Appendix F

PVSC Typical Hydrologic Year Report
and
NJDEP approval letter dated May 31, 2018

State of New Jersey

PHIL MURPHY
Governor

SHEILA OLIVER
Lt. Governor

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

CATHERINE R. McCABE
Acting Commissioner

May 31, 2018

Email and Hard Copy

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

Re: Review of "Typical Hydrologic Year Report"

Dear Ms. McKenna:

This letter is written to acknowledge receipt of and provide a determination on your submission dated May 2, 2018 entitled "Typical Hydrologic Year Report". This submission was prepared by PVSC on behalf of the New Jersey Combined Sewer Overflow (NJ CSO) Group permittees and includes certifications from the 21 permittees as per Part IV.D.1.b. As you know, the typical year (also known as average design conditions) is a major element for the Characterization Monitoring and Modeling of the Combined Sewer System as required by Part IV.G.1 of all New Jersey Pollutant Discharge Elimination System (NJPDES) CSO permits. This report describes the methodology that was utilized for the Typical Hydrologic Year section, the analysis that was completed, and the recommended Typical Hydrologic Year to be used in the development of a CSO Long Term Control Plan (LTCP).

The Department has reviewed your submission and has determined that all questions and comments have been addressed to the Department's satisfaction.

Thank you for your continued cooperation. Feel free to contact me at (609) 292-4860 or at susan.rosenwinkel@dep.nj.gov if you have any questions regarding this letter.

Sincerely,

Susan Rosenwinkel

Susan Rosenwinkel
Acting Bureau Chief
Bureau of Surface Water Permitting

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C: Tim Boyle, Bayonne MUA, NJPDES Permit No. NJ0109240
Brigite Goncalves, Borough of East Newark, NJPDES Permit No. NJ0117846
Rocco Russomanno, Harrison Town, NJPDES Permit No. NJ0108871
Richard Haytas, Jersey City MUA, NJPDES Permit No. NJ0108723
Robert Smith, Kearny Town, NJPDES Permit No. NJ0111244
Andrea Adebowale, Newark City, NJPDES Permit No. NJ0108758
Frank Pestana, North Bergen MUA, NJPDES Permit No. NJ0108898 & NJ0029084
Fred Margron, Paterson City, NJPDES Permit No. NJ0108880
Alberto Gabrera, Town of Guttenberg, NJPDES Permit No. NJ0108715
Stephen Dowhan, Joint Meeting of Essex & Union Counties, NJPDES Permit No. NJ0024741
Dan Loomis, Elizabeth City, NJPDES Permit No. NJ0108782
Fred Pocci, NHSA, NJPDES Permit No. NJ0026085 & NJ0025321
Richard L. Fitamant, Middlesex County Utilities Authority, NJPDES Permit No. NJ0020141
Luis A. Perez Jimenez, Perth Amboy City, NJPDES Permit No. NJ0156132
Dominic DiSalvo, Bergen County Utilities Authority, NJPDES Permit No. NJ0020028
Edward Mignone, Fort Lee Boro, NJPDES Permit No. NJ0034517
Jesse D'Amore, Hackensack City, NJPDES Permit No. NJ0108766
Alan O'Grady, Ridgefield Park Village, NJPDES Permit No. NJ0109118

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TYPICAL HYDROLOGIC YEAR REPORT

Prepared on behalf of the NJ CSO Group Permittees By Passaic Valley Sewerage Commission

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

"Protecting Public Health and the Environment"

May 2018

SECTION A - PROJECT MANAGEMENT

A.0 SUMMARY OF CHANGES

This Report is for the Typical Hydrologic Year to be utilized by the NJ CSO Group. This Report describes the methodology that was utilized for the Typical Hydrologic Year selection, the analysis that was completed, and the recommended Typical Hydrologic Year to be used in the development of a CSO Long Term Control Plan (LTCP). 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: Typical Hydrologic Year Report for the NJ CSO Group

Preparer:

Typical Year Analysis Project Officer: _____ 9/29/17
Michael J. Hope, P.E., Greeley and Hansen LLC — Date

Typical Year Analysis QA Officer: _____ 9/29/17
Timothy J. Dupuis, P.E., CDM Smith — Date

PVSC LTCP Consultants

LTCP Consultant Project Officer: _____ 9/29/17
Michael J. Hope, P.E., Greeley and Hansen LLC — Date

LTCP Consultant QA Officer: _____ 9/29/17
Timothy J. Dupuis, P.E., CDM Smith — Date

Passaic Valley Sewerage Commission

PVSC Program Manager: _____ 09/29/2017
Bridget McKenna, Chief Operating Officer, PVSC — Date

PVSC QA Officer: Marques Eley _____ 9/29/17
Marques Eley, PVSC — Date

Typical Hydrologic Year Report for the NJ CSO Group

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

NJPDES Number NJ0021016 (Passaic Valley Sewage Commission)

Approval of Report:

Permittee: 09/29/2017

Bridget McKenna — Date
Chief Operating Officer, Passaic Valley Sewerage 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 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: 09/29/2017

Bridget McKenna — Date
Chief Operating Officer, Passaic Valley Sewerage Commission

Typical Hydrologic Year Report for the NJ CSO Group

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

NJPDES Number NJ0109240 (Bayonne City)

Approval of Report:

Permittee: _____ 10.4.17

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 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: _____ 10.4.17

Timothy Boyle — Date
Superintendent, City of Bayonne Department of Public Works

Typical Hydrologic Year Report for the NJ CSO Group

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

NJPDES Number NJ0117846 (East Newark)

Approval of Report:

Permittee: 10/6/17

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 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: 10/6/17

Frank Pestana — Date
Licensed Operator, Borough of East Newark

Typical Hydrologic Year Report for the NJ CSO Group

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

NJPDES Number NJ0108871 (Harrison)

Approval of Report:

Permittee: _____ 10/18/17

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 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: _____ 10/18/17

Rocco Russomano — Date
Town Engineer, Town of Harrison

Typical Hydrologic Year Report for the NJ CSO Group

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: Richard Haytas 12/5/17

Rich Haytas
Senior Engineer, Jersey City MUA

Date

NJPDES Certification:

"Without prejudice to any objections timely made to permit conditions, I certify under penalty of law that this document and all attachments were prepared either: (a) under my direction or supervision; or (b) as part of a 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: Richard Haytas 12/5/17

Rich Haytas
Senior Engineer, Jersey City MUA

Date

Typical Hydrologic Year Report for the NJ CSO Group

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

NJPDES Number NJ0111244 (Kearny)

Approval of Report:

Permittee: _____ 11/17/17
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 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: _____ 11/17/17
Robert J. Smith — Date
Town Administrator, Town of Kearny

Typical Hydrologic Year Report for the NJ CSO Group

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

NJPDES Number NJ0108758 (Newark)

Approval of Report:

Permittee: _____ 10/16/17
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 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: _____ 10/16/17
Ras J Baraka — Date
Mayor, City of Newark

Typical Hydrologic Year Report for the NJ CSO Group

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

NJPDES Number NJ0108898 (North Bergen MUA)

Approval of Report:

Permittee: _____ 10/6/17
Frank Pestana — Date
Exec. Director, North Bergen 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: _____ 10/6/17
Frank Pestana — Date
Exec. Director, North Bergen MUA

Typical Hydrologic Year Report for the NJ CSO Group

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

NJPDES Number NJ0029084 (North Bergen Woodcliff)

Approval of Report:

Permittee: _____ 10/11/17

Frank Pestana — Date
Executive Director, North Bergen Township

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: _____ 10/11/17

Frank Pestana — Date
Executive Director, North Bergen Township

Typical Hydrologic Year Report for the NJ CSO Group

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

NJPDES Number NJ0108880 (Paterson)

Approval of Report:

Permittee: _____ 10/5/17
Manny Ojeda
Director Public Works, City of Paterson
Date

NJPDES Certification:

"Without prejudice to any objections timely made to permit conditions, I certify under penalty of law that this document and all attachments were prepared either: (a) under my direction or supervision; or (b) as part of a 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: _____ 10/5/17.
Manny Ojeda
Director Public Works, City of Paterson
Date

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Typical Hydrologic Year Report for the NJ CSO Group

