US Army Corps of Engineers®
New York District

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Integrated Hurricane Sandy General Reevaluation Report and Environmental Impact Statement

Atlantic Coast of New York

East Rockaway Inlet to Rockaway Inlet and Jamaica Bay

Interior Drainage Sub-Appendix E for Appendix A2

Jamaica Bay High Frequency Flood Risk Reduction Features Engineering and Design Appendix

August 2018

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1 INTRODUCTION

1.1 Scope

This appendix documents the development and evaluation of interior drainage facilities associated with four locations that met the initial screening criteria for implementation of High Frequency Flood Risk Reduction Features (HFFRRF) within Jamaica Bay. The initial screening of potential HFFRRF compared the line of protection costs and benefits. Four locations were identified for continued analysis, including the development of interior drainage cost estimates and estimation of residual damages. In addition, this appendix documents the rationale for identifying the interior drainage facilities including storm sewer outfalls, gates, natural/excavated ponding areas, and pump stations to control precipitation runoff. The analysis herein represents the results of the interior drainage facilities formulation.

The appendix has been organized to provide the reader with a summary of the results of the hydrologic/hydraulic models, design and economic criteria, followed by an overview of the formulation process leading to the identified plans. The formulation effort incorporates an analysis of varying types and sizes of interior drainage facilities to determine a plan that provides significant net benefits while meeting the Minimum Facility design criteria.

1.2 Climate Change

In accordance with Corps of Engineers ECB 2016-25, "Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects", documentation of a qualitative response to the question "Is climate change relevant to the project goals or design?" is required. The primary feature of the interior drainage facilities for the Jamaica Bay HFFRRF is a combination of gravity storm sewer outlets with backflow prevention and pumping stations which provides protection against coastal storm events and inland flooding from heavy rainfalls. Potential changes in precipitation intensity might only be relevant to the interior drainage hydrology and would not be a significant risk to the primary features of this project.

Because the selected interior drainage plan consists of existing storm sewer outlets (i.e. substantially-sized box culverts), the possible impact of climate change on these interior facilities is fairly limited. The selected line of protection, with the selected interior drainage plan, will reduce the interior water surface elevations within the project area. Existing gravity outlets are unlike features such as interior levees or pump stations, which can result in sudden and catastrophic increases in flood depths once their design capacity is exceeded.

The actual amount of available storage within the project area is limited. The interior drainage facilities, like most Flood Risk Management Projects, are designed based upon a large and infrequent event and, as such, are designed with the appropriate allowances for risk and

uncertainty. Projected climate change impacts appear to be well within the normal range of hydrologic variability for Flood Risk Management Projects.

1.3 Study Locations

The overall study area lies in and around Jamaica Bay with a total of approximately 1,500 acres. The principal communities studied are the following: Canarsie in the Borough of Brooklyn; the Villages of Cedarhurst and Lawrence of Nassau County on the South Shore of Long Island; Motts Basin North; and the Mid-Rockaway area, including Hammels, Arverne and Edgemere, on the Rockaway Peninsula in the Borough of Queens in New York City.

1.4 Source of Flooding

Flooding in this area can result from either high storm surges in Jamaica Bay or interior precipitation runoff that cannot be conveyed to the bay through the existing interior drainage system.

The frequency of inland inundation will continue and increase as sea level is projected to rise. Relative sea level in the project area has been rising at an average of 0.014 feet per year. It is also anticipated that continued development and fill placement will occur within the floodplain. As new construction is elevated above the base interior flood elevation, the fill will reduce storage for interior runoff and may exacerbate interior flooding conditions during high intensity rainfall events.

2 ANALYSIS OF HYDROLOGIC AND HYDRAULIC CONDITIONS

The analysis and design of the Interior Drainage Plan is intended to supplement the Engineering and Design Plan, and manage the residual risks from flooding. The Recommended Engineering and Design Plan includes an improved coastal barrier system made up of levees, tide gates, floodwalls, and a buried seawall/armored levee for the project reach. With the introduction of these new flood management measures, the hydraulic characteristics between the with- and without-project conditions may change during tidal and interior runoff flooding events.

The main objective of implementing a new Coastal Storm Risk Management System is to reduce the risk associated with flooding and while the Recommended Engineering and Design Plan is expected to achieve this objective for high surge levels, interior drainage measures are needed in order to address residual flooding during high precipitation rainfall events. At a minimum, the Interior Drainage Plan must demonstrate that the Minimum Facility is met or that the local storm drainage system functions essentially as it would without the Engineering and Design Plan in place (EM 1110-2-1413). Supplemental interior drainage measures may be introduced to further improve the interior flooding conditions under the condition that the additional cost of incorporating the additional design features does not outweigh the additional benefit resulting from a reduction in flood related damages.

2.1 Basis of Interior Drainage Design

The analysis presented herein is based on the concepts and guidelines contained in EM 1110-2-1413 "Hydrologic Analysis of Interior Areas", dated 15 Jan 1987, ER 1105-2-100 “Planning Guidance Notebook”, dated 22 April 2000, ER 1105-2-101 “Risk Analysis for Flood Damage Reduction Studies”, dated 03 Jan 2006, and EM 1110-2-1417 “Flood Runoff Analysis”, dated 10 Jul 2013.

2.1.1 Rainfall and Storm Surge Correlation Analysis

For the with- and without-project conditions, the exterior flood stage (stillwater elevation within Jamaica Bay) is an important factor affecting the drainage of interior precipitation runoff. The exterior stage is controlled by the tide cycle and storm surge elevations during storm events. Inland, the interior surface runoff is conveyed out into the bay through the existing high ground via stormwater outfalls. In the without-project condition, these outfalls cease to operate when the exterior stage (tide/storm surge level) rises above the interior stage because they rely on gravity to facilitate the conveyance of surface runoff. Similarly, if a new coastal storm risk management structure is introduced (with-project condition) to reduce the risk of storm surge entering the study area, the proposed outfalls, under high exterior (tailwater) stage conditions, would still not be able to drain through gravity flow. Therefore, it is important to develop an understanding of whether there is a relationship between interior surface runoff and exterior tidal events in both the with- and without-project conditions.

To understand the relationship between the interior and exterior stage conditions, if any, a correlation analysis needed to be performed. In accordance with EM 1110-2-1413, the correlation analysis should include a data analysis of the correlation, dependence, and coincidence of the interior and exterior stage relationship. From the recent USACE's correlation analyses presented in the Feasibility Study for Fort Wadsworth to Oakwood Beach of the South Shore of Staten Island Coastal Storm Risk Management and the South River Project, we can expect that the storm surge in the Jamaica Bay does not correlate to the precipitation events, is lightly dependent upon precipitation events, and that its peak stage is unpredictable but could randomly coincide with peak interior discharges.

As demonstrated in the recent USACE's correlation analyses, most of the higher tide events occurred with little rainfall, and most high rainfall events occurred with normal tides. This relationship, along with the general wide scatter of precipitation amounts with a constant storm surge and vice versa indicates that there is no correlation between the surge events and precipitation. Therefore, it is not reasonable to say that we could predict one condition from the other based on these historic records.

2.1.2 Analysis Approach

The interior stage analysis was conducted for events with eight recurrence intervals: the 2-year, 5-year, 10-year, 25-year, 50-year, 100-year, 250-year and 500-year frequency events. In order to develop a stage-frequency relationship, the interior events were routed against exterior tidal marigrams. For the most likely or expected flooding scenarios, the eight interior storm events were routed against a 2-year exterior tide, and a 2-year interior storm event was routed against all the exterior events. **Table 2-1** presents the different interior and exterior runs analyzed and the risk condition associated with each.

Table 2-1: Recommended Analysis Approach – Combination of Interior and Exterior Conditions

Varied Interior Condition		Varied Exterior Condition		Risk Condition
Interior Flow	Exterior Stage	Interior Flow	Exterior Stage	
2-year	Normal	N/A	N/A	Lower Bound
5-year	Normal	N/A	N/A	Lower Bound
10-year	Normal	N/A	N/A	Lower Bound
25-year	Normal	N/A	N/A	Lower Bound
50-year	Normal	N/A	N/A	Lower Bound
100-year	Normal	N/A	N/A	Lower Bound
250-year	Normal	N/A	N/A	Lower Bound
500-year	Normal	N/A	N/A	Lower Bound
2-year	2-year	2-year	2-year	Expected
5-year	2-year	2-year	5-year	Expected
10-year	2-year	2-year	10-year	Expected
25-year	2-year	2-year	10-year	Expected
50-year	2-year	2-year	10-year	Expected
100-year	2-year	2-year	10-year	Expected
250-year	2-year	2-year	10-year	Expected
500-year	2-year	2-year	10-year	Expected
2-year	2-year	2-year	2-year	Upper Bound
5-year	5-year	5-year	5-year	Upper Bound
10-year	10-year	10-year	10-year	Upper Bound
25-year	10-year	10-year	10-year	Upper Bound
50-year	10-year	10-year	10-year	Upper Bound
100-year	10-year	10-year	10-year	Upper Bound
250-year	10-year	10-year	10-year	Upper Bound
500-year	10-year	10-year	10-year	Upper Bound

As demonstrated in the Risk Condition column of **Table 2-1**, uncertainty was incorporated into the analysis by establishing lower and upper coincidental frequency bounds. For the lower bound, the interior storm events were routed against a normal exterior tidal condition and for the upper bound the interior events were routed against a 10-year external tide. The maximum water surface elevation of corresponding coincidental frequencies (e.g., 2-year interior and 10-year exterior, or 10-year interior and 2-year exterior) was identified as the most damaging flood level for the coincidental frequency. The three conditions: expected (design), lower bound, and upper bound were then incorporated into the economic analysis using a triangular probability distribution.

The Plan Formulation Section of this Sub-Appendix only presents the selected interior stage utilized in the economic comparison. Interior water surface elevations under all conditions demonstrated in **Table 2-1** are presented in **Attachment 3** of this Sub-Appendix.

2.1.3 Hydrologic Analysis

The HEC-HMS model, version 4.2.1, parameters are described in the subsequent sections of this appendix. Basic input parameters developed for the hydrologic models include: drainage area, rainfall generated for a series of hypothetical storm events (2 to 500-year recurrence intervals), runoff curve number, and time of concentration (Tc).

2.2 Hypothetical Storm Surge Data

For storm events, a storm hydrograph was developed to simulate surge levels during storm conditions. Two main assumptions were made to develop the storm hydrograph: (1) the peak elevation of the storm will occur at high tide; and (2) the duration of the storm is approximately 24 hours. Peak discharge hydrographs were developed for return periods from 2 to 500-years. Hypothetical tide marigrams (hydrographs) used in this study for the exterior stages for current and future conditions are plotted in **Figures 2-1** and **2-2**, respectively. Baseline conditions considered the current sea level, and future conditions considered a 1.1 feet rise in sea level and storm surge elevations (Intermediate sea level rise scenario). The storm surge duration was assumed to be 48 hours with four tide cycles. The storm surge data utilizes the stage frequency curves as described in **Appendix A2** (Engineering and Design Appendix).

The relationship between rainfall/runoff (including surface runoff flow) and storm surge is highly uncertain and may have a significant impact on interior stages. Uncertainty was incorporated into the analysis by routing the interior storm events against a normal exterior tidal condition to establish a lower bound of interior flood levels, and routing the interior events against a 10-year external storm surge conditions to establish a reasonable upper bound of interior flood levels. This methodology was then applied with a 2-year exterior surge level to create the expected interior flood levels.

2.3 Drainage Area Delineation

Interior drainage basins and subbasins were delineated in GIS utilizing publicly available LiDAR terrain data. For the Mid-Rockaway and Canarsie project areas, located within the City of New York, LiDAR data collected in the spring of 2010 was used. A Digital Elevation Model (DEM), which was was generated by interpolating the LiDAR ground points to create a one-foot resolution seamless surface, was downloaded for use. For the Cedarhurst-Lawrence project area, a three-meter DEM raster, produced by the State of New York by merging four separate datasets, was downloaded for use. For the Motts Basin North project area, a three-foot bare earth DEM, produced in November 2011 from the 2010 New York City LiDAR data, was used. One-foot

contours generated from the three DEMs along with aerial imagery from Web Mapping Service (WMS) 2016, Google Earth, and Bing Maps were used for subbasin delineation.

2.3.1 Delineation Methods

An interior drainage basin is defined, for the purpose of engineering analysis, to be a distinct drainage area which drains to one primary outlet location landward of the proposed line of protection alignment. The identification of such areas is complicated by the presence of man-made features such as storm sewers, which may divert flow into or out of a drainage area. In some cases, otherwise distinct and discrete interior areas have low-lying lands that may combine during low frequency storms because of the high pooling elevations that overtop the divide between drainage areas.

2.3.2 Hydraulic Analysis

Outlet structures, such as culverts and pipes running through the proposed line of protection were analyzed in the HEC-HMS model using inlet and outlet control analyses as described in Federal Highway Administration's Hydraulic Design Series No. 5 "Hydraulic Design of Highway Culverts" (HDS-5).

2.4 Delineated Interior Drainage Basins

The major interior drainage basins are named based on the neighborhoods through which the line of protection passes. The interior drainage subbasins used for the HEC-HMS analysis are depicted in **Figure 2-3** for the Mid-Rockaway project area, in **Figure 2-4** for the Canarsie project area, and in **Figure 2-5** for the Cedarhurst-Lawrence and Motts Basin North project areas.

2.4.1 Mid-Rockaway Project Area

The Mid-Rockaway project area is within the Rockaway Peninsula, in Queens County, New York. It covers approximately 1,130 acres and includes three interior drainage basins from west to east: Hammels, Arverne, and Edgemere. The drainage basins extend roughly from Beach 95th Street in the west and Beach 20th Street in the east. The following sections describe each of the Mid-Rockaway drainage basins in detail.

2.4.1.1 Hammels Drainage Basin

The Hammels drainage basin includes two subbasins, H1 and H2, covering approximately 104.5 acres and 139.0 acres, respectively. The Hammels drainage basin is almost fully developed, except for a few scattered grassy areas and is predominantly residential, with some commercial development.

2.4.1.2 Arverne Drainage Basin

The Arverne drainage basin has three subbasins A1, A2, and A3, covering approximately 72.5 acres, 139.5 acres, and 208.6 acres, respectively. The Arverne drainage basin is almost fully developed and predominantly residential, with a few, scattered undeveloped areas.

2.4.1.3 Edgemere Drainage Basin

The Edgemere drainage basin has two subbasins, E1 and E2, covering approximately 191.7 acres and 273.9 acres, respectively. The Edgemere drainage basin is almost fully developed and predominantly residential, except for a stretch of undeveloped, grassy area along the southern part of E1 and southwestern part of E2.

2.4.2 Canarsie Project Area

The Canarsie drainage basin is within Canarsie neighborhood of Brooklyn, New York in Kings County. It is located to the west of Fresh Creek and is roughly bounded by Flatlands Avenue, East 96th Street, and Seaview Avenue on the other three sides. It covers approximately 273 acres and is divided into three subbasins C1, C2, and C3 each covering approximately 119.7 acres, 69.3 acres, and 84.1 acres, respectively. There is an internal high area on either side of Avenue M, which defines a separation between subbasins C2 and C3. The Canarsie drainage basin is completely developed and predominantly residential, with some commercial development.

2.4.3 Cedarhurst-Lawrence Project Area

The Cedarhurst-Lawrence drainage basin is within Nassau County, between the villages of Lawrence and Cedarhurst. It is located immediately east of the Rockaway Turnpike, at the intersection with Peninsula Boulevard. It consists of a single subbasin L1, covering approximately 93.3 acres. The Cedarhurst-Lawrence drainage basin is fully developed and predominantly residential, with some commercial development.

2.4.4 Motts Basin North Project Area

The Motts Basin North area is within the village of Inwood, in Nassau County. It consists of a single subbasin M1, covering approximately 28.1 acres. It is fully developed and predominantly residential, with some commercial development and a wooded area in the southeastern part of M1.

2.5 Future Storm Drainage System

Numerous drainage improvement plans are currently proposed by the affected communties within the different HFFRRF project areas, which must be taken into consideration for this project:

- For the Mid-Rockaway project area, separation of combined sewer overflows (CSOs) from the flood risk reduction features being evaluated is required.
- In the Canarsie project area, the Governor's Office of Storm Recovery (GOSR) has a plan for Spring Creek, with many features similar to the ones being proposed for this project. However, it does not identify any significant upgrades to the interior drainage system.
- In the Cedarhurst-Lawrence project area, the New York State Department of Transportation (NYSDOT) is implementing a plan to elevate the Nassau Expressway to help alleviate flooding concerns. The proposed drainage improvements could eliminate the need for a line of protection in that area. In addition, it should be noted that, in the Village of Cedarhurst, GOSR has identified a pump station to improve drainage within the Village as part of the Five Towns Drainage Study. The pump station is proposed immediately to the east of the proposed line of protection and would not result in redundancy.

2.6 Development of Interior Inflow Runoff Hydrographs

HEC-HMS was used to model the interior runoff for a range of hypothetical rainfall frequencies and durations. Runoff curve numbers, routing reach travel times, lag times, and hydrograph combinations were used to define the interior basin response to the various hypothetical rainfall events. Each input parameter is described in more detail in the subsequent sections.

Generally, the capital letters used for Hydrologic Element identifications within the HEC-HMS models, have the following meanings:

SB = subbasin runoff computation; R = reservoir storage

The schematics shown in **Figures 2-6** and **Figure 2-7** represent the set-up of the interior flow HEC-HMS models for each of the interior drainage basins.

2.6.1 Rainfall Data

Specific frequency hypothetical point rainfall depths for a range of durations of and return periods were obtained from *National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 10, Version 2,* available online at https://hdsc.nws.noaa.gov/hdsc/pfds. Hypothetical point rainfall depths for the 1-year through 100-year storms for durations ranging from 5 min to 48 hours are shown in **Table 2-2**.

Table 2-2: Specific Frequency Hypothetical Point Rainfall Depths

Point Rainfall Depth (inches)								
Duration	Return Period (years)							
	2	5	10	25	50	100	200	500
5 min	0.438	0.556	0.654	0.788	0.892	0.996	1.13	1.31
15 min	0.730	0.927	1.09	1.31	1.49	1.66	1.88	2.18
1 hour	1.32	1.67	1.96	2.36	2.67	2.97	3.38	3.91
2 hours	1.71	2.15	2.51	3.00	3.38	3.77	4.26	4.92
3 hours	1.97	2.46	2.88	3.44	3.88	4.32	4.89	5.65
6 hours	2.43	3.07	3.60	4.34	4.90	5.46	6.22	7.23
12 hours	2.92	3.75	4.45	5.40	6.14	6.87	7.90	9.26
24 hours	3.38	4.42	5.29	6.48	7.39	8.31	9.62	11.4
48 hours	3.83	5.03	6.03	7.41	8.47	9.53	11.1	13.1

Data for the 24-hour storm duration were plotted on on a logarithmic scale and interpolated to project a point rainfall value for the 250-year storm. A 24-hour hypothetical storm was used to allow for HEC-HMS interior inflow routing for return periods of 2, 5, 10, 25, 50, 100, 250, and 500-years, against the exterior time-varying marigrams (astronomic tide plus storm surge) for a total duration of 48 hours.

To represent the variation in rainfall distribution in different regions of the United States, four synthetic 24-hour rainfall distributions (1, IA, II, and III) were developed by the NRCS from available National Weather Service data or local storm data. The project areas fall under the Type III rainfall.

2.6.2 NRCS Runoff Curve Numbers

The Natural Resources Conservation Service (NRCS) runoff curve number procedure as outlined in *NRCS Technical Release No. 55 (TR-55), Urban Hydrology For Small Watersheds* was used to define the rainfall-loss-excess (or runoff) behavior of the interior drainage subbasins in the HEC-HMS model. The runoff curve numbers (CN) relate total accumulated excess precipitation to total accumulated precipitation and are based on factors such as hydrologic soil group, land use, ground cover, quality of vegetative cover, and antecedent moisture conditions. Directly connected impervious areas for the subbasins were not specified separately, but accounted for by the curve numbers.

Soils data for the project areas were downloaded in GIS format from the Web Soil Survey developed and maintained by the NRCS (available online at https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx). The soils dataset also provides the Hydrologic Soil Group (HSG) rating for each soil type, with values of "A", "B", "C", "D", or a combination thereof. In case of a null value, the HSG was assumed to be "D", to be conservative. For combinations such as "A/D", "D" was assumed, to be conservative.

Land use for the interior drainage basins was assigned based on visually comparing aerial imagery from WMS 2016, Google Earth, and Bing Maps and assigning the areas to specific cateogries per the TR55 Urban Hydrology for Small Watersheds manual. For the Mid-Rockaway (Hammels, Arverne, and Edgemere), Canarsie, and Cedarhurst-Lawrence project areas, a majority of the drainage area falls under the category "Residential Districts, 1/8 acres or less". There are some scattered grassy, open spaces in Mid-Rockaway; these were included in the above residential districts category to account for future development. In the case of the Motts Basin North project area, three distinct land use categories were assigned: "Residential Districts, 1/8 acres or less", "Commercial and Business", and "Woods, good condition".

Following the guidance provided in TR-55, curve numbers were developed for this analysis based on the combined land use categories and hydrologic soil groups, as shown in **Table 2-3.** A composite curve number was estimated for each subbasin by computing an area-weighted average of curve numbers assigned within the subbasin.

Table 2-3: NRCS Runoff Curve Numbers

Land Use Categories	Hydrologic Soil Groups			
	A	B	C	D
Residential Districts, 1/8 acres or less	77	85	90	92
Commercial and Business	89	92	94	95
Woods, good condition	30	55	70	77

2.6.3 Time of Concentration

Time of concentration (Tc) for a watershed is the time taken for runoff to travel from the hydraulically most distant point of the watershed to the outlet point for the watershed. The longest hydraulic path for each subbasin was identified in ArcGIS. Tc was computed by summing travel times for consecutive components of the runoff conveyance system, which can typically be characterized into three types, per TR-55:

Sheet flow: Sheet flow refers to flow over plane surfaces, which usually occurs at the headwaters of a stream near the watershed boundary. A simplified version of the Manning's kinematic solution was used to compute travel time for sheet flow:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}}$$

where,

T_t = travel time, hours

n = Manning's roughness coefficients for sheet flow

L = sheet flow length, ft

P_2 = 2-year 24-hour rainfall, in

s = slope of land surface, ft/ft

Shallow Concentrated Flow: After the initial sheet flow, runoff usually transitions into shallow concentrated flow. The average velocity for shallow concentrated flow was estimated using:

$$V = 16.1345(s)^{0.5}, \text{ for unpaved areas}$$

$$V = 20.3282(s)^{0.5}, \text{ for paved areas}$$

where,

V = average velocity, ft/s

s = slope of hydraulic grade line or watercourse slope, ft/ft

Channel Flow: Channel flow is assumed to begin where channels can be identified based on available topographic data or aerial imagery. Average velocity for channel flow was determined using the Manning's equation, assuming bankfull elevation:

$$V = \frac{1.49(r)^{\frac{2}{3}}(s)^{\frac{1}{2}}}{n}$$

$$r = \frac{a}{p_w}$$

where,

V = average velocity, ft/s

r = hydraulic radius, ft

a = cross sectional flow area, ft^2

p_w = wetted perimeter, ft

s = slope of hydraulic grade line, ft/ft

n = Manning's roughness ceofficient for open channel flow

The travel times for the individual components of each subbasin were summed to obtain the time of concentration for the subbasin. The time of concentration calculations for all the subbasins are summarized in **Attachment 2** of this Sub-appendix.

2.6.4 NRCS Dimensionless Unit Hydrograph

The NRCS dimensionless unit hydrograph is based on a dimensionless table of discharge per unit area versus time, normalized to the peak discharge and time of concentration, respectively. The actual subbasin unit hydrograph is created within HEC-HMS, with the input of a specific drainage area and a lag time. The standard lag time for a basin is conceptually defined as the time from the center of mass of excess rainfall to the time of the peak discharge of the unit hydrograph. In general, lag time can be approximated as 0.6 times the time of concentration.

The shape of the unit hydrograph can be defined using two different graph types. Standard and Delmarva. The Standard Graph is generally applicable across the United States. The Delmarva Graph is applicable specifically to coastal plain areas of Delaware, Maryland, and Virigina. For this analysis, the Standard Graph was used.

For each of the subbasins modeled in HEC-HMS, **Table 2-4** summarizes three key modeling parameters: acreage, CN, and lag time.

Table 2-4: HEC-HMS Model Subbasin Data

Drainage Subbasin	Drainage Area (acres)	NRCS CN*	Lag Time (min)
Hammels H1	104.5	92	27
Hammels H2	139.0	91	19
Arverne A1	72.5	92	33
Arverne A2	139.5	92	36
Arverne A3	208.6	91	29
Edgemere E1	191.7	89	41
Edgemere E2	273.9	87	44
Canarsie C1	119.7	92	26
Canarsie C2	69.3	92	31
Canarsie C3	84.1	92	26
Cedarhurst-Lawrence L1	93.3	93	29
Motts Basin North M1	28.1	87	21

*The CN values shown are area-weighted values for each subbasin.

2.7 Peak Inflows

The peak interior drainage inflows for each of the subbasins are summarized in **Table 2-5** for return periods of 2, 5, 10, 25,50, 100, 250, and 500 years.

Table 2-5: Interior Drainage Peak Inflows

Interior Drainage Peak Inflows(cfs)								
Drainage Subbasin	Return Period							
	2-year	5-year	10-year	25-year	50-year	100-year	250-year	500-year
Hammels H1	145	199	244	306	353	400	491	557
Hammels H2	227	315	389	489	565	642	790	897
Arverne A1	90	123	152	190	219	248	305	346
Arverne A2	171	235	289	362	418	474	582	660
Arverne A3	278	387	478	601	695	789	972	1,104
Edgemere E1	195	277	346	439	511	582	721	822
Edgemere E2	248	360	454	584	682	782	974	1,113
Canarsie C1	165	227	279	348	401	455	559	634
Canarise C2	89	122	150	187	216	245	301	341
Canarsie C3	117	161	198	247	285	323	396	449
Cedarhurst-Lawrence L1	127	173	212	264	303	343	421	427
Motts Basin North M1	39	57	71	91	107	122	152	173

3 DESIGN PROCEDURE

As described in EM 1110-2-1413, "Hydrologic Analysis of Interior Areas", procedures for formulating and evaluating flood loss reduction measures for interior drainage basins are similar to planning procedures used in other types of investigations. The complexity of the process is dependent upon the nature of the study area, flood hazard, damage potential, and environmental and social factors. A comprehensive array of alternatives is formulated and evaluated through an iterative process until a final array of plans is developed. Data necessary to conduct the investigation includes basin hydrology, stage-frequency curves, hydraulic parameters of plan components, the annualized cost of construction and maintenance, and estimated residual damages. Using this data, with and without project benefits can be determined in order to identify the plan which maximizes net benefits.

3.1 Interior Flood Control Simulation Models

As discussed in Section 2, the hydrologic analysis program HEC-HMS was used to simulate the hydrologic response of the interior drainage basins and the operation of the drainage facilities. The program has some limitations in the modeling of existing storm sewer systems and natural flood storage area. It may, therefore underestimate outflow through the outlets through the line of protection and thereby overestimate interior water surface elevations by failing to account for runoff that may not accumulate in the natural flood storage area. This would be the case when

runoff passes directly into the bay when the head difference between tailwater elevation and the ground elevation behind the plan alignment is positive.

HEC-HMS computes both runoff and routes floods through interior drainage facilities taking into account variable tailwater conditions. This program was utilized to simulate the surface runoff response of the interior basins to precipitation while taking into account both the hydrologic and hydraulic components of these basins.

4 INTERIOR DRAINAGE HYDRAULICS

In addition to the development of hydrologic data, the analysis of interior drainage facilities required additional input to describe the physical and operational characteristics of the Minimum Facility and other alternatives. Input requirements consisted of potential storage volumes, and and pumping rates. HEC-HMS was utilized to evaluate the effects of existing or proposed hydraulic structures by routing interior fluvial flood events through the interior drainage basins. The hydraulic assumptions and criteria used to inform the models are described below.

4.1 Elevation/Storage Relationships

In order to evaluate the storage capacity behind the line of protection, elevation-storage relationships were developed. Using project mapping and commencing with the lowest elevation at the natural ponding site behind the line of protection, the planimetric area enveloped by a particular elevation was computed. For consecutive elevations, the average end-area method was used to compute the volume. The volumes between elevations were summed to generate an overall elevation-volume relationship for a particular ponding site. **Figure 4-1** is a plot of the elevation versus natural storage curves for the Mid-Rockaway project area that includes Hammels, Arverne, and Edgemere. **Figure 4-2** is a plot of the elevation versus natural storge curves for the Canarise, Cedarhurst-Lawrence, and Motts Basin North project areas.

4.2 Potential Interior Drainage Facilities

Potential interior drainage facilities (measures) are described below. No single measure is effective in all situations and typically no single measure is effective by itself. The most cost-effective approach to reducing interior flooding stages is likely to be a combination of measures.

4.2.1 Gravity Outlets

The driving head of runoff outflow from the protected areas is the elevation difference between two water surfaces; the elevation of runoff that is accumulated landward of the proposed alignment (headwater) and the elevation of the tidal surge seaward of the proposed alignment (tailwater).

There is no modeled backflow from the bay into natural flood storage areas because tide gates, which permit flow in only one direction, are assumed to be in place for the Minimum Facility as

well as all interior drainage alternatives. The program HEC-HMS would assume zero flow when tide level is higher than the interior headwater level.

Gravity outlets, typically the least expensive drainage measure, function best during the high rainfall coupled with low tide events, when there is sufficient head for gravity discharge. Gravity outlets also work well when the existing grade landward of the plan alignment is higher, again providing additional head. Conversely, gravity outlets are ineffective during high tide events when the tailwater elevations are higher than the interior elevations. During these events, outlets are effectively blocked and thus the gravity discharge is zero. Gravity outlets do not function well with large, low-lying natural flood storage areas such as freshwater wetlands, where even a moderate tide can prevent gravity discharge.

For this project, gravity outlets through the line of protection are a significant component of the hydraulic measures and considered part of the Minimum Facility scenario.

4.2.2 Ponding / Flood Storage

Ponding or flood storage can be an effective means for flood risk management. Runoff is stored in low-lying, non-damaging areas until the tidal surge (tailwater) drops sufficiently to permit gravity discharge. Ponding is most effective when runoff is first discharged through gravity outlets during low tailwater conditions, and then diverted into the pond as the gravity outlets become blocked. Directing all runoff into a pond will increase the size of the pond required. Excavating ponds to increase the runoff storage volume can be expensive, so natural flood storage areas should be used wherever possible, especially where development has already occurred or is expected to occur in low-lying areas.

Excavated ponds were considered for the project areas but were not found to be viable as the available storage was not sufficient to produce a significant difference in the interior flooding stages.

4.2.3 Pressure Outlets

If a significant portion of the drainage area is higher than the crest of the coastal storm risk management plan structure, it may be possible to divert the runoff from that higher area directly into the bay through pressure conduits. Typically, there must be sufficient head between the higher ground and the maximum tailwater to divert this runoff. Diversion effectively reduces the volume of runoff reaching the structure that would otherwise need to be handled by other means such as ponding or pumping. Pressurizing an existing gravity line by removing or sealing all of the lower catch basins is usually the most expensive method, so in some cases construction of a new pressure line may be justified.

Pressure outlets could be considered for subbasin E2 at the bottom of the steep slopes in the northeastern part of the subbasin. However, sufficient data is not available on the existing

stormwater system at this time to go forward with this approach. This can be reconsidered at a later phase of the design, when sufficient data is available.

4.2.4 Pumping

Pumping is usually the most expensive option in initial construction as well as operation and maintenance. Similar to pond excavation and pressure outlets, pumping is most effective during higher exterior stages when gravity outlets are blocked and there is insufficient natural flood storage area landward of the plan alignment. Pumping can be used to reduce the volume of a ponding area, or it can be used to handle the peak runoff. The construction of a pump station creates additional capital costs and also increases annual maintenance and operation costs. Capital expenditures affected by the addition of pump stations include mechanical equipment, associated housing, and any new outfalls. Increases in the cost of project operation and maintenance include power consumption, equipment operation, inspection and testing, maintenance and replacement.

Pumps typically have a minimum cycle time of about six starts per hour. To achieve this cycle time an adequate volume of surface runoff from the interior drainage basin must be stored and available whenever the pumping operation is initiated. The storage volume in cubic feet required between the lead pump-on and pump-off elevations is based on the following equation:

$$V = \frac{TQ_{pump}}{4}$$

where *V* is the volume in cubic feet, and Q_{pump} is the pump discharge rate in cubic feet per second, and T is the cycle time in seconds.

For this project, typically, each pump station has two pumps with one turning on at a flooding stage of 1 ft, NAVD88 and the other tunring on at 2 ft, NAVD88. In cases with three pumps, the third pump turns on at a flooding stage of 3ft, NAVD88. Once turned on, the pumps will remain on until the water level drops to below an elevation of -1 ft, NAVD88.

5 ECONOMIC ASSESSMENT

5.1 Conditions

Analysis of benefits and costs for formulation of interior drainage plans was conducted using a federal interest rate of 2.75% applied over a 50-year period-of-analysis. Baseline conditions considered the current sea level and future conditions considered a 1.1 foot rise in sea level and storm surge elevations (Intermediate sea level rise scenario).

5.2 Costs

Interior drainage consists of features required to maintain existing drainage and avoid induced flood-damage, and various interior drainage improvements that must be economically justified based on a comparison of benefits (reduction of Minimum Facility damages) and costs (annual cost above Minimum Facility costs). These costs consist of first construction costs, real estate costs, and annual operation and maintenance expenses. Interior drainage facility costs are based on incremental improvements and are additional to Minimum Facility features, which are considered part of the Recommended LOP Plan.

5.2.1 First Construction Costs

First construction costs for interior drainage facilities may include primary and secondary outlets, inlet and sluice gate structures, outlet gates, pump stations and new outfalls.

5.2.2 Operation and Maintenance

Annual costs attributed to the operation and maintenance of interior drainage facilities consist of, but are not limited to, labor charges for the inspection, care and cleaning of outlets and pump stations, as well as anticipated energy charges and annualized replacement costs.

5.3 Benefits

Flood damage reduction benefits for interior drainage facilities are calculated as the difference between the residual damages associated with the project with Minimum Facilities in place and the interior drainage alternative being evaluated.

5.3.1 Interior Flood Damage

The expected damage to each structure was calculated for the required range of flooding depths. These damages were then aggregated to determine composite stage versus damage relationships for each interior area.

5.3.2 Annual Damage

Annual damage was calculated using HEC-FDA Version 1.4.1 which applies Monte Carlo simulation techniques to compute the expected value of damage, while accounting for uncertainty in the value of key parameters such as structure value and elevation, damage as a percent of value at various stages, and hydrologic and hydraulic data such as stage-frequency relationships. The HEC-FDA model calculates the Average Annual Damages (AAD) for both the base and future conditions (with sea level change). Equivalent Annual Damages (EAD), which is the sum of the discounted value of the expected annual damage, was also calculated for the 50-year period-of-analysis.

5.3.3 Minimum Facility Damages

As noted above, the Minimum Facility becomes the starting point for evaluating interior drainage alternatives. The magnitude of these damages helps to guide decisions on the type and scale of interior flood risk management measures to consider. **Table 5-1** and **Table 5-2** provide a summary of the Minimum Facility AAD and EAD for each of the interior drainage subbasins.

Table 5-1: Minimum Facility Damage – Mid-Rockaway

Drainage Subbasins	Expected Annual Damage		Equivalent Annual Damage*
	Base Year	Future Year	
Hammels H1	$ 625,010	$ 1,305,130	$ 883,680
Hammels H2	$ 567,590	$ 936,910	$ 708,050
Arverne A1	$ 227,110	$ 409,860	$ 296,620
Arverne A2	$ 1,116,050	$ 1,452,560	$ 1,244,030
Arverne A3	$ 1,633,530	$ 2,796,050	$ 2,075,670
Edgemere E1	$ 1,188,750	$ 1,995,290	$ 1,495,500
Edgemere E2	$ 377,520	$ 797,130	$537,110

*2.75% Discount Rate

Table 5-2: Minimum Facility Damage – Canarsie, Cedarhurst-Lawrence, and Motts Basin North

Drainage Subbasins	Expected Annual Damage		Equivalent Annual Damage*
	Base Year	Future Year	
Canarsie C1	$ 1,052,900	$ 2,386,190	$ 1,559,990
Canarsie C2	$ 123,470	$ 343,680	$ 207,220
Canarsie C3	$ 317,220	$ 1,020,130	$ 584,560
Cedarhurst-Lawrence L1	$ 1,335,300	$ 3,107,130	$ 2,009,180
Motts Basin North M1	$ 60,170	$ 128,530	$ 86,170

*2.75% Discount Rate

6 PLAN FORMULATION

6.1 Minimum Facility Concept

As stated in EM 1110-2-1413, "Hydrologic Analysis of Interior Areas", the design Minimum Facilities should provide interior flood relief such that during all exterior stages, residual flooding is not induced above the level that would occur without the Coastal Storm Risk Management System in place. This is the starting point from which all additional interior drainage alternatives can be evaluated. Additional interior drainage measures may be designed to further reduce interior water levels beyond the Minimum Facility. These additional interior facilities must be incrementally justified.

6.2 National Economic Development for Interior Drainage Facilities

The benefits accrued from interior drainage alternatives are attributable to the reduction in the residual flood damages that may have remained under the Minimum Facility condition. Finally, a preferred drainage alternative is selected based on meeting National Economic Development (NED) objectives.

The interior drainage facilities must be formulated to maximize NED benefits while meeting NED objectives to provide a complete, effective, efficient, and acceptable plan of protection.

- Completeness is defined in Engineering Regulation (ER) 1105 2 100 as,
  a. The extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planning objectives, including actions by other Federal and non-Federal entities.
- Effectiveness is defined as,
  b. The extent to which the alternative plans contribute to achieve the planning objectives.
- Efficiency is defined as,
  c. The extent to which an alternative plan is the most cost effective means of achieving the objectives.
- Acceptability is defined as,
  d. The extent to which the alternative plans are acceptable in terms of applicable laws, regulations, and public policies.

6.3 Analysis of Alternative Plans

The Minimum Facility plan was the starting point from which alternative plans (herein called alternatives) were evaluated. The benefits accrued from alternatives are attributable to the reduction in the residual flood damages that would have remained under the Minimum Facility condition. For an alternative to be justified, it must be implementable and reasonably maximize benefits versus the additional cost required for its construction, operations and maintenance. Alternatives examined include the use of gravity outlets and pump stations. The following is a general description of several alternatives that were considered during the development of interior drainage facilities.

For the interior drainage measures described in Section 4.3, “Potential Interior Drainage Facilities”, no single measure could significantly lower the water surface elevation landward of the plan alignment. However, combinations of these measures can be effective in reducing

residual flooding. Alternatives consisting of combinations of measures are listed under **Section 6.5** Interior Plan Formulation.

Table 6-1 provides a list of the alternatives that were considered for each drainage subbasin.

Table 6-1: Interior Drainage Alternatives Evaluated

Drainage Subbasin	Minimum Facility	Pump Alternative 1	Pump Alternative 2
Hammels H1	Gravity Outlets	Gravity Outlets + 100 cfs Pump Station	N/A
Hammels H2	Gravity Outlets	Gravity Outlets + 160 cfs Pump Station	Gravity Outlets + 180 cfs Pump Station
Arverne A1	Gravity Outlets	Gravity Outlets + 70 cfs Pump Station	N/A
Arverne A2	Gravity Outlets	Gravity Outlets + 120 cfs Pump Station	Gravity Outlets + 180 cfs Pump Station
Arverne A3	Gravity Outlets	Gravity Outlets + 200 cfs Pump Station	Gravity Outlets + 300 cfs Pump Station
Edgemere E1	Gravity Outlets	Gravity Outlets + 140 cfs Pump Station	Gravity Outlets + 210 cfs Pump Station
Edgemere E2	Gravity Outlets	Gravity Outlets + 180 cfs Pump Station	Gravity Outlets + 120 cfs Pump Station
Canarsie C1	Gravity Outlets	Gravity Outlets + 70 cfs Pump Station	Gravity Outlets + 150 cfs Pump Station
Canarsie C2	Gravity Outlets	Gravity Outlets + 56 cfs Pump Station	N/A
Canarsie C3	Gravity Outlets	Gravity Outlets + 84 cfs Pump Station	N/A
Cedarhurst-Lawrence L1	Gravity Outlets	Gravity Outlets + 90 cfs Pump Station	N/A
Motts Basin North M1	Gravity Outlets	Gravity Outlets + 26 cfs Pump Station	N/A

6.4 Preferred Plan

The Preferred Plan is defined as the plan that maximizes net benefits over cost. As outlined within the description of Minimum Facility, the planning and development of interior drainage measures is performed independently from the Flood Risk Reduction line of protection features. Each interior drainage subbasin is analyzed to determine the preferred alternative based on the highest net benefits (benefits minus costs).

6.5 Interior Plan Formulation

The formulation of interior plans was an iterative process that considered a full range of measures for each drainage area. Only measures that are reasonably likely to meet the Minimum Facility or NED criteria discussed above were considered at any location.

6.5.1 Mid-Rockaway Project Area

The Mid-Rockaway project area covers approxiately 1,130 acres and includes three drainage basins: Hammels, Arverne, and Edgemere. The following sections describe the process of the interior drainage plan formualtion.

6.5.1.1 Hammels Drainage Basin

6.5.1.1.1 Minimum Facility

The Minimum Facility plan for the Hammels drainage basin consists of gravity outlets through the line of flood protection. Subbasin H1 was estimated to require 3 gravity outlets, including 2 existing outlets. Subbasin H2 was estimated to require 3 gravity outlets, including 1 existing outlet. Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipes will be replaced, if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 feet wide by 3 feet high box culverts. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets.

Table 6-2 provides a summary of the flood levels in the Hammels drainage basin for the Minimum Facility condition (based on a 2-year exterior storm). **Table 6-3** provides a similar summary under an Upper Bound condition.

Table 6-2: Hammels: Minimum Facility Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)	
	Subbasin H1	Subbasin H2
2-Year	4.76	5.06
5-Year	5.34	5.83
10-Year	5.47	6.06
25-Year	5.47	6.06

Table 6-3: Hammels: Minimum Facility Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)	
	Subbasin H1	Subbasin H2
2-Year	4.76	5.06
5-Year	5.53	6.00
10-Year	5.85	6.43
25-Year	6.03	6.59

The EAD for the Hammels drainage basin, with Minimum Facility measures in place, is estimated to be approximately $1,591,730.

6.5.1.1.2 Alternative Plans

The alternatives developed and analyzed for the Hammels drainage basin consist of pump stations, in addition to the gravity outlets that were described as part of the Minimum Facility. The gravity outlets will operate when the pump stations are not in operation. When the gravity outlets are blocked by a high tailwater condition, the ditches and/or drainage collection pipes along the line of protection will direct runoff towards the pump stations.

Pump Alternative 1 for Subbasin H1 consists of 3 gravity outlets (including 2 existing outlets) and a pump station with a total capacity of 100 cfs. Pump Alternatives 1 and 2 for Subbasin H2 consist of pump stations with a total capacity of 160 cfs and 180 cfs, respectively along with 3 gravity outlets (including 1 existing outlet).

Table 6-4 and **Table 6-5** provide the interior water surface elevations under the Most Likely and High Tailwater conditions, respectively, with the alternative measures in place. A complete set of hydraulic modeling results for the Hammels drainage basin is provided in **Attachment 3** of this Sub-Appendix.

Table 6-4: Hammels: Alternatives Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)		
	Subbasin H1	Subbasin H2	
	Pump Alternative 1	Pump Alternative 1	Pump Alternative 2
2-Year	3.78	4.38	3.62
5-Year	4.49	4.77	4.71
10-Year	4.64	5.00	4.93
25-Year	4.80	5.27	5.21

Table 6-5: Hammels: Alternatives Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)		
	Subbasin H1	Subbasin H2	
	Pump Alternative 1	Pump Alternative 1	Pump Alternative 2
2-Year	3.78	4.38	3.62
5-Year	4.66	5.33	5.20
10-Year	4.99	5.63	5.54
25-Year	5.27	5.90	5.82

Table 6-6 provides a summary of the alternatives considered for subbasins in the Hammels drainage basin based on the Most Likely condition.

Table 6-6: Summary of Alternatives for Hammels Drainage Basin

Items	Subbasin H1	Subbasin H2	
	Pump Alternative 1*	Pump Alternative 1	Pump Alternative2*
Damage ($)	209,280	333,290	249,500
Benefits ($)	674,320	384,920	468,710
Pump Size (cfs)	100	160	180
Pump Cost ($)	4,688,500	5,561,900	6,200,666
Annualized Pump Cost ($)	173,670	206,020	229,680
Annual O&M Cost ($)	93,800	111,200	124,000
Total Annual Pump Cost ($)	267,470	317,220	353,680
Net Benefits ($)	406,850	67,700	115,030
Benefit to Cost Ratio	2.5	1.2	1.3

* denotes the Preferred Plan

6.5.1.1.3 Preferred Plan

Based on the evaluation of the interior water surface elevations and net benefits, a Preferred Plan was identified for each subbasin. Pump Alternative 1, with an estimated pump capacity of 100 cfs, is the Preferred Plan for Subbasin H1. The proposed pump station for Subbasin H1 would be located at the southern end of Hammels near Beach 87th Street. Pump Alternative 2, with an estimated pump capacity of 180 cfs, is the Preferred Plan for Subbasin H2. The proposed pump station for subbasin H2 would be located at the northern end of Hammels near Beach Channel Drive. It should be noted that the Preferred Plan includes additional gravity capacity that will operate when the pump station is not in operation. **Table 6-7** lists the gravity outlets for the Preferred Plan for the Hammels drainage basin. The capacity of each pump station and gravity outlet will be refined during the project design phase.

Table 6-7: Preferred Plan Gravity Outlets for Hammels

Subbasin	Gravity Outlets Description
H1	Existing Outlet ROC-656
H1	Proposed Outlet H1-1, approximately 70 feet east of Beach 85th Street
H1	Existing Outlet ROC-657
H2	Proposed Outlet H2-1, approximately 350 feet west of Beach 80th Street
H2	Proposed Outlet H2-2, approximately 100 feet west of Beach 79th Street
H2	Existing Outlet ROC-653

Note: Size and location of gravity outlets will be refined during the project design phase

Plan layouts showing the interior drainage features are provided in Sub-Appendix B of Appendix A2 (Engineering and Design Appendix). **Figures 6-1** and **6-2** are plots of the peak stage versus frequency curves for both Minimum Facility and Preferred Plan for subbasins H1 and H2, respectively. **Figures 6-3** and **6-4** show inflow, outflow, and interior and exterior stage hydrographs for the Preferred Plan under the 10-year Most Likely Condition, for subbasins H1 and H2, respectively. Residual flooding for the Hammels drainage subbasin is discussed in detail in Section 7.

The Equivalent Annual Damages (EAD) for the Hammels drainage basin with the Preferred Plan in place is estimated to be approximately $458,780, which is a $1,132,950 reduction in annual damages compared to the Minimum Facility condition.

6.5.1.2 Arverne Drainage Basin

6.5.1.2.1 Minimum Facility

The Minimum Facility plan for the Arverne drainage basin consists of gravity outlets through the line of flood protection. Subbasin A1 was estimated to require 8 gravity outlets, including 5 existing outlets. Subbasin A2 was estimated to require 3 gravity outlets, all three being proposed. Subbasin A3 was estimated to require 5 gravity outlets, including 3 existing outlets. Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipes will be replaced, if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 feet wide by 3 feet high box culverts. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets.

Table 6-8 provides a summary of the most likely flood levels in the Arverne drainage basin for the Minimum Facility condition. **Table 6-9** provides a similar summary under an Upper Bound condition.

Table 6-8: Arverne: Minimum Facility Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)		
	Subbasin A1	Subbasin A2	Subbasin A3
2-Year	4.48	4.37	4.87
5-Year	4.79	4.56	5.71
10-Year	4.86	4.70	5.99
25-Year	4.86	4.86	5.99

Table 6-9: Arverne: Minimum Facility Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)		
	Subbasin A1	Subbasin A2	Subbasin A3
2-Year	4.48	4.37	4.87
5-Year	4.99	4.75	5.90
10-Year	5.24	4.98	6.37
25-Year	5.41	5.15	6.55

The EAD for the Arverne drainage basin, with Minimum Facility measures in place, is estimated to be approximately $3,616,320.

6.5.1.2.2 Alternative Plans

The alternatives developed and analyzed for the Arverne drainage basin consist of pump stations, in addition to the gravity outlets that were described as part of the Minimum Facility. The gravity outlets will operate when the pump stations are not in operation. When the gravity outlets are blocked by a high tailwater condition, the ditches and/or drainage collection pipes along the line of protection will direct runoff towards the pump stations.

Pump Alternative 1 for Subbasin A1 consists of 8 gravity outlets (including 5 existing outlets) and a pump station with a total capacity of about 70 cfs. Pump Alternatives 1 and 2 for Subbasin A2 consist of pump stations with a total capacity of about 120 cfs and 180 cfs, respectively along with 3 proposed gravity outlets. Pump Alternatives 1 and 2 for Subbasin A3 consist of pump stations with a total capacity of about 200 cfs and 300 cfs, respectively along with 5 gravity outlets (including 3 existing outlets).

Table 6-10 and **Table 6-11** provide the interior water surface elevations under the Most Likely and High Tailwater conditions, respectively, with the alternative measures in place. A complete set of hydraulic modeling results for the Arverne drainage basin is provided in **Attachment 3** of this Sub-Appendix.

Table 6-10: Arverne: Alternatives Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)				
	Subbasin A1	Subbasin A2		Subbasin A3	
	Pump Alternative 1*	Pump Alternative 1	Pump Alternative 2*	Pump Alternative 1	Pump Alternative 2*
2-Year	3.47	3.50	2.07	4.34	3.07
5-Year	4.09	3.94	3.47	4.64	4.39
10-Year	4.32	4.16	3.84	4.80	4.62
25-Year	4.44	4.36	4.15	5.04	4.83

Table 6-11: Arverne: Alternatives Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)				
	Subbasin A1	Subbasin A2		Subbasin A3	
	Pump Alternative 1*	Pump Alternative 1	Pump Alternative 2*	Pump Alternative 1	Pump Alternative 2*
2-Year	3.47	3.50	2.07	4.34	3.07
5-Year	4.10	3.94	3.47	5.15	4.39
10-Year	4.37	4.18	3.84	5.52	5.02
25-Year	4.65	4.44	4.16	5.86	5.52

Table 6-12 provides a summary of the alternatives considered for subbasins in the Arverne drainage basin based on the Most Likely condition.

