Stockton University Coastal Research Center: Flood Data Collection

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NEW JERSEY'S DISTINCTIVE PUBLIC UNIVERSITY

Stone Harbor, on 81st Street Friday October 11, 2019 (view towards 3rd Avenue).

FLOOD DATA COLLECTION to DOCUMENT NUISANCE FLOODING IMPACTS On STONE HARBOR, CAPE MAY COUNTY, NEW JERSEY (April 2018 – Nov 2019)

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Acknowledgements

This study was a collaboration between The Borough of Stone Harbor and Stockton University Coastal Research Center. The authors wish to thank the Stone Harbor Public Works Staff and other CRC staff for their willing assistance.

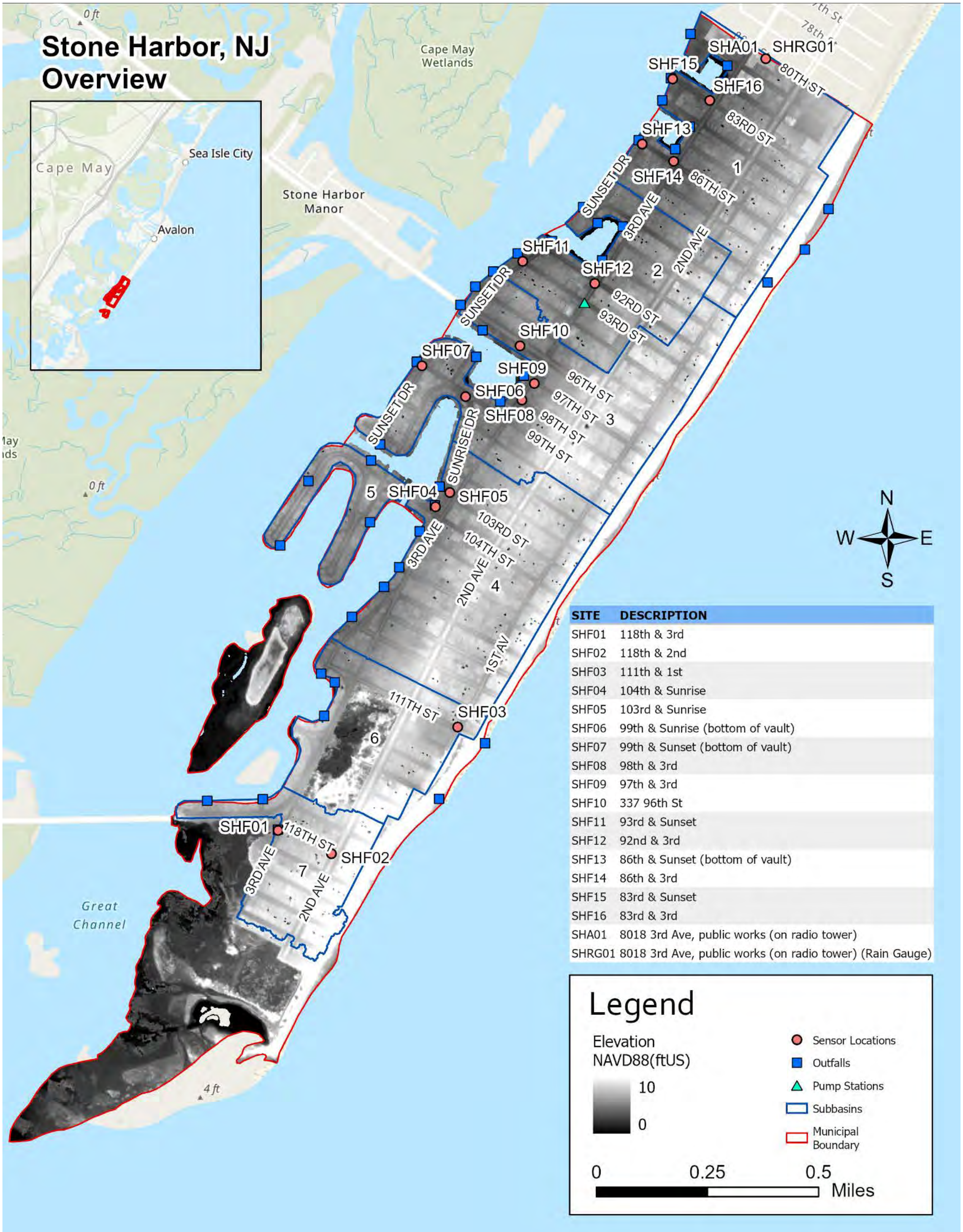
Introduction:

NOAA documented a 75% increase in annual high tide flood frequencies between 2000 and 2015, from 3.4 days to 6.0 days per year along the Northeast Atlantic coast[1]. Many New Jersey coastal communities have observed an increase in street flooding where water emerges from the stormwater discharge systems due to higher than normal tide levels or intense rainfall events and are not able to prevent street flooding. In April 2018, the Stockton University Coastal Research Center (CRC) commenced a flood study that included the deployment of 17 pressure sensors to measure flood (16) and air (1) changes every 4 minutes. The sensors were installed at locations where Borough officials knew were vulnerable and susceptible to flooding. The work was completed under an agreement with Stone Harbor for the purpose of documenting "Nuisance Flooding" within Stone Harbor Borough, New Jersey. The Borough contract (Resolution 2018-8-59) called for four, 90-day sensor deployments in Stone Harbor and the data collection portion was completed with the removal of the sensors on May 22, 2019. The Borough continued the study by approving two additional 90-day deployments of the sensors ending November 25, 2019, for a total of six deployments.

Methodology:

In cooperation with Stone Harbor Borough, 16 flood monitoring sites were selected for the study (Figure 1). *HOBO* pressure sensors were attached to the underside of the stormwater grate at each area of concern. Each sensor recorded pressure (mbar) at 4-minute intervals at approximately 90-day intervals for a total study duration lasting approximately from April 26, 2018 to November 25, 2019. The data from each sensor was interpolated from 4-minute to 1-minute intervals for future data comparison and then subtracted from the (air) control sensor, which only recorded atmospheric pressure. The pressure difference between a stormwater grate sensor and the atmospheric sensor was converted to a water depth (ft) above the surface of the stormwater grate to document event duration.

[1] Sweet, "Patterns and Projections of High Tide Flooding Along the U.S. Coastline Using a Common Impact Threshold, NOAA Technical Report NOS CO-OPS 086, 2018."



SITE	DESCRIPTION
SHF01	118th & 3rd
SHF02	118th & 2nd
SHF03	111th & 1st
SHF04	104th & Sunrise
SHF05	103rd & Sunrise
SHF06	99th & Sunrise (bottom of vault)
SHF07	99th & Sunset (bottom of vault)
SHF08	98th & 3rd
SHF09	97th & 3rd
SHF10	337 96th St
SHF11	93rd & Sunset
SHF12	92nd & 3rd
SHF13	86th & Sunset (bottom of vault)
SHF14	86th & 3rd
SHF15	83rd & Sunset
SHF16	83rd & 3rd
SHA01	8018 3rd Ave, public works (on radio tower)
SHRG01	8018 3rd Ave, public works (on radio tower) (Rain Gauge)

Figure 1. Overview Map

Figure 2 displays the elevations of the 16 site locations. SHF06, SHF07, and SHF13 were located at the bottom of the stormwater vault to capture water depths at all times, as requested by the Borough. The surface of the stormwater grate at SHF06 was 2.98ft. NAVD88, SHF07 was 3.75ft. NAVD88, and SHF13 was 2.81ft. NAVD88. The elevations for each of these sites displayed in Figure 2 are the stormwater grate surface minus the distance to where the sensor was located at the bottom of the stormwater vault. Apart from the three sites mentioned above, SHF14 had the lowest elevation at 2.05 ft. NAVD88 while SHF02 had the highest elevation at 6.9 ft. NAVD88.

Figure 2. Site Elevations (NAVD 1988) of the Stone Harbor HOBO sensors.
SHF06 grate surface = 2.98 ft.; SHF07 grate surface = 3.75 ft. and SHF13 grate surface = 2.81 ft. NAVD 1988

"Events" were defined as any duration where a sensor recorded a water depth above the surface of the stormwater grate. Events were further classified into two categories: Individual Events and Main Events (Figure 3). Individual Events illustrated the number of times each site recorded a water depth above the surface of the stormwater grate. Main Events were defined by a single site or multiple sites in the community recording water depths above the surface of the stormwater grate during the same time period (Appendix A). The duration of a Main Event was defined by the first site's recorded water depth above the surface of the stormwater grate to the last site's recorded water depth above the surface of the stormwater grate over a specific time period.

Meteorological data from Rutgers Cape May Court House (CMCH) weather station was compared over time to each Main Event to show wind direction, wind speed, and precipitation. In addition, the Borough requested to have a recording rain gauge installed at the public works yard to better detail local precipitation. The data was recorded in hourly cumulative sum and daily cumulative sum; however, it was not utilized in event classification due to the frequency being too great. Monthly plots were created to compare Cape May Court House precipitation(in./min.) and Stone Harbor Rain Gauge precipitation(in./hr.) (Appendix C). USGS Great Creek Channel at Stone Harbor gauge (Station #01411360) was used for recorded tidal data while NOAA Stone Harbor Great Channel (Station #8535581) was used for predicted tidal data. NOAA Astronomical Data (Northern Hemisphere) was used for moon phases. Main Events were separated into two categories, Nuisance Flooding Events and Storm Flooding Events that were based on the occurrence of precipitation during the Main Event. If recorded precipitation was greater than zero, the Main Event was classified as a Storm Flooding Event. For the purpose of this study Nuisance Flooding Events are defined as flooding not linked to storms or heavy rain. Every Main Event is listed by date of occurrence with graphics showing which sensor flooded, water depth, and for how long (Appendix B).

Figure 3 displays an example of a Main Event from a flood study conducted for the Township of Long Beach. This Main Event example was classified as Storm Flooding Event due to precipitation being recorded during the event. Each site that recorded a water depth above the surface of the stormwater grate is represented by a unique color. This is a great example of how Individual Events make up a Main Event and shows four well defined instances where multiple sites recorded water depths above the surface of the stormwater grate during the same time period. The first instance of this starts October 27, 2018 as multiple sites record Individual Events. There is a brief dry interval until a few more sites record very short Individual Events. Then, the majority of sites record water depths that are greater than the previous Individual Events. Site LBTF07 (red) continued to have a water depth above the surface of the stormwater grate while a few sites recorded an additional Individual Event towards the end. The combined Individual Events were bound into a Main Event by the presence of continued recorded water depths above the surface of the stormwater grate at Site LBTF08 (light orange) during all four instances while other sites recorded Individual Events during these instances.

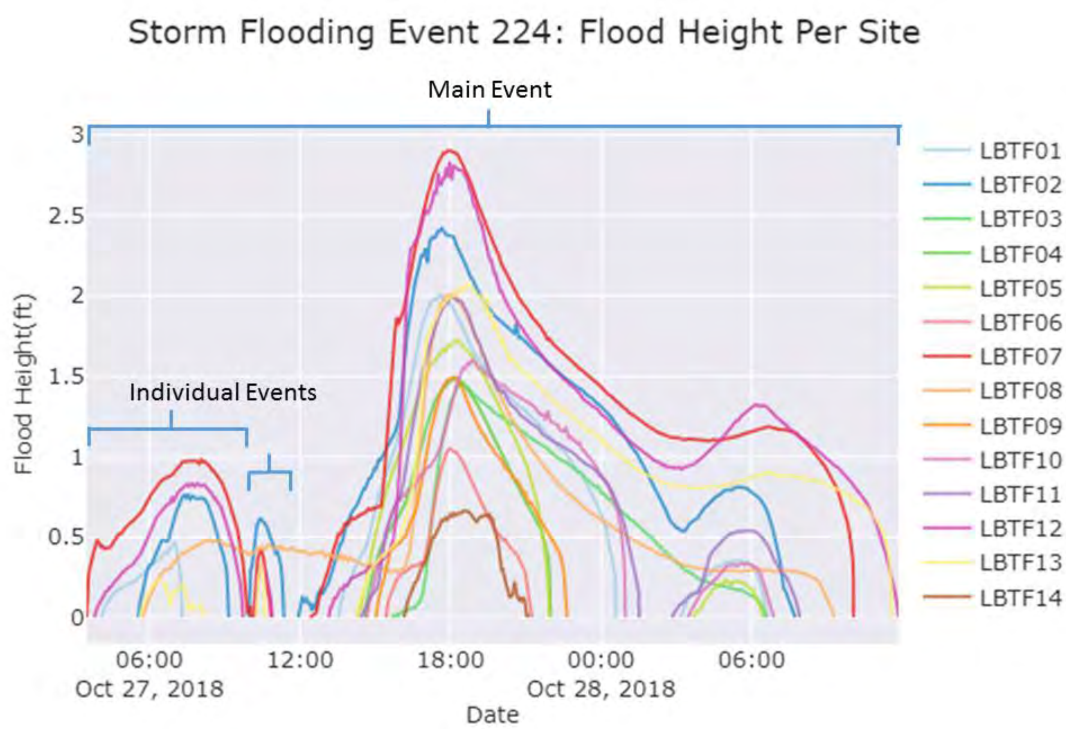


Figure 3. Description of events at Long Beach Township showing multiple Individual Events with LBT08 recording continuous flooding from 6am 10/27 to 9am 10/28.

Analysis:

Figure 4 displays the 16 site locations and indicates the total number of Individual Events at each site during the study. Site SHF11 recorded the most with 328 Individual Events while SHF09 recorded the least with 2 Individual Events.

Figure 4. Bar Graph of Total Individual Events per site during the study

Table 1 provides the deployment dates and the total number of Individual Events per deployment at each of the 16 sensor sites. Site SHF02 was redesigned ~2 weeks prior to the completion of deployment 3.

Table 1. Total Individual Events per deployment at each site

Site	Dep 1 04/26/2018 - 07/31/2018	Dep 2 07/31/2018 - 11/11/2018	Dep 3 11/14/2018 - 02/13/2019	Dep 4 02/13/2019 - 05/22/2019	Dep 5 05/22/2019 - 08/26/2019	Dep 6 08/26/2019 - 11/25/2019
SHF01	3	2	0	2	3	1
SHF02	23	25	14	3	14	5
SHF03	5	6	2	1	6	3
SHF04	3	6	3	1	2	4
SHF05	5	7	7	7	2	5
SHF06	11	21	11	15	16	29
SHF07	2	5	3	3	2	3
SHF08	5	7	5	7	4	11
SHF09	0	2	0	0	0	0
SHF10	2	4	4	1	2	2
SHF11	40	67	36	54	53	78
SHF12	19	21	22	21	12	11
SHF13	2	4	4	1	0	7
SHF14	30	32	23	27	20	43
SHF15	6	14	7	5	6	18
SHF16	4	9	6	4	1	11

Figures 5-7 utilize graduated symbology to display the total number of Individual Events at each site (Figure 5), site frequency where Main Events started (Figure 6), and site frequency where Main Events ended (Figure 7). Symbols range in size relative to the total number of events from small (least) to large (most). Between April 2018 and November 2019, a total of 368 Main Events were recorded at the 16 sites. Site SHF11 had the greatest number of Individual Events with 328 while site SHF09 had the least number of Individual Events with 2. Site SHF11, with an elevation of 2.14 ft. NAVD 88, had the greatest frequency where Main Events started 265 of the 328 (72.01%) and Main Events ended 263 of the 328 (71.47%).

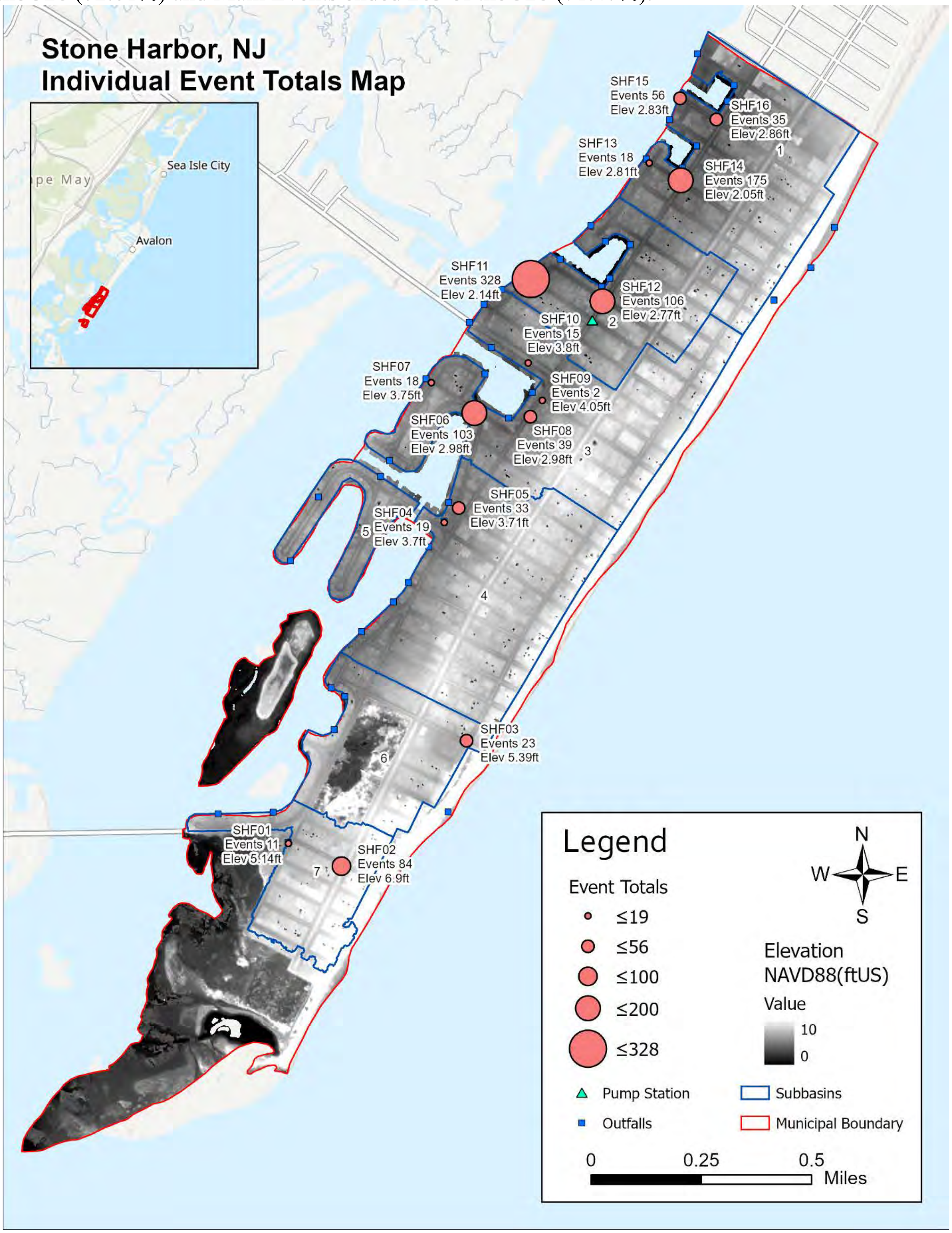


Figure 5. Total number of Individual Events at each site ranging in size from small (least) to large (most).

