey Department of Environmental Protection ("NJDEP"). The permits are reissued on a nominal five-year cycle. All twenty-one (21) New Jersey municipalities and municipal authorities with CSSs were issued new permits in 2015 that set forth the requirement for the completion of a Development and Evaluation of CSO Control Alternatives Report by July 1, 2019.

Part IV, Section D.3.b.v of the NJDPES Permit for each of the Permittees requires the completion of an approvable Development and Evaluation of Alternatives Report, to be prepared in accordance with Part IV, Sections G.2 through G.5 and G.9 of the permit. Those sections are listed below for reference:

- Section G.2 Public Participation Process
- Section G.3 Consideration of Sensitive Areas
- Section G.4 Evaluation of Alternatives
- Section G.5 Cost/Performance Considerations
- Section G.9 Compliance Monitoring Program (CMP)

Section G.4 states that the Evaluation of Alternatives must also comply with the requirements of Subsection D.3.a and Section G.10, recited below:

- Subsection D.3.a (under) Long Term Control Plan Submittal Requirements
  "The Department encourages a single LTCP to be developed and submitted on behalf of all of the permittees in a hydraulically connected sewer system."
- Section G.10 Permittee's LTCP Responsibilities
  "Where multiple permittees own/operate different portions of a hydraulically connected CSS, the permittee is required to work cooperatively with all other permittees to ensure the LTCPs are consistent. The LTCP documents must be based on the same data, characterization, models, engineering and cost studies, and other information, where appropriate. Each permittee is required to prepare the necessary information for the portion of the hydraulically connected system that the permittee owns/operates and provide this information to the other permittees within the hydraulically connected system in a timely manner for LTCP submission.

The specific requirements for the Development and Evaluation of CSO Control Alternatives Report are outlined in Section G.4. These requirements are reproduced in **Table A-2**, along with the section of this Regional Alternatives Report in which those requirements are addressed.

Table A-2: Review of Requirements of the Development and Evaluation of Regional Alternatives Report

Permit Section	Permit Requirement	Regional Report Section
Part IV G.4.a	"The permittee shall evaluate a reasonable range of CSO control alternatives, in accordance with D.3.a and G.10 that will meet the water quality-based requirements of the CWA using either the Presumption Approach or the Demonstration Approach (as described in Sections G.4.f.and G.4.g)."	**Section C:** Description of CSO Control Technologies
Part IV G.4.b	"The permittee shall submit, as per Section D.3.b.v, the Evaluation of Alternatives Report that will enable the permittee, in consultation with the Department, the public, owners and/or operators of the entire collection system that conveys flows to the treatment works, to select the alternatives to ensure the CSO controls will meet the water quality-based requirements of the CWA, will be protective of the existing and designated uses in accordance with N.J.A.C. 7:9B, give the highest priority to controlling CSOs to sensitive areas, and address minimizing impacts from SIU discharges."	Entire Regional Alternatives Report
Part IV G.4.c G.4.f G.4.g	"The permittee shall select either Demonstration or Presumption Approach for each group of hydraulically connected CSOs, and identify each CSO group and its individual discharge locations."	**Section A:** Introduction and Background
Part IV G.4.d	"The Evaluation of Alternatives Report shall include a list of control alternative(s) evaluated for each CSO."	**Section D:** Summary of Alternatives Analysis

Permit Section	Permit Requirement	Regional Report Section
Part IV G.4.e	"The permittee shall evaluate a range of CSO control alternatives predicted to accomplish the requirements of the CWA. In its evaluation of each potential CSO control alternative, the permittee shall use an NJDEP approved hydrologic, hydraulic and water quality models. The permittee shall utilize the models to simulate the existing conditions and conditions as they are expected to exist after construction and operation of the chosen alternative(s). The permittee shall evaluate the practical and technical feasibility of the proposed CSO control alternative(s), and water quality benefits of constructing and implementing various remedial controls and combination of such controls and activities"	**Section C:** Description of CSO Control Technologies
Part IV G.4.e.i	The permittee shall evaluate the practical and technical feasibility of, Green infrastructure"	**Section C:** Description of CSO Control Technologies
Part IV G.4.e.ii	The permittee shall evaluate the practical and technical feasibility of, Increased storage capacity in the collection system"	**Section C:** Description of CSO Control Technologies
Part IV G.4.e.iii	"The permittee shall evaluate the practical and technical feasibility of, STP expansion and/or storage at the plant (an evaluation of the capacity of the unit processes must be conducted at the STP resulting in a determination of whether there is any additional treatment and conveyance capacity within the STP). Based upon this information, the permittee shall determine (modeling may be used) the amount of CSO discharge reduction that would be achieved by utilizing this additional treatment capacity while maintaining compliance with all permit limits"	**Section C:** Description of CSO Control Technologies
Part IV G.4.e.iv	"The permittee shall evaluate the practical and technical feasibility of, I/I reduction to meet the definition of non-excessive infiltration and non-excessive inflow as defined in N.J.A.C. 7:14A-1.2 in the entire collection system that conveys flows to the treatment works to free up storage capacity or conveyance in the sewer system and/or treatment capacity at the STP, and feasibility of implementing in the entire system or portions thereof"	**Section C:** Description of CSO Control Technologies
Part IV G.4.e.v	"The permittee shall evaluate the practical and technical feasibility of, Sewer separation"	**Section C:** Description of CSO Control Technologies
Part IV G.4.e.vi	"The permittee shall evaluate the practical and technical feasibility of, Treatment of the CSO discharge"	**Section C:** Description of CSO Control Technologies

Permit Section	Permit Requirement	Regional Report Section
Part IV G.4.e.vii	"The permittee shall evaluate the practical and technical feasibility of, CSO related bypass of the secondary treatment portion of the STP in accordance with N.J.A.C. 7:14A-11.12 Appendix C, II C.7"	**Section C:** Description of CSO Control Technologies

A.7.3 USEPA's CSO Policy

USEPA's CSO Policy (the "CSO Policy") was issued in April of 1994 (59 FR 18688 - 18698) to elaborate on the 1989 National CSO Control Strategy and to expedite compliance with the requirements of the CWA. The CSO Policy provided guidance to municipal permittees with CSOs, to the state agencies issuing National Pollution Discharge Elimination permits (e.g., NJDEP and NJPDES permits) and to state and interstate water quality standards ("WQS"), authorities (e.g., the Interstate Environmental Commission). The CSO Policy establishes a framework for the coordination, planning, selection, and implementation of CSO controls required for permittee compliance with the CWA.

The CSO Policy Section II.C.4 – Evaluation of Alternatives states:

> *"EPA expects the long-term CSO control plan to consider a reasonable range of alternatives. The plan should, for example, evaluate controls that would be necessary to achieve zero overflow events per year, an average of one to three, four to seven, and eight to twelve overflow events per year. Alternatively, the long-term plan could evaluate controls that achieve 100% capture, 90% capture, 85% capture, 80% capture, and 75% capture for treatment. The long-term control plan should also consider expansion of POTW secondary and primary capacity in the CSO abatement alternative analysis. The analysis of alternatives should be sufficient to make a reasonable assessment of cost and performance as described in Section II.C.5. Because the final long-term CSO control plan will become the basis for NPDES permit limits and requirements, the selected controls should be sufficient to meet CWA requirements."*

The CSO Policy also states that "In addition to considering sensitive areas, the long-term control plan should adopt either the Presumption Approach or the Demonstration Approach.

A.7.3.1 Presumption Approach from USEPA's CSO Policy

Subsection II.C.4.a of the USEPA's CSO Policy (Presumption Approach) states that:

> *"A program that meets any of the criteria listed below would be presumed to provide an adequate level of control to meet the water quality-based requirements of the CWA, provided the permitting authority determines that such presumption is reasonable in light of the data and analysis conducted in the characterization, monitoring, and modeling of the system and the consideration of sensitive areas...These criteria are provided because data and modeling of wet weather events often do not give a clear picture of the level of CSO controls necessary to protect [water quality standards]."*

Under the Presumption Approach, CSO controls proposed in the LTCP are presumed to protect water quality in the receiving water bodies if the CSS achieves any of the following three (3) criteria:

i. *"No more than an average of four overflow events per year, provided that the permitting authority may allow up to two additional overflow events per year. For the purpose of this criterion, an overflow event is one or more overflows from a CSS as the result of a precipitation event that does not receive the minimum treatment specified below; or*

ii. *The elimination or the capture for treatment of no less than 85% by volume of the combined sewage collected in the CSS during precipitation events on a system-wide annual average basis; or*

iii. *The elimination or removal of no less than the mass of the pollutants identified as causing water quality impairment through the sewer system characterization, monitoring, and modeling effort, for the volumes that would be eliminated or captured for treatment under the paragraph ii above."*

"Minimum treatment," as noted in Item "i" above, is defined in Subsection II.C.4.a of the CSO Control Policy, which indicates that "combined sewer flows remaining after implementation of the nine minimum controls and within the criteria specified at II.C.4.a.i. or ii, should receive a minimum of:

- *Primary Clarification (Removal of floatables and settleable solids may be achieved by any combination of treatment technologies or methods that are shown to be equivalent to primary clarification.);*
- *Solids and floatables disposal; and*
- *Disinfection of effluent, if necessary, to meet [water quality standards], protect designated uses and protect human health, including removal of harmful disinfection chemical residuals, where necessary."*

Combined sewer flows are the flows that are remaining in the combined sewer system and are conveyed to the publically owned treatment works for treatment and discharge.

A.7.3.2 Demonstration Approach from USEPA's CSO Policy

Subsection II.C.4.b of the USEPA's CSO Policy (Demonstration Approach) states that:

"A permittee may demonstrate that a selected control program, though not meeting the criteria specified in II.C.4.a. above is adequate to meet the water quality-based requirements of the CWA."

Under the Demonstration Approach, the municipality would be required to successfully demonstrate compliance with each of the following criteria from the CSO Policy:

I. *"The planned control program is adequate to meet [water quality standards] and protect* *designated uses, unless [water quality standards] or uses cannot be met as a result of natural background conditions or pollution sources other than CSOs;*

II. *The CSO discharges remaining after implementation of the proposed control program will not preclude the attainment of [water quality standards] or the receiving waters' designated uses or contribution to their impairment. Where [water quality standards] are not met in part because of natural background conditions or pollution sources other than CSO discharges, a total maximum daily load, including a waste load allocation and a load allocation or other means should be used to apportion pollutant loads;*

III. *The planned control program will provide the maximum pollution reduction benefits reasonably attainable; and*

IV. *The planned control program is designed to allow cost effective expansion or cost effective retrofitting if additional controls are determined to be necessary to meet [water quality standards] or designated uses."*

A.7.4 USEPA's Guidance for Long-Term Control Plan Requirements

The USEPA's CSO Guidance for Long-Term Control Plan (or "CSO Guidance Document") states that the Demonstration Approach and the Presumption Approach are the two general approaches to attainment of WQS, and that these two approaches provide municipalities with targets for CSO controls that achieve compliance with the CWA, particularly the protection of designated uses.

Section 1.3 of the CSO Guidance Document states:

> *"Permittees should develop long-term control plans (LTCPs) for controlling CSOs. A permittee may use one of two approaches: 1) demonstrate that its plan is adequate to meet the water quality-based requirements of the CWA ("demonstration approach"), or 2) implement a minimum level of treatment (e.g., primary clarification of at least 85 percent of the collected combined sewage flows) that is presumed to meet the water quality-based requirements of the CWA, unless data indicate otherwise ("presumption approach")."*

Section 2.6.2.1 states that:

> *"Under the [CSO Policy], a municipality should develop an LTCP that adopts either the demonstration or the presumption approach to attainment of WQS. The demonstration approach is based on adequately demonstrating that the selected CSOs will provide for the attainment of WQS, including designated uses in the receiving water. The presumption approach does not explicitly call for analysis of receiving water impacts. The presumption approach usually involves at least screening-level models of receiving water impacts, however, because the approach will not apply if the NPDES permitting authority determines that the LTCP will not result in attainment of CWA requirements."*

A.7.4.1 Presumption Approach from USEPA's CSO Guidance for LTCP

For the Presumption Approach, Section 3.2.1 of the USEPA's CSO Guidance Document states that:

> *"If the data collected by a community do not provide "...a clear picture of the level of CSO controls necessary to protect WQS", the presumption approach may be considered. Use of the presumption approach is contingent, however, on the municipality presenting sufficient data to the NPDES permitting authority to allow the agency to make a reasonable judgment that WQS will probably be met with a control plan that meets one of the three presumption criteria."*

Furthermore, the CSO Guidance Document states:

> *"Use of the presumption approach does not release municipalities from the overall requirement that WQS be attained. If data collected during system characterization suggest that use of the presumption approach cannot be reasonably expected to result in attainment of WQS, the municipality should be required to use the demonstration approach instead. Furthermore, if implementation of the presumption approach does not result in attainment of WQS, additional controls beyond those already implemented might be required."*

A.7.4.2 Demonstration Approach from USEPA's CSO Guidance for LTCP

For the Demonstration Approach, Section 3.2.1 of the USEPA's CSO Guidance Document states that:

> *"Generally, if sufficient data are available to demonstrate that the proposed plan would result in an appropriate level of CSO control, then the demonstration approach will be selected. The demonstration approach is particularly appropriate where attainment of WQS cannot be achieved through CSO control alone, due to the impacts of non-CSO sources of pollution. In such cases, an appropriate level of CSO control cannot be dictated directly by existing WQS but must be defined based on water quality data, system performance modeling, and economic factors."*

The Demonstration Approach is consistent with the total maximum daily load ("TMDL") development approach and may be used in the TMDL process where the WQS and designated uses are not met in part because of natural background conditions or pollution sources other than CSOs. Section 3.2.1.1 of the CSO Guidance Document states:

> *"The demonstration approach encourages the development of total maximum daily loads and/or the use of a watershed approach throughout the LTCP process. In conducting the existing baseline water quality assessments as part of the system characterization, for example, the specific pollutants causing nonattainment of WQS, including existing or designated uses, would be identified, and then the sources of these pollutants could be identified and loads apportioned and quantified."*

A.7.5 Comparison of the Two Approaches

Table A-3 summarizes the major differences between the Presumption Approach and the Demonstration Approach.

Table A-3: Comparison of the Presumption Approach and Demonstration Approach

Item	Presumption Approach	Demonstration Approach
Criteria	• Meet one of three criteria and compliance is **presumed**: 1) No more than an average of 4-6 *CSO* events per year; 2) 85% capture (by volume) 3) Elimination or removal of the mass of pollutants, identified as causing water quality impairment.	• Number of CSO events, flow or pollutant loading limited by a proposed CSO system Waste Load Allocation which will not preclude the attainment of Water Quality Standards (WQS). • Relies on data collection and model simulation to **demonstrate** that the proposed LTCP results in meeting the current WQS and designated uses.
Monitoring Data Collection	• Flow metering of the collection system and/or water quality sampling of CSOs.	• Flow metering of the collection system and water quality sampling of CSOs and receiving water bodies.
Modeling	• Combined sewer system (CSS) hydrologic and hydraulic (H&H) model.	• CSS H&H Model and Receiving Water Quality Model(s).
Pollutant Sources Evaluated	• Only CSOs.	• The contributing pollutant sources in the watershed including urban stormwater, agricultural (if any), wildlife, etc.

The Demonstration Approach takes a holistic watershed based approach to understand the pollutant sources and their relative contributions, so that appropriate level of controls can be cost-effectively applied to each pollutant source instead of focusing on just the CSOs. The Demonstration Approach can help to understand where the current CSO program is in terms of meeting the WQS and demonstrate the impact of future WQS changes on the CSO controls. Under the Demonstration Approach, the permittee must document that their CSO control program is adequate to meet the water quality-based requirements of the CWA.

Use of the Presumption Approach for a particular water body is allowed when approved by the NJDEP that the specific presumption(s) to be used in a particular water body are reasonable pursuant to Section II.C.4.a of the CSO Policy.

Certain tasks must be completed regardless if the Presumption or Demonstration Approach is used, such as system characterization, sewer and Geographic Information System (GIS) mapping, and the evaluation of alternatives. However, it is to be noted that the study phase for the Demonstration Approach also requires water quality sampling and water quality modeling of the receiving waters. These tasks have been previously completed and the Reports and/or submittals that document the findings of each of these tasks have been submitted to the NJDEP in accordance with the NJPDES Permits.

A.7.6 NJPDES LTCP Permittees Approach and CSO Discharge Locations

Part IV, Section G.4.c of each Permittee's NJDPES Permit states:

> *"The permittee shall select either Demonstration or Presumption Approach for each group of hydraulically connected CSOs, and identify each CSO group and its individual discharge locations."*

As discussed with NJDEP a specific approach (either the Presumption Approach or the Demonstration Approach) is not being selected at this time for the purposes of this Regional Alternatives Report. Rather, various CSO technologies to provide varying levels of control (i.e., 0, 4, 8, 12, and 20 CSO events per year, and 85% CSO volume capture) have been evaluated for effectiveness. The designation of the hydraulically connected groups and the approach (either Presumption or Demonstration) will be selected when identifying the selected controls for implementation and will be presented in the subsequent Selection and Implementation of Alternatives Report in the Final LTCP.

Table A-4 summarizes the NJPDES, permittee name, CSO numbers, and receiving water body.

Table A-4: Summary of CSO Discharge Locations

NJPDES	Permittee	CSO Number	Receiving Water Body
NJ0109240	Bayonne	001A	Kill Van Kull
NJ0109240	Bayonne	002A	Kill Van Kull
NJ0109240	Bayonne	003A	Kill Van Kull
NJ0109240	Bayonne	004A	Kill Van Kull
NJ0109240	Bayonne	006A	Upper NY Bay
NJ0109240	Bayonne	007A	Upper NY Bay
NJ0109240	Bayonne	008A	Kill Van Kull
NJ0109240	Bayonne	009A	Kill Van Kull
NJ0109240	Bayonne	010A	Kill Van Kull
NJ0109240	Bayonne	011A	Newark Bay
NJ0109240	Bayonne	012A	Newark Bay
NJ0109240	Bayonne	013A	Newark Bay
NJ0109240	Bayonne	014A	Newark Bay
NJ0109240	Bayonne	015A	Newark Bay
NJ0109240	Bayonne	016A	Newark Bay
NJ0109240	Bayonne	017A	Newark Bay
NJ0109240	Bayonne	018A	Newark Bay
NJ0109240	Bayonne	019A	Newark Bay

NJPDES	Permittee	CSO Number	Receiving Water Body
NJ0109240	Bayonne	020A	Newark Bay
NJ0109240	Bayonne	021A	Upper NY Bay
NJ0109240	Bayonne	022A	Newark Bay
NJ0109240	Bayonne	024A	Kill Van Kull
NJ0109240	Bayonne	026A	Newark Bay
NJ0109240	Bayonne	028A	Newark Bay
NJ0109240	Bayonne	029A	Newark Bay
NJ0109240	Bayonne	030A	Newark Bay
NJ0109240	Bayonne	034A	Newark Bay
NJ0109240	Bayonne	037A	Kill Van Kull
NJ0117846	East Newark	001A	Passaic River
NJ0108871	Harrison	001A	Passaic River
NJ0108871	Harrison	002A	Passaic River
NJ0108871	Harrison	003A	Passaic River
NJ0108871	Harrison	005A	Passaic River
NJ0108871	Harrison	006A	Passaic River
NJ0108871	Harrison	007A	Passaic River
NJ0111244	Kearny	001A	Passaic River
NJ0111244	Kearny	004A	Passaic River
NJ0111244	Kearny	006A	Passaic River
NJ0111244	Kearny	007A	Frank's Creek
NJ0111244	Kearny	010A	Frank's Creek
NJ0108758	Newark	002A	Passaic River
NJ0108758	Newark	003A	Passaic River
NJ0108758	Newark	004A	Passaic River
NJ0108758	Newark	005A	Passaic River
NJ0108758	Newark	008A	Passaic River
NJ0108758	Newark	009A	Passaic River
NJ0108758	Newark	010A	Passaic River
NJ0108758	Newark	014A	Passaic River
NJ0108758	Newark	015A	Passaic River
NJ0108758	Newark	016A	Passaic River
NJ0108758	Newark	017A	Passaic River
NJ0108758	Newark	018A	Passaic River
NJ0108758	Newark	022A	Passaic River
NJ0108758	Newark	023A	Peripheral Ditch / Elizabeth Channel
NJ0108758	Newark	025A	Peripheral Ditch /

NJPDES	Permittee	CSO Number	Receiving Water Body
			Elizabeth Channel
NJ0108758	Newark	026A	Queen Ditch
NJ0108758	Newark	027A/029A	Peripheral Ditch / Elizabeth Channel
NJ0108758	Newark	030A	Peripheral Ditch / Elizabeth Channel
NJ0108898	North Bergen MUA	003A	Bellmans Creek
NJ0108898	North Bergen MUA	005A	Cromakill Creek
NJ0108898	North Bergen MUA	006A	Cromakill Creek
NJ0108898	North Bergen MUA	007A	Cromakill Creek
NJ0108898	North Bergen MUA	008A	Cromakill Creek
NJ0108898	North Bergen MUA	009A	Cromakill Creek
NJ0108898	North Bergen MUA	010A	Cromakill Creek
NJ0108898	North Bergen MUA	011A	Cromakill Creek
NJ0108898	North Bergen MUA	014A	Cromakill Creek
NJ0108880	Paterson	001A	Passaic River
NJ0108880	Paterson	003A	Passaic River
NJ0108880	Paterson	005A	Passaic River
NJ0108880	Paterson	006A	Passaic River
NJ0108880	Paterson	007A	Passaic River
NJ0108880	Paterson	010A	Passaic River
NJ0108880	Paterson	013A	Passaic River
NJ0108880	Paterson	014A	Passaic River
NJ0108880	Paterson	015A	Passaic River
NJ0108880	Paterson	016A	Passaic River
NJ0108880	Paterson	017A	Passaic River
NJ0108880	Paterson	021A	Passaic River
NJ0108880	Paterson	022A	Passaic River
NJ0108880	Paterson	023A	Passaic River
NJ0108880	Paterson	024A	Passaic River
NJ0108880	Paterson	025A	Passaic River
NJ0108880	Paterson	026A	Passaic River
NJ0108880	Paterson	027A	Passaic River
NJ0108880	Paterson	029A	Passaic River
NJ0108880	Paterson	030A	Passaic River
NJ0108880	Paterson	031A	Passaic River
NJ0108880	Paterson	032A	Passaic River
NJ0108880	Paterson	033A	Passaic River

A.8 EXISTING CONDITIONS

Section D.3.b.i of the NJPDES Permit for each Permittee required submittal of a System Characterization Work Plan to the NJDEP 6 months (January 1, 2016) from the EDP. To meet this requirement, the CSO Permittees and PVSC submitted two System Characterization and Landside Modeling Program Quality Assurance Project Plans ("QAPPs") to be executed and performed by PVSC. See **Table A-5** for each municipality and associated QAPP.