Table 6-12: Summary of Alternatives Considered for Arverne

Items	Subbasin A1	Subbasin A2		Subbasin A3	
	Pump Alternative 1*	Pump Alternative 1	Pump Alternative 2*	Pump Alternative 1	Pump Alternative 2*
Damage ($)	103,810	491,420	213,570	952,840	566,400
Benefits ($)	192,810	752,610	1,030,460	1,122,830	1,509,270
Pump Size (cfs)	70	120	180	200	300
Pump Cost ($)	2,532,200	4,246,700	6,200,666	6,200,700	9,769,642
Annualized Pump Cost ($)	93,800	157,300	229,680	229,680	361,880
Annual O&M Cost ($)	50,600	84,900	124,000	124,000	195,400
Total Annual Pump Cost ($)	144,400	242,200	353,680	353,680	557,280
Net Benefits ($)	48,410	510,410	676,780	769,150	951,990
Benefit to Cost Ratio	1.3	3.1	2.9	3.2	2.7

* denotes the Preferred Plan

6.5.1.2.3 Preferred Plan

Based on the evaluation on the interior water surface elevations and net benefits, a Preferred Plan was identified for each subbasin. Pump Alternative 1, with an estimated pump capacity of 70 cfs, is the Preferred Plan for Subbasin A1. The proposed pump station for Subbasin A1 would be located adjacent to DE Costa Avenue, near Beach 72nd Street. Pump Alternative 2, with an estimated pump capacity of 180 cfs, is the Preferred Plan for Subbasin A2. The proposed pump station for Subbasin A2 would be located on DE Costa Avenue, near Beach 63rd Street. Pump Alternative 2, with an estimated pump capacity of 300 cfs, is the Preferred Plan for Subbasin A3. The proposed pump station for Subbasin A3 would be located south of Thursby Avenue. It should be noted that the Preferred Plan includes additional gravity capacity that will operate when the pump station is not in operation. **Table 6-13** lists the gravity outlets for the Preferred

Plan for the Arverne drainage basin. The capacity of each pump station and gravity outlet will be refined during the project design phase.

Table 6-13: Preferred Plan Gravity Outlets for Arverne

Subbasin	Gravity Outlets Description
A1	Existing Outlet ROC-633
A1	Existing Outlet ROC-634
A1	Existing Outlet TEMP40062
A1	Proposed Outlet A1-1, located at the end of Hillmyer Avenue
A1	Proposed Outlet A1-2, located adjacent to Hillmyer Avenue and Barbadoes Avenue
A1	Existing Outlet ROC-658
A1	Proposed Outlet A1-3, located 250 feet west of Beach 69th Street
A1	Existing Outlet ROC-659
A2	Proposed Outlet A2-1, located on Bayfield Avenue 150 feet west of Beach 65th Street
A2	Proposed Outlet A2-2, located at the east end of DE Costa Avenue
A2	Proposed Outlet A2-3, located at the east end of Burchell Road
A3	Existing Outlet, located at the east end of Thursby Avenue
A3	Existing Outlet ROC-636
A3	Proposed Outlet A3-1, located 250 north of Beach Channel Drive on 58th Street
A3	Existing Outlet ROC-635
A3	Proposed Outlet A3-2, located 50 feet south of Beach Channel Drive on 58th Street

Note: Size and location of gravity outlets will be refined during the project design phase

Plan layouts showing the interior drainage features are provided in Sub-Appendix B of Appendix A2 (Engineering and Design Appendix). **Figures 6-5, 6-6** and **6-7** are plots of the peak stage versus frequency curves for both Minimum Facility and Preferred Plan for subbasins A1, A2, and A3, respectively. **Figures 6-8, 6-9,** and **6-10** show inflow, outflow, and interior and exterior stage hydrographs for the Preferred Plan under the 10-year Most Likely Condition, for subbasins A1, A2, and A3, respectively. Residual flooding for the Arverne drainage basin is discussed in detail in Section 7.

The Equivalent Annual Damages (EAD) for the Arverne drainage basin with the Preferred Plan in place is estimated to be approximately $883,740, which is a $2,732,580 reduction in annual damages compared to the Minimum Facility condition.

6.5.1.3 Edgemere Drainage Basin

6.5.1.3.1 Minimum Facility

The Minimum Facility plan for the Edgemere drainage basin consists of gravity outlets through the line of flood protection. Subbasin E1 was estimated to require 9 gravity outlets, including 2 existing outlets. Subbasin E2 was estimated to require 6 gravity outlets, including 1 existing outlet. Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage

system. The existing outlet pipes will be replaced, if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 feet wide by 3 feet high box culverts. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets.

Table 6-14 provides a summary of the most likely flood levels in the Edgemere drainage basin for the Minimum Facility condition. **Table 6-15** provides a similar summary under an Upper Bound condition.

Table 6-14: Edgemere: Minimum Facility Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)	
	Subbasin E1	Subbasin E2
2-Year	4.63	4.61
5-Year	5.18	5.36
10-Year	5.29	5.57
25-Year	5.29	5.57

Table 6-15: Edgemere: Minimum Facility Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)	
	Subbasin E1	Subbasin E2
2-Year	4.63	4.61
5-Year	5.33	5.53
10-Year	5.59	5.96
25-Year	5.73	6.14

The EAD for the Edgemere drainage basin, with Minimum Facility measures in place, is estimated to be approximately $2,032,610.

6.5.1.3.2 Alternative Plans

The alternatives developed and analyzed for the Edgemere drainage basin consist of pump stations, in addition to the gravity outlets that were described as part of the Minimum Facility. The gravity outlets will operate when the pump stations are not in operation. When the gravity outlets are blocked by a high tailwater condition, the ditches and/or drainage collection pipes along the line of protection will direct runoff towards the pump stations.

Pump Alternatives 1 and 2 for Subbasin E1 consist of pump stations with a total capacity of about 140 cfs and 210 cfs, respectively along with 9 gravity outlets (including 2 existing outlets). Pump Alternatives 1 and 2 for Subbasin E2 consist of pump stations with a total capacity of about 180 cfs and 120 cfs, respectively along with 6 gravity outlets (including 1 existing outlet).

Table 6-16 and **Table 6-17** provide the interior water surface elevations under the Most Likely and High Tailwater conditions, respectively, with the alternative measures in place. A complete set of hydraulic modeling results for the Edgemere drainage basin is provided in **Attachment 3** of this Sub-Appendix.

Table 6-16: Edgemere: Alternatives Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)			
	Subbasin E1		Subbasin E2	
	Pump Alternative 1	Pump Alternative 2	Pump Alternative 1	Pump Alternative 2
2-Year	4.36	3.10	4.04	4.37
5-Year	4.49	4.39	4.43	4.83
10-Year	4.55	4.49	4.53	4.83
25-Year	4.60	4.56	4.64	4.83

Table 6-17: Edgemere: Alternatives Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)			
	Subbasin E1		Subbasin E2	
	Pump Alternative 1	Pump Alternative 2	Pump Alternative 1	Pump Alternative 2
2-Year	4.36	3.10	4.04	4.37
5-Year	4.88	4.54	5.01	5.22
10-Year	5.07	4.83	5.35	5.58
25-Year	5.28	5.08	5.66	5.81

Table 6-18 provides a summary of the alternatives considered for subbasins in the Edgemere drainage basin based on the Most Likely condition.

Table 6-18: Summary of Alternatives Considered for Edgemere

Items	Subbasin E1		Subbasin E2	
	Pump Alternative 1	Pump Alternative 2*	Pump Alternative 1	Pump Alternative 2*
Damage ($)	462,550	263,520	137,050	238,420
Benefits ($)	1,018,700	1,217,730	400,060	298,690
Pump Size (cfs)	140	210	180	120
Pump Cost ($)	4,910,600	7,135,270	6,200,700	4,246,738
Annualized Pump Cost ($)	181,890	264,300	229,680	157,300
Annual O&M Cost ($)	98,200	142,700	124,000	84,900
Total Annual Pump Cost ($)	280,090	407,000	353,680	242,200
Net Benefits ($)	738,610	810,730	46,380	56,490
Benefit to Cost Ratio	3.6	3.0	1.1	1.2

* denotes the Preferred Plan

6.5.1.3.3 Preferred Plan

Based on the evaluation of the interior water surface elevations and net benefits, a Preferred Plan was identified for each subbasin. Pump Alternative 2, with an estimated pump capacity of 210 cfs, is the Preferred Plan for Subbasin E1. Due to the length of the subbasin along the line of protection and the difficulty in draining all of runoff to a single location, two pump stations are proposed for Subbasin E1, with a combined capacity of about 210 cfs. One pump station would be located near Norton Avenue and Beach 49th Street and the other near Beach 43rd Street and Hough Place. Pump Alternative 2, with an estimated pump capacity of 120 cfs, is the Preferred Plan for Subbasin E2. The proposed pump station for Subbasin E2 would be located near Beach 38th Street. It should be noted that the Preferred Plan includes additional gravity capacity that will operate when the pump station is not in operation. **Table 6-19** lists the gravity outlets for the Preferred Plan for the Edgemere drainage basin. The capacity of each pump station and gravity outlet will be refined during the project design phase.

Table 6-19: Preferred Plan Gravity Outlets for Edgemere

Edgemere	Gravity Outlets Description
E1	Existing Outlet ROC-648
E1	Proposed Outlet E1-1, located on Norton Avenue between Beach 47th and 48th Streets
E1	Proposed Outlet E1-2, located on Norton Avenue between Beach 46th and 45th Streets
E1	Proposed Outlet E1-3, located on Beach 45th Street north of Hough Place
E1	Proposed Outlet E1-4, located on the north end of Beach 45th Street
E1	Proposed Outlet E1-5, located adjacent to Beach 43rd Street, 550 feet north of Hough Place
E1	Proposed Outlet E1-6, located adjacent to Beach 43rd Street, 500 feet north of Hough Place
E1	Existing Outlet ROC-637
E1	Proposed Outlet E1-7, located 700 feet north of Beach 40th Street

Edgemere	Gravity Outlets Description
E2	Existing Outlet ROC-638
E2	Proposed Outlet E2-1, located 50 feet east of Beach 37th Street
E2	Proposed Outlet E2-2, located 50 feet east of Beach 37th Street
E2	Proposed Outlet E2-3, located 50 feet east of Beach 36th Street
E2	Proposed Outlet E2-4, located 50 feet east of Beach 36th Street
E2	Proposed Outlet E2-5, located between Beach 36th Street and Beach 35th Street

Note: Size and location of gravity outlets will be refined during the project design phase

Plan layouts showing the interior drainage features are provided in Sub-Appendix B of Appendix A2 (Engineering and Design Appendix). **Figures 6-11** and **6-12** are plots of the peak stage versus frequency curves for both Minimum Facility and Preferred Plan for subbasins E1 and E2, respectively. **Figures 6-13** and **6-14** show inflow, outflow, and interior and exterior stage hydrographs for the Preferred Plan under the 10-year Most Likely Condition, for subbasins E1 and E2, respectively. Residual flooding for the Edgemere drainage basin is discussed in detail in Section 7.

The Equivalent Annual Damages (EAD) for the Edgemere drainage basin with the Preferred Plan in place is estimated to be approximately $501,940, which is a $1,530,670 reduction in annual damages compared to the Minimum Facility condition.

6.5.2 Canarsie Project Area

6.5.2.1 Minimum Facility

The Minimum Facility plan for the Canarsie drainage basin consists of gravity outlets through the line of flood protection. Subbasin C1 was estimated to require 4 gravity outlets, Subbasin C2 was estimated to require 2 gravity outlets, and Subbasin C3 was estimated to require 5 gravity outlets. Each existing outlet will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipes will be replaced if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 feet wide by 3 feet high box culverts. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets.

Table 6-20 provides a summary of the most likely flood levels in the Canarsie drainage basin for the Minimum Facility condition. **Table 6-21** provides a similar summary under an Upper Bound condition.

Table 6-20: Canarsie: Minimum Facility Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)		
	Subbasin C1	Subbasin C2	Subbasin C3
2-Year	4.77	4.78	4.65
5-Year	5.96	5.98	5.85
10-Year	6.88	7.03	6.86
25-Year	6.88	7.03	6.86

Table 6-21: Canarsie: Minimum Facility Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)		
	Subbasin C1	Subbasin C2	Subbasin C3
2-Year	4.77	4.78	4.65
5-Year	6.11	6.17	5.88
10-Year	7.21	7.28	7.01
25-Year	7.38	7.43	7.08

The Equivalent Annual Damages (EAD) for the Canarsie project area, with Minimum Facility measures in place, is estimated to be approximately $2,351,770.

6.5.2.2 Alternative Plans

The alternatives developed and analyzed for the Canarsie drainage basin consist of pump stations, in addition to the gravity outlets that were described as part of the Minimum Facility. The gravity outlets will operate when the pump stations are not in operation. When the gravity outlets are blocked by a high tailwater condition, the ditches and/or drainage collection pipes along the line of protection will direct runoff towards the pump stations.

Pump Alternatives 1 and 2 for Subbasin C1 consist of pump stations with a total capacity of about 70 cfs and 150 cfs, respectively along with 4 gravity outlets. Pump Alternative 1 for Subbasin C2 consists of 2 gravity outlets and a pump station with a total capacity of about 56 cfs. Pump Alternative 1 for Subbasin C3 consists of 5 gravity outlets and a pump station with a total capacity of about 84 cfs.

Table 6-22 and **Table 6-23** provide the interior water surface elevations under the Most Likely and High Tailwater conditions, respectively, with the alternative measures in place. A complete set of hydraulic modeling results for the Canarsie drainage basin is provided in **Attachment 3** of this Sub-Appendix**.**

Table 6-22: Canarsie: Alternatives Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)			
	Subbasin C1		Subbasin C2	Subbasin C3
	Pump Alternative 1	Pump Alternative 2	Pump Alternative 1	Pump Alternative 1
2-Year	4.63	2.92	4.58	4.55
5-Year	5.68	4.59	5.38	5.26
10-Year	5.96	4.69	6.55	5.42
25-Year	5.96	4.86	6.55	5.42

Table 6-23: Canarsie: Alternatives Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)			
	Subbasin C1		Subbasin C2	Subbasin C3
	Pump Alternative 1	Pump Alternative 2	Pump Alternative 1	Pump Alternative 1
2-Year	4.63	2.92	4.58	4.55
5-Year	5.86	5.41	5.87	5.76
10-Year	6.80	6.09	6.93	6.66
25-Year	6.98	6.68	7.09	6.82

Table 6-24 provides a summary of the alternatives considered for subbasins in the Canarsie drainage basin based on the Most Likely condition.

Table 6-24: Summary of Alternatives Considered for Canarsie

Items	Subbasin C1		Subbasin C2	Subbasin C3
	Pump Alternative 1	Pump Alternative 2	Pump Alternative 1	Pump Alternative 2
Damage ($)	976,550	360,580	108,760	222,760
Benefits ($)	583,440	1,199,410	98,460	361,800
Pump Size (cfs)	70	150	56	84
Pump Cost ($)	3,314,900	3,851,340	2,664,200	3,959,400
Annualized Pump Cost ($)	122,790	142,660	98,680	146,660
Annual O&M Cost ($)	66,300	77,000	53,300	79,200
Total Annual Pump Cost ($)	189,090	219,660	151,980	225,860
Net Benefits ($)	394,350	979,750	-53,520	135,940
Benefit to Cost Ratio	3.1	5.5	0.65	1.6

6.5.2.3 Preferred Plan

Based on the evaluation of the interior water surface elevation and net benefits, no interior drainage plan that would result in a HFFRRF with a BCR above 1.0 was identified. Accordingly, there is not a Preferred Drainage Plan identified for the Canarsie drainage basin. Even with the pumps and improved gravity outlet drainage system, flood elevations for a 50% AEP rainfall occurring with the design storm tide are only reduced between 0.1 and 0.2 feet. Since residual flooding remains high for the Canarsie HFFRRF, NED benefits from the plan are not high enough to justify the federal investment, as will be discussed in Section 7, and the BCR drops below one.

6.5.3 Cedarhurst-Lawrence Project Area

6.5.3.1 Minimum Facility

The Minimum Facility plan for the Cedarhurst-Lawrence drainage basin consists of gravity outlets through the line of flood protection. Subbasin L1 was estimated to require 4 gravity outlets, including 3 existing outlets in the area where the bulkhead will be raised. Each of the existing outlets will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipes will be replaced if the design phase indicates it is necessary due to the condition of the pipes or a need for additional capacity. The new outlets are generally assumed to be 5 feet wide by 3 feet high box culverts. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with some inlets that will be connected to the existing or additional drainage outlets.

Table 6-25 provides a summary of the most likely flood levels in the Cedarhurst-Lawrence drainage basin for the Minimum Facility condition. **Table 6-26** provides a similar summary under an Upper Bound condition.

Table 6-25: Cedarhurst-Lawrence: Minimum Facility Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)
2-Year	4.65
5-Year	5.64
10-Year	5.90
25-Year	5.90

Table 6-26: Cedarhurst-Lawrence: Minimum Facility Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)
2-Year	4.65
5-Year	5.75
10-Year	6.25
25-Year	6.41

The EAD for the Cedarhurst-Lawrence project area, with Minimum Facility measures in place, is estimated to be approximately $586,110.

6.5.3.2 Alternative Plan

The alternative developed and analyzed for the Cedarhurst-Lawrence drainage basin consists of a pump station, in addition to the gravity outlets that were described as part of the Minimum Facility. The gravity outlets will operate when the pump station is not in operation. When the gravity outlets are blocked by a high tailwater condition, the ditches and/or drainage collection pipes along the line of protection will direct runoff towards the pump station.

Pump Alternative 1, the only alternative for Subbasin L1, consists of 4 gravity outlets (including 3 existing outlets) and a pump station with a total capacity of 90 cfs.

Table 6-27 and **Table 6-28** provide the interior water surface elevations under the Most Likely and High Tailwater conditions, respectively, with the alternative measures in place. A complete set of hydraulic modeling results for the Cedarhurst-Lawrence drainage basin is provided in **Attachment 3** of this Sub-Appendix.

Table 6-27: Cedarhurst-Lawrence: Alternative Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)
	Pump Alternative 1
2-Year	4.48
5-Year	4.66
10-Year	4.67
25-Year	4.67

Table 6-28: Cedarhurst-Lawrence: Alternative Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)
	Pump Alternative 1
2-Year	4.48
5-Year	5.17
10-Year	5.43
25-Year	5.69

Table 6-29 provides a summary of the alternatives considered for subbasins in the Cedarhurst-Lawrence drainage basin based on the Most Likely condition.

Table 6-29: Summary of Alternative Considered for Cedarhurst-Lawrence

Items	Pump Alternative 1*
Damage ($)	642,780
Benefits ($)	1,366,400
Pump Size (cfs)	90
Pump Cost ($)	4,233,800
Annualized Pump Cost ($)	156,820
Annual O&M Cost ($)	84,700
Total Annual Pump Cost ($)	241,520
Net Benefits ($)	1,124,880
Benefit to Cost Ratio	5.7

* denotes the Preferred Plan

6.5.3.3 Preferred Plan

Based on the evaluation of the interior water surface elevations and net benefits, Pump Alternative 1, with an estimated pump capacity of 90 cfs, is the Preferred Plan for the Cedarhurst-Lawrence drainage basin. The proposed pump station for L1 would be located approximately 260 feet north of Plaza Road. It should be noted that the Preferred Plan includes additional gravity capacity that will operate when the pump station is not in operation.

Table 6-30 lists the gravity outlets for the Preferred Plan for the Cedarhurst-Lawrence drainage basin. The capacity of each pump station and gravity outlet will be refined during the project design phase.

Table 6-30: Preferred Plan Gravity Outlets for Cedarhurst-Lawrence

Subbasin	Gravity Outlet Description
L1	Existing Outlet
L1	Existing (recently constructed) culvert, located approximately 100 feet north of Peninsula Boulevard and 150 feet west of Oxford Road
L1	Existing (recently constructed) culvert, located approximately 100 feet north of Peninsula Boulevard and 200 feet west of Oxford Road
L1	Proposed Outlet L-1, located approximately 250 feet from Peninsula Boulevard

Note: Size and location of gravity outlets will be refined during the project design phase

Plan layouts showing the interior drainage features are provided in Sub-Appendix B of Appendix A2 (Engineering and Design Appendix). **Figure 6-15** is a plot of the peak stage versus frequency curves for both Minimum Facility and Preferred Plan for subbasin L1. **Figure 6-16** shows inflow, outflow, and interior and exterior stage hydrographs for the Preferred Plan under the 10-year Most Likely Condition, for subbasin L1. Residual flooding for the Cedarhurst-Lawrence drainage basin is discussed in detail in Section 7.

The Equivalent Annual Damages (EAD) for the Cedarhurst-Lawrence drainage basin with the Preferred Plan in place is estimated to be approximately $642,780, which is a $1,366,390 reduction in annual damages compared to the Minimum Facility condition.

6.5.4 Motts Basin North Project Area

6.5.4.1 Minimum Facility

The Minimum Facility plan for the Motts Basin North drainage basin consists of gravity outlets through the line of flood protection. The Motts Basin North subbasin M1 was estimated to require 1 gravity outlet, which is existing. The existing outlet will be modified to add a valve chamber that will include a sluice gate and flap valve to prevent high tides or storm surge from flooding through the drainage system. The existing outlet pipe will be replaced if the design phase indicates it is necessary due to the condition of the pipe or a need for additional capacity. Drainage along the landward side of the berm/floodwall structures will be provided by a small ditch or drainage collection pipe, with inlets that will be connected to the existing drainage outlet.

Table 6-31 provides a summary of the most likely flood levels in the Motts Basin North drainage basin for the Minimum Facility condition. Table 6-32 provides a similar summary under an Upper Bound condition.

Table 6-31: Motts Basin North: Minimum Facility Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)
2-Year	4.73
5-Year	5.56
10-Year	5.70
25-Year	5.70

Table 6-32: Motts Basin North: Minimum Facility Impacts - Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)
2-Year	4.73
5-Year	5.71
10-Year	6.11
25-Year	6.30

The EAD for the Motts Basin North drainage basin, with Minimum Facility measures in place, is estimated to be approximately $86,170.

6.5.4.2 Alternative Plans

The alternative developed and analyzed for the Motts Basin North drainage basin consists of a pump station, in addition to the gravity outlet that was described as part of the Minimum Facility. The gravity outlet will operate when the pump station is not in operation. When the gravity outlet is blocked by a high tailwater condition, the ditches and/or drainage collection pipes along the line of protection will direct runoff towards the pump station.

Pump Alternative 1, the only alternative for Subbasin M1, consists of one existing gravity outlet and a pump station with a total capacity of 26 cfs.

Table 6-33 and **Table 6-34** provide the interior water surface elevations under the Most Likely and High Tailwater conditions, respectively, with the alternative measures in place. A complete set of hydraulic modeling results for the Motts Basin North drainage basin is provided in **Attachment 3** of this Sub-Appendix.

Table 6-33: Motts Basin North: Alternative Impacts

Storm	Interior Water Surface Elevation (feet, NAVD88)
	Pump Alternative 1
2-Year	4.56
5-Year	4.72
10-Year	4.76
25-Year	4.92

Table 6-34: Motts Basin North: Alternative Impacts – Upper Bound Condition

Storm	Interior Water Surface Elevation (feet, NAVD88)
	Pump Alternative 1
2-Year	4.56
5-Year	5.16
10-Year	5.40
25-Year	5.66

Table 6-35 provides a summary of the alternatives considered for subbasins in the Motts Basin North drainage basin based on the Most Likely condition.

Table 6-35: Summary of Alternative Considered for Motts Basin North

Items	Pump Alternative 1
Damage ($)	28,710
Benefits ($)	57,460
Pump Size (cfs)	26
Pump Cost ($)	1,249,200
Annualized Pump Cost ($)	46,270
Annual O&M Cost ($)	25,000
Total Annual Pump Cost ($)	71,270
Net Benefits ($)	-13,810
Benefit to Cost Ratio	0.8

6.5.4.3 Preferred Plan

Based on the evaluation of the interior water surface elevations and net benefits, the Minimum Facility is the Preferred Plan for the Motts Basin North project area. Pump Alternative 1 was found to have a negative net benefit and hence was eliminated from further consideration. The Preferred Plan for the Motts Basin North project (which is the Minimum Facility) consists of one gravity outlet as shown in **Table 6-36**. The capacity of the gravity outlet will be refined during the project design phase.

Table 6-36: Preferred Plan Gravity Outlet for Motts Basin North

Subbasin	Gravity Outlets Description
M1	Existing Outlet

Note: Size and location of gravity outlets will be defined during the project design phase.

Plan layouts showing the interior drainage features are provided in Sub-Appendix B of Appendix A2 (Engineering and Design Appendix). **Figure 6-17** is a plot of the peak stage versus frequency curves for both Minimum Facility and Preferred Plan for Subbasin M1. **Figure 6-18** shows inflow, outflow, and interior and exterior stage hydrographs for the Preferred Plan under the 10-year Most Likely Condition, for Subbasin M1. Residual flooding for the Motts Basin North drainage basin for the Preferred Plan (which is the Minimum Facility condition) is discussed in detail in Section 7.

The Equivalent Annual Damages (EAD) for Motts Basin North project area with the Preferred Plan in place (i.e., the Minimum Facility condition) is estimated to be approximately $86,170.

6.6 Preferred Plans for the Project Area

In the previous section, within each interior drainage subbasin, the economics for a series of alternative interior drainage measures were evaluated to determine the alternative providing the highest level of net benefits to the project, which was identified as the Preferred Plan. The Preferred Plan for each subbasin and associated costs and net benefits are presented in **Table 6-37**.

Table 6-37: Summary of Preferred Plans for the Project Areas

Project Area	Preferred Plans[1]	First Cost	O&M Cost[2]	Total Annual Cost[3]	Annual Benefits	Net Benefits
Hammels	H1 - 100 cfs pump H2 - 180 cfs pump	$10,889,000	$218,000	$621,200	$1,143,000	$521,800
Arverne	A1 - 70 cfs pump A2 - 180 cfs pump A3 - 300 cfs pump	$18,503,000	$370,000	$1,055,400	$2,732,600	$1,677,200
Edgemere	E1 - 210 cfs pump E2 - 120 cfs pump	$11,382,000	$227,600	$649,200	$1,516,400	$867,200
Cedarhurst-Lawrence	L1 - 90 cfs pump	$4,233,800	$84,700	$241,500	$1,366,400	$1,124,880
Motts Basin North	M1 - Minimum Facility	N/A	N/A	N/A	N/A	N/A
	Totals	**$45,007,800**	**$900,300**	**$2,567,300**	**$6,758,400**	**$4,191,080**

50-year period-of-analysis, 2.75% Federal Discout Rate, October 2017 price level

[1]Preferred Plans with a pump station also include gravity outlets

[2]Includes IDC and O&M Costs

[3]Includes Annualized Replacement Costs (See Cost Appendix)

7 RESIDUAL FLOOD ANALYSIS

The Preferred Plan is designed to reduce the risk from exterior coastal surge and either maintain or reduce the risk from interior residual flooding. Residual flooding, by definition, is the flooding that still occurs with the Preferred Plan in place. For the base year 20-year peak coastal surge, the flood stage exceeds the design elevation of the Preferred Plan, which is designed to a stillwater design of 6.8 to 8.0 feet NAVD88, depending on the individual project area. The overtopping in this case will create flood levels throughout the study area equivalent to the without-project condition.

The base year exterior flood stages from published FEMA coastal modeling studies are presented in **Table 7-1** and the residual peak flood stages from the Interior Drainage Analysis for the Most Likely Condition are presented in **Table 7-2**.

The residual peak interior flood stages are the expected flood conditions from the Interior Drainage Analysis. From the analysis it was found that the risk condition can increase or decrease according to the relationship between the interior and exterior stages. This phenomenon is characterized by three separate likelihoods or combinations of interior/exterior events: the lower bound, expected (most likely), or upper bound condition. For this study, the expected condition is used as the analysis condition for recording with project damage reduction. Due to uncertainty in precipitation intensity and duration, and the correlation with exterior surge stages, a worse flooding condition could occur (upper bound condition).

Table 7-1: Base Year Peak Exterior Stillwater Elevations for Project Areas

Project Area	Peak Exterior Stillwater Elevations, Base Year (feet, NAVD88)				
	20-year	50-year	100-year	200-year	500-year
Hammels	7.9	9.1	10.0	11.0	12.3
Arverne	7.8	9.0	10.0	11.0	12.3
Edgemere	7.8	9.0	9.9	10.9	12.2
Motts Basin North	7.7	8.9	9.9	10.8	12.1
Cedarhurst-Lawrence	7.8	9.0	9.9	10.9	12.2
Canarsie	8.1	9.7	10.8	11.9	13.6

Source: FEMA

Table 7-2: Base Year Peak Residual Interior Flood Stages for Project Areas

Drainage Subbasin	Peak Residual Interior Flood Stages, Most Likely Condition (feet, NAVD88)		
	2-year Storm	5-year Storm	10-year Storm
Hammels H1	3.78	4.49	4.64
Hammels H2	3.62	4.71	4.93
Arverne A1	3.47	4.09	4.32
Arverne A2	2.07	3.47	3.84
Arverne A3	3.07	4.39	4.62
Edgemere E1	3.10	4.39	4.49
Edgemere E2	4.37	4.83	4.83
Cedarhurst-Lawrence L1	4.48	4.66	4.67
Motts Basin North M1	4.73	5.56	5.70

Notes:
1. The peak residual flood stages shown assume no overtopping of the line of protection.
2. For all subbasins, the residual flood stages shown correspond to the Preferred Plan, typically a pump alternative with gravity outlets. Motts Basin North is the only area for which Minimum Facility is the Preferred Plan.

7.1 Line of Protection - Project Performance and Risk Analysis

The Line of Protection will be the first line of defense against surge and wave action experienced during high frequency coastal storm events. However, lower frequency coastal events that have a storm surge which exceeds the Preferred Plan Line of Protection stillwater design heights would overtop the LOP and cause extensive damages to structures in the study area, and life-safety risks.

ER 1105-2-101, "Risk Analysis for Flood Damage Reduction Studies (USACE, January 3, 2006) stipulates that the risk analysis for a flood protection project should quantify the performance of the plan and evaluate the residual risk, including the consequences of exceedance of the project's capacity. The guidance specifically stipulates, along with the basic economic performance of a project, the engineering performance of the project is to be reported in terms of:

- The annual exceedance probability
- The long-term risk of exceedance
- The conditional non-exceedance probability

The overall economic performance of the selected line of protection plan has been computed by HEC-FDA and the results are presented in **Table 7-3**.

Table 7-3: Expected and Probabilistic Values of Structure/Contents Damage Reduced by Project

Project Area	Equivalent Annual Damage (Line of Protection Only)			Probability that Damage Reduced Exceeds the Indicated Values		
	Without Project	With Project	Damage Reduced	75%	50%	25%
Hammels	$6,865,000	$5,315,000	$1,550,000	$1,067,000	$1,477,000	$1,991,000
Arverne	$23,069,000	$17,132,000	$5,937,000	$5,181,000	$5,968,000	$6,678,000
Edgemere	$14,447,000	$12,059,000	$1,388,000	$1,096,000	$1,365,000	$1,656000
Motts Basin North	$701,000	$478,000	$223,000	$194,000	$222,000	$252,000
Cedarhurst-Lawrence	$12,503,000	$6,755,000	$5,748,000	$4,863,000	$5,697,000	$6,617,000
Canarsie	$4,424,000	$3,557,000	$867,000	$805,000	$875,000	$939,000

The annual exceedance probability of a project is the likelihood that a target stage is exceeded by flood waters in any year and can be considered as an indication of the level of risk management provided by the Preferred Plan. The target stage is the point at which significant damage is incurred in the with-project condition, significant damage elevation being defined as the stage at which non-nominal damages begin to occur within each interior drainage basin

The target stage for each reach was used in HEC-FDA to calculate the base year median and expected annual exceedance probability for the Preferred Plan. The median value reflects the basic as-designed performance of the plan without the application of uncertainty to the basic discharge-frequency and stage-discharge functions, while the expected value is computed from the results of the Monte Carlo simulations which take into account uncertainty in hydrologic/hydraulic functions and project features such as diversion structures. Hence the difference between the two is an indication of the uncertainty associated with the project performance.

The long-term risk of exceedance is the probability that the design stage will be exceeded at least once in the specified durations of 10, 30, and 50 years, and the conditional non-exceedance probability measures the likelihood that the project will not be exceeded by a specified hydrologic event. For this analysis, the base year conditional non-exceedance probability has been computed for each alternative for the 10%, 4%, 2%, 1%, 0.4% and 0.2% annual chance exceedance events (10-, 25-, 50-, 100-, 250- and 500-year floods). These indicators of project performance and residual risk for the Preferred Plan are presented in **Table 7-4**.

Table 7-4: Project Performance Analysis - Tentatively Selected Line of Protection

Performance and Reliability Criteria		Hammels	Arverne	Edgemere	Canarsie	Cedarhurst-Lawrence	Motts Basin North
Annual Exceedance Probability of Target Stage	Median	10%	10%	10%	8%	5%	7%
	Expected	11%	11%	10%	8%	5%	7%
Long Term Exceedance Probability	10 Years	67%	67%	66%	56%	42%	51%
	30 Years	96%	96%	96%	92%	80%	88%
	50 Years	100%	100%	100%	98%	93%	98%
Conditional Non-Exceedance Probability	10%	46%	46%	48%	73%	90%	83%
	4%	5%	5%	5%	17%	43%	24%
	2%	1%	1%	1%	4%	19%	8%
	1%	1%	1%	1%	2%	8%	4%
	0.4%	1%	1%	0%	0%	1%	0%
	0.2%	0%	0%	0%	0%	2%	0%

7.2 Interior Drainage Residual Risk Analysis

For storm events where the Line of Protection stillwater design level is not exceeded, there are still residual flood risks from precipitation-runoff in the interior drainage basins landward of the Line of Protection. As part of the Preferred Plan, interior drainage measures are to be implemented so as to ensure that the high frequency flood risk reduction projects do not induce flooding as mandated by the criteria of the Minimum Facility, but also to be studied as to discover where additional measures may be implemented to increase the Net Benefits of the Preferred Plan.

Local flooding of roadways and some structural damages will occur around the 2- to 5-year storm event even with the high frequency flood risk reduction projects in place. As defined in **Section 7.1**, significant damage elevation is defined as the stage at which non-nominal damages begin to occur within each interior drainage basin. By setting significant damage elevations, it is possible to quantify different important flooding characteristics other than just the peak flood stage, such as the warning time, the rate of rise of floodwaters, and the duration of inundation.

- The start point for the warning time of impending inundation begins at the inflection point on the stage storage curve where the instantaneous change in stage begins to accelerate. In effect, this point in time is when the increase in exterior tide level begins blocking outflow through the stormwater outfalls and the stormwater conveyance system reaches full capacity. Prior to this point in time, there is only a steady and slight change in interior flood stages during an extended period of initial rainfall. The end value for the warning time function is the time when the interior stage equals the established significant damage elevation. Typically, the more severe the event, the shorter the warning time.
- The rate of rise for storm events, measures the rate of change in flood levels per minute. The rate is an average speed value from the time the flood stage first reaches the significant damage elevation until it reaches the peak flood stage.
- Duration of flooding refers to the amount of time during which the flood stage is above the significant damage elevation. In this case, the duration of flooding is controlled by the tide, which blocks the outfalls when the exterior stage is increased above the elevation of the outfall.

Figure 7-1 is a sample stage-time plot, which presents a visual interpretation of warning time, rate of rise, and flooding duration. The significant damage elevation set to 1.44 feet NAVD88.

Other important considerations to quantify flooding characteristics are the number of structures that will experience flood related damage in the with-project conditions and the remaining possibility for loss of life.

7.2.1 Access and Egress Problems and Impacts to Public Services

For more frequent rainfall events, local residents may still experience some local road closures and access issues. For events that produce higher rainfall and or coastal surge, some significant local thoroughfares can be expected to experience some level of inundation. The Preferred Plan does not reduce the risk of flooding from coastal surges with an annual probability of less than 20%, and some more severe events will cause extensive road closures and inundation of public facilities in the project areas. An overlay of the residual flooding extents on aerial imagery is presented in **Figures 7-2** through **7-10**, for each of the subbasins with an identified Preferred Plan.

7.2.2 Potential Loss of Life

The implementation of the Preferred Plan will not eliminate the potential for loss of life. The Preferred Plan will reduce the risk of flooding from high frequency storm surges in Jamaica Bay reaching the structures in the individual project areas and will therefore reduce the risk to residents of those areas. Instead of high velocity overtopping flows from the coast, the interior drainage basins will experience pools of water in low-lying areas from surface run-off. Interior Drainage flooding is predicted to have waters that rise over two feet per hour in some areas, which may generate life safety risks in addition to those created by the depth of flooding alone.

7.2.3 Residual Flood Related Damages

There are a number of structures within the study area that remain at risk of being inundated following project implementation. The with-project equivalent annual residual damages are presented in **Table 7-5**.

Table 7-5: Residual Flood Damage

Drainage Area	Equivalent Annual Damage
Hammels	$458,780
Arverne	$883,740
Edgemere	$501,940
Canarsie	$692,100
Cedarhurst-Lawrence	$642,780
Motts Basin North	$86,170
Total With Project Damage	**$2,671,980**

8 SUMMARY OF INTERIOR DRAINAGE FINDINGS

The LOP Alternative recommended in the NED Plan will be the first line of defense against significant coastal surge and wave action. However, implementation of the LOP will impact interior runoff resulting in residual damage that must be addressed with additional interior drainage features. Due to the limited availability of storage, this primarily includes pump alternatives to lower the interior water surface elevations in the project area.

Based on the evaluation of the Alternative Plans for each of the subbasins, below is a summary of the interior drainage study findings:

- Hammels Drainage Basin of the Mid-Rockaway Project Area: The Minimum Facility plan consists of gravity outlets through the line of flood protection. The EAD with Minimum Facility measures in place is estimated to be approximately $1,591,730. Pump Alternative 1 for Subbasin H1 and Pump Alternative 2 for Subbasin H2, which includes 100cfs and 180 cfs pumping stations, respectively, and 3 additional proposed outlets, were identified as the Preferred Plan. The residual EAD with the Preferred Plan in place is estimated to be approximately $458,780, which is a $1,132,950 reduction in annual damages compared to the Minimum Facility condition.
- Arverne Drainage Basin of the Mid-Rockaway Project Area: The Minimum Facility plan consists of gravity outlets through the line of flood protection. The EAD with Minimum Facility measures in place is estimated to be approximately $3,616,320. Pump Alternative 1 (70 cfs) for Subbasin A1, Pump Alternative 2 for Subbasin A2 (180 cfs), Pump Alternative 2 for Subbasin A3 (300 cfs), and 8 additional proposed outlets were identified as the Preferred Plan. The residual EAD with the Preferred Plan in place is estimated to be approximately $883,740, which is a $2,732,580 reduction in annual damages compared to the Minimum Facility condition.
- Edgemere Drainage Basin of the Mid-Rockaway Project Area: The Minimum Facility plan consists of gravity outlets through the line of flood protection. The EAD with Minimum Facility measures in place is estimated to be approximately $2,032,610. Pump Alternative 2 (210 cfs) for Subbasin E1, Pump Alternative 2 for Subbasin E2 (120 cfs), and 12 additional proposed outlets were identified as the Preferred Plan. The residual EAD with the Preferred Plan in place is estimated to be approximately $501,940, which is a $1,530,670 reduction in annual damages compared to the Minimum Facility condition.
- Canarsie Project Area: Based on the evaluation of the interior water surface elevation and net benefits, no interior drainage plan that would result in a HFFRRF with a BCR above 1.0 was identified. Accordingly, there is not a Preferred Drainage Plan identified for the Canarsie drainage basin. Even with the pumps and improved gravity

outlet drainage system, flood elevations for a 50% AEP rainfall occurring with the design storm tide are only reduced between 0.1 and 0.2 feet. Since residual flooding remains high for the Canarsie HFFRRF, NED benefits from the plan are not high enough to justify the federal investment and the BCR drops below one.

- Cedarhurst-Lawrence Project Area: The Minimum Facility plan consists of gravity outlets through the line of flood protection. The EAD with Minimum Facility measures in place is estimated to be approximately $2,009,180. Pump Alternative 1 and one additional proposed outlet were identified as the Preferred Plan. The residual EAD with the Preferred Plan in place is estimated to be approximately $642,780, which is a $1,366,390 reduction in annual damages compared to the Minimum Facility condition.
- Motts Basin North Project Area: The Minimum Facility plan consists of gravity outlets through the line of flood protection. The residual EAD with Minimum Facility measures in place is estimated to be approximately $86,170. Pump Alternative 1 was found to have a negative net benefit and hence was eliminated from further consideration. The Minimum Facility is selected as the Preferred Plan.

9 REFERENCES

Federal Highway Administration's Hydraulic Design Series No. 5 "Hydraulic Design of Highway Culverts" (HDS-5). Third Edition. (2012). U.S. Department of Transportation.

National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 10, Version 2, (https://hdsc.nws.noaa.gov/hdsc/pfds).

NRCS Technical Release No. 55 (TR-55), Urban Hydrology for Small Watersheds. (1986). United States Department of Agriculture.

NRCS Web Soil Survey (https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx).

U.S. Army Corps of Engineers. (1987). Hydrologic Analysis of Interior Areas (EM 1110-2-1413). Washington, D.C.: Department of the Army.

U.S. Army Corps of Engineers. (2000). Planning Guidance Notebook (ER 1105-2-100). Washington, D.C.: Department of the Army.

U.S. Army Corps of Engineers. (2006). Risk Analysis for Flood Damage Reduction Studies (ER 1105-2-101). Washington, D.C.: Department of the Army.

U.S. Army Corps of Engineers. (2013). Flood Runoff Analysis (EM 1110-2-14170). Washington, D.C.: Department of the Army.

U.S. Army Corps of Engineers. (2016). Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects (ECB 2016-25). Washington, D.C.: Department of the Army.

Interior Drainage Sub-Appendix E

Attachment 1: Figures

Figure 1-1: Study Area

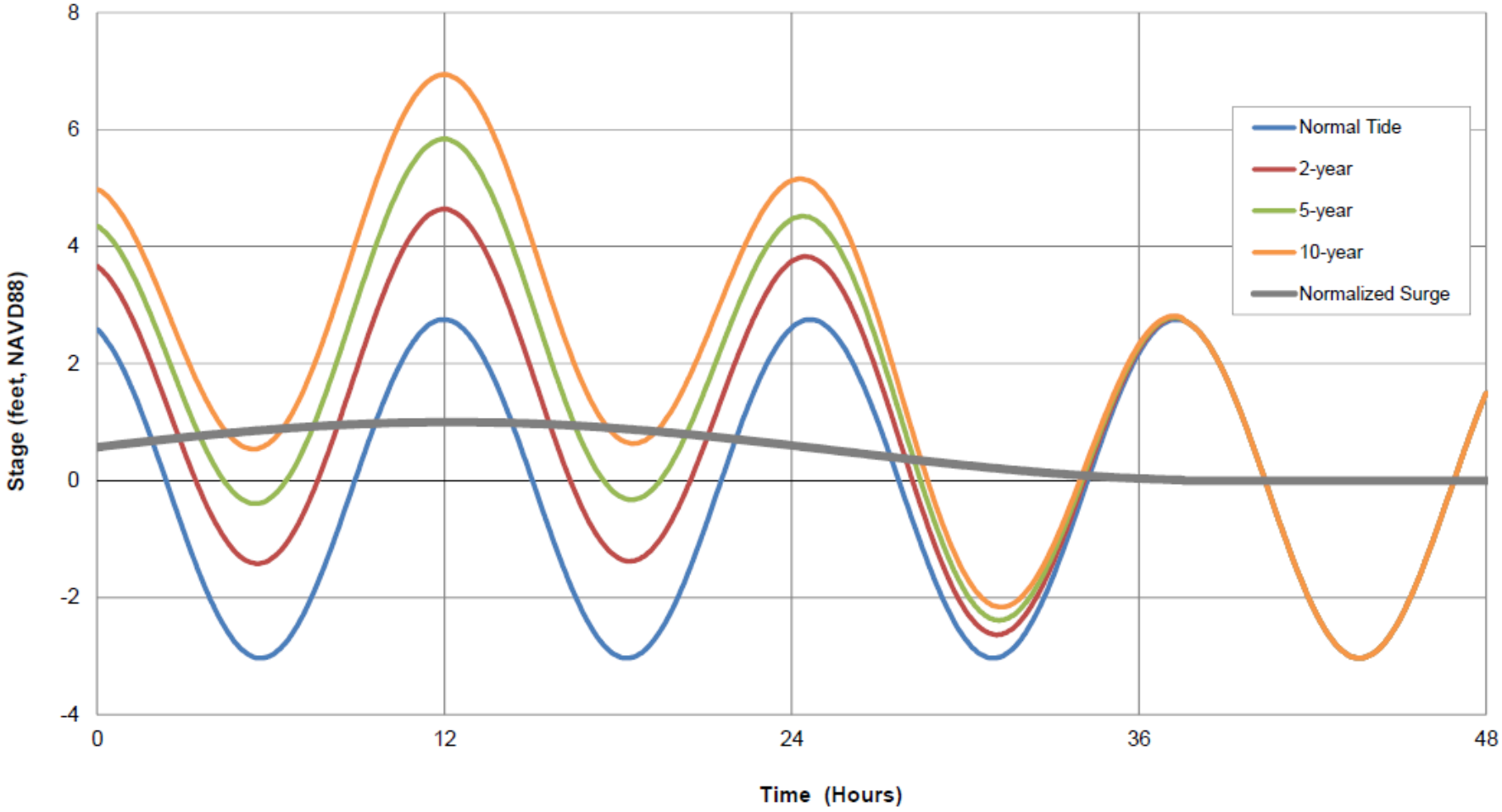


Figure 2-1: Hypothetical Tides (Current Condition)

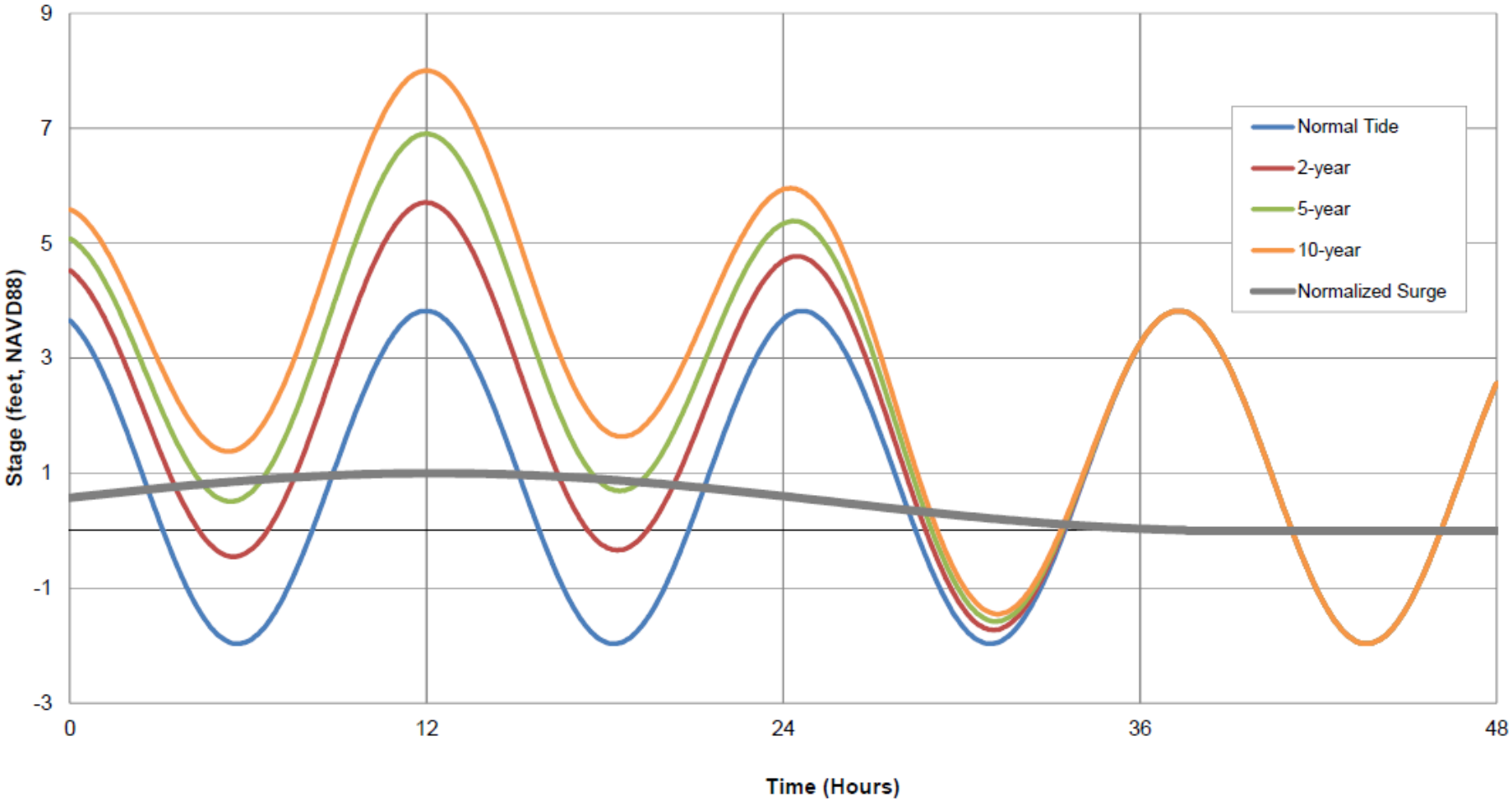


Figure 2-2: Hypothetical Tides (Future Condition)