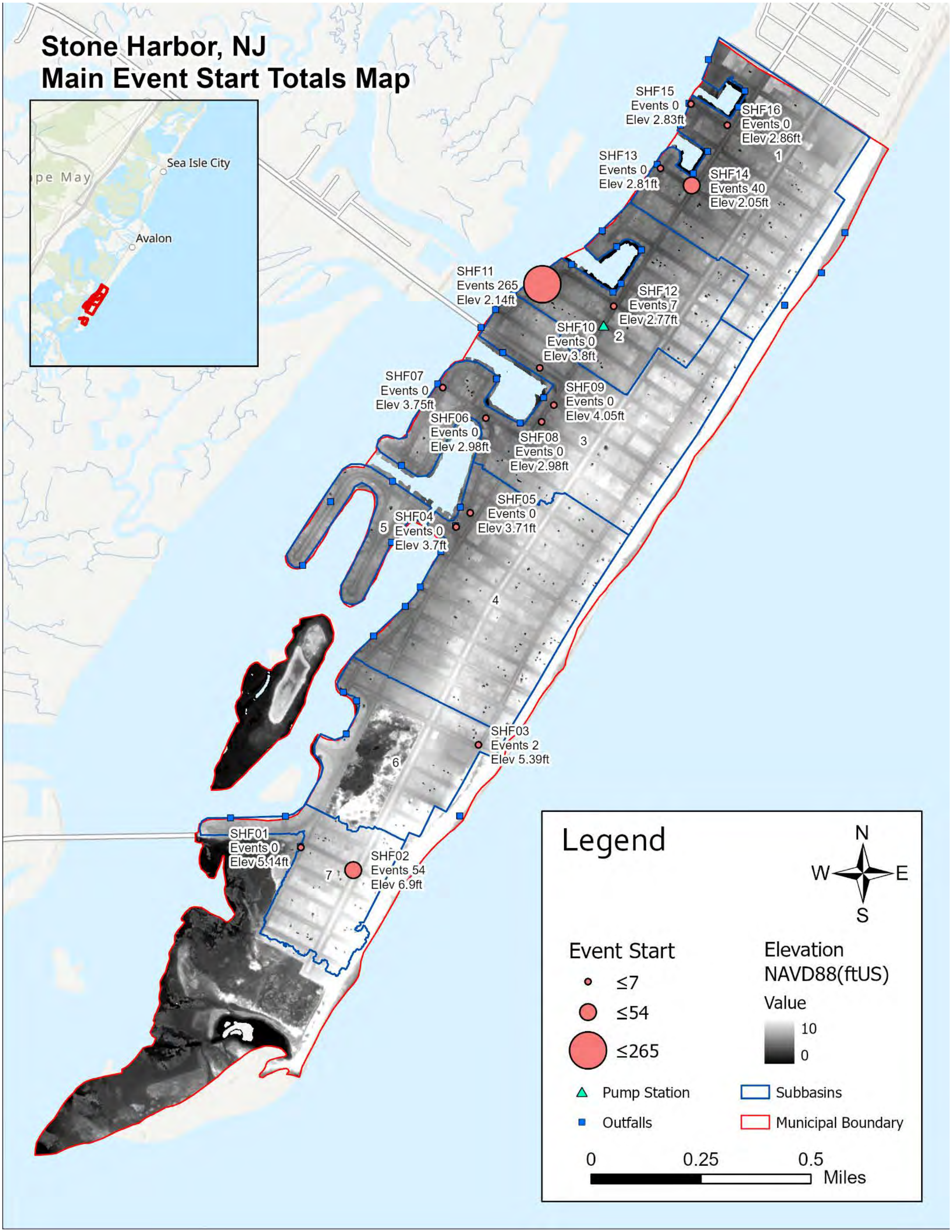


Figure 6. Site frequency where Main Events started ranging in size from small (least) to large (most).

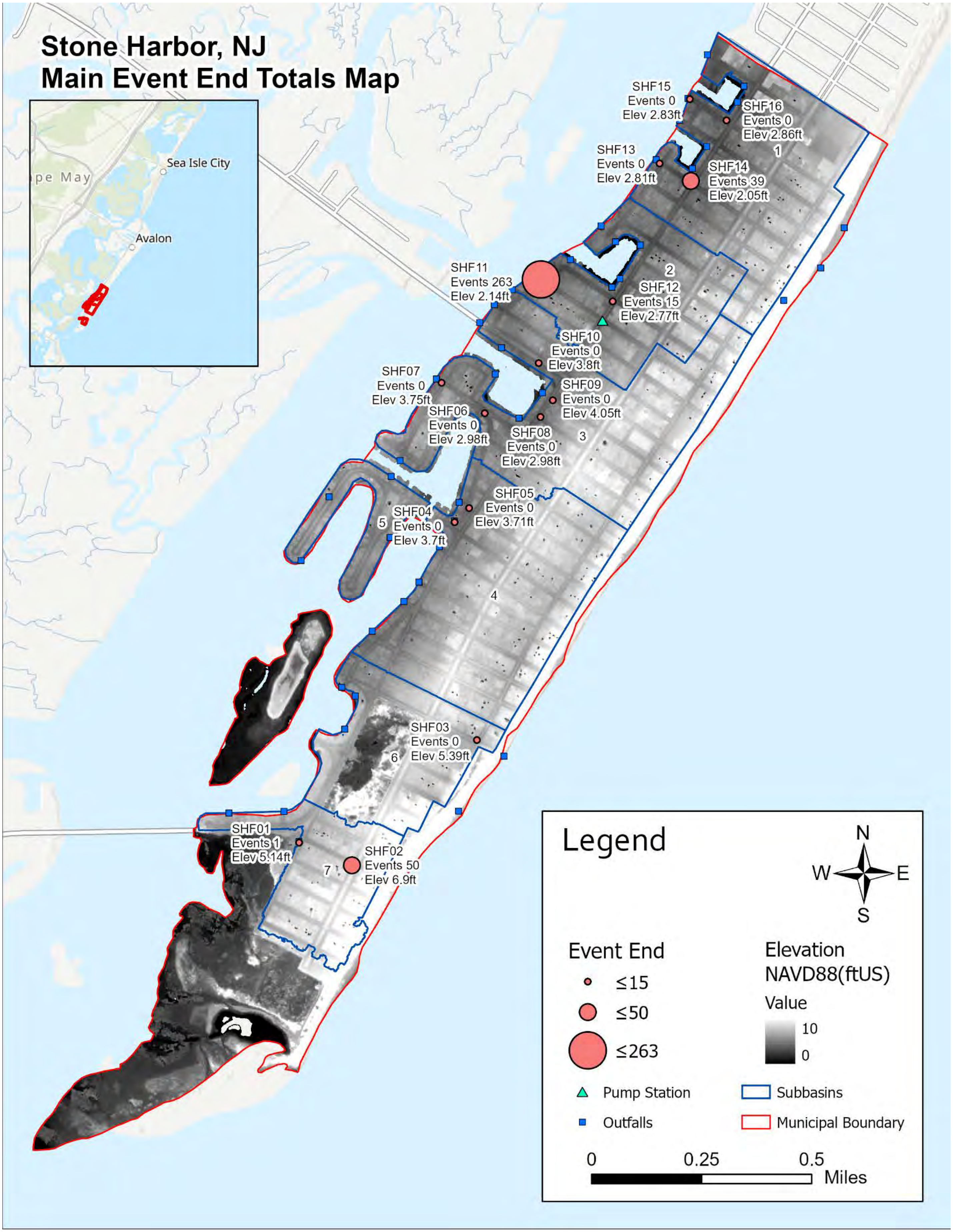


Figure 7. Site frequency where Main Events ended ranging in size from small (least) to large (most).

Table 2 provides a summary of all flooding events at each site with a total number of Individual Events (column 2), the maximum water depth in ft. (column 3) and the Main Event identifier it occurred (column 4), the maximum event duration in hours (column 5) and the Main Event identifier it occurred (column 6), the minimum event water depth in ft. (column 7) and the Main Event identifier it occurred (column 8), the minimum event duration in hours (column 9) and the Main Event identifier it occurred (column 10), the average event water depth in ft., and the average event duration in hours (columns 11&12). Site SHF11 had the greatest occurrence with 328 Individual Events and SHF14 had the greatest maximum water depth of 3.10 ft. during Storm Flooding Event 119. Thirteen of the 16 sites reached their maximum duration of flooding during Storm Flooding Event 77 (September 09, 2018 to September 10, 2018) while 13 of the 16 sites reached their maximum water depth during Storm Flooding Event 119 (October 27, 2018) (Appendix B).

Table 2. Summary table for site Individual Event totals and Main Events showing maximum water depth & flood duration; minimum depth & duration; and average depths and durations

Site	Total # of Events	Max Depth (ft)	Event # Max Depth	Max Dur. (hrs)	Event # Max Dur.	Min Depth (ft)	Event # Min Depth	Min Dur. (hrs)	Event # Min Dur	Average Event Depths	Average Dur. (hrs)
SHF01	11	0.66	229	2.25	113	0.22	200	0.23	240	0.39	0.47
SHF02	84	0.53	113	21.67	77	0.17	307	0.33	265	0.28	2.40
SHF03	23	1.03	128	1.58	113	0.25	263	0.07	263	0.59	0.29
SHF04	19	1.44	119	9.38	77	0.19	74	0.37	30	0.43	2.48
SHF05	33	1.35	119	9.43	77	0.17	15	0.33	208	0.38	1.55
SHF06	103	2.12	119	12.90	77	0.18	292	0.05	342	0.38	2.30
SHF07	18	1.28	119	8.42	77	0.17	190	0.12	208	0.31	1.49
SHF08	39	1.93	119	10.67	77	0.18	346	0.15	263	0.41	2.32
SHF09	2	1.12	119	3.87	119	0.67	77	3.32	77	0.89	3.59
SHF10	15	1.46	119	5.30	77	0.17	149	0.25	245	0.38	1.18
SHF11	328	2.99	119	17.55	77	0.17	360	0.15	202	0.47	2.95
SHF12	106	2.46	119	16.37	77	0.17	221	0.32	8	0.45	2.95
SHF13	18	2.28	119	10.32	77	0.18	358	1.52	354	0.30	2.32
SHF14	175	3.10	119	16.88	77	0.17	348	0.08	274	0.60	2.79
SHF15	56	2.38	119	12.57	77	0.17	267	1.55	267	0.33	2.73
SHF16	35	2.32	119	12.88	77	0.17	216	0.08	1	0.33	3.17

Table 3 provides a summary of each site that includes total number of Individual Events and the percentage of total number of Main Events, site frequency where Main Events started and the percentage of the total number of Main Events, and site frequency where Main Events ended and the percentage of the total number of Main Events. Site SHF11 had the greatest occurrence with 328 Individual Events, also had the greatest frequency where Main Events started 265 of the 368 (72.01%) and Main Events ended 263 of the 368 (71.47%).

Table 3. Summary table for site Individual Event totals, frequency of Main Events starts, and frequency of Main Event ends.

Site	Total # of Events	Percent Site Flooded	Event Started First	Percent Site Started First	Event Ended Last	Percent Site Ended Last
SHF01	11	1.03	0	0.00	1	0.27
SHF02	84	7.89	54	14.67	50	13.59
SHF03	23	2.16	2	0.54	0	0.00
SHF04	19	1.78	0	0.00	0	0.00
SHF05	33	3.10	0	0.00	0	0.00
SHF06	103	9.67	0	0.00	0	0.00
SHF07	18	1.69	0	0.00	0	0.00
SHF08	39	3.66	0	0.00	0	0.00
SHF09	2	0.19	0	0.00	0	0.00
SHF10	15	1.41	0	0.00	0	0.00
SHF11	328	30.80	265	72.01	263	71.47
SHF12	106	9.95	7	1.90	15	4.08
SHF13	18	1.69	0	0.00	0	0.00
SHF14	175	16.43	40	10.87	39	10.60
SHF15	56	5.26	0	0.00	0	0.00
SHF16	35	3.29	0	0.00	0	0.00

Defining Events:

This study classified Main Events into subcategories: Nuisance Flooding Events and Storm Flooding Events. Storm Flooding Events are defined by the presence of precipitation greater than 0.00 inches during a Main Event. Table 4 provides the number of events per classification: 235 Nuisance Flooding Events compared to 133 Storm Flooding Events during the study period.

Table 4. Table of Main Events Classification Totals

Type	Total
Main Events	368
Nuisance Flooding	235
Storm Flooding	133

Main Event Example:

The most dramatic Main Event was during Nuisance Flooding Event 332 that occurred between October 10, 2019 and October 11, 2019. Figure 8 shows dry conditions looking west along 92nd Street towards the intersection of 3rd Street at site SHF12. Figure 9 shows flooding conditions looking west along 92nd Street on October 11, 2019 as the event was ending.

Figure 8. Photo showing dry conditions along 92nd Street (view towards site SHF12).

Figure 9. Photo showing flood water associated with Stone Harbor Nuisance Flooding Event 332 towards site SHF12

Figures 10-11 illustrates why this event was classified as a Nuisance Flooding Event (no precipitation greater than 0.00 in). Nuisance Flooding Event 332 was a multi-day event that caused 10 of the 16 sites to record their maximum Nuisance Flooding water depth and 9 of the 16 sites to record their maximum Nuisance Flooding duration. This event is discussed in greater detail in the following section.

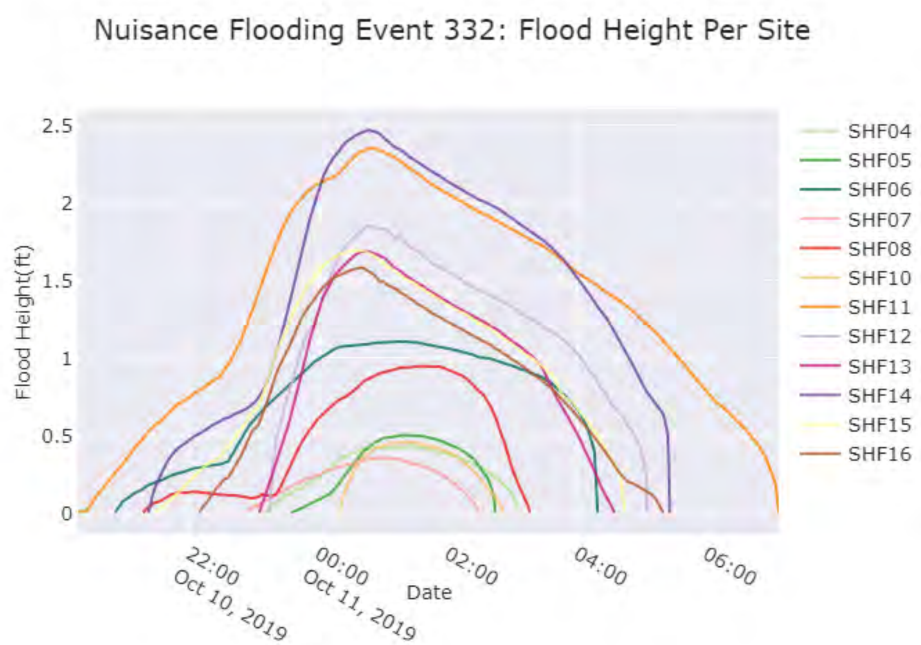


Figure 10. Nuisance Flooding Event 332 flood height above the surface of the stormwater grate per site

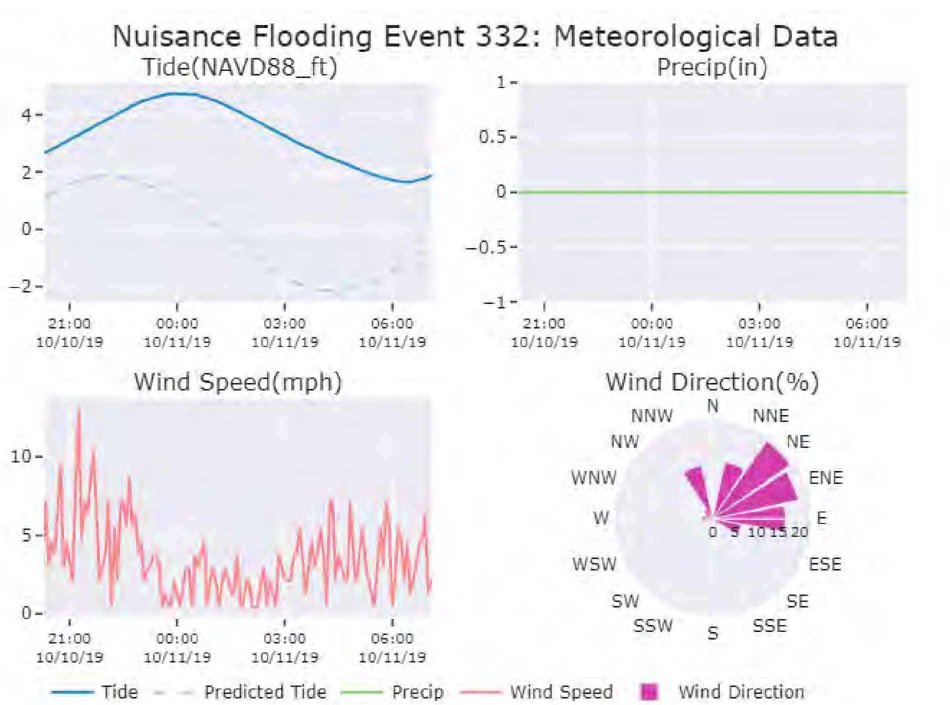


Figure 11. Nuisance Flooding Event 332 meteorological data

Nuisance Flooding Summary:

Nuisance Flooding Events are defined by water depth above the surface of the stormwater grate where no precipitation has been recorded.