Table A-5: Municipality and Associated QAPP Submissions

Municipalities and Permittees	QAPP Submission
PVSC; Borough of East Newark; Town of Harrison; Town of Kearny; City of Newark; City of Paterson; City of Bayonne; North Bergen MUA	PVSC QAPP Part 1
Jersey City MUA	PVSC QAPP Part 2

NOTE: NBMUA (Woodcliff) and Guttenberg was included under a separate QAPP.

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 LTCP.

In accordance with the Permits' LTCP requirements, two System Characterization Reports were submitted by July 1, 2018. The PVSC Treatment District System Characterization Report was developed on behalf of the following seven of the eight CSO Permittees in the PVSC Treatment District.

- Paterson
- Newark
- Kearny
- Harrison
- East Newark
- Bayonne
- North Bergen MUA

The Jersey City MUA System Characterization Report was submitted as a separate report

Each of the System Characterization Reports were developed to meet the permit requirements and incorporate the results of the QAPPs for the System Characterization and Landside Modeling Program, a summary of the Baseline Monitoring and Modeling Plan program, and the System Characterization mapping of the combined and separate sewer areas within the PVSC Treatment District. Details of the Baseline Compliance Monitoring Program were submitted under separate reports.

Section G.1 of the NJPDES Permits outline the requirements of the System Characterization Monitoring and Modeling of the Combined Sewer system study that will provide a comprehensive characterization of the CSS.

The objective of the System Characterization Report is to provide NJDEP, PVSC, and the Permittees with a comprehensive and empirical understanding of the physical nature and hydraulic performance of their respective sewerage systems for use in optimizing the performance of the current systems and in the development of CSO control alternatives.

A.8.1 System Characterization Report Summary

The PVSC Treatment District System Characterization Report provides a comprehensive characterization of the CSS developed through records review, monitoring, modeling establishing the existing baseline conditions to evaluate the efficacy of the CSO technology based controls, and determine the baseline conditions upon which the LTCP will be based.

PVSC and the municipal permittees have developed a thorough understanding of their respective sewerage systems, the systems' responses to precipitation events of varying duration and intensity, the characteristics of system overflows, and water quality issues associated with CSOs emanating from the systems and is presented in this report.

An overview of the organization and contents of the System Characterization Report are provided on **Table A-6.**

Table A-6: System Characterization Report Contents and Organization

Section		Topics Covered
A	Introduction and Background	Documents the problem definition, background, project description, summary and table of contents.
B	Regulatory Requirements	Describes the scope, purpose and regulatory context of the System Characterization Report.
C	Overview of Wastewater Facilities and Service Area	Characterizes the service area comprising the PVSC combined sewer municipalities that are the subject of this system characterization report and current wastewater treatment facilities within the service area.
D	Characteristics of the Combined Sewer System	Characterizes the municipal collection sewers, sewer mains, interceptors and appurtenances such as pump stations, existing CSO control facilities, regulator structures, and CSO outfalls.

Section		Topics Covered
E	Collection of Precipitation and Sewer Flow Monitoring	Documents the precipitation and flow monitoring programs, data analyses, integration of wastewater treatment plant operational data, data validation and QA/QC and presents the results of the analyses.
F	Characteristics of the Receiving Waters	Describes the watersheds, physical characteristics, and hydrodynamics of the receiving streams. Also describes the designated uses and current water quality compliance (e.g., 303(d) listings) and achievement of designated use status.
G	Collection of Water Quality Data	Documents the regulatory requirements for water quality data collection, historic water quality data collection, the water quality monitoring program and related QAPP and receiving water quality results.
H	Typical Hydrologic Period	Documents the requirements for and selection of the typical year and summarizes the hydrologic characteristics of the typical year.
I	Hydrologic and Hydraulic Modeling	Documents the development and scope of the H&H model used in this system characterization and to be used in the development of CSO control alternatives. The documentation includes model inputs, sensitivity analyses, model calibration and validation and modeling results.
J	References	
K	Abbreviations	

The latest revision of the PVSC Treatment District System Characterization Report provides a more comprehensive summary of the system characterization.

A.9 SENSITIVE AREAS

Pursuant to USEPA's CSO Policy, a permittee's LTCP must, "give the highest priority to controlling overflows to sensitive areas." (Federal Register 59 [April 19, 1994]: 18688-18698.) The purpose of the Sensitive Areas Report is to document the State and Federal Agencies that were researched and other means utilized in order to identify the location of potential sensitive areas as they may relate to the development of the CSO LTCP. This will allow the Permittees to develop a plan that incorporates consideration of these areas as physically possible and economically achievable.

The Permittees are in the process of developing a LTCP which follows the framework established by the USEPA. PVSC prepared the Sensitive Areas Report on behalf of the Permittees to identify all sensitive areas impacted by CSOs within the Study Area, which includes the receiving surface waters as well as the adjacent waters.

For the purposes of this report, the Sensitive Areas Study Area (the "Study Area") includes the combined sewer service areas, all receiving and adjacent downstream waters that may be potentially affected by CSOs, and the various combined sewer service areas of the PVSC Treatment District will be considered. Affected waters include the Passaic River, Hackensack

River, Newark Bay, Hudson River, Kill Van Kull, Arthur Kill, Upper New York Bay, as well as their tributaries within the Study Area of this report.

A.9.1 Sensitive Areas Report Summary

A comprehensive review to identify sensitive areas within the project area was completed. Results from this review can be found in the Identification of Sensitive Areas Report last revised and submitted on March 29, 2019, with the associated comments and communications filed with NJDEP.

SECTION B - RECEIVING WATERS CHARACTERIZATION

Characteristics of the receiving waters include description of the receiving waters designated use, shoreline characteristics, identification of the waters on the impaired waters of NJ and a summary of the sensitive areas within the receiving waters. USEPA's CSO Policy requires that highest priority is given to CSOs that discharge to sensitive areas.

B.1 RECEIVING WATERS OVERVIEW

Major receiving waters impacted from the PVSC Treatment District combined sewer overflows include the Passaic River, Hackensack River, Newark Bay, and the Upper New York Bay. Waterbodies connected to these four (4) receiving waters include the Hudson River, Kill Van Kull, Raritan River and Raritan Bay, as well as their tributaries. The NJDEP has categorized these receiving waters into Watershed Management Areas (WMA) 1 through 20 and refers to these designations in the 303(d) list of impaired waters.

B.1.1 CSO Receiving Waters

CSO receiving waters are water bodies that either a CSO discharges into, or receive flow from tributaries with CSOs. The receiving waters include the combined sewer service area of the PVSC Treatment District and expands from this service area to include all receiving and adjacent downstream waters that may be potentially affected by CSOs from the various combined sewer service areas of the NJ CSO Group. Receiving waters to which CSOs in PVSC's Treatment District discharge directly or indirectly include the Passaic River, Hudson River, Newark Bay, Upper New York Bay, Hackensack River, Kill Van Kull, as well as their tributaries. All of the CSO outfalls and the waterbodies into which they discharge are listed in the System Characterization Report.

B.1.2 Summary of Impacted Drainage Basins

The receiving waters and their tributaries belong to drainage basins that are impacted by CSO discharges. Drainage basins, or watersheds, are areas that are separated by drainage divides and within a watershed, all surface water drains to a single outlet such as a river. The impacted watersheds within PVSC Treatment District are listed in **Table B-1**. The watersheds are also shown with the QAPP Part 1 and Part 2 areas from the "System Characterization and Landside Modeling Program Quality Assurance Project Plan (QAPP)," which have been previously approved by NJDEP areas and are further shown in **Figure B-1**.

Table B-1: Watersheds Affected by CSO Discharges

Watershed Name	Area (sq. mi)
Hudson River	5
Passaic River Lower (Saddle to Pompton)	46
Hackensack River (below and including Hirschfeld Brook)	19
Passaic River Lower (Newark Bay to Saddle)	52
Elizabeth River	2
Newark Bay / Kill Van Kull / Upper NY Bay	25

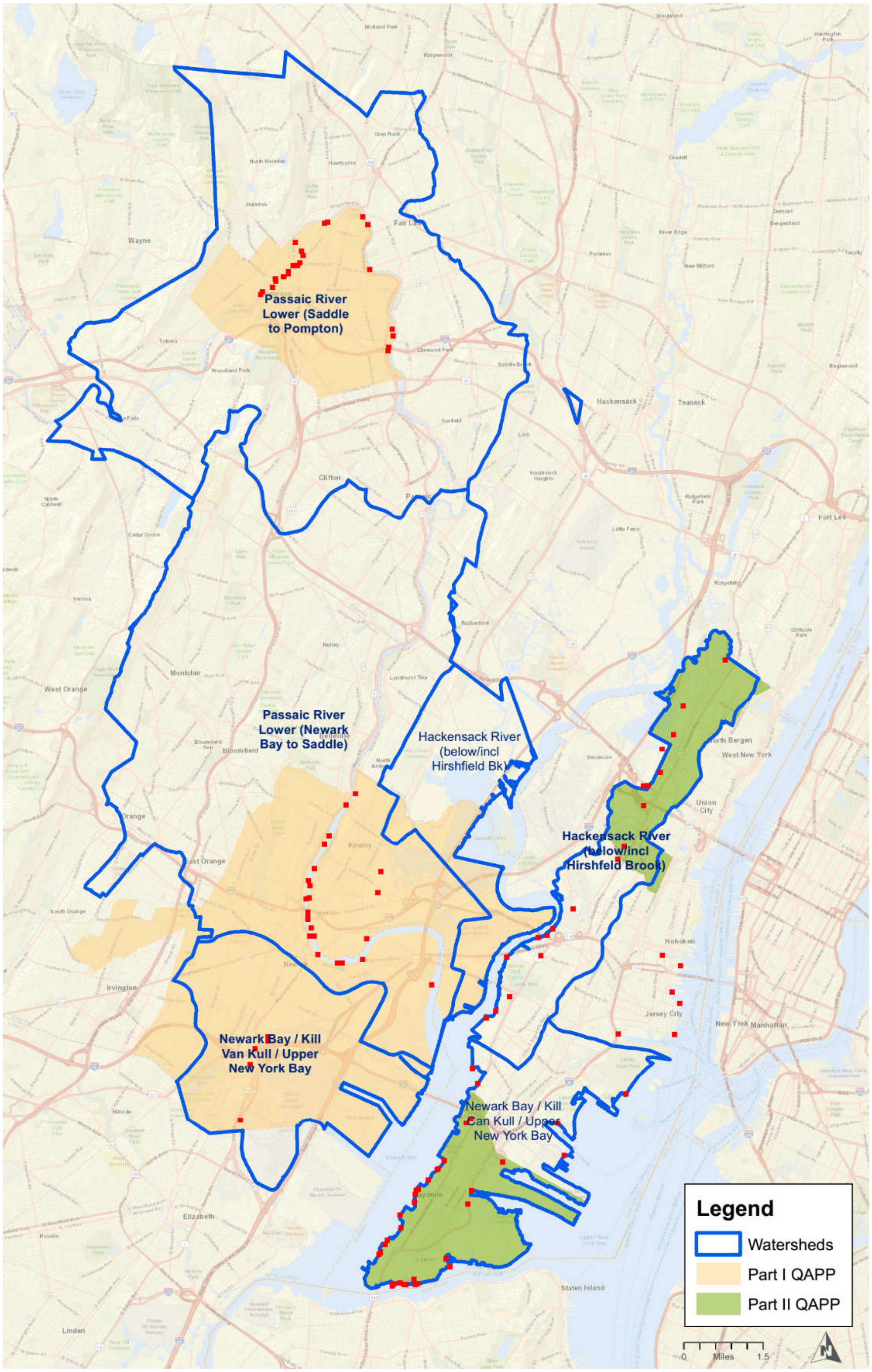

Figure B-1: PVSC Treatment District Watersheds

B.2 POLLUTANTS OF CONCERN IN THE RECEIVING WATERS

B.2.1 Summary of the Identified POCs for Each Receiving Water

Three (3) pollutants of concern ("POCs") were determined to apply to each of PVSC Treatment District's four (4) direct receiving waters. These three (3) POCs are parameters typically associated with CSO discharges, although they may also be associated with sources other than CSOs. The concentrations of these identified POCs in the receiving waters have been further investigated through the receiving water quality monitoring and modeling, subsequently described in the System Characterization Report and in the NJCSO Group Compliance Monitoring Program Report, which were previously submitted to the NJDEP. The NJDEP determined POCs for each of the receiving waters relative to the PVSC Treatment District are listed below:

- Passaic River
  - Fecal Coliform
  - Escherichia coli (E. coli) (fresh water)
  - Enterococcus
- Newark Bay
  - Fecal Coliform
  - E. coli (fresh water tributaries)
  - Enterococcus
- Upper New York Bay
  - Fecal Coliform
  - E. coli (fresh water tributaries)
  - Enterococcus
- Hackensack River
  - Fecal Coliform
  - E. coli (fresh water)
  - Enterococcus

B.3 APPLICABLE WATER QUALITY STANDARDS

B.3.1 NJ Integrated Water Quality Monitoring and Assessment Report (303(d) list)

Section 303(d) of the Clean Water Act requires each state to identify those waters for which effluent limitations are not stringent enough to attain applicable WQS; establish a priority ranking for such waters based on extent of water quality impairment and designated use non-support; establish a total maximum daily load ("TMDL") for each pollutant causing water quality impairment, based on their priority ranking, at a level necessary to attain applicable WQS; and submit a list to USEPA of all impaired waters and their pollutant causes (i.e., the 303(d) List).

NJDEP has established the 2014 New Jersey Integrated Water Quality Assessment Report. The primary source of information regarding causes of impairment, and the TMDL status of the water bodies (if any) is the 2014 New Jersey Integrated Water Quality Assessment Report, which satisfies New Jersey's requirement of both Section 303(d) and 305(b) of the Clean Water Act. The NJDEP Website explains the categories as shown in **Table B-2.**

Table B-2: Components of New Jersey's Integrated List of Water (Integrated List)

Sublist	Component
Sublist 1	An assessment unit is fully supporting all applicable designated uses and no uses are threatened. (The Department does not include the fish consumption use for determining placement on this sublist.)
Sublist 2	The assessment unit is fully supporting the designated use but is not supporting all applicable designated use(s).
Sublist 3	Insufficient data and information are available to determine if the designated use is fully supported.
Sublist 4	One or more designated uses are not supported or are threatened but TMDL development is not required because of one of the following reasons:
Sublist 4A	A TMDL has been completed for the parameter causing designated use non-support.
Sublist 4B	Other enforceable pollutant control measures are reasonably expected to result in fully supporting the designated use in the near future.
Sublist 4C	Non-support of the designated use is caused by something other than a pollutant.
Sublist 5	One or more designated uses are not supported or are threatened by a pollutant(s) that requires development of a TMDL.
Sublist 5A	Arsenic does not attain standards, but concentration are below those demonstrated to be from naturally occurring conditions.
Sublist 5L	Designated use impairment is caused by a "legacy" pollutant that is no longer actively discharged by a point source.
Sublist 5R	Water quality impairment is not effectively addressed by a TMDL, such as nonpoint source pollution that will be controlled under an approved watershed restoration plan or 319(h) Watershed Based Plan.

The Sublist 5 list constitutes the Section 303(d) list that the USEPA will approve or disapprove under the CWA. For the purposes of determining pollutants of concern, Sublists 4A and 5 are the relevant categories as they indicate the need for a TMDL in the receiving water body and the limiting of additional loadings for those parameters.

B.3.2 Interstate Environmental Commission Requirements

With the exception of the City of Paterson, the municipalities and authorities covered by this Regional Alternatives Report fall within the jurisdiction of the Interstate Environmental Commission (the "IEC"). The IEC is a tri-state air and water pollution control agency serving New York, New Jersey, and Connecticut. The IEC and its area of jurisdiction was established in 1936 pursuant to an interstate compact, with the consent of Congress. The IEC establishes the receiving stream WQS to which NJPDES permittees are subject under the federal Clean Water Act[1] and the New Jersey Water Pollution Control Act.[2]

The IEC has specified two (2) classes of waters:[3]

Class A Waters - Class A waters are suitable for all forms of primary and secondary contact recreation and for fish propagation, including shellfish harvesting in designated areas. There are no Class A waters within the receiving waters of the PVSC combined sewer municipalities.

Class B Waters – IEC identified two (2) sub-classes:

- **Class B-1** – the IEC WQS specify that Class B-1 waters remain "Suitable for fishing and secondary contact recreation. They shall be suitable for the growth and maintenance of fish life and other forms of marine life naturally occurring therein, but may not be suitable for fish propagation."
- **Class B-2** – the IEC WQS specify that Class B-2 waters remain: "Suitable for passage of anadromous fish and for the maintenance of fish life in a manner consistent with the criteria established by the general regulations."

The IEC WQS classification zones applicable to the PVSC combined sewer municipalities are shown on **Figure B-2**.

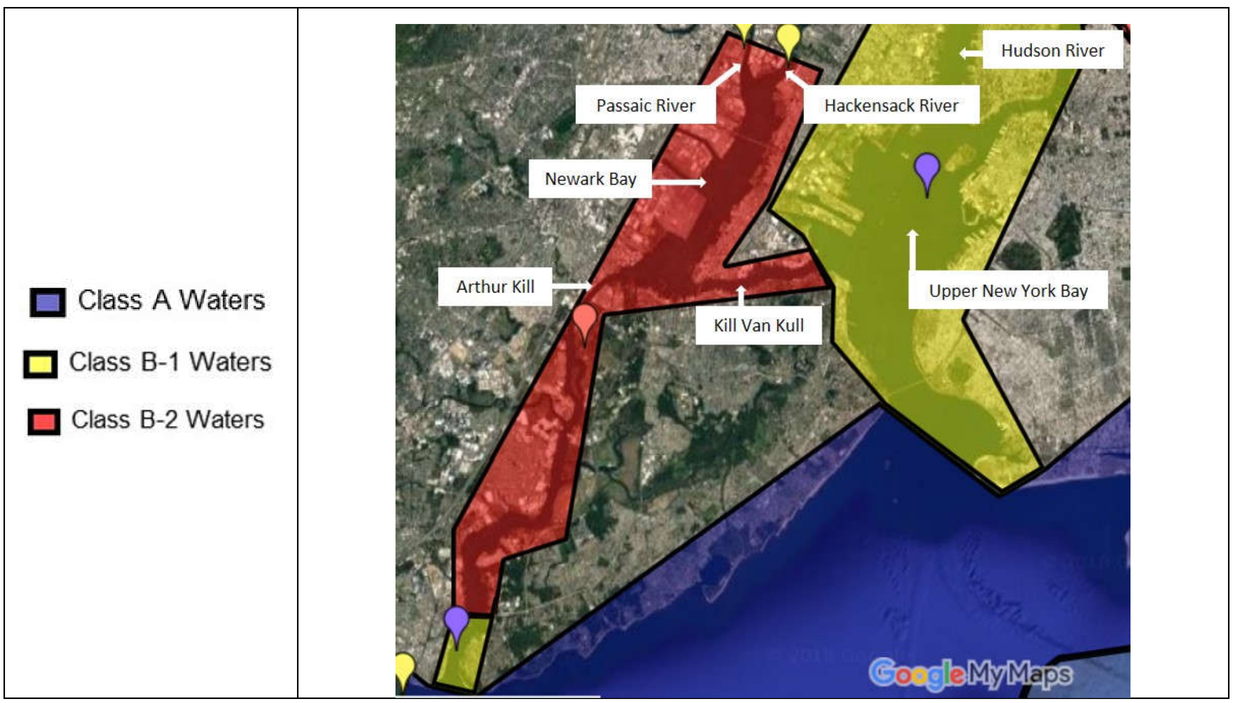

Figure B-2: Interstate Environmental Commission Water Quality Classifications

---

1 33 U.S.C. Chapter 26
2 N.J.S.A 58:10A-1 et seq.
3 Source: IEC website: http://www.iec-nynjct.org/wq.regulations.htm

As shown on **Figure B-2**, the mouth of the Passaic River, the mouth of the Hackensack River, Newark Bay, Kill Van Kull, and Arthur Kill are classified as B-2 waters and the Upper Bay (Hudson River) is classified as B-1. WQS applicable to Class B-1 and Class B-2 waters relevant to CSO discharges are provided in **Table B-3** below.