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

NJPDES Number NJ0024741 (Joint Meeting of Essex and Union Counties)

Approval of Report:

Permittee: _____ 10/6/17

Samuel McGhee — Date
Executive Director, Joint Meeting of Essex and Union Counties

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: _____ 10/6/17

Samuel McGhee — Date
Executive Director, Joint Meeting of Essex and Union Counties

Typical Hydrologic Year Report for the NJ CSO Group

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

NJPDES Number NJ0020141 (Middlesex County UA)

Approval of Report:

Permittee: 10-16-17

Richard L. Fitamant — Date
Executive Director, Middlesex County 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 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: 10-16-17

Richard L. Fitamant — Date
Executive Director, Middlesex County Utilities Authority

Typical Hydrologic Year Report for the NJ CSO Group

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

NJPDES Number NJ0108715 (Town of Guttenberg)

Approval of Report:

Permittee: 10/6/17

Frank Pestana — Date
Licensed Operator, Town of Guttenberg

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: 10/6/17

Frank Pestana — Date
Licensed Operator, Town of Guttenberg

Typical Hydrologic Year Report for the NJ CSO Group

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

NJPDES Number NJ0025321 (North Hudson Sewerage Authority)

Approval of Report:

Permittee: 10/11/17

Fredric J. Pocci, P.E. Date
Authority Engineer, North Hudson Sewerage 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 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: 10/11/17

Fredric J. Pocci, P.E. Date
Authority Engineer, North Hudson Sewerage Authority

Typical Hydrologic Year Report for the NJ CSO Group

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

NJPDES Number NJ0034517 (Borough of Fort Lee)

Approval of Report:

Permittee: 10-3-2017

Alfred R. Restaino — Date
Borough Administrator, Borough of Fort Lee

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: 10-3-2017

Alfred R. Restaino — Date
Borough Administrator, Borough of Fort Lee

Typical Hydrologic Year Report for the NJ CSO Group

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

NJPDES Number NJ0108766 (City of Hackensack)

Approval of Report:

Permittee: _____ 11/22/17
Jesse V. D'Amore — Date
Licensed Operator, City of Hackensack

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: _____ 11/22/17
Jesse V. D'Amore — Date
Licensed Operator, City of Hackensack

Typical Hydrologic Year Report for the NJ CSO Group

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

NJPDES Number NJ0109118 (Ridgefield Park Village)

Approval of Report:

Permittee: _____ 10/2/17
Alan O'Grady — Date
Superintendent, Ridgefield Park Village

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 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 reviewed this report, 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: _____ 10/2/17
Alan O'Grady — Date
Superintendent, Ridgefield Park Village

Typical Hydrologic Year Report for the NJ CSO Group

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

NJPDES Number NJ0108782 (City of Elizabeth)

Approval of Report:

Permittee: _____ 10/2/2017

Daniel Loomis, P.E. Date
City Engineer, City of Elizabeth

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: _____ 10/2/2017

Daniel Loomis, P.E. Date
City Engineer, City of Elizabeth

Typical Hydrologic Year Report for the NJ CSO Group

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

NJPDES Number NJ0156132 (Perth Amboy City)

Approval of Report:

Permittee: Luis Perez-Jimenez 10/13/17
Luis Perez-Jimenez — Date
Director of Water Operations, Perth Amboy City

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: Luis Perez-Jimenez 10/13/17
Luis Perez-Jimenez — Date
Director of Water Operations, Perth Amboy City

Typical Hydrologic Year Report for the NJ CSO Group

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

NJPDES Number NJ0020028 (Bergen County Utilities Authority)

Approval of Report:

Permittee: _____ 10/2/17
Robert E. Laux — Date
Executive Director, Bergen County 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 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 reviewed this report, 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: _____ 10/2/17
Robert E. Laux — Date
Executive Director, Bergen County Utilities Authority

A.2 DISTRIBUTION LIST

Passaic Valley Sewerage Commission

Bridget McKenna

Marques Eley

Other Entities Participating by Associated Sewage Treatment Plant

Passaic Valley Sewerage Commission (PVSC): Paterson; Newark; Kearny; Harrison; Bayonne MUA; Jersey City MUA; North Bergen MUA

Bergen County Utility Authority (BCUA): Ridgefield Park; Fort Lee; Hackensack

Joint Meeting of Essex and Union Counties: Elizabeth City

North Bergen MUA – Woodcliff Plant: North Bergen Township; Guttenberg; Union City

North Hudson Sewerage Authority (NHSA) – River Road STP: Weehawken; West New York;
Union City

North Hudson Sewerage Authority (NHSA) – Adams Street STP: Hoboken

Middlesex County Utilities Authority (MCUA): Perth Amboy

New Jersey Department of Environmental Protection

Marzooq Alebus, Surface Water Permitting

Nancy Kempel, Surface Water Permitting

Dwayne Kobesky, Surface Water Permitting

Joseph Mannick, Surface Water Permitting

Marc Ferko, Office of Quality Assurance

Biswarup Guha, Water Monitoring and Standards

A.3 PROGRAM CONTACT INFORMATION

Contact information for those parties involved in the Typical Hydrologic Year is as follows:

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

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

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

Biswarup Guha
NJDEP Water Monitoring
and Standards
PO Box 420
401 E. State St., 4nd Floor
Trenton, NJ 08625-0409

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

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

Timothy Boyle
Exec. Director MUA
Bayonne City MUA
630 Avenue C
Bayonne, NJ 07702

Frank Pestana
Licensed Operator
Borough of Newark
6200 Tonnelle Avenue
North Bergen, NJ 07047

Rocco Russomano
Town Engineer
Town of Harrison
318 Harrison Avenue
Harrison, NJ 07026

Rich Haytas
Senior Engineer
Jersey City MUA
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Section 1 Introduction

1.1 Typical Hydrologic Year Report Objectives for CSO LTCP Development

Precipitation generates urban storm water, combined sewer overflows (CSOs), and increased wet weather flows to the wastewater treatment plant. These will contribute bacteria and pollutants to the New York-New Jersey Harbor and its surrounding major tributaries. The effect of these contributors on the receiving streams mainly depends on the magnitude and duration of rainfall events and on the prevailing ambient river conditions controlling dilution and transport of the pollutants. This variability and complexity poses a significant challenge for assessing the performance of wet weather and CSO control alternatives.

In accordance with the USEPA CSO Control Policy (CSO Policy), dated April 19, 1994, the CSO control alternatives should be assessed on a "system-wide, annual average basis". This is accomplished by continuous simulation using a typical hydrologic period for the combined sewer system (CSS) and receiving water quality modeling applications. The CSO Policy supports continuous simulation modeling, i.e., using long-term precipitation records rather than records for individual storms. Long-term continuous precipitation records enable simulations to be based on a sequence of storms so that the additive effect of storms occurring close together can be examined. They also enable storms with a range of characteristics to be included.

The representative year is intended to contain the closest to average year for the years with available data. Average year conditions are defined as the arithmetic average of the predictions for the selected period.

1.2 Principal Data Users

The principal users of the typical year selection will be PVSC, hydraulically connected PVSC member municipalities, the LTCP engineering consultants supporting PVSC, and other CSO municipalities who elect to utilize the typical year. PVSC is sharing the data generated for the selection of the typical year with the cooperating members of the NJ CSO Group and, therefore, the NJ CSO Group members may use the data to satisfy certain NJPDES permit requirements related to the requirements of their NJPDES Permits. **Table 1-1** defines the list of primary data users.

Secondary users of the data, such as the New Jersey Department of Environmental Protection (NJDEP), are responsible for evaluating the data using quality criteria appropriate for their use and/or decision making process.