Figure 2-3: Mid-Rockaway Drainage Subbasins Layout

Figure 2-4: Canarsie Drainage Subbasins Layout

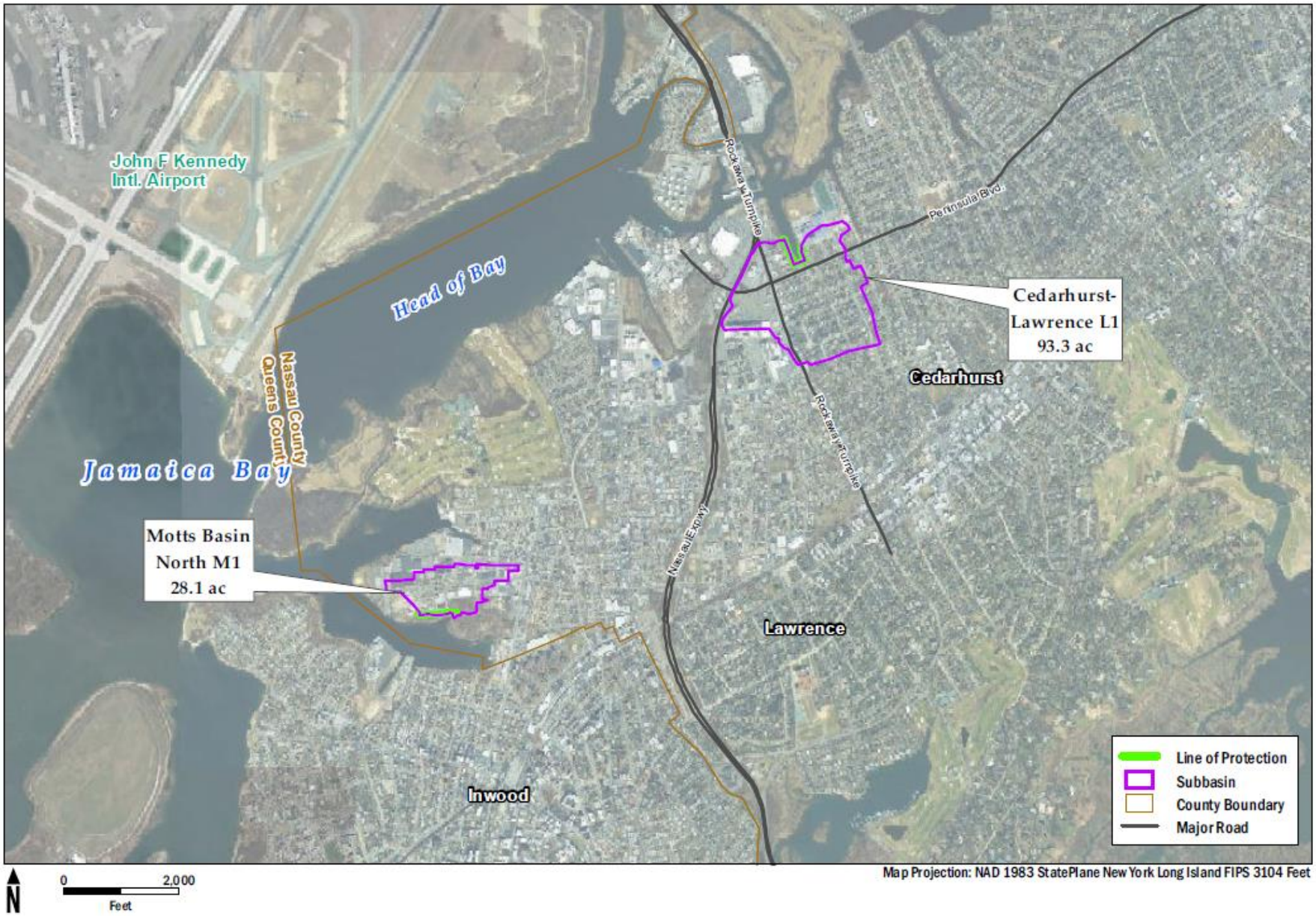


Figure 2-5: Cedarhurst-Lawrence and Motts Basin North Drainage Subbasins Layout

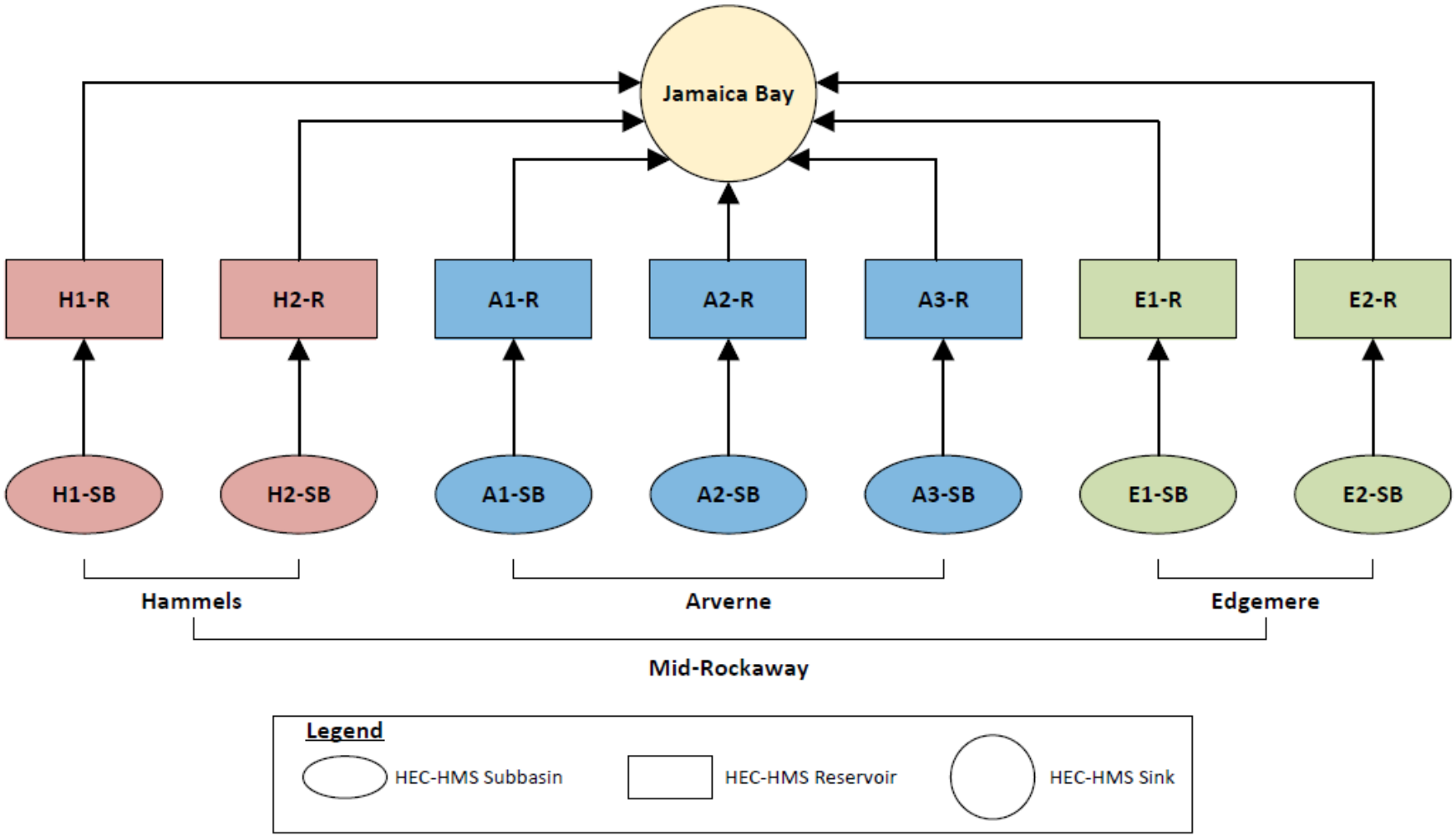


Figure 2-6: HEC-HMS Model Schematic - Mid-Rockaway

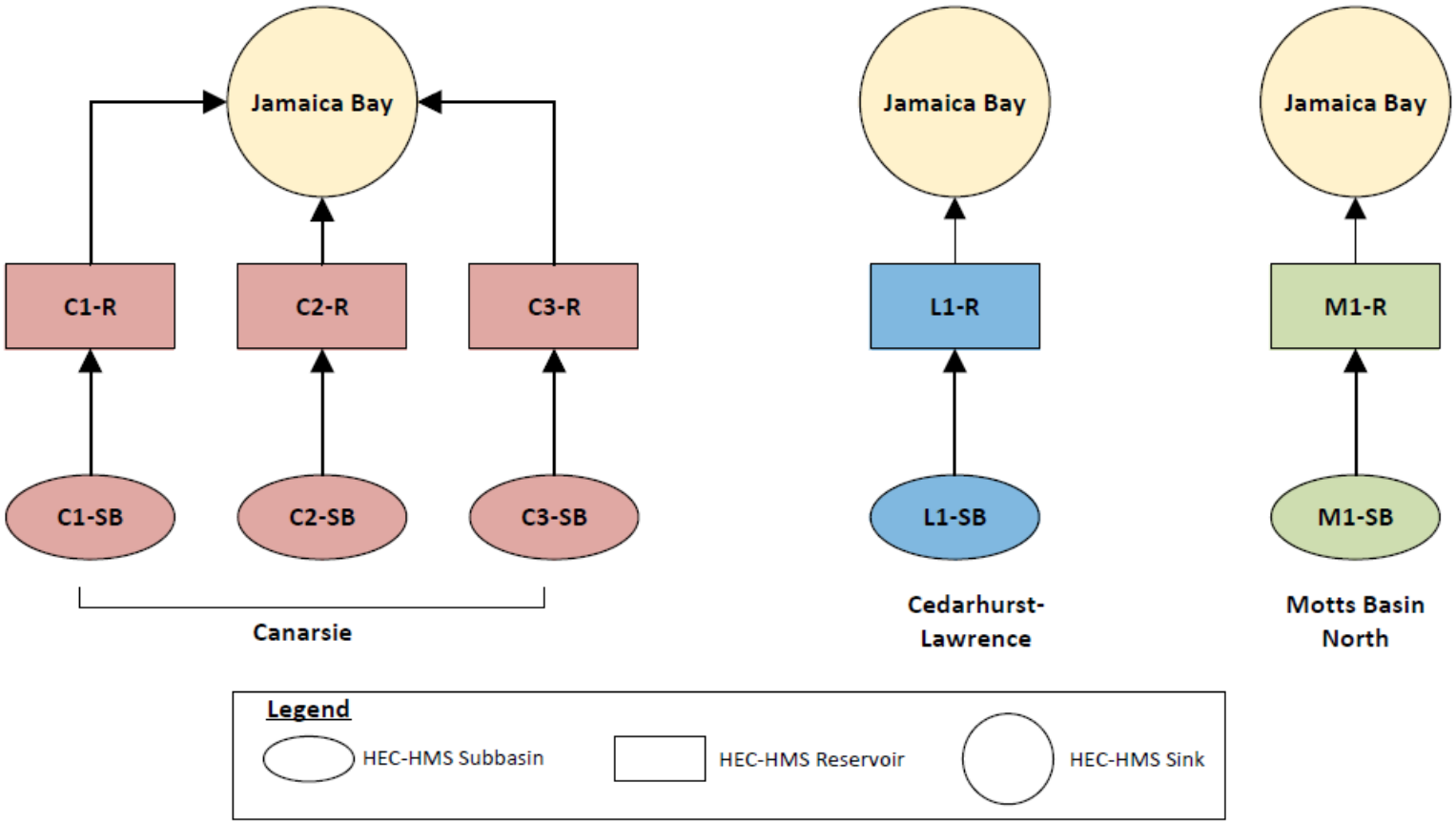


Figure 2-7: HEC-HMS Model Schematic - Canarsie, Cedarhurst-Lawrence, and Motts Basin North

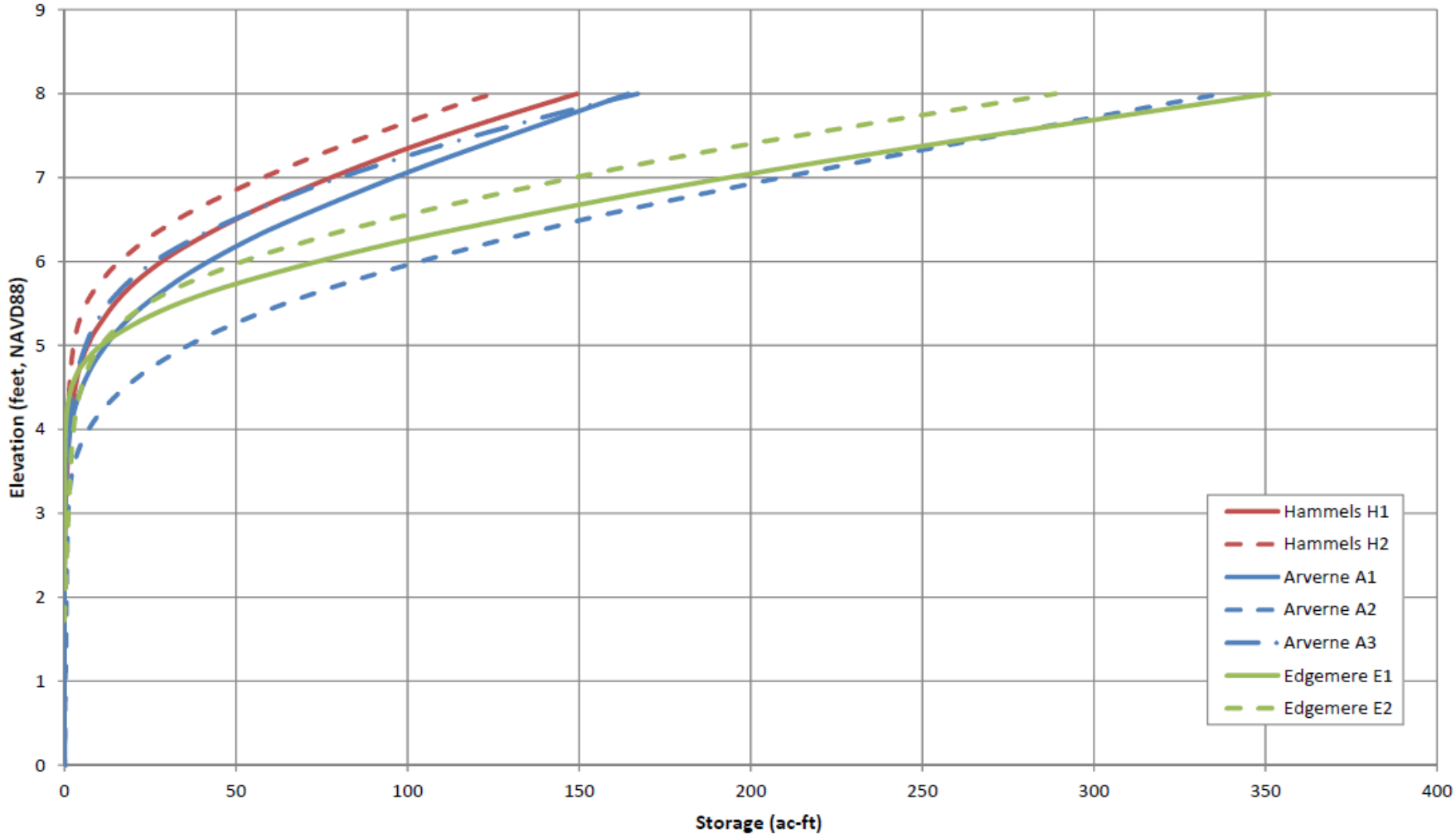


Figure 4-1: Elevation vs. Natural Storage Curves - Mid-Rockaway

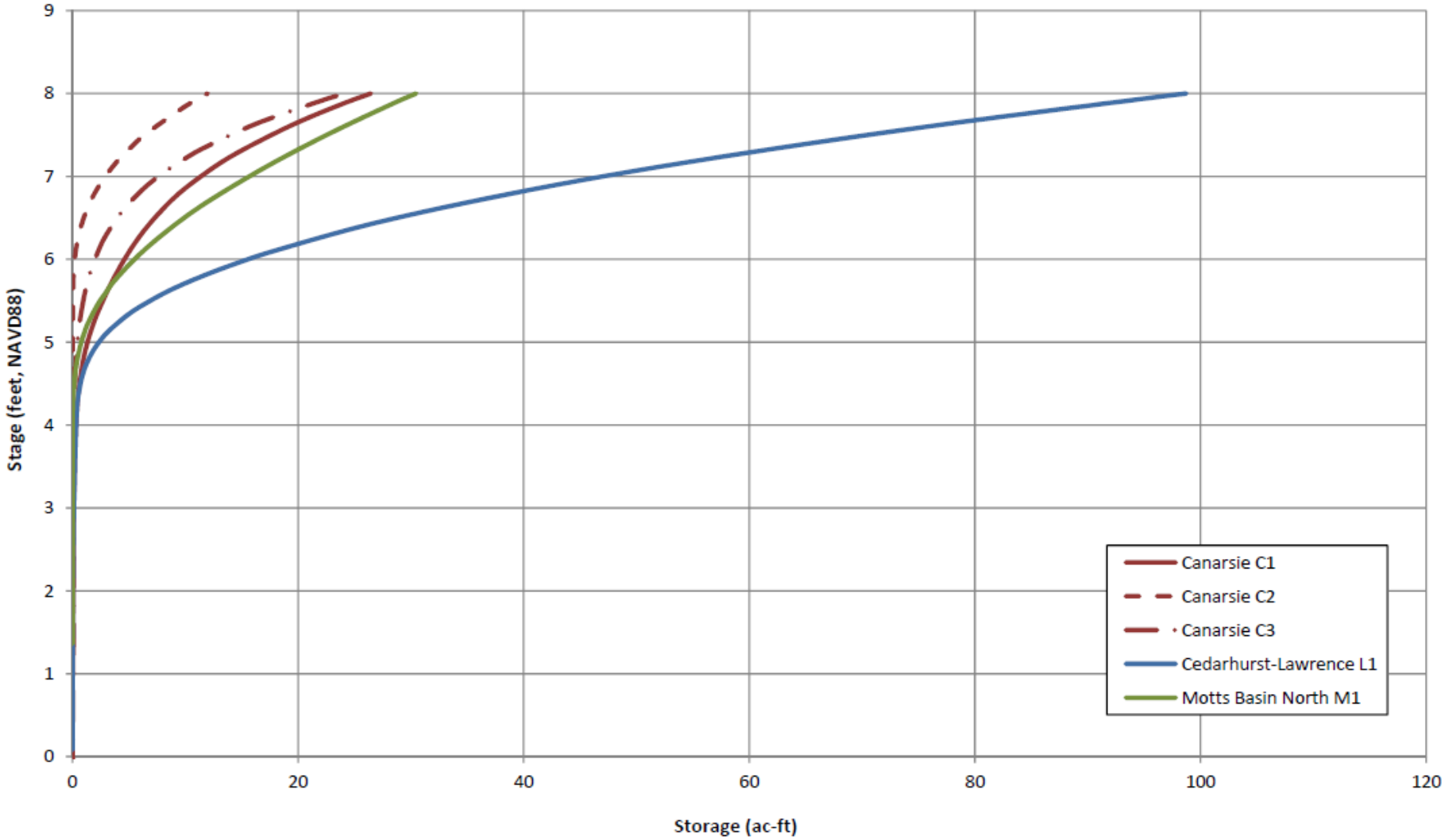


Figure 4-2: Elevation vs. Natural Storage Curves - Canarsie, Cedarhurst-Lawrence, and Motts Basin North

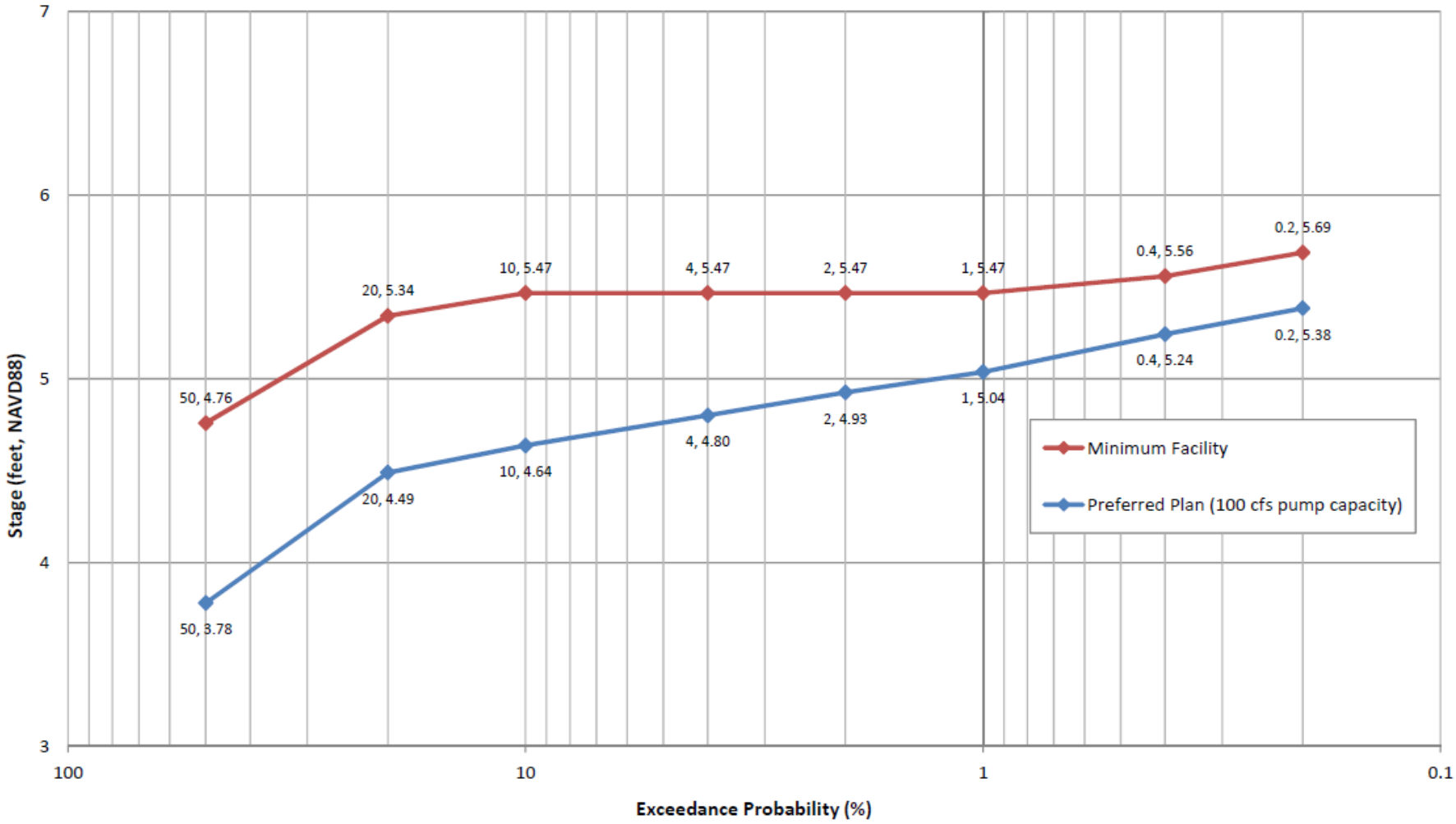


Figure 6-1: Peak Stage vs. Frequency Curves - Hammels H1

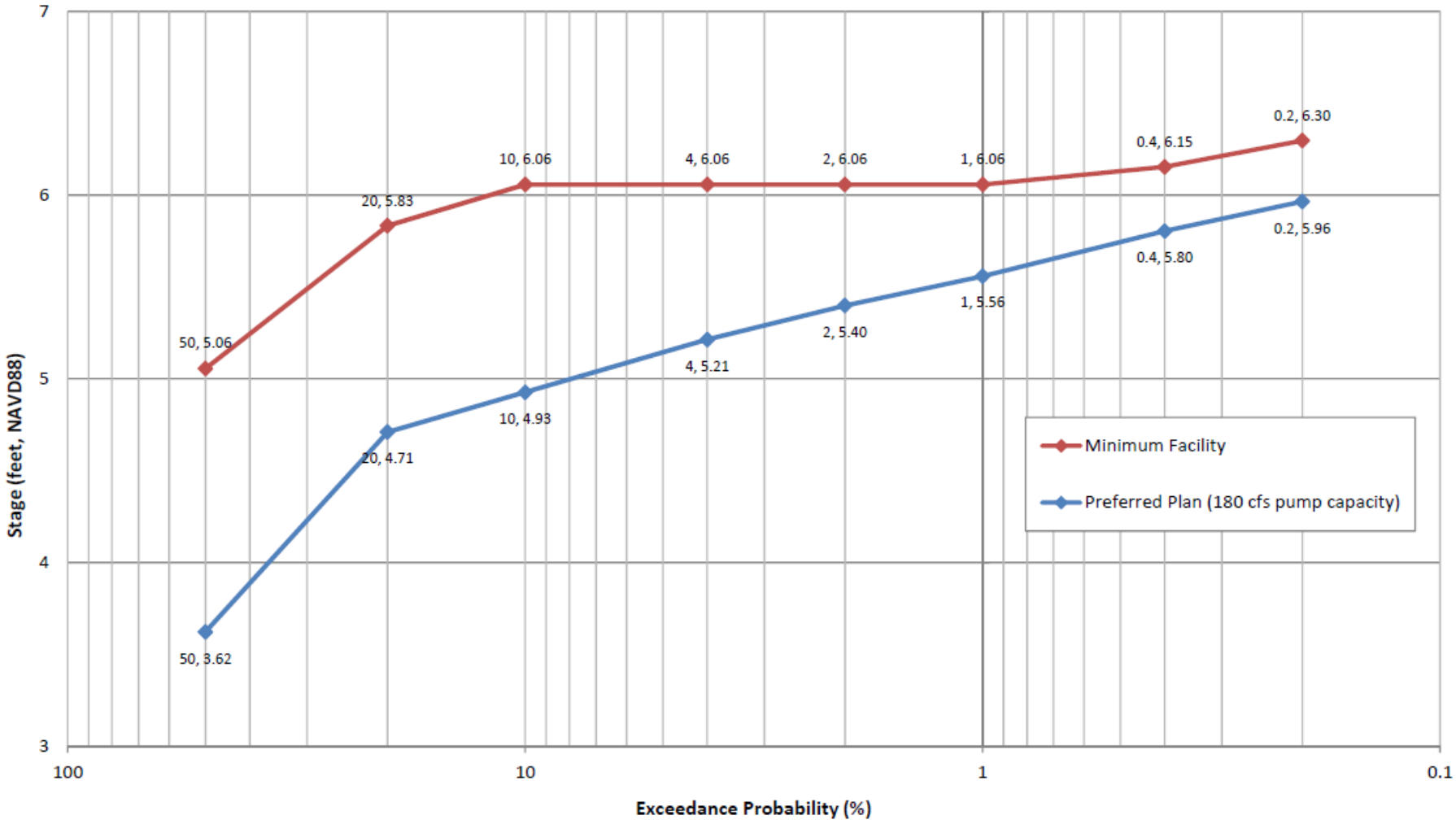
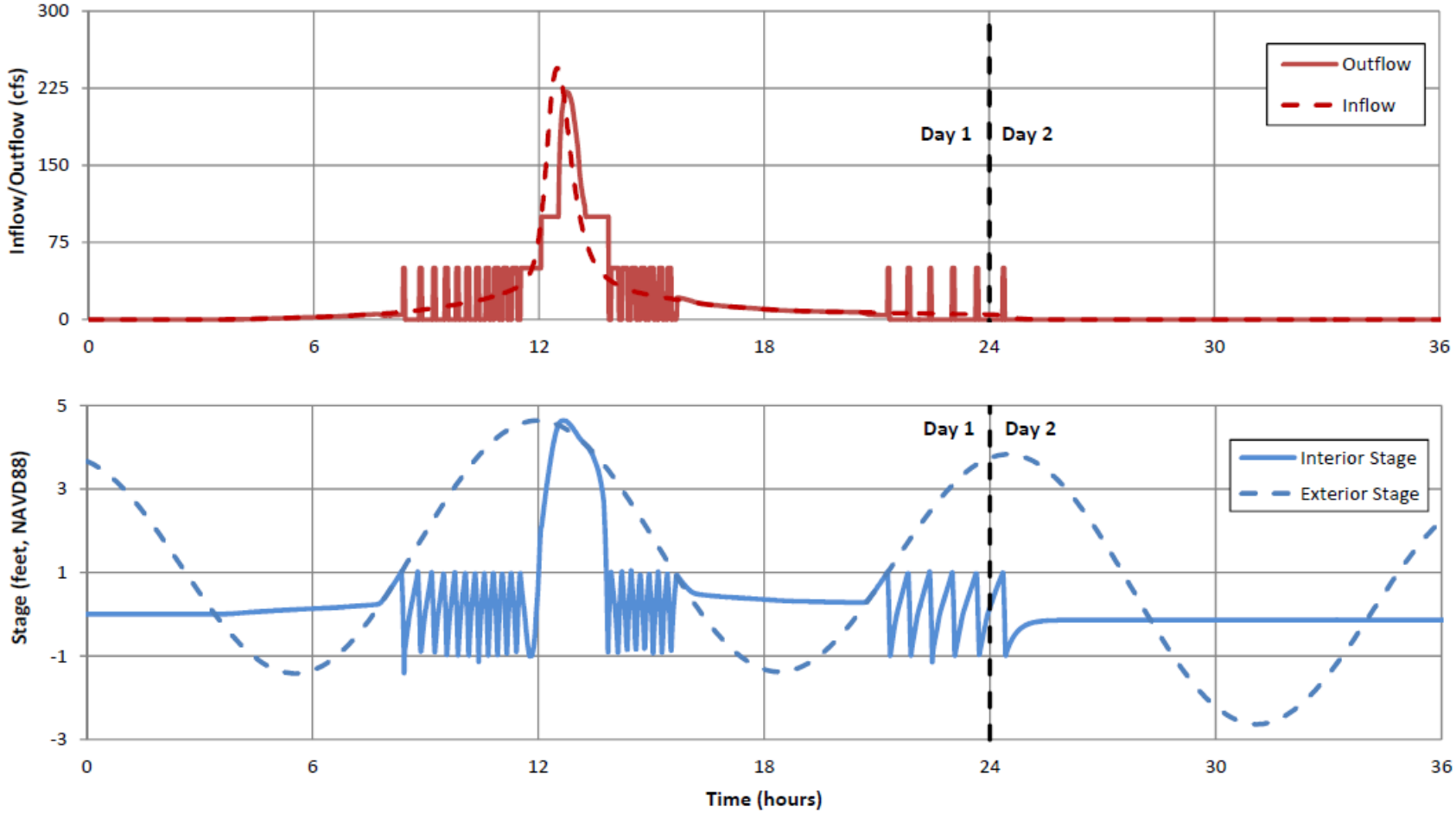
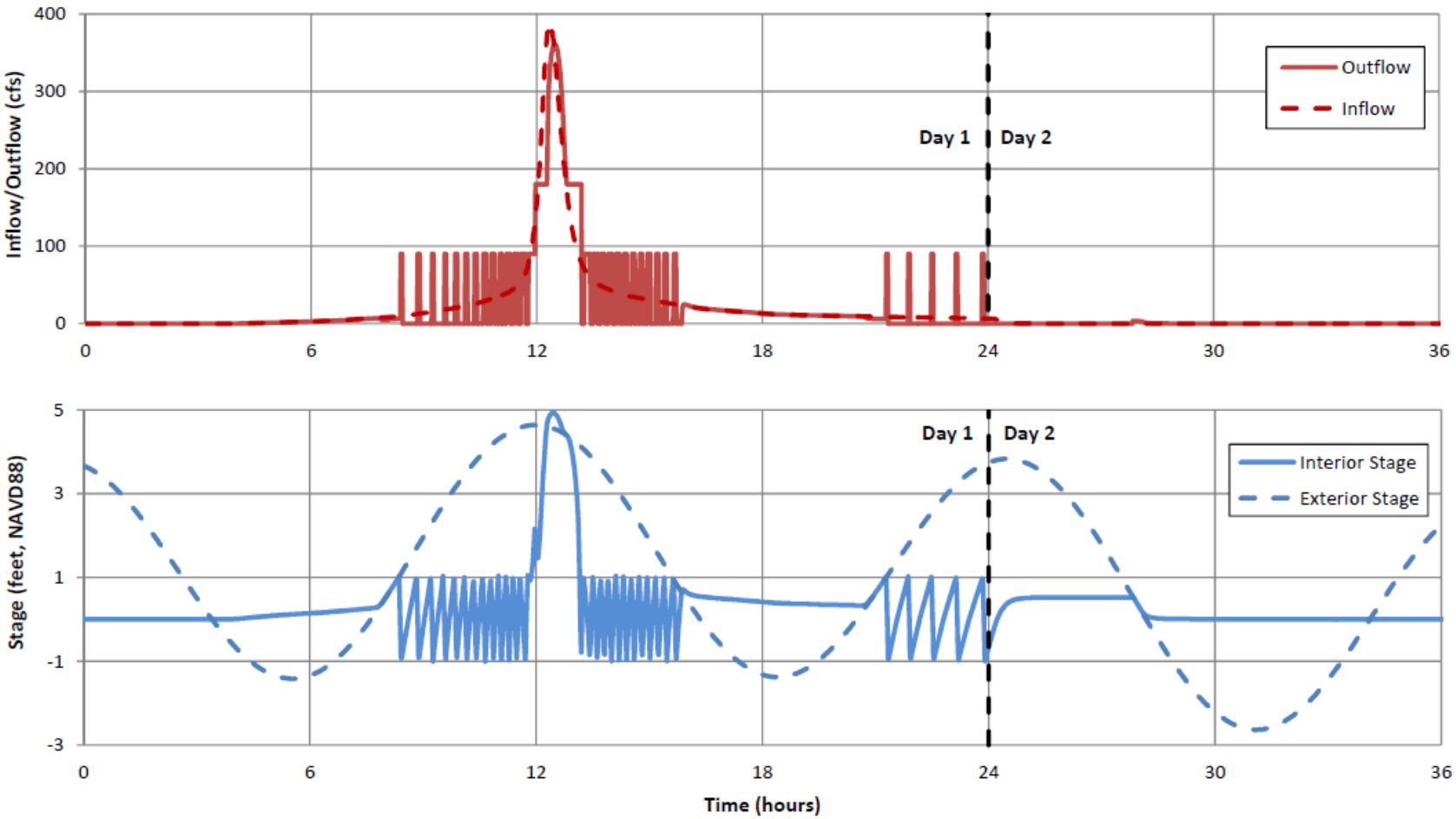


Figure 6-2: Peak Stage vs. Frequency Curves - Hammels H2



Inflow and Outflow Hydrographs and Interior and Exterior Stage Hydrographs for Mid-Rockaway Hammels Subbasin H1, Preferred Plan (100 cfs pump capacity), Most Likely Maximum Interior Stage (10-year storm, 2-year tide)

Figure 6-3: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Hammels H1



Inflow and Outflow Hydrographs and Interior and Exterior Stage Hydrographs for Mid-Rockaway Hammels Subbasin H2, Preferred Plan (180 cfs pump capacity), Most Likely Maximum Interior Stage (10-year storm, 2-year tide)

Figure 6-4: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Hammels H2

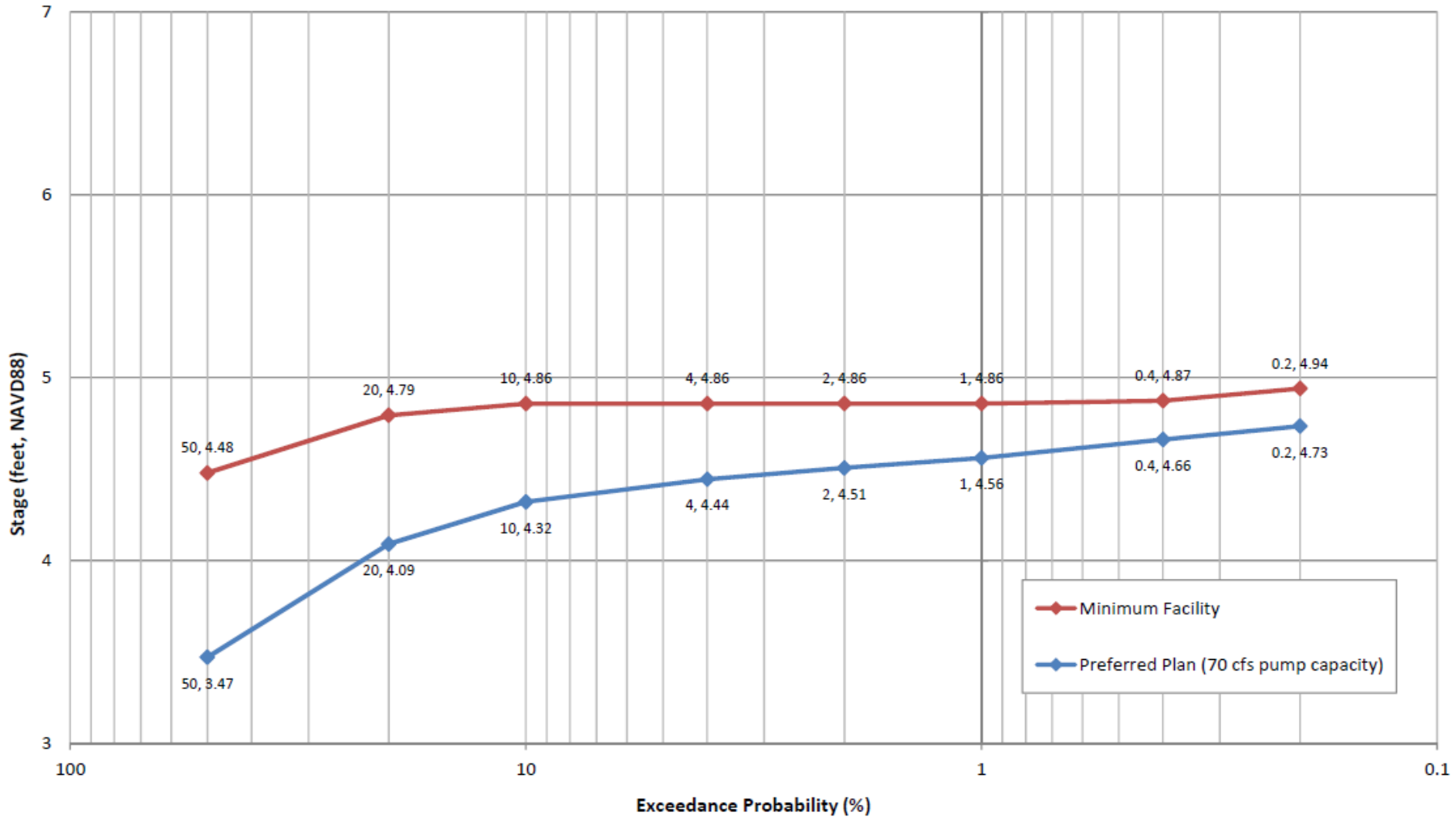


Figure 6-5: Peak Stage vs. Frequency Curves - Arverne A1

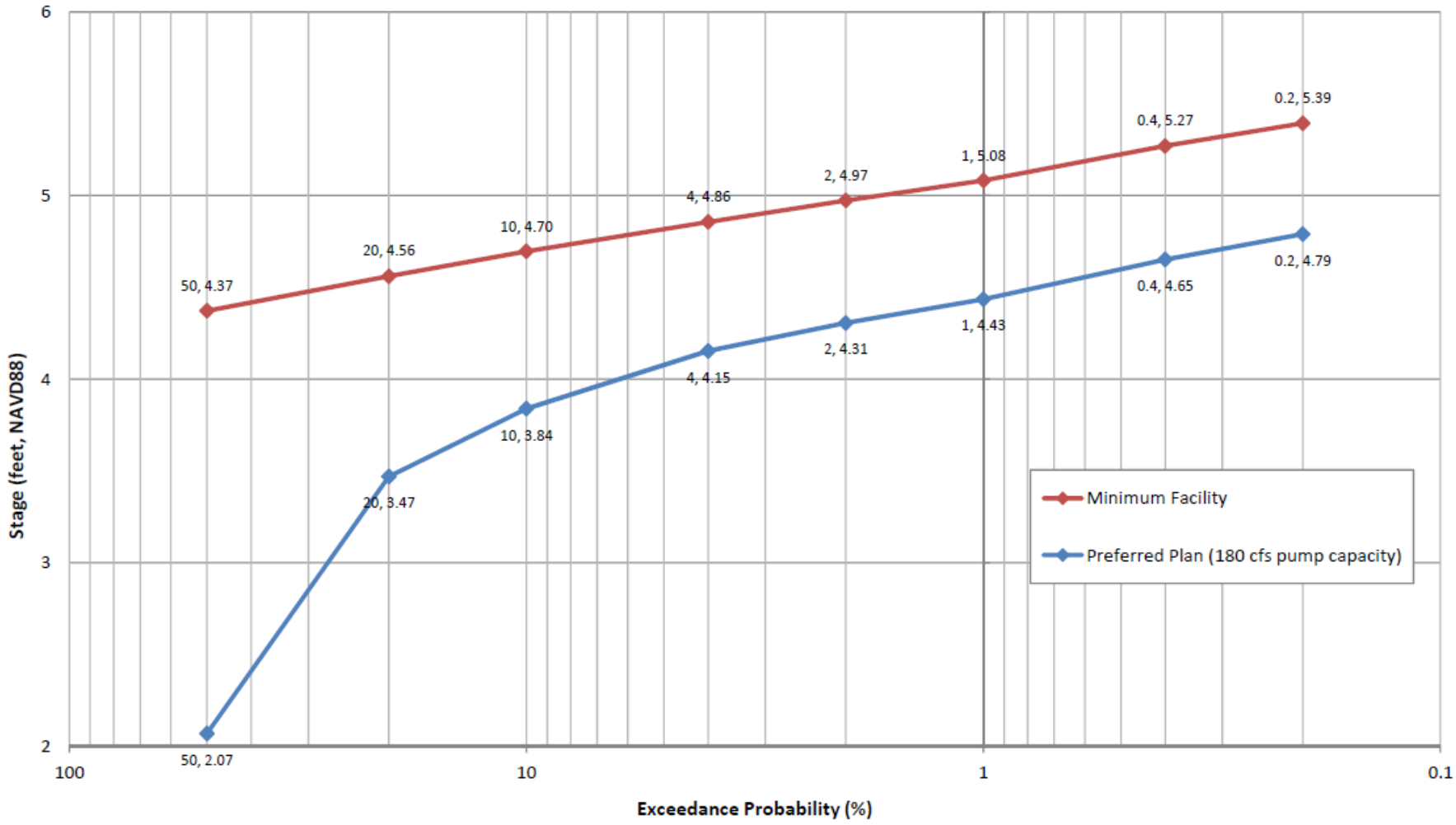


Figure 6-6: Peak Stage vs. Frequency Curves - Arverne A2

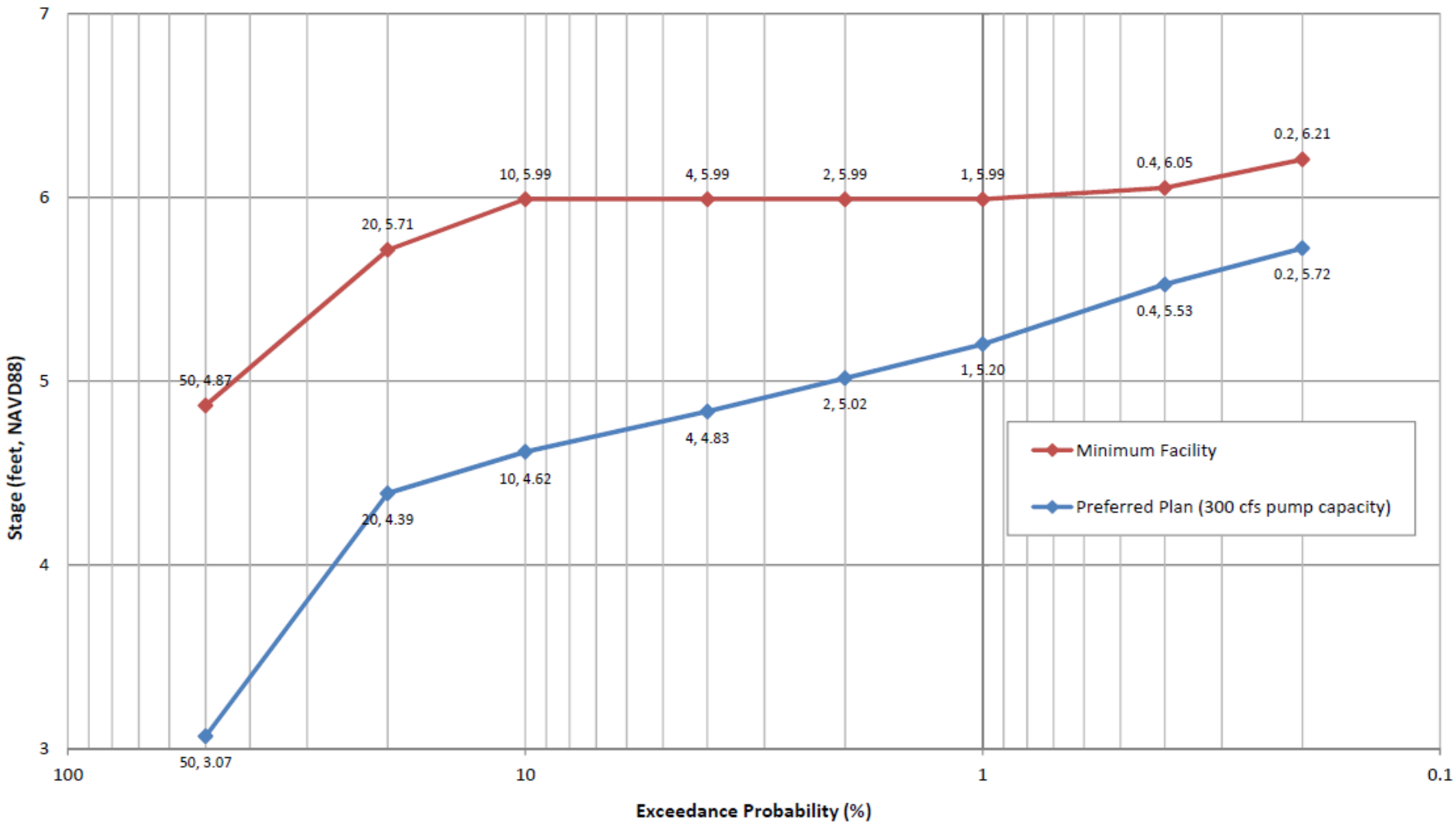
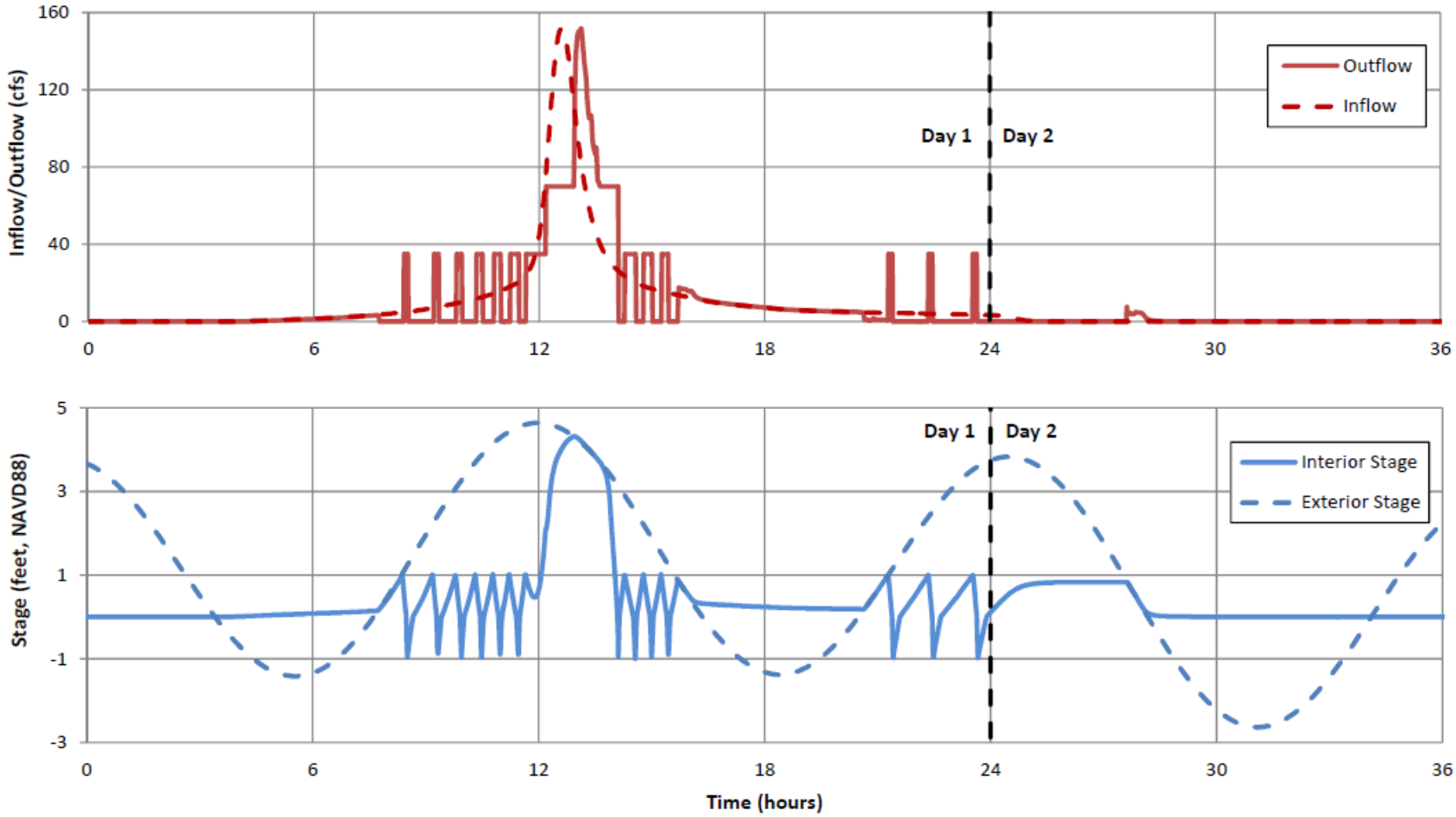
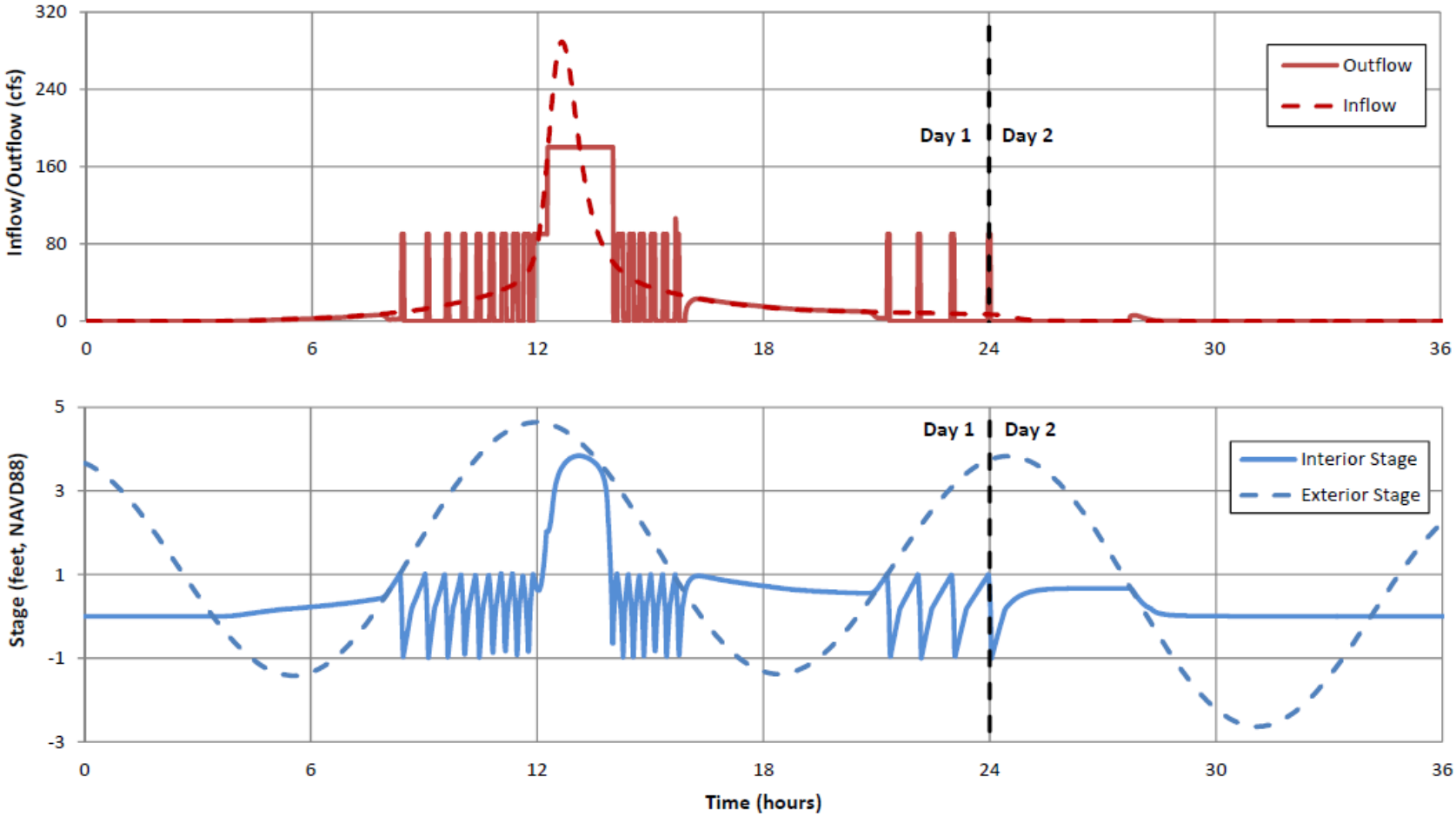