Table B-3: IEC Water Quality Standards for IEC Class B Waters

<table>
<tr><th>Water Quality Parameter</th><th>Value</th></tr>
<tr><td>Dissolved Oxygen Class B-1</td><td>≥ 4 milligrams per liter</td></tr>
<tr><td>Dissolved Oxygen Class B-2</td><td>≥ 5 milligrams per liter</td></tr>
<tr><td>Dissolved Oxygen Classes B-1 & B-2</td><td>Further, all sewage or other polluting matter discharged or permitted to flow into waters of the District shall first have been so treated as to effect a reduction in the oxygen demand of the effluent sufficient to maintain the applicable dissolved oxygen requirement in the waters of the District and also maintain the dissolved oxygen content in the general vicinity of the point of discharge of the sewage or other polluting matter into those waters, at a depth of about five (5) feet below the surface.</td></tr>
<tr><td>Fecal Coliform (effluent discharges)</td><td>• 200 per 100 ml on a 30 consecutive day geometric average;
• 400 per 100 ml on a 7 consecutive day geometric average;
• 800 per 100 ml on a 6 consecutive hour geometric average; and
• no sample may contain more than 2400 per 100 ml.</td></tr>
<tr><td colspan="2">General Requirements</td></tr>
<tr><td colspan="2">• All waters of the Interstate Environmental District (whether of Class A, Class B, or any subclass thereof) shall be of such quality and condition that they will be free from floating solids, settleable solids, oil, grease, sludge deposits, color or turbidity to the extent that none of the foregoing shall be noticeable in the water or deposited along the shore or on aquatic substrata in quantities detrimental to the natural biota; nor shall any of the foregoing be present in quantities that would render the waters in question unsuitable for use in accordance with their respective classifications.</td></tr>
<tr><td colspan="2">• No toxic or deleterious substances shall be present, either alone or in combination with other substances, in such concentrations as to be detrimental to fish or inhibit their natural migration or that will be offensive to humans or which would produce offensive tastes or odors or be unhealthful in biota used for human consumption.</td></tr>
<tr><td colspan="2">• No sewage or other polluting matters shall be discharged, permitted to flow into, be placed in, or permitted to fall or move into the waters of the District, except in conformity with these regulations.</td></tr>
</table>

The IEC website states:

> *"An effluent discharge which does not satisfy the requirements of the Commission shall not be considered to be in violation thereof if caused by temporary excess flows due to storm water conveyed to treatment plants through combined sewer systems, provided that the discharger is operating the facility with reasonable care, maintenance, and efficiency and has acted and continues to act with due diligence and speed to correct the condition resulting from the storm water flow.*

> *Unless there has been rainfall in greater than trace amounts or significant melting of frozen precipitation during the immediately preceding 24 hours, no discharges to the waters of the Interstate Environmental District shall occur from combined sewer regulating devices."*

Additional information relating to the applicable WQS and the current use attainment status of the receiving waters is provided in the System Characterization Report.

B.3.3 New Jersey Administrative Code

New Jersey Administrative Code ("NJAC") Section 7:9B (Surface Water Quality Standards) lists the classifications, designated uses, and water quality criteria for all New Jersey water bodies. The classification and WQS for the CSO receiving waters within the PVSC CSO Sewer District are shown in **Table B-4** below.

Table B-4: The NJ Administrative Code Classifications of PVSC Treatment District CSO Receiving Waters

Waterbody	Reach	Classification
Passaic River	Paterson - Outlet of Osborn Pond to Dundee Lake dam	FW2-NT
	Little Falls - Dundee Lake dam to confluence with Second River	FW2-NT/SE2
	Newark (@ Second River)	SE3
Hackensack River	Kearny Point	SE3
Hudson River	Englewood Cliffs	SE2
Kill Van Kull	Kill Van Kull	SE3
Newark Bay	Newark Bay	SE3

Classification	Designated Use(s)	Indicator Bacteria	Criteria (per 100 ml)
FW2-NT (Fresh Water Non Trout)	1. Maintenance, migration and propagation of the natural and established biota; 2. Primary contact recreation; 3. Industrial and agricultural water supply; 4. Public potable water supply after conventional filtration treatment (a series of processes including filtration, flocculation, coagulation, and sedimentation, resulting in substantial particulate removal but no consistent removal of chemical constituents) and disinfection; and	E. Coli	126 GM, 235 SSM

Classification	Designated Use(s)	Indicator Bacteria	Criteria (per 100 ml)
	5. Any other reasonable uses.		
SE2 (Saline Water)	1. Maintenance, migration and propagation of the natural and established biota; 2. Migration of diadromous fish; 3. Maintenance of wildlife; 4. Secondary contact recreation; and 5. Any other reasonable uses.	Fecal Coliform	770 GM
SE3 (Saline Water)	1. Secondary contact recreation; 2. Maintenance and migration of fish populations; 3. Migration of diadromous fish; 4. Maintenance of wildlife; and 5. Any other reasonable uses.	Fecal Coliform	1500 GM

* *"The geometric mean (GM) shall be calculated using a minimum of five (5) samples collected over a thirty-day period"*

A map showing the administrative classifications for all of the waterbodies is found below as **Figure B-3.**

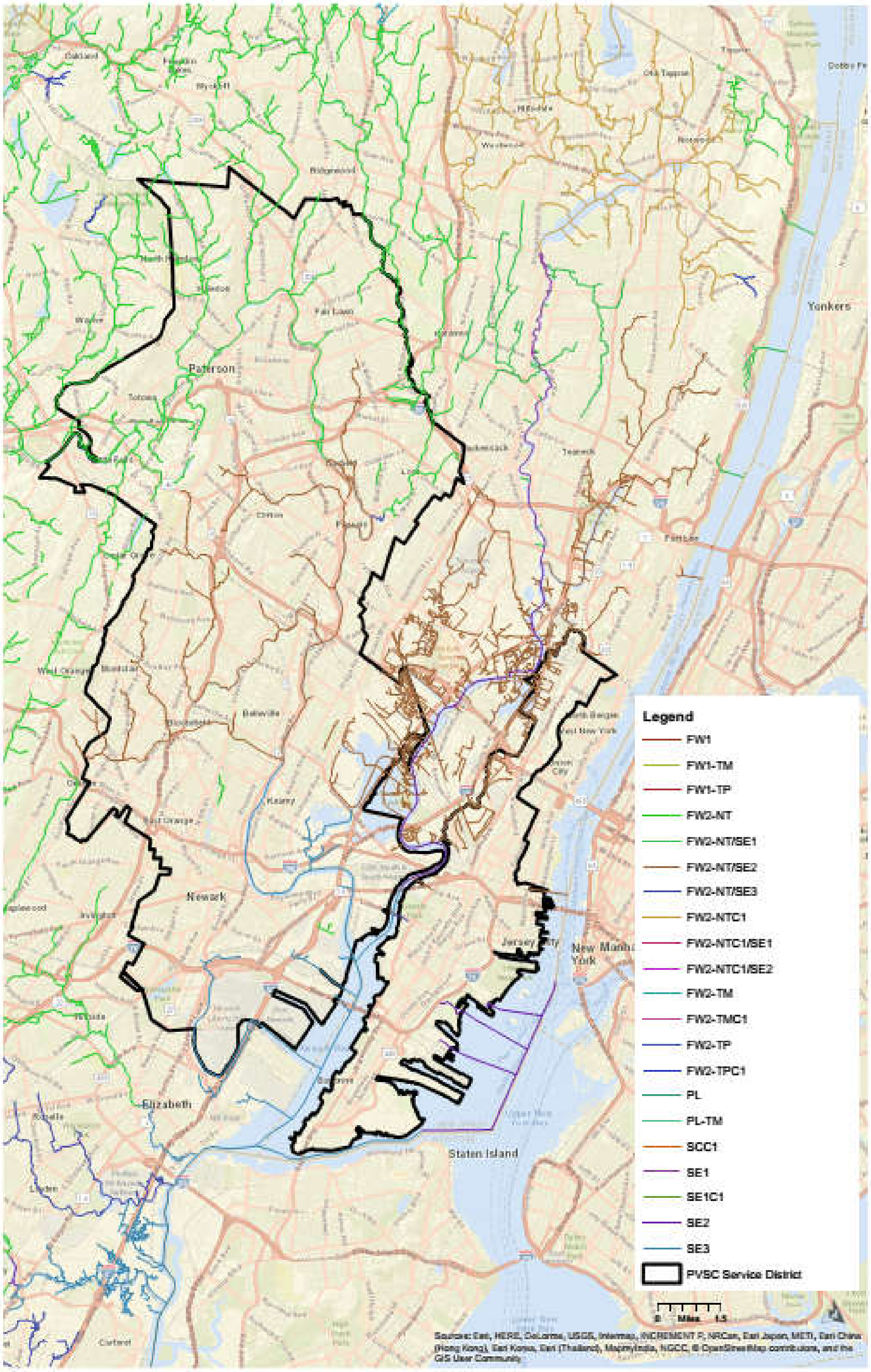

Figure B-3: Administrative Classifications of PVSC Treatment District Waterbodies

SECTION C - DESCRIPTION OF CSO CONTROL TECHNOLOGIES

C.1 INTRODUCTION

This section of the report focuses on the technology screening process and the evaluation of CSO control alternatives as per the requirements of the NJPDES Permit for the following Municipalities shown in **Table C-1**.

Table C-1: NJPDES Permit Numbers

Municipality	NJPDES #
PVSC	NJ0021016
Borough of East Newark	NJ0117846
Town of Harrison	NJ0108871
Town of Kearny	NJ0111244
City of Newark	NJ0108758
City of Paterson	NJ0108880
City of Bayonne	NJ0209240
North Bergen MUA	NJ0108898
Jersey City MUA	NJ0108723

In order to determine the appropriate combined sewer overflow control technologies, a review of Combined Sewer Overflow (CSO) technologies was completed to determine those technologies that have the greatest potential to meet the requirements of the NJPDES Permit. This screening of technologies is consistent with the requirements of the CSOs Control Policy Section II.C.4 and the USEPA's "Guidance for Long Term Control Plan." The Alternatives Evaluation shall consist of:

- Technology Screening Process
- Evaluation of Specific CSO Control Alternatives

This screening of technologies does not consider cost or the cost effectiveness, and is only meant to exclude those CSO control technologies not technically or physically appropriate for the PVSC Treatment District. The screening of CSO control technologies has also been presented to the public at a PVSC Regional Supplemental CSO Team Meeting. Public input received on the screening of CSO control technologies has been reviewed and considered in this evaluation. The results of this screening have brought several CSO control technologies forward for consideration in the development of the LTCP. These control technologies are further discussed in Section D of this report.

C.1.1 Water Quality and CSO Control Goals

With respect to water quality, control technologies are screened for their effectiveness at addressing pollutants of concern and CSO control goals in order to achieve compliance with the

CWA. The control technologies were screened based on the following pollutants of concern and CSO control goals.

- Reducing the count of fecal coliform colonies
- Reducing the count of Enterococcus colonies
- Reducing the count of Escherichia coli colonies
- CSO discharge volume reduction

The above-listed bacteria have been identified as POC applicable to each of PVSC Treatment District's four receiving waters. **Table C-2** through **Table C-7** contain the maximum concentrations, based on the NJAC Section 7:9B Surface Water Quality Standards, for the POC within the Passaic River, Newark Bay, Upper New York Bay, Kill Van Kull, Hudson River, and Hackensack River. The geometric mean (GM) shall be calculated using a minimum of five samples collected over a thirty-day period.

Table C-2: NJ Administrative Code Regarding the Passaic River

Classification	Designated Use(s)	Indicator Bacteria	Criteria (per 100 mL)
FW2	Primary Contact	E. coli	126 GM, 235 SSM
SE2	Secondary Contact	Fecal Coliform	770 GM
SE3	Secondary Contact	Fecal Coliform	1500 GM

Table C-3: NJ Administrative Code regarding the Newark Bay

Classification	Designated Use(s)	Indicator Bacteria	Criteria (per 100 mL)
SE3	Secondary Contact	Fecal Coliform	1500 GM

Table C-4: NJ Administrative Code regarding the Upper New York Bay

Classification	Designated Use(s)	Indicator Bacteria	Criteria (per 100 mL)
SE2	Secondary Contact	Fecal Coliform	770 GM

Table C-5: NJ Administrative Code regarding the Kill Van Kull

Classification	Designated Use(s)	Indicator Bacteria	Criteria (per 100 mL)
SE3	Secondary Contact	Fecal Coliform	1500 GM

Table C-6: NJ Administrative Code regarding the Hudson River

Classification	Designated Use(s)	Indicator Bacteria	Criteria (per 100 mL)
SE2	Secondary Contact	Fecal Coliform	770 GM

Table C-7: NJ Administrative Code regarding the Hackensack River

Classification	Designated Use(s)	Indicator Bacteria	Criteria (per 100 mL)
SE1	Primary Contact	Enterococci	35 GM, 104 SSM
SE2	Secondary Contact	Fecal Coliform	770 GM
SE3	Secondary Contact	Fecal Coliform	1500 GM

The reduction in CSO discharge indirectly addresses the POC found in combined sewer overflows. **Table C-8** presents the baseline existing wet weather percent captured for the PVSC system in the PVSC Interceptor Communities and HCFM communities. This information has been updated as a result of refinements to the H&H model since the submittal of the System Characterization Report, and will continue to change as the model is refined. No significant changes from the System Characterization Report have resulted from the updated model, and JCMUA's information has been added to the HCFM communities.

Table C-8: Typical Year % Capture

	PVSC Interceptor Communities	Hudson County Force Main Communities
Total Wet Weather Volume (MG)	12,495	6,411
Total CSO Volume (MG)	2,042	2,222
% Capture	83.7%	65.3%
Additional Capture Volume (MG) for 85% Capture	168	1,260

The CSO goals mentioned above serve as an initial roadmap to narrow down the best control technologies for utilization during the alternative analysis. **Section C.1.2** describes the evaluation methodology used for the screening of CSO Control Technologies.

C.1.2 Evaluation Methodology Used for this Study

The CSO control technologies evaluated in this section have been assigned a value based on their effectiveness at reaching primary CSO control goals. Descriptions of the goal effectiveness categories are detailed below:

- High: The CSO control technology will have a significant impact on this CSO control goal and is among the best technologies available to achieve that goal. These technologies may be considered for further evaluation for this reason.
- Medium: This technology is effective at achieving the CSO control goal, but is not considered among the most effective technologies to achieve that goal.
- Low: This technology will have a minor impact on this CSO control goal. These technologies will need other positive attributes to be considered for further evaluation.
- None: The CSO control technology will have zero or negative effect on the CSO control goals.

Additionally, the positive impacts that each of the technologies may have on the community beyond achieving the primary goals described above were evaluated.

CSO control technologies will be recommended for further evaluation by each Permittee based on multiple factors. The first factor will be the goal-effectiveness value that generally quantifies the impact a technology will have towards achieving a water quality goal. These goal-effectiveness values are described above. In addition to the goal-effectiveness, identification of the potential community benefits the technology may bring when applied will also be considered. Another factor is whether or not the NJPDES Permit requires investigation of a technology. The permit identifies certain technologies that must be evaluated. The final factor in determining whether a technology will be evaluated as an alternative is the current or future implementation and operation of that technology. If the technology is currently in place, will be implemented, or is mandated by the Nine Minimum Controls, then an evaluation is unnecessary.

Potential CSO control technologies generally fall into the following broad categories:

- **Source Controls:** Green infrastructure ("GI"); public and private infiltration and inflow ("I/I") reduction and removal; sewer separation; and best management practices ("BMPs")/Nine Minimum Controls, including floatables control
- **Collection System Controls:** Gravity sewers; pump stations; hydraulic relief structures; in-line storage; outfall relocation/consolidation; and regulator/diversion structure modification
- **Storage Technologies:** Above and below ground tanks; and tunnels
- **Treatment Technologies:** Screening and disinfection; vortex separation; retention/treatment basins; high rate clarification; and satellite sewage treatment

Table C-9, **Table C-10**, and **Table C-11**, located in Section C.9 Screening of Control Technologies, group technologies based on the broad categories mentioned above and contain a brief description of the implementation and operation factors for each technology. A CSO technology that is highly effective in one or all evaluation factors will likely be recommended for further investigation. A CSO technology that does not reach a "medium" effectiveness in meeting CSO control goals will likely not be recommended for further evaluation.

The "Community Benefits" column in each of the three tables listed above provides a brief list of benefits that the technologies could bring to the community. This list was developed using general knowledge about each of the technologies, the New Jersey DEP Division of Water Quality's report entitled "Evaluating Green Infrastructure: A Combined Sewer Overflow Control Alternative for Long Term Control Plans," and the New Jersey Green Infrastructure Municipal Toolkit website (https://gitoolkit.njfuture.org/). The following discussion is structured to closely follow the order of CSO technologies listed in the NJPDES Permit. A summary of technologies recommended for further investigation for each permittee is provided in their respective Development and Evaluation of Alternatives Reports.

C.2 SOURCE CONTROL

USEPA defines source controls as those that impact the quality or quantity of runoff entering the combined sewer system. Source control measures can reduce volumes, peak flows, or pollutant discharges that may decrease the need for more capital-intensive technologies downstream in the CSS. However, source controls typically require a high level of effort to implement on a scale that can achieve a measureable impact. Source controls discussed in the following section will include both quantity control and quality control measures.

C.2.1 Stormwater Management

Stormwater management controls consist of measures designed to capture, treat, or delay stormwater prior to entering the CSS.

C.2.1.1 Street/Parking Lot Storage (Catch Basin Control)

Street and parking lot storage can be accomplished by modifying catch basins to restrict the rate of stormwater runoff that enters the CSS. A portion of the stormwater runoff that would otherwise immediately enter the CSS is allowed to pond on streets or parking lots for a period of time before entering the CSS. This control measure can be very effective at reducing peak flows during wet weather events, when most CSOs occur. However, this practice typically faces strong public opposition and can lead to hazardous road conditions if not managed properly (e.g., hydroplaning, ice formation during winter months, etc.).

C.2.1.2 Catch Basin Modification (Floatables Control)

Catch basin modifications consist of various devices that prevent floatables from entering the CSS. Inlet grates can reduce the amount of street litter and debris that enters the catch basin. Other modifications such as hoods, submerged outlets and vortex valves alter the outlet pipe hydraulics and keep floatables from exiting the catch basin and continuing downstream. These devices also provide a water seal for containing sewer gas. The success of a catch basin modification program is dependent on having catch basins with sumps deep enough to install hood-type devices. A potential disadvantage of catch basin outlet modifications and other insert-type devices is the fact that retained materials could clog the outlet if cleaning is not performed regularly.

C.2.1.3 Catch Basin Modifications (Leaching)

Catch basin modifications for leaching consist of catch basin base and riser sections that permit infiltration of stormwater into the ground. Leaching catch basins are generally installed in a geotextile and crushed stone lined excavation. Leaching catch basin installations are limited to highly permeable soils and should not be installed in series with other drainage structures. Leaching catch basins can be installed with or without an outflow pipe. Basins without an outflow can overflow into streets and parking lots and then freeze under excessive storm events or if soils decrease permeability over time. These control measures function much like an infiltration basin without an emergency overflow pipe. In order to avoid this adverse feature, an outflow pipe should be necessary in all leaching modified catch basins unless there is minimal flow to the basin, and a low overflow damage risk to the surrounding area.

C.2.2 Public Outreach Program

Public education and outreach is a non-structural control measure aimed at limiting the negative effects of certain human behavior on the CSS. Promoting certain human actions and discouraging others can impact the quality and quantity of water discharged to the CSS. A collaboration of entities who own and operate combined sewer systems within the PVSC Treatment District and the NBMUA services areas have established the Clean Waterways, Healthy Neighborhoods initiative. The initiative aims to foster public awareness by keeping the public informed of the efforts being taken to reduce the water quality impact of CSOs on the receiving waters in the area. Additional information is available on the following website: https://www.njcleanwaterways.com/.

PVSC's webpage (www.nj.gov/pvsc) provides numerous informational postings related to the CSO LTCP, such as information regarding CSO construction-related activities for each of the permittees within the PVSC Sewerage District. There is also a link to the NJ CSO Group's CSO Notification System. Notices for public meetings, plant tour request forms, as well as the history of and descriptions of PVSC's infrastructure are posted on the website. PVSC also advertises volunteering opportunities and educational outreach programs for kids K-12 on their website. Additionally, the NBMUA webpage (www.nbmua.com) provides a number of postings of information for the public related to the NBMUA-Woodcliff and Town of Guttenberg LTCP. The website includes information on the CSO construction-related activities, a link to the NJ CSO Group's CSO Notification System, as well as notices for public meetings.

A LTCP Facebook and Twitter social media plan was developed to enhance electronic outreach about the LTCP. The PVSC Facebook page provides relevant information about their services and ways that communities can learn more about getting involved with the agency. The page is open for comments and questions, which are answered by PVSC personnel. This allows the agency to showcase transparency and signals a real commitment to public input. Additionally, a Clean Waterways, Healthy Neighborhoods LTCP Facebook page was also developed. The LTCP Facebook page is branded with the Clean Waterways, Healthy Neighborhoods logo. It is updated on a regular basis to keep it fresh and informative, and serves to promote relevant LTCP information, including upcoming events and meetings, project visuals, Supplemental CSO Team and relevant municipal information, and other related news and articles. Both the PVSC Facebook page and the LTCP Facebook page are open to public feedback and comment. The PVSC Facebook page is accessible through the PVSC website and the LTCP Facebook page is accessible through the Clean Waterways, Healthy Neighborhoods website.

As with the Clean Waterways, Healthy Neighborhoods Facebook page, the Twitter page is branded with the Clean Waterways, Healthy Neighborhoods logo and is updated on a regular basis to keep it fresh and informative. The Twitter feed serves to promote relevant LTCP information, including upcoming events and meetings, project visuals, Supplemental CSO Team and relevant municipal information, and other related news and articles. The LTCP Twitter page is also open to public feedback and comment.

The NJ CSO Group was originally formed to work cooperatively to fulfill the requirements of the last CSO General Permit. The group was recently expanded to include more permittees that discharge to the tidally connected waterbodies in the NY/NJ Harbor Estuary. The NJ CSO Group has created a CSO Notification System (njcso.hdrgateway.com/). This system provides up-to-date information regarding where CSO discharges may or may not be occurring.

Additional information on the Public Outreach Program can be found in the Public Participation Process Report, dated June 2018 and last revised January 25, 2019.

C.2.2.1 Water Conservation

Water conservation in CSS areas can reduce the volume of direct discharges to the system. Water conservation measures include the installation of low-flow fixtures, education to reduce water waste, leak detection and correction, and other programs. Although this measure has the potential to decrease CSS flows, it has very little impact on peak flows, which cause most CSOs.

C.2.2.2 Catch Basin Stenciling

Stenciling consists of marking catch basins with symbols and text such as, “Drains to the River” or “Only Rain Down the Storm Drain”. This measure can help increase public awareness of the sewer system and discourage the public from dumping trash into the CSS, which can cause blockages and lead to CSOs. Catch basin stenciling is only as effective as the public’s understanding and input of the program. Catch basin inlet grates have the equivalent effect while not relying on public cooperation.

C.2.2.3 Community Cleanup Program

Community cleanup programs are an inexpensive and effective way to reduce floatables entering the CSS and provide educational benefits to the community. Cleanup activities can be organized by local businesses, non-profit organizations, and student chapters at all levels. It is a great way to raise the sense of community spirit and environmental awareness.