Nuisance flood data were parsed out from the whole dataset and Table 5 provides a summary of the total number of Individual Storm Flooding Events (column 2), the maximum event water depth in ft. (column 3) and the Nuisance Flooding Event identifier it occurred (column 4), the maximum event duration in hours (column 5) and the Nuisance Flooding Event identifier it occurred (column 6), the minimum event water depth in ft. (column 7) and the Nuisance Flooding Event identifier it occurred (column 8), the minimum event duration in hours (column 9) and the Nuisance Flooding Event identifier it occurred (column 10), the average event water depth in ft., and the average event duration in hours (columns 11&12). Of the 235 Nuisance Flooding Events, site SHF11 had the greatest occurrence with 221 Individual Nuisance Flooding Events, site SHF14 had the greatest maximum water depth of 2.47 feet during Nuisance Flooding Event 332, and site SHF14 had the greatest maximum duration of 9.37 hours during Nuisance Flooding Event 334 (Appendix B).

Table 5. Summary table for Nuisance Flooding Events by site.

Site	Total # of Events	Max Depth (ft)	Event # Max Depth	Max Dur. (hrs)	Event # Max Dur.	Min Depth (ft)	Event # Min Depth	Min Dur. (hrs)	Event # Min Dur.	Average Event Dephts	Average Dur. (hrs)
SHF01	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.00
SHF02	5	0.48	67	1.53	67	0.17	307	0.45	296	0.23	0.72
SHF03	1	0.27	307	0.12	307	0.27	307	0.12	307	0.27	0.12
SHF04	3	0.45	334	3.97	334	0.25	333	2.85	333	0.44	3.93
SHF05	4	0.50	332	3.18	332	0.18	333	1.55	134	0.36	2.53
SHF06	35	1.11	332	7.48	332	0.18	292	1.35	292	0.32	2.30
SHF07	3	0.36	332	3.63	332	0.20	333	2.30	333	0.33	3.47
SHF08	9	0.96	334	6.00	332	0.18	346	1.75	36	0.25	2.65
SHF09	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.00
SHF10	2	0.46	332	2.55	332	0.44	334	2.50	334	0.45	2.53
SHF11	221	2.35	332	10.85	332	0.17	360	1.20	107	0.43	2.77
SHF12	19	1.85	332	7.13	333	0.17	221	2.10	150	0.25	3.40
SHF13	5	1.69	332	5.52	332	0.18	358	2.10	358	1.18	4.45
SHF14	71	2.47	332	9.37	334	0.17	348	0.73	22	0.45	2.45
SHF15	23	1.70	332	7.28	332	0.17	267	1.55	267	0.25	2.28
SHF16	7	1.58	332	7.20	332	0.20	134	2.18	134	0.48	3.98

Table 6 provides a summary of each site that includes total number of Individual Nuisance Flooding Events and the percentage of total number of Nuisance Flooding Events, site frequency where Nuisance Flooding Events started and the percentage of the total number of Nuisance Flooding Events, and site frequency where Nuisance Flooding Events ended and the percentage of the total number of Nuisance Flooding Events. Site SHF11 had the greatest occurrence with 221 Individual Nuisance Flooding Events, had the greatest frequency where Nuisance Flooding started 205 of the 235 (87.23%), and had the greatest frequency where Nuisance Flooding Events ended 202 of the 235 (85.96%).

Table 6. Summary table for site Individual Nuisance Flooding Event totals, frequency of Nuisance Flooding Event starts, and frequency of Nuisance Flooding Event ends

Site	Total # of Events	Percent Site Flooded	Event Started First	Percent Site Started First	Event Ended Last	Percent Site Ended Last
SHF01	0	0.00	0	0.00	0	0.00
SHF02	5	1.23	5	2.13	5	2.13
SHF03	1	0.25	0	0.00	0	0.00
SHF04	3	0.74	0	0.00	0	0.00
SHF05	4	0.98	0	0.00	0	0.00
SHF06	35	8.58	0	0.00	0	0.00
SHF07	3	0.74	0	0.00	0	0.00
SHF08	9	2.21	0	0.00	0	0.00
SHF09	0	0.00	0	0.00	0	0.00
SHF10	2	0.49	0	0.00	0	0.00
SHF11	221	54.17	205	87.23	202	85.96
SHF12	19	4.66	1	0.43	1	0.43
SHF13	5	1.23	0	0.00	0	0.00
SHF14	71	17.40	24	10.21	27	11.49
SHF15	23	5.64	0	0.00	0	0.00
SHF16	7	1.72	0	0.00	0	0.00

Table 7 provides the top five Nuisance Flooding Events defined by the largest total number of sites affected by water depth above the surface of the stormwater grate where no precipitation was recorded.

Table 7. Table of Top 5 Nuisance Flooding Events

Event	Date Start	Date End	Total Sites
332	2019-10-10 20:17:00	2019-10-11 07:07:00	12
334	2019-10-11 20:17:00	2019-10-12 06:50:00	12
333	2019-10-11 07:44:00	2019-10-11 17:56:00	11
335	2019-10-12 09:00:00	2019-10-12 16:47:00	8
134	2018-11-25 13:03:00	2018-11-25 18:20:00	7

Figures 12 through 17 display the flood data for the top five Nuisance Flooding Events.
Nuisance Flooding Event 332 caused a 1.5 ft. of water depth above the surface of the stormwater grate at 6 of 12 sites between October 10, 2019 and October 11, 2019 (Figure 12). Sites SHF01, SHF02, SHF03, and SHF09 did not record any water depth above the surface of the stormwater grate. The recorded tide was higher than the predicted low tide, no precipitation occurred, and winds out of the Northeast and East Northeast were 0-15 mph (Figure 13). Astronomical alignments that occurred within two days before and after the event included moon in apogee and moon on equator.

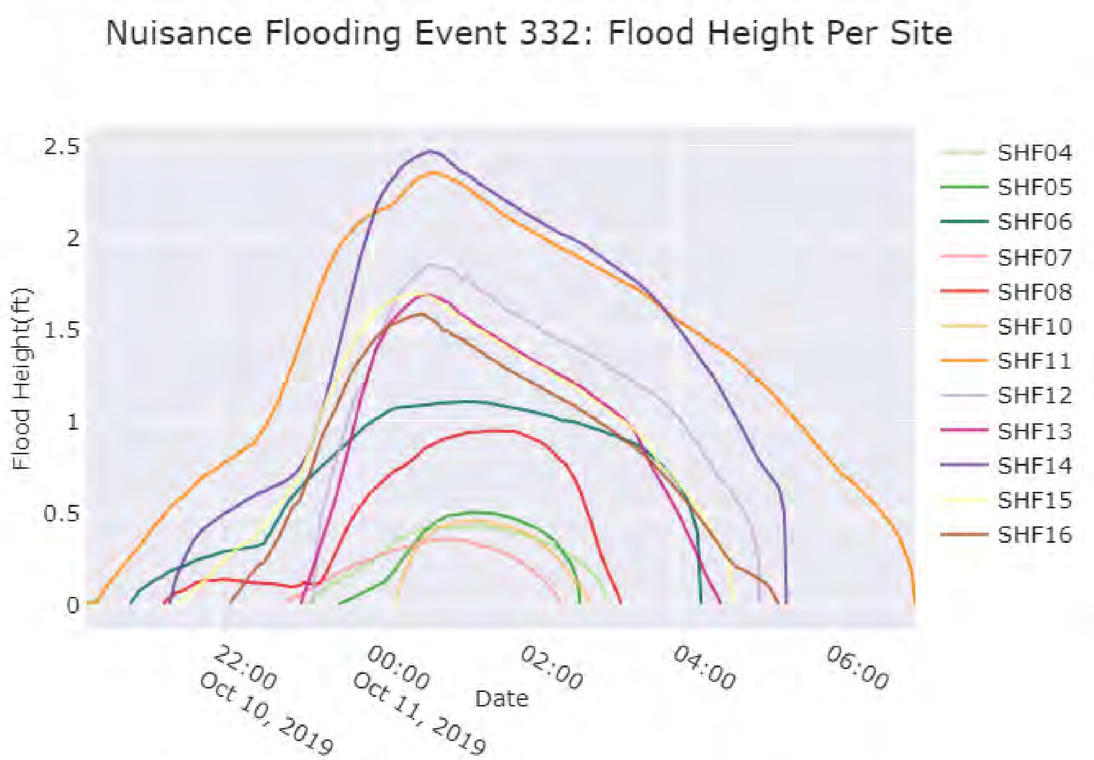


Figure 12. Nuisance Flooding Event 332 flood height above the surface of the stormwater grate per site.

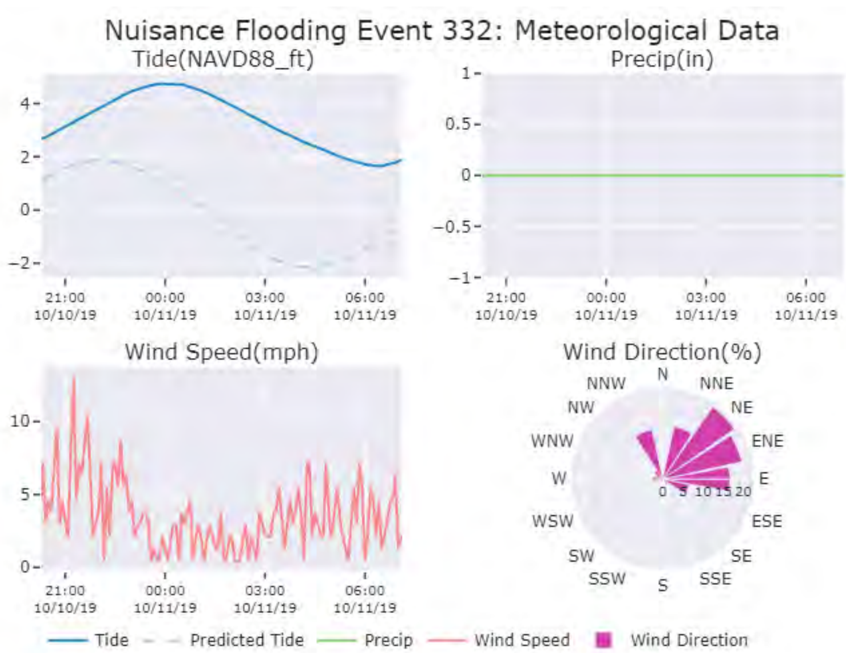


Figure 13. Nuisance Flooding Event 332 meteorological data

Nuisance Flooding Event 334 caused over 1.5 ft. of water depth above the surface of the stormwater grate at 6 of 12 sites between October 11, 2019 and October 12, 2019 (Figure 14). Sites SHF01, SHF02, SHF03, and SHF09 did not record any water depth above the surface of the stormwater grate. The recorded tide was higher than the predicted low tide, no precipitation occurred, and winds out of the North Northwest and Northwest were 0-6 mph (Figure 15). Astronomical alignment that occurred within two days before and after the event included moon in apogee, moon on equator, and full moon.

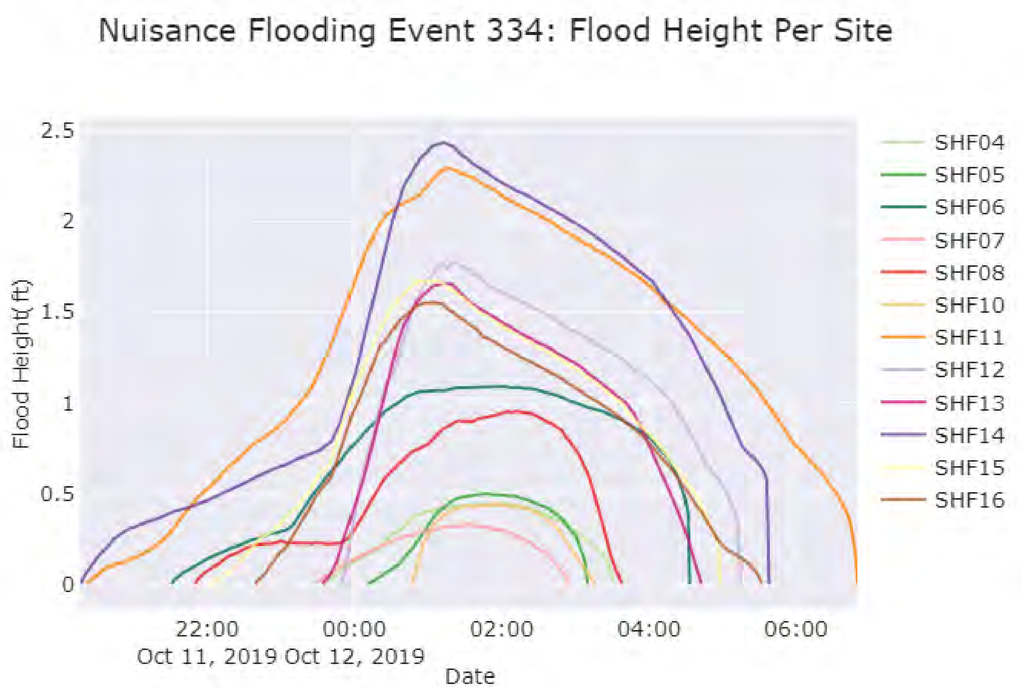


Figure 14. Nuisance Flooding Event 334 flood height above the surface of the stormwater grate per site

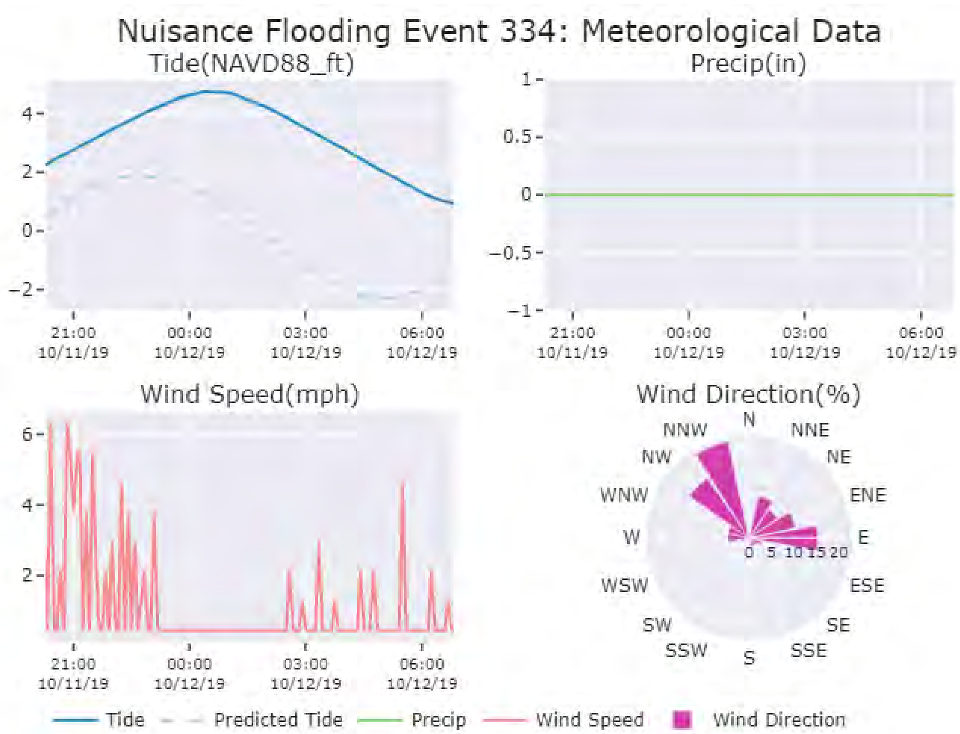


Figure 15. Nuisance Flooding Event 334 meteorological data

Nuisance Flooding Event 333 caused more than 1 foot of water depth above the surface of the stormwater grate at 7 of 11 sites on October 11, 2019 (Figure 16). Sites SHF01, SHF02, SHF03, SHF09 and SHF10 did not record any water depth above the surface of the stormwater grate. The recorded tide was higher than the predicted low tide, no precipitation occurred, and winds out of the East to North Northeast were 0-10 mph (Figure 17). Astronomical alignments that occurred within two days before and after the event included moon in apogee and moon on equator.