Table 1-1: List of Primary Data Users

Central Sewage Treatment Facility	Hydraulically Connected CSO Municipalities and Permittees
Passaic Valley Sewage Commission (PVSC)	Paterson City[1]; Newark City[1]; Kearny Town[1]; Harrison Town[1]; East Newark Borough[1]; Bayonne MUA[1]; Jersey City MUA[1]; North Bergen MUA[1]
Bergen County Utility Authority (BCUA)	Village of Ridgefield Park[1] Fort Lee City[1] Hackensack City[1]
Joint Meeting of Essex and Union Counties[1] (JMEUC)	Elizabeth City[1]
North Bergen Municipal Utility Authority (NBMUA)[1] – Woodcliff Plant	North Bergen MUA[1] Guttenberg Town[1]
North Hudson Sewerage Authority (NHSA)-River Road STP	Weehawken Township[2] West New York Town[2] Union City[2]
North Hudson Sewerage Authority (NHSA) –Adams Street STP	Hoboken City[2] Union City[2]
Middlesex County Utilities Authority (MCUA)	Perth Amboy City[1]

[1] Owns CSO Permitted outfalls discharging to modeled receiving waters. [2]Municipality with CSOs within their limits but not a permit holder

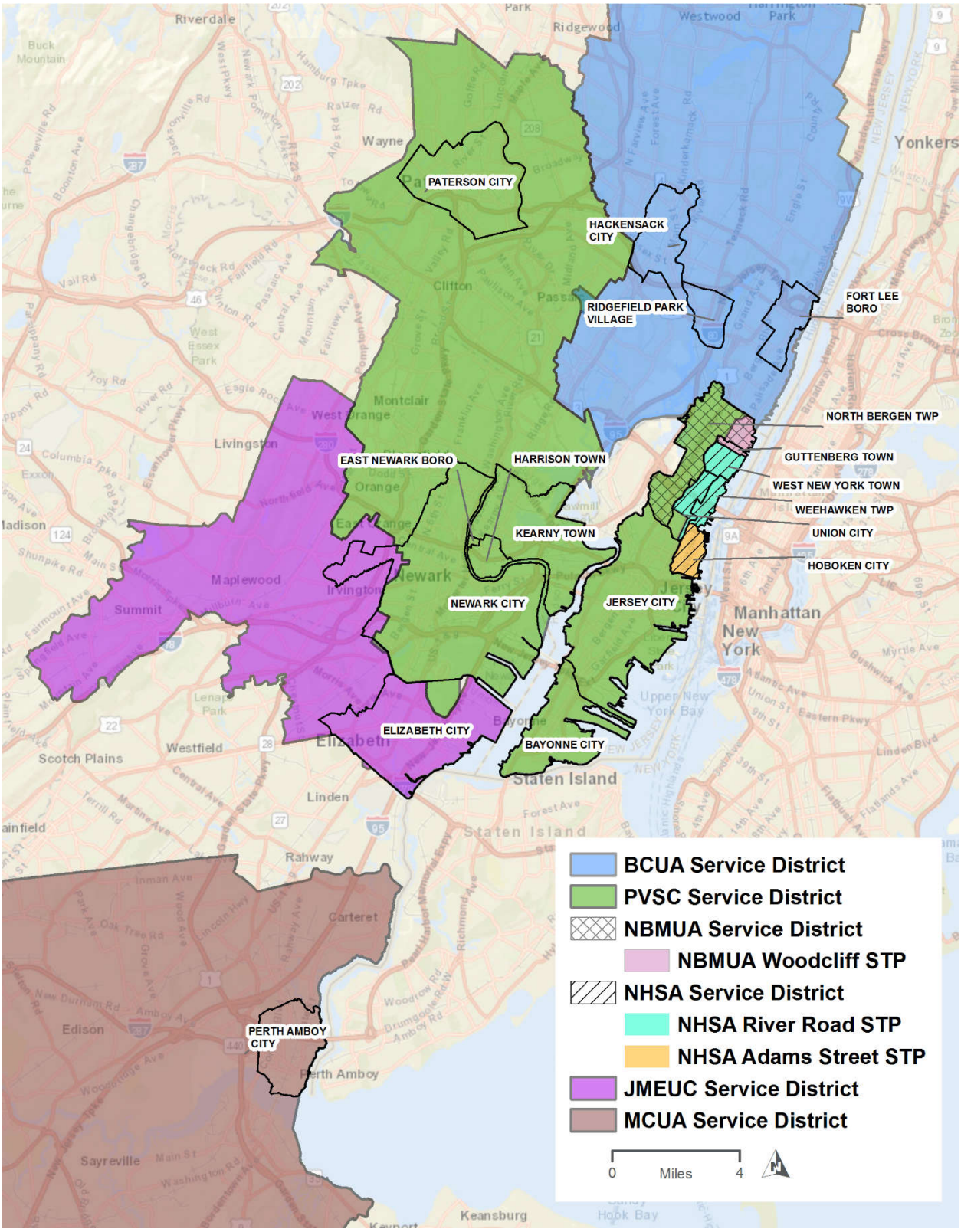
1.3 Decision Makers

NJDEP has decision-making authority for the selection and application of the typical year. The Program Manager for PVSC is ultimately responsible for all technical, financial, and resource-related elements of the Program and is the main contact for interagency communications. Any changes made to the typical year selection as outlined in this Report will be reported in writing for signatory approval and amendments to the Report will be submitted, as necessary.

1.4 Problem Definition and Background

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. Member utilities provide service to multiple municipalities, and the interrelationships are numerous and varied as shown on **Figure 1-1**.

Figure 1-1: Participating NJCSO Group Members and Associated Central Sewage Treatment Facilities



For example:

- The utilities responsible for providing treatment typically do not have permitted CSOs, which are the responsibility of the municipalities;
- The municipalities with permitted CSOs may not be able to reduce their discharges without the treatment utility modifying its treatment and/or conveyance system;
- Certain municipalities own and operate their own combined sewer systems, interceptors, CSO control facilities, and pumping stations, while others do not own their collection systems; and
- Combinations of utilities and municipalities may jointly own force mains, pumping stations, and other appurtenances but remain independently permitted by the State of New Jersey.

Because of these complex interrelationships, the NJ CSO Group elected to have PVSC lead the technical work required for CSO permit compliance relative to the selection of a typical year. Participating members may use the results generated by the typical year analysis for assessing CSO impacts and potential mitigation strategies.

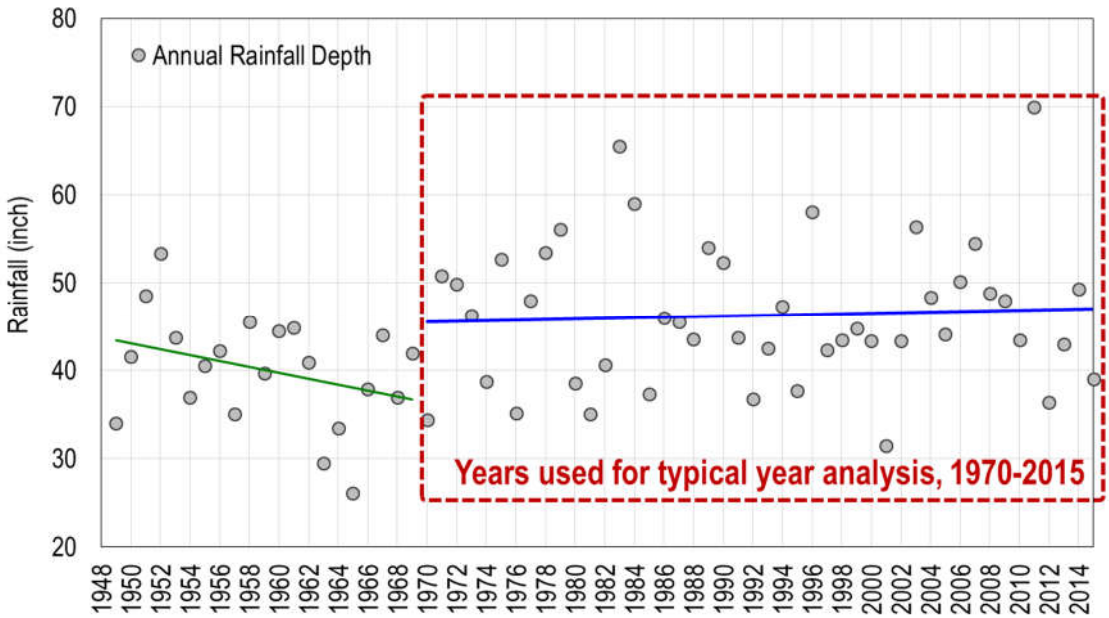
1.5 Annual Precipitation Trend 1948-2015

Average U.S. precipitation has increased since 1900, but there are regional differences, with some areas having larger increases, and others, decreases. Local climate change should be considered when selecting appropriate data records for the typical period analysis.