Figure 6-7: Peak Stage vs. Frequency Curves - Arverne A3



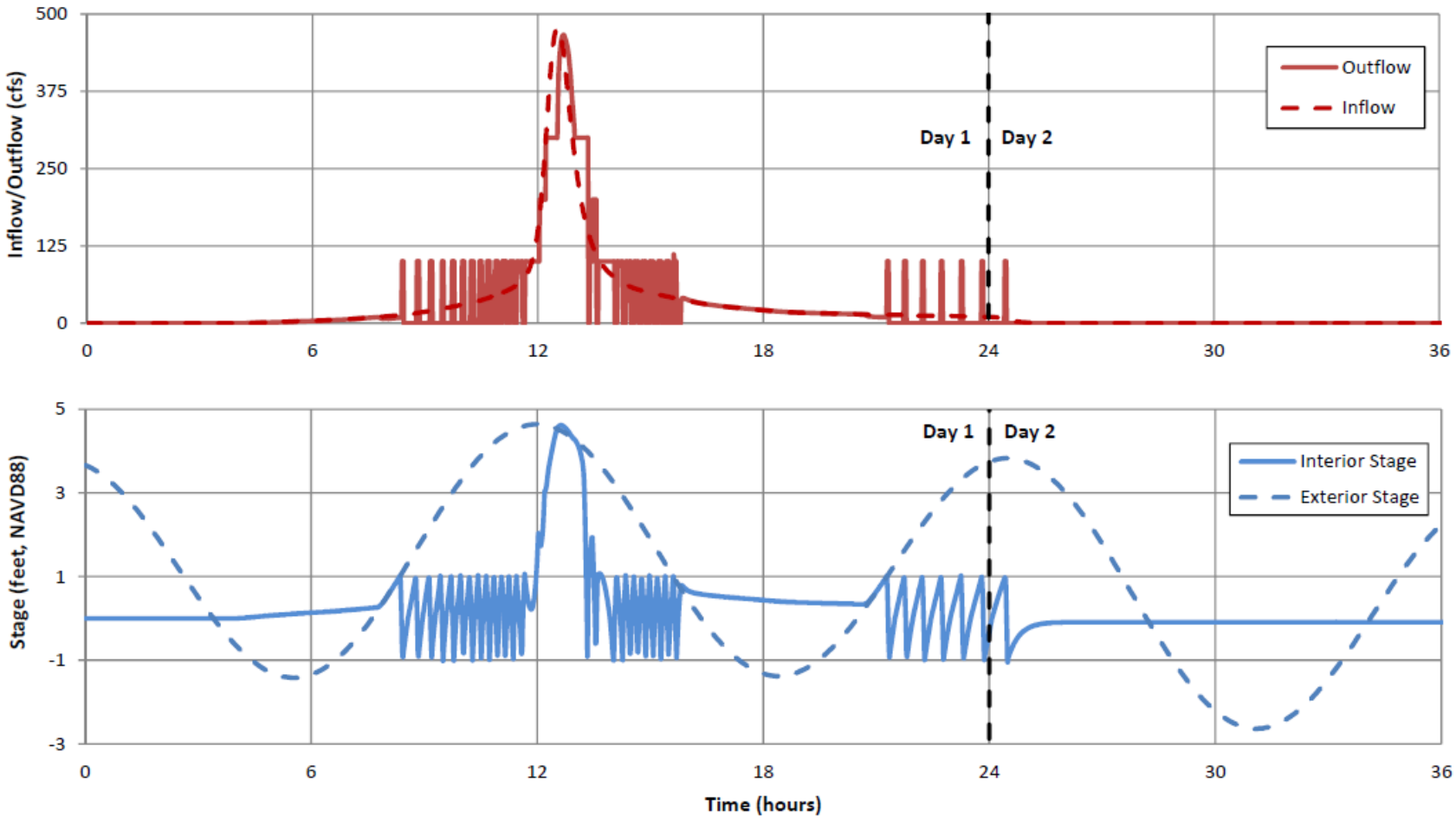
Inflow and Outflow Hydrographs and Interior and Exterior Stage Hydrographs for Mid-Rockaway Arverne Subbasin A1, Preferred Plan (70 cfs pump capacity), Most Likely Maximum Interior Stage (10-year storm, 2-year tide)

Figure 6-8: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Arverne A1



Inflow and Outflow Hydrographs and Interior and Exterior Stage Hydrographs for Mid-Rockaway Arverne Subbasin A2, Preferred Plan (180 cfs pump capacity), Most Likely Maximum Interior Stage (10-year storm, 2-year tide)

Figure 6-9: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Arverne A2



Inflow and Outflow Hydrographs and Interior and Exterior Stage Hydrographs for Mid-Rockaway Arverne Subbasin A3, Preferred Plan (300 cfs pump capacity), Most Likely Maximum Interior Stage (10-year storm, 2-year tide)

Figure 6-10: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Arverne A3

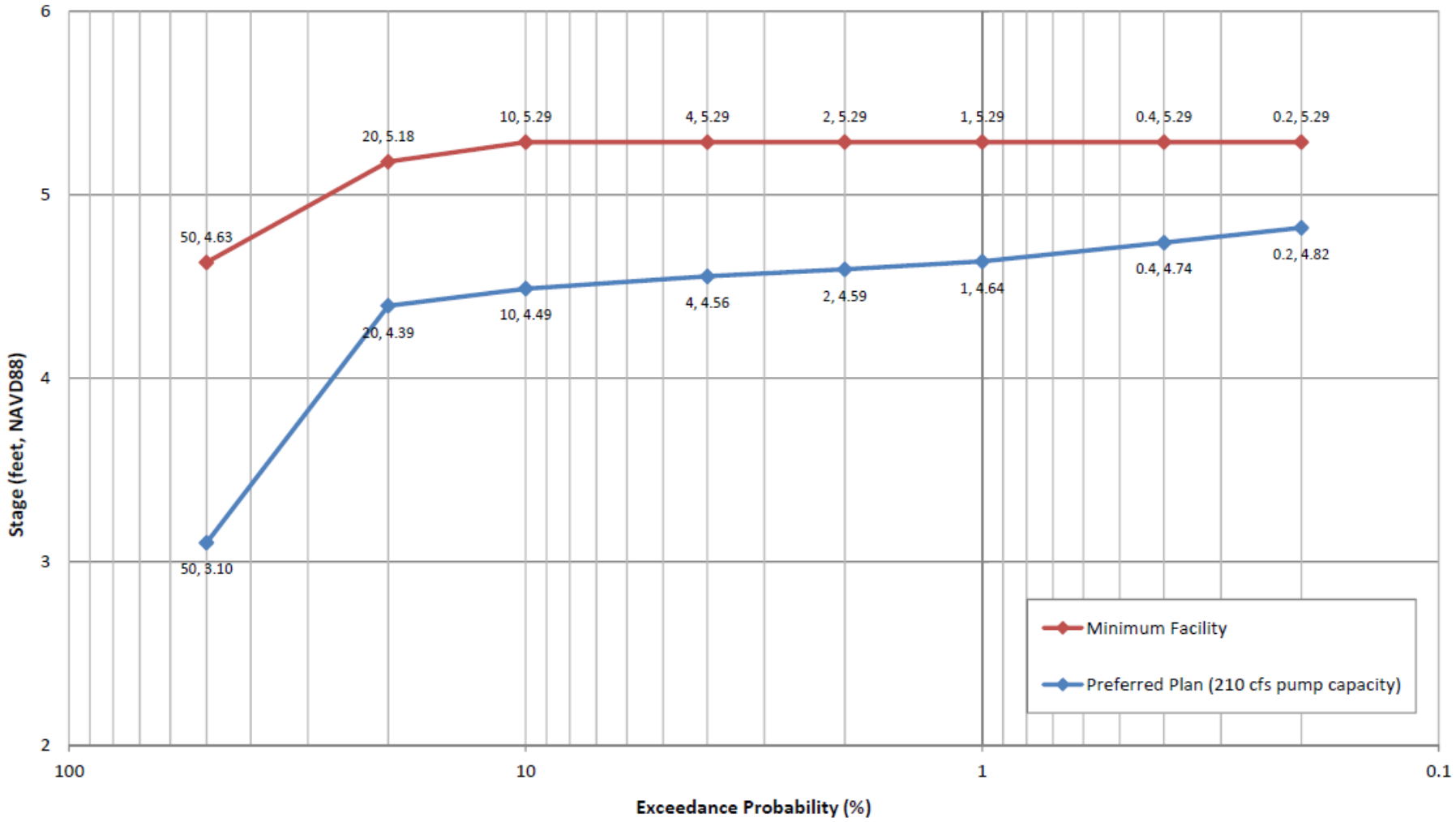


Figure 6-11: Peak Stage vs. Frequency Curves - Edgemere E1

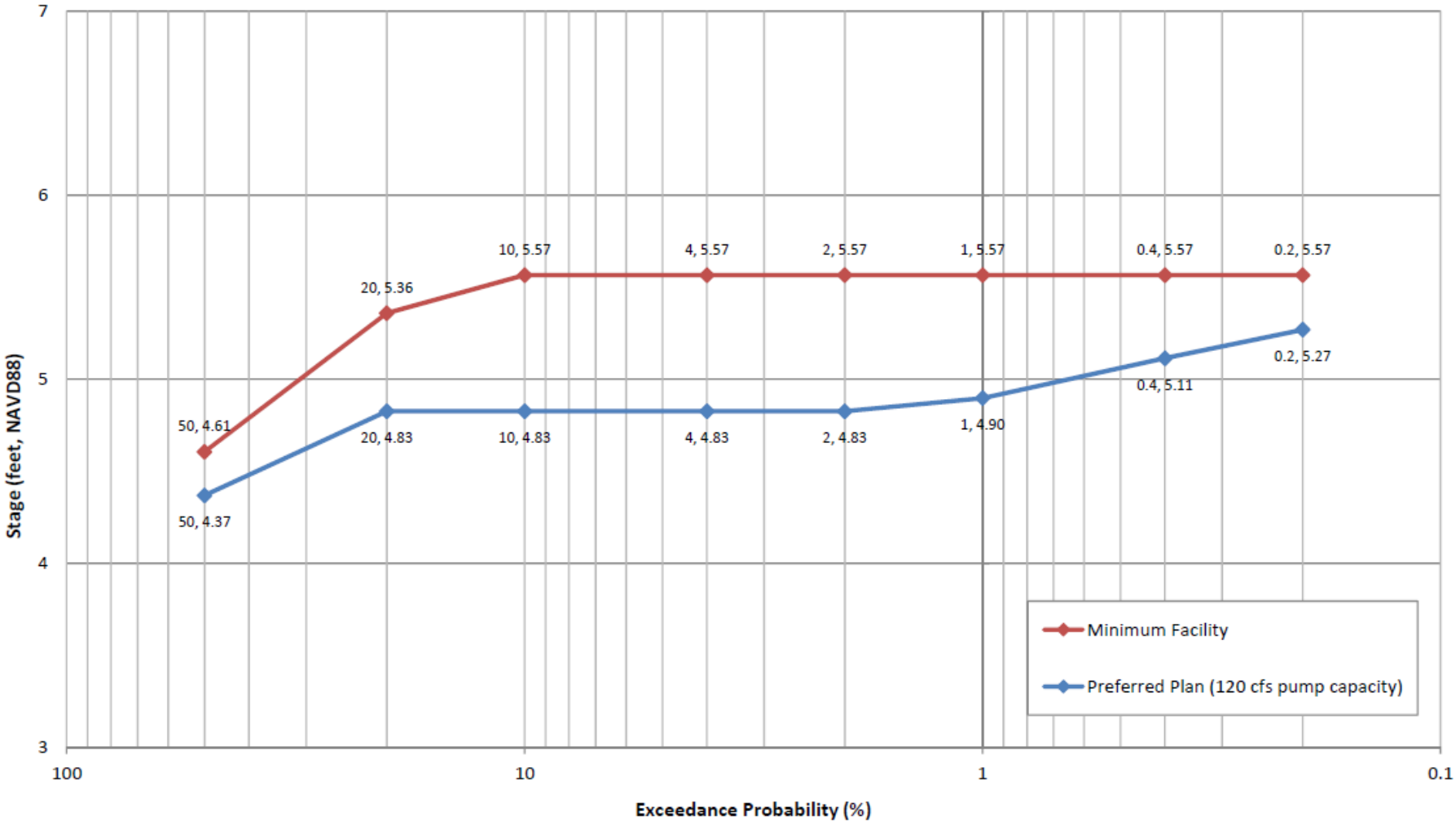
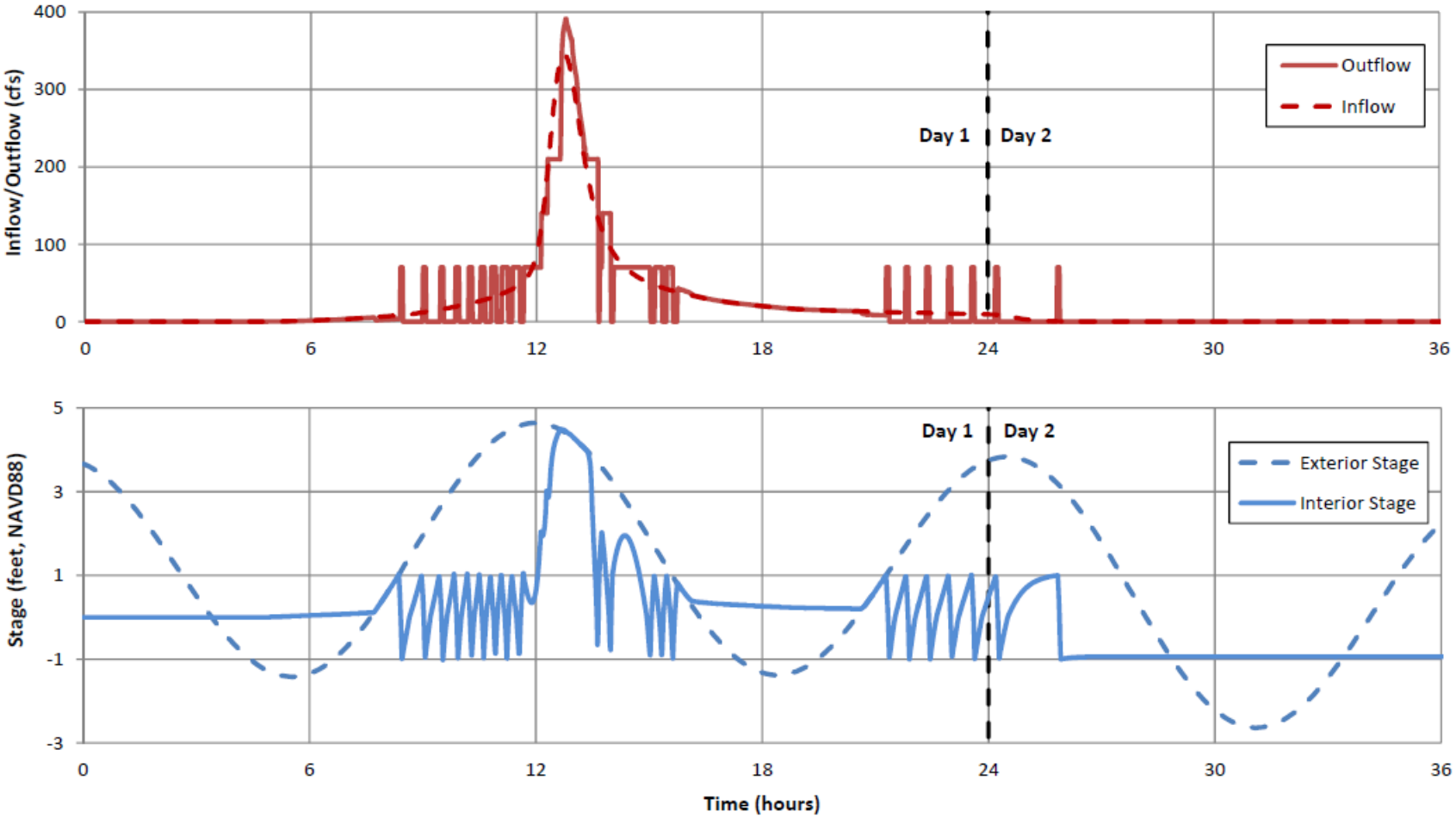
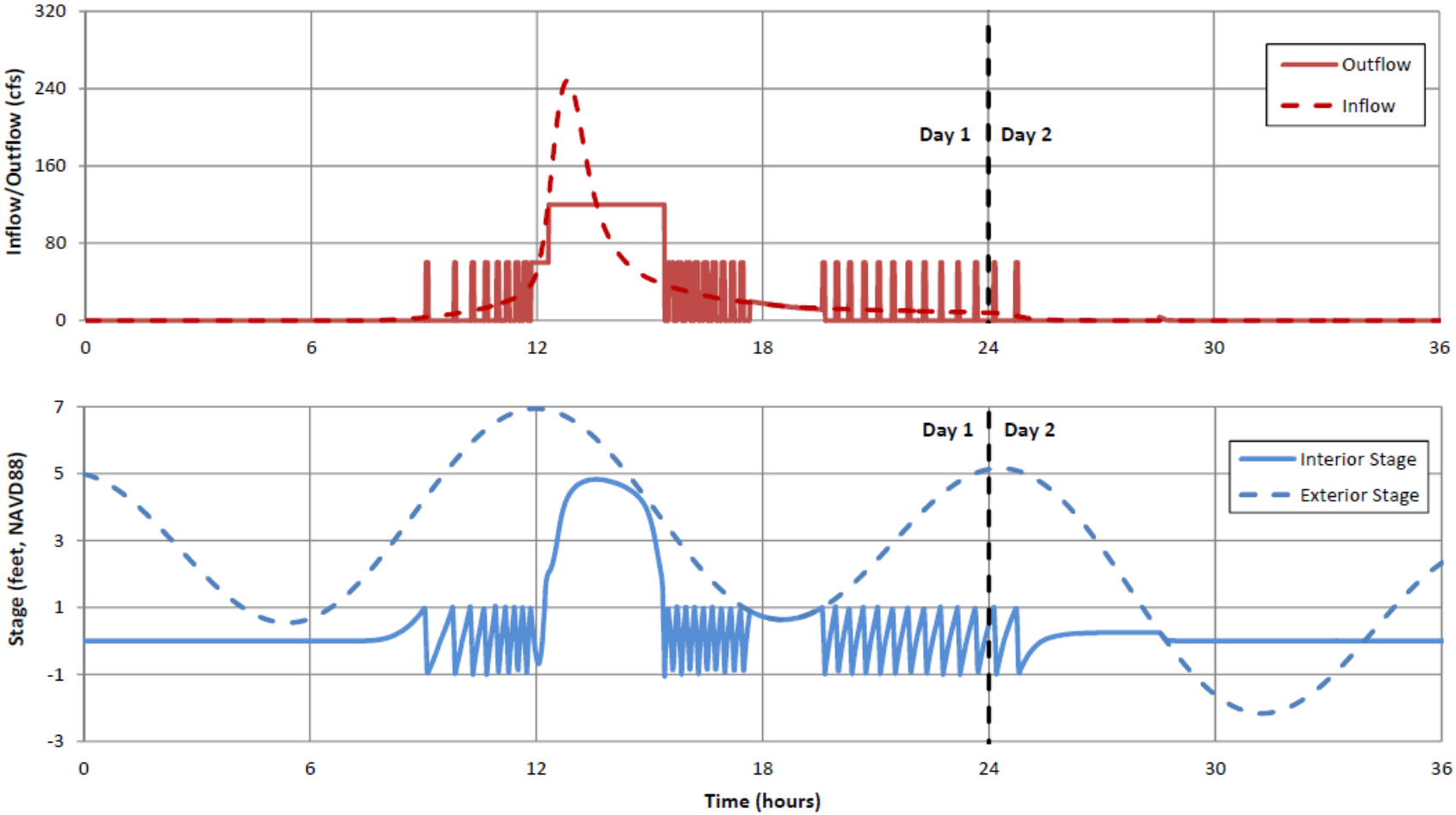


Figure 6-12: Peak Stage vs. Frequency Curves - Edgemere E2



Inflow and Outflow Hydrographs and Interior and Exterior Stage Hydrographs for Mid-Rockaway Edgemere Subbasin E1, Preferred Plan (210 cfs pump capacity), Most Likely Maximum Interior Stage (10-year storm, 2-year tide)

Figure 6-13: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Edgemere E1



Inflow and Outflow Hydrographs and Interior and Exterior Stage Hydrographs for Mid-Rockaway Edgemere Subbasin E2, Preferred Plan (120 cfs pump capacity), Most Likely Maximum Interior Stage (10-year storm, 2-year tide)

Figure 6-14: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Edgemere E2

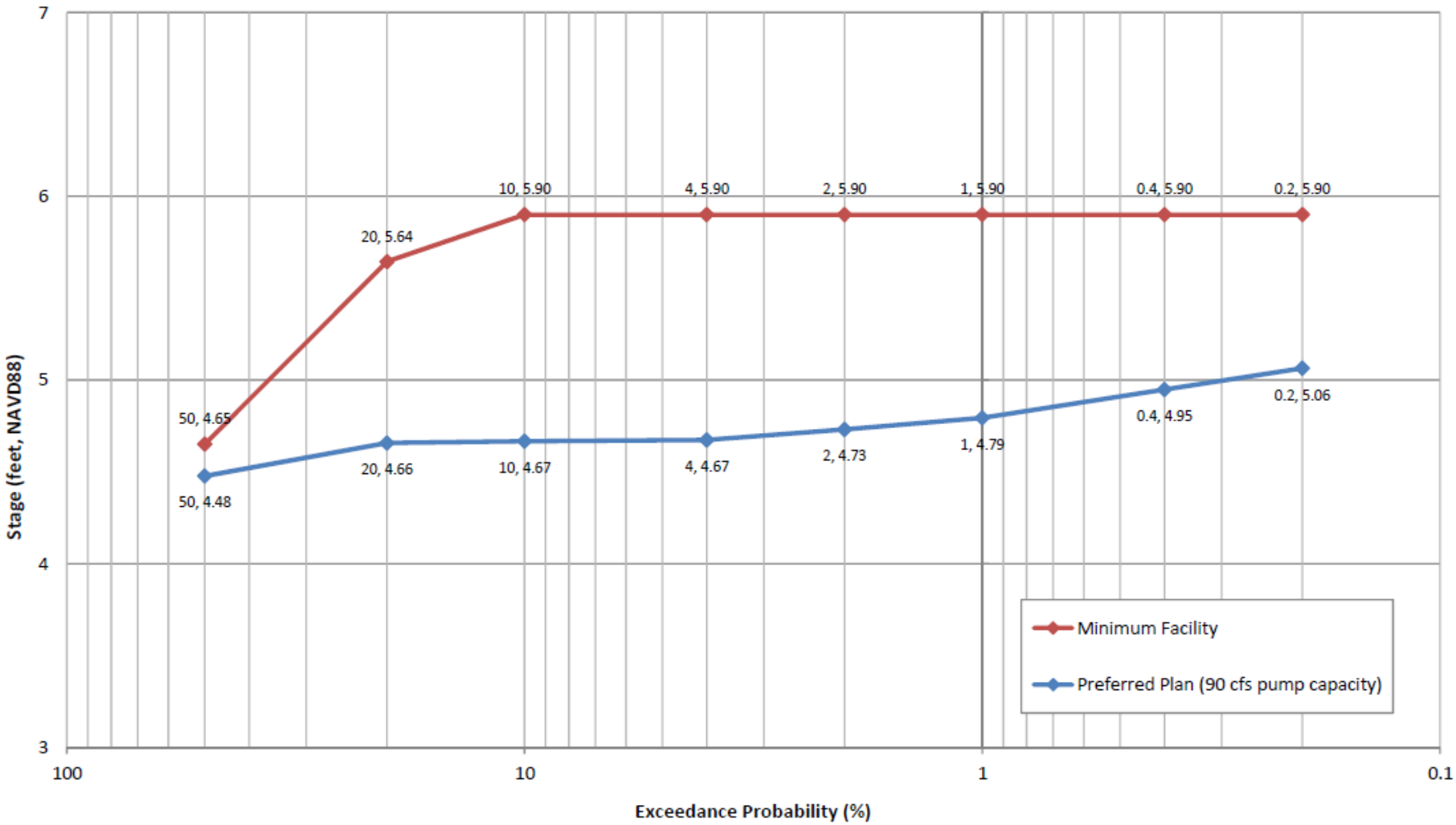
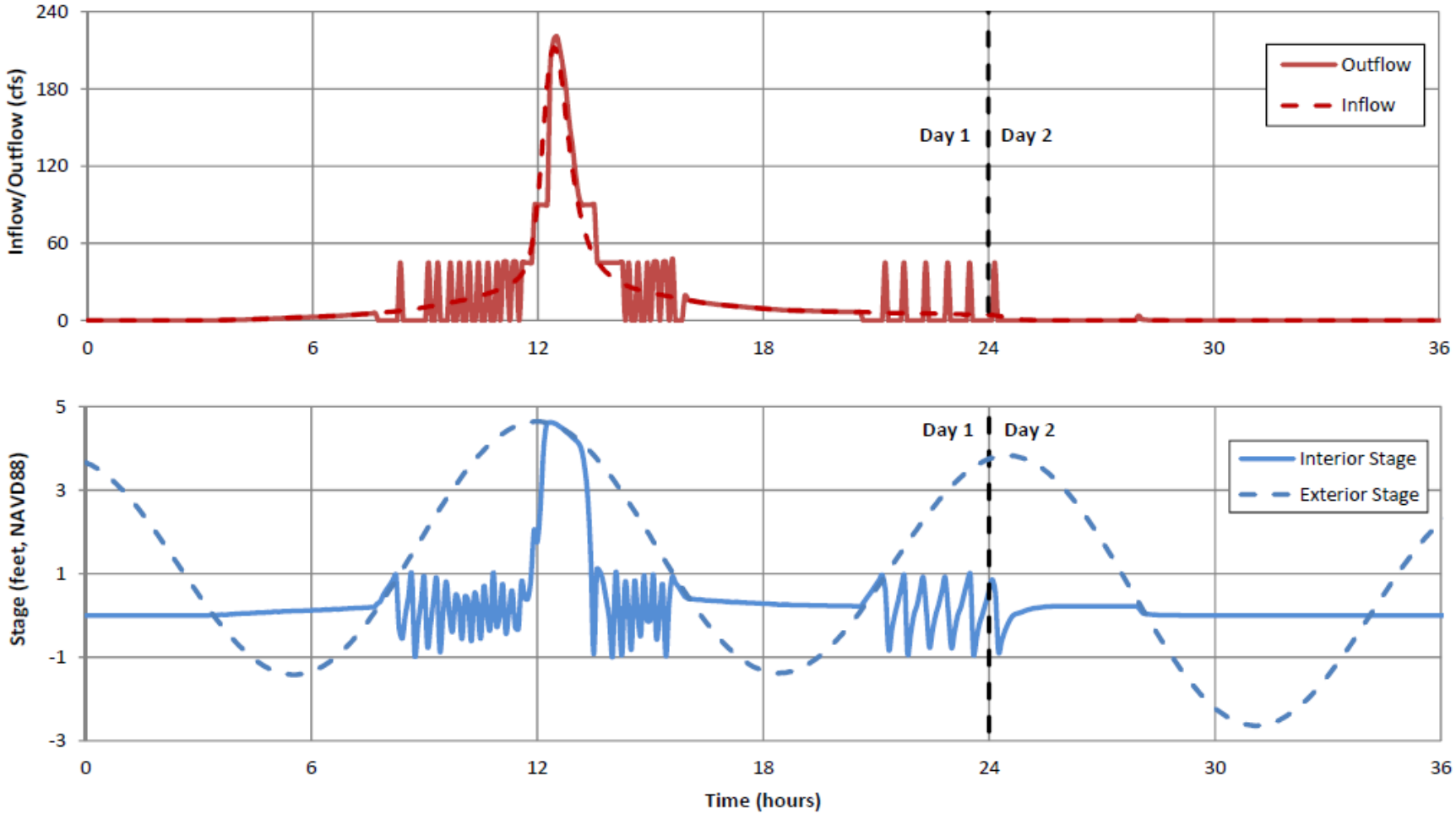


Figure 6-15: Peak Stage vs. Frequency Curves - Cedarhurst-Lawrence L1



Inflow and Outflow Hydrographs and Interior and Exterior Stage Hydrographs for Cedarhurst-Lawrence Subbasin L1, Preferred Plan (90 cfs pump capacity), Most Likely Maximum Interior Stage (10-year storm, 2-year tide)

Figure 6-16: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Cedarhurst-Lawrence L1

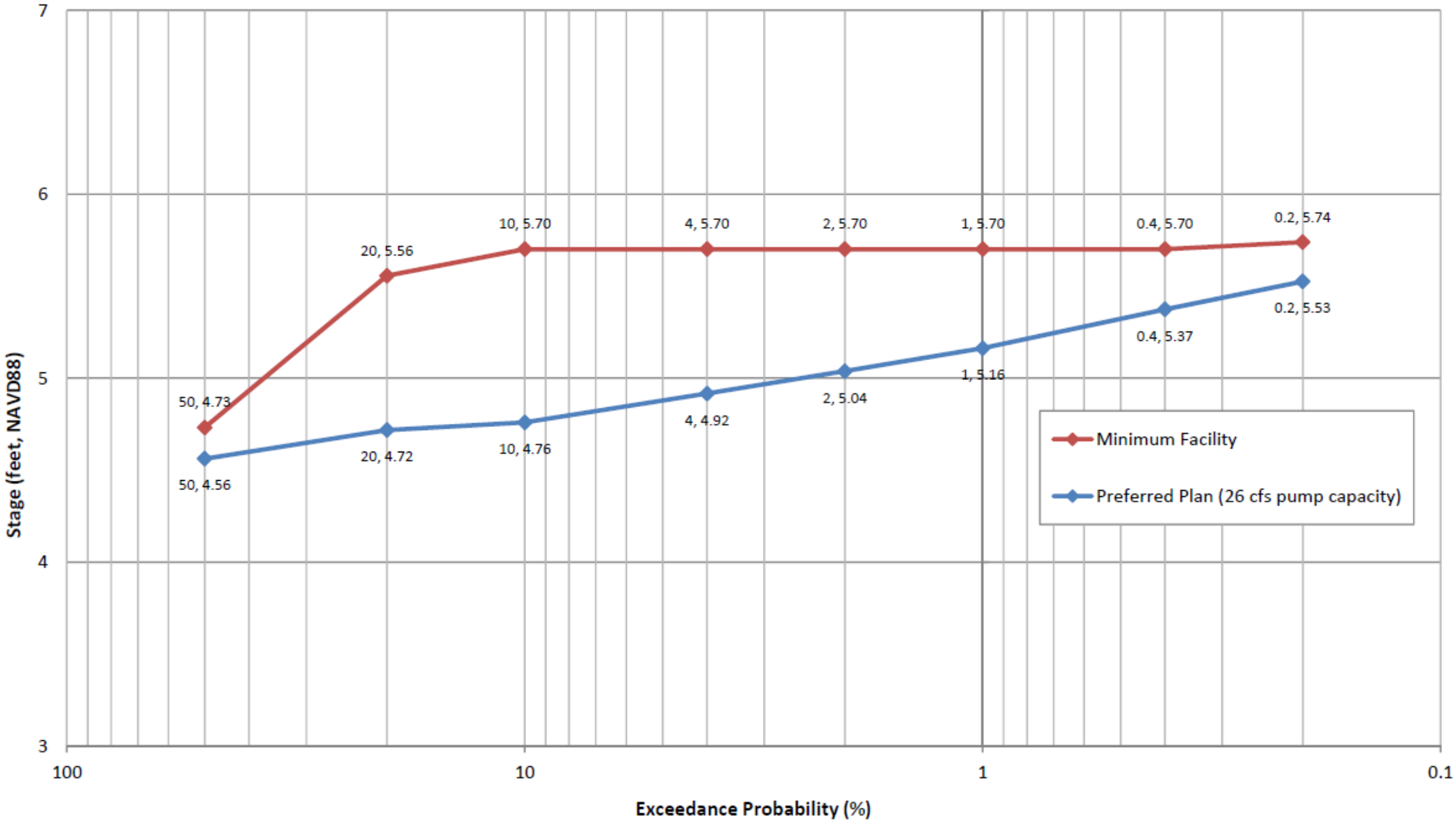
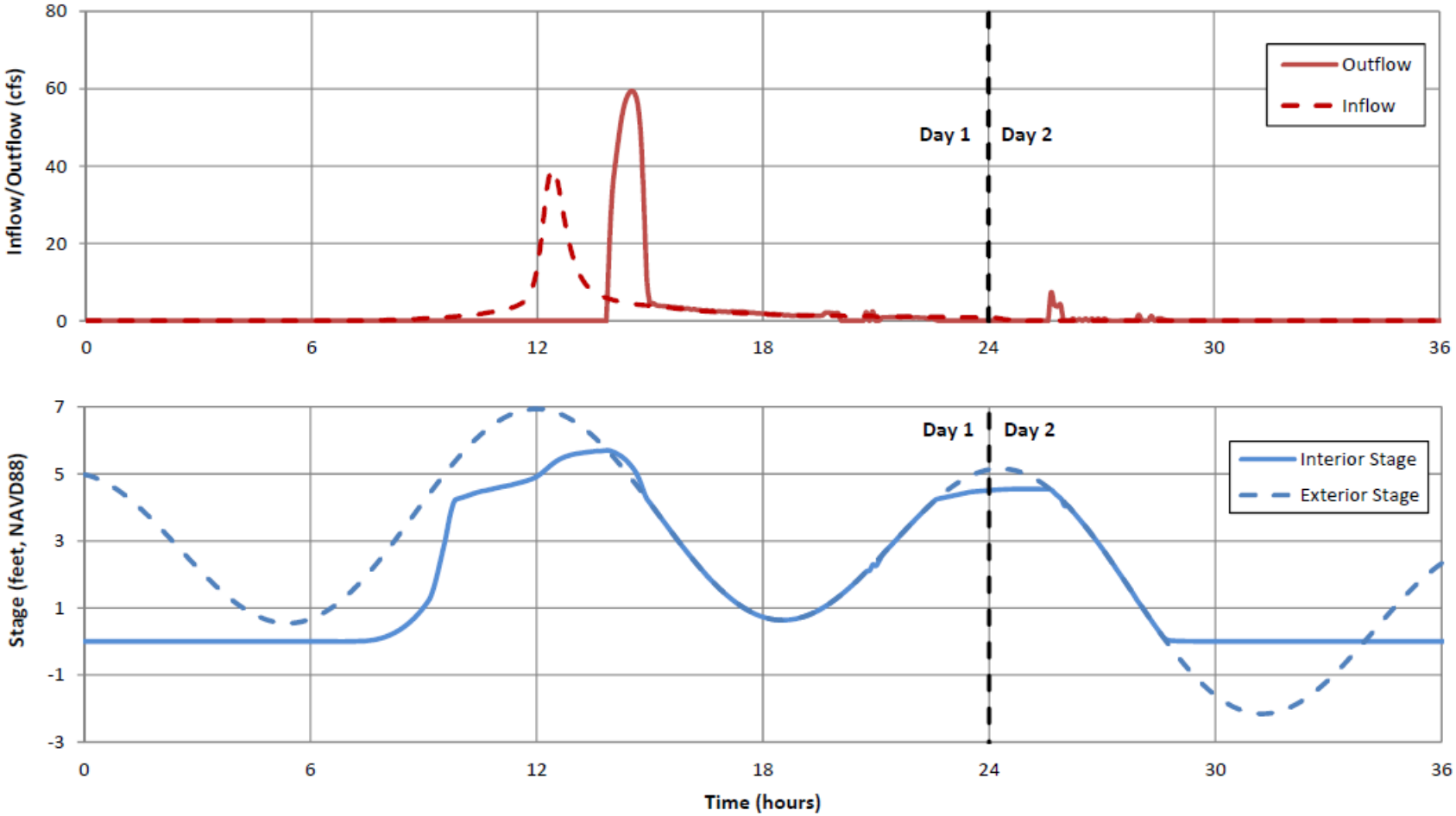


Figure 6-17: Peak Stage vs. Frequency Curves - Motts Basin North M1



Inflow and Outflow Hydrographs and Interior and Exterior Stage Hydrographs for Motts Subbasin M1, Preferred Plan (Minimum Facility), Most Likely Maximum Interior Stage (2-year storm, 10-year tide)

Figure 6-18: Inflow, Outflow, and Stage Hydrographs for Preferred Plan - Motts Basin North M1