C.2.2.4 Public Outreach (Public Meetings)

As part of the public outreach program to help raise citizens’ awareness of water quality and other environmental issues, Public Meetings are held to educate citizens about CSS’s and encourage people to do their part to reduce the grease, toxic chemicals, and floatables from entering local waterways. This is currently accomplished through Supplemental CSO Team Meetings (public meetings). Information presented in meetings is available as handouts.

C.2.2.5 FOG Program

Fats, oils and grease (“FOG”) are not water soluble and will buildup and clog sewer and drainage pipes, resulting in messy, costly sanitary sewer overflows. These overflows are bad for commercial and retail businesses, the environment, and public health. FOG programs often consist of food service establishment inspection, installation of Grease Removal Devices (“GRDs”) and development of a preferred pumper program for proper maintenance of GRDs. However, FOG programs have little effect on the amount of bacteria in the collection system and do not provide any flow reductions. PVSC currently has a robust FOG program that permits and inspects all commercial cooking establishments in the State to ensure grease traps are installed and maintained.

C.2.2.6 Garbage Disposal Restrictions

Garbage disposals provide a convenient means for residences and businesses to dispose of food waste. However, the use of garbage disposals increases the amount of food scrap entering the sewer system and is known to cause blockages and decrease the flow capacity in the CSS. Restricting garbage disposal usage has the potential to decrease the number of blockages that occur each year. Garbage disposal restrictions require an increased allocation of resources for enforcement and can face considerable public resistance. Furthermore, this practice does very little to reduce wet weather CSO events or decrease bacteria loads.

C.2.2.7 Pet Waste Management

When pet waste is not properly disposed of, it can be carried away by stormwater runoff and washed into storm drains or nearby streams. Since storm drains do not always connect to treatment facilities, untreated animal feces often end up in waterways, causing significant water pollution. An effective pet waste management program can help increase public awareness and encourage proper waste disposal. This is a low cost, long term program that has the potential to reduce bacteria loads to both the CSS and directly to local streams.

C.2.2.8 Lawn and Garden Maintenance

Failure to apply chemical treatments to lawns or gardens per USEPA guidelines may lead to ineffective treatment and contamination of the waterways through runoff or groundwater. A public outreach program that explains the guidelines and the reasons they exist may help reduce waterway contamination. This information is currently available to the public on the following USEPA website: https://www.epa.gov/safepestcontrol/lawn-and-garden. Runoff that contains chemical treatments can contribute to decreased water quality downstream of the CSS in the receiving waters.

C.2.2.9 Hazardous Waste Collection

Improperly disposed hazardous waste can find its way into stormwater runoff and into storm drains and waterways. Hazardous waste that ends up in waterways does not necessarily end up in a treatment facility and can cause significant surface water pollution. To prevent this, household hazardous waste collection events can be scheduled a few times every year to allow the community to properly dispose of any hazardous waste.

C.2.3 Ordinance Enforcement

C.2.3.1 Construction Site Erosion and Sediment Control

Construction site erosion and sediment control involves management practices aimed at controlling the transport of sediment and silt by stormwater from disturbed land. Erosion and sediment control has the potential to reduce sediment loads to both the CSS and directly to streams, and can help reduce sewer cleanout Operation and Maintenance ("O&M") costs. The N.J.S.A. 4:24-39, NJ Soil Erosion and Sediment Control Act, requires all construction activities greater than 5,000 square feet to complete an application for certification of an erosion and sediment control plan for activities during construction.

C.2.3.2 Illegal Dumping Control

Illegal dumping is the disposal of trash or garbage by dumping, burying, scattering, or unloading trash in an unauthorized place, such as public or private property, streets or alleys, or directly into the CSS. When it occurs, illegal dumping contributes a considerable amount of floatables to stormwater runoff, as well as a moderate amount of bacteria, settleable solids, and other pollutants. Enforcement of illegal dumping regulations is being led by State Park Police & Conservation Officers and the NJDEP Department of Compliance & Enforcement.

C.2.3.3 Pet Waste Control

As described in the previous section, pet waste can be a significant contributor of bacteria to stormwater. Public education and outreach programs can help raise public awareness and reduce the level of improper waste disposal. Additional gains can be made through enforcement of the pet waste ordinances, which can be an effective tool in achieving public compliance. Significant resources would need to be devoted to enforcement to achieve similar improvements to Pet Waste Management, which requires very few resources to implement.

C.2.3.4 Litter Control

Litter consists of waste products that have been disposed of improperly in an inappropriate area. Litter is easily washed into the collection system during wet weather events, which increases the amount of floatables in the system. Strict enforcement of the litter control ordinances can help to curb violations and decrease the amount of floatables that make their way into the CSS. Similar to Pet Waste Control, public outreach and education is a more effective use of resources to achieve similar water quality improvements.

C.2.3.5 Illicit Connection Control

An illicit discharge is any discharge to the municipal separate storm sewer system (MS4) that is not composed entirely of storm water, except for discharges allowed under a NPDES permit or waters used for firefighting operations. Illicit connections can contribute polluted water, solids, and trash to the stormwater system, where it is eventually discharged to the environment without receiving proper treatment. These connections can be reduced through the implementation of an illicit discharge detection and elimination (“IDDE”) program. Although this measure does not directly target the CSS, it can have significant impacts on local water quality that can help to address Total Maximum Daily Loads. Illicit connection control is not particularly effective at achieving any of the primary goals of the LTCP.

C.2.4 Good Housekeeping

C.2.4.1 Street Sweeping/Flushing

Municipal street cleaning enhances the aesthetic appearance of streets by periodically removing the surface accumulation of litter, debris, dust and dirt, which prevents these pollutants from entering storm or combined sewers. Common methods of street cleaning are manual, mechanical and vacuum sweepers, and street flushing. However, the total public area accessible to street sweepers is limited, and generally does not include sidewalks, traffic islands, and congested street parking areas. Although street sweeping/flushing can reduce the concentration of floatables and pollutants in storm runoff that originate from the street, the measure has minimal impact on bacteria or CSO volume reduction.

C.2.4.2 Leaf Collection

Leaf collection is an important part of stormwater management because it not only keeps leaves out of the stormwater system to maintain its maximum flow capacity, but also benefits water quality by reducing nutrients such as phosphorous and nitrogen that can originate from the decomposition of leaves. In most municipalities, this long term stormwater management measure is scheduled based on seasonal patterns, and is an effective tool to maintain capacity in both the separate storm sewer and the CSS.

C.2.4.3 Recycling Programs

Recycling programs provide a means for the public to properly dispose of items that may otherwise end up entering the CSS, such as motor oil, anti-freeze, pesticides, animal waste, fertilizers, chemicals, and litter. These programs are usually effective in reducing floatables and toxins.

C.2.4.4 Storage/Loading/Unloading Areas

Industrial and commercial users would be required to designate and use specific areas for loading and unloading operations. This would concentrate the potential for loading and unloading related waste to a few locations on site, making it easier to manage waste. The effectiveness of this technology is limited to the number of industrial users upstream of CSO regulators. If there are no industrial users in the CSS, then this is technology is not applicable.

C.2.4.5 Industrial Spill Control

Industrial users would be required to utilize spill control technologies like containment berms and absorbent booms to mitigate the risk of contaminants entering the waterway or collection system. Similar to Storage/Loading/Unloading Areas, the effectiveness of this technology is limited to the number of industrial users upstream of CSO regulators.

C.2.5 Green Infrastructure

GI is a source control that uses natural processes such as infiltration, evapotranspiration, filtration, storage, and controlled release to reduce the stormwater volume, peak flows, or pollutant loads entering the sewer system or surface waters. A wide range of GI technologies are currently in use throughout the country and include pervious paving, bioretention basins, vegetated swales, green roofs, blue roofs, and rainwater harvesting. These technologies can be used alone in a scalable manner, or in conjunction with gray infrastructure to reduce the size and cost of gray infrastructure.

GI's benefits extend beyond reducing the flow of water into CSSs during wet weather events. By mimicking a more naturalized system, GI can deliver a broad range of ecosystem services or benefits to people, some of which include: improvements to community livability (aesthetics and property values), human health, air quality, water quality, groundwater recharge, wildlife habitats and connectivity, reduced heat island effects, reduced energy use, increased green jobs, and more recreational opportunities (USEPA, 2014). As described in Greening CSO Plans: Planning and

Modeling Green Infrastructure for Combined Sewer Overflow (CSO) Control (USEPA, 2014), the USEPA requires that any incorporation of GI into a LTCP include analysis in two areas:

1. Community and political support for GI
2. Realistic potential for GI implementation

PVSC and the Permittees will assess the public support for GI and other CSO control alternatives through the implementation of the LTCP Public Participation Plan. This includes hosting quarterly public meetings with the Clean Waterways, Healthy Neighborhoods Supplemental CSO Team, participating in the meetings of various local groups, attending public events, meeting with municipal representatives, and soliciting public input through the Clean Waterways, Healthy Neighborhoods website and social media platforms. The realistic potential for the implementation will first be screened within this report and refined further in the alternatives evaluation.

There are a wide range of potential GI technologies currently in use throughout the country, and many of these include numerous design variations incorporated into a variety of documents and design manuals. The intent of this section is to summarize important aspects of the relevant practices, rather than to provide a comprehensive catalog or detailed design documents.

In addition, there are watershed-scale GI options that are not appropriate for **PVSC Treatment District** due to highly urbanized nature of the CSS area or improper resources to maintain the technology. These include land conservation efforts and creation, preservation, or restoration of riparian buffers, flood plains, wetlands, open space, and forests. These GI options should be encouraged when land use can easily be converted for this intention with minimal upkeep, but this report will not consider these technologies to reduce runoff volume and bacterial loading. With the above considerations in mind, feasible and appropriate GI technologies were evaluated for implementation in buildings, impervious areas, and pervious areas in **PVSC Treatment District** publically-owned property.

C.2.5.1 Green Roofs

Green roofs have bioretention media that collect runoff to promote evapotranspiration and achieve WQS through soil media filtration. They are typically shallow in depth (4-8”) based on the ability of the building to support the weight of the media, plantings, and captured rainfall. Green roofs may be built in layers on a roof or installed as cells in crates. An example green roof section can be found in **Figure C-1**.

Green roofs are recommended for use on buildings with flat roofs (recommended 1-2% slope) that have the structural capacity to support the weight of the media, plantings, and water. Structural improvements to an existing building to support the additional weight associated with a green roof are not typically recommended; therefore this technology is more feasible on new construction. Green roofs can be installed in a section or across an entire roof. An overflow system is typically installed. The vegetation may require irrigation during the first 1-2 years to establish growth. Recommended maintenance for green roofs includes semi-annual maintenance of vegetation.

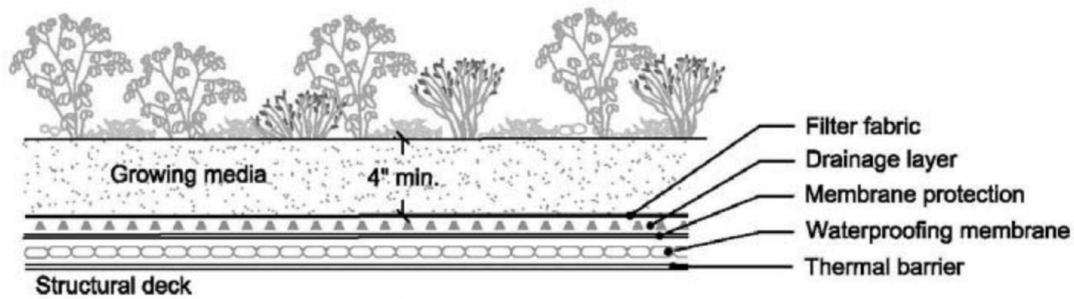

Figure C-1: Example Green Roof Section

Many rooftop retrofits are required for this GI technology to have measureable impact. Most of the buildings in the CSS are privately owned. Implementing this technology on a scale that would have a measureable impact would require retrofits on private property.

C.2.5.2 Blue Roofs

Blue roofs collect runoff to promote evaporation (they do not have plantings) through detention. They are typically shallow in depth (4-8") based on the ability of the building to support the weight of the media and captured rainfall. Blue roofs may be built in layers on a roof or installed as cells in crates. Unlike green roofs, a blue roof may not provide any water quality benefits, unless filters or storage media are used specifically for this purpose. The water detained from blue roofs may be used on-site instead of being released with the appropriate modifications.

Blue roofs are recommended for use on buildings with flat roofs (recommended 1-2% slope) that have the structural capacity to support the weight of the media and water. Structural improvements to an existing building to support the additional weight associated with a blue roof are not typically recommended; therefore this option is more feasible on new construction. Blue roofs can be installed in a section or across an entire roof. An overflow system is typically installed to direct the detained water off of the roof. Recommended maintenance for blue roofs includes semi-annual maintenance for clearing of debris.

Similar to green roofs, blue roofs would require implementation on private property to have a measureable impact.

C.2.5.3 Rainwater Harvesting

Rainwater harvesting is the collection and storage of rainfall from buildings to delay or eliminate runoff. The reduction in runoff volume varies based on the size of the rain barrel or cistern storage unit, and the reuse of the stored rainfall. A few typical reuse options are irrigation and vehicle washing. Indoor reuse options, such as toilet flushing and heating and cooling, may be possible if coordinated with building policies.

Rainwater harvesting is applicable to all types of buildings with gutters and downspouts but may be reserved for buildings where green or blue roofs are not appropriate (roof slopes greater than 2%). Storage units may be sized and installed for each downspout or for the building as a whole. Rain barrels, such as those in **Figure C-2**, are typically used for residential installations and larger cisterns are typically used for non-residential applications. They are typically placed at grade but can be buried below grade if a pumping system for water reuse is provided. An overflow system is typically installed. Recommended maintenance for rainwater harvesting includes semi-annual maintenance for clearing of debris in the piping or storage unit.

Figure C-2: Example Rain Barrels

Similar to green and blue roofs, this technology is limited by the number of available roofs, most of which are private. Private residential uses of cisterns are much less common than on private commercial properties, but are encouraged to help reduce combined sewer overflows.

C.2.5.4 Permeable Paving

Permeable pavements promote runoff infiltration and rely on a permeable substrate (engineered soils) to store runoff and remove pollutants. There are different types of permeable pavements, most commonly constructed with asphalt, concrete, or pavers. Permeable asphalt and concrete are similar to traditional mixes except that the amount of fine aggregates is reduced or eliminated. Permeable pavers are individual paver units laid together to create a paved surface. The depth of the permeable substrate, anywhere from 3-10 feet, will have the largest impact on runoff volume reduction. Substrate design may incorporate stormwater retention chambers to increase storage volume. Underdrains may be necessary depending on the local soil types, depth of substrate, and groundwater elevation.

Permeable pavements are recommended for low traffic and low speed traffic areas such as sidewalks, parking lanes, parking lots, driveways, and alleys**. Figure C-3**, **Figure C-4**, and **Figure C-5** show slightly different permeable pavement details for each of these surfaces. Recommended maintenance for permeable pavement includes semi-annual inspection and vacuuming. Preventative maintenance is also necessary to minimize the introduction of soil and other fine particles that could clog the pavement pores.

This GI technology can be very effective when implemented in parking lots, parking lanes, and narrow sidewalks where planter boxes cannot be implemented.

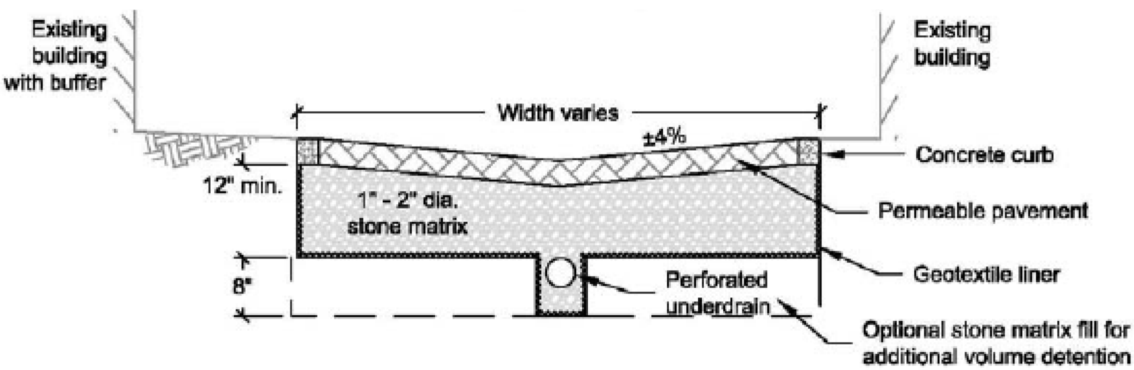

Figure C-3: Example Permeable Pavement Design near Existing Buildings

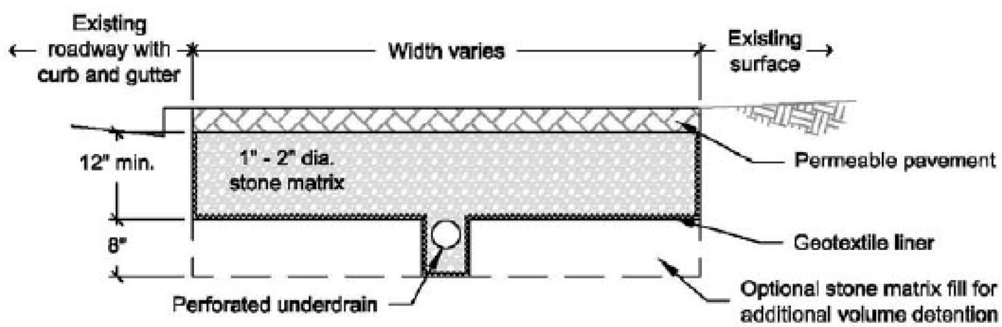

Figure C-4: Example Permeable Pavement Design near Existing Roadway and Surface

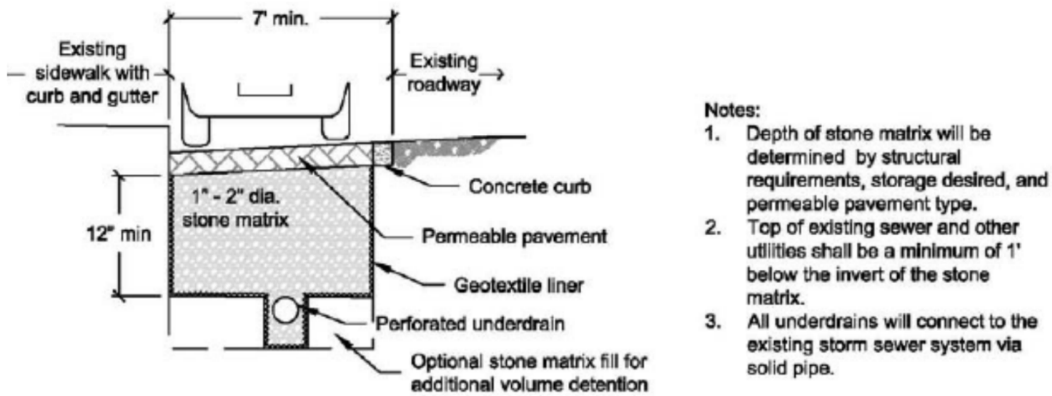

Figure C-5: Example Permeable Pavement Design near Existing Roadway and Sidewalk

C.2.5.5 Planter Boxes

Planter boxes are bioretention cells that collect runoff and promote runoff infiltration. These walled units are similar to free-form rain gardens as vegetated depressions (12-24") that rely on ponding and a permeable substrate (engineered soils) to store runoff and remove pollutants. The depth of the permeable substrate, anywhere from 3-10 feet, will have the largest impact on runoff volume reduction. An Example Planter Bumpout Section can be found in **Figure C-6**. Substrate design may incorporate stormwater retention chambers to increase storage volume. Properly designed planter boxes limit ponding to 3-6 hours after a storm. Ponding overflow pipes and/or underdrains may be necessary depending on the local soil types, depth of substrate, and groundwater elevation. The vegetation promotes evapotranspiration to reduce the volume of the stored runoff.

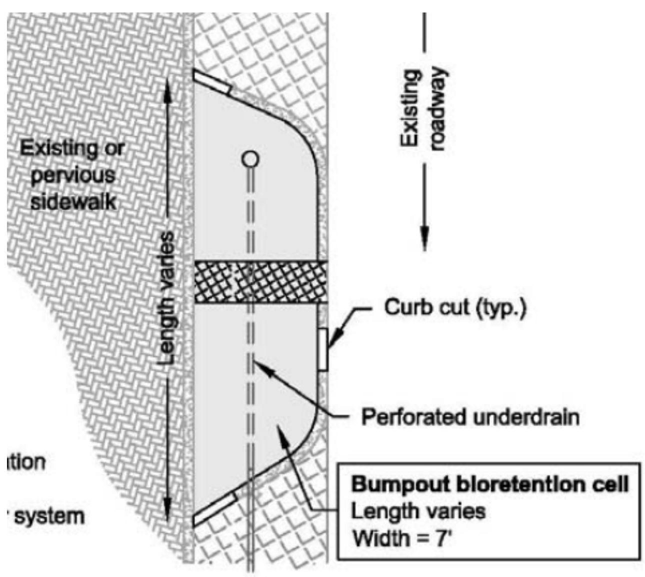

Figure C-6: Example Planter Bumpout Section

There are two (2) primary sizes of planter boxes for use based on the drainage pattern in developed areas: sidewalk planter boxes and bumpout planter boxes. Sidewalk planter boxes may also be more specifically referred to as a Tree Well BMP, a Tree Well with Soil Panels, a Continuous Planting Strip, Mid-Sidewalk BMP, or a Back of Sidewalk BMP. Sidewalk planter boxes are depressed below the elevation of the existing sidewalk. Bumpout planter boxes are larger units that extend from the sidewalk curb into an area of a parking lane. An example of this design can be found in **Figure C-6**. Curb cuts into planter boxes allow roadway runoff to enter the cells and overflow to street inlets once the maximum ponding depth has been reached. Planter boxes are recommended for use in regularly spaced intervals in the downstream drainage path in areas of impervious cover.

Recommended maintenance for planter boxes includes semi-annual inspections and improvements to vegetation and mulch, and annual inspection of overflow pipes and underdrains, if applicable. Inspection after a large storm is also recommended. If there is evidence of ponding after 48 hours, mulch replacement or overflow pipe cleaning may be necessary.