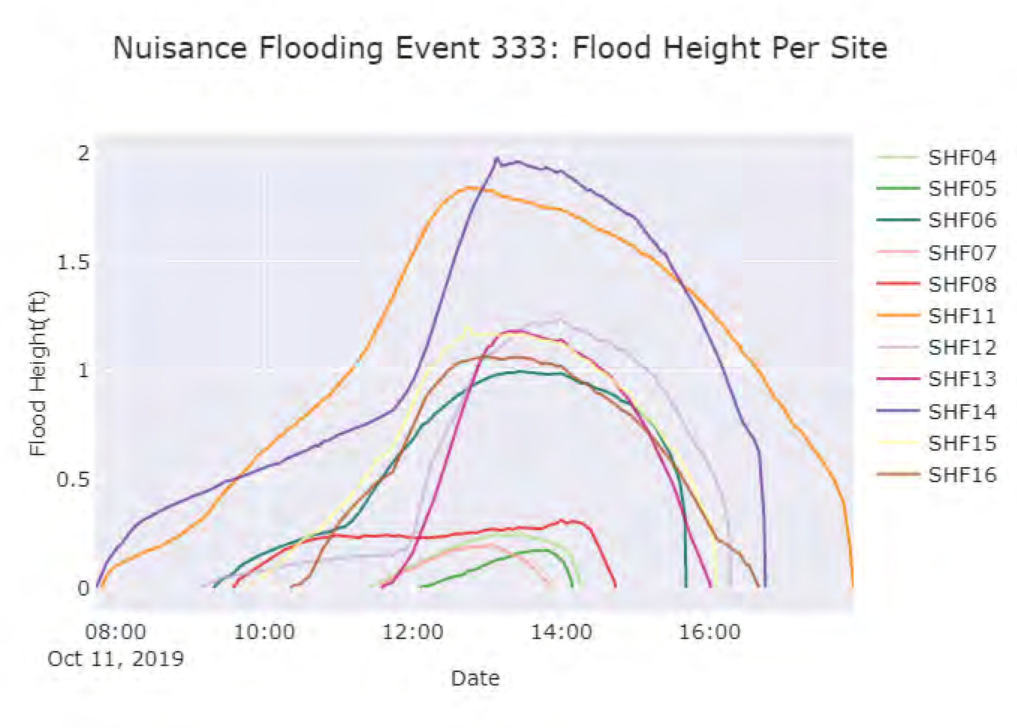


Figure 16. Nuisance Flooding Event 333 flood height above the surface of the stormwater grate per site

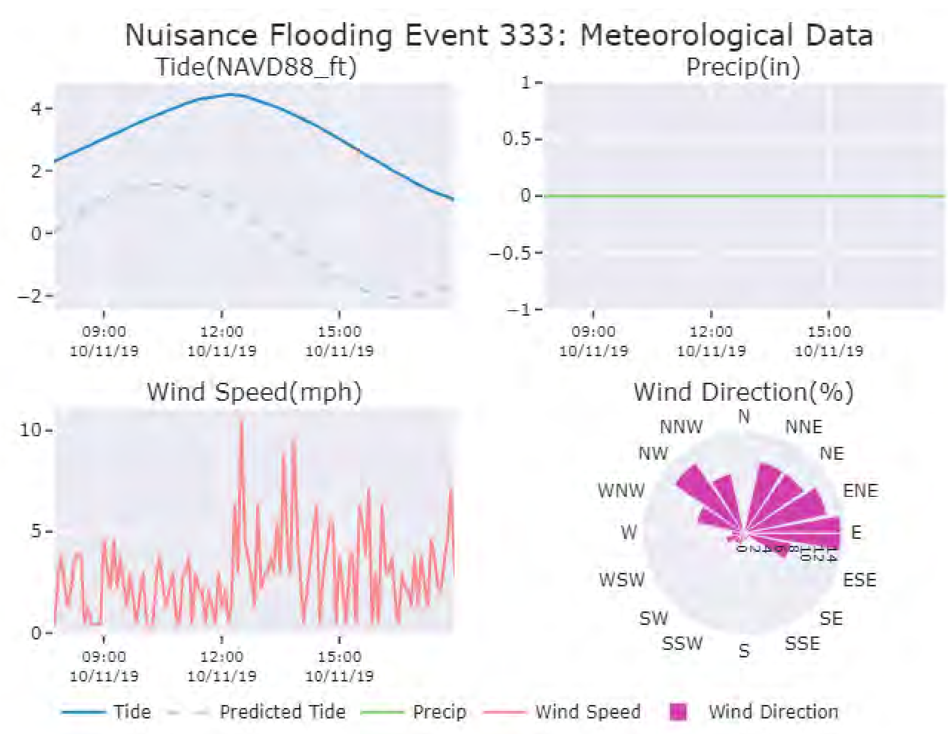


Figure 17. Nuisance Flooding Event 333 meteorological data

Nuisance Flooding Event 335 caused less than 1 foot of water depth above the surface of the stormwater grate at 7 of 8 sites on October 12, 2019 (Figure 18). Sites SHF01, SHF02, SHF03, SHF04, SHF05, SHF07, SHF09 and SHF10 did not record any water depth above the surface of the stormwater grate. The recorded tide was higher than the predicted low tide, no precipitation occurred, and winds out of the Northwest were 0-5 mph (Figure 19). Astronomical alignments that occurred within two days before and after the event included moon in apogee, moon on equator and full moon.

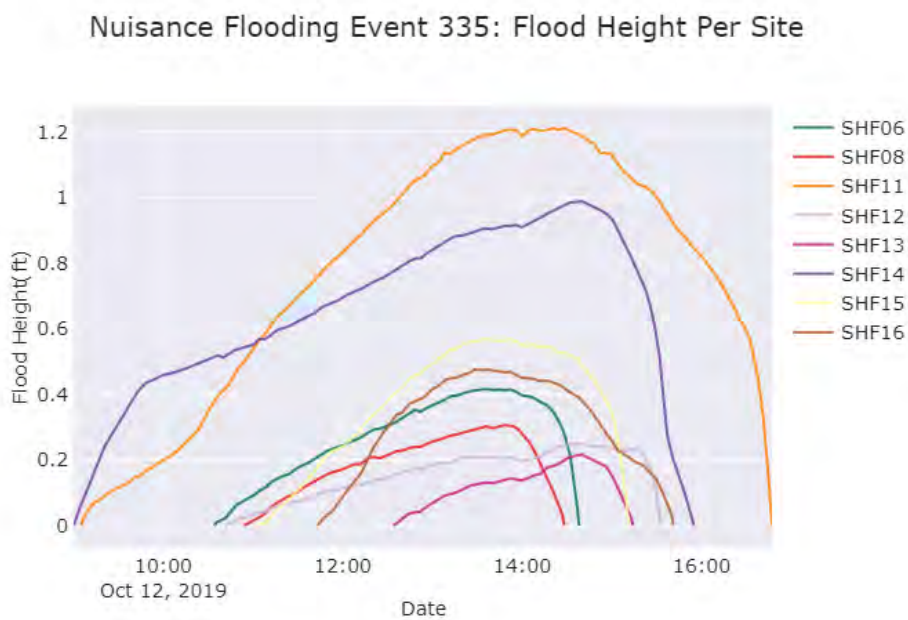


Figure 18. Nuisance Flooding Event 335 flood height above the surface of the stormwater grate per site

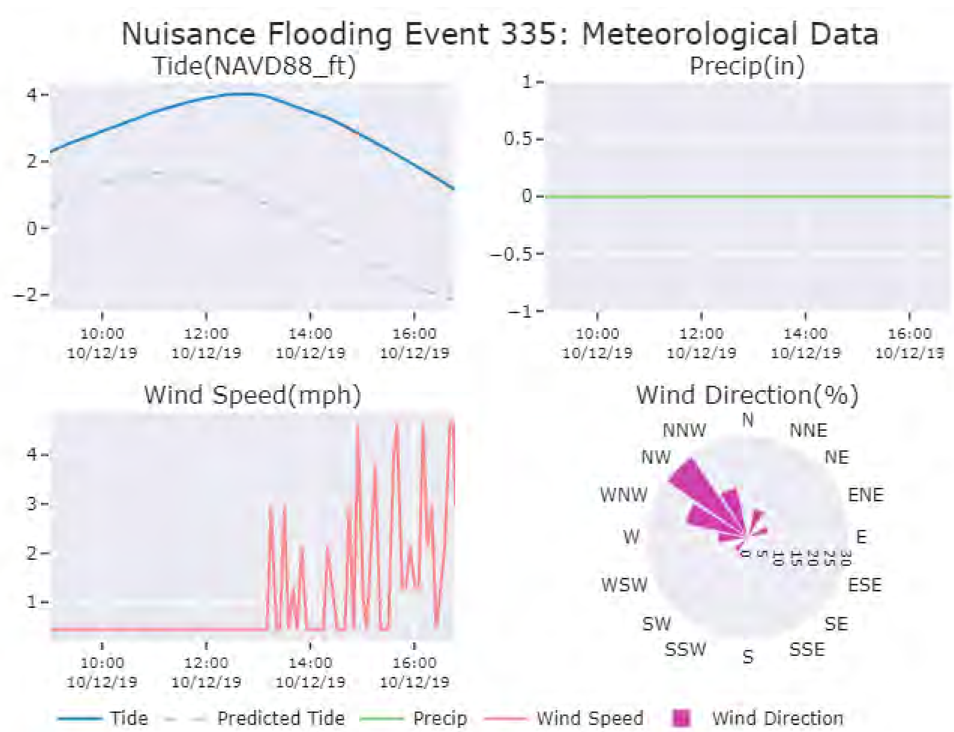


Figure 19. Nuisance Flooding Event 335 meteorological data

Nuisance Flooding Event 134 caused less than 1 foot of water depth above the surface of the stormwater grate at 6 of 7 sites on November 25, 2018 (Figure 20). Sites SHF01, SHF02, SHF03, SHF04, SHF07, SHF08, SHF09, SHF10 and SHF13 did not record any water depth above the surface of the stormwater grate. The recorded tide was higher than the predicted low tide, no precipitation occurred, and winds out of the Northwest and West Southwest were 0-10 mph (Figure 21). Astronomical alignments that occurred within two days before and after the event included moon farthest from the equator and moon in perigee.

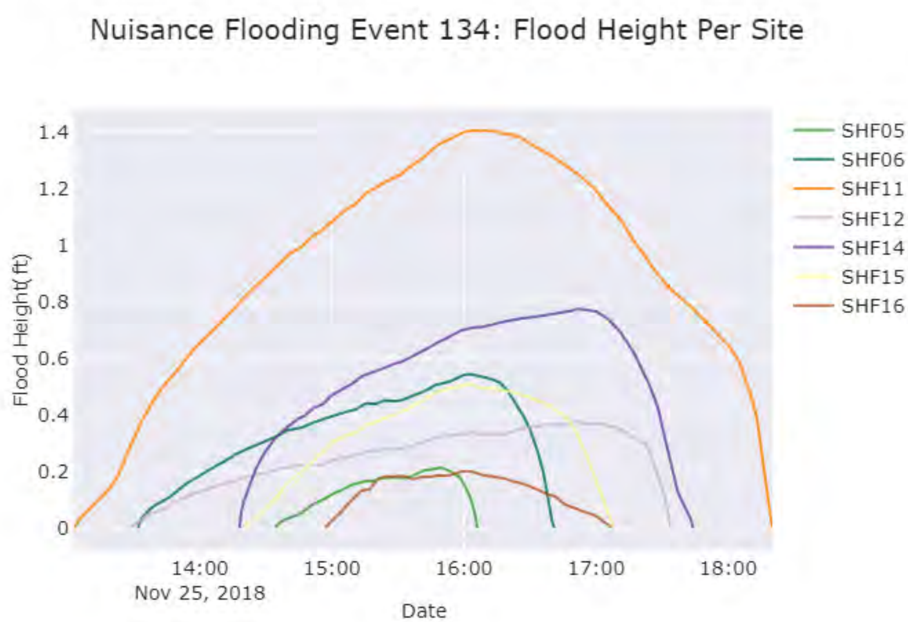


Figure 20. Nuisance Flooding Event 134 flood height above the surface of the stormwater grate per site

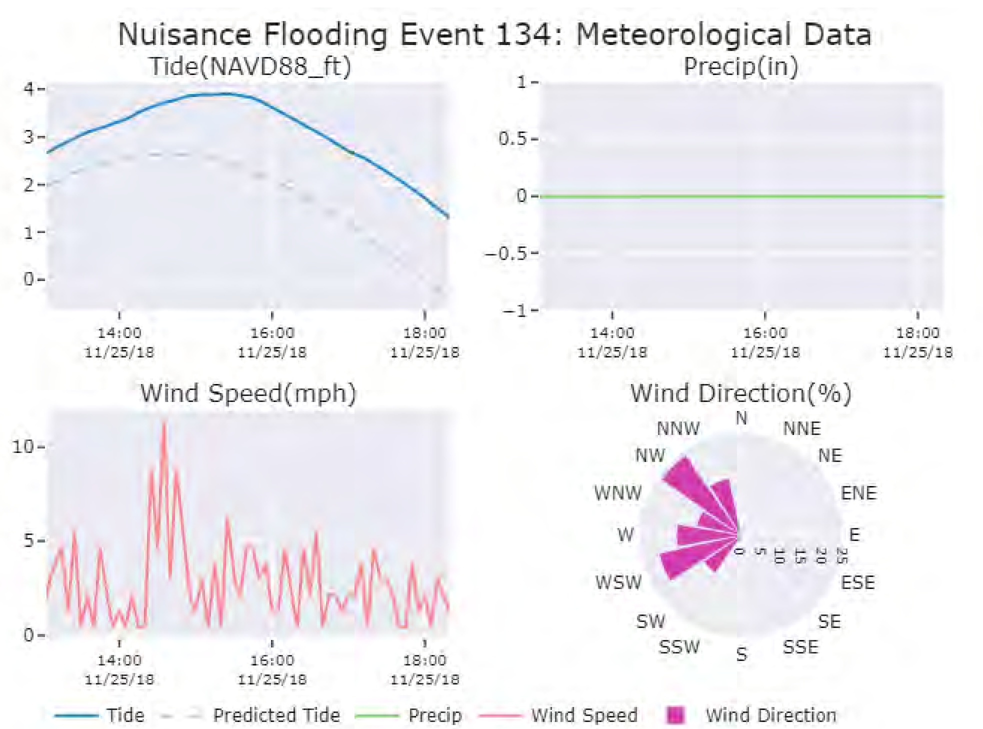


Figure 21. Nuisance Flooding Event 134 meteorological data

Storm Flooding Summary:

Storm Flooding Events are defined by water depth above the surface of the stormwater grate where precipitation has been recorded.

Storm flood data were parsed out from the whole dataset and Table 8 provides a summary of each site that includes total number of Individual Storm Flooding Events (column 2), the maximum event water depth in ft. (column 3) and the Storm Flooding Event identifier it occurred (column 4), the maximum event duration in hours (column 5) and the Storm Flooding Event identifier it occurred (column 6), the minimum event water depth in ft. (column 7) and the Storm Flooding Event identifier it occurred (column 8), the minimum event duration in hours (column 9) and the Storm Flooding Event identifier it occurred (column 10), the average event water depth in ft., and the average event duration in hours (columns 11&12). Of the 133 Storm Flooding Events, site SHF11 had the greatest occurrence with 107 Individual Storm Flooding Events, SHF14 had the greatest maximum water depth of 3.10 feet during Storm Flooding Event 119, and SHF02 had the greatest maximum duration of 21.67 hours during Storm Flooding Event 77 (Appendix B).

Table 8. Summary table for site Individual Storm Flooding Event totals and Storm Flooding Events maximum depth & duration, minimum depth & duration, and average depths and durations

Site	Total # of Events	Max Depth (ft)	Event # Max Depth	Max Dur. (hrs)	Event # Max Dur.	Min Depth (ft)	Event # Min Depth	Min Dur. (hrs)	Event # Min Dur.	Average Event Dephts	Average Dur. (hrs)
SHF01	11	0.66	229	2.25	113	0.22	200	0.23	240	0.39	0.47
SHF02	79	0.53	113	21.67	77	0.17	139	0.33	265	0.29	2.68
SHF03	22	1.03	128	1.58	113	0.25	263	0.07	263	0.59	0.30
SHF04	16	1.44	119	9.38	77	0.19	74	0.37	30	0.42	2.18
SHF05	29	1.35	119	9.43	77	0.17	15	0.33	208	0.38	1.32
SHF06	68	2.12	119	12.90	77	0.20	29	0.05	342	0.46	2.23
SHF07	15	1.28	119	8.42	77	0.17	190	0.12	208	0.28	0.82
SHF08	30	1.93	119	10.67	77	0.18	330	0.15	263	0.48	2.17
SHF09	2	1.12	119	3.87	119	0.67	77	3.32	77	0.89	3.59
SHF10	13	1.46	119	5.30	77	0.17	149	0.25	245	0.34	0.88
SHF11	107	2.99	119	17.55	77	0.17	222	0.15	202	0.55	3.75
SHF12	87	2.46	119	16.37	77	0.17	92	0.32	8	0.50	2.75
SHF13	13	2.28	119	10.32	77	0.19	354	1.52	354	0.30	2.22
SHF14	104	3.10	119	16.88	77	0.20	192	0.08	274	0.70	3.33
SHF15	33	2.38	119	12.57	77	0.17	130	1.72	112	0.37	3.05
SHF16	28	2.32	119	12.88	77	0.17	216	0.08	1	0.29	3.05

Table 9 provides a summary of each site that includes total number of Individual Storm Flooding Events and the percentage of total number of Storm Flooding Events, site frequency where Storm Flooding Events started and the percentage of the total number of Storm Flooding Events, and site frequency where Storm Flooding Events ended and the percentage of the total number of Storm Flooding Events. Site SHF11 had the greatest occurrence with 107 Individual Storm Flooding Events, had the greatest frequency where Storm Flooding started 60 of the 133 (45.11%), and had the greatest frequency where Storm Flooding Events ended 60 of the 133 (45.11%).