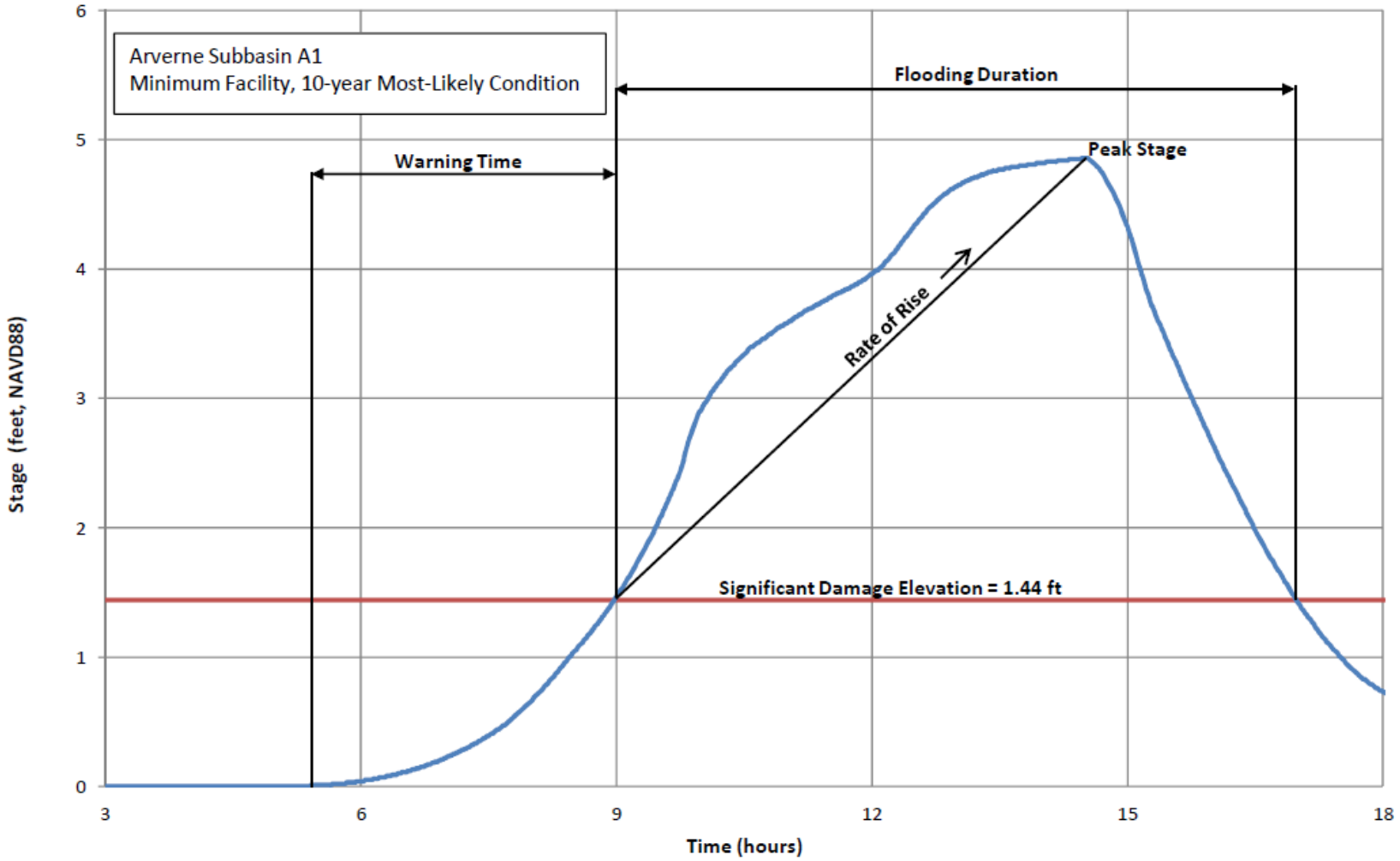


Figure 7-1: Sample Interior Stage vs. Time Plot

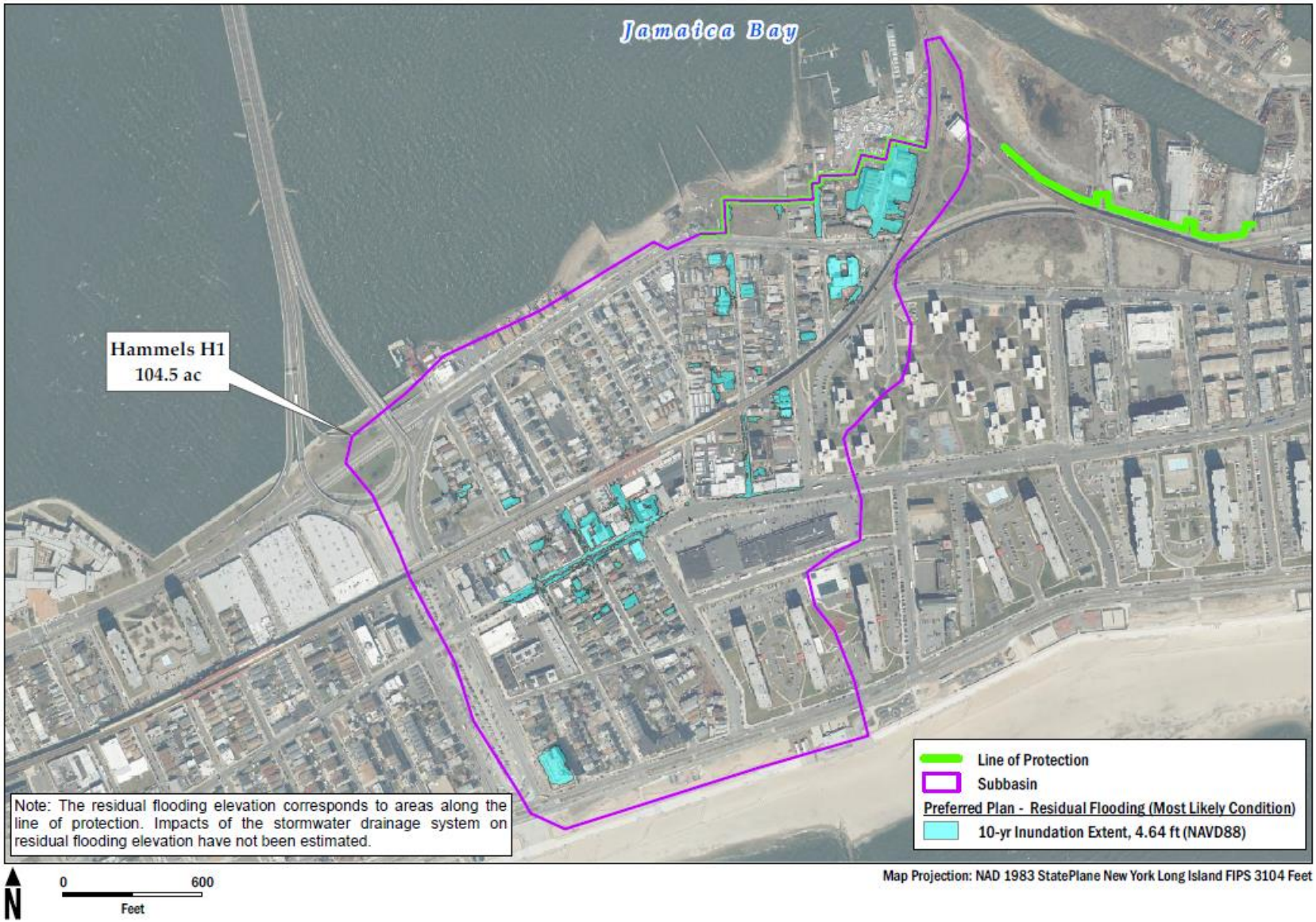


Figure 7-2: Residual Flooding - Mid-Rockaway Hammels Subbasin H1

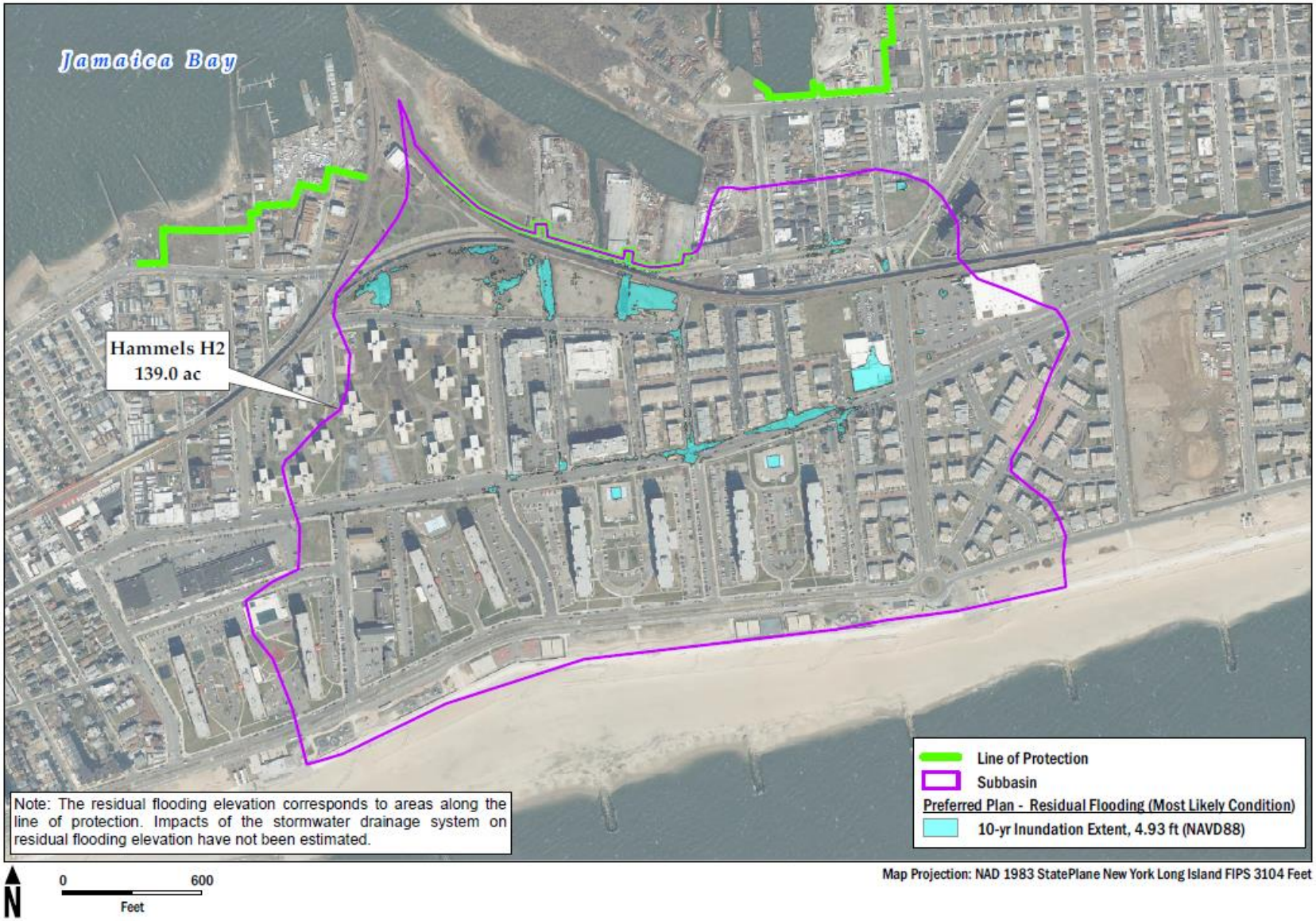


Figure 7-3: Residual Flooding - Mid-Rockaway Hammels Subbasin H2

Figure 7-4: Residual Flooding - Mid-Rockaway Arverne Subbasin A1

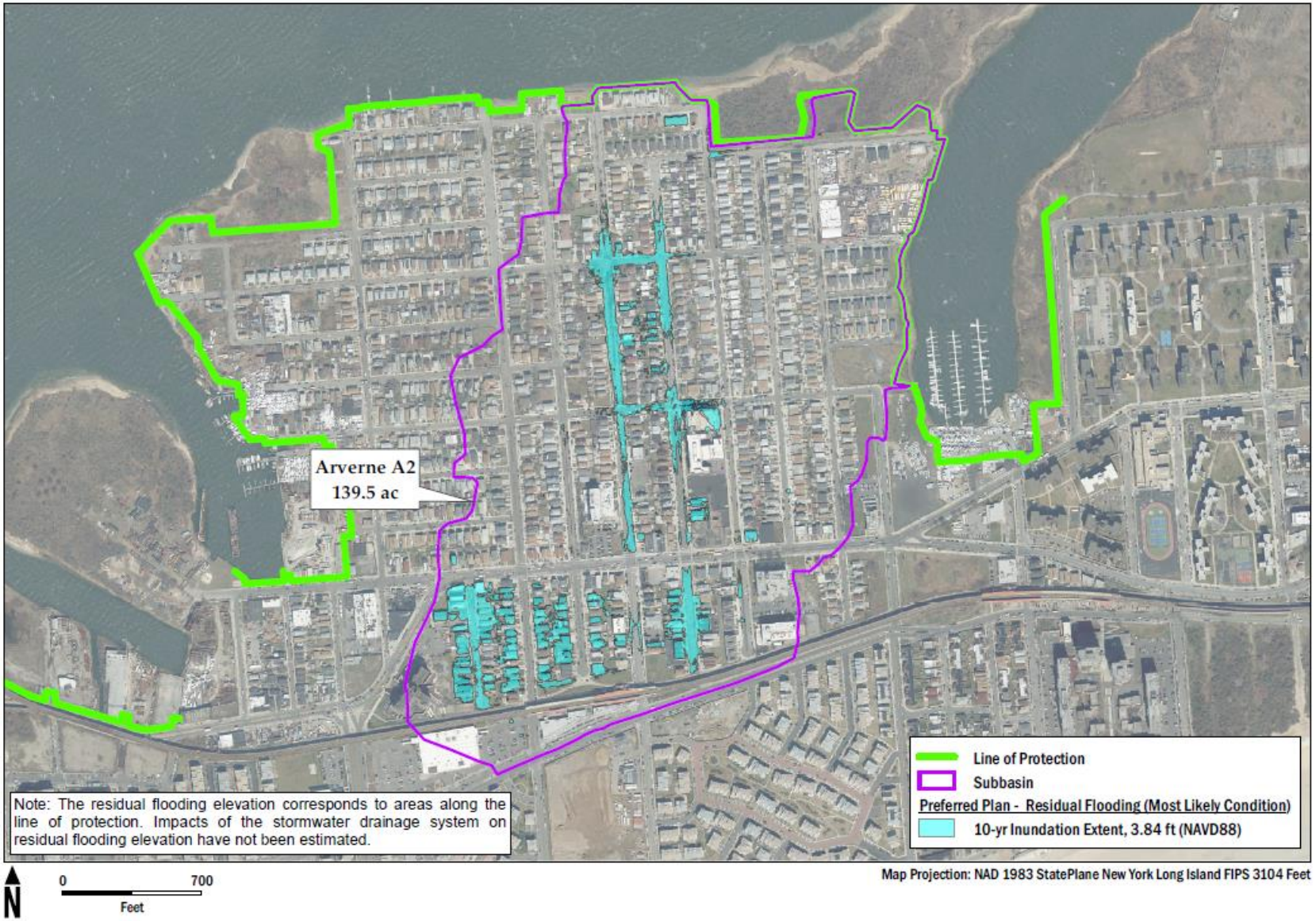


Figure 7-5: Residual Flooding - Mid-Rockaway Arverne Subbasin A2

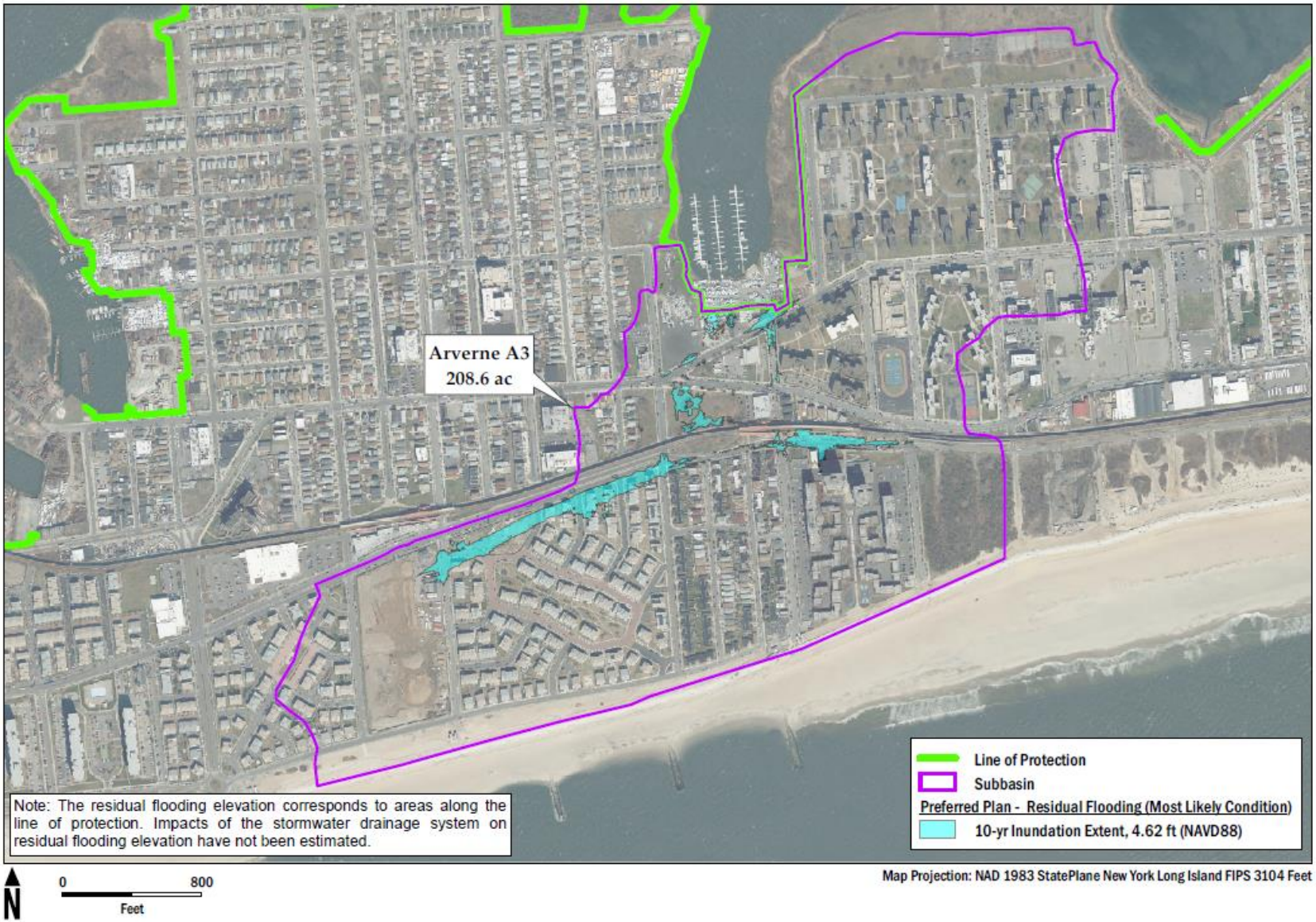


Figure 7-6: Residual Flooding - Mid-Rockaway Arverne Subbasin A3

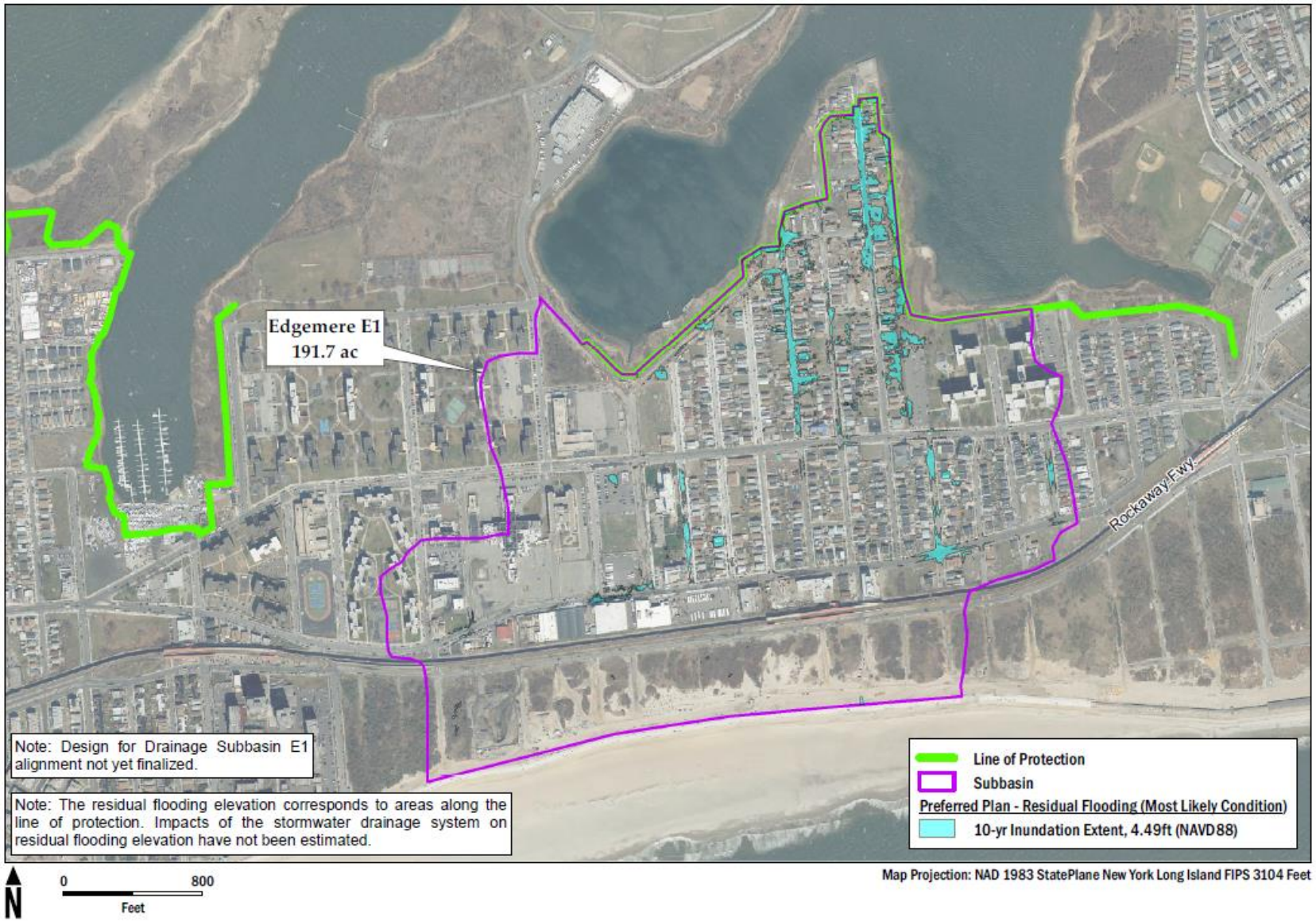


Figure 7-7: Residual Flooding - Mid-Rockaway Edgemere Subbasin E1

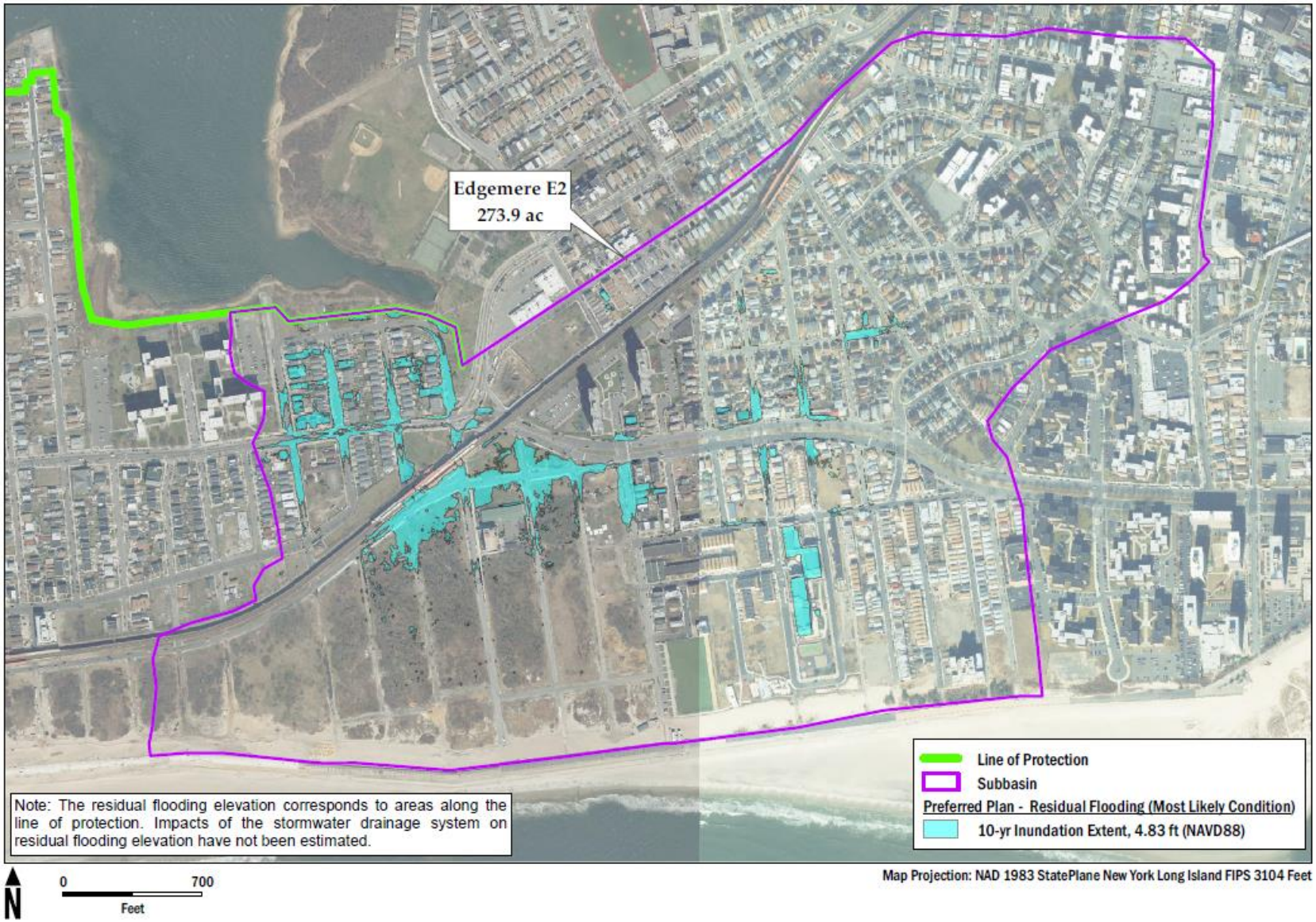


Figure 7-8: Residual Flooding - Mid-Rockaway Edgemere Subbasin E2

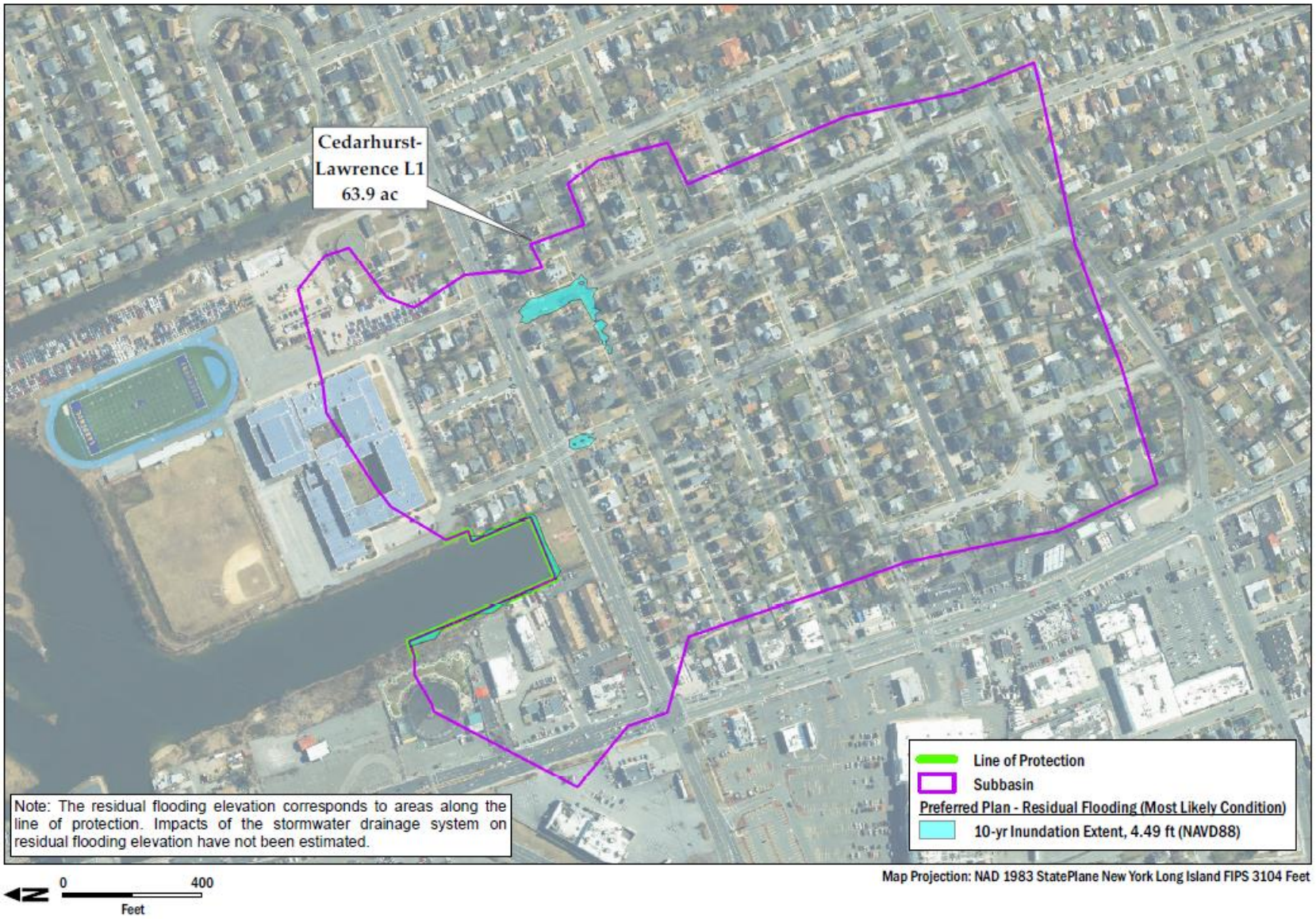


Figure 7-9: Residual Flooding - Cedarhurst-Lawrence Subbasin L1

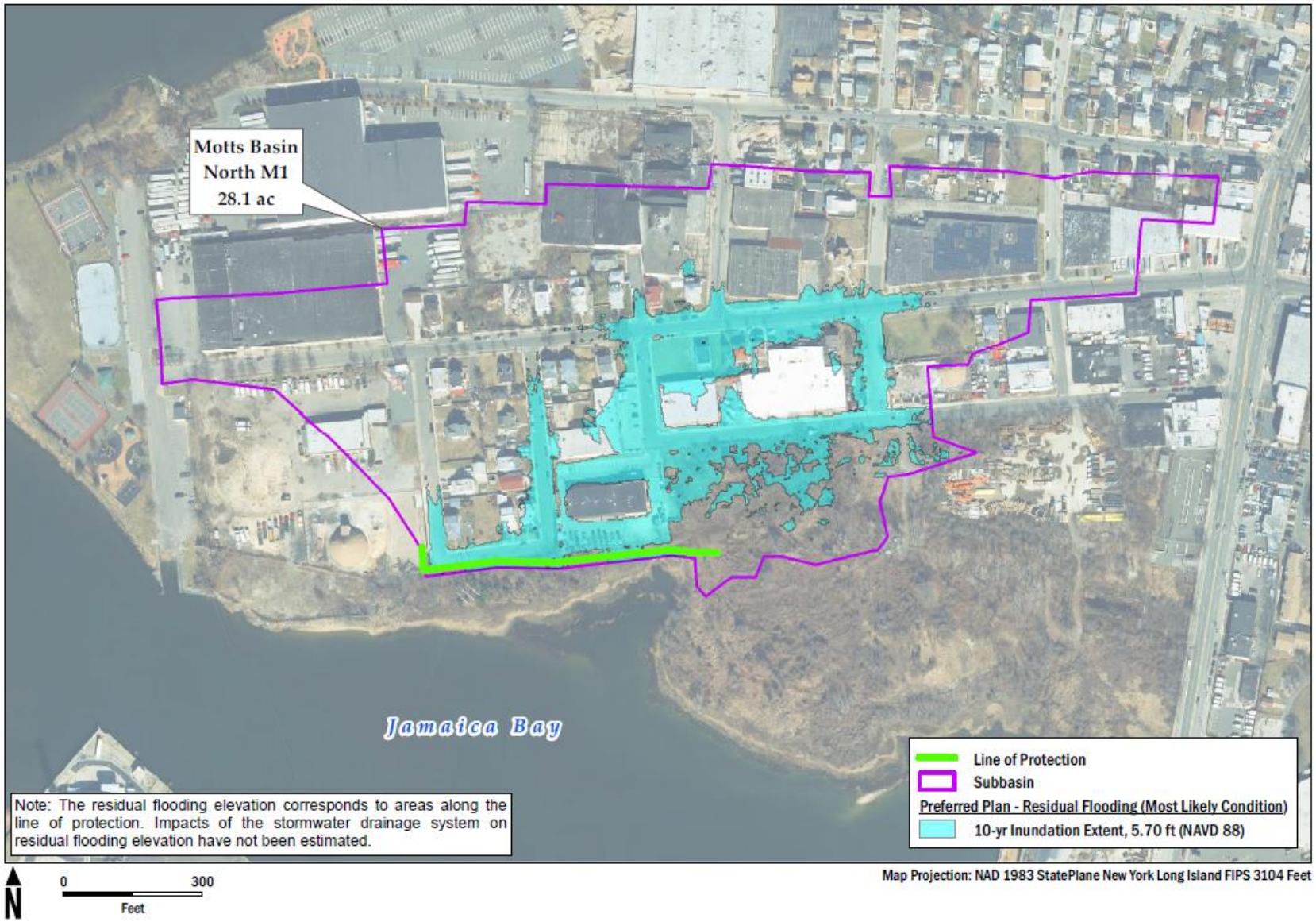


Figure 7-10: Residual Flooding - Motts Basin North Subbasin M1

Interior Drainage Sub-Appendix E

Attachment 2: Time of Concentration Calculations

Subbasin Name: H1		
Location: Hammels, Mid-Rockaway Back-Bay		
Sheet Flow		
Surface Description		Smooth surface
Manning's roughness coefficient, n		0.011
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.005
Travel time, T_1	**hr**	**0.03**
$T = 0.007(nL)^{0.8}$	**min**	**2.05**
$(P_2)^{0.5} s^{0.4}$		
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	277.4
Watercourse slope, s	ft/ft	0.003
Average velocity, V	ft/s	1.1
Unpaved $V = 16.1345 (s)^{0.5}$		
Paved $V = 20.3282 (s)^{0.5}$		
Travel time, T2	**hr**	**0.07**
	min	**4.20**
Channel Flow		
Cross Sectional Flow area, A	sq ft	10
Wetted perimeter, p_w	ft	40.5
Hydraulic radius, $r = A/p_w$	ft	0.25
Channel slope, s	ft/ft	0.002
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	3808.6
Velocity, V	ft/s	1.64
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.65**
	min	**38.73**
Subbasin Time of concentration, Tc	**min**	**44.98**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**27**
$T_{lag} = 0.6 T_c$		

Subbasin Name: H2		
Location: Hammels, Mid-Rockaway Back-Bay		
Sheet Flow		
Surface Description		smooth surface
Manning's roughness coefficient, n		0.011
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.014
Travel time, T_1	**hr**	**0.02**
$T = 0.007(nL)^{0.8}$	**min**	**1.36**
$(P_2)^{0.5} s^{0.4}$		
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	109.8
Watercourse slope, s	ft/ft	0.013
Average velocity, V	ft/s	2.3
Unpaved $V = 16.1345\ (s)^{0.5}$		
Paved $V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.01**
	min	**0.80**
Channel Flow		
Cross Sectional Flow area, A	sq ft	7.5
Wetted perimeter, p_w	ft	30.5
Hydraulic radius, $r = A/p_w$	ft	0.25
Channel slope, s	ft/ft	0.002
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	2962.8
Velocity, V	ft/s	1.63
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.50**
	min	**30.21**
Subbasin Time of concentration, Tc	**min**	**32.36**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**19**
$T_{lag} = 0.6 T_c$		

Subbasin Name: A1		
Location: Arvene, Mid-Rockaway Back-Bay		
Sheet Flow		
Surface Description		smooth surface
Manning's roughness coefficient, n		0.011
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.094
Travel time, T_1	**hr**	**0.01**
$T = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}}$	**min**	**0.63**
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	159.2
Watercourse slope, s	ft/ft	0.008
Average velocity, V	ft/s	1.8
Unpaved $V = 16.1345\ (s)^{0.5}$		
Paved $V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.02**
	min	**1.47**
Channel Flow		
Cross Sectional Flow area, A	sq ft	3.75
Wetted perimeter, p_w	ft	15.5
Hydraulic radius, $r = A/p_w$	ft	0.24
Channel slope, s	ft/ft	0.001
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	3647
Velocity, V	ft/s	1.14
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.89**
	min	**53.16**
Subbasin Time of concentration, Tc	**min**	**55.27**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**33**
$T_{lag} = 0.6 T_c$		

Subbasin Name: A2		
Location: Arvene, Mid-Rockaway Back-Bay		
Sheet Flow		
Surface Description		smooth surface
Manning's roughness coefficient, n		0.011
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.002
Travel time, T_1	**hr**	**0.05**
$T = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}}$	**min**	**2.96**
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	236.6
Watercourse slope, s	ft/ft	0.01
Average velocity, V	ft/s	2
Unpaved $V = 16.1345\ (s)^{0.5}$		
Paved $V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.03**
	min	**1.97**
Channel Flow		
Cross Sectional Flow area, A	sq ft	7.5
Wetted perimeter, p_w	ft	30.5
Hydraulic radius, $r = A/p_w$	ft	0.25
Channel slope, s	ft/ft	0.001
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	3813.5
Velocity, V	ft/s	1.16
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.92**
	min	**54.99**
Subbasin Time of concentration, Tc	**min**	**59.92**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**36**
$T_{lag} = 0.6 T_c$		

Subbasin Name: A3		
Location: Arvene, Mid-Rockaway Back-Bay		
Sheet Flow		
Surface Description		smooth surface
Manning's roughness coefficient, n		0.011
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.034
Travel time, T_1	**hr**	**0.02**
$T = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}}$	**min**	**0.95**
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	163.3
Watercourse slope, s	ft/ft	0.021
Average velocity, V	ft/s	2.9
Unpaved $V = 16.1345\ (s)^{0.5}$		
Paved $V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.02**
	min	**0.94**
Channel Flow		
Cross Sectional Flow area, A	sq ft	7.5
Wetted perimeter, p_w	ft	30.5
Hydraulic radius, $r = A/p_w$	ft	0.25
Channel slope, s	ft/ft	0.002
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	4476.7
Velocity, V	ft/s	1.63
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.76**
	min	**45.64**
Subbasin Time of concentration, Tc	**min**	**47.54**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**29**
$T_{lag} = 0.6 T_c$		

Subbasin Name: E1		
Location: Edgemere Mid-Rockaway Back-Bay		
Sheet Flow		
Surface Description		smooth surface
Manning's roughness coefficient, n		0.011
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.027
Travel time, T_1	**hr**	**0.02**
$T = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}}$	**min**	**1.05**
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	650.2
Watercourse slope, s	ft/ft	0.008
Average velocity, V	ft/s	1.8
Unpaved $V = 16.1345\ (s)^{0.5}$		
Paved $V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.10**
	min	**6.02**
Channel Flow		
Cross Sectional Flow area, A	sq ft	5
Wetted perimeter, p_w	ft	20.5
Hydraulic radius, $r = A/p_w$	ft	0.24
Channel slope, s	ft/ft	0.001
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	4262.1
Velocity, V	ft/s	1.15
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**1.03**
	min	**61.79**
Subbasin Time of concentration, Tc	**min**	**68.86**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**41**
$T_{lag} = 0.6 T_c$		

Subbasin Name: E2		
Location: Edgemere, Mid-Rockaway Back-Bay		
Sheet Flow		
Surface Description		smooth surface
Manning's roughness coefficient, n		0.011
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.003
Travel time, T_1	**hr**	**0.04**
$T = 0.007(nL)^{0.8}$	**min**	**2.52**
$(P_2)^{0.5} s^{0.4}$		
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	211.8
Watercourse slope, s	ft/ft	0.008
Average velocity, V	ft/s	1.8
Unpaved $V = 16.1345\ (s)^{0.5}$		
Paved $V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.03**
	min	**1.96**
Channel Flow Segment 1		
Cross Sectional Flow area, A	sq ft	3.75
Wetted perimeter, p_w	ft	15.5
Hydraulic radius, $r = A/p_w$	ft	0.24
Channel slope, s	ft/ft	0.017
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	1100
Velocity, V	ft/s	4.71
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.06**
	min	**3.89**
Channel Flow Segment 2		
Cross Sectional Flow area, A	sq ft	10
Wetted perimeter, p_w	ft	40.5
Hydraulic radius, $r = A/p_w$	ft	0.25
Channel slope, s	ft/ft	0.001
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	4523.9
Velocity, V	ft/s	1.16
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**1.08**
	min	**65.05**
Subbasin Time of concentration, Tc	**min**	**73.42**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**44**
$T_{lag} = 0.6 T_c$		

Subbasin Name: C1		
Location: Canarsie, Brooklyn, NY		
Sheet Flow		
Surface Description		short grass
Manning's roughness coefficient, n		0.15
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.024
Travel time, T_1	**hr**	**0.15**
$T = 0.007(nL)^{0.8}$	**min**	**8.86**
$(P_2)^{0.5} s^{0.4}$		
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	1735
Watercourse slope, s	ft/ft	0.004
Average velocity, V	ft/s	1.3
$Unpaved\ V = 16.1345\ (s)^{0.5}$		
$Paved\ V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.37**
	min	**22.24**
Channel Flow		
Cross Sectional Flow area, A	sq ft	3.75
Wetted perimeter, p_w	ft	15.5
Hydraulic radius, $r = A/p_w$	ft	0.24
Channel slope, s	ft/ft	0.004
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	1735
Velocity, V	ft/s	2.29
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.21**
	min	**12.65**
Subbasin Time of concentration, Tc	**min**	**43.75**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**26.25**
$T_{lag} = 0.6T_c$		

Subbasin Name: C2		
Location: Canarsie, Brooklyn, NY		
Sheet Flow		
Surface Description		short grass
Manning's roughness coefficient, n		0.15
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.022
Travel time, T_1	**hr**	**0.15**
$T = 0.007(nL)^{0.8}$	**min**	**9.18**
$(P_2)^{0.5} s^{0.4}$		
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	2075
Watercourse slope, s	ft/ft	0.004
Average velocity, V	ft/s	1.3
Unpaved $V = 16.1345\ (s)^{0.5}$		
Paved $V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.44**
	min	**26.60**
Channel Flow		
Cross Sectional Flow area, A	sq ft	3.75
Wetted perimeter, p_w	ft	15.5
Hydraulic radius, $r = A/p_w$	ft	0.24
Channel slope, s	ft/ft	0.004
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	2075
Velocity, V	ft/s	2.29
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.25**
	min	**15.12**
Subbasin Time of concentration, Tc	**min**	**50.90**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**30.54**
$T_{lag} = 0.6 T_c$		

Subbasin Name: C3		
Location: Canarsie, Brooklyn, NY		
Sheet Flow		
Surface Description		short grass
Manning's roughness coefficient, n		0.15
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.032
Travel time, T_1	**hr**	**0.13**
$T = 0.007(nL)^{0.8}$	**min**	**7.90**
$(P_2)^{0.5} s^{0.4}$		
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	1475
Watercourse slope, s	ft/ft	0.003
Average velocity, V	ft/s	1.1
Unpaved $V = 16.1345\ (s)^{0.5}$		
Paved $V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.37**
	min	**22.35**
Channel Flow		
Cross Sectional Flow area, A	sq ft	3.75
Wetted perimeter, p_w	ft	15.5
Hydraulic radius, $r = A/p_w$	ft	0.24
Channel slope, s	ft/ft	0.003
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	1475
Velocity, V	ft/s	1.98
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.21**
	min	**12.41**
Subbasin Time of concentration, Tc	**min**	**42.66**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**25.60**
$T_{lag} = 0.6T_c$		

Subbasin Name: L1		
Location: Cedarhurst-Lawrence, Nassau County, NY		
Sheet Flow		
Surface Description		short grass
Manning's roughness coefficient, n		0.15
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.00383
Travel time, T_1	**hr**	**0.31**
$T = 0.007(nL)^{0.8}$	**min**	**18.47**
$(P_2)^{0.5} s^{0.4}$		
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	1150
Watercourse slope, s	ft/ft	0.00265
Average velocity, V	ft/s	1
Unpaved $V = 16.1345\ (s)^{0.5}$		
Paved $V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.32**
	min	**19.17**
Channel Flow		
Cross Sectional Flow area, A	sq ft	3.75
Wetted perimeter, p_w	ft	15.5
Hydraulic radius, $r = A/p_w$	ft	0.24
Channel slope, s	ft/ft	0.00265
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	1150
Velocity, V	ft/s	1.86
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.17**
	min	**10.30**
Subbasin Time of concentration, Tc	**min**	**47.93**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**28.76**
$T_{lag} = 0.6T_c$		

Subbasin Name: M1		
Location: Motts Basin North, Nassau County, NY		
Sheet Flow		
Surface Description		short grass
Manning's roughness coefficient, n		0.15
Flow length, L	ft	100
2-year 24-hour rainfall, P_2	in	3.38
Slope of hydraulic grade line/land slope, s	ft/ft	0.01
Travel time, T_1	**hr**	**0.21**
$T = 0.007(nL)^{0.8}$	**min**	**12.58**
$(P_2)^{0.5} s^{0.4}$		
Shallow Concentrated Flow		
Surface Description (paved/unpaved)		paved
Flow length, L	ft	1620
Watercourse slope, s	ft/ft	0.0037
Average velocity, V	ft/s	1.2
Unpaved $V = 16.1345\ (s)^{0.5}$		
Paved $V = 20.3282\ (s)^{0.5}$		
Travel time, T2	**hr**	**0.38**
	min	**22.50**
Channel Flow		
Cross Sectional Flow area, A	sq ft	3.75
Wetted perimeter, p_w	ft	15.5
Hydraulic radius, $r = A/p_w$	ft	0.24
Channel slope, s	ft/ft	0.0037
Manning's roughness coefficient for open channel flow, n		0.016
Flow length, L	ft	0
Velocity, V	ft/s	2.20
$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$		
Travel time, T3	**hr**	**0.00**
	min	**0.00**
Subbasin Time of concentration, Tc	**min**	**35.08**
$T_c = T_1 + T_2 + T_3$		
Subbasin Lag Time, T_{lag}	**min**	**21.05**
$T_{lag} = 0.6T_c$		

Interior Drainage Sub-Appendix E

Attachment 3: HEC-HMS Modeling Results by Subbasin

Mid-Rockaway Hammels - Minimum Facility, Present Tides													
Subbasin H1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.94	145	2.75							2.94	145	Low
5 yr	Normal	Present	3.16	199	2.75							3.16	199	Low
10 yr	Normal	Present	3.40	244	2.75							3.40	244	Low
25 yr	Normal	Present	3.75	306	2.75							3.75	306	Low
50 yr	Normal	Present	4.03	353	2.75							4.03	353	Low
100 yr	Normal	Present	4.30	400	2.75							4.30	400	Low
250 yr	Normal	Present	4.72	491	2.75							4.72	491	Low
500 yr	Normal	Present	4.95	557	2.75							4.95	557	Low
2 yr	2 yr	Present	4.76	145	4.64	2 yr	2 yr	Present	4.76	145	4.64	4.76	145	Likely
5 yr	2 yr	Present	4.90	199	4.64	2 yr	5 yr	Present	5.34	145	5.94	5.34	199	Likely
10 yr	2 yr	Present	5.01	244	4.64	2 yr	10 yr	Present	5.47	145	6.94	5.47	244	Likely
25 yr	2 yr	Present	5.16	306	4.64	2 yr	10yr	Present	5.47	145	6.94	5.47	306	Likely
50 yr	2 yr	Present	5.26	353	4.64	2 yr	10yr	Present	5.47	145	6.94	5.47	353	Likely
100 yr	2 yr	Present	5.36	400	4.64	2 yr	10yr	Present	5.47	145	6.94	5.47	400	Likely
250 yr	2 yr	Present	5.56	491	4.64	2 yr	10yr	Present	5.47	145	6.94	5.56	491	Likely
500 yr	2 yr	Present	5.69	557	4.64	2 yr	10yr	Present	5.47	145	6.94	5.69	557	Likely
2 yr	2 yr	Present	4.76	145	4.64	2yr	2 yr	Present	4.76	145	4.64	4.76	145	High
5 yr	5 yr	Present	5.53	199	5.94	5 yr	5 yr	Present	5.53	199	5.94	5.53	199	High
10 yr	10 yr	Present	5.85	244	6.94	10 yr	10 yr	Present	5.85	244	6.94	5.85	244	High
25 yr	10 yr	Present	6.03	306	6.94	10 yr	10yr	Present	5.85	244	6.94	6.03	306	High
50 yr	10 yr	Present	6.14	353	6.94	10 yr	10yr	Present	5.85	244	6.94	6.14	353	High
100 yr	10 yr	Present	6.24	400	6.94	10 yr	10yr	Present	5.85	244	6.94	6.24	400	High
250 yr	10 yr	Present	6.41	491	6.94	10 yr	10yr	Present	5.85	244	6.94	6.41	491	High
500 yr	10 yr	Present	6.51	557	6.94	10 yr	10yr	Present	5.85	244	6.94	6.51	557	High

Mid-Rockaway Hammels - Pump Alternative 1, Present Tides													
Subbasin H1, 100 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.72	145	2.75							2.72	145	Low
5 yr	Normal	Present	2.80	199	2.75							2.80	199	Low
10 yr	Normal	Present	2.93	244	2.75							2.93	244	Low
25 yr	Normal	Present	3.19	306	2.75							3.19	306	Low
50 yr	Normal	Present	3.43	353	2.75							3.43	353	Low
100 yr	Normal	Present	3.69	400	2.75							3.69	400	Low
250 yr	Normal	Present	4.21	491	2.75							4.21	491	Low
500 yr	Normal	Present	4.55	557	2.75							4.55	557	Low
2 yr	2 yr	Present	3.78	145	4.64	2 yr	2 yr	Present	3.78	145	4.64	3.78	145	Likely
5 yr	2 yr	Present	4.49	199	4.64	2 yr	5 yr	Present	3.79	145	5.84	4.49	199	Likely
10 yr	2 yr	Present	4.64	244	4.64	2 yr	10 yr	Present	3.80	145	6.94	4.64	244	Likely
25 yr	2 yr	Present	4.80	306	4.64	2 yr	10yr	Present	3.80	145	6.94	4.80	306	Likely
50 yr	2 yr	Present	4.93	353	4.64	2 yr	10yr	Present	3.80	145	6.94	4.93	353	Likely
100 yr	2 yr	Present	5.04	400	4.64	2 yr	10yr	Present	3.80	145	6.94	5.04	400	Likely
250 yr	2 yr	Present	5.24	491	4.64	2 yr	10yr	Present	3.80	145	6.94	5.24	491	Likely
500 yr	2 yr	Present	5.38	557	4.64	2 yr	10yr	Present	3.80	145	6.94	5.38	557	Likely
2 yr	2 yr	Present	3.78	145	4.64	2yr	2 yr	Present	3.78	145	4.64	3.78	145	High
5 yr	5 yr	Present	4.66	199	5.84	5 yr	5 yr	Present	4.66	199	5.84	4.66	199	High
10 yr	10 yr	Present	4.99	244	6.94	10 yr	10 yr	Present	4.99	244	6.94	4.99	244	High
25 yr	10 yr	Present	5.27	306	6.94	10 yr	10yr	Present	4.99	244	6.94	5.27	306	High
50 yr	10 yr	Present	5.46	353	6.94	10 yr	10yr	Present	4.99	244	6.94	5.46	353	High
100 yr	10 yr	Present	5.62	400	6.94	10 yr	10yr	Present	4.99	244	6.94	5.62	400	High
250 yr	10 yr	Present	5.88	491	6.94	10 yr	10yr	Present	4.99	244	6.94	5.88	491	High
500 yr	10 yr	Present	6.03	557	6.94	10 yr	10yr	Present	4.99	244	6.94	6.03	557	High

Mid-Rockaway Hammels - Minimum Facility, Future Tides													
Subbasin H1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	4.00	145	3.82							4.00	145	Low
5 yr	Normal	Future	4.19	199	3.82							4.19	199	Low
10 yr	Normal	Future	4.37	244	3.82							4.37	244	Low
25 yr	Normal	Future	4.62	306	3.82							4.62	306	Low
50 yr	Normal	Future	4.78	353	3.82							4.78	353	Low
100 yr	Normal	Future	4.94	400	3.82							4.94	400	Low
250 yr	Normal	Future	5.18	491	3.82							5.18	491	Low
500 yr	Normal	Future	5.33	557	3.82							5.33	557	Low
2 yr	2 yr	Future	5.31	145	5.71	2 yr	2 yr	Future	5.31	145	5.71	5.31	145	Likely
5 yr	2 yr	Future	5.49	199	5.71	2 yr	5 yr	Future	5.47	145	6.91	5.49	199	Likely
10 yr	2 yr	Future	5.61	244	5.71	2 yr	10 yr	Future	5.52	145	8.00	5.61	244	Likely
25 yr	2 yr	Future	5.74	306	5.71	2 yr	10yr	Future	5.52	145	8.00	5.74	306	Likely
50 yr	2 yr	Future	5.84	353	5.71	2 yr	10yr	Future	5.52	145	8.00	5.84	353	Likely
100 yr	2 yr	Future	5.93	400	5.71	2 yr	10yr	Future	5.52	145	8.00	5.93	400	Likely
250 yr	2 yr	Future	6.09	491	5.71	2 yr	10yr	Future	5.52	145	8.00	6.09	491	Likely
500 yr	2 yr	Future	6.19	557	5.71	2 yr	10yr	Future	5.52	145	8.00	6.19	557	Likely
2 yr	2 yr	Future	5.31	145	5.71	2yr	2 yr	Future	5.31	145	5.71	5.31	145	High
5 yr	5 yr	Future	5.70	199	6.91	5 yr	5 yr	Future	5.70	199	6.91	5.70	199	High
10 yr	10 yr	Future	5.92	244	8.00	10 yr	10 yr	Future	5.92	244	8.00	5.92	244	High
25 yr	10 yr	Future	6.11	306	8.00	10 yr	10yr	Future	5.92	244	8.00	6.11	306	High
50 yr	10 yr	Future	6.23	353	8.00	10 yr	10yr	Future	5.92	244	8.00	6.23	353	High
100 yr	10 yr	Future	6.34	400	8.00	10 yr	10yr	Future	5.92	244	8.00	6.34	400	High
250 yr	10 yr	Future	6.54	491	8.00	10 yr	10yr	Future	5.92	244	8.00	6.54	491	High
500 yr	10 yr	Future	6.67	557	8.00	10 yr	10yr	Future	5.92	244	8.00	6.67	557	High

Mid-Rockaway Hammels - Pump Alternative 1, Future Tides													
Subbasin H1, 100 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	3.67	145	3.82							3.67	145	Low
5 yr	Normal	Present	3.84	199	3.82							3.84	199	Low
10 yr	Normal	Present	3.98	244	3.82							3.98	244	Low
25 yr	Normal	Present	4.19	306	3.82							4.19	306	Low
50 yr	Normal	Present	4.37	353	3.82							4.37	353	Low
100 yr	Normal	Present	4.56	400	3.82							4.56	400	Low
250 yr	Normal	Present	4.87	491	3.82							4.87	491	Low
500 yr	Normal	Present	5.05	557	3.82							5.05	557	Low
2 yr	2 yr	Present	3.80	145	5.71	2 yr	2 yr	Present	3.80	145	5.71	3.80	145	Likely
5 yr	2 yr	Present	4.65	199	5.71	2 yr	5 yr	Present	3.80	145	6.91	4.65	199	Likely
10 yr	2 yr	Present	4.98	244	5.71	2 yr	10 yr	Present	3.80	145	8.00	4.98	244	Likely
25 yr	2 yr	Present	5.27	306	5.71	2 yr	10yr	Present	3.80	145	8.00	5.27	306	Likely
50 yr	2 yr	Present	5.41	353	5.71	2 yr	10yr	Present	3.80	145	8.00	5.41	353	Likely
100 yr	2 yr	Present	5.51	400	5.71	2 yr	10yr	Present	3.80	145	8.00	5.51	400	Likely
250 yr	2 yr	Present	5.68	491	5.71	2 yr	10yr	Present	3.80	145	8.00	5.68	491	Likely
500 yr	2 yr	Present	5.78	557	5.71	2 yr	10yr	Present	3.80	145	8.00	5.78	557	Likely
2 yr	2 yr	Present	3.80	145	5.71	2yr	2 yr	Present	3.80	145	5.71	3.80	145	High
5 yr	5 yr	Present	4.66	199	6.91	5 yr	5 yr	Present	4.66	199	6.91	4.66	199	High
10 yr	10 yr	Present	4.98	244	8.00	10 yr	10 yr	Present	4.98	244	8.00	4.98	244	High
25 yr	10 yr	Present	5.27	306	8.00	10 yr	10yr	Present	4.98	244	8.00	5.27	306	High
50 yr	10 yr	Present	5.46	353	8.00	10 yr	10yr	Present	4.98	244	8.00	5.46	353	High
100 yr	10 yr	Present	5.62	400	8.00	10 yr	10yr	Present	4.98	244	8.00	5.62	400	High
250 yr	10 yr	Present	5.88	491	8.00	10 yr	10yr	Present	4.98	244	8.00	5.88	491	High
500 yr	10 yr	Present	6.03	557	8.00	10 yr	10yr	Present	4.98	244	8.00	6.03	557	High

Mid-Rockaway Hammels - Minimum Facility, Present Tides													
Subbasin H2 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	3.29	227	2.75							3.29	227	Low
5 yr	Normal	Present	3.80	315	2.75							3.80	315	Low
10 yr	Normal	Present	4.28	389	2.75							4.28	389	Low
25 yr	Normal	Present	4.88	489	2.75							4.88	489	Low
50 yr	Normal	Present	5.18	565	2.75							5.18	565	Low
100 yr	Normal	Present	5.41	642	2.75							5.41	642	Low
250 yr	Normal	Present	5.72	790	2.75							5.72	790	Low
500 yr	Normal	Present	5.90	897	2.75							5.90	897	Low
2 yr	2 yr	Present	5.06	227	4.64	2 yr	2 yr	Present	5.06	227	4.64	5.06	227	Likely
5 yr	2 yr	Present	5.30	315	4.64	2 yr	5 yr	Present	5.83	227	5.94	5.83	315	Likely
10 yr	2 yr	Present	5.48	389	4.64	2 yr	10 yr	Present	6.06	227	6.94	6.06	389	Likely
25 yr	2 yr	Present	5.68	489	4.64	2 yr	10yr	Present	6.06	227	6.94	6.06	489	Likely
50 yr	2 yr	Present	5.81	565	4.64	2 yr	10yr	Present	6.06	227	6.94	6.06	565	Likely
100 yr	2 yr	Present	5.94	642	4.64	2 yr	10yr	Present	6.06	227	6.94	6.06	642	Likely
250 yr	2 yr	Present	6.15	790	4.64	2 yr	10yr	Present	6.06	227	6.94	6.15	790	Likely
500 yr	2 yr	Present	6.30	897	4.64	2 yr	10yr	Present	6.06	227	6.94	6.30	897	Likely
2 yr	2 yr	Present	5.06	227	4.64	2yr	2 yr	Present	5.06	227	4.64	5.06	227	High
5 yr	5 yr	Present	6.00	315	5.94	5 yr	5 yr	Present	6.00	315	5.94	6.00	315	High
10 yr	10 yr	Present	6.43	389	6.94	10 yr	10 yr	Present	6.43	389	6.94	6.43	389	High
25 yr	10 yr	Present	6.59	489	6.94	10 yr	10yr	Present	6.43	389	6.94	6.59	489	High
50 yr	10 yr	Present	6.69	565	6.94	10 yr	10yr	Present	6.43	389	6.94	6.69	565	High
100 yr	10 yr	Present	6.78	642	6.94	10 yr	10yr	Present	6.43	389	6.94	6.78	642	High
250 yr	10 yr	Present	6.96	790	6.94	10 yr	10yr	Present	6.43	389	6.94	6.96	790	High
500 yr	10 yr	Present	7.07	897	6.94	10 yr	10yr	Present	6.43	389	6.94	7.07	897	High