Planter boxes are well suited for highly developed areas where space allows. They can be installed block by-block to contain, infiltrate, and evapotranspirate stormwater runoff.

C.2.5.6 Bioswales

Bioswales are vegetated channels that reduce runoff velocity and promote runoff infiltration. These are linear channels with shallow depressions (6-12") that incorporate vegetation and a permeable substrate (engineered soils). As a channel, runoff not infiltrated does not pond, but flows through the swale and is conveyed elsewhere. The channels, especially those with slopes greater than 6%, may incorporate check dams to assist in reducing runoff velocity and promote infiltration and pollutant removal. A design example for a bioswale is found in **Figure C-7**.

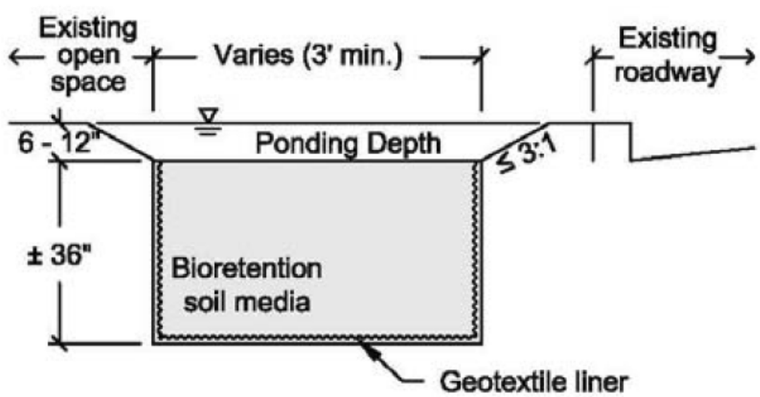

Figure C-7: Example Bioswale Design

Bioswales are recommended for use in parks and areas of natural cover since they primarily reduce runoff velocity and have a low volume reduction per square foot. Due to their linear nature, bioswales may also be effective in the buffer between open space areas and impervious areas with high volumes of runoff such as roads and parking lots. Recommended maintenance for bioswales includes semi-annual inspections and improvements to vegetation and mulch.

This technology incorporates both stormwater treatment and stormwater conveyance. While not as flexible as planter boxes, there may be locations in within the community where a bioswale could be effective.

C.2.5.7 Free-Form Rain Gardens

Rain gardens are bioretention basins that collect runoff and promote runoff infiltration. These are vegetated depressions (12-24”) that rely on ponding and a permeable substrate (engineered soils) to store runoff and remove pollutants. The size and shape of rain gardens can be tailored to site-specific needs, but the depth of the permeable substrate (anywhere from 3-10 feet) will have the largest impact on runoff volume reduction. Substrate design may incorporate stormwater retention chambers to increase storage volume. Properly designed rain gardens limit ponding to 3-6 hours after a storm. Ponding overflow pipes and/or underdrains may be necessary depending on the local soil types, depth of substrate, and groundwater elevation. The vegetation promotes evapotranspiration to reduce the volume of the stored runoff, and infiltration helps improve water quality. An example of a free-form rain garden design is found in **Figure C-8**.

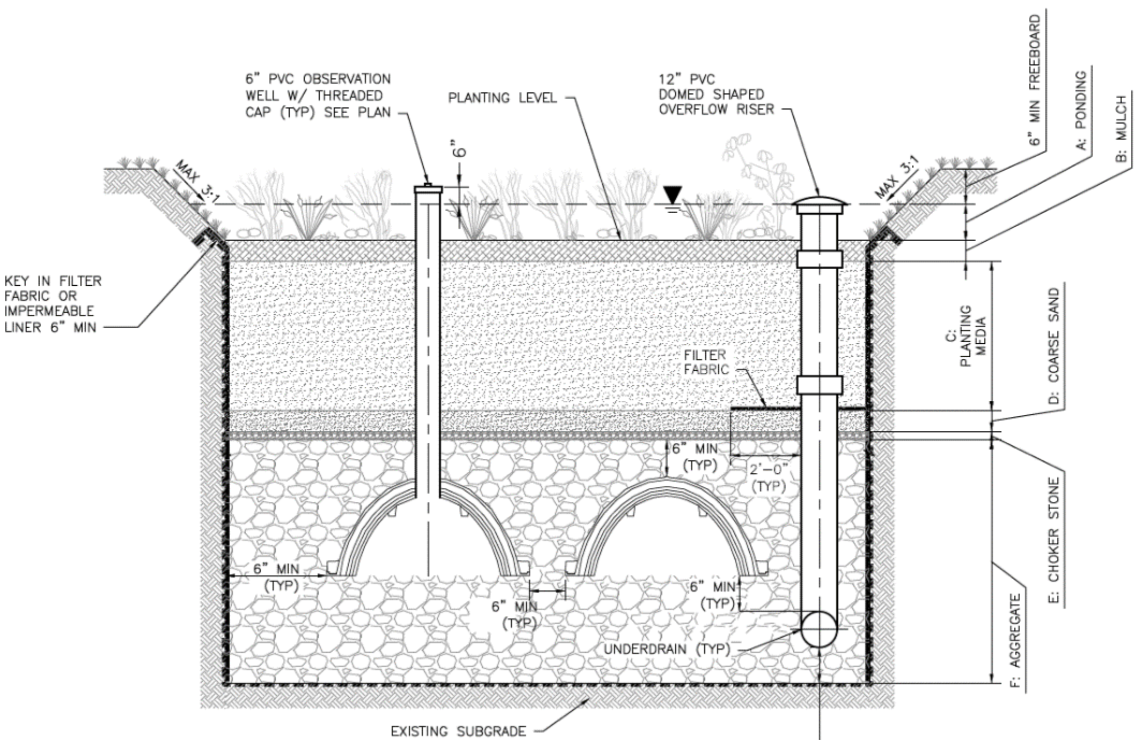

Figure C-8: Example Free-Form Rain Garden Design

Rain gardens are recommended for use in low points in parks and areas of natural cover so they can blend in seamlessly with a grassed buffer and enhance the vegetation without appearing to be a stormwater control mechanism. Locations near the transition from pervious to impervious cover can provide runoff reduction for nearby impervious areas.

Recommended maintenance for rain gardens includes semi-annual inspections and improvements to vegetation and mulch and annual inspection of overflow pipes and underdrains, if applicable. Annual inspection after a large storm is also recommended. If evidence of ponding exists after 48 hours, mulch and/or soil replacement or overflow pipe cleaning may be necessary.

Rain gardens are very effective at capturing and treating stormwater and have versatile footprints that make them advantageous for use in highly developed urban environments.

C.3 INFILTRATION AND INFLOW CONTROL

Infiltration and inflow control falls under the USEPA category collection system controls. Collection system controls are defined as measures that reduce CSO volume and frequency by removing or diverting stormwater runoff to maximize the capacity of the collection system. Collection system controls have the potential to reduce the volume of CSO events.

C.3.1 Infiltration Inflow (I/I) Reduction

Excessive infiltration and inflow can consume the hydraulic capacity of a collection system and increase overall operations and maintenance costs. Inflow comes from sources such as roof drains, manhole covers, cross connections from storm sewers, catch basins, and surface runoff. Within a CSS, surface drainage is the primary source of inflow. Infiltration comes from groundwater that seeps in through leaking pipe joints, cracked pipes, manholes, and other similar sources. The flow from infiltration tends to be constant, but at a lower volume than that of inflow.

Identifying I/I sources is labor intensive and requires specialized equipment. Significant I/I reductions can also be difficult and expensive to achieve. However, the benefit of a good I/I control program is that it can save money by extending the life of the system, reducing the need for expansion, and lowering treatment costs. I/I reduction for combined sewers provides limited gains, since water tends to find another way into the system. However, I/I reductions in sanitary sewers can have significant impacts on increasing the available capacity in the downstream CSS.

C.3.2 Advanced System Inspection and Maintenance

System inspection and maintenance programs can provide valuable knowledge about the condition of the CSS infrastructure, which is beneficial for planning, inspection, and maintenance activities. This can help ensure design flow capacity is consistently available to prevent CSO events. This technology offers relatively minor advances towards meeting the primary and secondary goals of the LTCP.

C.3.3 Combined Sewer Flushing

This type of O&M practice re-suspends solids that have settled in the CSS and flushes them downstream. This practice consists of introducing a controlled volume of water over a short duration at key points in the collection system using external water from a tank truck, pressurized feed, or by detaining the CSS flow for a period, and then releasing it. Overall, this practice helps reduce the amount of settled solids that are resuspended and discharged during significant wet weather events. This measure is most effective when applied to flat collection systems since solids are more likely to become deposited on flat grades.

C.3.4 Catch Basin Cleaning

Catch basin cleaning reduces the transport of solids and floatables to the CSS by regularly removing accumulated catch basin deposits. Methods to clean catch basins include manual, bucket, and vacuum removal. Catch basin cleaning can be effective in reducing floatables in combined sewer; however, it is not effective at bacteria reduction or volume reduction, nor is it particularly effective at biochemical oxygen demand ("BOD") reduction.

C.4 SEWER SYSTEM OPTIMIZATION

Sewer system optimization involves collection system controls and modifications that affect CSO flows and loads once the runoff has entered the collection system. Options for system optimization include measures that maximize the volume of flow stored in the collection system or maximize the capacity of the system to convey flow to the treatment plant. Sewer system optimization techniques have no impact on water quality, but do have the potential to reduce the volume of CSO events.

C.4.1 Increased Storage Capacity in the Collection System

Options for increased storage capacity rely on maximizing the volume of flow stored in the collection system or increasing the conveyance capacity of the system. Maximizing the use of the existing system involves ongoing maintenance and inspection of the collection system, and can include minor modifications/repairs to existing structures to increase the volume of flow retained in the system. Increasing conveyance capacity is typically achieved by providing additional conveyance pipes or upsizing the existing conveyance system to handle a greater capacity.

C.4.1.1 Additional Conveyance

Conveyance is a technology that transports the combined sewage out of a particular area to a location where the flow can be stored, treated, or discharged where direct public contact with the water is less likely. Conveyance is accomplished by providing additional conveyance pipes or upsizing the existing conveyance pipe to a greater capacity. This practice can effectively reduce overflow volume and frequency in the affected areas. Large conveyance projects can be expensive and may require a lengthy permitting process.

C.4.1.2 Regulator Modifications

A CSO regulator can be uniquely configured to control combined sewer overflow frequency and volume. The existing regulators may be modified based on site-specific conditions. Regulator modifications can include adjusting gate control logic, increasing conveyance between the regulators and interceptor through pipe or regulator modifications, or increasing the overflow weir height. This technology is especially effective for CSO outfalls with high overflow frequency and low overflow volume, because the additional volume held back in the system is small and less likely to have negative impacts on upstream conditions.

C.4.1.3 Outfall Consolidation/Relocation

Consolidation of one or multiple outfalls can help eliminate CSO discharges in sensitive areas. Outfall consolidation may require modification or relocation of an outfall, the installation of additional conveyance to accommodate new flow configurations, and may also require additional permitting with government agencies. This practice typically lowers O&M requirements for the CSS by limiting the number of outfall structures that need to be monitored. Outfall consolidation works best in areas where outfalls are located in close proximity to each other and require limited additional conveyance. Similar to regulator modifications, outfall consolidation is especially effective at reducing high frequency, low volume CSOs. This practice typically doesn't add a significant amount of extra capacity to the CSS (depending on the amount of conveyance pipe associated with the consolidation project), so its impact on infrequent, large volume CSO events can be limited. The H&H model can determine the level of impact that outfall consolidation will have in terms of reducing the number of CSO events.

C.4.1.4 Real Time Control

Real Time Control ("RTC") is a highly automated system in which sewer level and flow data are measured at key points in the sewer system and used to provide system control to maximize the storage capacity of the CSS and limit CSO events. The collected data is typically transferred to a control device where program logic is used to operate gates, pump stations, inflatable dams and other control components. Local dynamic controls are used to control regulators to prevent flooding and system wide dynamic controls are used to implement control objectives, such as maximizing flow to the treatment plant or transferring flows from one portion of the CSS to another to fully utilize the system. Predicative control, which incorporates use of weather forecast data, is an optional feature, but it should be noted that it is complex and requires sophisticated operational capabilities. Additionally, it is important to note that RTC involves the installation of numerous mechanical control, which require upkeep and maintenance, and can only reduce CSO volumes where in-system storage capacity is available.

C.5 STORAGE

The objective of storage is to reduce overflows by capturing and storing wet weather flows, greater than CSS conveyance/treatment plant capacity, for controlled release back into the system once treatment and conveyance capacity have been restored. A storage facility can attenuate peak flows in the CSS and provide a relatively constant flow into the treatment plant after peak events. Storage technologies do not prevent water from entering the CSS or treat bacterial loads in CSO discharge, but are effective at reducing or eliminating CSO events. Storage technologies typically have high construction and O&M costs compared to other CSO control technologies, but are a reliable means of achieving CSO control goals.

C.5.1 Linear Storage

Linear storage is provided by underground storage facilities that are sized to detain peak flows during wet weather events for controlled release back into the system after the event. In-line linear storage (storage in series with the CSS) can be provided by over-sizing the existing interceptors for conveyance, as described in the previous section, whereas off-line linear storage (storage parallel to the CSS) can be provided by installing new facilities such as tunnels and pipelines.

C.5.1.1 Pipelines

Large diameter parallel pipelines or conduits can provide significant storage in addition to the ability to convey flow. Pipelines are typically constructed between an overflow point and a pump station or treatment facility. The pipelines include discharge controls to allow flow to be stored within the pipeline during wet weather events, and slowly released by gravity following the event. The pipelines' conveyance to the desired endpoint depends on the additional capacity necessary to handle the increased flow and is developed concurrently with the pipeline. A force main pipeline constructed from a pump station relies heavily on the increased flow capacity as the storage benefits are negligible. Pipelines have the advantage of requiring less area for construction compared to point storage. If trenchless technologies can be utilized, such as horizontal directional drilling (HDD), land requirements can be reduced even further.

A disadvantage of pipelines is that a larger volume is typically required to accommodate combined sewer storage needs. The installation of large diameter pipelines is typically less cost effective than tunneling, and the installation of smaller diameter pipes typically requires a significant length in order to provide adequate storage. Additionally, the installation of pipelines is very disruptive, typically requiring open trenches and the temporary closure of public streets.

C.5.1.2 Tunnels

Tunnels provide large storage volumes, while maintaining the ability to convey flow. Tunnel excavation is accomplished completely underground, and therefore results in minimal surface disruption and requires little right-of-way, outside of drop shafts and conveyance piping to the drop shafts. Overall costs for tunnels can be high, but their cost per million gallons of storage can be fairly reasonable compared to other storage technologies, depending on local geology. Tunnels are typically used in congested urban areas where available land is scarce and connections to most, if not all, of the CSO regulators can be made.

C.5.2 Point Storage

Point storage can be provided by above-ground or underground storage facilities such as tanks and equalization basins. These off-line facilities are placed at specific points in the system to detain peak flows for controlled return back to the system, reducing CSO discharge volume and bacterial loading.

C.5.2.1 Tanks

This technology reduces overflow quantity and frequency by storing all or a portion of diverted wet weather combined flows in off-line storage tanks. Stored flows are returned to the interceptor for conveyance to the treatment plant once system capacity becomes available. Storage tanks are generally fed by gravity and the stored flow is typically pumped back to the interceptor after the storm. The benefit of off-line storage tanks is that they are well suited for early action projects at critical CSO outfalls. Storage tanks capture the most concentrated first flush portion wet weather peak flow and help to reduce the downstream capacity needs for conveyance and treatment.

A disadvantage of off-line storage tanks is that they typically require large land area for installation, which may not be available in congested urban areas. Additionally, if the existing sewers are deep, then the storage tank must also be deep, which results in additional construction costs. Operation and maintenance costs can also be high, especially if the application includes provisions for partial treatment and discharge, rather than simple storage and bleed-back to the sewer. Depending on the application, odor problems may also be an issue. However, storage tanks can be a very effective means of CSO control.

C.5.2.2 Industrial Discharge Detention

This technology would require industrial users to build and maintain storage basins to hold industrial discharge during wet weather events and subsequently release it back to the CSS. This would limit the peak wet weather flow to the WRRF. The effectiveness of this technology is limited to the number of industrial users upstream of CSO regulators. If there are no industrial users in the CSS, then this is technology is not applicable.

C.6 SEWAGE TREATMENT PLANT EXPANSION OR STORAGE AT THE PLANT

C.6.1 Additional Treatment Capacity

CSOs can potentially be reduced by increasing the treatment capacity of plant. Other technologies can make use of this increased treatment capacity by providing more flow to the plant instead of CSO outfalls.

C.6.2 Wet Weather Blending

Blending is the practice of allowing portions of the wet weather peak flow to bypass certain treatment facilities at the plant. In blending, wet weather flows are typically routed through primary treatment, allowed to bypass secondary and tertiary treatment, and then recombined with effluent from all processes prior to disinfection and discharge to the environment. This practice may require increasing the capacity of primary treatment and disinfection facilities, but doesn't require the upsizing of secondary treatment facilities, which can be the more costly components. Other technologies can make use of the increased wet weather peak flow capacity by providing more flow to the plant instead of CSO outfalls.

C.7 SEWER SEPARATION

C.7.1 Roof Leader Disconnection

Roof leaders may directly be connected to the CSS. Roof leaders can be disconnected in order to divert stormwater elsewhere and/or to delay its entry into the CSS. Depending on the neighborhood, roof leaders may be run to dry well, vegetation bed, lawn, storm sewer, or street. This technology typically has limited benefits in dense urban areas due to the lack of pervious areas available to divert flow for infiltration. Unfortunately, the most feasible roof leader disconnection scheme in these areas is usually diversion to the street. In this case, disconnection can lead to nuisance street flooding and is only able to briefly delay the water from entering the CSS through catch basins. Roof leader disconnection is typically much more effective in areas with separate sewers where the roof leader was previously connected to a sanitary sewer, since the diverted rainwater does not have a direct path back into the system. Roof leader disconnection can be effective for both sanitary and storm sewers; however, the effect of this measure is highly contingent upon the extent of roof leaders in the system, site specific conditions, and the ability to find an adequate location to divert stormwater flow from the roof leader.

C.7.2 Sump Pump Disconnection

Buildings with basements below the ground water table sometimes are kept dry by using dewatering pumps. In many cases, these pumps discharge to the CSS or sanitary sewers. Sump pump disconnection diverts this pumped groundwater flow to a location other than these sewers. Sump pump disconnection programs are typically more effective in separate sewer areas and are subject to the same limitations as roof leader disconnection programs (extent, site conditions, diversion options, etc.). There are many limitations to the effectiveness of this approach in terms of the resources, impact on the public and difficulties implementing.

C.7.3 Combined Sewer Separation

Sewer separation is the conversion of a CSS into a system of separate storm sewers and sanitary sewers. This can be accomplished by installing a new sanitary sewer and using the existing combined sewer as a storm sewer or vice versa. This practice can be very expensive, disruptive to the public, and difficult to implement, especially in downtown areas or other densely developed urban environments. It typically requires closure of public streets for construction while the new pipes are installed and the sewer is separated.

C.8 TREATMENT OF CSO DISCHARGE

Treatment technologies are intended to reduce the pollutant loads to receiving waters by treating wet weather flows prior to discharging to the environment. Specific technologies can address different pollutant constituents, such as settleable solids, floatables, or bacteria.

C.8.1 Treatment – CSO Facility

C.8.1.1 Vortex Separators

Vortex separation is a process that removes floatables and settleable solids from a wastewater stream by directing influent flow tangentially into a cylindrical tank, thereby creating a vortex. The vortex action causes settleable solids to move toward the center of the tank where they are concentrated with a fraction of the influent flow and directed to the underflow at the bottom of the tank. The underflow is then conveyed downstream to the treatment plant. The remaining influent flow travels under a baffle plate, which traps any floatables, and then over a circular baffle located in the center of the tank. It is then discharged to receiving waters or conveyed to storage or treatment devices for further processing. This technology does not address CSO volume or bacteria reduction, and would only help meet water quality and CSO control goals only if used in combination with other technologies.

C.8.1.2 Screens and Trash Racks

Screens and trash racks consist of a series of vertical and horizontal bars or wires that trap floatables while allowing water to pass through the openings between the bars or wires. They can be installed at select points within a CSS to capture floatables and prevent their discharge during CSO events. Due to limited hydraulic capacity, screens are most suitable for small outfalls. Trash racks or static screens can be located on top of an overflow weir or near the outfall. These devices are inexpensive but usually incur high maintenance costs due to their tendency to become clogged. Frequent cleaning (after every storm) is usually required to prevent clogging, which can cause serious flooding and sewer backups.

Mechanical screens can remove floatables and some solids without frequent manual cleaning. This can be a significant advantage when compared to the maintenance requirements and the potential for flooding caused by a clogged static screen. However, most mechanical screens (climber screens, cog screens, or rake screens) require structural modifications to the outfall chamber to house and protect the screens. If weir-mounted mechanical screens are used instead, they require much less headroom and can be retrofitted into an existing overflow chamber with little to no structural modifications.

As this technology does not address CSO volume or bacteria reduction, it would do little to meet water quality and CSO control goals.

C.8.1.3 Netting

Netting systems involve mesh nets that are attached to a CSO outfall to capture floatable material as the CSO discharges into the receiving water. The nets are nylon mesh bags that can be concealed inside the CSO outfall until an overflow occurs. The advantage of this technology is that it captures floatables inexpensively, and can provide a base level of control at some CSO sites. However the operation and maintenance requirements are high and it has some negative aesthetic impacts associated with the visibility of collected trash in the waterbody. This technology is strictly for floatables control and will not address water quality and CSO control goals alone.

C.8.1.4 Containment Booms

A containment boom is a temporary floating barrier used to contain floatables entering into the waterway from a CSO outfall. Containment booms are used to reduce the spread of floatables and reduce the level of effort for post-storm cleanup. These devices are very simple to install, but can be difficult to maintain. Also, there are some negative aesthetic impacts associated with visibility of collected trash in a waterbody. This technology is strictly for floatables control and will not address water quality and CSO control goals alone.