Table 9. Summary table for Individual Storm Flooding Events at the Stone Harbor sensor locations.

Site	Total # of Events	Percent Site Flooded	Event Started First	Percent Site Started First	Event Ended Last	Percent Site Ended Last
SHF01	11	1.67	0	0.00	0	0.00
SHF02	79	12.02	49	36.84	49	36.84
SHF03	22	3.35	2	1.50	2	1.50
SHF04	16	2.44	0	0.00	0	0.00
SHF05	29	4.41	0	0.00	0	0.00
SHF06	68	10.35	0	0.00	0	0.00
SHF07	15	2.28	0	0.00	0	0.00
SHF08	30	4.57	0	0.00	0	0.00
SHF09	2	0.30	0	0.00	0	0.00
SHF10	13	1.98	0	0.00	0	0.00
SHF11	107	16.29	60	45.11	60	45.11
SHF12	87	13.24	6	4.51	6	4.51
SHF13	13	1.98	0	0.00	0	0.00
SHF14	104	15.83	16	12.03	16	12.03
SHF15	33	5.02	0	0.00	0	0.00
SHF16	28	4.26	0	0.00	0	0.00

Table 10 provides the top five Storm Flooding Events defined by the greatest total number of sites affected by water depth above the surface of the stormwater grate where precipitation has been recorded. The top 3 Storm Flooding Events (Events 10, 77 and 119) affected 15 of the 16 sites each.

Table 10. Table of Top 5 Storm Flooding Events

Event	Date Start	Date End	Total Sites
10	2018-05-17 00:43:00	2018-05-17 05:04:00	15
77	2018-09-09 16:34:00	2018-09-10 18:23:00	15
119	2018-10-27 01:30:00	2018-10-27 20:45:00	15
168	2019-01-24 13:53:00	2019-01-24 19:13:00	13
128	2018-11-09 21:59:00	2018-11-10 02:59:00	13

Figures 22 through 27 display the flood and meteorological data for the top five Storm Flooding Events.

Storm Flooding Event 10 caused less than 1.2 feet of water depth above the surface of the stormwater grate at 14 of 16 sites on May 17, 2018 (Figure 22). The recorded tide was higher than the predicted tide for most of the event, minor (hundredths of an inch) precipitation during the beginning of the event, and winds from the East and East Northeast were 0-8 mph (Figure 23). Astronomical alignment that occurred within two days before and after the event included new moon, moon in perigee, and moon farthest north of equator.

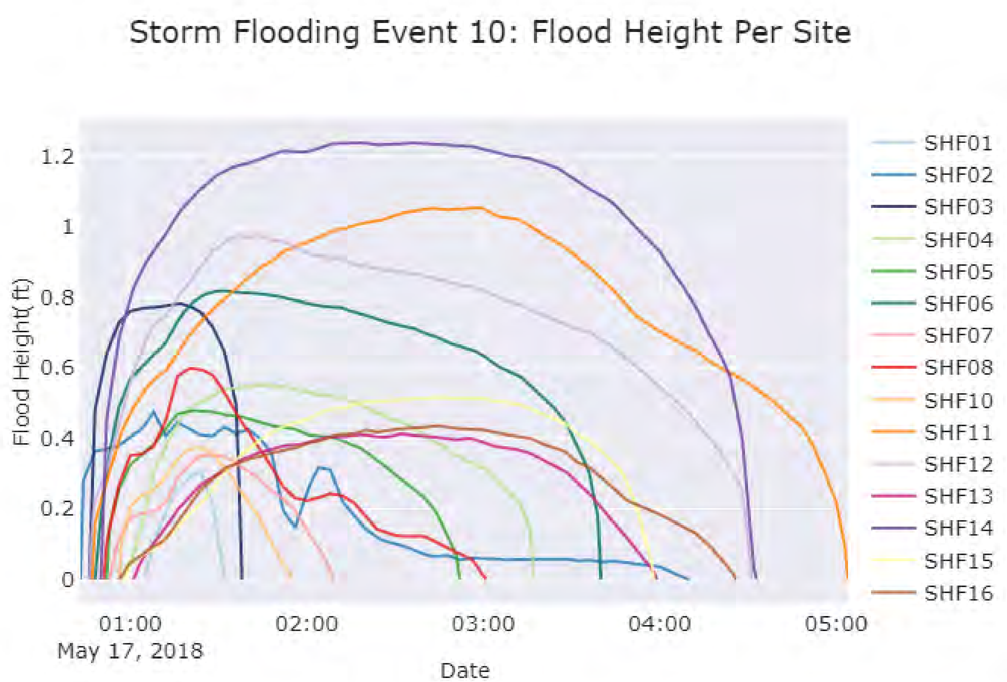


Figure 22. Storm Flooding Event 10 flood height above the surface of the stormwater grate per site.

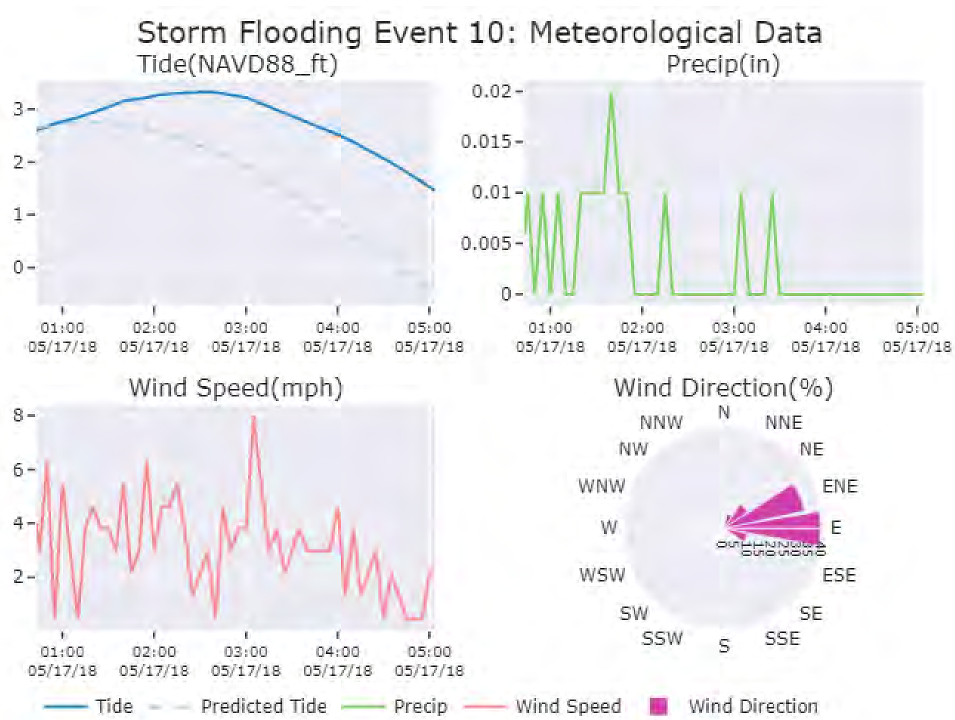


Figure 23. Storm Flooding Event 10 meteorological data

Storm Flooding Event 77 caused less than 2.5 foot of water depth above the surface of the stormwater grate at 13 of 16 sites on September 9, 2018 (Figure 24). The recorded tide was higher than the predicted tide for the entirety of the event, minor (hundredths of an inch) precipitation during the majority event, and winds from the East and East Northeast were 0-20 mph (Figure 25). This Event caused 13 of the 16 sites maximum duration. Astronomical alignment that occurred within two days before and after the event included moon in perigee, new moon, and moon on equator.

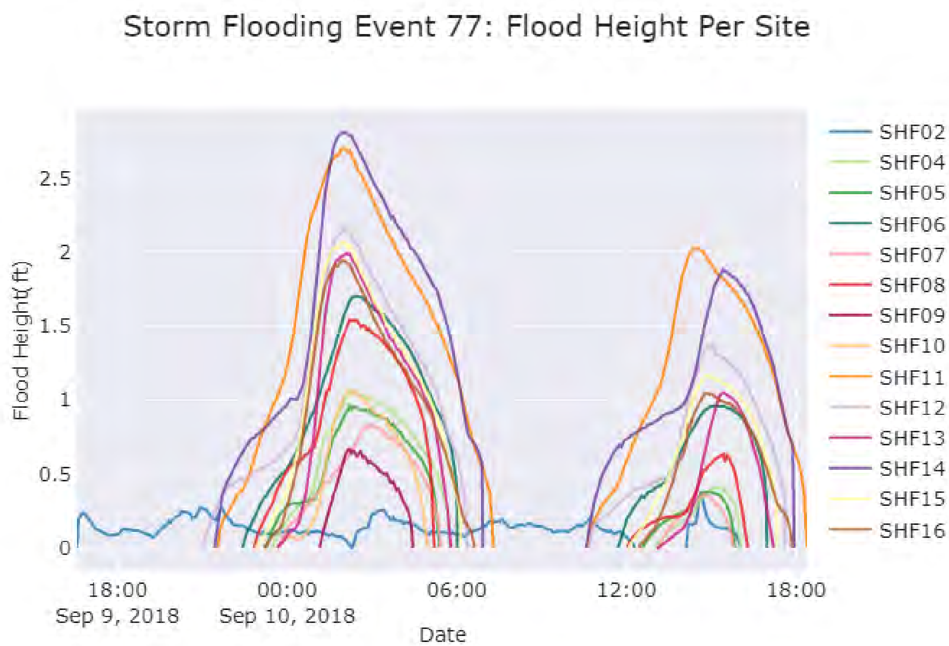


Figure 24. Storm Flooding Event 77 flood height above the surface of the stormwater grate per site

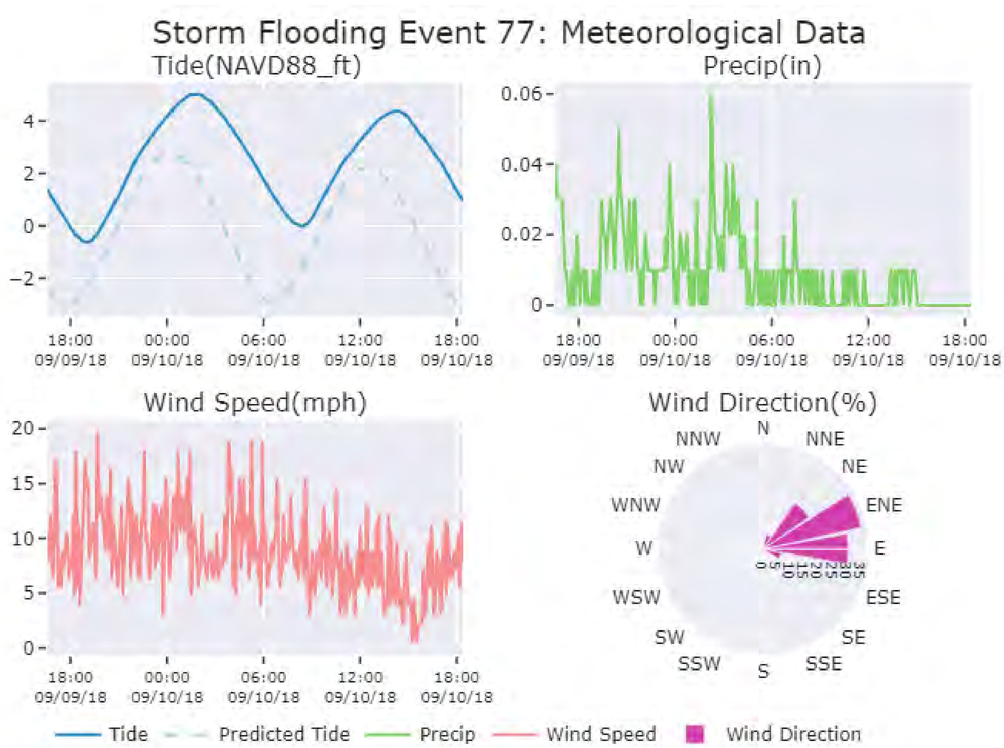


Figure 25. Storm Flooding Event 77 meteorological data

Storm Flooding Event 119 caused around 3 foot or less of water depth above the surface of the stormwater grate at 15 of 16 sites on October 27, 2018 (Figure 26). The recorded tide was higher than the predicted low tide for the entire event, minor (hundredths of an inch) precipitation during most of the event, and winds from the East and East Northeast were 0-25 mph (Figure 27). Astronomical alignment that occurred within two days before and after the event included moon farthest north of equator.

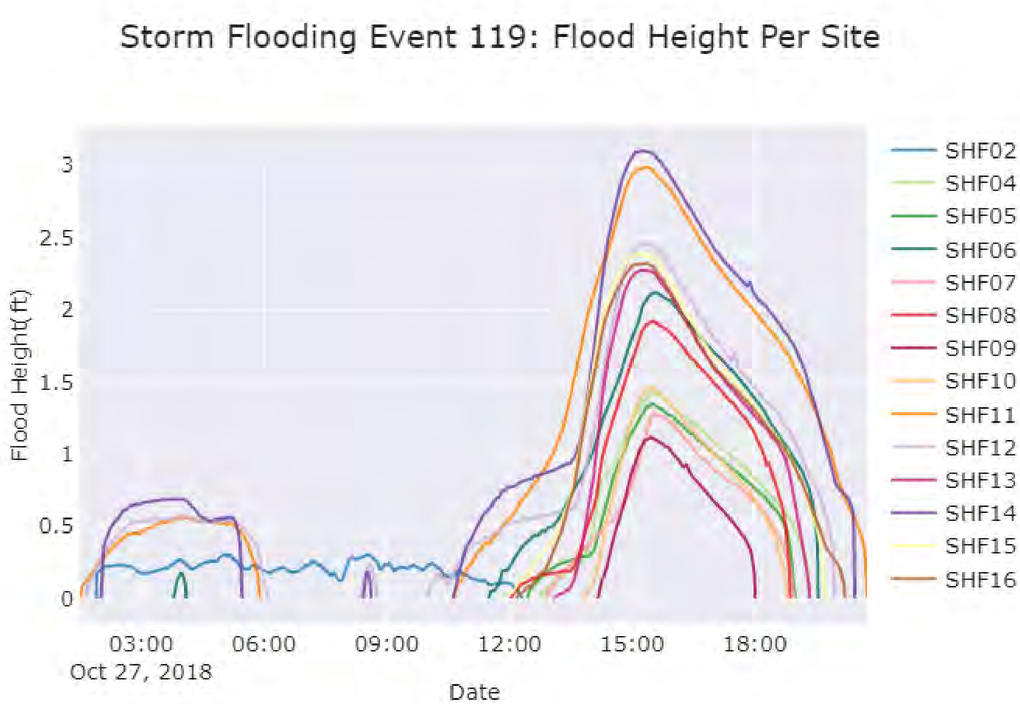


Figure 26. Storm Flooding Event 119 flood height above the surface of the stormwater grate per site

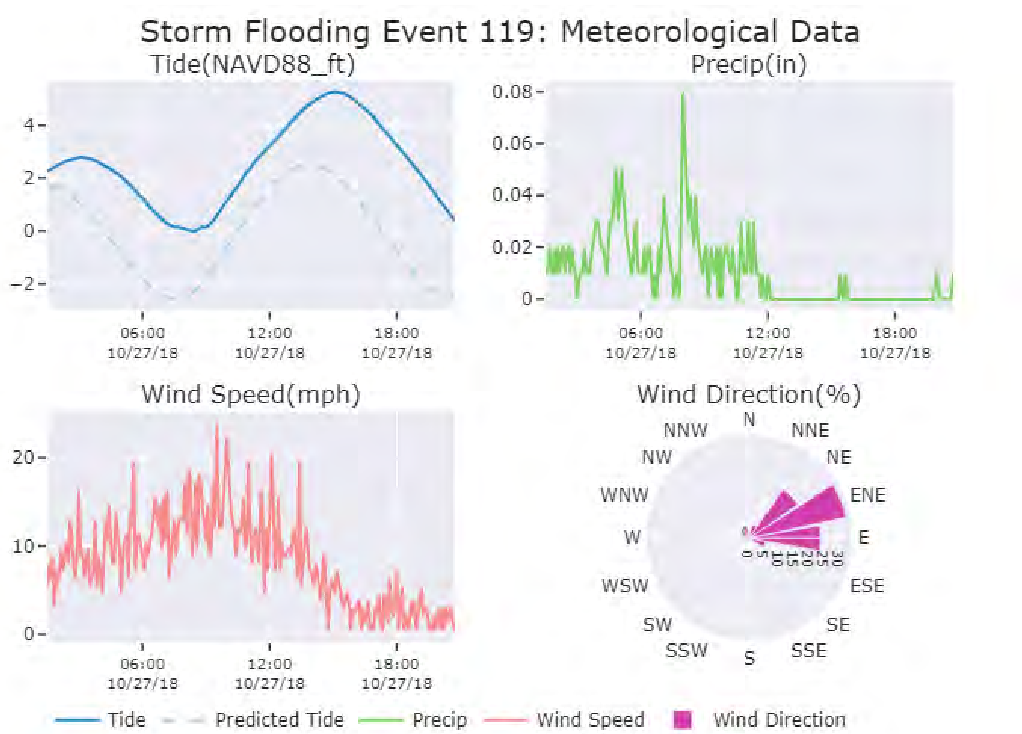


Figure 27. Storm Flooding Event 119 meteorological data

Storm Flooding Event 168 caused less than 1.2 feet of water depth above the surface of the stormwater grate at 13 of 16 sites January 24, 2019 (Figure 28). The recorded tide was higher than the predicted low tide, minor (hundredths of an inch) precipitation during the beginning of the event, and winds from the South Southwest were 0-15 mph (Figure 29). Astronomical alignments that occurred within two days before and after the event included moon on equator.