Daily Precipitation data from Newark Liberty International Airport were obtained from the National Oceanic and Atmospheric Administration (NOAA) from 1948 through 2015 to evaluate precipitation trend.

Figure 1-2 shows annual precipitation depth from 1948 to 2015. An average straight trend line using sum of least squares is also shown in the figure for characterizing long-term precipitation pattern. During 1948 through 2015, annual precipitation depth ranges from 26.9 to 69.91 inches, with the driest year in 1963 and the wettest year in 2011. The figure splits to show the trend line change from 1948 to 1970 contrasted to 1970 to 2015. From 1948 to 1970 shows a declining pattern with an approximate change of -0.337 inch per year. From 1970 to 2015 shows an inclining pattern with an approximate change of +0.032 inch per year. The latter trend line is more relevant to present day. Therefore it is determined that the typical period for the LTCP to be selected based on statistical analysis of precipitation records in recent 46 years (i.e., 1970-2015).

Figure 1-2: Annual Precipitation Depth at Newark Liberty International Airport



1.6 Methodology of Typical Year Selection

The typical hydrologic year is selected to provide representative and unbiased approximations of expected conditions in terms of both averages and historical variability. Representativeness is assessed using objective criteria for each of the ambient factors (i.e., river flow and precipitation). As indicated in the previous section, the selection of the typical hydrologic period is based on the historical records in the past 46 years from 1970 through 2015.

The following datasets are used for the analysis of the typical hydrologic period:

- Hourly precipitation data for the National Climate Data Center gauge at Newark Liberty International Airport for 1970 – 2015 is used for analyzing individual rainfall event and event characteristics.
- Daily precipitation data for the National Climate Data Center gauge at Newark WSO Airport for 1970 – 2015 is used for analyzing annual and seasonal precipitation amounts.

The EPA's CSO Control Policy (1994) identifies two general approaches to attainment of water quality standards (WQS): the demonstration approach and the presumption approach.

Under the demonstration approach, the municipality would be required to successfully demonstrate compliance with each of the following criteria (II.C.4.b):

i. *the planned control program is adequate to meet WQS and protect designated uses, unless WQS 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 planned control program will not preclude the attainment of WQS or the receiving waters' designated uses or contribute to their impairment. Where WQS and designated uses are not met in part because of natural background conditions or pollution sources other than CSOs, a total maximum daily load, including a wasteload allocation, 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 subsequently determined to be necessary to meet WQS or designated uses.*

Under the presumption approach, controls adopted in the LTCP should be required to meet one of the following criteria (II.C.4.a):

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…*[see definition of minimum treatment, 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 paragraph ii above.*

Criteria used in this typical year analysis were developed based on requirements listed in the presumption approach and the demonstration approach, and potential operational and maintenance considerations for CSO control facility.

Key criteria parameters used in the evaluation are listed in **Table 1-2**. Each parameter is given a weighting factor to describe the individual importance on the averageness of the analyzed time period.

- Annual precipitation depth: it is the total precipitation depth in a specific year. This parameter is important in evaluating annual overflow volume and potential storage volume needed for CSO controls.
- Number of events with rainfall depth equal to or greater than 0.2 inch: this parameter is selected because a previous study indicates that for a storm event of 0.2 inch, 40% of the CSOs are activated in the municipalities tributary to the main interceptor and 25% of the CSO s in the City of Bayonne are activated. As a result, 0.2 inch of total rainfall volume provides a conservative metric for defining a system overflow event.
- Number of events with rainfall depth equal to or greater than 0.1 inch: it is recommended a rainfall trigger of 0.1 inch be used in the analysis. Such rainfall trigger is used to indicate potential start of surface runoff and trigger for overflow in some of the systems.
- The 5th largest storm volume: this is the 5th largest storm by volume in a specific year. This parameter is important for designing maximum storage capacity for potential presumptive approach. One of the presumption approach requires "*No more than an average of four overflow events per year*" which means that the system would need to retain the 5th largest storm to avoid overflows more than four events.
- Rainfall volume for 85% captured: this is the individual precipitation depth that the collection system should be able to capture to achieve an annual goal of at least 85% capture of wet weather volumes. This parameter is also important for determining maximum storage volume or WWTP capacity for potential presumptive approach. Another requirement of the presumption approach indicates "*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*". This parameter is estimated by assigning a precipitation depth (named "R85") to a specific year, rainfall events with precipitation depth equal to or less than this value (R85) will be completely captured, and rainfall events with precipitation depth greater than this value (R85) will be captured up to the assigned value. The ratio of the total captured precipitation depth to the total annual precipitation depth in the year should be 0.85. Calculation of R85 is an iterative process.
- Number of back-to-back rainfall events: this parameter is important for determining antecedent conditions and maximum storage volume or WWTP capacity. If the next rainfall event's starting time is within 24 hours of the previous rainfall event's ending time, these two rainfall events are considered as back-to-back rainfall events. This parameter could impact potential CSO facility operations.

- Maximum peak intensities of the 5th largest storm and less: this is the maximum of the peak precipitation intensities of rainfall events that is smaller than the fourth largest storm by volume in a specific year. This parameter is important for determining the sizing of conveyance pipes, diversions, regulators, pumps, etc. The system would need to be able to pass this peak intensity to avoid overflows at the 5th largest storm event.
- Number of storm events with return frequency equal to or greater than 1-year: this parameter is to calculate the total storm event number that has return frequencies of 1-year and above. This parameter is important for determining extremely large storms. The return frequency is determined by comparing precipitation depth to the NOAA's precipitation frequency estimates for Newark CSO Airport (**Table 1-3** & **Figure 1-3**). **Figure 1-3** shows example plots of three rainfall events with precipitation frequency more than 1-year. The three events have different durations, the 5 to 10-year event is above 5-year frequency in duration 4-9 hour, the 2-year event is above 2-year frequency in duration 17-24 hour, and the 1-year event has 1-year frequency in duration 4-6 hour.
- Average Rainfall Duration: this parameter is important for determining storage capacity. The longer the duration of s rainfall event the more likely the system reaches its capacity and start overflowing.
- Average Rainfall Intensity: this parameter is important for determining storage capacity of the system including pipes, regulators, diversions, etc.

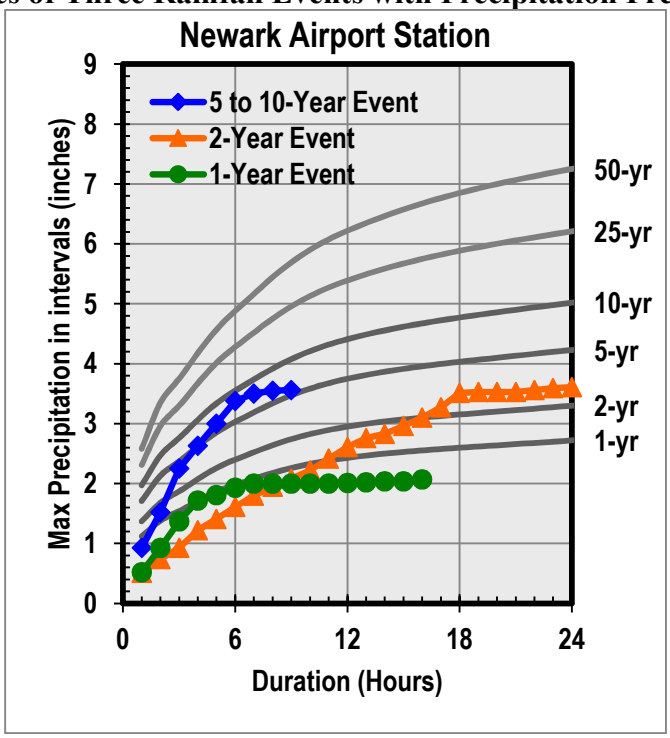
Table 1-2: Typical Hydrologic Year Ranking Parameters