C.8.1.5 Baffles

Baffles are simple floatables control devices that are typically installed at flow regulators within the CSS. They consist of vertical steel plates or concrete beams that extend from the top of the sewer to just below the top of the regulating weir. During a CSO event, floatables are retained by the baffles while water passes under the baffles, over the regulator, and into the receiving water body. When the flow recedes below the bottom of the baffle, floatable material is carried downstream to the treatment plant. Baffles are easy to install and require little maintenance, but do require proper hydraulic configuration. This technology is strictly for floatables control and will not address water quality and CSO control goals alone.

C.8.1.6 Disinfection and Satellite Treatment

This technology consists of disinfecting and treating sewer overflows at a local facility near the CSO outfall. Disinfection is very effective at reducing bacteria through inactivation, but provides only limited opportunities for volume reduction. Disinfection alone cannot provide reductions in total suspended solids (“TSS”), floatables, and nutrient loads unless other processes (e.g., screening, high-rate clarification, etc.) are provided upstream of the disinfection facility. The combination of these other processes with disinfection can provide a satellite location that helps reduce pollutants of concern.

Disinfection of wet weather flow is more challenging to design and control than traditional disinfection at a treatment plant, because of the complex characteristics of the flow. Intermittent occurrences and highly variable flowrates make it more challenging to regulate the addition of disinfectant. One way to address the variable flow issue is to provide flow retention facilities that provide for disinfectant contact time and capture through storage of the first flush of TSS, floatables and nutrients.

Wet weather flows can vary widely in temperature, suspended solids concentrations, and bacterial composition. Therefore, pilot studies are usually needed to characterize the range of conditions that exist for a particular area and the design criteria that need to be considered. Experience has shown that the long contact time required for conventional wastewater treatment is not appropriate for the treatment of wet weather flows. Disinfection can be achieved by providing an increased disinfection dosage and intense mixing to ensure disinfectant contact with the maximum number of microorganisms.

Although chlorination is the most common method for wastewater disinfection, various disinfection technologies are available, both with and without chlorine compounds. In addition to disinfection effectiveness, many factors should be considered when selecting a disinfectant, including potential toxic effects to the environment, regulations for residuals, safety precautions, and ease of operation and maintenance. Ultraviolet ("UV") light and Peracetic acid (PAA) are two (2) alternatives to chlorine compounds for wet weather disinfection.

- Ultraviolet Light - The main advantages of UV include its ability to quickly respond to flow variation and the absence of a disinfectant residual, among others. The size of the UV system mainly depends on the UV transmittance (i.e., the ability of wastewater to transmit UV light) and TSS concentrations in the wastewater. One of the challenges for UV disinfection is determining how to manage the disinfection of effluent during a power outage. In addition, UV typically has higher capital cost compared to chlorine disinfection systems.
- Peracetic Acid ("PAA") - The main advantage of PAA over sodium hypochlorite (chlorine) is its long "shelf life" without product deterioration. Due to the intermittent nature of CSO flows, stored sodium hypochlorite may degrade over time if not used. However, PAA systems generally have higher operating costs than chlorine systems

C.8.1.7 High Rate Physical/Chemical Treatment (ActiFlo®)

High rate physical/chemical processes, such as Veolia's Actiflo® or Infilco-Degremont's DENSADEG®, are treatment facilities that require a much smaller footprint than conventional processes. These two (2) competing products have very similar applications, but have processes that differ from each other considerably. For brevity, only one of these processes (Actiflo®) is described in detail below.

Fundamentally, the Actiflo® process is very similar to conventional coagulation, flocculation, and sedimentation water treatment technology. Both processes use coagulant for suspended solid destabilization and flocculent aid (polymer) for the aggregation of suspended materials. The primary difference between Actiflo® and conventional processes is the addition of microsand for the formation of high-density flocs that have a higher-density nucleus and thus settle more rapidly.

Clarified water exits the process by flowing over a weir in the settling tank. The sand and sludge mixture that remains is collected at the bottom of the settling tank and pumped to a hydrocyclone which separates the sludge from the microsand. Sludge is discharged out of the top of the hydrocyclone while the sand is recycled back into the Actiflo® process for further use. This process requires upstream screening to ensure that particles larger than 3 to 6 mm do not clog the hydrocyclone.

Actiflo® performance varies, but in general removal rates of 80 - 95% for TSS and 30 - 60% for BOD are typical. Phosphorous and nitrogen are also removable with this process, although the removal efficiencies are dependent on the solubility of these compounds present in the wastewater. Phosphorous removal is typically between 60 – 90%, and nitrogen removal is typically between 15 – 35%. Removal efficiencies are also dependent on start-up time. Typically the Actiflo® process takes about 15 minutes before optimum removal rates are achieved.

The LTCP primary goals are bacteria reduction and CSO volume reduction. While high rate physical/chemical treatment reduces bacteria somewhat, its principal purpose is TSS reduction. Disinfection would be required downstream for bacteria inactivation.

Furthermore, while technologies such as Actiflo® or DENSADEG® reduce the footprint of conventional treatment, they still require a significant amount of available space for implementation.

C.8.1.8 High Rate Physical Treatment (Fuzzy Filters)

The Fuzzy Filter® by Schreiber or the WesTech WWETCO FlexFilter™ is an innovative filtration technology that used a compressible filter media that allows for a much smaller footprint than conventional filtration (footprint reductions of nearly 90%). Both technologies use a synthetic fiber media, as opposed to granular media such as sand, which can handle increased flux rates (up to 30 – 40 gpm/sf). Additionally, the process uses compressed air scour with influent flow for filter backwashing which eliminates the need for storage tanks. The filter removes up to 80% of influent particles up to 4 microns in diameter. Overall, this is a relatively low maintenance process, which requires periodic lubrication and detergent addition for media washing.

This technology is designed for TSS reduction and does not address the primary goals of the LTCP (bacteria reduction and overflow volume reduction). Since downstream disinfection would be required for bacteria inactivation, this technology provides little benefit compared to disinfection alone. Additionally, although this technology decreases the footprint of conventional filtration, it still requires a substantial footprint for implementation.

C.9 SCREENING OF CONTROL TECHNOLOGIES

Templates of the screening tables used by the nine (9) municipalities for screening of the control technologies are presented in this Section. **Table C-9** presents the source control technologies,

Table C-10 presents the collection system technologies, and **Table C-11** presents the storage and treatment technologies. Screening tables with the last two columns filled out by each municipality are presented in the individual Development and Evaluation of Alternatives Reports in **Appendix A** – **Appendix I**.

Table C-9: Source Control Technologies Screening Table

Source Control Technologies								
Technology Group	Practice	Primary Goals		Community Benefits	Implementation & Operation Factors	Consider Combining w/ Other Technologies	Being Implemented	Recommendation for Alternatives Evaluation
		Bacteria Reduction	Volume Reduction					
Stormwater Management	Street/Parking Lot Storage (Catch Basin Control)	Low	Low	▪ Reduced surface flooding	Flow restrictions to the CSS can cause flooding in lots, yards and buildings; potential for freezing in lots; low operational cost. Effective at reducing peak flows during wet weather events but can cause dangerous conditions for the public if pedestrian areas freeze during flooding.	No		
	Catch Basin Modification (for Floatables Control)	Low	None	▪ Water quality improvements ▪ Reduced surface flooding	Requires periodic catch basin cleaning; requires suitable catch basin configuration; potential for street flooding and increased maintenance efforts. Reduces debris and floatables that can cause operational problems with the mechanical regulators.	No		
	Catch Basin Modification (Leaching)	Low	Low	▪ Water quality improvements ▪ Reduced surface flooding	Can be installed in new developments or used as replacements for existing catch basins. Require similar maintenance as traditional catch basins. Leaching catch basins have minor effects on the primary CSO control goals.	No		
Public Education and Outreach	Water Conservation	None	Low	▪ Reduced surface flooding ▪ Align with goals for a sustainable community	Water purveyor is responsible for the water system and all related programs in the respective City. However, water conservation is a common topic for public education programs. Water conservation can reduce CSO discharge volume but would have little impact on peak flows.	Yes		
	Catch Basin Stenciling	None	None	▪ Align with goals for a sustainable community	Inexpensive; easy to implement; public education. Is only as effective as the public's input and understanding of the message. Public outreach programs would have a more effective result.	Yes		
	Community Cleanup Programs	None	None	▪ Water quality improvements ▪ Align with goals for a sustainable community	Inexpensive; sense of community ownership; educational BMP; aesthetic enhancement. Community cleanups are inexpensive and build ownership in the city.	Yes		
	Public Outreach Programs	Low	None	▪ Align with goals for a sustainable community	Public education program is ongoing. Permittee should continue its public education program as control measures demonstrate implementation of the NMC.	Yes		
	FOG Program	Low	None	▪ Water quality improvements ▪ Improves collection system efficiency	Requires communication with business owners; Permittee may not have enforcement authority. Reduces buildup and maintains flow capacity. Only as effective as business owner cooperation.	Yes		
	Garbage Disposal Restriction	Low	None	▪ Water quality improvements	Permittee may not be responsible for Garbage Disposal. This requires an increased allocation of resources for enforcement while providing very little reduction to wet weather CSO events.	Yes		
	Pet Waste Management	Medium	None	▪ Water quality improvements	Low cost of implementation and little to no maintenance. This is a low-cost technology that can significantly reduce bacteria loading in wet weather CSO's.	Yes		
	Lawn and Garden Maintenance	Low	Low	▪ Water quality improvements	Requires communication with business and homeowners. Guidelines are already established per USEPA. Educating the public on proper lawn and garden treatment protocols developed by USEPA will reduce waterway contamination. Since this information is already available to the public it is unlikely to have a significant effect on improving water quality.	Yes		
	Hazardous Waste Collection	Low	None	▪ Water quality improvements	The N.J.A.C. prohibits the discharge of hazardous waste to the collection system.	Yes		

Source Control Technologies								
Technology Group	Practice	Primary Goals		Community Benefits	Implementation & Operation Factors	Consider Combining w/ Other Technologies	Being Implemented	Recommendation for Alternatives Evaluation
		Bacteria Reduction	Volume Reduction					
Ordinance Enforcement	Construction Site Erosion & Sediment Control	None	None	▪ Water quality improvements	In building code; reduces sediment and silt loads to waterways; reduces clogging of catch basins; little O&M required; contractor or owner pays for erosion control. A Soil Erosion & Sediment Control Plan Application or 14-day notification (if Permittee covered under permit-by-rule) will be required by NJDEP per the N.J.A.C.	Yes		
	Illegal Dumping Control	Low	None	▪ Water quality improvements ▪ Aesthetic benefits	Enforcement of current law requires large number of code enforcement personnel; recycling sites maintained. Local ordinances already in place can be used as needed to address illegal dumping complaints.	Yes		
	Pet Waste Control	Medium	None	▪ Water quality improvements ▪ Reduced surface flooding	Requires resources to enforce pet waste ordinances. Public education and outreach is a more efficient use of resources, but this may also provide an alternative to reducing bacterial loads.	Yes		
	Litter Control	None	None	▪ Property value uplift ▪ Water quality improvements ▪ Reduced surface flooding	Aesthetic enhancement; labor intensive; City function. Litter control provides an aesthetic and water quality enhancement. It will require city resources to enforce. Public education and outreach is a more efficient use of resources.	Yes		
	Illicit Connection Control	Low	Low	▪ Water quality improvements ▪ Align with goals for sustainable community	Site specific; more applicable to separate sanitary system; new storm sewers may be required; interaction with homeowners required. The primary goal of the LTCP is to meet the NJPDES Permit requirements relative to POCs. Illicit connection control is not particularly effective at any of these goals and is not recommended for further evaluation unless separate sewers are in place.	Yes		
Good Housekeeping	Street Sweeping/Flushing	Low	None	▪ Reduced surface flooding	Labor intensive; specialized equipment; doesn't address flow or bacteria; City function. Street sweeping and flushing primarily addresses floatables entering the CSS while offering an aesthetic improvement.	Yes		
	Leaf Collection	Low	None	▪ Reduced surface flooding ▪ Aesthetic benefits	Requires additional seasonal labor. Leaf collection maximizes flow capacity and removes nutrients from the collection system.	Yes		
	Recycling Programs	None	None	▪ Align with goals for sustainable community	Most Cities have an ongoing recycling program.	Yes		
	Storage/Loading/Unloading Areas	None	None	▪ Water quality improvements	Requires industrial & commercial facilities designate and use specific areas for loading/unloading operations. There may be few major commercial or industrial users upstream of CSO regulators.	Yes		
	Industrial Spill Control	Low	None	▪ Protect surface waters ▪ Protect public health	PVSC has established a pretreatment program for industrial users subject to the Federal Categorical Pretreatment Standards 40 CFR 403.1.	Yes		
Green Infrastructure Buildings	Green Roofs	None	Medium	▪ Improved air quality ▪ Reduced carbon emissions ▪ Reduced heat island effect ▪ Property value uplift ▪ Local jobs ▪ Reduced surface flooding ▪ Reduced basement sewage flooding ▪ Align with goals for a sustainable community	Adds modest cost to new construction; not applicable to all retrofits; low operational resource demand; will require the Permittee or private owners to implement; requires regular cleaning of gutters & pipes; upkeep of roof vegetation. Portions of Cities have densely populated areas, but this technology is limited to rooftops. Can be difficult to require on private properties.	Yes		

Source Control Technologies								
Technology Group	Practice	Primary Goals		Community Benefits	Implementation & Operation Factors	Consider Combining w/ Other Technologies	Being Implemented	Recommendation for Alternatives Evaluation
		Bacteria Reduction	Volume Reduction					
Green Infrastructure Buildings	Blue Roofs	None	Medium	▪ Reduced heat island effect ▪ Property value uplift ▪ Local jobs ▪ Reduced surface flooding ▪ Reduced basement sewage flooding ▪ Align with goals for a sustainable community	Adds modest cost to new construction; not applicable to all retrofits; low operational resource demand; will require the Permittees or private owners to implement; requires regular cleaning of gutters & pipes; upkeep of roof debris. Portions of the Cities have densely populated areas, but this technology is limited to rooftops. Can be difficult to require on private properties.	Yes		
	Rainwater Harvesting	None	Medium	▪ Reduced surface flooding ▪ Reduced basement sewage flooding ▪ Align with goals for a sustainable community ▪ Water saving	Simple to install and operate; low operational resource demand; will require the Permittees or private owners to implement; requires regular cleaning of gutters & pipes. Portions of the Cities have densely populated areas, but this technology is limited to capturing rooftop drainage. Capture is limited to available storage, which can vary on rainwater use. Can be difficult to require on private properties.	Yes		
Green Infrastructure Impervious Areas	Permeable Pavements	Low	Medium	▪ Improved air quality ▪ Reduced carbon emissions ▪ Reduced heat island effect ▪ Property value uplift ▪ Water quality improvements ▪ Reduced surface flooding ▪ Reduced basement sewage flooding ▪ Align with goals for a sustainable community	Not durable and clogs in winter; oil and grease will clog; significant O&M requirements with vacuuming and replacing deteriorated surfaces; can be very effective in parking lots, lanes and sidewalks. Maintenance requirements could be reduced if located in low-traffic areas and can utilize underground infiltration beds or detention tanks to increase storage.	Yes		
	Planter Boxes	Low	Medium	▪ Improved air quality ▪ Reduced carbon emissions ▪ Reduced heat island effect ▪ Property value uplift ▪ Reduced surface flooding ▪ Reduced basement sewage flooding ▪ Align with goals for a sustainable community	Site specific; good BMP; minimal vegetation & mulch O&M requirements with regular overflow and underdrain cleaning; effective at containing, infiltrating and evapotranspiring runoff in developed areas. Flexible and can be implemented even on a small-scale to any high-priority drainage areas. Underground infiltration beds or detention tanks can be utilized to increase storage.	Yes		
Green Infrastructure Pervious Areas	Bioswales	Low	Low	▪ Improved air quality ▪ Reduced carbon emissions ▪ Reduced heat island effect ▪ Property value uplift	Site specific; good BMP; minimal vegetation & mulch O&M requirements; not as flexible or infiltrate as much stormwater as planter boxes. Technology requires open space and is primarily a surface conveyance technology with additional storage & infiltration benefits. Can be modified with check dams to slow water	Yes		

Source Control Technologies								
Technology Group	Practice	Primary Goals		Community Benefits	Implementation & Operation Factors	Consider Combining w/ Other Technologies	Being Implemented	Recommendation for Alternatives Evaluation
		Bacteria Reduction	Volume Reduction					
				▪ Local jobs ▪ Passive and active recreational improvements ▪ Reduced surface flooding ▪ Reduced basement sewage flooding ▪ Community aesthetic improvements ▪ Reduced crime ▪ Align with goals for a sustainable community ▪ Increased pedestrian safety through curb retrofits	flow. Limited open space in most Cities means land can be utilized in more effective ways with the existing infrastructure.			
	Free-Form Rain Gardens	Low	Medium	▪ Improved air quality ▪ Reduced carbon emissions ▪ Reduced heat island effect ▪ Property value uplift ▪ Passive and active recreational improvements ▪ Reduced surface flooding ▪ Reduced basement sewage flooding ▪ Community aesthetic improvements ▪ Reduced crime ▪ Align with goals for a sustainable community	Site specific; good BMP; minimal vegetation & mulch O&M requirements with regular overflow and underdrain cleaning; effective at containing, infiltrating and evapotranspiring diverted runoff. Rain Gardens are flexible and can be modified to fit into the previous areas. Underground infiltration beds or detention tanks can be utilized to increase storage.	Yes		

Table C-10: Collection System Technologies Screening Table

Collection System Technologies								
Technology Group	Practice	Primary Goals		Community Benefits	Implementation & Operation Factors	Consider Combining w/ Other Technologies	Being Implemented	Recommendation for Alternatives Evaluation
		Bacteria Reduction	Volume Reduction					
Operation and Maintenance	I/I Reduction	Low	Medium	▪ Water quality improvements ▪ Reduced basement sewage flooding	Requires labor intensive work; changes to the conveyance system require temporary pumping measures; repairs on private property required by homeowners. Reduces the volume of flow and frequency; Provides additional capacity for future growth; House laterals account for 1/2 the sewer system length and significant sources of I/I in the sanitary sewer.	Yes		
	Advanced System Inspection & Maintenance	Low	Low	▪ Water quality improvements ▪ Reduced basement sewage flooding	Requires additional resources towards regular inspection and maintenance work. Inspection and maintenance programs can provide detailed information about the condition and future performance of infrastructure. Offers relatively small advances towards goals of the LTCP.	Yes		
	Combined Sewer Flushing	Low	Low	▪ Water quality improvements ▪ Reduced basement sewage flooding	Requires inspection after every flush; no changes to the existing conveyance system needed; requires flushing water source. Ongoing: CSO Operational Plan; maximizes existing collection system; reduces first flush effect.	Yes		
	Catch Basin Cleaning	Low	None	▪ Water quality improvements ▪ Reduced surface flooding	Labor intensive; requires specialized equipment. Catch Basin Cleaning reduces litter and floatables but will have no effect on flow and little effect on bacteria and BOD levels.	Yes		
Combined Sewer Separation	Roof Leader Disconnection	Low	Low	▪ Reduced basement sewage flooding	Site specific; Includes area drains and roof leaders; new storm sewers may be required; requires home and business owner participation. The Cities are densely populated and disconnected roof leaders have limited options for discharge to pervious space. Disconnection may be coupled with other GI technologies but is not considered an effective standalone option.	Yes		
	Sump Pump Disconnection	Low	Low	▪ Reduced basement sewage flooding	Site specific; more applicable to separate sanitary system; new storm sewers may be required; interaction with homeowners required. The Cities are densely populated and disconnected sump pumps have limited options for discharge to pervious space. Disconnection may be coupled with other GI technologies but is not considered an effective standalone option.	Yes		
	Combined Sewer Separation	High	High	▪ Water quality improvements ▪ Reduced basement sewage flooding ▪ Reduced surface flooding	Very disruptive to affected areas; requires homeowner participation; sewer asset renewal achieved at the same time; labor intensive.	No		
Combined Sewer Optimization	Additional Conveyance	High	High	▪ Water quality improvements ▪ Reduced basement sewage flooding	Additional conveyance can be costly and would require additional maintenance to keep new structures and pipelines operating.	No		
	Regulator Modifications	Medium	Medium	▪ Water quality improvements	Relatively easy to implement with existing regulators; mechanical controls will require O&M. May increase risk of upstream flooding. Permittees have an ongoing O&M program and system wide replacement program for CSO regulators and tide gates.	Yes		
	Outfall Consolidation/Relocation	High	High	▪ Water quality improvements ▪ Passive and active recreational improvements	Lower operational requirements; may reduce permitting/monitoring; can be used in conjunction with storage & treatment technologies. Combining and relocating outfalls may lower operating costs and CSO flows. It can also direct flow away from specific areas.	Yes		
	Real Time Control	High	High	▪ Water quality improvements ▪ Reduced basement sewage flooding	Requires periodic inspection of flow elements; highly automated system; increased potential for sewer backups. RTC is only effective if additional storage capacity is present in the system.	Yes		