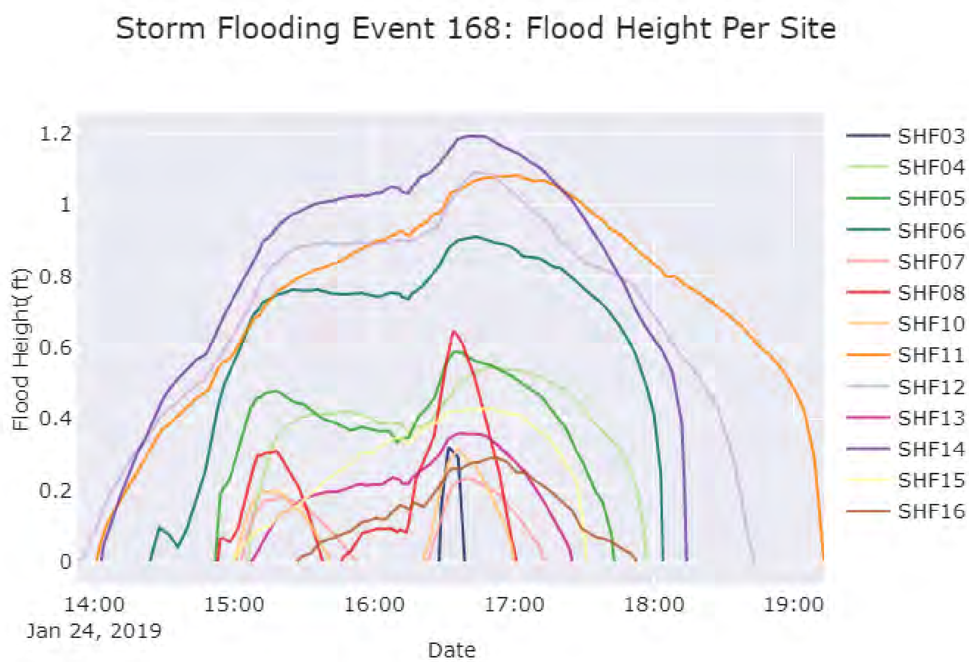


Figure 28. Storm Flooding Event 168 flood height above the surface of the stormwater grate per site

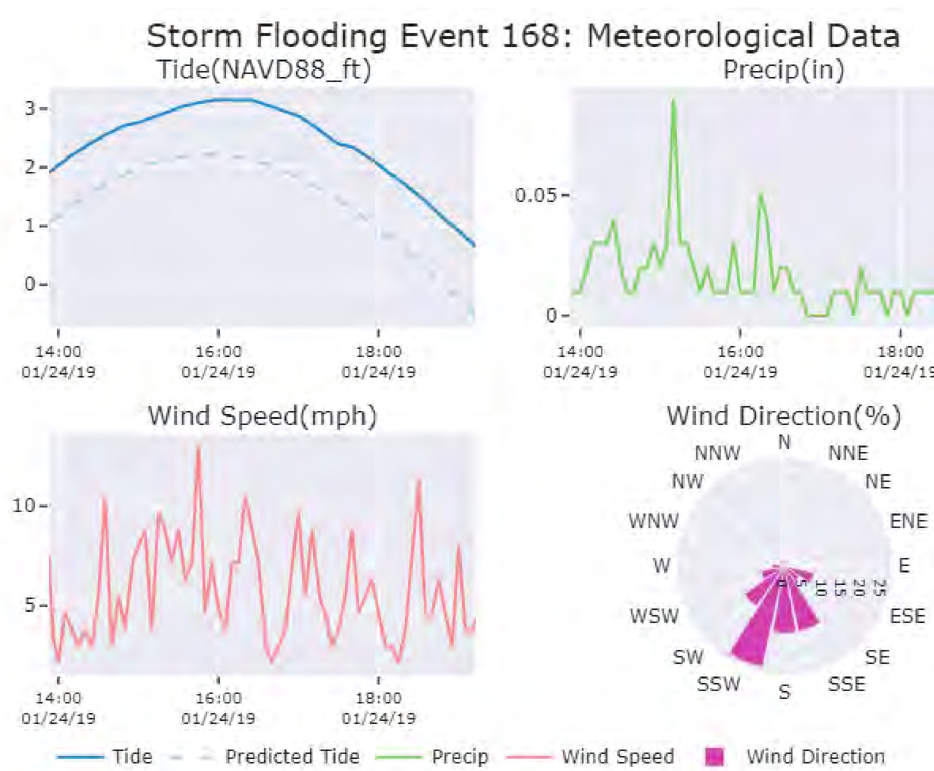


Figure 29. Storm Flooding Event 168 meteorological data

Storm Flooding Event 128 caused around 1 foot or less of water depth above the surface of the stormwater grate at 13 of 16 sites between November 9, 2018 and November 10, 2018 (Figure 30). The recorded tide was higher than the predicted low tide, moderate (tenths of an inch) precipitation during the beginning of the event, and 0-5 mph winds out of the Northwest (Figure 31). There were no astronomical alignments that occurred within two days before and after the event.

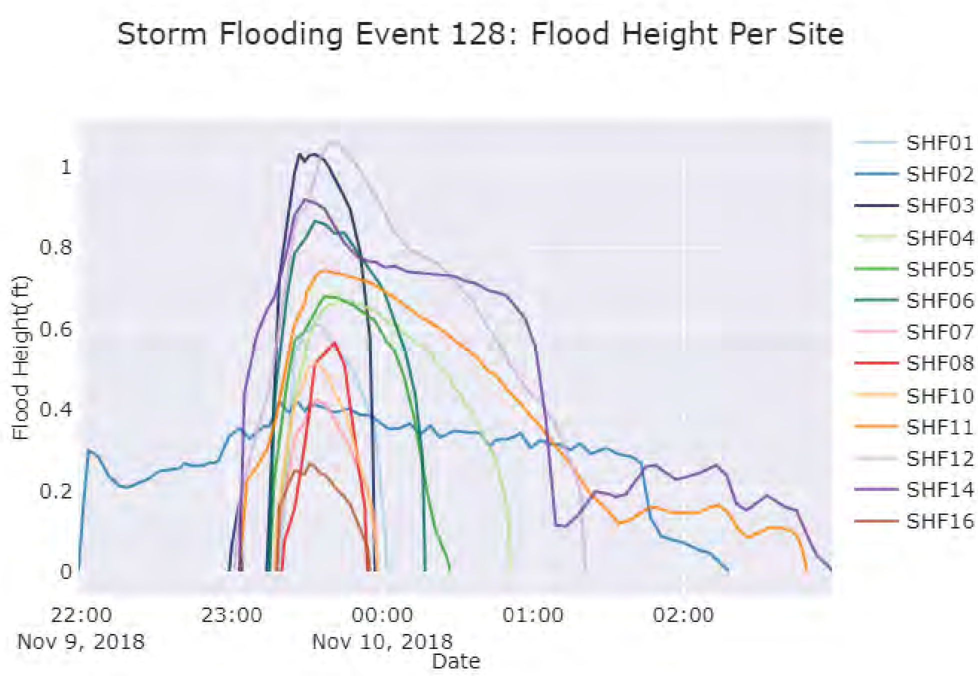


Figure 30. Storm Flooding Event 128 flood height above the surface of the stormwater grate per site

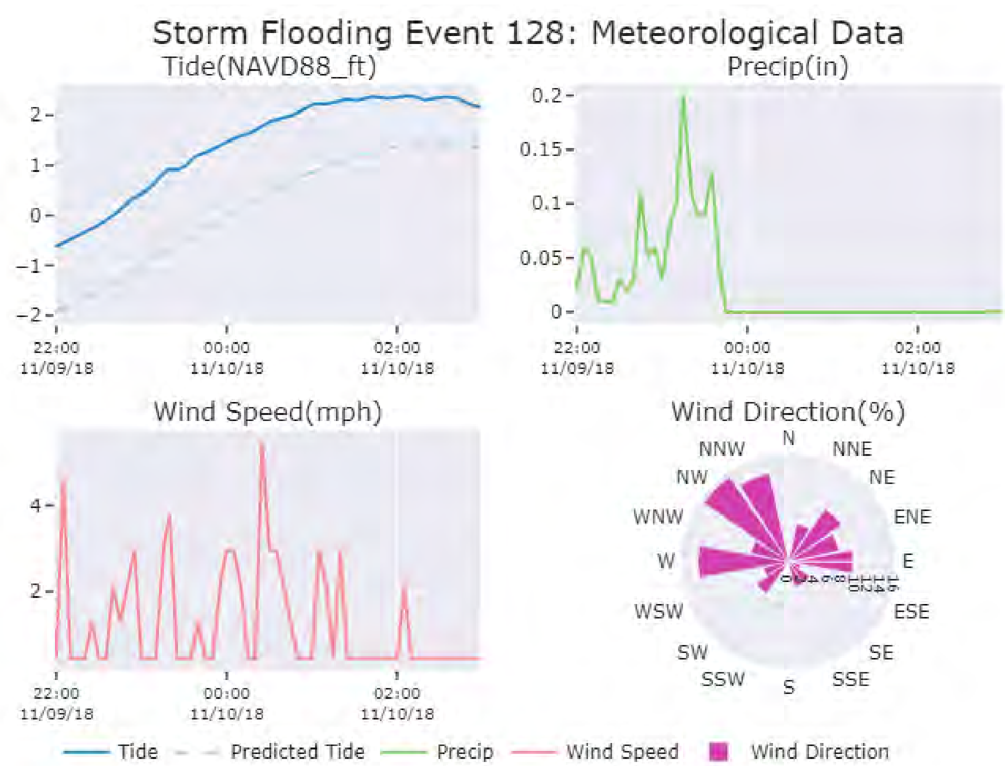


Figure 31. Storm Flooding Event 128 meteorological data

Conclusions:

The Stockton University Coastal Research Center observed the following characteristics of flooding within Stone Harbor Borough from the 18-month monitoring study:

1. The range of water depths during 368 Main Events of any type produced between 0.17 and 3.10 ft. of water. Average depths ranged between 0.28 and 0.89 ft. Average durations ranged between 1.18 and 3.59 hours.
2. The Sensors at sites SHF06, SHF07, SHF13 were all located at the bottom of their stormwater vault at public works request. The distance from the sensor to the surface of the stormwater grate was corrected to show Individual Events above the grates surface to be comparable to the other sites. Water depths for episodes occurring below the three stormwater grates can be generated with further analysis.
3. Sites SHF01, SHF02, and SHF03 were all above 5 ft. NAVD88, however, they recorded a higher than expected number of events. Site SHF02 was redesigned ~2 weeks prior to the completion of deployment 3 (February 13, 2019). Prior to the redesign, there was a total of 62 Individual Events. After the redesign, there was a total of 22 Individual Events. Of the total 84 Individual Events, 79 were classified as Storm Flooding (presence of precipitation). This suggests there is a drainage issue caused primarily by precipitation. The number of events declined after redesign, confirming that probability.
4. The remaining sites (SHF04, SHF05, SHF08, SHF09, SHF10, SHF11, SHF12, SHF14, SHF15, and SHF16) showed an anticipated relationship between a lower number of Individual Events as elevation increased. Of those sites, the two with the lowest elevations accounted for the two highest total number of Individual Events (SHF11 at 2.14 ft. NAVD88 had 328 events while SHF14 at 2.05 ft. NAVD88 had 175 events). This is further confirmed by site SHF09 at 4.05 ft. NAVD88 having only 2 events.
5. SHF02 was the 2nd highest to start flooding with 54 (14.67%) and ended flooding with 50 (13.59%). The first and third highest to start and end were SHF11 and SHF14, respectively. This further suggests a draining issue at site SHF02, compared to an elevation problem at SHF11 and SHF14.
6. 4 out of the top 5 Nuisance Flooding Events were affected most by northwest winds and had a higher recorded tide than predicted. This suggests that wind direction and tidal conditions could be predictive indicators for future Nuisance Flooding Events.

Some limitations exist in this preliminary study that require further analysis:

1. Main Events were defined by a single site or multiple sites in Stone Harbor recording water depths above the surface of the stormwater grate during the same time period. Since all sites were above elevation 2 ft. NAVD88*, many sites did not remain flooded for extended periods of time. If these sites are compared to other towns, such as Long Beach Island during the same time frame, elevations should be considered as well as the meteorological conditions when determining the classification between Nuisance Flooding Events and Storm Flooding Events.

**The three storm vaults (SHF06, SHF07 and SHF13) with sensors placed at the bottom of the vault were corrected to yield grate surface flooding events. The surface of the stormwater grate at SHF06 was 2.98 ft. NAVD88, SHF07 was 3.75 ft. NAVD88, and SHF13 was 2.81 ft. NAVD88.*

On many of New Jersey's barrier islands, low elevation roadways appear to be flooding more than in past decades. If predicted sea levels of 3.0 to 4.5 feet higher than today do become reality by 2100, the worst nuisance flood of today becomes normal high tide flooding twice every day. While this study was designed to quantify all flooding events in the Stone Harbor Borough between April 2018 and November 2019, further analysis of actionable data is required to specifically correlate Individual Events with unique causes (meteorological & astronomical) and flooding impacts to the surrounding area. This continued analysis can help communities assess future flood risk and may be useful in developing an early warning system.

Stone Harbor was unique in requesting the installation of a recording rain gauge at public works to more precisely characterize the accumulated rainfall volume in the Borough rather than rely on external, yet regional recording stations. The Rutgers University Cape May Courthouse station records precipitation on a 5-minute cumulation basis whereas the Stone Harbor rain gauge recorded rainfall on an hourly cumulative basis. Correlating the sensor records with the Cape May Court House data was far easier due to the similar time stamps, but each record for both the Cape May Court House and Stone Harbor on site rainfall information is collated in the appendix to provide direct comparison as to time, frequency and amount of rainfall recorded. It did not seem a prudent expenditure of time to attempt to correlate the Stone Harbor rain data with the event times after observing the relative similarity of the two sources. Both rainfall records are complete and could be subjected to a subsequent investigation at some point, perhaps by a local student.

Appendix A.

Event Date/Time:

Event	Start	End	Event	Start	End
1	2018-04-27 10:42:00	2018-04-27 12:20:00	51	2018-07-25 06:47:00	2018-07-25 10:09:00
2	2018-04-27 23:52:00	2018-04-28 00:53:00	52	2018-07-25 23:38:00	2018-07-26 01:30:00
3	2018-05-06 13:43:00	2018-05-06 15:18:00	53	2018-08-08 22:11:00	2018-08-09 00:44:00
4	2018-05-12 09:55:00	2018-05-12 10:55:00	54	2018-08-09 22:42:00	2018-08-10 02:16:00
5	2018-05-12 12:20:00	2018-05-12 13:19:00	55	2018-08-10 23:18:00	2018-08-11 03:28:00
6	2018-05-13 01:27:00	2018-05-13 03:33:00	56	2018-08-12 00:17:00	2018-08-12 04:23:00
7	2018-05-13 11:31:00	2018-05-13 13:45:00	57	2018-08-13 01:17:00	2018-08-13 05:04:00
8	2018-05-14 04:56:00	2018-05-14 07:25:00	58	2018-08-13 14:48:00	2018-08-13 16:22:00
9	2018-05-16 01:28:00	2018-05-16 07:14:00	59	2018-08-14 02:18:00	2018-08-14 05:32:00
10	2018-05-17 00:43:00	2018-05-17 05:04:00	60	2018-08-19 03:29:00	2018-08-19 07:15:00
11	2018-05-17 08:16:00	2018-05-17 12:16:00	61	2018-08-19 19:45:00	2018-08-19 22:28:00
12	2018-05-17 13:47:00	2018-05-17 15:16:00	62	2018-08-20 21:09:00	2018-08-20 22:59:00
13	2018-05-18 01:01:00	2018-05-18 05:28:00	63	2018-08-21 22:04:00	2018-08-21 23:56:00
14	2018-05-18 08:27:00	2018-05-18 21:21:00	64	2018-08-22 01:14:00	2018-08-22 02:29:00
15	2018-05-19 01:13:00	2018-05-19 07:37:00	65	2018-08-31 16:42:00	2018-08-31 18:12:00
16	2018-05-19 12:04:00	2018-05-19 17:16:00	66	2018-09-01 17:23:00	2018-09-01 18:39:00
17	2018-05-20 02:57:00	2018-05-20 06:34:00	67	2018-09-01 20:10:00	2018-09-01 21:41:00
18	2018-05-22 18:43:00	2018-05-22 19:40:00	68	2018-09-06 22:17:00	2018-09-06 23:53:00
19	2018-05-23 07:49:00	2018-05-23 08:52:00	69	2018-09-07 17:04:00	2018-09-07 17:45:00
20	2018-05-27 22:19:00	2018-05-28 04:50:00	70	2018-09-07 22:21:00	2018-09-08 01:56:00
21	2018-05-28 11:16:00	2018-05-28 13:25:00	71	2018-09-08 11:19:00	2018-09-08 13:51:00
22	2018-05-29 00:31:00	2018-05-29 02:21:00	72	2018-09-08 14:05:00	2018-09-08 15:52:00
23	2018-05-31 02:07:00	2018-05-31 03:39:00	73	2018-09-08 18:39:00	2018-09-08 19:48:00
24	2018-06-03 17:12:00	2018-06-03 20:10:00	74	2018-09-08 22:11:00	2018-09-09 04:11:00
25	2018-06-03 20:57:00	2018-06-04 00:51:00	75	2018-09-09 05:06:00	2018-09-09 06:27:00
26	2018-06-04 01:45:00	2018-06-04 08:21:00	76	2018-09-09 07:51:00	2018-09-09 16:19:00
27	2018-06-04 16:00:00	2018-06-04 18:33:00	77	2018-09-09 16:34:00	2018-09-10 18:23:00
28	2018-06-05 04:16:00	2018-06-05 07:13:00	78	2018-09-10 23:04:00	2018-09-11 05:47:00
29	2018-06-09 18:39:00	2018-06-09 19:53:00	79	2018-09-11 12:09:00	2018-09-11 17:16:00
30	2018-06-10 22:36:00	2018-06-11 02:29:00	80	2018-09-12 01:23:00	2018-09-12 05:00:00
31	2018-06-11 09:22:00	2018-06-11 12:22:00	81	2018-09-12 14:10:00	2018-09-12 17:12:00
32	2018-06-11 22:07:00	2018-06-12 01:57:00	82	2018-09-13 02:27:00	2018-09-13 05:19:00
33	2018-06-12 23:40:00	2018-06-13 02:21:00	83	2018-09-13 09:25:00	2018-09-13 10:49:00
34	2018-06-14 00:36:00	2018-06-14 03:09:00	84	2018-09-13 15:00:00	2018-09-13 18:27:00
35	2018-06-15 01:11:00	2018-06-15 04:30:00	85	2018-09-14 03:50:00	2018-09-14 06:08:00
36	2018-06-16 01:35:00	2018-06-16 05:50:00	86	2018-09-14 15:42:00	2018-09-14 19:22:00
37	2018-06-17 03:08:00	2018-06-17 05:50:00	87	2018-09-15 17:17:00	2018-09-15 19:17:00
38	2018-06-18 04:27:00	2018-06-18 06:05:00	88	2018-09-18 22:34:00	2018-09-19 01:05:00
39	2018-06-23 22:01:00	2018-06-23 23:51:00	89	2018-09-19 20:40:00	2018-09-19 23:41:00
40	2018-06-29 01:42:00	2018-06-29 03:18:00	90	2018-09-20 21:22:00	2018-09-21 00:51:00
41	2018-07-11 22:51:00	2018-07-12 02:47:00	91	2018-09-21 23:05:00	2018-09-22 00:24:00
42	2018-07-12 23:43:00	2018-07-13 03:30:00	92	2018-09-23 15:42:00	2018-09-24 02:31:00
43	2018-07-14 00:48:00	2018-07-14 04:13:00	93	2018-09-24 03:29:00	2018-09-24 14:46:00
44	2018-07-15 02:07:00	2018-07-15 04:49:00	94	2018-09-24 23:17:00	2018-09-25 04:40:00
45	2018-07-16 02:55:00	2018-07-16 05:41:00	95	2018-09-25 11:08:00	2018-09-25 16:30:00
46	2018-07-17 04:31:00	2018-07-17 05:47:00	96	2018-09-26 00:57:00	2018-09-26 03:15:00
47	2018-07-17 23:09:00	2018-07-18 00:49:00	97	2018-09-26 13:36:00	2018-09-26 15:53:00
48	2018-07-21 18:58:00	2018-07-21 23:42:00	98	2018-09-27 14:36:00	2018-09-27 16:20:00
49	2018-07-22 00:47:00	2018-07-22 03:57:00	99	2018-09-28 02:47:00	2018-09-28 04:36:00
50	2018-07-22 19:54:00	2018-07-22 23:21:00	100	2018-09-28 14:33:00	2018-09-28 16:47:00

Event	Start	End	Event	Start	End
101	2018-10-03 19:56:00	2018-10-03 21:20:00	151	2018-12-22 11:04:00	2018-12-22 14:30:00
102	2018-10-04 20:58:00	2018-10-04 22:50:00	152	2018-12-24 13:29:00	2018-12-24 16:42:00
103	2018-10-05 20:53:00	2018-10-06 01:28:00	153	2018-12-25 14:57:00	2018-12-25 16:54:00
104	2018-10-06 10:47:00	2018-10-06 12:16:00	154	2018-12-26 16:09:00	2018-12-26 17:30:00
105	2018-10-06 22:22:00	2018-10-07 01:27:00	155	2018-12-28 11:21:00	2018-12-28 19:02:00
106	2018-10-07 23:57:00	2018-10-08 01:32:00	156	2018-12-28 19:48:00	2018-12-29 00:32:00
107	2018-10-08 12:51:00	2018-10-08 14:02:00	157	2018-12-31 21:45:00	2019-01-01 02:35:00
108	2018-10-09 00:01:00	2018-10-09 03:26:00	158	2019-01-01 04:38:00	2019-01-01 10:53:00
109	2018-10-09 12:49:00	2018-10-09 15:28:00	159	2019-01-05 11:45:00	2019-01-05 15:35:00
110	2018-10-10 14:07:00	2018-10-10 15:33:00	160	2019-01-05 20:53:00	2019-01-05 22:22:00
111	2018-10-11 11:18:00	2018-10-11 12:30:00	161	2019-01-06 12:44:00	2019-01-06 15:47:00
112	2018-10-11 12:46:00	2018-10-11 17:24:00	162	2019-01-08 14:15:00	2019-01-08 16:39:00
113	2018-10-12 01:20:00	2018-10-12 10:31:00	163	2019-01-18 10:15:00	2019-01-18 12:08:00
114	2018-10-12 13:08:00	2018-10-12 19:12:00	164	2019-01-19 11:05:00	2019-01-19 13:19:00
115	2018-10-13 03:29:00	2018-10-13 05:02:00	165	2019-01-20 08:24:00	2019-01-20 09:02:00
116	2018-10-13 15:11:00	2018-10-13 18:32:00	166	2019-01-20 09:39:00	2019-01-20 17:23:00
117	2018-10-15 13:14:00	2018-10-15 14:25:00	167	2019-01-23 13:49:00	2019-01-23 16:13:00
118	2018-10-21 02:46:00	2018-10-21 04:08:00	168	2019-01-24 13:53:00	2019-01-24 19:13:00
119	2018-10-27 01:30:00	2018-10-27 20:45:00	169	2019-02-08 15:24:00	2019-02-08 16:29:00
120	2018-10-28 01:37:00	2018-10-28 04:54:00	170	2019-02-12 15:47:00	2019-02-12 18:08:00
121	2018-10-28 14:01:00	2018-10-28 17:15:00	171	2019-02-13 05:00:00	2019-02-13 08:28:00
122	2018-11-03 06:18:00	2018-11-03 09:53:00	172	2019-02-16 08:06:00	2019-02-16 12:32:00
123	2018-11-05 14:26:00	2018-11-06 02:02:00	173	2019-02-17 09:16:00	2019-02-17 14:12:00
124	2018-11-06 10:37:00	2018-11-06 14:56:00	174	2019-02-18 09:38:00	2019-02-18 15:25:00
125	2018-11-06 20:35:00	2018-11-07 01:11:00	175	2019-02-19 11:39:00	2019-02-19 15:17:00
126	2018-11-07 12:21:00	2018-11-07 14:29:00	176	2019-02-20 12:38:00	2019-02-20 15:48:00
127	2018-11-09 13:21:00	2018-11-09 17:03:00	177	2019-02-21 00:53:00	2019-02-21 04:15:00
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129	2018-11-10 14:00:00	2018-11-10 16:18:00	179	2019-02-22 02:15:00	2019-02-22 04:12:00
130	2018-11-15 16:10:00	2018-11-16 10:02:00	180	2019-02-23 02:47:00	2019-02-23 05:27:00
131	2018-11-23 13:02:00	2018-11-23 14:51:00	181	2019-02-23 14:59:00	2019-02-23 17:47:00
132	2018-11-24 12:50:00	2018-11-24 16:15:00	182	2019-02-24 03:26:00	2019-02-24 07:08:00
133	2018-11-24 23:23:00	2018-11-25 05:21:00	183	2019-02-24 14:58:00	2019-02-24 19:28:00
134	2018-11-25 13:03:00	2018-11-25 18:20:00	184	2019-02-25 04:26:00	2019-02-25 06:19:00
135	2018-11-26 13:39:00	2018-11-26 21:48:00	185	2019-03-02 08:24:00	2019-03-02 13:42:00
136	2018-11-27 02:06:00	2018-11-27 05:08:00	186	2019-03-03 10:14:00	2019-03-03 12:51:00
137	2018-11-27 15:07:00	2018-11-27 18:30:00	187	2019-03-03 22:39:00	2019-03-04 01:41:00
138	2018-11-30 18:57:00	2018-11-30 20:48:00	188	2019-03-04 03:38:00	2019-03-04 04:33:00
139	2018-12-02 02:58:00	2018-12-02 11:16:00	189	2019-03-04 09:22:00	2019-03-04 14:57:00
140	2018-12-02 20:04:00	2018-12-02 22:55:00	190	2019-03-10 13:21:00	2019-03-10 17:31:00
141	2018-12-03 09:34:00	2018-12-03 11:38:00	191	2019-03-11 02:06:00	2019-03-11 06:00:00
142	2018-12-05 11:11:00	2018-12-05 14:17:00	192	2019-03-21 12:48:00	2019-03-21 15:41:00
143	2018-12-06 12:14:00	2018-12-06 14:17:00	193	2019-03-22 00:20:00	2019-03-22 06:07:00
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145	2018-12-15 08:43:00	2018-12-15 15:24:00	195	2019-03-23 02:03:00	2019-03-23 04:04:00
146	2018-12-16 03:15:00	2018-12-16 14:58:00	196	2019-04-10 03:59:00	2019-04-10 06:09:00
147	2018-12-16 15:16:00	2018-12-17 01:19:00	197	2019-04-15 08:33:00	2019-04-15 11:04:00
148	2018-12-17 06:38:00	2018-12-17 10:10:00	198	2019-04-18 12:14:00	2019-04-18 14:05:00
149	2018-12-21 03:09:00	2018-12-21 17:49:00	199	2019-04-19 00:18:00	2019-04-19 02:51:00
150	2018-12-21 22:35:00	2018-12-22 02:02:00	200	2019-04-20 01:11:00	2019-04-20 05:14:00

Event	Start	End	Event	Start	End
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202	2019-04-20 10:59:00	2019-04-20 11:36:00	252	2019-07-06 02:52:00	2019-07-06 05:45:00
203	2019-04-20 12:30:00	2019-04-20 15:02:00	253	2019-07-07 02:44:00	2019-07-07 06:10:00
204	2019-04-21 01:35:00	2019-04-21 04:11:00	254	2019-07-08 04:24:00	2019-07-08 07:50:00
205	2019-04-22 02:52:00	2019-04-22 04:40:00	255	2019-07-08 17:35:00	2019-07-08 19:45:00
206	2019-04-23 03:23:00	2019-04-23 05:25:00	256	2019-07-12 01:51:00	2019-07-12 02:22:00
207	2019-04-26 18:42:00	2019-04-26 20:00:00	257	2019-07-12 20:42:00	2019-07-12 23:40:00
208	2019-05-03 00:18:00	2019-05-03 01:15:00	258	2019-07-13 22:38:00	2019-07-14 00:34:00
209	2019-05-06 00:13:00	2019-05-06 05:56:00	259	2019-07-14 23:39:00	2019-07-15 01:12:00
210	2019-05-06 13:00:00	2019-05-06 15:41:00	260	2019-07-16 00:19:00	2019-07-16 01:56:00
211	2019-05-07 01:33:00	2019-05-07 04:44:00	261	2019-07-17 01:08:00	2019-07-17 02:44:00
212	2019-05-09 03:46:00	2019-05-09 05:32:00	262	2019-07-18 03:59:00	2019-07-18 04:44:00
213	2019-05-10 04:34:00	2019-05-10 06:25:00	263	2019-07-23 05:22:00	2019-07-23 06:13:00
214	2019-05-12 05:38:00	2019-05-12 08:22:00	264	2019-07-30 23:21:00	2019-07-31 01:54:00
215	2019-05-12 17:13:00	2019-05-12 23:32:00	265	2019-07-31 23:57:00	2019-08-01 03:15:00
216	2019-05-13 05:03:00	2019-05-13 12:24:00	266	2019-08-02 00:38:00	2019-08-02 04:21:00
217	2019-05-13 18:36:00	2019-05-13 23:46:00	267	2019-08-03 01:40:00	2019-08-03 05:12:00
218	2019-05-14 06:53:00	2019-05-14 12:20:00	268	2019-08-04 02:32:00	2019-08-04 05:50:00
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220	2019-05-15 09:01:00	2019-05-15 11:51:00	270	2019-08-05 17:01:00	2019-08-05 18:16:00
221	2019-05-15 21:49:00	2019-05-16 00:55:00	271	2019-08-06 04:44:00	2019-08-06 06:39:00
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223	2019-05-16 22:51:00	2019-05-17 01:32:00	273	2019-08-07 18:41:00	2019-08-07 20:08:00
224	2019-05-17 11:31:00	2019-05-17 13:11:00	274	2019-08-07 23:15:00	2019-08-08 00:02:00
225	2019-05-17 23:48:00	2019-05-18 02:28:00	275	2019-08-08 00:14:00	2019-08-08 01:23:00
226	2019-05-19 00:36:00	2019-05-19 03:15:00	276	2019-08-08 19:22:00	2019-08-08 21:30:00
227	2019-05-20 01:30:00	2019-05-20 03:45:00	277	2019-08-09 20:28:00	2019-08-09 22:15:00
228	2019-05-26 05:58:00	2019-05-26 07:01:00	278	2019-08-13 22:09:00	2019-08-13 22:51:00
229	2019-05-29 01:22:00	2019-05-29 02:03:00	279	2019-08-13 23:33:00	2019-08-14 01:26:00
230	2019-05-30 00:15:00	2019-05-30 00:38:00	280	2019-08-14 20:55:00	2019-08-14 21:35:00
231	2019-05-30 22:05:00	2019-05-31 00:11:00	281	2019-08-14 23:08:00	2019-08-15 03:06:00
232	2019-06-01 23:20:00	2019-06-02 01:58:00	282	2019-08-16 00:33:00	2019-08-16 04:01:00
233	2019-06-02 23:40:00	2019-06-03 02:56:00	283	2019-08-17 01:28:00	2019-08-17 03:55:00
234	2019-06-04 00:51:00	2019-06-04 02:59:00	284	2019-08-18 02:31:00	2019-08-18 04:12:00
235	2019-06-05 01:44:00	2019-06-05 03:53:00	285	2019-08-25 18:57:00	2019-08-26 00:41:00
236	2019-06-07 03:15:00	2019-06-07 05:49:00	286	2019-08-26 07:31:00	2019-08-26 11:17:00
237	2019-06-08 04:08:00	2019-06-08 06:30:00	287	2019-08-26 19:58:00	2019-08-27 01:04:00
238	2019-06-09 05:11:00	2019-06-09 07:30:00	288	2019-08-27 21:09:00	2019-08-28 01:45:00
239	2019-06-10 06:08:00	2019-06-10 08:33:00	289	2019-08-28 22:05:00	2019-08-29 02:35:00
240	2019-06-13 09:28:00	2019-06-13 13:07:00	290	2019-08-29 23:17:00	2019-08-30 03:21:00
241	2019-06-13 21:03:00	2019-06-14 01:36:00	291	2019-08-31 00:32:00	2019-08-31 03:32:00
242	2019-06-18 01:20:00	2019-06-18 03:19:00	292	2019-09-01 01:21:00	2019-09-01 04:38:00
243	2019-06-19 01:51:00	2019-06-19 04:09:00	293	2019-09-01 14:23:00	2019-09-01 16:29:00
244	2019-06-20 02:22:00	2019-06-20 05:01:00	294	2019-09-02 02:13:00	2019-09-02 05:28:00
245	2019-06-21 01:08:00	2019-06-21 06:25:00	295	2019-09-02 14:56:00	2019-09-02 17:30:00
246	2019-06-22 03:08:00	2019-06-22 06:05:00	296	2019-09-03 01:59:00	2019-09-03 02:25:00
247	2019-06-30 23:08:00	2019-07-01 01:22:00	297	2019-09-03 02:48:00	2019-09-03 05:29:00
248	2019-07-01 23:32:00	2019-07-02 02:28:00	298	2019-09-03 15:45:00	2019-09-03 18:34:00
249	2019-07-03 00:15:00	2019-07-03 03:33:00	299	2019-09-04 16:55:00	2019-09-04 18:56:00
250	2019-07-04 00:52:00	2019-07-04 04:49:00	300	2019-09-05 17:31:00	2019-09-05 20:00:00