Criteria Parameter	Description / Importance	Weighing Factor
Annual rainfall depth	Impacting annual overflow volume and storage volume	30%
# of events with rainfall depth ≥ 0.2 in	Rainfall depth to trigger overflow in existing system	10%
# of events with rainfall depth ≥ 0.1 in	Rainfall depth to trigger surface runoff	5%
5th largest storm volume	Determining max storage capacity or WWTP capacity	5%
Rainfall volume for 85% captured	Determining max storage capacity or WWTP capacity	5%
# of back-to-back rainfall events	Determining antecedent conditions and potential storage facility operation	10%
Maximum peak intensities of the 5th largest storm and less	Determining the sizing of conveyance pipes, diversions, regulators, pumps, etc.	5%
# of storms with return frequency ≥ 1-year	Extremely large storms to be avoid	5%
Average Rainfall Duration	Determining storage capacity	15%
Average Rainfall Intensity	Determining storage capacity including pipes, regulators, diversions, etc.	10%

Table 1-3: Partial Duration Series (PDS) - Based Precipitation Frequency Estimates With 90% Confidence Intervals (in inches) for Newark WSO Airport
(Source: NOAA Precipitation Frequency Data Server)

Duration	Average recurrence interval (years)					
	1	2	5	10	25	50
5-min	**0.332** (0.304-0.365)	**0.396** (0.363-0.435)	**0.469** (0.429-0.516)	**0.522** (0.476-0.573)	**0.59** (0.536-0.647)	**0.636** (0.575-0.698)
10-min	**0.529** (0.484-0.580)	**0.633** (0.580-0.695)	**0.75** (0.685-0.824)	**0.834** (0.759-0.915)	**0.935** (0.848-1.03)	**1.01** (0.909-1.11)
15-min	**0.66** (0.604-0.724)	**0.793** (0.726-0.870)	**0.946** (0.863-1.04)	**1.05** (0.957-1.15)	**1.18** (1.07-1.30)	**1.27** (1.15-1.40)
30-min	**0.903** (0.827-0.991)	**1.09** (1.00-1.20)	**1.34** (1.22-1.47)	**1.52** (1.38-1.67)	**1.74** (1.58-1.91)	**1.91** (1.72-2.09)
60-min	**1.12** (1.03-1.23)	**1.37** (1.25-1.50)	**1.71** (1.56-1.88)	**1.97** (1.80-2.16)	**2.31** (2.10-2.54)	**2.58** (2.33-2.83)
2-hr	**1.38** (1.26-1.52)	**1.68** (1.53-1.85)	**2.13** (1.93-2.35)	**2.47** (2.24-2.73)	**2.96** (2.66-3.26)	**3.35** (3.00-3.69)
3-hr	**1.54** (1.40-1.69)	**1.87** (1.71-2.06)	**2.37** (2.16-2.61)	**2.76** (2.51-3.04)	**3.3** (2.98-3.63)	**3.75** (3.36-4.12)
6-hr	**1.98** (1.81-2.18)	**2.4** (2.20-2.64)	**3.03** (2.77-3.33)	**3.55** (3.22-3.88)	**4.28** (3.85-4.68)	**4.88** (4.37-5.34)
12-hr	**2.43** (2.22-2.67)	**2.95** (2.70-3.24)	**3.75** (3.42-4.11)	**4.41** (4.01-4.83)	**5.39** (4.85-5.87)	**6.22** (5.56-6.76)
24-hr	**2.72** (2.52-2.96)	**3.3** (3.06-3.58)	**4.23** (3.91-4.59)	**5.02** (4.63-5.44)	**6.21** (5.69-6.72)	**7.25** (6.59-7.83)

Figure 1-3: Examples of Three Rainfall Events with Precipitation Frequency above 1-year



Section 2 Typical Year Analysis

2.1 Statistical Analysis 1970-2015

The 46-year hourly precipitation data (1970 - 2015) from the Newark WSO Airport was analyzed to evaluate all individual rainfall events in the period. An inter-event time (IET) of 6 hours (i.e. minimum dry time of 6 hours between rainfall events) was used to differentiate between individual rainfall events. All rainfall events for the data period were analyzed for duration, inter-event duration, total rainfall amount, as well as maximum rainfall intensities.

A total of 4,812 rainfall events were counted for the period of 1970 – 2015 (3022 events with a total depth ≥ 0.1 inch). Events with a total precipitation depth equal to or greater than 0.1 inch are used for further analysis. **Table 2-1** summarizes rainfall events on an annual basis for annual rainfall depth, number of events above 0.2 inch, number of events above 0.1 inch, the 5th largest storm volume, rainfall volume for 85% captured, number of back-to-back rainfall events, maximum peak intensity of 5th largest and smaller events, number of events with return frequency of 1-year and above, average rainfall duration, and average rainfall intensity. The average of the 46 years is shown at the end of the table for each criteria parameter.

Table 2-1: Annual Rainfall Statistics 1970-2015

Year	Annual Rainfall (in)	# of Events > =0.2" Rainfall Depth	# of Events > =0.1" Rainfall Depth	5th Largest Storm (in)	Rainfall Volume for 85% Captured (in)	# of back-to-back events	Maximum Peak Intensity of 5th Largest & Smaller	# of Storms with Return Freq > 1-yr	Average Rainfall Duration (hr)	Average Rainfall Intensity (in/hr)
1970	34.39	50	64	1.07	0.77	17	0.98	0	9.36	0.080
1971	50.77	49	64	1.67	3.02	14	0.99	3	10.33	0.092
1972	49.86	57	82	1.78	1.35	14	0.62	4	11.00	0.060
1973	46.29	50	61	2.15	1.27	7	0.72	2	11.77	0.082
1974	38.76	54	74	1.2	0.93	11	0.88	1	9.16	0.076
1975	52.65	59	78	1.72	1.57	18	1.01	4	11.19	0.078
1976	35.19	50	66	1.3	0.94	11	0.91	2	9.14	0.082
1977	47.97	49	73	2.04	2.05	9	1.00	1	10.47	0.071
1978	53.41	51	72	2.42	1.54	13	1.28	5	11.85	0.073
1979	56.1	59	76	2.17	1.55	17	0.87	3	11.45	0.075
1980	38.51	37	48	1.85	1.32	4	0.71	2	11.15	0.079
1981	35.04	47	63	1.45	0.94	12	0.92	1	9.03	0.068
1982	40.58	44	55	1.54	1.15	8	0.75	1	11.20	0.068
1983	65.5	58	65	2.49	1.39	9	0.93	4	13.22	0.090
1984	59.01	51	71	1.98	1.63	9	0.94	7	10.90	0.087
1985	37.29	40	58	1.42	1.21	12	0.84	2	11.29	0.069
1986	45.95	52	67	1.77	1.43	13	0.76	2	11.03	0.072