Mid-Rockaway Hammels - Pump Alternative 1, Present Tides													
Subbasin H2, 160 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.76	227	2.75							2.76	227	Low
5 yr	Normal	Present	2.98	315	2.75							2.98	315	Low
10 yr	Normal	Present	3.29	389	2.75							3.29	389	Low
25 yr	Normal	Present	3.85	489	2.75							3.85	489	Low
50 yr	Normal	Present	4.34	565	2.75							4.34	565	Low
100 yr	Normal	Present	4.78	642	2.75							4.78	642	Low
250 yr	Normal	Present	5.32	790	2.75							5.32	790	Low
500 yr	Normal	Present	5.57	897	2.75							5.57	897	Low
2 yr	2 yr	Present	4.38	227	4.64	2 yr	2 yr	Present	4.38	227	4.64	4.38	227	Likely
5 yr	2 yr	Present	4.77	315	4.64	2 yr	5 yr	Present	4.34	227	5.84	4.77	315	Likely
10 yr	2 yr	Present	5.00	389	4.64	2 yr	10 yr	Present	4.34	227	6.94	5.00	389	Likely
25 yr	2 yr	Present	5.27	489	4.64	2 yr	10yr	Present	4.34	227	6.94	5.27	489	Likely
50 yr	2 yr	Present	5.45	565	4.64	2 yr	10yr	Present	4.34	227	6.94	5.45	565	Likely
100 yr	2 yr	Present	5.60	642	4.64	2 yr	10yr	Present	4.34	227	6.94	5.60	642	Likely
250 yr	2 yr	Present	5.84	790	4.64	2 yr	10yr	Present	4.34	227	6.94	5.84	790	Likely
500 yr	2 yr	Present	6.00	897	4.64	2 yr	10yr	Present	4.34	227	6.94	6.00	897	Likely
2 yr	2 yr	Present	4.38	227	4.64	2yr	2 yr	Present	4.38	227	4.64	4.38	227	High
5 yr	5 yr	Present	5.33	315	5.84	5 yr	5 yr	Present	5.33	315	5.84	5.33	315	High
10 yr	10 yr	Present	5.63	389	6.94	10 yr	10 yr	Present	5.63	389	6.94	5.63	389	High
25 yr	10 yr	Present	5.90	489	6.94	10 yr	10yr	Present	5.63	389	6.94	5.90	489	High
50 yr	10 yr	Present	6.05	565	6.94	10 yr	10yr	Present	5.63	389	6.94	6.05	565	High
100 yr	10 yr	Present	6.21	642	6.94	10 yr	10yr	Present	5.63	389	6.94	6.21	642	High
250 yr	10 yr	Present	6.45	790	6.94	10 yr	10yr	Present	5.63	389	6.94	6.45	790	High
500 yr	10 yr	Present	6.60	897	6.94	10 yr	10yr	Present	5.63	389	6.94	6.60	897	High

Mid-Rockaway Hammels - Pump Alternative 2, Present Tides													
Subbasin H2, 180 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.74	227	2.75							2.74	227	Low
5 yr	Normal	Present	2.92	315	2.75							2.92	315	Low
10 yr	Normal	Present	3.19	389	2.75							3.19	389	Low
25 yr	Normal	Present	3.72	489	2.75							3.72	489	Low
50 yr	Normal	Present	4.21	565	2.75							4.21	565	Low
100 yr	Normal	Present	4.67	642	2.75							4.67	642	Low
250 yr	Normal	Present	5.27	790	2.75							5.27	790	Low
500 yr	Normal	Present	5.53	897	2.75							5.53	897	Low
2 yr	2 yr	Present	3.62	227	4.64	2 yr	2 yr	Present	3.62	227	4.64	3.62	227	Likely
5 yr	2 yr	Present	4.71	315	4.64	2 yr	5 yr	Present	3.67	227	5.84	4.71	315	Likely
10 yr	2 yr	Present	4.93	389	4.64	2 yr	10 yr	Present	3.72	227	6.94	4.93	389	Likely
25 yr	2 yr	Present	5.21	489	4.64	2 yr	10yr	Present	3.72	227	6.94	5.21	489	Likely
50 yr	2 yr	Present	5.40	565	4.64	2 yr	10yr	Present	3.72	227	6.94	5.40	565	Likely
100 yr	2 yr	Present	5.56	642	4.64	2 yr	10yr	Present	3.72	227	6.94	5.56	642	Likely
250 yr	2 yr	Present	5.80	790	4.64	2 yr	10yr	Present	3.72	227	6.94	5.80	790	Likely
500 yr	2 yr	Present	5.96	897	4.64	2 yr	10yr	Present	3.72	227	6.94	5.96	897	Likely
2 yr	2 yr	Present	3.62	227	4.64	2 yr	2 yr	Present	3.62	227	4.64	3.62	227	High
5 yr	5 yr	Present	5.20	315	5.84	5 yr	5 yr	Present	5.20	315	5.84	5.20	315	High
10 yr	10 yr	Present	5.54	389	6.94	10 yr	10 yr	Present	5.54	389	6.94	5.54	389	High
25 yr	10 yr	Present	5.82	489	6.94	10 yr	10yr	Present	5.54	389	6.94	5.82	489	High
50 yr	10 yr	Present	5.99	565	6.94	10 yr	10yr	Present	5.54	389	6.94	5.99	565	High
100 yr	10 yr	Present	6.15	642	6.94	10 yr	10yr	Present	5.54	389	6.94	6.15	642	High
250 yr	10 yr	Present	6.40	790	6.94	10 yr	10yr	Present	5.54	389	6.94	6.40	790	High
500 yr	10 yr	Present	6.55	897	6.94	10 yr	10yr	Present	5.54	389	6.94	6.55	897	High

Mid-Rockaway Hammels - Minimum Facility, Future Tides													
Subbasin H2 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	4.33	227	3.82							4.33	227	Low
5 yr	Normal	Future	4.75	315	3.82							4.75	315	Low
10 yr	Normal	Future	5.06	389	3.82							5.06	389	Low
25 yr	Normal	Future	5.37	489	3.82							5.37	489	Low
50 yr	Normal	Future	5.55	565	3.82							5.55	565	Low
100 yr	Normal	Future	5.70	642	3.82							5.70	642	Low
250 yr	Normal	Future	5.95	790	3.82							5.95	790	Low
500 yr	Normal	Future	6.10	897	3.82							6.10	897	Low
2 yr	2 yr	Future	5.78	227	5.71	2 yr	2 yr	Future	5.78	227	5.71	5.78	227	Likely
5 yr	2 yr	Future	5.95	315	5.71	2 yr	5 yr	Future	6.06	227	6.91	6.06	315	Likely
10 yr	2 yr	Future	6.06	389	5.71	2 yr	10 yr	Future	6.12	227	8.00	6.12	389	Likely
25 yr	2 yr	Future	6.21	489	5.71	2 yr	10yr	Future	6.12	227	8.00	6.21	489	Likely
50 yr	2 yr	Future	6.31	565	5.71	2 yr	10yr	Future	6.12	227	8.00	6.31	565	Likely
100 yr	2 yr	Future	6.41	642	5.71	2 yr	10yr	Future	6.12	227	8.00	6.41	642	Likely
250 yr	2 yr	Future	6.58	790	5.71	2 yr	10yr	Future	6.12	227	8.00	6.58	790	Likely
500 yr	2 yr	Future	6.68	897	5.71	2 yr	10yr	Future	6.12	227	8.00	6.68	897	Likely
2 yr	2 yr	Future	5.78	227	5.71	2yr	2 yr	Future	5.78	227	5.71	5.78	227	High
5 yr	5 yr	Future	6.28	315	6.91	5 yr	5 yr	Future	6.28	315	6.91	6.28	315	High
10 yr	10 yr	Future	6.52	389	8.00	10 yr	10 yr	Future	6.52	389	8.00	6.52	389	High
25 yr	10 yr	Future	6.71	489	8.00	10 yr	10yr	Future	6.52	389	8.00	6.71	489	High
50 yr	10 yr	Future	6.83	565	8.00	10 yr	10yr	Future	6.52	389	8.00	6.83	565	High
100 yr	10 yr	Future	6.95	642	8.00	10 yr	10yr	Future	6.52	389	8.00	6.95	642	High
250 yr	10 yr	Future	7.15	790	8.00	10 yr	10yr	Future	6.52	389	8.00	7.15	790	High
500 yr	10 yr	Future	7.29	897	8.00	10 yr	10yr	Future	6.52	389	8.00	7.29	897	High

Mid-Rockaway Hammels - Pump Alternative 1, Future Tides													
Subbasin H2, 160 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	3.80	227	3.82							3.80	227	Low
5 yr	Normal	Present	4.04	315	3.82							4.04	315	Low
10 yr	Normal	Present	4.32	389	3.82							4.32	389	Low
25 yr	Normal	Present	4.77	489	3.82							4.77	489	Low
50 yr	Normal	Present	5.08	565	3.82							5.08	565	Low
100 yr	Normal	Present	5.30	642	3.82							5.30	642	Low
250 yr	Normal	Present	5.62	790	3.82							5.62	790	Low
500 yr	Normal	Present	5.80	897	3.82							5.80	897	Low
2 yr	2 yr	Present	4.42	227	5.71	2 yr	2 yr	Present	4.42	227	5.71	4.42	227	Likely
5 yr	2 yr	Present	5.34	315	5.71	2 yr	5 yr	Present	4.34	227	6.91	5.34	315	Likely
10 yr	2 yr	Present	5.58	389	5.71	2 yr	10 yr	Present	4.34	227	8.00	5.58	389	Likely
25 yr	2 yr	Present	5.75	489	5.71	2 yr	10yr	Present	4.34	227	8.00	5.75	489	Likely
50 yr	2 yr	Present	5.86	565	5.71	2 yr	10yr	Present	4.34	227	8.00	5.86	565	Likely
100 yr	2 yr	Present	5.97	642	5.71	2 yr	10yr	Present	4.34	227	8.00	5.97	642	Likely
250 yr	2 yr	Present	6.16	790	5.71	2 yr	10yr	Present	4.34	227	8.00	6.16	790	Likely
500 yr	2 yr	Present	6.29	897	5.71	2 yr	10yr	Present	4.34	227	8.00	6.29	897	Likely
2 yr	2 yr	Present	4.42	227	5.71	2yr	2 yr	Present	4.42	227	5.71	4.42	227	High
5 yr	5 yr	Present	5.34	315	6.91	5 yr	5 yr	Present	5.34	315	6.91	5.34	315	High
10 yr	10 yr	Present	5.63	389	8.00	10 yr	10 yr	Present	5.63	389	8.00	5.63	389	High
25 yr	10 yr	Present	5.89	489	8.00	10 yr	10yr	Present	5.63	389	8.00	5.89	489	High
50 yr	10 yr	Present	6.05	565	8.00	10 yr	10yr	Present	5.63	389	8.00	6.05	565	High
100 yr	10 yr	Present	6.21	642	8.00	10 yr	10yr	Present	5.63	389	8.00	6.21	642	High
250 yr	10 yr	Present	6.45	790	8.00	10 yr	10yr	Present	5.63	389	8.00	6.45	790	High
500 yr	10 yr	Present	6.62	897	8.00	10 yr	10yr	Present	5.63	389	8.00	6.62	897	High

Mid-Rockaway Hammels - Pump Alternative 2, Future Tides													
Subbasin H2, 180 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.73	227	3.82							3.73	227	Low
5 yr	Normal	Future	3.97	315	3.82							3.97	315	Low
10 yr	Normal	Future	4.24	389	3.82							4.24	389	Low
25 yr	Normal	Future	4.68	489	3.82							4.68	489	Low
50 yr	Normal	Future	5.00	565	3.82							5.00	565	Low
100 yr	Normal	Future	5.24	642	3.82							5.24	642	Low
250 yr	Normal	Future	5.58	790	3.82							5.58	790	Low
500 yr	Normal	Future	5.76	897	3.82							5.76	897	Low
2 yr	2 yr	Future	3.68	227	5.71	2 yr	2 yr	Future	3.68	227	5.71	3.68	227	Likely
5 yr	2 yr	Future	5.19	315	5.71	2 yr	5 yr	Future	3.72	227	6.91	5.19	315	Likely
10 yr	2 yr	Future	5.53	389	5.71	2 yr	10 yr	Future	3.72	227	8.00	5.53	389	Likely
25 yr	2 yr	Future	5.71	489	5.71	2 yr	10yr	Future	3.72	227	8.00	5.71	489	Likely
50 yr	2 yr	Future	5.82	565	5.71	2 yr	10yr	Future	3.72	227	8.00	5.82	565	Likely
100 yr	2 yr	Future	5.93	642	5.71	2 yr	10yr	Future	3.72	227	8.00	5.93	642	Likely
250 yr	2 yr	Future	6.12	790	5.71	2 yr	10yr	Future	3.72	227	8.00	6.12	790	Likely
500 yr	2 yr	Future	6.26	897	5.71	2 yr	10yr	Future	3.72	227	8.00	6.26	897	Likely
2 yr	2 yr	Future	3.68	227	5.71	2 yr	2 yr	Future	3.68	227	5.71	3.68	227	High
5 yr	5 yr	Future	5.19	315	6.91	5 yr	5 yr	Future	5.19	315	6.91	5.19	315	High
10 yr	10 yr	Future	5.55	389	8.00	10 yr	10 yr	Future	5.55	389	8.00	5.55	389	High
25 yr	10 yr	Future	5.82	489	8.00	10 yr	10yr	Future	5.55	389	8.00	5.82	489	High
50 yr	10 yr	Future	5.99	565	8.00	10 yr	10yr	Future	5.55	389	8.00	5.99	565	High
100 yr	10 yr	Future	6.15	642	8.00	10 yr	10yr	Future	5.55	389	8.00	6.15	642	High
250 yr	10 yr	Future	6.40	790	8.00	10 yr	10yr	Future	5.55	389	8.00	6.40	790	High
500 yr	10 yr	Future	6.56	897	8.00	10 yr	10yr	Future	5.55	389	8.00	6.56	897	High

Mid-Rockaway Arverne - Minimum Facility, Present Tides													
Subbasin A1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.76	90	2.75							2.76	90	Low
5 yr	Normal	Present	2.76	123	2.75							2.76	123	Low
10 yr	Normal	Present	2.79	152	2.75							2.79	152	Low
25 yr	Normal	Present	2.85	190	2.75							2.85	190	Low
50 yr	Normal	Present	2.91	219	2.75							2.91	219	Low
100 yr	Normal	Present	2.98	248	2.75							2.98	248	Low
250 yr	Normal	Present	3.15	305	2.75							3.15	305	Low
500 yr	Normal	Present	3.29	346	2.75							3.29	346	Low
2 yr	2 yr	Present	4.48	90	4.64	2 yr	2 yr	Present	4.48	90	4.64	4.48	90	Likely
5 yr	2 yr	Present	4.57	123	4.64	2 yr	5 yr	Present	4.79	90	5.84	4.79	123	Likely
10 yr	2 yr	Present	4.62	152	4.64	2 yr	10 yr	Present	4.86	90	6.94	4.86	152	Likely
25 yr	2 yr	Present	4.68	190	4.64	2 yr	10yr	Present	4.86	90	6.94	4.86	190	Likely
50 yr	2 yr	Present	4.73	219	4.64	2 yr	10yr	Present	4.86	90	6.94	4.86	219	Likely
100 yr	2 yr	Present	4.78	248	4.64	2 yr	10yr	Present	4.86	90	6.94	4.86	248	Likely
250 yr	2 yr	Present	4.87	305	4.64	2 yr	10yr	Present	4.86	90	6.94	4.87	305	Likely
500 yr	2 yr	Present	4.94	346	4.64	2 yr	10yr	Present	4.86	90	6.94	4.94	346	Likely
2 yr	2 yr	Present	4.48	90	4.64	2yr	2 yr	Present	4.48	90	4.64	4.48	90	High
5 yr	5 yr	Present	4.99	123	5.84	5 yr	5 yr	Present	4.99	123	5.84	4.99	123	High
10 yr	10 yr	Present	5.24	152	6.94	10 yr	10 yr	Present	5.24	152	6.94	5.24	152	High
25 yr	10 yr	Present	5.41	190	6.94	10 yr	10yr	Present	5.24	152	6.94	5.41	190	High
50 yr	10 yr	Present	5.51	219	6.94	10 yr	10yr	Present	5.24	152	6.94	5.51	219	High
100 yr	10 yr	Present	5.61	248	6.94	10 yr	10yr	Present	5.24	152	6.94	5.61	248	High
250 yr	10 yr	Present	5.78	305	6.94	10 yr	10yr	Present	5.24	152	6.94	5.78	305	High
500 yr	10 yr	Present	5.89	346	6.94	10 yr	10yr	Present	5.24	152	6.94	5.89	346	High

Mid-Rockaway Arverne - Pump Alternative 1, Present Tides													
Subbasin A1, 70 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.66	90	2.75							2.66	90	Low
5 yr	Normal	Present	2.70	123	2.75							2.70	123	Low
10 yr	Normal	Present	2.74	152	2.75							2.74	152	Low
25 yr	Normal	Present	2.75	190	2.75							2.75	190	Low
50 yr	Normal	Present	2.78	219	2.75							2.78	219	Low
100 yr	Normal	Present	2.82	248	2.75							2.82	248	Low
250 yr	Normal	Present	2.94	305	2.75							2.94	305	Low
500 yr	Normal	Present	3.05	346	2.75							3.05	346	Low
2 yr	2 yr	Present	3.47	90	4.64	2 yr	2 yr	Present	3.47	90	4.64	3.47	90	Likely
5 yr	2 yr	Present	4.09	123	4.64	2 yr	5 yr	Present	3.45	90	5.84	4.09	123	Likely
10 yr	2 yr	Present	4.32	152	4.64	2 yr	10 yr	Present	3.46	90	6.94	4.32	152	Likely
25 yr	2 yr	Present	4.44	190	4.64	2 yr	10yr	Present	3.46	90	6.94	4.44	190	Likely
50 yr	2 yr	Present	4.51	219	4.64	2 yr	10yr	Present	3.46	90	6.94	4.51	219	Likely
100 yr	2 yr	Present	4.56	248	4.64	2 yr	10yr	Present	3.46	90	6.94	4.56	248	Likely
250 yr	2 yr	Present	4.66	305	4.64	2 yr	10yr	Present	3.46	90	6.94	4.66	305	Likely
500 yr	2 yr	Present	4.73	346	4.64	2 yr	10yr	Present	3.46	90	6.94	4.73	346	Likely
2 yr	2 yr	Present	3.47	90	4.64	2yr	2 yr	Present	3.47	90	4.64	3.47	90	High
5 yr	5 yr	Present	4.10	123	5.84	5 yr	5 yr	Present	4.10	123	5.84	4.10	123	High
10 yr	10 yr	Present	4.37	152	6.94	10 yr	10 yr	Present	4.37	152	6.94	4.37	152	High
25 yr	10 yr	Present	4.65	190	6.94	10 yr	10yr	Present	4.37	152	6.94	4.65	190	High
50 yr	10 yr	Present	4.82	219	6.94	10 yr	10yr	Present	4.37	152	6.94	4.82	219	High
100 yr	10 yr	Present	4.96	248	6.94	10 yr	10yr	Present	4.37	152	6.94	4.96	248	High
250 yr	10 yr	Present	5.21	305	6.94	10 yr	10yr	Present	4.37	152	6.94	5.21	305	High
500 yr	10 yr	Present	5.35	346	6.94	10 yr	10yr	Present	4.37	152	6.94	5.35	346	High

Mid-Rockaway Arverne - Minimum Facility, Future Tides													
Subbasin A1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.83	90	3.82							3.83	90	Low
5 yr	Normal	Future	3.83	123	3.82							3.83	123	Low
10 yr	Normal	Future	3.86	152	3.82							3.86	152	Low
25 yr	Normal	Future	3.91	190	3.82							3.91	190	Low
50 yr	Normal	Future	3.97	219	3.82							3.97	219	Low
100 yr	Normal	Future	4.03	248	3.82							4.03	248	Low
250 yr	Normal	Future	4.16	305	3.82							4.16	305	Low
500 yr	Normal	Future	4.26	346	3.82							4.26	346	Low
2 yr	2 yr	Future	4.78	90	5.71	2 yr	2 yr	Future	4.78	90	5.71	4.78	90	Likely
5 yr	2 yr	Future	4.98	123	5.71	2 yr	5 yr	Future	4.86	90	6.91	4.98	123	Likely
10 yr	2 yr	Future	5.10	152	5.71	2 yr	10 yr	Future	4.90	90	8.00	5.10	152	Likely
25 yr	2 yr	Future	5.23	190	5.71	2 yr	10yr	Future	4.90	90	8.00	5.23	190	Likely
50 yr	2 yr	Future	5.32	219	5.71	2 yr	10yr	Future	4.90	90	8.00	5.32	219	Likely
100 yr	2 yr	Future	5.39	248	5.71	2 yr	10yr	Future	4.90	90	8.00	5.39	248	Likely
250 yr	2 yr	Future	5.50	305	5.71	2 yr	10yr	Future	4.90	90	8.00	5.50	305	Likely
500 yr	2 yr	Future	5.58	346	5.71	2 yr	10yr	Future	4.90	90	8.00	5.58	346	Likely
2 yr	2 yr	Future	4.78	90	5.71	2yr	2 yr	Future	4.78	90	5.71	4.78	90	High
5 yr	5 yr	Future	5.08	123	6.91	5 yr	5 yr	Future	5.08	123	6.91	5.08	123	High
10 yr	10 yr	Future	5.28	152	8.00	10 yr	10 yr	Future	5.28	152	8.00	5.28	152	High
25 yr	10 yr	Future	5.47	190	8.00	10 yr	10yr	Future	5.28	152	8.00	5.47	190	High
50 yr	10 yr	Future	5.58	219	8.00	10 yr	10yr	Future	5.28	152	8.00	5.58	219	High
100 yr	10 yr	Future	5.68	248	8.00	10 yr	10yr	Future	5.28	152	8.00	5.68	248	High
250 yr	10 yr	Future	5.87	305	8.00	10 yr	10yr	Future	5.28	152	8.00	5.87	305	High
500 yr	10 yr	Future	5.99	346	8.00	10 yr	10yr	Future	5.28	152	8.00	5.99	346	High

Mid-Rockaway Arverne - Pump Alternative 1, Future Tides													
Subbasin A1, 70 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.48	90	3.82							3.48	90	Low
5 yr	Normal	Future	3.71	123	3.82							3.71	123	Low
10 yr	Normal	Future	3.76	152	3.82							3.76	152	Low
25 yr	Normal	Future	3.81	190	3.82							3.81	190	Low
50 yr	Normal	Future	3.84	219	3.82							3.84	219	Low
100 yr	Normal	Future	3.89	248	3.82							3.89	248	Low
250 yr	Normal	Future	3.99	305	3.82							3.99	305	Low
500 yr	Normal	Future	4.08	346	3.82							4.08	346	Low
2 yr	2 yr	Future	3.45	90	5.71	2 yr	2 yr	Future	3.45	90	5.71	3.45	90	Likely
5 yr	2 yr	Future	4.10	123	5.71	2 yr	5 yr	Future	3.46	90	6.91	4.10	123	Likely
10 yr	2 yr	Future	4.38	152	5.71	2 yr	10 yr	Future	3.46	90	8.00	4.38	152	Likely
25 yr	2 yr	Future	4.65	190	5.71	2 yr	10yr	Future	3.46	90	8.00	4.65	190	Likely
50 yr	2 yr	Future	4.82	219	5.71	2 yr	10yr	Future	3.46	90	8.00	4.82	219	Likely
100 yr	2 yr	Future	4.96	248	5.71	2 yr	10yr	Future	3.46	90	8.00	4.96	248	Likely
250 yr	2 yr	Future	5.16	305	5.71	2 yr	10yr	Future	3.46	90	8.00	5.16	305	Likely
500 yr	2 yr	Future	5.26	346	5.71	2 yr	10yr	Future	3.46	90	8.00	5.26	346	Likely
2 yr	2 yr	Future	3.45	90	5.71	2yr	2 yr	Future	3.45	90	5.71	3.45	90	High
5 yr	5 yr	Future	4.10	123	6.91	5 yr	5 yr	Future	4.10	123	6.91	4.10	123	High
10 yr	10 yr	Future	4.37	152	8.00	10 yr	10 yr	Future	4.37	152	8.00	4.37	152	High
25 yr	10 yr	Future	4.64	190	8.00	10 yr	10yr	Future	4.37	152	8.00	4.64	190	High
50 yr	10 yr	Future	4.82	219	8.00	10 yr	10yr	Future	4.37	152	8.00	4.82	219	High
100 yr	10 yr	Future	4.96	248	8.00	10 yr	10yr	Future	4.37	152	8.00	4.96	248	High
250 yr	10 yr	Future	5.21	305	8.00	10 yr	10yr	Future	4.37	152	8.00	5.21	305	High
500 yr	10 yr	Future	5.35	346	8.00	10 yr	10yr	Future	4.37	152	8.00	5.35	346	High

Mid-Rockaway Arverne - Minimum Facility, Present Tides													
Subbasin A2 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	3.53	171	2.75							3.53	171	Low
5 yr	Normal	Present	3.83	235	2.75							3.83	235	Low
10 yr	Normal	Present	4.03	289	2.75							4.03	289	Low
25 yr	Normal	Present	4.26	362	2.75							4.26	362	Low
50 yr	Normal	Present	4.41	418	2.75							4.41	418	Low
100 yr	Normal	Present	4.55	474	2.75							4.55	474	Low
250 yr	Normal	Present	4.78	582	2.75							4.78	582	Low
500 yr	Normal	Present	4.93	660	2.75							4.93	660	Low
2 yr	2 yr	Present	4.37	171	4.64	2 yr	2 yr	Present	4.37	171	4.64	4.37	171	Likely
5 yr	2 yr	Present	4.56	235	4.64	2 yr	5 yr	Present	4.53	171	5.84	4.56	235	Likely
10 yr	2 yr	Present	4.70	289	4.64	2 yr	10 yr	Present	4.59	171	6.94	4.70	289	Likely
25 yr	2 yr	Present	4.86	362	4.64	2 yr	10yr	Present	4.59	171	6.94	4.86	362	Likely
50 yr	2 yr	Present	4.97	418	4.64	2 yr	10yr	Present	4.59	171	6.94	4.97	418	Likely
100 yr	2 yr	Present	5.08	474	4.64	2 yr	10yr	Present	4.59	171	6.94	5.08	474	Likely
250 yr	2 yr	Present	5.27	582	4.64	2 yr	10yr	Present	4.59	171	6.94	5.27	582	Likely
500 yr	2 yr	Present	5.39	660	4.64	2 yr	10yr	Present	4.59	171	6.94	5.39	660	Likely
2 yr	2 yr	Present	4.37	171	4.64	2yr	2 yr	Present	4.37	171	4.64	4.37	171	High
5 yr	5 yr	Present	4.75	235	5.84	5 yr	5 yr	Present	4.75	235	5.84	4.75	235	High
10 yr	10 yr	Present	4.98	289	6.94	10 yr	10 yr	Present	4.98	289	6.94	4.98	289	High
25 yr	10 yr	Present	5.15	362	6.94	10 yr	10yr	Present	4.98	289	6.94	5.15	362	High
50 yr	10 yr	Present	5.27	418	6.94	10 yr	10yr	Present	4.98	289	6.94	5.27	418	High
100 yr	10 yr	Present	5.38	474	6.94	10 yr	10yr	Present	4.98	289	6.94	5.38	474	High
250 yr	10 yr	Present	5.58	582	6.94	10 yr	10yr	Present	4.98	289	6.94	5.58	582	High
500 yr	10 yr	Present	5.70	660	6.94	10 yr	10yr	Present	4.98	289	6.94	5.70	660	High

Mid-Rockaway Arverne - Pump Alternative 1, Present Tides													
Subbasin A2, 120 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.73	171	2.75							2.73	171	Low
5 yr	Normal	Present	3.13	235	2.75							3.13	235	Low
10 yr	Normal	Present	3.47	289	2.75							3.47	289	Low
25 yr	Normal	Present	3.79	362	2.75							3.79	362	Low
50 yr	Normal	Present	3.98	418	2.75							3.98	418	Low
100 yr	Normal	Present	4.15	474	2.75							4.15	474	Low
250 yr	Normal	Present	4.43	582	2.75							4.43	582	Low
500 yr	Normal	Present	4.60	660	2.75							4.60	660	Low
2 yr	2 yr	Present	3.50	171	4.64	2 yr	2 yr	Present	3.50	171	4.64	3.50	171	Likely
5 yr	2 yr	Present	3.94	235	4.64	2 yr	5 yr	Present	3.50	171	5.84	3.94	235	Likely
10 yr	2 yr	Present	4.16	289	4.64	2 yr	10 yr	Present	3.50	171	6.94	4.16	289	Likely
25 yr	2 yr	Present	4.36	362	4.64	2 yr	10yr	Present	3.50	171	6.94	4.36	362	Likely
50 yr	2 yr	Present	4.49	418	4.64	2 yr	10yr	Present	3.50	171	6.94	4.49	418	Likely
100 yr	2 yr	Present	4.60	474	4.64	2 yr	10yr	Present	3.50	171	6.94	4.60	474	Likely
250 yr	2 yr	Present	4.80	582	4.64	2 yr	10yr	Present	3.50	171	6.94	4.80	582	Likely
500 yr	2 yr	Present	4.93	660	4.64	2 yr	10yr	Present	3.50	171	6.94	4.93	660	Likely
2 yr	2 yr	Present	3.50	171	4.64	2yr	2 yr	Present	3.50	171	4.64	3.50	171	High
5 yr	5 yr	Present	3.94	235	5.84	5 yr	5 yr	Present	3.94	235	5.84	3.94	235	High
10 yr	10 yr	Present	4.18	289	6.94	10 yr	10 yr	Present	4.18	289	6.94	4.18	289	High
25 yr	10 yr	Present	4.44	362	6.94	10 yr	10yr	Present	4.18	289	6.94	4.44	362	High
50 yr	10 yr	Present	4.60	418	6.94	10 yr	10yr	Present	4.18	289	6.94	4.60	418	High
100 yr	10 yr	Present	4.75	474	6.94	10 yr	10yr	Present	4.18	289	6.94	4.75	474	High
250 yr	10 yr	Present	4.99	582	6.94	10 yr	10yr	Present	4.18	289	6.94	4.99	582	High
500 yr	10 yr	Present	5.14	660	6.94	10 yr	10yr	Present	4.18	289	6.94	5.14	660	High

Mid-Rockaway Arverne - Pump Alternative 2, Present Tides													
Subbasin A2, 180 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.04	171	2.75							2.04	171	Low
5 yr	Normal	Present	2.74	235	2.75							2.74	235	Low
10 yr	Normal	Present	3.07	289	2.75							3.07	289	Low
25 yr	Normal	Present	3.52	362	2.75							3.52	362	Low
50 yr	Normal	Present	3.75	418	2.75							3.75	418	Low
100 yr	Normal	Present	3.94	474	2.75							3.94	474	Low
250 yr	Normal	Present	4.25	582	2.75							4.25	582	Low
500 yr	Normal	Present	4.44	660	2.75							4.44	660	Low
2 yr	2 yr	Present	2.07	171	4.64	2 yr	2 yr	Present	2.07	171	4.64	2.07	171	Likely
5 yr	2 yr	Present	3.47	235	4.64	2 yr	5 yr	Present	2.06	171	5.84	3.47	235	Likely
10 yr	2 yr	Present	3.84	289	4.64	2 yr	10 yr	Present	2.04	171	6.94	3.84	289	Likely
25 yr	2 yr	Present	4.15	362	4.64	2 yr	10yr	Present	2.04	171	6.94	4.15	362	Likely
50 yr	2 yr	Present	4.31	418	4.64	2 yr	10yr	Present	2.04	171	6.94	4.31	418	Likely
100 yr	2 yr	Present	4.43	474	4.64	2 yr	10yr	Present	2.04	171	6.94	4.43	474	Likely
250 yr	2 yr	Present	4.65	582	4.64	2 yr	10yr	Present	2.04	171	6.94	4.65	582	Likely
500 yr	2 yr	Present	4.79	660	4.64	2 yr	10yr	Present	2.04	171	6.94	4.79	660	Likely
2 yr	2 yr	Present	2.07	171	4.64	2yr	2 yr	Present	2.07	171	4.64	2.07	171	High
5 yr	5 yr	Present	3.47	235	5.84	5 yr	5 yr	Present	3.47	235	5.84	3.47	235	High
10 yr	10 yr	Present	3.84	289	6.94	10 yr	10 yr	Present	3.84	289	6.94	3.84	289	High
25 yr	10 yr	Present	4.16	362	6.94	10 yr	10yr	Present	3.84	289	6.94	4.16	362	High
50 yr	10 yr	Present	4.35	418	6.94	10 yr	10yr	Present	3.84	289	6.94	4.35	418	High
100 yr	10 yr	Present	4.51	474	6.94	10 yr	10yr	Present	3.84	289	6.94	4.51	474	High
250 yr	10 yr	Present	4.78	582	6.94	10 yr	10yr	Present	3.84	289	6.94	4.78	582	High
500 yr	10 yr	Present	4.94	660	6.94	10 yr	10yr	Present	3.84	289	6.94	4.94	660	High

Mid-Rockaway Arverne - Minimum Facility, Future Tides													
Subbasin A2 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	4.11	171	3.82							4.11	171	Low
5 yr	Normal	Future	4.31	235	3.82							4.31	235	Low
10 yr	Normal	Future	4.45	289	3.82							4.45	289	Low
25 yr	Normal	Future	4.62	362	3.82							4.62	362	Low
50 yr	Normal	Future	4.73	418	3.82							4.73	418	Low
100 yr	Normal	Future	4.84	474	3.82							4.84	474	Low
250 yr	Normal	Future	5.04	582	3.82							5.04	582	Low
500 yr	Normal	Future	5.16	660	3.82							5.16	660	Low
2 yr	2 yr	Future	4.53	171	5.71	2 yr	2 yr	Future	4.53	171	5.71	4.53	171	Likely
5 yr	2 yr	Future	4.74	235	5.71	2 yr	5 yr	Future	4.59	171	6.91	4.74	235	Likely
10 yr	2 yr	Future	4.87	289	5.71	2 yr	10 yr	Future	4.63	171	8.00	4.87	289	Likely
25 yr	2 yr	Future	5.05	362	5.71	2 yr	10yr	Future	4.63	171	8.00	5.05	362	Likely
50 yr	2 yr	Future	5.15	418	5.71	2 yr	10yr	Future	4.63	171	8.00	5.15	418	Likely
100 yr	2 yr	Future	5.25	474	5.71	2 yr	10yr	Future	4.63	171	8.00	5.25	474	Likely
250 yr	2 yr	Future	5.44	582	5.71	2 yr	10yr	Future	4.63	171	8.00	5.44	582	Likely
500 yr	2 yr	Future	5.56	660	5.71	2 yr	10yr	Future	4.63	171	8.00	5.56	660	Likely
2 yr	2 yr	Future	4.53	171	5.71	2yr	2 yr	Future	4.53	171	5.71	4.53	171	High
5 yr	5 yr	Future	4.82	235	6.91	5 yr	5 yr	Future	4.82	235	6.91	4.82	235	High
10 yr	10 yr	Future	5.03	289	8.00	10 yr	10 yr	Future	5.03	289	8.00	5.03	289	High
25 yr	10 yr	Future	5.21	362	8.00	10 yr	10yr	Future	5.03	289	8.00	5.21	362	High
50 yr	10 yr	Future	5.34	418	8.00	10 yr	10yr	Future	5.03	289	8.00	5.34	418	High
100 yr	10 yr	Future	5.45	474	8.00	10 yr	10yr	Future	5.03	289	8.00	5.45	474	High
250 yr	10 yr	Future	5.65	582	8.00	10 yr	10yr	Future	5.03	289	8.00	5.65	582	High
500 yr	10 yr	Future	5.78	660	8.00	10 yr	10yr	Future	5.03	289	8.00	5.78	660	High

Mid-Rockaway Arverne - Pump Alternative 1, Future Tides													
Subbasin A2, 120 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.48	171	3.82							3.48	171	Low
5 yr	Normal	Future	3.76	235	3.82							3.76	235	Low
10 yr	Normal	Future	3.93	289	3.82							3.93	289	Low
25 yr	Normal	Future	4.15	362	3.82							4.15	362	Low
50 yr	Normal	Future	4.29	418	3.82							4.29	418	Low
100 yr	Normal	Future	4.42	474	3.82							4.42	474	Low
250 yr	Normal	Future	4.64	582	3.82							4.64	582	Low
500 yr	Normal	Future	4.79	660	3.82							4.79	660	Low
2 yr	2 yr	Future	3.50	171	5.71	2 yr	2 yr	Future	3.50	171	5.71	3.50	171	Likely
5 yr	2 yr	Future	3.94	235	5.71	2 yr	5 yr	Future	3.50	171	6.91	3.94	235	Likely
10 yr	2 yr	Future	4.18	289	5.71	2 yr	10 yr	Future	3.50	171	8.00	4.18	289	Likely
25 yr	2 yr	Future	4.44	362	5.71	2 yr	10yr	Future	3.50	171	8.00	4.44	362	Likely
50 yr	2 yr	Future	4.60	418	5.71	2 yr	10yr	Future	3.50	171	8.00	4.60	418	Likely
100 yr	2 yr	Future	4.75	474	5.71	2 yr	10yr	Future	3.50	171	8.00	4.75	474	Likely
250 yr	2 yr	Future	4.96	582	5.71	2 yr	10yr	Future	3.50	171	8.00	4.96	582	Likely
500 yr	2 yr	Future	5.09	660	5.71	2 yr	10yr	Future	3.50	171	8.00	5.09	660	Likely
2 yr	2 yr	Future	3.50	171	5.71	2yr	2 yr	Future	3.50	171	5.71	3.50	171	High
5 yr	5 yr	Future	3.93	235	6.91	5 yr	5 yr	Future	3.93	235	6.91	3.93	235	High
10 yr	10 yr	Future	4.18	289	8.00	10 yr	10 yr	Future	4.18	289	8.00	4.18	289	High
25 yr	10 yr	Future	4.44	362	8.00	10 yr	10yr	Future	4.18	289	8.00	4.44	362	High
50 yr	10 yr	Future	4.60	418	8.00	10 yr	10yr	Future	4.18	289	8.00	4.60	418	High
100 yr	10 yr	Future	4.75	474	8.00	10 yr	10yr	Future	4.18	289	8.00	4.75	474	High
250 yr	10 yr	Future	4.99	582	8.00	10 yr	10yr	Future	4.18	289	8.00	4.99	582	High
500 yr	10 yr	Future	5.14	660	8.00	10 yr	10yr	Future	4.18	289	8.00	5.14	660	High

Mid-Rockaway Arverne - Pump Alternative 2, Future Tides													
Subbasin A2, 180 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	2.00	171	3.82							2.00	171	Low
5 yr	Normal	Future	3.47	235	3.82							3.47	235	Low
10 yr	Normal	Future	3.71	289	3.82							3.71	289	Low
25 yr	Normal	Future	3.94	362	3.82							3.94	362	Low
50 yr	Normal	Future	4.09	418	3.82							4.09	418	Low
100 yr	Normal	Future	4.24	474	3.82							4.24	474	Low
250 yr	Normal	Future	4.49	582	3.82							4.49	582	Low
500 yr	Normal	Future	4.79	660	3.82							4.79	660	Low
2 yr	2 yr	Future	2.00	171	5.71	2 yr	2 yr	Future	2.00	171	5.71	2.00	171	Likely
5 yr	2 yr	Future	3.47	235	5.71	2 yr	5 yr	Future	2.04	171	6.91	3.47	235	Likely
10 yr	2 yr	Future	3.84	289	5.71	2 yr	10 yr	Future	2.04	171	8.00	3.84	289	Likely
25 yr	2 yr	Future	4.16	362	5.71	2 yr	10yr	Future	2.04	171	8.00	4.16	362	Likely
50 yr	2 yr	Future	4.35	418	5.71	2 yr	10yr	Future	2.04	171	8.00	4.35	418	Likely
100 yr	2 yr	Future	4.51	474	5.71	2 yr	10yr	Future	2.04	171	8.00	4.51	474	Likely
250 yr	2 yr	Future	4.78	582	5.71	2 yr	10yr	Future	2.04	171	8.00	4.78	582	Likely
500 yr	2 yr	Future	4.93	660	5.71	2 yr	10yr	Future	2.04	171	8.00	4.93	660	Likely
2 yr	2 yr	Future	2.00	171	5.71	2yr	2 yr	Future	2.00	171	5.71	2.00	171	High
5 yr	5 yr	Future	3.47	235	6.91	5 yr	5 yr	Future	3.47	235	6.91	3.47	235	High
10 yr	10 yr	Future	3.84	289	8.00	10 yr	10 yr	Future	3.84	289	8.00	3.84	289	High
25 yr	10 yr	Future	4.16	362	8.00	10 yr	10yr	Future	3.84	289	8.00	4.16	362	High
50 yr	10 yr	Future	4.35	418	8.00	10 yr	10yr	Future	3.84	289	8.00	4.35	418	High
100 yr	10 yr	Future	4.51	474	8.00	10 yr	10yr	Future	3.84	289	8.00	4.51	474	High
250 yr	10 yr	Future	4.78	582	8.00	10 yr	10yr	Future	3.84	289	8.00	4.78	582	High
500 yr	10 yr	Future	4.94	660	8.00	10 yr	10yr	Future	3.84	289	8.00	4.94	660	High

Mid-Rockaway Arverne - Minimum Facility, Present Tides													
Subbasin A3 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	3.05	278	2.75							3.05	278	Low
5 yr	Normal	Present	3.41	387	2.75							3.41	387	Low
10 yr	Normal	Present	3.76	478	2.75							3.76	478	Low
25 yr	Normal	Present	4.27	601	2.75							4.27	601	Low
50 yr	Normal	Present	4.63	695	2.75							4.63	695	Low
100 yr	Normal	Present	4.92	789	2.75							4.92	789	Low
250 yr	Normal	Present	5.39	972	2.75							5.39	972	Low
500 yr	Normal	Present	5.64	1104	2.75							5.64	1104	Low
2 yr	2 yr	Present	4.87	278	4.64	2 yr	2 yr	Present	4.87	278	4.64	4.87	278	Likely
5 yr	2 yr	Present	5.09	387	4.64	2 yr	5 yr	Present	5.71	278	5.84	5.71	387	Likely
10 yr	2 yr	Present	5.27	478	4.64	2 yr	10 yr	Present	5.99	278	6.94	5.99	478	Likely
25 yr	2 yr	Present	5.51	601	4.64	2 yr	10yr	Present	5.99	278	6.94	5.99	601	Likely
50 yr	2 yr	Present	5.66	695	4.64	2 yr	10yr	Present	5.99	278	6.94	5.99	695	Likely
100 yr	2 yr	Present	5.81	789	4.64	2 yr	10yr	Present	5.99	278	6.94	5.99	789	Likely
250 yr	2 yr	Present	6.05	972	4.64	2 yr	10yr	Present	5.99	278	6.94	6.05	972	Likely
500 yr	2 yr	Present	6.21	1104	4.64	2 yr	10yr	Present	5.99	278	6.94	6.21	1104	Likely
2 yr	2 yr	Present	4.87	278	4.64	2yr	2 yr	Present	4.87	278	4.64	4.87	278	High
5 yr	5 yr	Present	5.90	387	5.84	5 yr	5 yr	Present	5.90	387	5.84	5.90	387	High
10 yr	10 yr	Present	6.37	478	6.94	10 yr	10 yr	Present	6.37	478	6.94	6.37	478	High
25 yr	10 yr	Present	6.55	601	6.94	10 yr	10yr	Present	6.37	478	6.94	6.55	601	High
50 yr	10 yr	Present	6.67	695	6.94	10 yr	10yr	Present	6.37	478	6.94	6.67	695	High
100 yr	10 yr	Present	6.78	789	6.94	10 yr	10yr	Present	6.37	478	6.94	6.78	789	High
250 yr	10 yr	Present	6.99	972	6.94	10 yr	10yr	Present	6.37	478	6.94	6.99	972	High
500 yr	10 yr	Present	7.12	1104	6.94	10 yr	10yr	Present	6.37	478	6.94	7.12	1104	High

Mid-Rockaway Arverne - Pump Alternative 1, Present Tides													
Subbasin A3, 200 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.71	278	2.75							2.71	278	Low
5 yr	Normal	Present	2.84	387	2.75							2.84	387	Low
10 yr	Normal	Present	3.05	478	2.75							3.05	478	Low
25 yr	Normal	Present	3.46	601	2.75							3.46	601	Low
50 yr	Normal	Present	3.81	695	2.75							3.81	695	Low
100 yr	Normal	Present	4.19	789	2.75							4.19	789	Low
250 yr	Normal	Present	4.83	972	2.75							4.83	972	Low
500 yr	Normal	Present	5.19	1104	2.75							5.19	1104	Low
2 yr	2 yr	Present	4.34	278	4.64	2 yr	2 yr	Present	4.34	278	4.64	4.34	278	Likely
5 yr	2 yr	Present	4.64	387	4.64	2 yr	5 yr	Present	4.32	278	5.84	4.64	387	Likely
10 yr	2 yr	Present	4.80	478	4.64	2 yr	10 yr	Present	4.31	278	6.94	4.80	478	Likely
25 yr	2 yr	Present	5.04	601	4.64	2 yr	10yr	Present	4.31	278	6.94	5.04	601	Likely
50 yr	2 yr	Present	5.23	695	4.64	2 yr	10yr	Present	4.31	278	6.94	5.23	695	Likely
100 yr	2 yr	Present	5.40	789	4.64	2 yr	10yr	Present	4.31	278	6.94	5.40	789	Likely
250 yr	2 yr	Present	5.70	972	4.64	2 yr	10yr	Present	4.31	278	6.94	5.70	972	Likely
500 yr	2 yr	Present	5.89	1104	4.64	2 yr	10yr	Present	4.31	278	6.94	5.89	1104	Likely
2 yr	2 yr	Present	4.34	278	4.64	2yr	2 yr	Present	4.34	278	4.64	4.34	278	High
5 yr	5 yr	Present	5.15	387	5.84	5 yr	5 yr	Present	5.15	387	5.84	5.15	387	High
10 yr	10 yr	Present	5.52	478	6.94	10 yr	10 yr	Present	5.52	478	6.94	5.52	478	High
25 yr	10 yr	Present	5.86	601	6.94	10 yr	10yr	Present	5.52	478	6.94	5.86	601	High
50 yr	10 yr	Present	6.06	695	6.94	10 yr	10yr	Present	5.52	478	6.94	6.06	695	High
100 yr	10 yr	Present	6.22	789	6.94	10 yr	10yr	Present	5.52	478	6.94	6.22	789	High
250 yr	10 yr	Present	6.47	972	6.94	10 yr	10yr	Present	5.52	478	6.94	6.47	972	High
500 yr	10 yr	Present	6.60	1104	6.94	10 yr	10yr	Present	5.52	478	6.94	6.60	1104	High

Mid-Rockaway Arverne - Pump Alternative 2, Present Tides													
Subbasin A3, 300 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.71	278	2.75							2.71	278	Low
5 yr	Normal	Present	2.84	387	2.75							2.84	387	Low
10 yr	Normal	Present	3.01	478	2.75							3.01	478	Low
25 yr	Normal	Present	3.11	601	2.75							3.11	601	Low
50 yr	Normal	Present	3.43	695	2.75							3.43	695	Low
100 yr	Normal	Present	3.78	789	2.75							3.78	789	Low
250 yr	Normal	Present	4.48	972	2.75							4.48	972	Low
500 yr	Normal	Present	4.90	1104	2.75							4.90	1104	Low
2 yr	2 yr	Present	3.07	278	4.64	2 yr	2 yr	Present	3.07	278	4.64	3.07	278	Likely
5 yr	2 yr	Present	4.39	387	4.64	2 yr	5 yr	Present	3.10	278	5.84	4.39	387	Likely
10 yr	2 yr	Present	4.62	478	4.64	2 yr	10 yr	Present	3.05	278	6.94	4.62	478	Likely
25 yr	2 yr	Present	4.83	601	4.64	2 yr	10yr	Present	3.05	278	6.94	4.83	601	Likely
50 yr	2 yr	Present	5.02	695	4.64	2 yr	10yr	Present	3.05	278	6.94	5.02	695	Likely
100 yr	2 yr	Present	5.20	789	4.64	2 yr	10yr	Present	3.05	278	6.94	5.20	789	Likely
250 yr	2 yr	Present	5.53	972	4.64	2 yr	10yr	Present	3.05	278	6.94	5.53	972	Likely
500 yr	2 yr	Present	5.72	1104	4.64	2 yr	10yr	Present	3.05	278	6.94	5.72	1104	Likely
2 yr	2 yr	Present	3.07	278	4.64	2yr	2 yr	Present	3.07	278	4.64	3.07	278	High
5 yr	5 yr	Present	4.39	387	5.84	5 yr	5 yr	Present	4.39	387	5.84	4.39	387	High
10 yr	10 yr	Present	5.02	478	6.94	10 yr	10 yr	Present	5.02	478	6.94	5.02	478	High
25 yr	10 yr	Present	5.52	601	6.94	10 yr	10yr	Present	5.02	478	6.94	5.52	601	High
50 yr	10 yr	Present	5.77	695	6.94	10 yr	10yr	Present	5.02	478	6.94	5.77	695	High
100 yr	10 yr	Present	5.97	789	6.94	10 yr	10yr	Present	5.02	478	6.94	5.97	789	High
250 yr	10 yr	Present	6.28	972	6.94	10 yr	10yr	Present	5.02	478	6.94	6.28	972	High
500 yr	10 yr	Present	6.46	1104	6.94	10 yr	10yr	Present	5.02	478	6.94	6.46	1104	High