Table C-11: Storage and Treatment Technologies Screening Table

Storage and Treatment Technologies									
Technology Group	Practice	Primary Goals		Community Benefits	Implementation & Operation Factors	Consider Combining w/ Other Technologies	Being Implemented	Recommendation for Alternatives Evaluation
		Bacteria Reduction	Volume Reduction					
Linear Storage	Pipeline	High	High	▪ Water quality improvements ▪ Reduced surface flooding ▪ Local jobs	Can only be implemented if in-line storage potential exists in the system; increased potential for basement flooding if not properly designed; maximizes use of existing facilities. Pipe storage for a CSS typically requires large diameter pipes to have a significant effect on reducing CSOs. This typically requires large open trenches and temporary closure of streets to install.	No		
	Tunnel	High	High	▪ Water quality improvements ▪ Reduced surface flooding	Requires small area at ground level relative to storage basins; disruptive at shaft locations; increased O&M burden.	No		
Point Storage	Tank (Above or Below Ground)	High	High	▪ Water quality improvements ▪ Reduced basement sewage flooding	Storage tanks typically require pumps to return wet weather flow to the system which will require additional O&M; disruptive to affected areas during construction. Several CSO outfalls have space available for tank storage. There may be existing tanks in abandoned commercial and industrial areas to be converted to hold stormwater. Tanks are an effective technology to reduce wet weather CSO's.	No		
	Industrial Discharge Detention	Low	Low	▪ Water quality improvements	Requires cooperation with industrial users; more resources devoted to enforcement; depends on IUs to maintain storage basins. IUs hold stormwater or combined sewage until wet weather flows subside; there may be commercial or industrial users upstream of CSO regulators.	Yes		
Treatment-CSO Facility	Vortex Separators	None	None	▪ Water quality improvements	Space required; challenging controls for intermittent and highly variable wet weather flows. Vortex separators would remove floatables and suspended solids when installed. It does not address volume, bacteria or BOD.	Yes		
	Screens and Trash Racks	None	None	▪ Water quality improvements	Prone to clogging; requires manual maintenance; requires suitable physical configuration; increased O&M burden. Screens and trash racks will only address floatables.	Yes		
	Netting	None	None	▪ Water quality improvements	Easy to implement; labor intensive; potential negative aesthetic impact; requires additional resources for inspection and maintenance. Netting will only address floatables.	Yes		
	Contaminant Booms	None	None	▪ Water quality improvements	Difficult to maintain requiring additional resources. Contaminant booms will only address floatables.	Yes		
	Baffles	None	None	▪ Water quality improvements	Very low maintenance; easy to install; requires proper hydraulic configuration; long lifespan. Baffles will only address floatables.	Yes		
	Disinfection & Satellite Treatment	High	None	▪ Water quality improvements ▪ Reduced basement sewage flooding	Requires additional flow stabilizing measures; requires additional resources for maintenance; requires additional system analysis. Disinfection is an effective control to reduce bacteria and BOD in CSO's.	Yes		
	High Rate Physical/Chemical Treatment (High Rate Clarification Process - ActiFlo)	None	None	▪ Water quality improvements	Challenging controls for intermittent and highly variable wet weather flows; smaller footprint than conventional methods. This technology primarily focuses on TSS & BOD removal but does not help reduce the bacteria or CSO discharge volume.	Yes		
	High Rate Physical (Fuzzy Filters)	None	None	▪ Water quality improvements	Relatively low O&M requirements; smaller footprint than traditional filtration methods. This technology primarily focuses on TSS removal but does not help reduce the bacteria or CSO discharge volume.	Yes		

Storage and Treatment Technologies								
Technology Group	Practice	Primary Goals		Community Benefits	Implementation & Operation Factors	Consider Combining w/ Other Technologies	Being Implemented	Recommendation for Alternatives Evaluation
		Bacteria Reduction	Volume Reduction					
Treatment-WRRF	Additional Treatment Capacity	High	High	▪ Water quality improvements ▪ Reduced surface flooding ▪ Reduced basement sewage flooding	May require additional space; increased O&M burden.	No		
	Wet Weather Blending	Low	High	▪ Water quality improvements ▪ Reduced surface flooding ▪ Reduced basement sewage flooding	Requires upgrading the capacity of influent pumping, primary treatment and disinfection processes; increased O&M burden. Wet weather blending does not address bacteria reduction, as it is a secondary treatment bypass for the POTW. Permittee must demonstrate there are no feasible alternatives to the diversion for this to be implemented.	Yes		
Treatment-Industrial	Industrial Pretreatment Program	Low	Low	▪ Water quality improvements ▪ Align with goals for a sustainable community	Requires cooperation with Industrial User's; more resources devoted to enforcement; depends on IU's to maintain treatment standards. May require Permits.	Yes		

SECTION D - SUMMARY OF ALTERNATIVES ANALYSIS

D.1 DEVELOPMENT AND EVALUATION OF ALTERNATIVES

This section describes the development of preliminary CSO control alternatives applicable to the permittees in the PVSC Treatment District, the approaches selected to perform the evaluations, and the factors used to evaluate each of the alternatives. This section also factors cost into each alternative analysis. As part of this evaluation, four alternatives were developed and evaluated regionally and are incorporated in this Regional Alternatives Report, as per requirement of the PVSC NJPDES Permit No. NJ0021016 (hereon referred to as “the Permit”) Combined Sewer Management (CSM) Part IV.D.1.c.

D.1.1 Alternatives Evaluation Approach

This section of the report discuss the regulatory requirements and guidelines used to develop the alternatives evaluation criteria and approach. In accordance with the NJPDES Permit and as defined by the USEPA’s National CSO Policy and the New Jersey Administrative Code , a reasonable range of CSO control alternatives must be evaluated to meet the water quality-based requirements of the CWA. For the purpose of the evaluation of alternatives, various CSO control technologies were evaluated for varying levels of control, including 0, 4, 8, 12, and 20 CSO events per year, as well as 85% capture by volume.

Development of Alternatives

The preliminary alternatives were developed using the overflow control technologies identified as feasible for implementation by the permittees in each of their Development and Evaluation of Alternatives Reports, and as required as part of the Permit in Part IV.G.4.e. Control technologies used for alternatives include: GI, regulator modifications, storage tanks, tunnels, baseflow reduction, water conservation, increased wastewater conveyance to PVSC for treatment, maximizing pump station and force main capacities, parallel interceptor, bypass line, satellite treatment, and sewer separation. A range of alternatives was developed to evaluate each of the screened and preselected technologies, both individually and in combination with other technologies simultaneously. The resulting alternatives are listed in **Table D-1** below.

Table D-1: Regional Alternatives

Alternative	Description
No. 1	Most cost-effective alternatives for each permittee
No. 2	Regional Tunnel
No. 3	Newark Regulator Modifications and Rehabilitation + Parallel Interceptor + Plant Expansion (720 MGD) + Jersey City Pipe (146 MGD HCFM)
No. 4	Newark Regulator Modifications and Rehabilitation + Parallel Interceptor + Plant Expansion (720 MGD) + Jersey City Pipe (146 MGD HCFM) + Tunnels

Evaluation factors for the analysis of alternatives are discussed below. Factors include siting, institutional issues, implementability concerns, public input, performance considerations, and cost.

D.1.2 Siting

Identifying an appropriate site for the alternatives is an important consideration when determining the feasibility of the alternative. Siting is unique to each permittee and is discussed in individual reports in **Appendix B** through **Appendix I**.

D.1.3 Institutional Issues

PVSC does not own any of the CSO outfalls in the CSS. The outfalls are owned by the City of Paterson, City of Newark, Township of Kearny, Town of Harrison, Borough of East Newark, City of Bayonne, Jersey City MUA, and North Bergen MUA, who have received authorization to discharge under their respective NJPDES Permits for Combined Sewer Management.

As a result, and in the continued effort to cooperate with each of the Permittees to develop a collaborative LTCP, the ultimate selection of the controls for implementation will continue to be coordinated with the Permittees within PVSC Treatment District. These various factors that must be considered and coordinated with the various Permittees will occur prior to the completion of the subsequent Selection and Implementation of Alternatives Report in the Final LTCP.

D.1.4 Implementability

Implementation refers to considerations beyond cost and performance that influence the selection of a CSO control technology; these issues are often intertwined with political and institutional considerations. See **Section D.1.3** and **Section D.1.5**. for specific discussions of public input and institutional issues. The purview of this subsection is limited to scheduling, phasing, and constructability concerns for each of the overflow control technologies considered in the alternatives.

The CSO Policy provides that *"schedules for implementation of the CSO controls may be phased based on the relative importance of adverse impacts upon WQS and designated uses, priority projects identified in the long-term plan, and on a permittee's financial capability. Given the cost of CSO control facilities, municipalities might determine that projects can be implemented in smaller parts over a period of time are more affordable than a single, large one-time project. Phased implementation also allows time for evaluating completed portions of the overall project and the opportunity to modify later parts of the project due to unanticipated changes in conditions. The initial stages of phased projects often can be implemented sooner than a single, more massive project, bringing more immediate relief to a CSO problem."*

Constructability concerns were initially discussed in the screening of CSO control technologies portion of this report, which can be found in **Section C**. Additional implementation concerns applicable to an alternative are discussed further in the appropriate alternative subsection found within **Section D.2**. Concerns regarding the scheduling and phasing of alternatives will be considered prior to the completion of the Final Regional LTCP Report.

D.1.5 Public Input

As a majority of the alternatives discussed within this report will directly impact the public, both during construction and operation, public input has been and will continue to be solicited throughout the development of the LTCP.

PVSC has continuously solicited public input for the various CSO control technologies through the implementation of the LTCP Public Participation Plan ("PPP"). The implementation of the LTCP PPP is an ongoing process that includes hosting quarterly public meetings with the Clean Waterways, Healthy Neighborhoods Supplemental CSO Team, participating in the meetings of various local groups, participating as an active member of the PVSC Treatment District Communities GI Programs, including Newark DIG, Paterson SMART, Bayonne Water Guardians, Harrison TIDE, and Kearny AWAKE and partnering with Rutgers University in a GI municipal outreach program, attending public events, meeting with municipal representatives, and soliciting public input through the Clean Waterways, Healthy Neighborhoods website and social media platforms.

Public input will be one of the various factors considered when ultimately selecting the controls for implementation. For instance, the public has expressed interest in GI as a part of the CSO controls. This evaluation of alternatives has considered GI and is discussed further within this Report.

D.1.6 Performance Considerations

The primary evaluation criteria for the evaluation of alternatives is the performance of an alternative at meeting the water quality and CSO control goals detailed in **Section C.1.1**. All four (4) regional alternatives evaluated increasing the volume capture of CSOs throughout the collection system to no less than 85% by volume. In addition, Alternative 1, Alternative 2, and Alternative 4 also evaluated the feasibility of reducing number of CSO events to a maximum of 0, 4, 8, 12, and 20 occurrences per year in the hydraulically connected system. In order to compare the effectiveness of reducing the number of CSO events to the selected target of a minimum of 85% CSO volume captured, the equivalent CSO volume captured by the number of CSO events has been calculated.

D.1.7 Cost

Cost is a significant evaluation factor in determining the feasibility of each alternative. The Costs for Regional Alternative 1 include capital costs and contingencies as described in each of the individual reports in **Appendix B** through **Appendix I**.

The opinions of probable construction cost used for the Regional Alternatives 2 through 4 are considered Level 5 estimates, as designated by Association for the Advancement of Cost Engineering ("AACE") Recommended Practice No. 18R-97. The accuracy range for Class 5 estimates is generally within a range of fifty percent less (-50%) to one-hundred percent more

(+100%) than the actual cost. To develop the present worth values of Alternatives, the primary components of the Alternative Opinion of Probable Construction Cost Methodology is:

- Identify appropriate alternative cost line items;
- Generate initial capital cost curves; and
- Generate operation and maintenance (O&M) costs along with contingency and other cost factor percentages to calculate life cycle costs

The first two items have been developed previously through the PVSC LTCP Technical Guidance Manual (PVSC TGM), which can be found in **Appendix J**. Any additional information used to supplement the cost line items or cost curves used comes from the following:

- Completed project construction cost data
- RS Means
- Manufacturer’s cost data
- Environmental Protection Agency (“EPA”) project cost data and cost curves
- Anderson, Indiana CSO Long Term Control Plan: Basis for Cost Opinion

Unless a specific control technology cost was gathered from another estimate or quote, typical markups from the initial capital costs include the following list, where applicable, due to the heavily urbanized area where PVSC operates:

- Pipe Installation – Heavy Utilities Contingency (65%)
- Tank/Storage Conduit – Heavy Utilities Contingency (65%)
- Pump Station – Difficult Installation Contingency (65%)
- WRRF Upgrade – Difficult Modification Contingency (65%)
- Sewer Separation – Heavy Utilities Contingency (65%)
- Overhead and Profit (15%)
- Bonds and Insurance (3%)
- Mobilization/Demobilization (5%)

These costs are combined for a construction cost subtotal. This subtotal then has the following additional markups applied to get a Total Cost (referred to as the Capital Cost):

- Engineering (25%)
- Permitting (3%)

The following O&M costs are applied to the Capital Cost, where applicable:

- Continuous Operating Post (1 COP = $470,000/yr.)
- Tank/Structure Maintenance (3% of Construction Cost)
- Tunnel Maintenance (2% of Construction Cost)
- Pipe Transmission Maintenance (2% of Pipe Construction Costs

To combine O&M and capital costs for each control technology, present worth calculations have to be completed. For this, a discount rate (i) of 2.75% is used (taken from the Rate for Federal Water Projects, Natural Resources Conservation Service ("NRCS") Economics, Department of the Interior) with a life span (n) of 20 years. The following equation is then utilized to calculate the present worth factor to convert from annual O&M costs to present worth:

$$(P/A, i\%, n) = ((1+i)^n - 1) / ((i(1+i)^n)$$

The result of the equation is then multiplied by the annual O&M costs and then added to the construction costs to obtain the total life cycle cost. Salvage value is considered to be $0, as it is assumed no resale value will result from the control technologies utilized. Life cycle costs for each alternative are provided in Subsection D.2.

The life cycle cost for each level of control for an alternative was then divided by the applicable volume of capture to determine a cost per gallon ($/gal). These costs provide an additional method to compare alternatives.

D.2 CONTROL PROGRAM ALTERNATIVES

This section summarizes the four regional alternatives that were determined through coordination facilitated by PVSC. Alternative 1, which is summarized in **Section D.2.1**, was determined based on an analysis that each permittee performed to determine the most cost-effective alternative to meet each of the yearly CSO event frequencies used for the analysis (0, 4, 8, 12, and 20). The permittees detailed the CSO captures and costs for each alternative evaluated in their individual reports, which are included in the following appendices:

- Appendix B: City of Bayonne
- Appendix C: Borough of East Newark
- Appendix D: Town of Harrison
- Appendix E: Jersey City MUA
- Appendix F: Town of Kearny
- Appendix G: City of Newark
- Appendix H: North Bergen MUA
- Appendix I: City of Paterson

Using the data provided by the permittees, Alternative 1 was determined by combining the most cost-effective alternatives for each permittee to meet the yearly CSO frequencies and 85% capture scenario. Alternative 2, which is summarized in **Section D.2.2**, was created as a regional approach to improve capture and treatment using regional tunnels to meet the yearly CSO frequencies and 85% capture scenario. **Section D.2.3** describes Alternative 3, which evaluates a combination of Newark Regulator Modifications and Rehabilitation + Parallel Interceptor + Plant Expansion (720 MGD) + Hudson County Force Main Pump Expansion (146 MGD HCFM) to meet the 85% capture scenario. Finally, Alternative 4, which is a combination of Newark Regulator Modifications and Rehabilitation + Parallel Interceptor + Plant Expansion (720 MGD)

+ Hudson County Force Main Pump Expansion (146 MGD HCFM) + Tunnels, was evaluated to meet the yearly CSO frequencies and 85% capture scenario, as summarized in **Section D.2.4**.

D.2.1 Regional Alternative 1

Regional Alternative 1 incorporates the most cost-effective alternative for each permittee to meet the yearly CSO frequencies and 85% capture. Each permittee evaluated a variety of alternatives as discussed in **Section D.1.1**. **Table D-2** and **Table D-3** summarize the anticipated life cycle costs and the CSO volume capture, respectively, for the lowest cost alternative for each yearly CSO frequency and the 85% capture scenario for each permittee.

Table D-2: Regional Alternative 1 – Life Cycle Cost vs. # CSO/CSO Capture

CSO Events	Regional Alternative 1 – Life Cycle Costs ($M)								
	Permittees								Total Life Cycle Cost ($M)
	BA	EN	HA	JC	KEA	NE	NB	PAT	
0	828.1	44.6	78.2	5,824.4	747.7	1,485.6	137.9	637.0	9,784
≤4	549.0	34.0	58.6	857.26	262.4	1,019.8	113.5	363.0	3,258
≤8	365.4	23.7	57.8	794.1	212.6	665.6	92.8	234.0	2,446
≤12	351.9	19.3	46.7	719.5	188.7	577.5	83.9	203.0	2,191
≤20	220.2	16.2	41.1	546.6	170.3	321.0	67.0	172.0	1,554
85%	180.9	12.8	5.8	515.3	100.6	5.8	62.9	77.3	961

Key: BA: Bayonne; EN: East Newark; HA: Harrison Town; JC: Jersey City; KEA: Kearny Town, NE: Newark; NB: North Bergen; PAT: Patterson

Table D-3: Regional Alternative 1 – CSO Volume Captured vs. # CSO/CSO Capture

CSO Events	Regional Alternative 1 – CSO Volume Captured (MG)							
	Permittees							
	BA	EN	HA	JC	KEA	NE	NB	PAT
0	748	17.2	61.5	1,557	254.7	1,313	274	353
≤4	720	16.7	57.7	1,473	228.7	1,211	263	311
≤8	666	14.1	57.5	1,449	169.7	886	242	268
≤12	657	12.9	51.8	1,405	143.7	700	217	232
≤20	542	10.3	48.1	1,181	109.7	457	175	156
85%	441	6.4	18.8	985	34.4	114	155	109

Key: BA: Bayonne; EN: East Newark; HA: Harrison Town; JC: Jersey City; KEA: Kearny Town, NE: Newark; NB: North Bergen; PAT: Patterson

As described in each permittee's individual report, various alternatives were evaluated alone and in combination with each other. Alternatives were found to have varying applicability, effectiveness, and cost, with some alternatives being more effective in combination with others. The following summarizes the alternatives found to be the most cost effective or the most capable of achieving major performance objectives, either alone or in combination with other alternatives:

- City of Bayonne: Sewer separation, PAA disinfection with potential solids treatment, offline storage with increased conveyance of wet-weather flows to PVSC for treatment, and GI.
- Borough of East Newark: 5% conversion of impervious area to GI, partial sewer separation followed by storage tanks or high rate filtration with PAA disinfection.
- Town of Harrison: consolidated tanks storage, 2.5% GI
- Jersey City MUA: grouped storage tanks
- Town of Kearny: complete sewer separation, partial sewer separation, high rate filtration with PAA disinfection
- City of Newark: PAA disinfection with pretreatment (level of pretreatment based on treatability studies), gate delay and disinfection at NE022
- North Bergen MUA: high rate filtration with PAA disinfection
- City of Paterson: Partial Sewer Separation, GI, PAA disinfection with potential primary treatment based on pilot project results

It is noted that as the LTCP continues to develop, the models used for each permittee may be updated as well. Based on the model updates and feedback from NJDEP, the list of alternatives above, and hence, the life cycle costs and CSO volume discharged presented in **Table D-2** and **Table D-3**, may change for any or all permittees.

As expected, regardless of the alternative that each permittee listed above, the life cycle costs and CSO volumes captured are anticipated to be the highest when meeting the 0 CSO events per year scenario, and the costs and volume captured decreases as the number of CSO events per year increases. The difference in magnitude of costs stems mainly from the anticipated CSO volume captured (MG) for each permittee. For example, based on the analysis performed for Jersey City MUA, which has the highest life cycle costs for all scenarios, 1,557 MG of CSO volume is anticipated to be captured for the 0 CSO events per year scenario. In contrast, East Newark, which has significantly lower life cycle costs, is anticipated to only capture 17.2 MG of CSO volume for the 0 CSO events per year scenario.

In terms of the 85% capture scenario, the life cycle costs and CSO volumes captured are generally lower than for all of the CSO events per year scenarios. This is because even capturing all but 20 CSO events per year would capture more than 85% volume. In addition, the 85% capture scenario can be attained in many cases with projects associated with the largest outfalls rather than all outfalls.

The total life cycle costs are the summed life cycle costs for all of the alternatives used for each level of control and are also presented in **Table D-2** and discussed in more detail in **Section D.1.7** above. Overall, the costs to meet the 0 CSO events per year scenario are significantly higher than the costs to meet the 4, 8, 12, and 20 CSO Events per year scenarios.

D.2.2 Regional Alternative 2

Regional Alternative 2 includes infrastructure that can serve the region: three regional tunnels. PVSC's Evaluation of Alternatives Report (**Appendix A**) provided the basis for two of the tunnels, with an additional tunnel to serve the HCFM communities. Regional Alternative 2 was evaluated to meet each of the yearly CSO event frequencies and for 85% CSO volume capture for the PVSC interceptor communities and the west side of the HCFM Communities. The regional tunnels would include the Paterson Citywide Tunnel, McCarter Highway Tunnel, and the NJ440 Tunnel, as shown in **Figure D-1** below. It is noted dedicated surface level piping leading to the drop shafts and microtunneling to connect the drop shafts to McCarter Highway Tunnel will be needed in Harrison, East Newark, and Kearny.

The total life cycle costs, CSO volume discharged and captured, and life cycle cost efficiency (cost/MG of CSO captured) were estimated to meet each yearly CSO frequency and the 85% capture scenario, as summarized in **Table D-4**Error! Reference source not found..

Table D-4: Regional Alternative 2 – Summary of Life Cycle Cost, CSO Volume Discharged and Captured, and Life Cycle Cost Efficiency

CSO Events	Total Life Cycle Cost ($M)	Total CSO Volume Discharged (MG)	Total CSO Volume Captured (MG)	Life Cycle Cost Efficiency ($/gal)
0	$2,928	641	3,623	$0.81
≤4	$1,907	1,077	3,187	$0.60
≤8	$1,722	1,318	2,946	$0.58
≤12	$1,583	1,721	2,543	$0.62
≤20	$1,212	2,769	1,495	$0.81
85%	$1,051	2,838	1,426	$0.74

Overflow volume is anticipated even for the 0 CSO events per year scenario because the NJ440 Tunnel only collects flow from the west sides of North Bergen, Jersey City, and Bayonne. Although the overflow volume discharged for the 85% capture scenario is similar to the 20 CSO events per year scenario, the life cycle costs are lower. This is because for the 0, 4, 8, 12, and 20 CSO events per year scenarios, all three tunnels are required to control all regulators, whereas the 85% capture scenario only requires the McCarter Highway Tunnel sized for the 4 CSO events per year scenario.