Year	Annual Rainfall (in)	# of Events > =0.2" Rainfall Depth	# of Events > =0.1" Rainfall Depth	5th Largest Storm (in)	Rainfall Volume for 85% Captured (in)	# of back-to-back events	Maximum Peak Intensity of 5th Largest & Smaller	# of Storms with Return Freq > 1-yr	Average Rainfall Duration (hr)	Average Rainfall Intensity (in/hr)
1987	45.53	54	64	1.61	1.07	12	0.97	0	11.39	0.079
1988	43.51	55	59	1.66	1.12	10	0.80	2	10.81	0.078
1989	53.99	61	79	1.95	1.23	15	0.69	2	10.14	0.093
1990	52.3	62	79	1.88	1.08	11	1.04	2	9.78	0.096
1991	43.76	54	64	1.95	1.33	5	0.88	2	11.03	0.084
1992	36.74	46	65	1.31	1.22	9	0.80	2	11.09	0.058
1993	42.51	50	60	1.65	1.07	10	0.80	1	12.60	0.074
1994	47.32	57	72	1.76	1.16	12	0.96	0	11.18	0.077
1995	37.67	43	58	1.35	1.05	7	0.60	1	10.05	0.073
1996	58.07	63	76	2	1.30	10	1.09	3	10.09	0.086
1997	42.35	45	60	1.35	1.21	7	0.71	2	10.75	0.066
1998	43.47	43	56	1.89	1.42	10	1.23	2	11.59	0.089
1999	44.75	52	60	1.43	1.82	11	0.65	3	11.92	0.076
2000	43.35	49	63	1.43	1.02	10	0.50	2	10.24	0.081
2001	31.44	40	55	1.41	0.95	8	0.69	0	10.40	0.058
2002	43.37	49	54	1.67	1.14	5	1.03	1	12.24	0.107
2003	56.33	64	76	1.89	1.16	18	0.86	2	11.41	0.081
2004	48.37	54	73	1.63	1.18	12	0.99	3	10.33	0.084
2005	44.14	44	57	1.4	2.16	3	0.80	2	12.75	0.061
2006	50.16	52	65	2.01	1.44	12	1.17	3	11.26	0.078
2007	54.49	52	67	2.36	1.88	4	1.46	6	9.72	0.095
2008	48.83	49	69	1.84	1.34	11	0.77	3	10.04	0.094
2009	47.93	54	74	1.87	1.13	13	0.80	1	10.91	0.074
2010	43.47	44	52	1.6	1.51	10	0.93	2	12.08	0.103
2011	69.91	59	76	2.4	2.76	17	0.89	4	10.22	0.106
2012	36.35	51	68	1.47	0.94	11	1.01	1	8.81	0.095
2013	42.94	49	61	1.43	1.06	9	1.10	1	10.41	0.083
2014	49.40	60	69	1.56	1.24	10	1.26	2	10.99	0.083
2015	38.98	42	54	1.46	0.95	5	0.99	1	11.43	0.089
Average (1970-2015)	**46.28**	**51.2**	**65.7**	**1.72**	**1.35**	**10.54**	**0.90**	**2.2**	**10.9**	**0.081**

2.2 Ranking Analysis

Ranking analysis was performed by the following steps:

Step 1. Calculation of absolute deviation from average values
(Using 1970 annual rainfall as an example)
Absolute deviation = abs (34.39-46.28) = 11.89 in

Step 2. Calculation of relative deviation by dividing the absolute deviation by the average value:
Relative deviation = 11.89 / 46.28 = 0.257

Step 3: Calculation of weighted deviation score by multiplying the weighting factor (**Table 1-2)** to the relative deviation:
Weighted deviation score = 30% x 0.257 = 0.077
Table 2-2 shows weighted deviation scores for all parameters and years.

Step 4: Calculation of final score by adding the weighted deviation scores of all the ten ranking parameters:
Final score for 1970 =
0.077+0.002+0.001+0.019+0.022+0.061+0.004+0.050+0.021+0.001 = 0.258
Table 2-2 shows final scores for all years.

Step 5: Rank the years based on the final scores. The lower the final score, the higher the rank for the hydrologic period (i.e., the closer it is to the average condition).

Figure 2-1 and **Table 2-2** show the ranking results of the 46 years, with a ranking of 1 being the highest and a ranking of 46 being the lowest ranked hydrologic period.

Figure 2-1: Ranking Score of 1970-2015

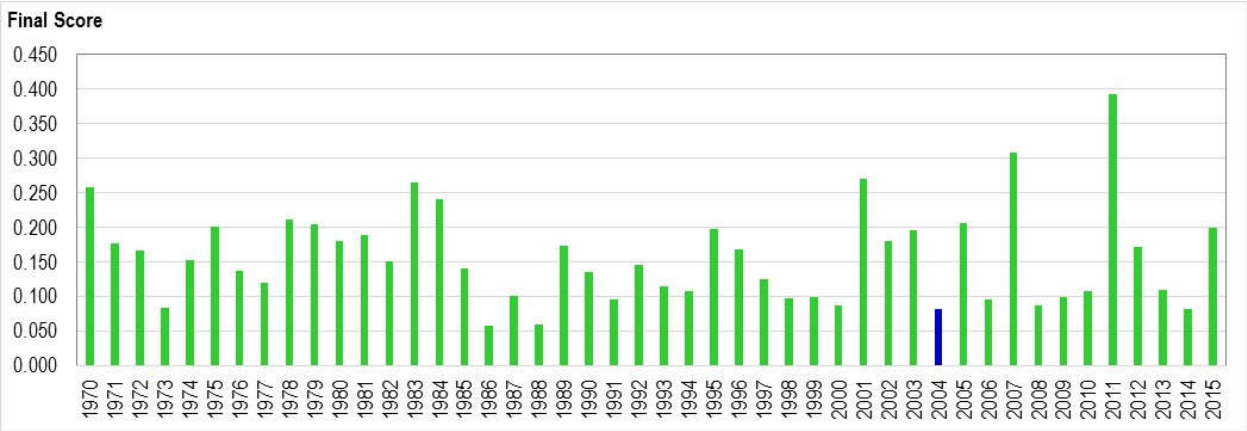


Table 2-2: Typical Hydraulic Year Ranking Analysis_Deviation Score

Year	Annual Rainfall (in)	# of Events >=0.2" Rainfall Depth	# of Events >=0.1" Rainfall Depth	5th Largest Storm (in)	Rainfall Volume for 85% Captured (in)	# of back-to-back events	Maximum Peak Intensity of 5th Largest & Smaller	# of Storms with Return Freq > 1-yr	Average Rainfall Duration (hr)	Average Rainfall Intensity (in/hr)	Final Score	Rank
Weighing Factor	10%	5.0%	5.0%	10%	15%	15%	5%	15%	15%	5%		
1970	0.077	0.002	0.001	0.019	0.022	0.061	0.004	0.050	0.021	0.001	0.258	42
1971	0.029	0.004	0.001	0.002	0.062	0.033	0.005	0.019	0.007	0.014	0.176	30
1972	0.023	0.011	0.012	0.002	0.000	0.033	0.016	0.042	0.002	0.025	0.166	26
1973	**0.000**	**0.002**	**0.004**	**0.012**	**0.003**	**0.034**	**0.010**	**0.004**	**0.013**	**0.002**	**0.084**	**5**
1974	0.049	0.006	0.006	0.015	0.016	0.004	0.001	0.027	0.023	0.005	0.153	25
1975	0.041	0.015	0.009	0.000	0.008	0.071	0.006	0.042	0.005	0.003	0.200	37
1976	0.072	0.002	0.000	0.012	0.015	0.004	0.000	0.004	0.024	0.002	0.136	21
1977	0.011	0.004	0.006	0.009	0.026	0.015	0.005	0.027	0.005	0.012	0.120	18
1978	0.046	0.000	0.005	0.020	0.007	0.023	0.021	0.065	0.014	0.010	0.211	40
1979	0.064	0.015	0.008	0.013	0.008	0.061	0.002	0.019	0.008	0.007	0.205	38
1980	0.050	0.028	0.013	0.004	0.001	0.062	0.011	0.004	0.004	0.002	0.180	31
1981	0.073	0.008	0.002	0.008	0.015	0.014	0.001	0.027	0.025	0.015	0.188	33
1982	0.037	0.014	0.008	0.005	0.007	0.024	0.009	0.027	0.005	0.015	0.151	24
1983	0.125	0.013	0.001	0.022	0.001	0.015	0.001	0.042	0.033	0.012	0.265	43
1984	0.083	0.000	0.004	0.007	0.011	0.015	0.002	0.111	0.001	0.008	0.242	41
1985	0.058	0.022	0.006	0.009	0.005	0.014	0.004	0.004	0.006	0.014	0.141	22
1986	**0.002**	**0.002**	**0.001**	**0.001**	**0.003**	**0.023**	**0.008**	**0.004**	**0.002**	**0.011**	**0.058**	**1**
1987	0.005	0.006	0.001	0.003	0.010	0.014	0.004	0.050	0.007	0.001	0.101	13
1988	**0.018**	**0.007**	**0.005**	**0.002**	**0.009**	**0.005**	**0.006**	**0.004**	**0.001**	**0.004**	**0.060**	**2**
1989	0.050	0.019	0.010	0.007	0.005	0.042	0.012	0.004	0.010	0.016	0.174	29
1990	0.039	0.021	0.010	0.005	0.010	0.004	0.008	0.004	0.015	0.020	0.135	20
1991	0.016	0.006	0.001	0.007	0.001	0.053	0.001	0.004	0.002	0.005	0.096	9
1992	0.062	0.010	0.001	0.012	0.005	0.015	0.006	0.004	0.003	0.029	0.146	23
1993	0.024	0.002	0.004	0.002	0.010	0.005	0.006	0.027	0.024	0.009	0.114	17
1994	0.007	0.011	0.005	0.001	0.007	0.014	0.003	0.050	0.005	0.005	0.107	14
1995	0.056	0.016	0.006	0.011	0.011	0.034	0.017	0.027	0.011	0.009	0.197	35
1996	0.076	0.023	0.008	0.008	0.002	0.005	0.010	0.019	0.011	0.007	0.169	27
1997	0.025	0.012	0.004	0.011	0.005	0.034	0.011	0.004	0.001	0.017	0.125	19
1998	0.018	0.016	0.007	0.005	0.003	0.005	0.018	0.004	0.010	0.011	0.097	10
1999	0.010	0.002	0.004	0.008	0.017	0.004	0.014	0.019	0.015	0.005	0.099	11
2000	0.019	0.004	0.002	0.008	0.012	0.005	0.022	0.004	0.008	0.001	0.086	7
2001	0.096	0.022	0.008	0.009	0.015	0.024	0.012	0.050	0.006	0.029	0.271	44
2002	0.019	0.004	0.009	0.002	0.008	0.053	0.007	0.027	0.019	0.033	0.180	32
2003	0.065	0.025	0.008	0.005	0.007	0.071	0.002	0.004	0.008	0.000	0.195	34
2004	**0.014**	**0.006**	**0.006**	**0.003**	**0.006**	**0.014**	**0.005**	**0.019**	**0.007**	**0.004**	**0.082**	**3**
2005	0.014	0.014	0.007	0.009	0.030	0.072	0.006	0.004	0.026	0.024	0.205	39
2006	0.025	0.002	0.001	0.008	0.003	0.014	0.015	0.019	0.006	0.003	0.095	8
2007	0.053	0.002	0.001	0.019	0.020	0.062	0.031	0.088	0.016	0.018	0.308	45
2008	0.017	0.004	0.003	0.003	0.000	0.004	0.007	0.019	0.011	0.017	0.086	6
2009	0.011	0.006	0.006	0.004	0.008	0.023	0.006	0.027	0.001	0.008	0.099	12
2010	0.018	0.014	0.010	0.004	0.006	0.005	0.001	0.004	0.017	0.028	0.108	15
2011	0.153	0.015	0.008	0.020	0.052	0.061	0.001	0.042	0.009	0.031	0.393	46
2012	0.064	0.000	0.002	0.007	0.015	0.004	0.006	0.027	0.028	0.017	0.172	28
2013	0.022	0.004	0.004	0.008	0.011	0.015	0.011	0.027	0.006	0.003	0.110	16
2014	**0.020**	**0.017**	**0.003**	**0.005**	**0.004**	**0.005**	**0.020**	**0.004**	**0.002**	**0.003**	**0.082**	**4**
2015	0.047	0.018	0.009	0.008	0.015	0.053	0.005	0.027	0.008	0.010	0.199	36