Mid-Rockaway Arverne - Minimum Facility, Future Tides													
Subbasin A3 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	4.10	278	3.82							4.10	278	Low
5 yr	Normal	Future	4.39	387	3.82							4.39	387	Low
10 yr	Normal	Future	4.66	478	3.82							4.66	478	Low
25 yr	Normal	Future	4.99	601	3.82							4.99	601	Low
50 yr	Normal	Future	5.23	695	3.82							5.23	695	Low
100 yr	Normal	Future	5.43	789	3.82							5.43	789	Low
250 yr	Normal	Future	5.75	972	3.82							5.75	972	Low
500 yr	Normal	Future	5.95	1104	3.82							5.95	1104	Low
2 yr	2 yr	Future	5.66	278	5.71	2 yr	2 yr	Future	5.66	278	5.71	5.66	278	Likely
5 yr	2 yr	Future	5.84	387	5.71	2 yr	5 yr	Future	5.99	278	6.91	5.99	387	Likely
10 yr	2 yr	Future	5.97	478	5.71	2 yr	10 yr	Future	6.06	278	8.00	6.06	478	Likely
25 yr	2 yr	Future	6.14	601	5.71	2 yr	10yr	Future	6.06	278	8.00	6.14	601	Likely
50 yr	2 yr	Future	6.25	695	5.71	2 yr	10yr	Future	6.06	278	8.00	6.25	695	Likely
100 yr	2 yr	Future	6.36	789	5.71	2 yr	10yr	Future	6.06	278	8.00	6.36	789	Likely
250 yr	2 yr	Future	6.55	972	5.71	2 yr	10yr	Future	6.06	278	8.00	6.55	972	Likely
500 yr	2 yr	Future	6.68	1104	5.71	2 yr	10yr	Future	6.06	278	8.00	6.68	1104	Likely
2 yr	2 yr	Future	5.66	278	5.71	2yr	2 yr	Future	5.66	278	5.71	5.66	278	High
5 yr	5 yr	Future	6.22	387	6.91	5 yr	5 yr	Future	6.22	387	6.91	6.22	387	High
10 yr	10 yr	Future	6.50	478	8.00	10 yr	10 yr	Future	6.50	478	8.00	6.50	478	High
25 yr	10 yr	Future	6.72	601	8.00	10 yr	10yr	Future	6.50	478	8.00	6.72	601	High
50 yr	10 yr	Future	6.86	695	8.00	10 yr	10yr	Future	6.50	478	8.00	6.86	695	High
100 yr	10 yr	Future	7.00	789	8.00	10 yr	10yr	Future	6.50	478	8.00	7.00	789	High
250 yr	10 yr	Future	7.22	972	8.00	10 yr	10yr	Future	6.50	478	8.00	7.22	972	High
500 yr	10 yr	Future	7.37	1104	8.00	10 yr	10yr	Future	6.50	478	8.00	7.37	1104	High

Mid-Rockaway Arverne - Pump Alternative 1, Future Tides													
Subbasin A3, 200 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.75	278	3.82							3.75	278	Low
5 yr	Normal	Future	3.90	387	3.82							3.90	387	Low
10 yr	Normal	Future	4.09	478	3.82							4.09	478	Low
25 yr	Normal	Future	4.41	601	3.82							4.41	601	Low
50 yr	Normal	Future	4.68	695	3.82							4.68	695	Low
100 yr	Normal	Future	4.92	789	3.82							4.92	789	Low
250 yr	Normal	Future	5.34	972	3.82							5.34	972	Low
500 yr	Normal	Future	5.58	1104	3.82							5.58	1104	Low
2 yr	2 yr	Future	4.31	278	5.71	2 yr	2 yr	Future	4.31	278	5.71	4.31	278	Likely
5 yr	2 yr	Future	5.15	387	5.71	2 yr	5 yr	Future	4.31	278	6.91	5.15	387	Likely
10 yr	2 yr	Future	5.45	478	5.71	2 yr	10 yr	Future	4.31	278	8.00	5.45	478	Likely
25 yr	2 yr	Future	5.65	601	5.71	2 yr	10yr	Future	4.31	278	8.00	5.65	601	Likely
50 yr	2 yr	Future	5.77	695	5.71	2 yr	10yr	Future	4.31	278	8.00	5.77	695	Likely
100 yr	2 yr	Future	5.89	789	5.71	2 yr	10yr	Future	4.31	278	8.00	5.89	789	Likely
250 yr	2 yr	Future	6.11	972	5.71	2 yr	10yr	Future	4.31	278	8.00	6.11	972	Likely
500 yr	2 yr	Future	6.25	1104	5.71	2 yr	10yr	Future	4.31	278	8.00	6.25	1104	Likely
2 yr	2 yr	Future	4.31	278	5.71	2yr	2 yr	Future	4.31	278	5.71	4.31	278	High
5 yr	5 yr	Future	5.14	387	6.91	5 yr	5 yr	Future	5.14	387	6.91	5.14	387	High
10 yr	10 yr	Future	5.52	478	8.00	10 yr	10 yr	Future	5.52	478	8.00	5.52	478	High
25 yr	10 yr	Future	5.86	601	8.00	10 yr	10yr	Future	5.52	478	8.00	5.86	601	High
50 yr	10 yr	Future	6.06	695	8.00	10 yr	10yr	Future	5.52	478	8.00	6.06	695	High
100 yr	10 yr	Future	6.22	789	8.00	10 yr	10yr	Future	5.52	478	8.00	6.22	789	High
250 yr	10 yr	Future	6.52	972	8.00	10 yr	10yr	Future	5.52	478	8.00	6.52	972	High
500 yr	10 yr	Future	6.71	1104	8.00	10 yr	10yr	Future	5.52	478	8.00	6.71	1104	High

Mid-Rockaway Arverne - Pump Alternative 2, Future Tides													
Subbasin A3, 300 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.02	278	3.82							3.02	278	Low
5 yr	Normal	Future	3.77	387	3.82							3.77	387	Low
10 yr	Normal	Future	3.88	478	3.82							3.88	478	Low
25 yr	Normal	Future	4.14	601	3.82							4.14	601	Low
50 yr	Normal	Future	4.39	695	3.82							4.39	695	Low
100 yr	Normal	Future	4.65	789	3.82							4.65	789	Low
250 yr	Normal	Future	5.11	972	3.82							5.11	972	Low
500 yr	Normal	Future	5.58	1104	3.82							5.58	1104	Low
2 yr	2 yr	Future	3.02	278	5.71	2 yr	2 yr	Future	3.02	278	5.71	3.02	278	Likely
5 yr	2 yr	Future	4.39	387	5.71	2 yr	5 yr	Future	3.05	278	6.91	4.39	387	Likely
10 yr	2 yr	Future	5.02	478	5.71	2 yr	10 yr	Future	3.05	278	8.00	5.02	478	Likely
25 yr	2 yr	Future	5.47	601	5.71	2 yr	10yr	Future	3.05	278	8.00	5.47	601	Likely
50 yr	2 yr	Future	5.61	695	5.71	2 yr	10yr	Future	3.05	278	8.00	5.61	695	Likely
100 yr	2 yr	Future	5.74	789	5.71	2 yr	10yr	Future	3.05	278	8.00	5.74	789	Likely
250 yr	2 yr	Future	5.97	972	5.71	2 yr	10yr	Future	3.05	278	8.00	5.97	972	Likely
500 yr	2 yr	Future	6.11	1104	5.71	2 yr	10yr	Future	3.05	278	8.00	6.11	1104	Likely
2 yr	2 yr	Future	3.02	278	5.71	2yr	2 yr	Future	3.02	278	5.71	3.02	278	High
5 yr	5 yr	Future	4.39	387	6.91	5 yr	5 yr	Future	4.39	387	6.91	4.39	387	High
10 yr	10 yr	Future	5.02	478	8.00	10 yr	10 yr	Future	5.02	478	8.00	5.02	478	High
25 yr	10 yr	Future	5.52	601	8.00	10 yr	10yr	Future	5.02	478	8.00	5.52	601	High
50 yr	10 yr	Future	5.77	695	8.00	10 yr	10yr	Future	5.02	478	8.00	5.77	695	High
100 yr	10 yr	Future	5.97	789	8.00	10 yr	10yr	Future	5.02	478	8.00	5.97	789	High
250 yr	10 yr	Future	6.28	972	8.00	10 yr	10yr	Future	5.02	478	8.00	6.28	972	High
500 yr	10 yr	Future	6.48	1104	8.00	10 yr	10yr	Future	5.02	478	8.00	6.48	1104	High

Mid-Rockaway Edgemere - Minimum Facility, Present Tides													
Subbasin E1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.75	195	2.75							2.75	195	Low
5 yr	Normal	Present	2.76	277	2.75							2.76	277	Low
10 yr	Normal	Present	2.77	346	2.75							2.77	346	Low
25 yr	Normal	Present	2.83	439	2.75							2.83	439	Low
50 yr	Normal	Present	2.89	511	2.75							2.89	511	Low
100 yr	Normal	Present	2.97	582	2.75							2.97	582	Low
250 yr	Normal	Present	3.18	721	2.75							3.18	721	Low
500 yr	Normal	Present	3.35	822	2.75							3.35	822	Low
2 yr	2 yr	Present	4.63	195	4.64	2 yr	2 yr	Present	4.63	195	4.64	4.63	195	Likely
5 yr	2 yr	Present	4.65	277	4.64	2 yr	5 yr	Present	5.18	195	5.84	5.18	277	Likely
10 yr	2 yr	Present	4.65	346	4.64	2 yr	10 yr	Present	5.29	195	6.94	5.29	346	Likely
25 yr	2 yr	Present	4.70	439	4.64	2 yr	10yr	Present	5.29	195	6.94	5.29	439	Likely
50 yr	2 yr	Present	4.75	511	4.64	2 yr	10yr	Present	5.29	195	6.94	5.29	511	Likely
100 yr	2 yr	Present	4.81	582	4.64	2 yr	10yr	Present	5.29	195	6.94	5.29	582	Likely
250 yr	2 yr	Present	4.94	721	4.64	2 yr	10yr	Present	5.29	195	6.94	5.29	721	Likely
500 yr	2 yr	Present	5.03	822	4.64	2 yr	10yr	Present	5.29	195	6.94	5.29	822	Likely
2 yr	2 yr	Present	4.63	195	4.64	2 yr	2 yr	Present	4.63	195	4.64	4.63	195	High
5 yr	5 yr	Present	5.33	277	5.84	5 yr	5 yr	Present	5.33	277	5.84	5.33	277	High
10 yr	10 yr	Present	5.59	346	6.94	10 yr	10 yr	Present	5.59	346	6.94	5.59	346	High
25 yr	10 yr	Present	5.73	439	6.94	10 yr	10yr	Present	5.59	346	6.94	5.73	439	High
50 yr	10 yr	Present	5.82	511	6.94	10 yr	10yr	Present	5.59	346	6.94	5.82	511	High
100 yr	10 yr	Present	5.90	582	6.94	10 yr	10yr	Present	5.59	346	6.94	5.90	582	High
250 yr	10 yr	Present	6.05	721	6.94	10 yr	10yr	Present	5.59	346	6.94	6.05	721	High
500 yr	10 yr	Present	6.15	822	6.94	10 yr	10yr	Present	5.59	346	6.94	6.15	822	High

Mid-Rockaway Edgemere - Pump Alternative 1, Present Tides													
Subbasin E1, 140 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.65	195	2.75							2.65	195	Low
5 yr	Normal	Present	2.70	277	2.75							2.70	277	Low
10 yr	Normal	Present	2.73	346	2.75							2.73	346	Low
25 yr	Normal	Present	2.74	439	2.75							2.74	439	Low
50 yr	Normal	Present	2.77	511	2.75							2.77	511	Low
100 yr	Normal	Present	2.82	582	2.75							2.82	582	Low
250 yr	Normal	Present	2.97	721	2.75							2.97	721	Low
500 yr	Normal	Present	3.11	822	2.75							3.11	822	Low
2 yr	2 yr	Present	4.36	195	4.64	2 yr	2 yr	Present	4.36	195	4.64	4.36	195	Likely
5 yr	2 yr	Present	4.49	277	4.64	2 yr	5 yr	Present	4.48	195	5.84	4.49	277	Likely
10 yr	2 yr	Present	4.55	346	4.64	2 yr	10 yr	Present	4.48	195	6.94	4.55	346	Likely
25 yr	2 yr	Present	4.60	439	4.64	2 yr	10yr	Present	4.48	195	6.94	4.60	439	Likely
50 yr	2 yr	Present	4.64	511	4.64	2 yr	10yr	Present	4.48	195	6.94	4.64	511	Likely
100 yr	2 yr	Present	4.69	582	4.64	2 yr	10yr	Present	4.48	195	6.94	4.69	582	Likely
250 yr	2 yr	Present	4.80	721	4.64	2 yr	10yr	Present	4.48	195	6.94	4.80	721	Likely
500 yr	2 yr	Present	4.89	822	4.64	2 yr	10yr	Present	4.48	195	6.94	4.89	822	Likely
2 yr	2 yr	Present	4.36	195	4.64	2 yr	2 yr	Present	4.36	195	4.64	4.36	195	High
5 yr	5 yr	Present	4.88	277	5.84	5 yr	5 yr	Present	4.88	277	5.84	4.88	277	High
10 yr	10 yr	Present	5.07	346	6.94	10 yr	10 yr	Present	5.07	346	6.94	5.07	346	High
25 yr	10 yr	Present	5.28	439	6.94	10 yr	10yr	Present	5.07	346	6.94	5.28	439	High
50 yr	10 yr	Present	5.41	511	6.94	10 yr	10yr	Present	5.07	346	6.94	5.41	511	High
100 yr	10 yr	Present	5.53	582	6.94	10 yr	10yr	Present	5.07	346	6.94	5.53	582	High
250 yr	10 yr	Present	5.72	721	6.94	10 yr	10yr	Present	5.07	346	6.94	5.72	721	High
500 yr	10 yr	Present	5.83	822	6.94	10 yr	10yr	Present	5.07	346	6.94	5.83	822	High

Mid-Rockaway Edgemere - Pump Alternative 2, Present Tides													
Subbasin E1, 210 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.65	195	2.75							2.65	195	Low
5 yr	Normal	Present	2.70	277	2.75							2.70	277	Low
10 yr	Normal	Present	2.73	346	2.75							2.73	346	Low
25 yr	Normal	Present	2.74	439	2.75							2.74	439	Low
50 yr	Normal	Present	2.77	511	2.75							2.77	511	Low
100 yr	Normal	Present	2.82	582	2.75							2.82	582	Low
250 yr	Normal	Present	2.97	721	2.75							2.97	721	Low
500 yr	Normal	Present	3.01	822	2.75							3.01	822	Low
2 yr	2 yr	Present	3.10	195	4.64	2 yr	2 yr	Present	3.10	195	4.64	3.10	195	Likely
5 yr	2 yr	Present	4.39	277	4.64	2 yr	5 yr	Present	3.04	195	5.84	4.39	277	Likely
10 yr	2 yr	Present	4.49	346	4.64	2 yr	10 yr	Present	3.04	195	6.94	4.49	346	Likely
25 yr	2 yr	Present	4.56	439	4.64	2 yr	10yr	Present	3.04	195	6.94	4.56	439	Likely
50 yr	2 yr	Present	4.59	511	4.64	2 yr	10yr	Present	3.04	195	6.94	4.59	511	Likely
100 yr	2 yr	Present	4.64	582	4.64	2 yr	10yr	Present	3.04	195	6.94	4.64	582	Likely
250 yr	2 yr	Present	4.74	721	4.64	2 yr	10yr	Present	3.04	195	6.94	4.74	721	Likely
500 yr	2 yr	Present	4.82	822	4.64	2 yr	10yr	Present	3.04	195	6.94	4.82	822	Likely
2 yr	2 yr	Present	3.10	195	4.64	2 yr	2 yr	Present	3.10	195	4.64	3.10	195	High
5 yr	5 yr	Present	4.54	277	5.84	5 yr	5 yr	Present	4.54	277	5.84	4.54	277	High
10 yr	10 yr	Present	4.83	346	6.94	10 yr	10 yr	Present	4.83	346	6.94	4.83	346	High
25 yr	10 yr	Present	5.08	439	6.94	10 yr	10yr	Present	4.83	346	6.94	5.08	439	High
50 yr	10 yr	Present	5.22	511	6.94	10 yr	10yr	Present	4.83	346	6.94	5.22	511	High
100 yr	10 yr	Present	5.36	582	6.94	10 yr	10yr	Present	4.83	346	6.94	5.36	582	High
250 yr	10 yr	Present	5.58	721	6.94	10 yr	10yr	Present	4.83	346	6.94	5.58	721	High
500 yr	10 yr	Present	5.71	822	6.94	10 yr	10yr	Present	4.83	346	6.94	5.71	822	High

Mid-Rockaway Edgemere - Minimum Facility, Future Tides													
Subbasin E1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.82	195	3.82							3.82	195	Low
5 yr	Normal	Future	3.83	277	3.82							3.83	277	Low
10 yr	Normal	Future	3.84	346	3.82							3.84	346	Low
25 yr	Normal	Future	3.90	439	3.82							3.90	439	Low
50 yr	Normal	Future	3.97	511	3.82							3.97	511	Low
100 yr	Normal	Future	4.05	582	3.82							4.05	582	Low
250 yr	Normal	Future	4.24	721	3.82							4.24	721	Low
500 yr	Normal	Future	4.39	822	3.82							4.39	822	Low
2 yr	2 yr	Future	5.16	195	5.71	2 yr	2 yr	Future	5.16	195	5.71	5.16	195	Likely
5 yr	2 yr	Future	5.29	277	5.71	2 yr	5 yr	Future	5.29	195	6.91	5.29	277	Likely
10 yr	2 yr	Future	5.37	346	5.71	2 yr	10 yr	Future	5.33	195	8.00	5.37	346	Likely
25 yr	2 yr	Future	5.46	439	5.71	2 yr	10yr	Future	5.33	195	8.00	5.46	439	Likely
50 yr	2 yr	Future	5.53	511	5.71	2 yr	10yr	Future	5.33	195	8.00	5.53	511	Likely
100 yr	2 yr	Future	5.59	582	5.71	2 yr	10yr	Future	5.33	195	8.00	5.59	582	Likely
250 yr	2 yr	Future	5.69	721	5.71	2 yr	10yr	Future	5.33	195	8.00	5.69	721	Likely
500 yr	2 yr	Future	5.76	822	5.71	2 yr	10yr	Future	5.33	195	8.00	5.76	822	Likely
2 yr	2 yr	Future	5.16	195	5.71	2 yr	2 yr	Future	5.16	195	5.71	5.16	195	High
5 yr	5 yr	Future	5.47	277	6.91	5 yr	5 yr	Future	5.47	277	6.91	5.47	277	High
10 yr	10 yr	Future	5.65	346	8.00	10 yr	10 yr	Future	5.65	346	8.00	5.65	346	High
25 yr	10 yr	Future	5.80	439	8.00	10 yr	10yr	Future	5.65	346	8.00	5.80	439	High
50 yr	10 yr	Future	5.90	511	8.00	10 yr	10yr	Future	5.65	346	8.00	5.90	511	High
100 yr	10 yr	Future	6.00	582	8.00	10 yr	10yr	Future	5.65	346	8.00	6.00	582	High
250 yr	10 yr	Future	6.18	721	8.00	10 yr	10yr	Future	5.65	346	8.00	6.18	721	High
500 yr	10 yr	Future	6.29	822	8.00	10 yr	10yr	Future	5.65	346	8.00	6.29	822	High

Mid-Rockaway Edgemere - Pump Alternative 1, Future Tides													
Subbasin E1, 140 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.69	195	3.82							3.69	195	Low
5 yr	Normal	Future	3.76	277	3.82							3.76	277	Low
10 yr	Normal	Future	3.79	346	3.82							3.79	346	Low
25 yr	Normal	Future	3.81	439	3.82							3.81	439	Low
50 yr	Normal	Future	3.84	511	3.82							3.84	511	Low
100 yr	Normal	Future	3.89	582	3.82							3.89	582	Low
250 yr	Normal	Future	4.04	721	3.82							4.04	721	Low
500 yr	Normal	Future	4.18	822	3.82							4.18	822	Low
2 yr	2 yr	Future	4.48	195	5.71	2 yr	2 yr	Future	4.48	195	5.71	4.48	195	Likely
5 yr	2 yr	Future	4.88	277	5.71	2 yr	5 yr	Future	4.48	195	6.91	4.88	277	Likely
10 yr	2 yr	Future	5.05	346	5.71	2 yr	10 yr	Future	4.48	195	8.00	5.05	346	Likely
25 yr	2 yr	Future	5.20	439	5.71	2 yr	10yr	Future	4.48	195	8.00	5.20	439	Likely
50 yr	2 yr	Future	5.28	511	5.71	2 yr	10yr	Future	4.48	195	8.00	5.28	511	Likely
100 yr	2 yr	Future	5.35	582	5.71	2 yr	10yr	Future	4.48	195	8.00	5.35	582	Likely
250 yr	2 yr	Future	5.46	721	5.71	2 yr	10yr	Future	4.48	195	8.00	5.46	721	Likely
500 yr	2 yr	Future	5.54	822	5.71	2 yr	10yr	Future	4.48	195	8.00	5.54	822	Likely
2 yr	2 yr	Future	4.48	195	5.71	2 yr	2 yr	Future	4.48	195	5.71	4.48	195	High
5 yr	5 yr	Future	4.87	277	6.91	5 yr	5 yr	Future	4.87	277	6.91	4.87	277	High
10 yr	10 yr	Future	5.07	346	8.00	10 yr	10 yr	Future	5.07	346	8.00	5.07	346	High
25 yr	10 yr	Future	5.28	439	8.00	10 yr	10yr	Future	5.07	346	8.00	5.28	439	High
50 yr	10 yr	Future	5.41	511	8.00	10 yr	10yr	Future	5.07	346	8.00	5.41	511	High
100 yr	10 yr	Future	5.53	582	8.00	10 yr	10yr	Future	5.07	346	8.00	5.53	582	High
250 yr	10 yr	Future	5.74	721	8.00	10 yr	10yr	Future	5.07	346	8.00	5.74	721	High
500 yr	10 yr	Future	5.87	822	8.00	10 yr	10yr	Future	5.07	346	8.00	5.87	822	High

Mid-Rockaway Edgemere - Pump Alternative 2, Future Tides													
Subbasin E1, 210 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	2.95	248	3.82							2.95	248	Low
5 yr	Normal	Future	3.72	360	3.82							3.72	360	Low
10 yr	Normal	Future	3.76	454	3.82							3.76	454	Low
25 yr	Normal	Future	3.78	584	3.82							3.78	584	Low
50 yr	Normal	Future	3.80	682	3.82							3.80	682	Low
100 yr	Normal	Future	3.83	782	3.82							3.83	782	Low
250 yr	Normal	Future	3.96	974	3.82							3.96	974	Low
500 yr	Normal	Future	4.08	1113	3.82							4.08	1113	Low
2 yr	2 yr	Future	3.04	248	5.71	2 yr	2 yr	Future	3.04	248	5.71	3.04	248	Likely
5 yr	2 yr	Future	4.54	360	5.71	2 yr	5 yr	Future	3.04	248	6.91	4.54	360	Likely
10 yr	2 yr	Future	4.83	454	5.71	2 yr	10 yr	Future	3.04	248	8.00	4.83	454	Likely
25 yr	2 yr	Future	5.07	584	5.71	2 yr	10yr	Future	3.04	248	8.00	5.07	584	Likely
50 yr	2 yr	Future	5.18	682	5.71	2 yr	10yr	Future	3.04	248	8.00	5.18	682	Likely
100 yr	2 yr	Future	5.27	782	5.71	2 yr	10yr	Future	3.04	248	8.00	5.27	782	Likely
250 yr	2 yr	Future	5.40	974	5.71	2 yr	10yr	Future	3.04	248	8.00	5.40	974	Likely
500 yr	2 yr	Future	5.47	1113	5.71	2 yr	10yr	Future	3.04	248	8.00	5.47	1113	Likely
2 yr	2 yr	Future	3.04	248	5.71	2 yr	2 yr	Future	3.04	248	5.71	3.04	248	High
5 yr	5 yr	Future	4.54	360	6.91	5 yr	5 yr	Future	4.54	360	6.91	4.54	360	High
10 yr	10 yr	Future	4.83	454	8.00	10 yr	10 yr	Future	4.83	454	8.00	4.83	454	High
25 yr	10 yr	Future	5.08	584	8.00	10 yr	10yr	Future	4.83	454	8.00	5.08	584	High
50 yr	10 yr	Future	5.22	682	8.00	10 yr	10yr	Future	4.83	454	8.00	5.22	682	High
100 yr	10 yr	Future	5.36	782	8.00	10 yr	10yr	Future	4.83	454	8.00	5.36	782	High
250 yr	10 yr	Future	5.58	974	8.00	10 yr	10yr	Future	4.83	454	8.00	5.58	974	High
500 yr	10 yr	Future	5.72	1113	8.00	10 yr	10yr	Future	4.83	454	8.00	5.72	1113	High

Mid-Rockaway Edgemere - Minimum Facility, Present Tides													
Subbasin E2 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.76	248	2.75							2.76	248	Low
5 yr	Normal	Present	2.76	360	2.75							2.76	360	Low
10 yr	Normal	Present	2.82	454	2.75							2.82	454	Low
25 yr	Normal	Present	2.97	584	2.75							2.97	584	Low
50 yr	Normal	Present	3.12	682	2.75							3.12	682	Low
100 yr	Normal	Present	3.28	782	2.75							3.28	782	Low
250 yr	Normal	Present	3.68	974	2.75							3.68	974	Low
500 yr	Normal	Present	4.01	1113	2.75							4.01	1113	Low
2 yr	2 yr	Present	4.61	248	4.64	2 yr	2 yr	Present	4.61	248	4.64	4.61	248	Likely
5 yr	2 yr	Present	4.65	360	4.64	2 yr	5 yr	Present	5.36	248	5.84	5.36	360	Likely
10 yr	2 yr	Present	4.70	454	4.64	2 yr	10 yr	Present	5.57	248	6.94	5.57	454	Likely
25 yr	2 yr	Present	4.83	584	4.64	2 yr	10yr	Present	5.57	248	6.94	5.57	584	Likely
50 yr	2 yr	Present	4.93	682	4.64	2 yr	10yr	Present	5.57	248	6.94	5.57	682	Likely
100 yr	2 yr	Present	5.04	782	4.64	2 yr	10yr	Present	5.57	248	6.94	5.57	782	Likely
250 yr	2 yr	Present	5.26	974	4.64	2 yr	10yr	Present	5.57	248	6.94	5.57	974	Likely
500 yr	2 yr	Present	5.41	1113	4.64	2 yr	10yr	Present	5.57	248	6.94	5.57	1113	Likely
2 yr	2 yr	Present	4.61	248	4.64	2 yr	2 yr	Present	4.61	248	4.64	4.61	248	High
5 yr	5 yr	Present	5.53	360	5.84	5 yr	5 yr	Present	5.53	360	5.84	5.53	360	High
10 yr	10 yr	Present	5.96	454	6.94	10 yr	10 yr	Present	5.96	454	6.94	5.96	454	High
25 yr	10 yr	Present	6.14	584	6.94	10 yr	10yr	Present	5.96	454	6.94	6.14	584	High
50 yr	10 yr	Present	6.25	682	6.94	10 yr	10yr	Present	5.96	454	6.94	6.25	682	High
100 yr	10 yr	Present	6.35	782	6.94	10 yr	10yr	Present	5.96	454	6.94	6.35	782	High
250 yr	10 yr	Present	6.52	974	6.94	10 yr	10yr	Present	5.96	454	6.94	6.52	974	High
500 yr	10 yr	Present	6.63	1113	6.94	10 yr	10yr	Present	5.96	454	6.94	6.63	1113	High

Mid-Rockaway Edgemere - Pump Alternative 1, Present Tides													
Subbasin E2, 180 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.58	248	2.75							2.58	248	Low
5 yr	Normal	Present	2.68	360	2.75							2.68	360	Low
10 yr	Normal	Present	2.71	454	2.75							2.71	454	Low
25 yr	Normal	Present	2.77	584	2.75							2.77	584	Low
50 yr	Normal	Present	2.87	682	2.75							2.87	682	Low
100 yr	Normal	Present	2.99	782	2.75							2.99	782	Low
250 yr	Normal	Present	3.30	974	2.75							3.30	974	Low
500 yr	Normal	Present	3.58	1113	2.75							3.58	1113	Low
2 yr	2 yr	Present	4.04	248	4.64	2 yr	2 yr	Present	4.04	248	4.64	4.04	248	Likely
5 yr	2 yr	Present	4.43	360	4.64	2 yr	5 yr	Present	4.04	248	5.84	4.43	360	Likely
10 yr	2 yr	Present	4.53	454	4.64	2 yr	10 yr	Present	4.04	248	6.94	4.53	454	Likely
25 yr	2 yr	Present	4.64	584	4.64	2 yr	10yr	Present	4.04	248	6.94	4.64	584	Likely
50 yr	2 yr	Present	4.73	682	4.64	2 yr	10yr	Present	4.04	248	6.94	4.73	682	Likely
100 yr	2 yr	Present	4.83	782	4.64	2 yr	10yr	Present	4.04	248	6.94	4.83	782	Likely
250 yr	2 yr	Present	5.04	974	4.64	2 yr	10yr	Present	4.04	248	6.94	5.04	974	Likely
500 yr	2 yr	Present	5.20	1113	4.64	2 yr	10yr	Present	4.04	248	6.94	5.20	1113	Likely
2 yr	2 yr	Present	4.04	248	4.64	2 yr	2 yr	Present	4.04	248	4.64	4.04	248	High
5 yr	5 yr	Present	5.01	360	5.84	5 yr	5 yr	Present	5.01	360	5.84	5.01	360	High
10 yr	10 yr	Present	5.35	454	6.94	10 yr	10 yr	Present	5.35	454	6.94	5.35	454	High
25 yr	10 yr	Present	5.66	584	6.94	10 yr	10yr	Present	5.35	454	6.94	5.66	584	High
50 yr	10 yr	Present	5.83	682	6.94	10 yr	10yr	Present	5.35	454	6.94	5.83	682	High
100 yr	10 yr	Present	5.95	782	6.94	10 yr	10yr	Present	5.35	454	6.94	5.95	782	High
250 yr	10 yr	Present	6.17	974	6.94	10 yr	10yr	Present	5.35	454	6.94	6.17	974	High
500 yr	10 yr	Present	6.29	1113	6.94	10 yr	10yr	Present	5.35	454	6.94	6.29	1113	High

Mid-Rockaway Edgemere - Pump Alternative 2, Present Tides													
Subbasin E2, 120 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.66	248	2.75							2.66	248	Low
5 yr	Normal	Present	2.72	360	2.75							2.72	360	Low
10 yr	Normal	Present	2.74	454	2.75							2.74	454	Low
25 yr	Normal	Present	2.83	584	2.75							2.83	584	Low
50 yr	Normal	Present	2.94	682	2.75							2.94	682	Low
100 yr	Normal	Present	3.08	782	2.75							3.08	782	Low
250 yr	Normal	Present	3.42	974	2.75							3.42	974	Low
500 yr	Normal	Present	3.72	1113	2.75							3.72	1113	Low
2 yr	2 yr	Present	4.37	248	4.64	2 yr	2 yr	Present	4.37	248	4.64	4.37	248	Likely
5 yr	2 yr	Present	4.51	360	4.64	2 yr	5 yr	Present	4.83	248	5.84	4.83	360	Likely
10 yr	2 yr	Present	4.59	454	4.64	2 yr	10 yr	Present	4.83	248	6.94	4.83	454	Likely
25 yr	2 yr	Present	4.70	584	4.64	2 yr	10yr	Present	4.83	248	6.94	4.83	584	Likely
50 yr	2 yr	Present	4.79	682	4.64	2 yr	10yr	Present	4.83	248	6.94	4.83	682	Likely
100 yr	2 yr	Present	4.90	782	4.64	2 yr	10yr	Present	4.83	248	6.94	4.90	782	Likely
250 yr	2 yr	Present	5.11	974	4.64	2 yr	10yr	Present	4.83	248	6.94	5.11	974	Likely
500 yr	2 yr	Present	5.27	1113	4.64	2 yr	10yr	Present	4.83	248	6.94	5.27	1113	Likely
2 yr	2 yr	Present	4.37	248	4.64	2 yr	2 yr	Present	4.37	248	4.64	4.37	248	High
5 yr	5 yr	Present	5.22	360	5.84	5 yr	5 yr	Present	5.22	360	5.84	5.22	360	High
10 yr	10 yr	Present	5.58	454	6.94	10 yr	10 yr	Present	5.58	454	6.94	5.58	454	High
25 yr	10 yr	Present	5.81	584	6.94	10 yr	10yr	Present	5.58	454	6.94	5.81	584	High
50 yr	10 yr	Present	5.94	682	6.94	10 yr	10yr	Present	5.58	454	6.94	5.94	682	High
100 yr	10 yr	Present	6.07	782	6.94	10 yr	10yr	Present	5.58	454	6.94	6.07	782	High
250 yr	10 yr	Present	6.26	974	6.94	10 yr	10yr	Present	5.58	454	6.94	6.26	974	High
500 yr	10 yr	Present	6.39	1113	6.94	10 yr	10yr	Present	5.58	454	6.94	6.39	1113	High

Mid-Rockaway Edgemere - Minimum Facility, Future Tides													
Subbasin E2 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.82	248	3.82							3.82	248	Low
5 yr	Normal	Future	3.83	360	3.82							3.83	360	Low
10 yr	Normal	Future	3.90	454	3.82							3.90	454	Low
25 yr	Normal	Future	4.04	584	3.82							4.04	584	Low
50 yr	Normal	Future	4.18	682	3.82							4.18	682	Low
100 yr	Normal	Future	4.33	782	3.82							4.33	782	Low
250 yr	Normal	Future	4.66	974	3.82							4.66	974	Low
500 yr	Normal	Future	4.88	1113	3.82							4.88	1113	Low
2 yr	2 yr	Future	5.31	248	5.71	2 yr	2 yr	Future	5.31	248	5.71	5.31	248	Likely
5 yr	2 yr	Future	5.47	360	5.71	2 yr	5 yr	Future	5.56	248	6.91	5.56	360	Likely
10 yr	2 yr	Future	5.58	454	5.71	2 yr	10 yr	Future	5.64	248	8.00	5.64	454	Likely
25 yr	2 yr	Future	5.70	584	5.71	2 yr	10yr	Future	5.64	248	8.00	5.70	584	Likely
50 yr	2 yr	Future	5.79	682	5.71	2 yr	10yr	Future	5.64	248	8.00	5.79	682	Likely
100 yr	2 yr	Future	5.86	782	5.71	2 yr	10yr	Future	5.64	248	8.00	5.86	782	Likely
250 yr	2 yr	Future	6.02	974	5.71	2 yr	10yr	Future	5.64	248	8.00	6.02	974	Likely
500 yr	2 yr	Future	6.13	1113	5.71	2 yr	10yr	Future	5.64	248	8.00	6.13	1113	Likely
2 yr	2 yr	Future	5.31	248	5.71	2 yr	2 yr	Future	5.31	248	5.71	5.31	248	High
5 yr	5 yr	Future	5.80	360	6.91	5 yr	5 yr	Future	5.80	360	6.91	5.80	360	High
10 yr	10 yr	Future	6.07	454	8.00	10 yr	10 yr	Future	6.07	454	8.00	6.07	454	High
25 yr	10 yr	Future	6.28	584	8.00	10 yr	10yr	Future	6.07	454	8.00	6.28	584	High
50 yr	10 yr	Future	6.41	682	8.00	10 yr	10yr	Future	6.07	454	8.00	6.41	682	High
100 yr	10 yr	Future	6.54	782	8.00	10 yr	10yr	Future	6.07	454	8.00	6.54	782	High
250 yr	10 yr	Future	6.76	974	8.00	10 yr	10yr	Future	6.07	454	8.00	6.76	974	High
500 yr	10 yr	Future	6.89	1113	8.00	10 yr	10yr	Future	6.07	454	8.00	6.77	1113	High

Mid-Rockaway Edgemere - Pump Alternative 1, Future Tides													
Subbasin E2, 180 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.54	248	3.82							3.54	248	Low
5 yr	Normal	Future	3.71	360	3.82							3.71	360	Low
10 yr	Normal	Future	3.77	454	3.82							3.77	454	Low
25 yr	Normal	Future	3.85	584	3.82							3.85	584	Low
50 yr	Normal	Future	3.94	682	3.82							3.94	682	Low
100 yr	Normal	Future	4.06	782	3.82							4.06	782	Low
250 yr	Normal	Future	4.35	974	3.82							4.35	974	Low
500 yr	Normal	Future	4.58	1113	3.82							4.58	1113	Low
2 yr	2 yr	Future	4.04	248	5.71	2 yr	2 yr	Future	4.04	248	5.71	4.04	248	Likely
5 yr	2 yr	Future	5.00	360	5.71	2 yr	5 yr	Future	4.04	248	6.91	5.00	360	Likely
10 yr	2 yr	Future	5.22	454	5.71	2 yr	10 yr	Future	4.04	248	8.00	5.22	454	Likely
25 yr	2 yr	Future	5.39	584	5.71	2 yr	10yr	Future	4.04	248	8.00	5.39	584	Likely
50 yr	2 yr	Future	5.48	682	5.71	2 yr	10yr	Future	4.04	248	8.00	5.48	682	Likely
100 yr	2 yr	Future	5.57	782	5.71	2 yr	10yr	Future	4.04	248	8.00	5.57	782	Likely
250 yr	2 yr	Future	5.73	974	5.71	2 yr	10yr	Future	4.04	248	8.00	5.73	974	Likely
500 yr	2 yr	Future	5.83	1113	5.71	2 yr	10yr	Future	4.04	248	8.00	5.83	1113	Likely
2 yr	2 yr	Future	4.04	248	5.71	2 yr	2 yr	Future	4.04	248	5.71	4.04	248	High
5 yr	5 yr	Future	5.01	360	6.91	5 yr	5 yr	Future	5.01	360	6.91	5.01	360	High
10 yr	10 yr	Future	5.35	454	8.00	10 yr	10 yr	Future	5.35	454	8.00	5.35	454	High
25 yr	10 yr	Future	5.66	584	8.00	10 yr	10yr	Future	5.35	454	8.00	5.66	584	High
50 yr	10 yr	Future	5.84	682	8.00	10 yr	10yr	Future	5.35	454	8.00	5.84	682	High
100 yr	10 yr	Future	6.00	782	8.00	10 yr	10yr	Future	5.35	454	8.00	6.00	782	High
250 yr	10 yr	Future	6.28	974	8.00	10 yr	10yr	Future	5.35	454	8.00	6.28	974	High
500 yr	10 yr	Future	6.45	1113	8.00	10 yr	10yr	Future	5.35	454	8.00	6.45	1113	High

Mid-Rockaway Edgemere - Pump Alternative 2, Future Tides													
Subbasin E2, 120 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.68	248	3.82							3.68	248	Low
5 yr	Normal	Future	3.76	360	3.82							3.76	360	Low
10 yr	Normal	Future	3.81	454	3.82							3.81	454	Low
25 yr	Normal	Future	3.90	584	3.82							3.90	584	Low
50 yr	Normal	Future	4.01	682	3.82							4.01	682	Low
100 yr	Normal	Future	4.14	782	3.82							4.14	782	Low
250 yr	Normal	Future	4.45	974	3.82							4.45	974	Low
500 yr	Normal	Future	4.68	1113	3.82							4.68	1113	Low
2 yr	2 yr	Future	4.83	248	5.71	2 yr	2 yr	Future	4.83	248	5.71	4.83	248	Likely
5 yr	2 yr	Future	5.19	360	5.71	2 yr	5 yr	Future	4.83	248	6.91	5.19	360	Likely
10 yr	2 yr	Future	5.33	454	5.71	2 yr	10 yr	Future	4.83	248	8.00	5.33	454	Likely
25 yr	2 yr	Future	5.47	584	5.71	2 yr	10yr	Future	4.83	248	8.00	5.47	584	Likely
50 yr	2 yr	Future	5.55	682	5.71	2 yr	10yr	Future	4.83	248	8.00	5.55	682	Likely
100 yr	2 yr	Future	5.64	782	5.71	2 yr	10yr	Future	4.83	248	8.00	5.64	782	Likely
250 yr	2 yr	Future	5.80	974	5.71	2 yr	10yr	Future	4.83	248	8.00	5.80	974	Likely
500 yr	2 yr	Future	5.91	1113	5.71	2 yr	10yr	Future	4.83	248	8.00	5.91	1113	Likely
2 yr	2 yr	Future	4.83	248	5.71	2 yr	2 yr	Future	4.83	248	5.71	4.83	248	High
5 yr	5 yr	Future	5.32	360	6.91	5 yr	5 yr	Future	5.32	360	6.91	5.32	360	High
10 yr	10 yr	Future	5.59	454	8.00	10 yr	10 yr	Future	5.59	454	8.00	5.59	454	High
25 yr	10 yr	Future	5.84	584	8.00	10 yr	10yr	Future	5.59	454	8.00	5.84	584	High
50 yr	10 yr	Future	6.02	682	8.00	10 yr	10yr	Future	5.59	454	8.00	6.02	682	High
100 yr	10 yr	Future	6.17	782	8.00	10 yr	10yr	Future	5.59	454	8.00	6.17	782	High
250 yr	10 yr	Future	6.42	974	8.00	10 yr	10yr	Future	5.59	454	8.00	6.42	974	High
500 yr	10 yr	Future	6.58	1113	8.00	10 yr	10yr	Future	5.59	454	8.00	6.58	1113	High

Canarsie - Minimum Facility, Present Tides													
Subbasin C1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.88	165	2.75							2.88	165	Low
5 yr	Normal	Present	3.10	227	2.75							3.10	227	Low
10 yr	Normal	Present	3.32	279	2.75							3.32	279	Low
25 yr	Normal	Present	3.62	348	2.75							3.62	348	Low
50 yr	Normal	Present	4.08	401	2.75							4.08	401	Low
100 yr	Normal	Present	4.49	455	2.75							4.49	455	Low
250 yr	Normal	Present	5.18	559	2.75							5.18	559	Low
500 yr	Normal	Present	5.63	634	2.75							5.63	634	Low
2 yr	2 yr	Present	4.77	165	4.64	2 yr	2 yr	Present	4.77	165	4.64	4.77	165	Likely
5 yr	2 yr	Present	4.95	227	4.64	2 yr	5 yr	Present	5.96	165	5.84	5.96	227	Likely
10 yr	2 yr	Present	5.12	279	4.64	2 yr	10 yr	Present	6.88	165	6.94	6.88	279	Likely
25 yr	2 yr	Present	5.39	348	4.64	2 yr	10yr	Present	6.88	165	6.94	6.88	348	Likely
50 yr	2 yr	Present	5.61	401	4.64	2 yr	10yr	Present	6.88	165	6.94	6.88	401	Likely
100 yr	2 yr	Present	5.84	455	4.64	2 yr	10yr	Present	6.88	165	6.94	6.88	455	Likely
250 yr	2 yr	Present	6.30	559	4.64	2 yr	10yr	Present	6.88	165	6.94	6.88	559	Likely
500 yr	2 yr	Present	6.59	634	4.64	2 yr	10yr	Present	6.88	165	6.94	6.88	634	Likely
2 yr	2 yr	Present	4.77	165	4.64	2 yr	2 yr	Present	4.77	165	4.64	4.77	165	High
5 yr	5 yr	Present	6.11	227	5.84	5 yr	5 yr	Present	6.11	227	5.84	6.11	227	High
10 yr	10 yr	Present	7.21	279	6.94	10 yr	10 yr	Present	7.21	279	6.94	7.21	279	High
25 yr	10 yr	Present	7.38	348	6.94	10 yr	10yr	Present	7.21	279	6.94	7.38	348	High
50 yr	10 yr	Present	7.50	401	6.94	10 yr	10yr	Present	7.21	279	6.94	7.50	401	High
100 yr	10 yr	Present	7.63	455	6.94	10 yr	10yr	Present	7.21	279	6.94	7.63	455	High
250 yr	10 yr	Present	7.85	559	6.94	10 yr	10yr	Present	7.21	279	6.94	7.85	559	High
500 yr	10 yr	Present	8.01	634	6.94	10 yr	10yr	Present	7.21	279	6.94	8.01	634	High

Canarsie - Pump Alternative 1, Present Tides													
Subbasin C1, 70 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.75	165	2.75							2.75	165	Low
5 yr	Normal	Present	2.88	227	2.75							2.88	227	Low
10 yr	Normal	Present	3.03	279	2.75							3.03	279	Low
25 yr	Normal	Present	3.31	348	2.75							3.31	348	Low
50 yr	Normal	Present	3.53	401	2.75							3.53	401	Low
100 yr	Normal	Present	3.93	455	2.75							3.93	455	Low
250 yr	Normal	Present	4.73	559	2.75							4.73	559	Low
500 yr	Normal	Present	5.20	634	2.75							5.20	634	Low
2 yr	2 yr	Present	4.63	165	4.64	2 yr	2 yr	Present	4.63	165	4.64	4.63	165	Likely
5 yr	2 yr	Present	4.75	227	4.64	2 yr	5 yr	Present	5.68	165	5.84	5.68	227	Likely
10 yr	2 yr	Present	4.89	279	4.64	2 yr	10 yr	Present	5.96	165	6.94	5.96	279	Likely
25 yr	2 yr	Present	5.11	348	4.64	2 yr	10yr	Present	5.96	165	6.94	5.96	348	Likely
50 yr	2 yr	Present	5.32	401	4.64	2 yr	10yr	Present	5.96	165	6.94	5.96	401	Likely
100 yr	2 yr	Present	5.53	455	4.64	2 yr	10yr	Present	5.96	165	6.94	5.96	455	Likely
250 yr	2 yr	Present	5.97	559	4.64	2 yr	10yr	Present	5.96	165	6.94	5.97	559	Likely
500 yr	2 yr	Present	6.30	634	4.64	2 yr	10yr	Present	5.96	165	6.94	6.30	634	Likely
2 yr	2 yr	Present	4.63	165	4.64	2 yr	2 yr	Present	4.63	165	4.64	4.63	165	High
5 yr	5 yr	Present	5.86	227	5.84	5 yr	5 yr	Present	5.86	227	5.84	5.86	227	High
10 yr	10 yr	Present	6.80	279	6.94	10 yr	10 yr	Present	6.80	279	6.94	6.80	279	High
25 yr	10 yr	Present	6.98	348	6.94	10 yr	10yr	Present	6.80	279	6.94	6.98	348	High
50 yr	10 yr	Present	7.11	401	6.94	10 yr	10yr	Present	6.80	279	6.94	7.11	401	High
100 yr	10 yr	Present	7.25	455	6.94	10 yr	10yr	Present	6.80	279	6.94	7.25	455	High
250 yr	10 yr	Present	7.51	559	6.94	10 yr	10yr	Present	6.80	279	6.94	7.51	559	High
500 yr	10 yr	Present	7.70	634	6.94	10 yr	10yr	Present	6.80	279	6.94	7.70	634	High

Canarsie - Pump Alternative 2, Present Tides													
Subbasin C1, 150 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.62	165	2.75							2.62	165	Low
5 yr	Normal	Present	2.72	227	2.75							2.72	227	Low
10 yr	Normal	Present	2.81	279	2.75							2.81	279	Low
25 yr	Normal	Present	3.00	348	2.75							3.00	348	Low
50 yr	Normal	Present	3.20	401	2.75							3.20	401	Low
100 yr	Normal	Present	3.39	455	2.75							3.39	455	Low
250 yr	Normal	Present	4.12	559	2.75							4.12	559	Low
500 yr	Normal	Present	4.68	634	2.75							4.68	634	Low
2 yr	2 yr	Present	2.92	165	4.64	2 yr	2 yr	Present	2.92	165	4.64	2.92	165	Likely
5 yr	2 yr	Present	4.59	227	4.64	2 yr	5 yr	Present	2.38	165	5.84	4.59	227	Likely
10 yr	2 yr	Present	4.69	279	4.64	2 yr	10 yr	Present	2.43	165	6.94	4.69	279	Likely
25 yr	2 yr	Present	4.86	348	4.64	2 yr	10yr	Present	2.43	165	6.94	4.86	348	Likely
50 yr	2 yr	Present	5.01	401	4.64	2 yr	10yr	Present	2.43	165	6.94	5.01	401	Likely
100 yr	2 yr	Present	5.20	455	4.64	2 yr	10yr	Present	2.43	165	6.94	5.20	455	Likely
250 yr	2 yr	Present	5.61	559	4.64	2 yr	10yr	Present	2.43	165	6.94	5.61	559	Likely
500 yr	2 yr	Present	5.92	634	4.64	2 yr	10yr	Present	2.43	165	6.94	5.92	634	Likely
2 yr	2 yr	Present	2.92	165	4.64	2 yr	2 yr	Present	2.92	165	4.64	2.92	165	High
5 yr	5 yr	Present	5.41	227	5.84	5 yr	5 yr	Present	5.41	227	5.84	5.41	227	High
10 yr	10 yr	Present	6.09	279	6.94	10 yr	10 yr	Present	6.09	279	6.94	6.09	279	High
25 yr	10 yr	Present	6.68	348	6.94	10 yr	10yr	Present	6.09	279	6.94	6.68	348	High
50 yr	10 yr	Present	6.84	401	6.94	10 yr	10yr	Present	6.09	279	6.94	6.84	401	High
100 yr	10 yr	Present	6.98	455	6.94	10 yr	10yr	Present	6.09	279	6.94	6.98	455	High
250 yr	10 yr	Present	7.23	559	6.94	10 yr	10yr	Present	6.09	279	6.94	7.23	559	High
500 yr	10 yr	Present	7.40	634	6.94	10 yr	10yr	Present	6.09	279	6.94	7.40	634	High

Canarsie - Minimum Facility, Future Tides													
Subbasin C1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.96	165	3.82							3.96	165	Low
5 yr	Normal	Future	4.16	227	3.82							4.16	227	Low
10 yr	Normal	Future	4.35	279	3.82							4.35	279	Low
25 yr	Normal	Future	4.66	348	3.82							4.66	348	Low
50 yr	Normal	Future	4.93	401	3.82							4.93	401	Low
100 yr	Normal	Future	5.20	455	3.82							5.20	455	Low
250 yr	Normal	Future	5.70	559	3.82							5.70	559	Low
500 yr	Normal	Future	6.07	634	3.82							6.07	634	Low
2 yr	2 yr	Future	5.83	165	5.71	2 yr	2 yr	Future	5.83	165	5.71	5.83	165	Likely
5 yr	2 yr	Future	5.98	227	5.71	2 yr	5 yr	Future	6.86	165	6.91	6.86	227	Likely
10 yr	2 yr	Future	6.13	279	5.71	2 yr	10 yr	Future	7.37	165	8.00	7.37	279	Likely
25 yr	2 yr	Future	6.35	348	5.71	2 yr	10yr	Future	7.37	165	8.00	7.37	348	Likely
50 yr	2 yr	Future	6.54	401	5.71	2 yr	10yr	Future	7.37	165	8.00	7.37	401	Likely
100 yr	2 yr	Future	6.71	455	5.71	2 yr	10yr	Future	7.37	165	8.00	7.37	455	Likely
250 yr	2 yr	Future	7.03	559	5.71	2 yr	10yr	Future	7.37	165	8.00	7.37	559	Likely
500 yr	2 yr	Future	7.24	634	5.71	2 yr	10yr	Future	7.37	165	8.00	7.37	634	Likely
2 yr	2 yr	Future	5.83	165	5.71	2 yr	2 yr	Future	5.83	165	5.71	5.83	165	High
5 yr	5 yr	Future	7.04	227	6.91	5 yr	5 yr	Future	7.04	227	6.91	7.04	227	High
10 yr	10 yr	Future	7.83	279	8.00	10 yr	10 yr	Future	7.83	279	8.00	7.83	279	High
25 yr	10 yr	Future	8.02	348	8.00	10 yr	10yr	Future	7.83	279	8.00	8.02	348	High
50 yr	10 yr	Future	8.14	401	8.00	10 yr	10yr	Future	7.83	279	8.00	8.14	401	High
100 yr	10 yr	Future	8.26	455	8.00	10 yr	10yr	Future	7.83	279	8.00	8.26	455	High
250 yr	10 yr	Future	8.48	559	8.00	10 yr	10yr	Future	7.83	279	8.00	8.48	559	High
500 yr	10 yr	Future	8.63	634	8.00	10 yr	10yr	Future	7.83	279	8.00	8.63	634	High