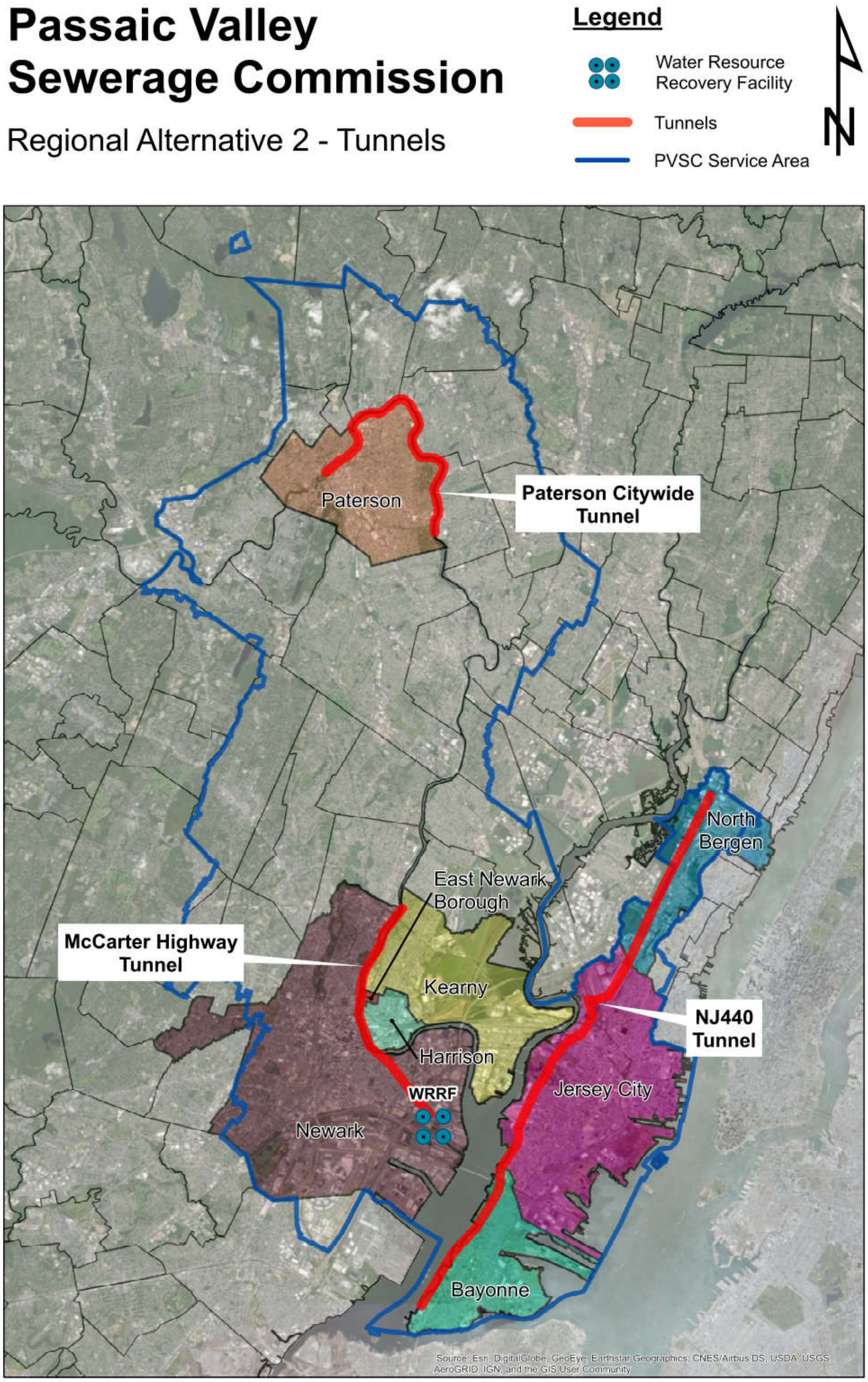

Figure D-1: Map of Regional Tunnels Locations NJ440

There is a significant difference between the life cycle costs for the two alternatives for the 0 CSO events per year scenario, due to the high capital costs required for system wide sewer separation, which was the lowest cost alternative evaluated for the 0 CSO events per year scenario.

D.2.3 Regional Alternative 3

Regional Alternative 3 is the same as Alternative 5a that was evaluated by PVSC (See **Appendix A**) and includes Newark Regular Modifications & Rehabilitation + Parallel Interceptor + Plant Expansion (720 MGD) + Hudson County Force Main Pump Expansion (146 MGD HCFM). This alternative aims to reduce CSO frequency by increasing storage and flow capacities using multiple CSO control technologies. **Figure D-2** depicts the components of Regional Alternative 3.

This section provides a brief summary of each technology for this alternative and further details regarding the technologies are included in **Appendix A**.

The first technology for this alternative is Newark Regulator Modifications & Rehabilitation. Within the PVSC CSS, there are 11 PVSC-owned and operated CSO regulators where regulator modifications may have a positive effect on reducing CSO frequency and increase storage capacity in the collection system. The 11 PVSC-owned and operated CSO regulators have existing gates to shut off flow entering the PVSC Main Interceptor. The current peak flow capacity at the WRRF is 400 MGD. When the combined wet weather inflow of the PVSC Main Interceptor, South Side Interceptor, and the HCFM gets closer to this peak capacity, the regulator gates close and CSOs occur.

It is possible to adjust the regulator gate shutoff timing to maximize flow into the PVSC Main Interceptor and WRRF. Updating the gate shutoff based on the results of the PVSC CSS model during the typical year and WRRF inflow rate can reduce both CSO occurrence and volume. The control technology itself does not require any additional capital investments or upkeep from what is currently in place. However, the effectiveness of this control technology would be increased with the addition of any technologies that increase flow capacity such as a parallel interceptor, secondary treatment expansion, or secondary flow bypass. In addition to the regulator modifications, a parallel interceptor would run from the WRRF to outfall regulator NE002. Regulator flows or upstream flows would be redirected to this new interceptor to reduce overflow and make use of an expanded 720 MGD treatment capacity at the WRRF. Finally, the HCFM, which receives flow from the cities of Jersey City, Bayonne, North Bergen, and South Kearny, would be maximized to 146 MGD.

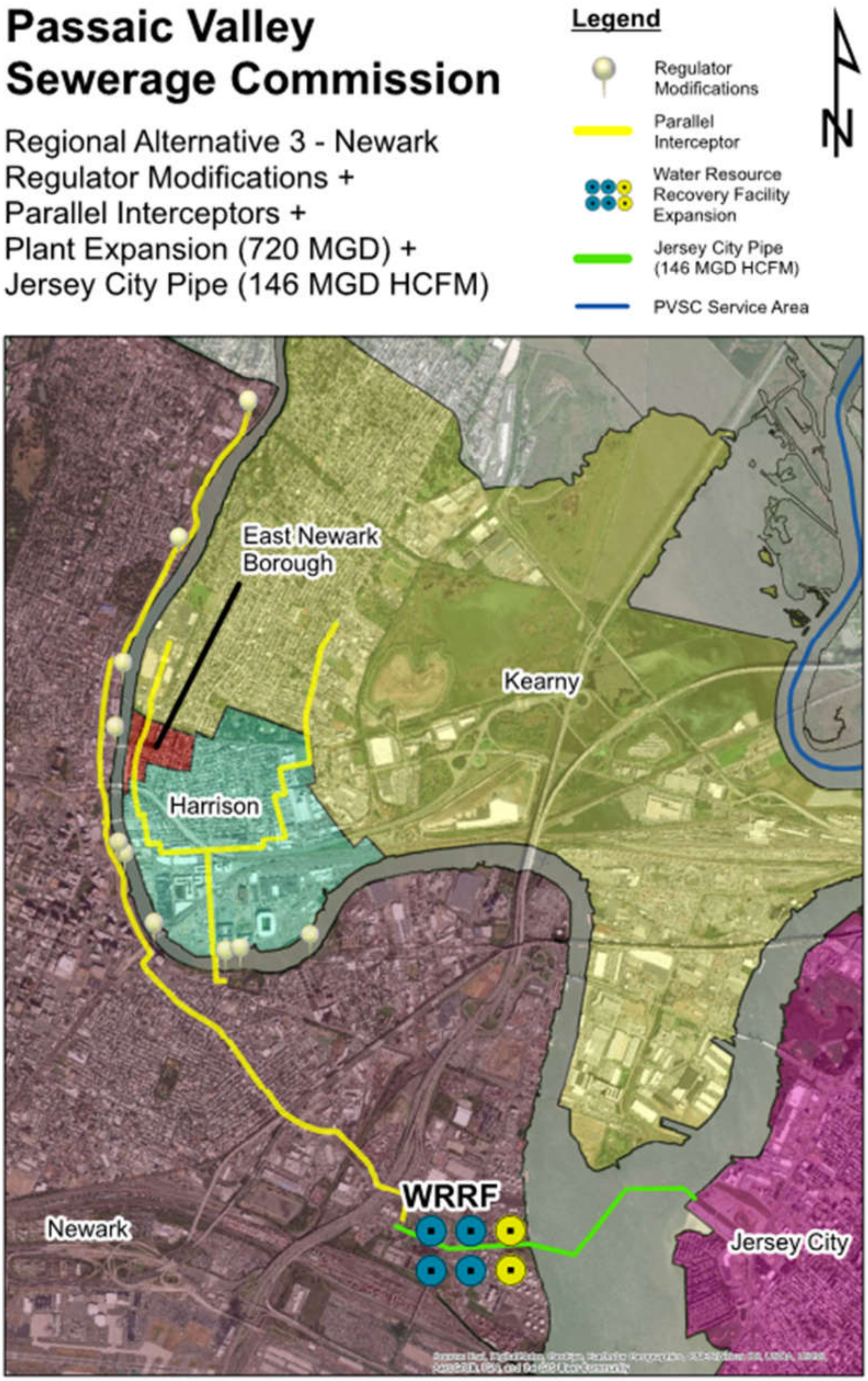

Figure D-2: Regional Alternative 3

Regional Alternative 3 was evaluated to meet the 85% CSO volume capture scenario only because the level of controls cannot be adjusted for the individual technologies. The total life cycle costs, CSO volume discharged and captured, and life cycle cost efficiency (cost/MG of CSO captured) estimated to meet the 85% capture scenario were as follows:

- Total life cycle costs: $465 M
- Total CSO Volume Discharged (MG): 2,884 MG
- Total CSO Volume Captured (MG): 1,380 MG
- Life Cycle Cost Efficiency: $0.34/gal

D.2.4 Regional Alternative 4

Regional Alternative 4 is the same as Alternative 6 that was evaluated by PVSC. This alternative combines Regional Alternative 2 and Regional Alternative 3. Regional Alternative 4 was evaluated to meet each of the yearly CSO event frequencies and for 85% CSO volume capture. This alternative aims to reduce CSO frequency by increasing storage and flow capacities using multiple CSO control technologies. **Figure D-3** depicts the components of Regional Alternative 4. Further details regarding the technologies for this alternative are included in **Appendix A**. The total life cycle costs, CSO volume discharged, and life cycle cost efficiency (cost/MG of CSO captured) were estimated to meet each yearly CSO event frequency and the 85% capture scenario, as summarized in **Table D-5**.

Table D-5: Regional Alternative 4 – Summary of Life Cycle Cost, CSO Volume Discharged and Captured, and Life Cycle Cost Efficiency

CSO Events	Total Life Cycle Cost ($M)	Total CSO Volume Discharged (MG)	Total CSO Volume Captured (MG)	Life Cycle Cost Efficiency ($/gal)
0	$2,924	579	3,685	$0.79
≤4	$2,149	878	3,386	$0.63
≤8	$1,910	1,208	3,056	$0.63
≤12	$1,667	1,530	2,734	$0.61
≤20	$1,402	2,055	2,209	$0.63
85%	$465	2,884	1,380	$0.34

Similar to Regional Alternative 1 and Regional Alternative 2, the life cycle costs are anticipated to be highest when meeting the 0 CSO events per year scenario, and the decrease as the number of CSO events per year increases. The opposite trend is observed for overflow volume discharged, where the least volume is discharged for the 0 CSO events per year scenario and the volumes increase as the number of CSO events per year increases. The 85% capture scenario values are the same for Regional Alternative 3 and Regional Alternative 4 because the regional tunnels will not be needed for the 85% scenario.

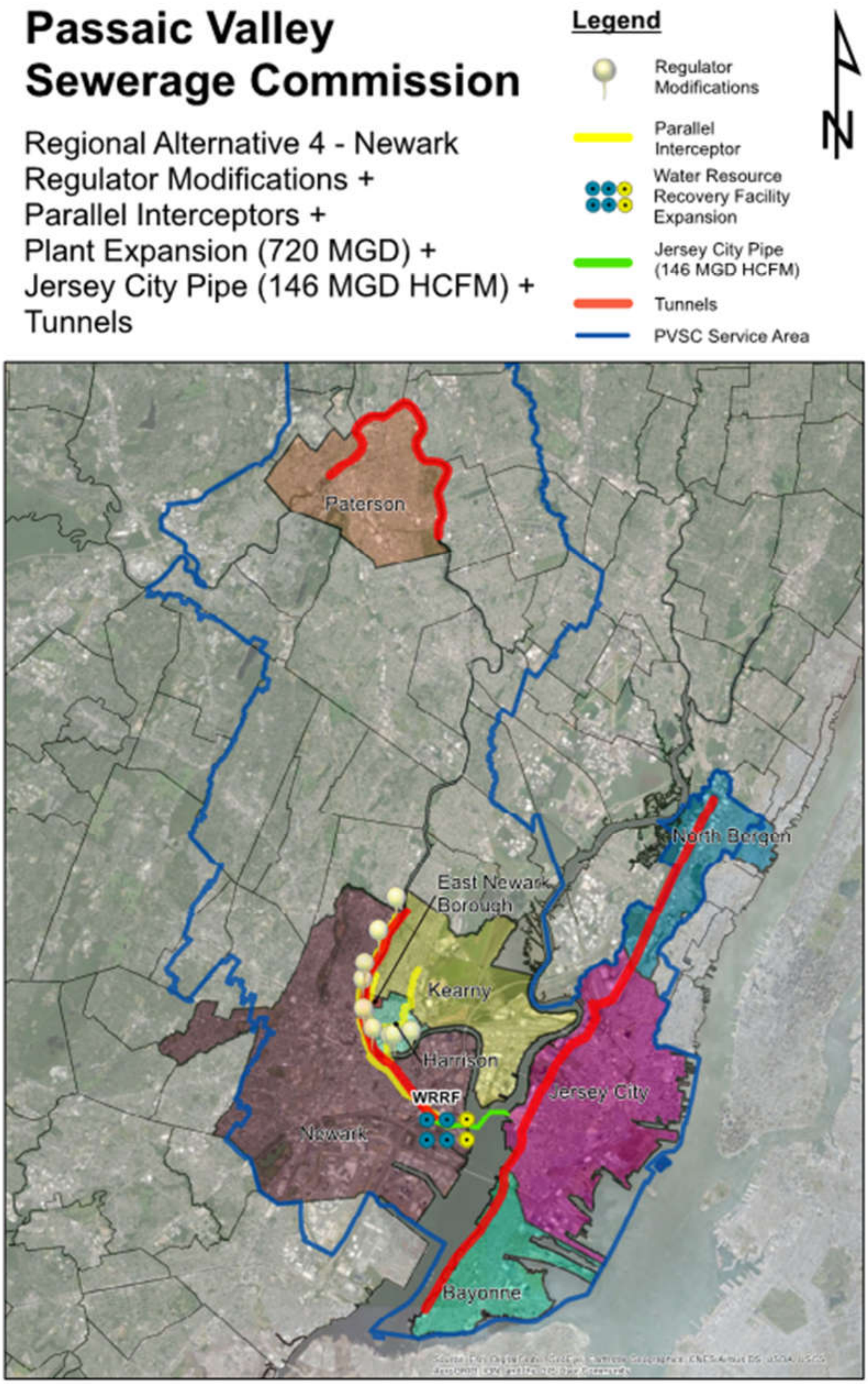

Figure D-3: Regional Alternative 4

D.2.5 Summary of Cost Opinions

Cost opinions were determined for each of the four (4) regional alternatives. The most advantageous alternative is one that reduces the volume or frequency of CSO discharges for the lowest cost.

Permittees will select alternatives that provide the most benefits for the lowest costs. Afterward, further discussion between the Permittees and NJDEP will be conducted to arrive at a satisfactory conclusion for both parties and NJDEP approval.

D.3 SELECTION OF ALTERNATIVES

This section of the report describes the strategy that will be used for the final evaluation of CSO control alternatives for the permittees within the PVSC Treatment District. The selected alternative will meet each permittee's Permit requirements and will be considered feasible for application in conjunction with alternatives developed by the other CSO permittees within the hydraulically connected system, as per requirement by the Permits. The evaluation factors will be finalized and the selection of the regional alternative will be determined after this Regional Alternatives Report is submitted, pending approval from the NJDEP of the alternatives to be evaluated. The selection of the CSO control alternatives and the corresponding implementation schedule will be provided in the subsequent Selection and Implementation of Alternatives Report in the Final LTCP.

D.3.1 Evaluation Factors

The evaluation factors comprise of cost and non-cost factors deemed important for alternatives analysis. Two of the factors, cost and performance (level of CSO control), are summarized in **Section D.1**. Additional factors, such as public factors, water quality, public health, and environmental impacts, operational impacts, and implementation concerns, may be accounted for while still considering cost and performance.

The criteria, weighting, and ranking method (quantitative or qualitative) will be discussed and determined through collaboration with the permittees.

D.3.2 Regulatory Compliance

Alternatives analyzed within this report includes those required by the NJPDES Permit requirements noted in Section G.4.e for each permittee.

D.3.3 Selection of Regional Alternative

As discussed above, the selection of the regional alternative will be determined after this Regional Alternatives Report is submitted and discussion with NJDEP and the Permittees takes place. The evaluation and selected regional alternative will be presented in the Final Regional LTCP (Selection and Implementation of Alternatives Report), due for submission by June 1, 2020.

SECTION E - REFERENCES

Greeley and Hansen. (2015). *Baseline Compliance Monitoring Program Quality Assurance Project Plant (QAPP)*. Report prepared for Passaic Valley Sewerage Commission (PVSC).

Greeley and Hansen. (2015). *System Characterization and Landside Modeling Program Quality Assurance Project Plan (QAPP) Part 1*. Report prepared for Passaic Valley Sewerage Commission (PVSC).

Greeley and Hansen. (2015). *System Characterization and Landside Modeling Program Quality Assurance Project Plan (QAPP) Part 2*. Report prepared for Passaic Valley Sewerage Commission (PVSC).

Greeley and Hansen. (2018). *Identification of Sensitive Areas Report*. Report prepared for Passaic Valley Sewerage Commission (PVSC).

Greeley and Hansen. (2018). *NJCSO Group Compliance Monitoring Program Report*. Report prepared for Passaic Valley Sewerage Commission (PVSC).

Greeley and Hansen. (2018). *Public Participation Process Report*. Report prepared for Passaic Valley Sewerage Commission (PVSC).

Greeley and Hansen. (2018). *Service Area System Characterization Report*. Report prepared for Passaic Valley Sewerage Commission (PVSC).

Interstate Environmental Commission. (2018, April 2). *IEC Regulations*. Retrieved from Interstate Environmental Commission: http://www.iec-nynjct.org/wq.regulations.htm

New Jersey Administrative Code (NJAC) -7:9B Surface Water Quality Standards, October 2016. https://www.nj.gov/dep/rules/rules/njac7_9b.pdf

New Jersey Department of Environmental Protection. (2017). *2014 New Jersey Integrated Water Quality Assessment Report: Appendix B: Final 303(d) List of Water Quality Limited Waters with Sublist 5 Subpart and Priority Ranking for TMDL Development*. Division of Water Monitoring and Standards, Bureau of Environmental Analysis, Restoration and Standards.

New Jersey Department of Environmental Protection. (2018). *Evaluating Green Infrastructure: A Combined Sewer Overflow Control Alternative for Long Term Control Plans*. Division of Water Quality.

United States Environmental Protection Agency (USEPA) - Federal Water Pollution Control Act, November 2002.
https://www.epa.gov/sites/production/files/2017-08/documents/federal-water-pollution-control-act-508full.pdf

United States Environmental Protection Agency (USEPA) - EPA Combined Sewer Overflow (CSO) Control Policy, April, 1994. https://www.epa.gov/sites/production/files/2015-10/documents/owm0111.pdf

United States Environmental Protection Agency (USEPA) - EPA CSO Guidance for LTCP, September, 1995. http://water.epa.gov/polwaste/npdes/cso/upload/owm0272.pdf

SECTION F - ABBREVIATIONS

AACE: Association for the Advancement of Cost Engineering
BA: Bayonne
BMP: Best Management Practices
BOD: Biochemical Oxygen Demand
CMP: Compliance Monitoring Program
CSO: Combined Sewer Overflow
CSS: Combined Sewer System
CWA: Clean Water Act
EDP: Effective Date of the Permit
EN: East Newark
EPA: Environmental Protection Agency
FOG: Fats, Oils, and Grease
FW2-NT: Fresh Water Non Trout
GI: Green Infrastructure
GIS: Geographic Information System
GM: Geometric Mean
GRDs: Grease Removal Devices
HA: Harrison Town
HCFM: Hudson County Force Main
HDD: Horizontal Directional Drilling
H&H: Hydrologic and Hydraulic
IDDE: Illicit Discharge Detection and Elimination
IEC: Interstate Environmental Commission
I/I: Inflow and Infiltration
JC: Jersey City
JCMUA: Jersey City Municipal Utilities Authority
KEA: Kearny Town
LTCP: Long Term Control Plan
MGD: Million Gallons Per Day
MUA: Municipal Utilities Authority
NJAC: New Jersey Administrative Code
NB: North Bergen
NBMUA: North Bergen Municipal Utilities Authority
NE: Newark
NJDEP: New Jersey Department of Environmental Protection
NJPDES: New Jersey Pollutant Discharge Elimination System
NRCS: Natural Resources Conservation Service
O&M: Operation and Maintenance
PAA: Peracetic Acid
PAT: Paterson
POC: Pollutants of Concern
POTW: Publicly Owned Treatment Works
PPP: Public Participation Plan

PVSC: Passaic Valley Sewerage Commission
QAPP: Quality Assurance Project Plan
RTC: Real Time Control
SE2 or SE3: Saline Water
SIU: Significant Indirect User
STP: Sewage Treatment Plant
TGM: Technical Guidance Manual
TMDL: Total Maximum Daily Load
TSS: Total Suspended Solids
USEPA: United States Environmental Protection Agency
UV: Ultraviolet
WMA: Watershed Management Areas
WQS: Water Quality Standards
WRRF: Water Resource Recovery Facility