2.3 Top 20 Ranked Years

Table 2-3 summarizes top 20 ranked years based on the ranking analysis. It was decided that a more recent period be used for the PVSC CSO LTCP study to reflect recent climate conditions. It was also determined that the typical year should be selected from years with annual precipitation depth greater than the average value (highlighted with green background in **Table 2-3**) to be more conservative. Therefore the following five years are the top years to be considered for typical year selection:

- 1: 2004
- 2: 2014
- 3: 1973
- 4: 2008
- 5: 2006

Table 2-3: Top 20 Ranked Years

Preliminary Rank	Year	Deviation Score	Annual Rainfall (in)	# of Events >=0.2" Rainfall Depth	# of Events >=0.1" Rainfall Depth	5th Largest Storm (in)	Rainfall Volume for 85% Captured (in)	# of back-to-back events	Maximum Peak Intensity of 5th Largest & Smaller	# of Storms with Return Freq > 1-yr	Average Rainfall Duration (hr)	Average Rainfall Intensity (in/hr)
		Weighing Factor	30%	10%	5%	5%	5%	10%	5%	5%	15%	10%
		Average 1970-2015	46.3	51.2	66	1.7	1.35	10.54	0.90	2.2	10.85	0.081
1	1986	0.058	46.0	52	67	1.77	1.43	13	0.76	2	11.03	0.072
2	1988	0.060	43.5	55	59	1.66	1.12	10	0.80	2	10.81	0.078
3	2004	0.082	48.4	54	73	1.63	1.18	12	0.99	3	10.33	0.084
4	2014	0.082	49.3	60	69	1.56	1.24	10	1.26	2	10.99	0.083
5	1973	0.084	46.3	50	61	2.15	1.27	7	0.72	2	11.77	0.082
6	2008	0.086	48.8	49	69	1.84	1.34	11	0.77	3	10.04	0.094
7	2000	0.086	43.4	49	63	1.43	1.02	10	0.50	2	10.24	0.081
8	2006	0.095	50.2	52	65	2.01	1.44	12	1.17	3	11.26	0.078
9	1991	0.096	43.8	54	64	1.95	1.33	5	0.88	2	11.03	0.084
10	1998	0.097	43.5	43	56	1.89	1.42	10	1.23	2	11.59	0.089
11	1999	0.099	44.8	52	60	1.43	1.82	11	0.65	3	11.92	0.076
12	2009	0.099	47.9	54	74	1.87	1.13	13	0.80	1	10.91	0.074
13	1987	0.101	45.5	54	64	1.61	1.07	12	0.97	0	11.39	0.079
14	1994	0.107	47.3	57	72	1.76	1.16	12	0.96	0	11.18	0.077
15	2010	0.108	43.5	44	52	1.60	1.51	10	0.93	2	12.08	0.103
16	2013	0.110	42.9	49	61	1.43	1.06	9	1.10	1	10.41	0.083
17	1993	0.114	42.5	50	60	1.65	1.07	10	0.80	1	12.60	0.074
18	1977	0.120	48.0	49	73	2.04	2.05	9	1.00	1	10.47	0.071
19	1997	0.125	42.4	45	60	1.35	1.21	7	0.71	2	10.75	0.066
20	1990	0.135	52.3	62	79	1.88	1.08	11	1.04	2	9.78	0.096

Table 2-4 summarizes quantity of large rainfall events with return frequencies for the above-mentioned five years.

Table 2-4: Quantity of Rainfall Events above 1-year Return Frequency

Final Rank	Year	Quantity of Rainfall Events with Return Frequency Above				
		1-yr	2-yr	5-yr	10-yr	50-yr
1	2004	2	1			
2	2014	1			1	0
3	1973	2				
4	2008	1	1	1		
5	2006	1		1		1

2.4 Hydrologic and Hydraulic Model Results

A hydrologic and hydraulic (H&H) model was simulated from 1996 to 2015 to include the 20 most recent years. The simulation results were analyzed to verify if the selected typical year yields overflow quantity and volume close to the average conditions. The model used was the PVSC model that was re-calibrated in 2016. This model includes the five CSO communities of Paterson, Newark, East Newark, Kearny and Harrison within PVSC's service area. **Figure 2-2** and **Figure 2-3** show the simulated results for volume of overflows and number of CSO events, respectively.