Canarsie - Pump Alternative 1, Future Tides													
Subbasin C1, 70 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.82	165	3.82							3.82	165	Low
5 yr	Normal	Future	3.94	227	3.82							3.94	227	Low
10 yr	Normal	Future	4.10	279	3.82							4.10	279	Low
25 yr	Normal	Future	4.35	348	3.82							4.35	348	Low
50 yr	Normal	Future	4.58	401	3.82							4.58	401	Low
100 yr	Normal	Future	4.83	455	3.82							4.83	455	Low
250 yr	Normal	Future	5.34	559	3.82							5.34	559	Low
500 yr	Normal	Future	5.70	634	3.82							5.70	634	Low
2 yr	2 yr	Future	5.59	165	5.71	2 yr	2 yr	Future	5.59	165	5.71	5.59	165	Likely
5 yr	2 yr	Future	5.76	227	5.71	2 yr	5 yr	Future	5.96	165	6.91	5.96	227	Likely
10 yr	2 yr	Future	5.89	279	5.71	2 yr	10 yr	Future	5.96	165	8.00	5.96	279	Likely
25 yr	2 yr	Future	6.09	348	5.71	2 yr	10yr	Future	5.96	165	8.00	6.09	348	Likely
50 yr	2 yr	Future	6.26	401	5.71	2 yr	10yr	Future	5.96	165	8.00	6.26	401	Likely
100 yr	2 yr	Future	6.44	455	5.71	2 yr	10yr	Future	5.96	165	8.00	6.44	455	Likely
250 yr	2 yr	Future	6.78	559	5.71	2 yr	10yr	Future	5.96	165	8.00	6.78	559	Likely
500 yr	2 yr	Future	7.01	634	5.71	2 yr	10yr	Future	5.96	165	8.00	7.01	634	Likely
2 yr	2 yr	Future	5.59	165	5.71	2 yr	2 yr	Future	5.59	165	5.71	5.59	165	High
5 yr	5 yr	Future	6.59	227	6.91	5 yr	5 yr	Future	6.59	227	6.91	6.59	227	High
10 yr	10 yr	Future	7.12	279	8.00	10 yr	10 yr	Future	7.12	279	8.00	7.12	279	High
25 yr	10 yr	Future	7.48	348	8.00	10 yr	10yr	Future	7.12	279	8.00	7.48	348	High
50 yr	10 yr	Future	7.66	401	8.00	10 yr	10yr	Future	7.12	279	8.00	7.66	401	High
100 yr	10 yr	Future	7.79	455	8.00	10 yr	10yr	Future	7.12	279	8.00	7.79	455	High
250 yr	10 yr	Future	8.03	559	8.00	10 yr	10yr	Future	7.12	279	8.00	8.03	559	High
500 yr	10 yr	Future	8.18	634	8.00	10 yr	10yr	Future	7.12	279	8.00	8.18	634	High

Canarsie - Pump Alternative 2, Future Tides													
Subbasin C1, 150 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	2.56	165	3.82							2.56	165	Low
5 yr	Normal	Future	3.79	227	3.82							3.79	227	Low
10 yr	Normal	Future	3.88	279	3.82							3.88	279	Low
25 yr	Normal	Future	4.06	348	3.82							4.06	348	Low
50 yr	Normal	Future	4.25	401	3.82							4.25	401	Low
100 yr	Normal	Future	4.46	455	3.82							4.46	455	Low
250 yr	Normal	Future	4.95	559	3.82							4.95	559	Low
500 yr	Normal	Future	5.31	634	3.82							5.31	634	Low
2 yr	2 yr	Future	2.26	165	5.71	2 yr	2 yr	Future	2.26	165	5.71	2.26	165	Likely
5 yr	2 yr	Future	5.41	227	5.71	2 yr	5 yr	Future	2.43	165	6.91	5.41	227	Likely
10 yr	2 yr	Future	5.64	279	5.71	2 yr	10 yr	Future	2.43	165	8.00	5.64	279	Likely
25 yr	2 yr	Future	5.83	348	5.71	2 yr	10yr	Future	2.43	165	8.00	5.83	348	Likely
50 yr	2 yr	Future	5.98	401	5.71	2 yr	10yr	Future	2.43	165	8.00	5.98	401	Likely
100 yr	2 yr	Future	6.14	455	5.71	2 yr	10yr	Future	2.43	165	8.00	6.14	455	Likely
250 yr	2 yr	Future	6.47	559	5.71	2 yr	10yr	Future	2.43	165	8.00	6.47	559	Likely
500 yr	2 yr	Future	6.70	634	5.71	2 yr	10yr	Future	2.43	165	8.00	6.70	634	Likely
2 yr	2 yr	Future	2.26	165	5.71	2 yr	2 yr	Future	2.26	165	5.71	2.26	165	High
5 yr	5 yr	Future	5.38	227	6.91	5 yr	5 yr	Future	5.38	227	6.91	5.38	227	High
10 yr	10 yr	Future	6.09	279	8.00	10 yr	10 yr	Future	6.09	279	8.00	6.09	279	High
25 yr	10 yr	Future	6.77	348	8.00	10 yr	10yr	Future	6.09	279	8.00	6.77	348	High
50 yr	10 yr	Future	7.13	401	8.00	10 yr	10yr	Future	6.09	279	8.00	7.13	401	High
100 yr	10 yr	Future	7.42	455	8.00	10 yr	10yr	Future	6.09	279	8.00	7.42	455	High
250 yr	10 yr	Future	7.75	559	8.00	10 yr	10yr	Future	6.09	279	8.00	7.75	559	High
500 yr	10 yr	Future	7.90	634	8.00	10 yr	10yr	Future	6.09	279	8.00	7.90	634	High

Canarsie - Minimum Facility, Present Tides													
Subbasin C2 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.89	89	2.75							2.89	89	Low
5 yr	Normal	Present	3.11	122	2.75							3.11	122	Low
10 yr	Normal	Present	3.39	150	2.75							3.39	150	Low
25 yr	Normal	Present	3.87	187	2.75							3.87	187	Low
50 yr	Normal	Present	4.49	216	2.75							4.49	216	Low
100 yr	Normal	Present	4.99	245	2.75							4.99	245	Low
250 yr	Normal	Present	5.92	301	2.75							5.92	301	Low
500 yr	Normal	Present	6.38	341	2.75							6.38	341	Low
2 yr	2 yr	Present	4.78	89	4.64	2 yr	2 yr	Present	4.78	89	4.64	4.78	89	Likely
5 yr	2 yr	Present	4.99	122	4.64	2 yr	5 yr	Present	5.98	89	5.84	5.98	122	Likely
10 yr	2 yr	Present	5.26	150	4.64	2 yr	10 yr	Present	7.03	89	6.94	7.03	150	Likely
25 yr	2 yr	Present	5.62	187	4.64	2 yr	10yr	Present	7.03	89	6.94	7.03	187	Likely
50 yr	2 yr	Present	5.95	216	4.64	2 yr	10yr	Present	7.03	89	6.94	7.03	216	Likely
100 yr	2 yr	Present	6.23	245	4.64	2 yr	10yr	Present	7.03	89	6.94	7.03	245	Likely
250 yr	2 yr	Present	6.69	301	4.64	2 yr	10yr	Present	7.03	89	6.94	7.03	301	Likely
500 yr	2 yr	Present	6.95	341	4.64	2 yr	10yr	Present	7.03	89	6.94	7.03	341	Likely
2 yr	2 yr	Present	4.78	89	4.64	2 yr	2 yr	Present	4.78	89	4.64	4.78	89	High
5 yr	5 yr	Present	6.17	122	5.84	5 yr	5 yr	Present	6.17	122	5.84	6.17	122	High
10 yr	10 yr	Present	7.28	150	6.94	10 yr	10 yr	Present	7.28	150	6.94	7.28	150	High
25 yr	10 yr	Present	7.43	187	6.94	10 yr	10yr	Present	7.28	150	6.94	7.43	187	High
50 yr	10 yr	Present	7.55	216	6.94	10 yr	10yr	Present	7.28	150	6.94	7.55	216	High
100 yr	10 yr	Present	7.66	245	6.94	10 yr	10yr	Present	7.28	150	6.94	7.66	245	High
250 yr	10 yr	Present	7.88	301	6.94	10 yr	10yr	Present	7.28	150	6.94	7.88	301	High
500 yr	10 yr	Present	8.03	341	6.94	10 yr	10yr	Present	7.28	150	6.94	8.03	341	High

Canarsie - Pump Alternative 1, Present Tides													
Subbasin C2, 56 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.71	89	2.75							2.71	89	Low
5 yr	Normal	Present	2.79	122	2.75							2.79	122	Low
10 yr	Normal	Present	2.92	150	2.75							2.92	150	Low
25 yr	Normal	Present	3.19	187	2.75							3.19	187	Low
50 yr	Normal	Present	3.47	216	2.75							3.47	216	Low
100 yr	Normal	Present	3.87	245	2.75							3.87	245	Low
250 yr	Normal	Present	5.00	301	2.75							5.00	301	Low
500 yr	Normal	Present	5.69	341	2.75							5.69	341	Low
2 yr	2 yr	Present	4.58	89	4.64	2 yr	2 yr	Present	4.58	89	4.64	4.58	89	Likely
5 yr	2 yr	Present	4.67	122	4.64	2 yr	5 yr	Present	5.38	89	5.84	5.38	122	Likely
10 yr	2 yr	Present	4.80	150	4.64	2 yr	10 yr	Present	6.55	89	6.94	6.55	150	Likely
25 yr	2 yr	Present	5.10	187	4.64	2 yr	10yr	Present	6.55	89	6.94	6.55	187	Likely
50 yr	2 yr	Present	5.34	216	4.64	2 yr	10yr	Present	6.55	89	6.94	6.55	216	Likely
100 yr	2 yr	Present	5.68	245	4.64	2 yr	10yr	Present	6.55	89	6.94	6.55	245	Likely
250 yr	2 yr	Present	6.22	301	4.64	2 yr	10yr	Present	6.55	89	6.94	6.55	301	Likely
500 yr	2 yr	Present	6.54	341	4.64	2 yr	10yr	Present	6.55	89	6.94	6.55	341	Likely
2 yr	2 yr	Present	4.58	89	4.64	2 yr	2 yr	Present	4.58	89	4.64	4.58	89	High
5 yr	5 yr	Present	5.87	122	5.84	5 yr	5 yr	Present	5.87	122	5.84	5.87	122	High
10 yr	10 yr	Present	6.93	150	6.94	10 yr	10 yr	Present	6.93	150	6.94	6.93	150	High
25 yr	10 yr	Present	7.09	187	6.94	10 yr	10yr	Present	6.93	150	6.94	7.09	187	High
50 yr	10 yr	Present	7.21	216	6.94	10 yr	10yr	Present	6.93	150	6.94	7.21	216	High
100 yr	10 yr	Present	7.33	245	6.94	10 yr	10yr	Present	6.93	150	6.94	7.33	245	High
250 yr	10 yr	Present	7.56	301	6.94	10 yr	10yr	Present	6.93	150	6.94	7.56	301	High
500 yr	10 yr	Present	7.72	341	6.94	10 yr	10yr	Present	6.93	150	6.94	7.72	341	High

Canarsie - Minimum Facility, Future Tides													
Subbasin C2 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.97	89	3.82							3.97	89	Low
5 yr	Normal	Future	4.18	122	3.82							4.18	122	Low
10 yr	Normal	Future	4.43	150	3.82							4.43	150	Low
25 yr	Normal	Future	4.87	187	3.82							4.87	187	Low
50 yr	Normal	Future	5.21	216	3.82							5.21	216	Low
100 yr	Normal	Future	5.59	245	3.82							5.59	245	Low
250 yr	Normal	Future	6.27	301	3.82							6.27	301	Low
500 yr	Normal	Future	6.61	341	3.82							6.61	341	Low
2 yr	2 yr	Future	5.85	89	5.71	2 yr	2 yr	Future	5.85	89	5.71	5.85	89	Likely
5 yr	2 yr	Future	6.05	122	5.71	2 yr	5 yr	Future	7.00	89	6.91	7.00	122	Likely
10 yr	2 yr	Future	6.24	150	5.71	2 yr	10 yr	Future	7.62	89	8.00	7.62	150	Likely
25 yr	2 yr	Future	6.51	187	5.71	2 yr	10yr	Future	7.62	89	8.00	7.62	187	Likely
50 yr	2 yr	Future	6.70	216	5.71	2 yr	10yr	Future	7.62	89	8.00	7.62	216	Likely
100 yr	2 yr	Future	6.89	245	5.71	2 yr	10yr	Future	7.62	89	8.00	7.62	245	Likely
250 yr	2 yr	Future	7.21	301	5.71	2 yr	10yr	Future	7.62	89	8.00	7.62	301	Likely
500 yr	2 yr	Future	7.41	341	5.71	2 yr	10yr	Future	7.62	89	8.00	7.62	341	Likely
2 yr	2 yr	Future	5.85	89	5.71	2 yr	2 yr	Future	5.85	89	5.71	5.85	89	High
5 yr	5 yr	Future	7.13	122	6.91	5 yr	5 yr	Future	7.13	122	6.91	7.13	122	High
10 yr	10 yr	Future	7.94	150	8.00	10 yr	10 yr	Future	7.94	150	8.00	7.94	150	High
25 yr	10 yr	Future	8.09	187	8.00	10 yr	10yr	Future	7.94	150	8.00	8.09	187	High
50 yr	10 yr	Future	8.20	216	8.00	10 yr	10yr	Future	7.94	150	8.00	8.20	216	High
100 yr	10 yr	Future	8.30	245	8.00	10 yr	10yr	Future	7.94	150	8.00	8.30	245	High
250 yr	10 yr	Future	8.50	301	8.00	10 yr	10yr	Future	7.94	150	8.00	8.50	301	High
500 yr	10 yr	Future	8.63	341	8.00	10 yr	10yr	Future	7.94	150	8.00	8.63	341	High

Canarsie - Pump Alternative 1, Future Tides													
Subbasin C2, 56 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.78	89	3.82							3.78	89	Low
5 yr	Normal	Future	3.85	122	3.82							3.85	122	Low
10 yr	Normal	Future	3.99	150	3.82							3.99	150	Low
25 yr	Normal	Future	4.29	187	3.82							4.29	187	Low
50 yr	Normal	Future	4.60	216	3.82							4.60	216	Low
100 yr	Normal	Future	4.93	245	3.82							4.93	245	Low
250 yr	Normal	Future	5.66	301	3.82							5.66	301	Low
500 yr	Normal	Future	6.09	341	3.82							6.09	341	Low
2 yr	2 yr	Future	5.65	89	5.71	2 yr	2 yr	Future	5.65	89	5.71	5.65	89	Likely
5 yr	2 yr	Future	5.74	122	5.71	2 yr	5 yr	Future	6.54	89	6.91	6.54	122	Likely
10 yr	2 yr	Future	5.87	150	5.71	2 yr	10 yr	Future	6.55	89	8.00	6.55	150	Likely
25 yr	2 yr	Future	6.11	187	5.71	2 yr	10yr	Future	6.55	89	8.00	6.55	187	Likely
50 yr	2 yr	Future	6.31	216	5.71	2 yr	10yr	Future	6.55	89	8.00	6.55	216	Likely
100 yr	2 yr	Future	6.50	245	5.71	2 yr	10yr	Future	6.55	89	8.00	6.55	245	Likely
250 yr	2 yr	Future	6.86	301	5.71	2 yr	10yr	Future	6.55	89	8.00	6.86	301	Likely
500 yr	2 yr	Future	7.08	341	5.71	2 yr	10yr	Future	6.55	89	8.00	7.08	341	Likely
2 yr	2 yr	Future	5.65	89	5.71	2 yr	2 yr	Future	5.65	89	5.71	5.65	89	High
5 yr	5 yr	Future	6.80	122	6.91	5 yr	5 yr	Future	6.80	122	6.91	6.80	122	High
10 yr	10 yr	Future	7.36	150	8.00	10 yr	10 yr	Future	7.36	150	8.00	7.36	150	High
25 yr	10 yr	Future	7.61	187	8.00	10 yr	10yr	Future	7.36	150	8.00	7.61	187	High
50 yr	10 yr	Future	7.74	216	8.00	10 yr	10yr	Future	7.36	150	8.00	7.74	216	High
100 yr	10 yr	Future	7.85	245	8.00	10 yr	10yr	Future	7.36	150	8.00	7.85	245	High
250 yr	10 yr	Future	8.04	301	8.00	10 yr	10yr	Future	7.36	150	8.00	8.04	301	High
500 yr	10 yr	Future	8.18	341	8.00	10 yr	10yr	Future	7.36	150	8.00	8.18	341	High

Canarsie - Minimum Facility, Present Tides													
Subbasin C3 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.76	117	2.75							2.76	117	Low
5 yr	Normal	Present	2.79	161	2.75							2.79	161	Low
10 yr	Normal	Present	2.85	198	2.75							2.85	198	Low
25 yr	Normal	Present	2.94	247	2.75							2.94	247	Low
50 yr	Normal	Present	3.03	285	2.75							3.03	285	Low
100 yr	Normal	Present	3.14	323	2.75							3.14	323	Low
250 yr	Normal	Present	3.40	396	2.75							3.40	396	Low
500 yr	Normal	Present	3.60	449	2.75							3.60	449	Low
2 yr	2 yr	Present	4.65	117	4.64	2 yr	2 yr	Present	4.65	117	4.64	4.65	117	Likely
5 yr	2 yr	Present	4.67	161	4.64	2 yr	5 yr	Present	5.85	117	5.84	5.85	161	Likely
10 yr	2 yr	Present	4.73	198	4.64	2 yr	10 yr	Present	6.86	117	6.94	6.86	198	Likely
25 yr	2 yr	Present	4.82	247	4.64	2 yr	10yr	Present	6.86	117	6.94	6.86	247	Likely
50 yr	2 yr	Present	4.90	285	4.64	2 yr	10yr	Present	6.86	117	6.94	6.86	285	Likely
100 yr	2 yr	Present	5.00	323	4.64	2 yr	10yr	Present	6.86	117	6.94	6.86	323	Likely
250 yr	2 yr	Present	5.22	396	4.64	2 yr	10yr	Present	6.86	117	6.94	6.86	396	Likely
500 yr	2 yr	Present	5.41	449	4.64	2 yr	10yr	Present	6.86	117	6.94	6.86	449	Likely
2 yr	2 yr	Present	4.65	117	4.64	2 yr	2 yr	Present	4.65	117	4.64	4.65	117	High
5 yr	5 yr	Present	5.88	161	5.84	5 yr	5 yr	Present	5.88	161	5.84	5.88	161	High
10 yr	10 yr	Present	7.01	198	6.94	10 yr	10 yr	Present	7.01	198	6.94	7.01	198	High
25 yr	10 yr	Present	7.08	247	6.94	10 yr	10yr	Present	7.01	198	6.94	7.08	247	High
50 yr	10 yr	Present	7.14	285	6.94	10 yr	10yr	Present	7.01	198	6.94	7.14	285	High
100 yr	10 yr	Present	7.20	323	6.94	10 yr	10yr	Present	7.01	198	6.94	7.20	323	High
250 yr	10 yr	Present	7.32	396	6.94	10 yr	10yr	Present	7.01	198	6.94	7.32	396	High
500 yr	10 yr	Present	7.41	449	6.94	10 yr	10yr	Present	7.01	198	6.94	7.41	449	High

Canarsie - Pump Alternative 1, Present Tides													
Subbasin C3, 84 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.71	117	2.75							2.71	117	Low
5 yr	Normal	Present	2.74	161	2.75							2.74	161	Low
10 yr	Normal	Present	2.74	198	2.75							2.74	198	Low
25 yr	Normal	Present	2.79	247	2.75							2.79	247	Low
50 yr	Normal	Present	2.85	285	2.75							2.85	285	Low
100 yr	Normal	Present	2.92	323	2.75							2.92	323	Low
250 yr	Normal	Present	3.12	396	2.75							3.12	396	Low
500 yr	Normal	Present	3.28	449	2.75							3.28	449	Low
2 yr	2 yr	Present	4.55	117	4.64	2 yr	2 yr	Present	4.55	117	4.64	4.55	117	Likely
5 yr	2 yr	Present	4.60	161	4.64	2 yr	5 yr	Present	5.26	117	5.84	5.26	161	Likely
10 yr	2 yr	Present	4.62	198	4.64	2 yr	10 yr	Present	5.42	117	6.94	5.42	198	Likely
25 yr	2 yr	Present	4.67	247	4.64	2 yr	10yr	Present	5.42	117	6.94	5.42	247	Likely
50 yr	2 yr	Present	4.73	285	4.64	2 yr	10yr	Present	5.42	117	6.94	5.42	285	Likely
100 yr	2 yr	Present	4.80	323	4.64	2 yr	10yr	Present	5.42	117	6.94	5.42	323	Likely
250 yr	2 yr	Present	4.98	396	4.64	2 yr	10yr	Present	5.42	117	6.94	5.42	396	Likely
500 yr	2 yr	Present	5.13	449	4.64	2 yr	10yr	Present	5.42	117	6.94	5.42	449	Likely
2 yr	2 yr	Present	4.55	117	4.64	2 yr	2 yr	Present	4.55	117	4.64	4.55	117	High
5 yr	5 yr	Present	5.76	161	5.84	5 yr	5 yr	Present	5.76	161	5.84	5.76	161	High
10 yr	10 yr	Present	6.66	198	6.94	10 yr	10 yr	Present	6.66	198	6.94	6.66	198	High
25 yr	10 yr	Present	6.82	247	6.94	10 yr	10yr	Present	6.66	198	6.94	6.82	247	High
50 yr	10 yr	Present	6.89	285	6.94	10 yr	10yr	Present	6.66	198	6.94	6.89	285	High
100 yr	10 yr	Present	6.96	323	6.94	10 yr	10yr	Present	6.66	198	6.94	6.96	323	High
250 yr	10 yr	Present	7.08	396	6.94	10 yr	10yr	Present	6.66	198	6.94	7.08	396	High
500 yr	10 yr	Present	7.18	449	6.94	10 yr	10yr	Present	6.66	198	6.94	7.18	449	High

Canarsie - Minimum Facility, Future Tides													
Subbasin C3 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.83	117	3.82							3.83	117	Low
5 yr	Normal	Future	3.86	161	3.82							3.86	161	Low
10 yr	Normal	Future	3.91	198	3.82							3.91	198	Low
25 yr	Normal	Future	4.01	247	3.82							4.01	247	Low
50 yr	Normal	Future	4.10	285	3.82							4.10	285	Low
100 yr	Normal	Future	4.20	323	3.82							4.20	323	Low
250 yr	Normal	Future	4.40	396	3.82							4.40	396	Low
500 yr	Normal	Future	4.60	449	3.82							4.60	449	Low
2 yr	2 yr	Future	5.72	117	5.71	2 yr	2 yr	Future	5.72	117	5.71	5.72	117	Likely
5 yr	2 yr	Future	5.75	161	5.71	2 yr	5 yr	Future	6.84	117	6.91	6.84	161	Likely
10 yr	2 yr	Future	5.80	198	5.71	2 yr	10 yr	Future	7.31	117	8.00	7.31	198	Likely
25 yr	2 yr	Future	5.88	247	5.71	2 yr	10yr	Future	7.31	117	8.00	7.31	247	Likely
50 yr	2 yr	Future	5.97	285	5.71	2 yr	10yr	Future	7.31	117	8.00	7.31	285	Likely
100 yr	2 yr	Future	6.05	323	5.71	2 yr	10yr	Future	7.31	117	8.00	7.31	323	Likely
250 yr	2 yr	Future	6.23	396	5.71	2 yr	10yr	Future	7.31	117	8.00	7.31	396	Likely
500 yr	2 yr	Future	6.38	449	5.71	2 yr	10yr	Future	7.31	117	8.00	7.31	449	Likely
2 yr	2 yr	Future	5.72	117	5.71	2 yr	2 yr	Future	5.72	117	5.71	5.72	117	High
5 yr	5 yr	Future	6.92	161	6.91	5 yr	5 yr	Future	6.92	161	6.91	6.92	161	High
10 yr	10 yr	Future	7.68	198	8.00	10 yr	10 yr	Future	7.68	198	8.00	7.68	198	High
25 yr	10 yr	Future	7.81	247	8.00	10 yr	10yr	Future	7.68	198	8.00	7.81	247	High
50 yr	10 yr	Future	7.90	285	8.00	10 yr	10yr	Future	7.68	198	8.00	7.90	285	High
100 yr	10 yr	Future	7.97	323	8.00	10 yr	10yr	Future	7.68	198	8.00	7.97	323	High
250 yr	10 yr	Future	8.10	396	8.00	10 yr	10yr	Future	7.68	198	8.00	8.10	396	High
500 yr	10 yr	Future	8.19	449	8.00	10 yr	10yr	Future	7.68	198	8.00	8.19	449	High

Canarsie - Pump Alternative 1, Future Tides													
Subbasin C3, 84 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.76	117	3.82							3.76	117	Low
5 yr	Normal	Future	3.80	161	3.82							3.80	161	Low
10 yr	Normal	Future	3.81	198	3.82							3.81	198	Low
25 yr	Normal	Future	3.86	247	3.82							3.86	247	Low
50 yr	Normal	Future	3.92	285	3.82							3.92	285	Low
100 yr	Normal	Future	4.00	323	3.82							4.00	323	Low
250 yr	Normal	Future	4.18	396	3.82							4.18	396	Low
500 yr	Normal	Future	4.34	449	3.82							4.34	449	Low
2 yr	2 yr	Future	5.46	117	5.71	2 yr	2 yr	Future	5.46	117	5.71	5.46	117	Likely
5 yr	2 yr	Future	5.64	161	5.71	2 yr	5 yr	Future	5.42	117	6.91	5.64	161	Likely
10 yr	2 yr	Future	5.69	198	5.71	2 yr	10 yr	Future	5.42	117	8.00	5.69	198	Likely
25 yr	2 yr	Future	5.75	247	5.71	2 yr	10yr	Future	5.42	117	8.00	5.75	247	Likely
50 yr	2 yr	Future	5.80	285	5.71	2 yr	10yr	Future	5.42	117	8.00	5.80	285	Likely
100 yr	2 yr	Future	5.87	323	5.71	2 yr	10yr	Future	5.42	117	8.00	5.87	323	Likely
250 yr	2 yr	Future	6.02	396	5.71	2 yr	10yr	Future	5.42	117	8.00	6.02	396	Likely
500 yr	2 yr	Future	6.15	449	5.71	2 yr	10yr	Future	5.42	117	8.00	6.15	449	Likely
2 yr	2 yr	Future	5.46	117	5.71	2 yr	2 yr	Future	5.46	117	5.71	5.46	117	High
5 yr	5 yr	Future	6.31	161	6.91	5 yr	5 yr	Future	6.31	161	6.91	6.31	161	High
10 yr	10 yr	Future	6.72	198	8.00	10 yr	10 yr	Future	6.72	198	8.00	6.72	198	High
25 yr	10 yr	Future	7.09	247	8.00	10 yr	10yr	Future	6.72	198	8.00	7.09	247	High
50 yr	10 yr	Future	7.32	285	8.00	10 yr	10yr	Future	6.72	198	8.00	7.32	285	High
100 yr	10 yr	Future	7.48	323	8.00	10 yr	10yr	Future	6.72	198	8.00	7.48	323	High
250 yr	10 yr	Future	7.70	396	8.00	10 yr	10yr	Future	6.72	198	8.00	7.70	396	High
500 yr	10 yr	Future	7.80	449	8.00	10 yr	10yr	Future	6.72	198	8.00	7.80	449	High

Cedarhurst-Lawrence - Minimum Facility, Present Tides													
Subbasin L1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.76	127	2.75							2.76	127	Low
5 yr	Normal	Present	2.79	173	2.75							2.79	173	Low
10 yr	Normal	Present	2.85	212	2.75							2.85	212	Low
25 yr	Normal	Present	2.94	264	2.75							2.94	264	Low
50 yr	Normal	Present	3.03	303	2.75							3.03	303	Low
100 yr	Normal	Present	3.14	343	2.75							3.14	343	Low
250 yr	Normal	Present	3.37	421	2.75							3.37	421	Low
500 yr	Normal	Present	3.58	477	2.75							3.58	477	Low
2 yr	2 yr	Present	4.65	127	4.64	2 yr	2 yr	Present	4.65	127	4.64	4.65	127	Likely
5 yr	2 yr	Present	4.68	173	4.64	2 yr	5 yr	Present	5.64	127	5.84	5.64	173	Likely
10 yr	2 yr	Present	4.73	212	4.64	2 yr	10 yr	Present	5.90	127	6.94	5.90	212	Likely
25 yr	2 yr	Present	4.82	264	4.64	2 yr	10yr	Present	5.90	127	6.94	5.90	264	Likely
50 yr	2 yr	Present	4.90	303	4.64	2 yr	10yr	Present	5.90	127	6.94	5.90	303	Likely
100 yr	2 yr	Present	4.98	343	4.64	2 yr	10yr	Present	5.90	127	6.94	5.90	343	Likely
250 yr	2 yr	Present	5.15	421	4.64	2 yr	10yr	Present	5.90	127	6.94	5.90	421	Likely
500 yr	2 yr	Present	5.27	477	4.64	2 yr	10yr	Present	5.90	127	6.94	5.90	477	Likely
2 yr	2 yr	Present	4.65	127	4.64	2 yr	2 yr	Present	4.65	127	4.64	4.65	127	High
5 yr	5 yr	Present	5.75	173	5.84	5 yr	5 yr	Present	5.75	173	5.84	5.75	173	High
10 yr	10 yr	Present	6.25	212	6.94	10 yr	10 yr	Present	6.25	212	6.94	6.25	212	High
25 yr	10 yr	Present	6.41	264	6.94	10 yr	10yr	Present	6.25	212	6.94	6.41	264	High
50 yr	10 yr	Present	6.50	303	6.94	10 yr	10yr	Present	6.25	212	6.94	6.50	303	High
100 yr	10 yr	Present	6.58	343	6.94	10 yr	10yr	Present	6.25	212	6.94	6.58	343	High
250 yr	10 yr	Present	6.73	421	6.94	10 yr	10yr	Present	6.25	212	6.94	6.73	421	High
500 yr	10 yr	Present	6.82	477	6.94	10 yr	10yr	Present	6.25	212	6.94	6.82	477	High

Cedarhurst-Lawrence - Pump Alternative 1, Present Tides													
Subbasin L1, 90 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.69	127	2.75							2.69	127	Low
5 yr	Normal	Present	2.73	173	2.75							2.73	173	Low
10 yr	Normal	Present	2.74	212	2.75							2.74	212	Low
25 yr	Normal	Present	2.79	264	2.75							2.79	264	Low
50 yr	Normal	Present	2.85	303	2.75							2.85	303	Low
100 yr	Normal	Present	2.92	343	2.75							2.92	343	Low
250 yr	Normal	Present	3.10	421	2.75							3.10	421	Low
500 yr	Normal	Present	3.26	477	2.75							3.26	477	Low
2 yr	2 yr	Present	4.48	127	4.64	2 yr	2 yr	Present	4.48	127	4.64	4.48	127	Likely
5 yr	2 yr	Present	4.57	173	4.64	2 yr	5 yr	Present	4.66	127	5.84	4.66	173	Likely
10 yr	2 yr	Present	4.62	212	4.64	2 yr	10 yr	Present	4.67	127	6.94	4.67	212	Likely
25 yr	2 yr	Present	4.67	264	4.64	2 yr	10yr	Present	4.67	127	6.94	4.67	264	Likely
50 yr	2 yr	Present	4.73	303	4.64	2 yr	10yr	Present	4.67	127	6.94	4.73	303	Likely
100 yr	2 yr	Present	4.79	343	4.64	2 yr	10yr	Present	4.67	127	6.94	4.79	343	Likely
250 yr	2 yr	Present	4.95	421	4.64	2 yr	10yr	Present	4.67	127	6.94	4.95	421	Likely
500 yr	2 yr	Present	5.06	477	4.64	2 yr	10yr	Present	4.67	127	6.94	5.06	477	Likely
2 yr	2 yr	Present	4.48	127	4.64	2 yr	2 yr	Present	4.48	127	4.64	4.48	127	High
5 yr	5 yr	Present	5.17	173	5.84	5 yr	5 yr	Present	5.17	173	5.84	5.17	173	High
10 yr	10 yr	Present	5.43	212	6.94	10 yr	10 yr	Present	5.43	212	6.94	5.43	212	High
25 yr	10 yr	Present	5.69	264	6.94	10 yr	10yr	Present	5.43	212	6.94	5.69	264	High
50 yr	10 yr	Present	5.86	303	6.94	10 yr	10yr	Present	5.43	212	6.94	5.86	303	High
100 yr	10 yr	Present	6.01	343	6.94	10 yr	10yr	Present	5.43	212	6.94	6.01	343	High
250 yr	10 yr	Present	6.25	421	6.94	10 yr	10yr	Present	5.43	212	6.94	6.25	421	High
500 yr	10 yr	Present	6.39	477	6.94	10 yr	10yr	Present	5.43	212	6.94	6.39	477	High

Cedarhurst-Lawrence - Minimum Facility, Future Tides													
Subbasin L1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.83	127	3.82							3.83	127	Low
5 yr	Normal	Future	3.86	173	3.82							3.86	173	Low
10 yr	Normal	Future	3.92	212	3.82							3.92	212	Low
25 yr	Normal	Future	4.01	264	3.82							4.01	264	Low
50 yr	Normal	Future	4.10	303	3.82							4.10	303	Low
100 yr	Normal	Future	4.21	343	3.82							4.21	343	Low
250 yr	Normal	Future	4.44	421	3.82							4.44	421	Low
500 yr	Normal	Future	4.62	477	3.82							4.62	477	Low
2 yr	2 yr	Future	5.58	127	5.71	2 yr	2 yr	Future	5.58	127	5.71	5.58	127	Likely
5 yr	2 yr	Future	5.67	173	5.71	2 yr	5 yr	Future	5.90	127	6.91	5.90	173	Likely
10 yr	2 yr	Future	5.73	212	5.71	2 yr	10 yr	Future	5.97	127	8.00	5.97	212	Likely
25 yr	2 yr	Future	5.80	264	5.71	2 yr	10yr	Future	5.97	127	8.00	5.97	264	Likely
50 yr	2 yr	Future	5.86	303	5.71	2 yr	10yr	Future	5.97	127	8.00	5.97	303	Likely
100 yr	2 yr	Future	5.92	343	5.71	2 yr	10yr	Future	5.97	127	8.00	5.97	343	Likely
250 yr	2 yr	Future	6.03	421	5.71	2 yr	10yr	Future	5.97	127	8.00	6.03	421	Likely
500 yr	2 yr	Future	6.11	477	5.71	2 yr	10yr	Future	5.97	127	8.00	6.11	477	Likely
2 yr	2 yr	Future	5.58	127	5.71	2 yr	2 yr	Future	5.58	127	5.71	5.58	127	High
5 yr	5 yr	Future	6.11	173	6.91	5 yr	5 yr	Future	6.11	173	6.91	6.11	173	High
10 yr	10 yr	Future	6.37	212	8.00	10 yr	10 yr	Future	6.37	212	8.00	6.37	212	High
25 yr	10 yr	Future	6.56	264	8.00	10 yr	10yr	Future	6.37	212	8.00	6.56	264	High
50 yr	10 yr	Future	6.69	303	8.00	10 yr	10yr	Future	6.37	212	8.00	6.69	303	High
100 yr	10 yr	Future	6.80	343	8.00	10 yr	10yr	Future	6.37	212	8.00	6.80	343	High
250 yr	10 yr	Future	7.01	421	8.00	10 yr	10yr	Future	6.37	212	8.00	7.01	421	High
500 yr	10 yr	Future	7.13	477	8.00	10 yr	10yr	Future	6.37	212	8.00	7.13	477	High

Cedarhurst-Lawrence - Pump Alternative 1, Future Tides													
Subbasin L1, 90 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.74	127	3.82							3.74	127	Low
5 yr	Normal	Future	3.79	173	3.82							3.79	173	Low
10 yr	Normal	Future	3.81	212	3.82							3.81	212	Low
25 yr	Normal	Future	3.86	264	3.82							3.86	264	Low
50 yr	Normal	Future	3.91	303	3.82							3.91	303	Low
100 yr	Normal	Future	3.99	343	3.82							3.99	343	Low
250 yr	Normal	Future	4.17	421	3.82							4.17	421	Low
500 yr	Normal	Future	4.33	477	3.82							4.33	477	Low
2 yr	2 yr	Future	4.65	127	5.71	2 yr	2 yr	Future	4.65	127	5.71	4.65	127	Likely
5 yr	2 yr	Future	5.17	173	5.71	2 yr	5 yr	Future	4.67	127	6.91	5.17	173	Likely
10 yr	2 yr	Future	5.39	212	5.71	2 yr	10 yr	Future	4.67	127	8.00	5.39	212	Likely
25 yr	2 yr	Future	5.52	264	5.71	2 yr	10yr	Future	4.67	127	8.00	5.52	264	Likely
50 yr	2 yr	Future	5.60	303	5.71	2 yr	10yr	Future	4.67	127	8.00	5.60	303	Likely
100 yr	2 yr	Future	5.66	343	5.71	2 yr	10yr	Future	4.67	127	8.00	5.66	343	Likely
250 yr	2 yr	Future	5.78	421	5.71	2 yr	10yr	Future	4.67	127	8.00	5.78	421	Likely
500 yr	2 yr	Future	5.85	477	5.71	2 yr	10yr	Future	4.67	127	8.00	5.85	477	Likely
2 yr	2 yr	Future	4.65	127	5.71	2 yr	2 yr	Future	4.65	127	5.71	4.65	127	High
5 yr	5 yr	Future	5.17	173	6.91	5 yr	5 yr	Future	5.17	173	6.91	5.17	173	High
10 yr	10 yr	Future	5.43	212	8.00	10 yr	10 yr	Future	5.43	212	8.00	5.43	212	High
25 yr	10 yr	Future	5.69	264	8.00	10 yr	10yr	Future	5.43	212	8.00	5.69	264	High
50 yr	10 yr	Future	5.86	303	8.00	10 yr	10yr	Future	5.43	212	8.00	5.86	303	High
100 yr	10 yr	Future	6.01	343	8.00	10 yr	10yr	Future	5.43	212	8.00	6.01	343	High
250 yr	10 yr	Future	6.27	421	8.00	10 yr	10yr	Future	5.43	212	8.00	6.27	421	High
500 yr	10 yr	Future	6.45	477	8.00	10 yr	10yr	Future	5.43	212	8.00	6.45	477	High

Motts Basin North - Minimum Facility, Present Tides													
Subbasin M1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.85	39	2.75							2.85	39	Low
5 yr	Normal	Present	3.04	57	2.75							3.04	57	Low
10 yr	Normal	Present	3.24	71	2.75							3.24	71	Low
25 yr	Normal	Present	3.58	91	2.75							3.58	91	Low
50 yr	Normal	Present	4.20	107	2.75							4.20	107	Low
100 yr	Normal	Present	4.53	122	2.75							4.53	122	Low
250 yr	Normal	Present	4.96	152	2.75							4.96	152	Low
500 yr	Normal	Present	5.19	173	2.75							5.19	173	Low
2 yr	2 yr	Present	4.73	39	4.64	2 yr	2 yr	Present	4.73	39	4.64	4.73	39	Likely
5 yr	2 yr	Present	4.86	57	4.64	2 yr	5 yr	Present	5.56	39	5.84	5.56	57	Likely
10 yr	2 yr	Present	4.99	71	4.64	2 yr	10 yr	Present	5.70	39	6.94	5.70	71	Likely
25 yr	2 yr	Present	5.15	91	4.64	2 yr	10yr	Present	5.70	39	6.94	5.70	91	Likely
50 yr	2 yr	Present	5.27	107	4.64	2 yr	10yr	Present	5.70	39	6.94	5.70	107	Likely
100 yr	2 yr	Present	5.38	122	4.64	2 yr	10yr	Present	5.70	39	6.94	5.70	122	Likely
250 yr	2 yr	Present	5.59	152	4.64	2 yr	10yr	Present	5.70	39	6.94	5.70	152	Likely
500 yr	2 yr	Present	5.74	173	4.64	2 yr	10yr	Present	5.70	39	6.94	5.74	173	Likely
2 yr	2 yr	Present	4.73	39	4.64	2 yr	2 yr	Present	4.73	39	4.64	4.73	39	High
5 yr	5 yr	Present	5.71	57	5.84	5 yr	5 yr	Present	5.71	57	5.84	5.71	57	High
10 yr	10 yr	Present	6.11	71	6.94	10 yr	10 yr	Present	6.11	71	6.94	6.11	71	High
25 yr	10 yr	Present	6.30	91	6.94	10 yr	10yr	Present	6.11	71	6.94	6.30	91	High
50 yr	10 yr	Present	6.43	107	6.94	10 yr	10yr	Present	6.11	71	6.94	6.43	107	High
100 yr	10 yr	Present	6.54	122	6.94	10 yr	10yr	Present	6.11	71	6.94	6.54	122	High
250 yr	10 yr	Present	6.72	152	6.94	10 yr	10yr	Present	6.11	71	6.94	6.72	152	High
500 yr	10 yr	Present	6.84	173	6.94	10 yr	10yr	Present	6.11	71	6.94	6.84	173	High

Motts Basin North - Pump Alternative 1, Present Tides													
Subbasin M1, 26 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Present	2.73	39	2.75							2.73	39	Low
5 yr	Normal	Present	2.79	57	2.75							2.79	57	Low
10 yr	Normal	Present	2.91	71	2.75							2.91	71	Low
25 yr	Normal	Present	3.11	91	2.75							3.11	91	Low
50 yr	Normal	Present	3.44	107	2.75							3.44	107	Low
100 yr	Normal	Present	3.67	122	2.75							3.67	122	Low
250 yr	Normal	Present	4.58	152	2.75							4.58	152	Low
500 yr	Normal	Present	4.88	173	2.75							4.88	173	Low
2 yr	2 yr	Present	4.56	39	4.64	2 yr	2 yr	Present	4.56	39	4.64	4.56	39	Likely
5 yr	2 yr	Present	4.66	57	4.64	2 yr	5 yr	Present	4.72	39	5.84	4.72	57	Likely
10 yr	2 yr	Present	4.76	71	4.64	2 yr	10 yr	Present	4.72	39	6.94	4.76	71	Likely
25 yr	2 yr	Present	4.92	91	4.64	2 yr	10yr	Present	4.72	39	6.94	4.92	91	Likely
50 yr	2 yr	Present	5.04	107	4.64	2 yr	10yr	Present	4.72	39	6.94	5.04	107	Likely
100 yr	2 yr	Present	5.16	122	4.64	2 yr	10yr	Present	4.72	39	6.94	5.16	122	Likely
250 yr	2 yr	Present	5.37	152	4.64	2 yr	10yr	Present	4.72	39	6.94	5.37	152	Likely
500 yr	2 yr	Present	5.53	173	4.64	2 yr	10yr	Present	4.72	39	6.94	5.53	173	Likely
2 yr	2 yr	Present	4.56	39	4.64	2 yr	2 yr	Present	4.56	39	4.64	4.56	39	High
5 yr	5 yr	Present	5.16	57	5.84	5 yr	5 yr	Present	5.16	57	5.84	5.16	57	High
10 yr	10 yr	Present	5.40	71	6.94	10 yr	10 yr	Present	5.40	71	6.94	5.40	71	High
25 yr	10 yr	Present	5.66	91	6.94	10 yr	10yr	Present	5.40	71	6.94	5.66	91	High
50 yr	10 yr	Present	5.83	107	6.94	10 yr	10yr	Present	5.40	71	6.94	5.83	107	High
100 yr	10 yr	Present	5.98	122	6.94	10 yr	10yr	Present	5.40	71	6.94	5.98	122	High
250 yr	10 yr	Present	6.23	152	6.94	10 yr	10yr	Present	5.40	71	6.94	6.23	152	High
500 yr	10 yr	Present	6.40	173	6.94	10 yr	10yr	Present	5.40	71	6.94	6.40	173	High

Motts Basin North - Minimum Facility, Future Tides													
Subbasin M1 - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.93	39	3.82							3.93	39	Low
5 yr	Normal	Future	4.10	57	3.82							4.10	57	Low
10 yr	Normal	Future	4.29	71	3.82							4.29	71	Low
25 yr	Normal	Future	4.56	91	3.82							4.56	91	Low
50 yr	Normal	Future	4.75	107	3.82							4.75	107	Low
100 yr	Normal	Future	4.92	122	3.82							4.92	122	Low
250 yr	Normal	Future	5.22	152	3.82							5.22	152	Low
500 yr	Normal	Future	5.39	173	3.82							5.39	173	Low
2 yr	2 yr	Future	5.51	39	5.71	2 yr	2 yr	Future	5.51	39	5.71	5.51	39	Likely
5 yr	2 yr	Future	5.65	57	5.71	2 yr	5 yr	Future	5.70	39	6.91	5.70	57	Likely
10 yr	2 yr	Future	5.76	71	5.71	2 yr	10 yr	Future	5.75	39	8.00	5.76	71	Likely
25 yr	2 yr	Future	5.88	91	5.71	2 yr	10yr	Future	5.75	39	8.00	5.88	91	Likely
50 yr	2 yr	Future	5.97	107	5.71	2 yr	10yr	Future	5.75	39	8.00	5.97	107	Likely
100 yr	2 yr	Future	6.06	122	5.71	2 yr	10yr	Future	5.75	39	8.00	6.06	122	Likely
250 yr	2 yr	Future	6.23	152	5.71	2 yr	10yr	Future	5.75	39	8.00	6.23	152	Likely
500 yr	2 yr	Future	6.35	173	5.71	2 yr	10yr	Future	5.75	39	8.00	6.35	173	Likely
2 yr	2 yr	Future	5.51	39	5.71	2 yr	2 yr	Future	5.51	39	5.71	5.51	39	High
5 yr	5 yr	Future	5.94	57	6.91	5 yr	5 yr	Future	5.94	57	6.91	5.94	57	High
10 yr	10 yr	Future	6.20	71	8.00	10 yr	10 yr	Future	6.20	71	8.00	6.20	71	High
25 yr	10 yr	Future	6.42	91	8.00	10 yr	10yr	Future	6.20	71	8.00	6.42	91	High
50 yr	10 yr	Future	6.57	107	8.00	10 yr	10yr	Future	6.20	71	8.00	6.57	107	High
100 yr	10 yr	Future	6.70	122	8.00	10 yr	10yr	Future	6.20	71	8.00	6.70	122	High
250 yr	10 yr	Future	6.94	152	8.00	10 yr	10yr	Future	6.20	71	8.00	6.94	152	High
500 yr	10 yr	Future	7.09	173	8.00	10 yr	10yr	Future	6.20	71	8.00	7.09	173	High

Motts Basin North - Pump Alternative 1, Future Tides													
Subbasin M1, 26 cfs pump - Stages (feet, NAVD88) and Inflows (cfs)													
Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Interior Flow	Exterior Stage	Time Condition	Peak Interior WSEL	Peak Interior Inflow	Peak Exterior Stage	Max Interior WSEL	Max Peak Interior Inflow	Risk
2 yr	Normal	Future	3.79	39	3.82							3.79	39	Low
5 yr	Normal	Future	3.86	57	3.82							3.86	57	Low
10 yr	Normal	Future	3.98	71	3.82							3.98	71	Low
25 yr	Normal	Future	4.25	91	3.82							4.25	91	Low
50 yr	Normal	Future	4.42	107	3.82							4.42	107	Low
100 yr	Normal	Future	4.61	122	3.82							4.61	122	Low
250 yr	Normal	Future	4.94	152	3.82							4.94	152	Low
500 yr	Normal	Future	5.15	173	3.82							5.15	173	Low
2 yr	2 yr	Future	4.72	39	5.71	2 yr	2 yr	Future	4.72	39	5.71	4.72	39	Likely
5 yr	2 yr	Future	5.16	57	5.71	2 yr	5 yr	Future	4.72	39	6.91	5.16	57	Likely
10 yr	2 yr	Future	5.40	71	5.71	2 yr	10 yr	Future	4.72	39	8.00	5.40	71	Likely
25 yr	2 yr	Future	5.56	91	5.71	2 yr	10yr	Future	4.72	39	8.00	5.56	91	Likely
50 yr	2 yr	Future	5.66	107	5.71	2 yr	10yr	Future	4.72	39	8.00	5.66	107	Likely
100 yr	2 yr	Future	5.75	122	5.71	2 yr	10yr	Future	4.72	39	8.00	5.75	122	Likely
250 yr	2 yr	Future	5.90	152	5.71	2 yr	10yr	Future	4.72	39	8.00	5.90	152	Likely
500 yr	2 yr	Future	6.02	173	5.71	2 yr	10yr	Future	4.72	39	8.00	6.02	173	Likely
2 yr	2 yr	Future	4.72	39	5.71	2 yr	2 yr	Future	4.72	39	5.71	4.72	39	High
5 yr	5 yr	Future	5.16	57	6.91	5 yr	5 yr	Future	5.16	57	6.91	5.16	57	High
10 yr	10 yr	Future	5.40	71	8.00	10 yr	10 yr	Future	5.40	71	8.00	5.40	71	High
25 yr	10 yr	Future	5.66	91	8.00	10 yr	10yr	Future	5.40	71	8.00	5.66	91	High
50 yr	10 yr	Future	5.82	107	8.00	10 yr	10yr	Future	5.40	71	8.00	5.82	107	High
100 yr	10 yr	Future	5.98	122	8.00	10 yr	10yr	Future	5.40	71	8.00	5.98	122	High
250 yr	10 yr	Future	6.24	152	8.00	10 yr	10yr	Future	5.40	71	8.00	6.24	152	High
500 yr	10 yr	Future	6.42	173	8.00	10 yr	10yr	Future	5.40	71	8.00	6.42	173	High