Figure 2-2: Hydrologic and Hydraulic Model - CSO Volume

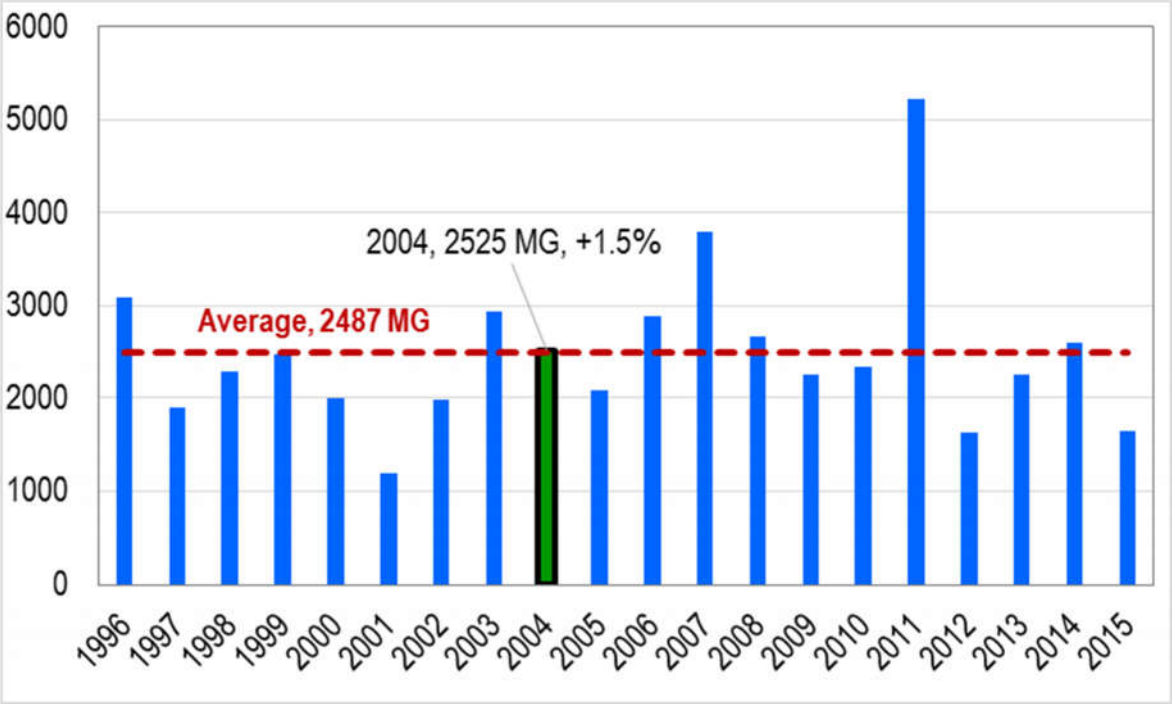
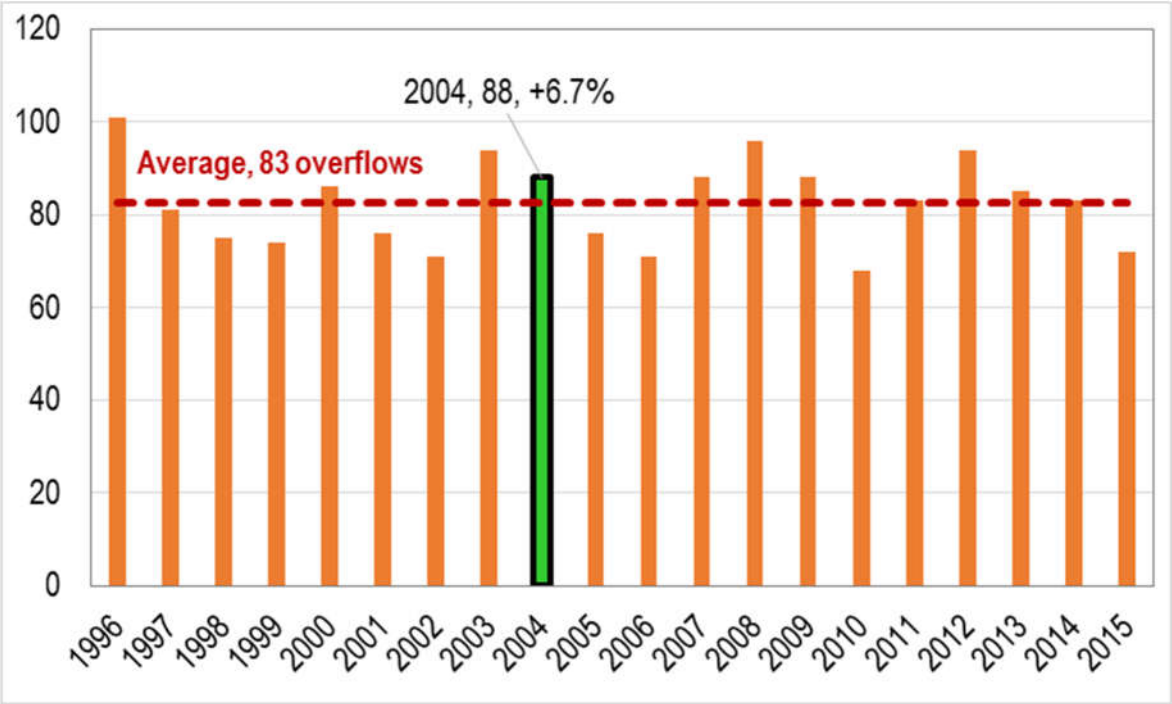


Figure 2-3: Hydrologic and Hydraulic Model - Number of CSO Events



The model results show that overflow in 2004 is close to the average conditions: only 1.5% greater than the average for CSO volume and 6.7% greater than the average for CSO event number. Another year that is close to the average conditions in terms of CSO volume and event number is 2014. 2014 is not considered as a good candidate because it has an extremely large storm with 10-year return frequency.

2.5 Recommendations

It is recommended the year 2004 selected as the typical hydrologic year for the CSO LTCP based on ranking analysis and H&H modeling results. The year 2004 was ranked first in the criteria described above and contains a wide range of storms and antecedent conditions, and it has close to an average CSO volume and event number based on the hydrologic and hydraulic model results.

A summary of the parameters and the percent difference is shown below in **Table 2-5**. The top 20 rainfall events (by depth) in 2004 is shown in **Table 2-6**.

Table 2-5: Summary of the Recommended Typical Year - 2004

Parameters	2004
Annual Precipitation*	48.37 in (4.5% greater than average 46.27)
Number of Events >=0.2" Rainfall Depth	54 (5% greater than average 51.2)
Number of Events >=0.1" Rainfall Depth	73 (11% greater than average 66)
5th Largest Storm Volume	1.63 in (5% less than average 1.70)
Rainfall Volume for 85% Capture	1.18 in (12% less than average 1.35)
Back-to-Back Storm Events	12 (14% greater than average 10.5)
Max Peak Intensity of 5th Largest Storm & Smaller	0.99 in/hr (9.5% greater than average 0.90)
Extreme Storm	1 Year Storm (2) 2 Year Storm (1)
Average Rainfall Duration	10.3 hr (4.8% less than average 10.8)
Average Rainfall Intensity	0.084 in/hr (3.8% greater than average 0.081)

*Note: Includes snowfall.

Table 2-6: Top 20 Rainfall Events by Depth in 2004

2004	Event Start	Duration (hr)	Precipitation Depth (in)	Max Rainfall Intensity (in/hr)	Average Rainfall Intensity (in/hr)	Return Frequency
1	9/28/2004 1:00	28	**3.68**	0.53	0.13	2-yr – 24hr
2	9/8/2004 4:00	25	**2.21**	0.63	0.09	1-yr – 6hr
3	7/12/2004 9:00	27	**1.99**	0.32	0.07	
4	4/12/2004 17:00	30	**1.67**	0.25	0.06	
5	4/25/2004 14:00	35	**1.67**	0.25	0.05	
6	7/23/2004 10:00	24	**1.66**	0.33	0.07	
7	2/6/2004 5:00	33	**1.63**	0.33	0.05	
8	7/18/2004 16:00	14	**1.60**	0.64	0.11	
9	11/28/2004 2:00	12	**1.50**	0.85	0.13	
10	7/27/2004 15:00	18	**1.45**	0.41	0.08	
11	9/17/2004 22:00	12	**1.44**	1.33	0.12	1-yr – 2hr 2-hr – 1hr
12	6/25/2004 17:00	5	**1.39**	0.40	0.28	
13	11/12/2004 7:00	23	**1.08**	0.10	0.05	
14	5/12/2004 16:00	2	**1.08**	0.99	0.54	
15	11/4/2004 14:00	16	**1.03**	0.20	0.06	
16	7/5/2004 3:00	12	**1.00**	0.69	0.08	
17	12/1/2004 4:00	10	**1.00**	0.18	0.10	
18	8/16/2004 0:00	21	**0.94**	0.60	0.04	
19	8/21/2004 14:00	3	**0.84**	0.81	0.28	
20	12/6/2004 12:00	39	**0.83**	0.20	0.02	