Event	Start	End
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302	2019-09-07 06:05:00	2019-09-07 10:28:00
303	2019-09-07 18:42:00	2019-09-07 23:01:00
304	2019-09-12 23:10:00	2019-09-13 03:00:00
305	2019-09-13 12:23:00	2019-09-13 14:46:00
306	2019-09-14 00:00:00	2019-09-14 03:29:00
307	2019-09-15 13:07:00	2019-09-15 13:42:00
308	2019-09-17 14:36:00	2019-09-17 16:42:00
309	2019-09-18 14:50:00	2019-09-18 18:14:00
310	2019-09-19 03:03:00	2019-09-19 06:36:00
311	2019-09-19 15:30:00	2019-09-19 18:33:00
312	2019-09-24 21:06:00	2019-09-24 22:55:00
313	2019-09-25 21:25:00	2019-09-26 00:50:00
314	2019-09-26 22:20:00	2019-09-27 01:38:00
315	2019-09-27 11:44:00	2019-09-27 13:12:00
316	2019-09-27 23:19:00	2019-09-28 02:41:00
317	2019-09-28 12:25:00	2019-09-28 14:10:00
318	2019-09-29 00:27:00	2019-09-29 03:06:00
319	2019-09-29 13:07:00	2019-09-29 15:37:00
320	2019-09-30 01:00:00	2019-09-30 04:25:00
321	2019-09-30 13:18:00	2019-09-30 17:29:00
322	2019-10-01 02:03:00	2019-10-01 04:49:00
323	2019-10-01 14:15:00	2019-10-01 17:50:00
324	2019-10-02 15:54:00	2019-10-02 17:42:00
325	2019-10-03 14:55:00	2019-10-03 21:41:00
326	2019-10-04 17:34:00	2019-10-04 19:35:00
327	2019-10-05 17:47:00	2019-10-05 20:49:00
328	2019-10-08 20:59:00	2019-10-09 00:21:00
329	2019-10-09 09:36:00	2019-10-09 13:01:00
330	2019-10-09 20:36:00	2019-10-10 03:29:00
331	2019-10-10 09:13:00	2019-10-10 15:05:00
332	2019-10-10 20:17:00	2019-10-11 07:07:00
333	2019-10-11 07:44:00	2019-10-11 17:56:00
334	2019-10-11 20:17:00	2019-10-12 06:50:00
335	2019-10-12 09:00:00	2019-10-12 16:47:00
336	2019-10-12 22:20:00	2019-10-13 03:24:00
337	2019-10-13 12:13:00	2019-10-13 14:37:00
338	2019-10-14 00:04:00	2019-10-14 02:50:00
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340	2019-10-15 13:46:00	2019-10-15 15:37:00
341	2019-10-16 13:40:00	2019-10-16 16:39:00
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343	2019-10-19 15:29:00	2019-10-19 17:50:00
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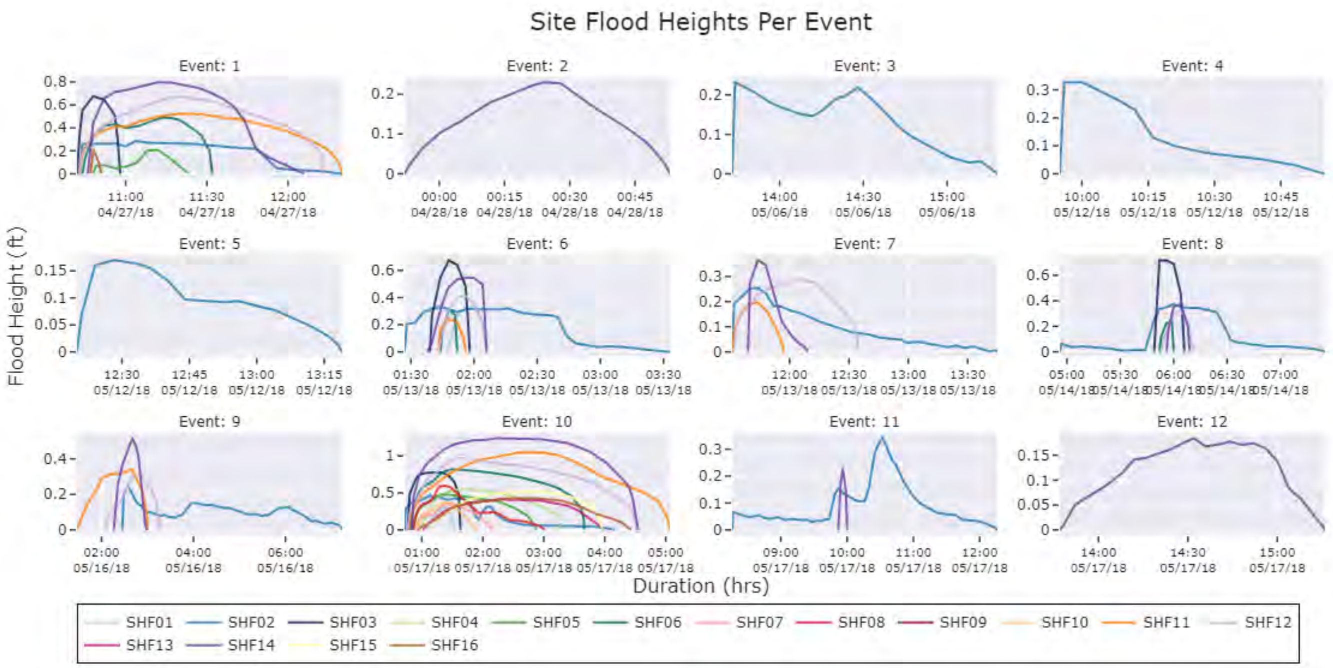
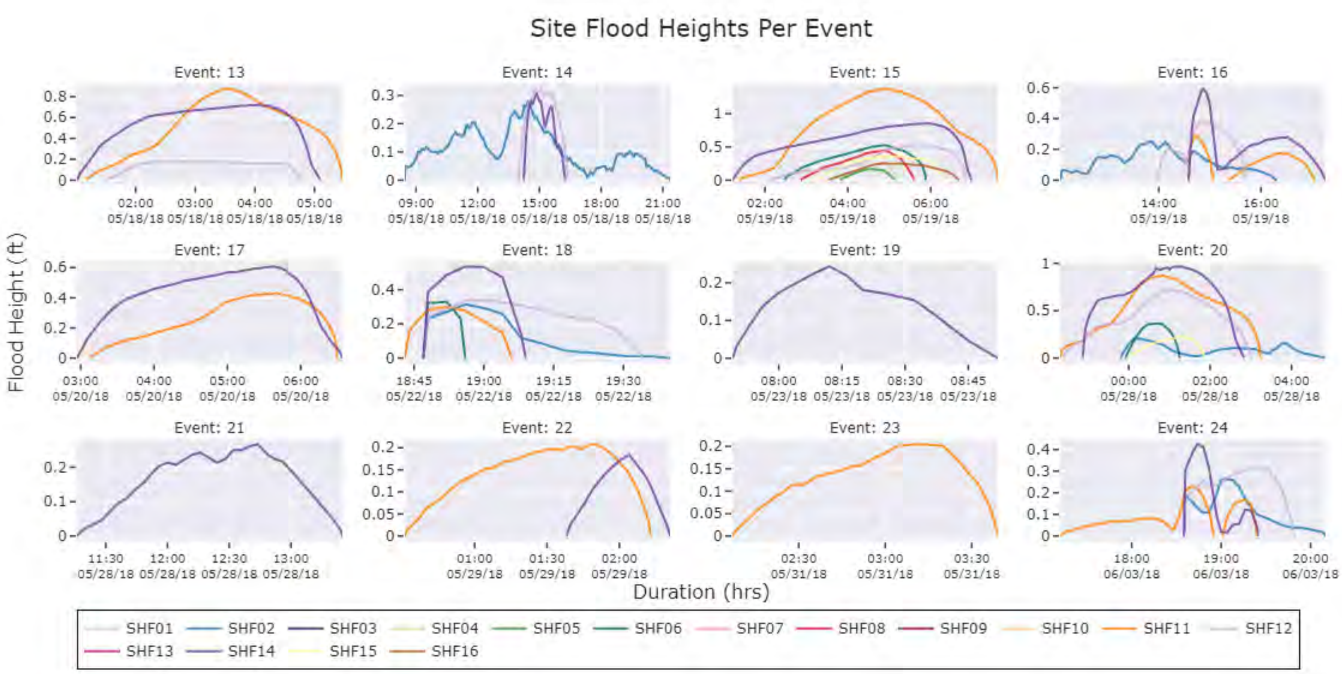
345	2019-10-21 04:53:00	2019-10-21 08:07:00
346	2019-10-21 16:16:00	2019-10-21 22:11:00
347	2019-10-22 17:42:00	2019-10-22 22:26:00
348	2019-10-23 19:30:00	2019-10-23 22:24:00
349	2019-10-26 23:27:00	2019-10-27 01:39:00
350	2019-10-27 11:03:00	2019-10-27 17:39:00

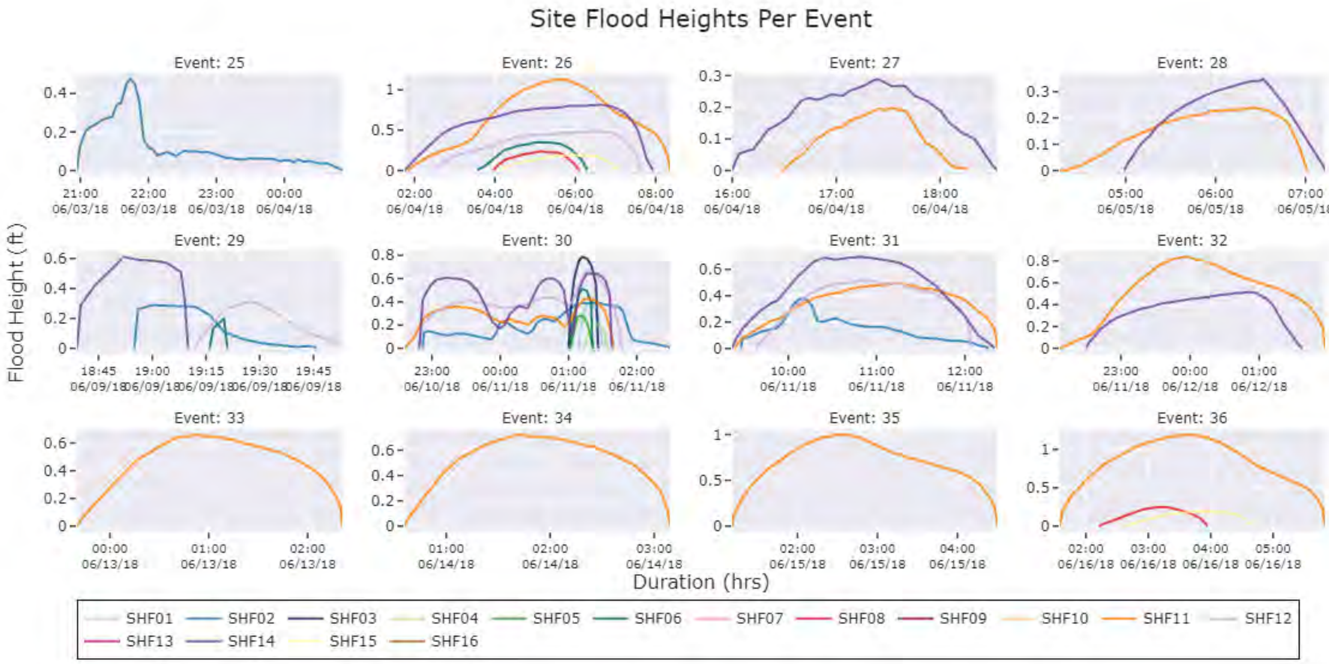
Event	Start	End
351	2019-10-27 23:15:00	2019-10-28 02:26:00
352	2019-10-28 11:58:00	2019-10-28 16:14:00
353	2019-10-29 01:04:00	2019-10-29 03:20:00
354	2019-10-29 12:12:00	2019-10-29 18:15:00
355	2019-10-30 01:21:00	2019-10-30 03:37:00
356	2019-10-30 12:54:00	2019-10-30 17:53:00
357	2019-10-31 02:17:00	2019-10-31 04:09:00
358	2019-10-31 13:20:00	2019-10-31 18:12:00
359	2019-11-01 05:12:00	2019-11-01 06:27:00
360	2019-11-02 16:55:00	2019-11-02 18:22:00
361	2019-11-16 14:36:00	2019-11-16 19:29:00
362	2019-11-17 04:01:00	2019-11-17 06:08:00
363	2019-11-17 14:48:00	2019-11-17 20:56:00
364	2019-11-18 03:04:00	2019-11-18 08:37:00
365	2019-11-18 14:20:00	2019-11-18 22:34:00
366	2019-11-19 04:19:00	2019-11-19 07:58:00
367	2019-11-19 16:18:00	2019-11-19 20:56:00
368	2019-11-24 08:46:00	2019-11-24 14:05:00

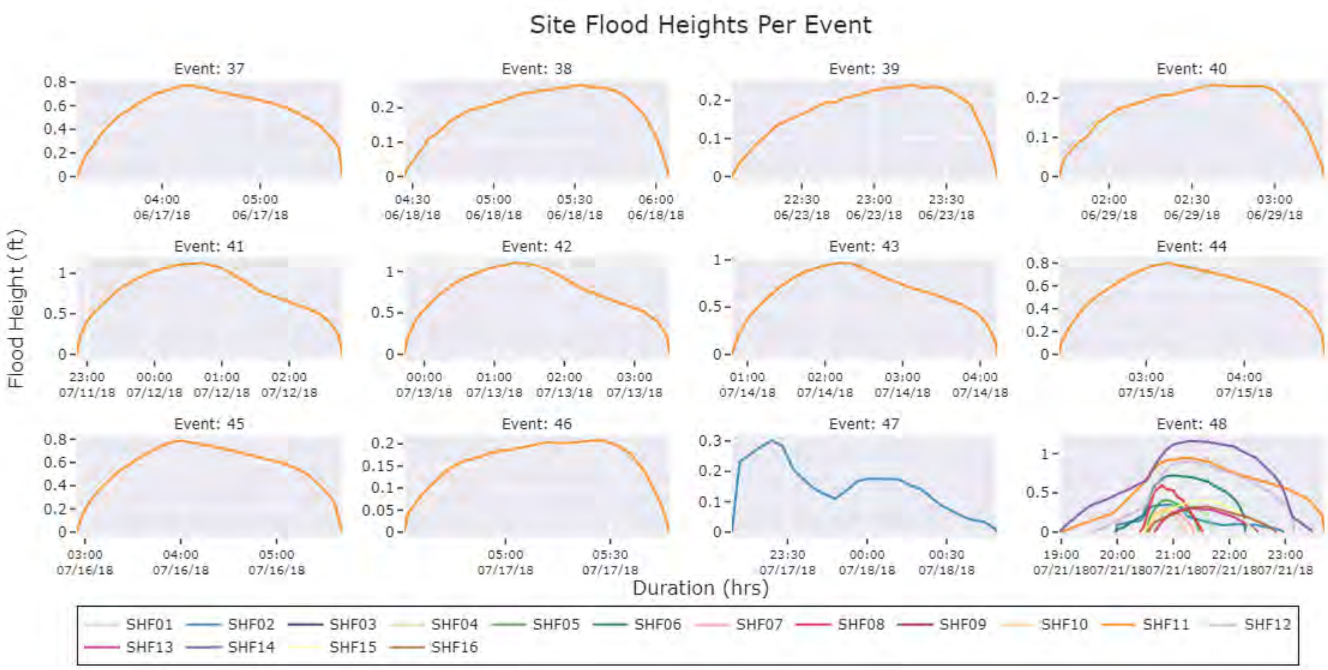
Appendix B.

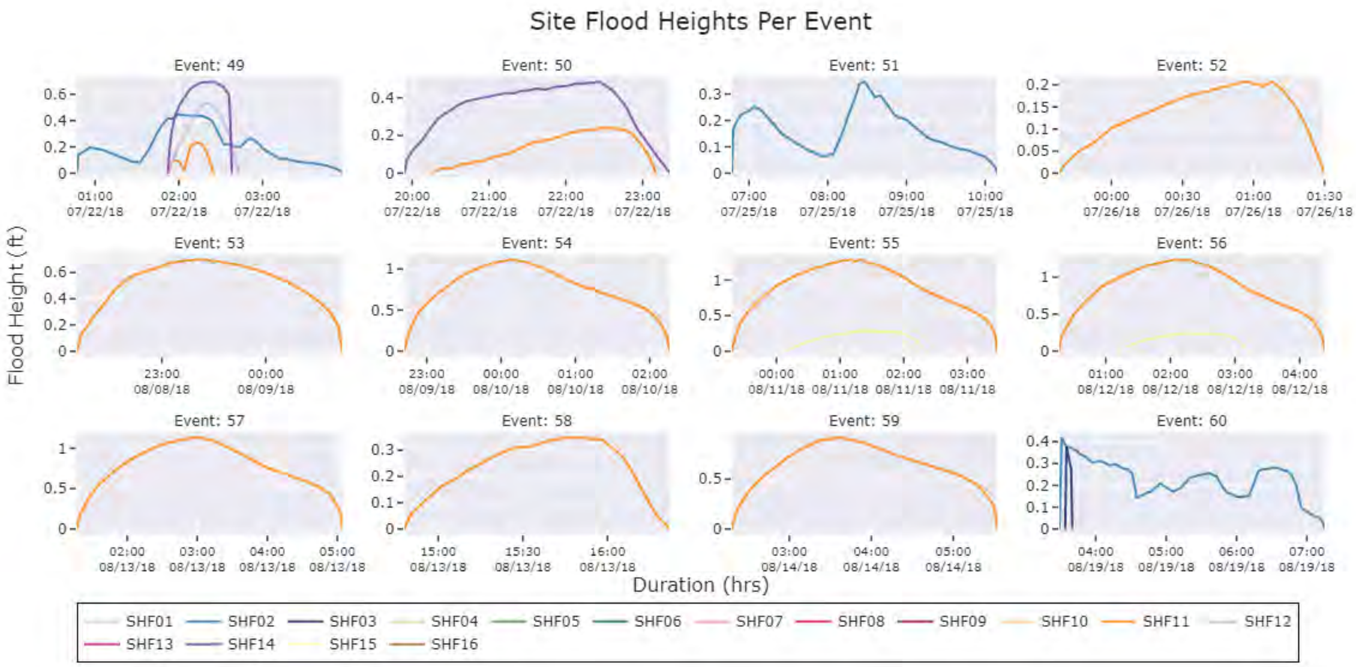
Main Event (Nuisance Flooding and Storm Flooding) Water Depths & Durations as Graphical Illustrations:

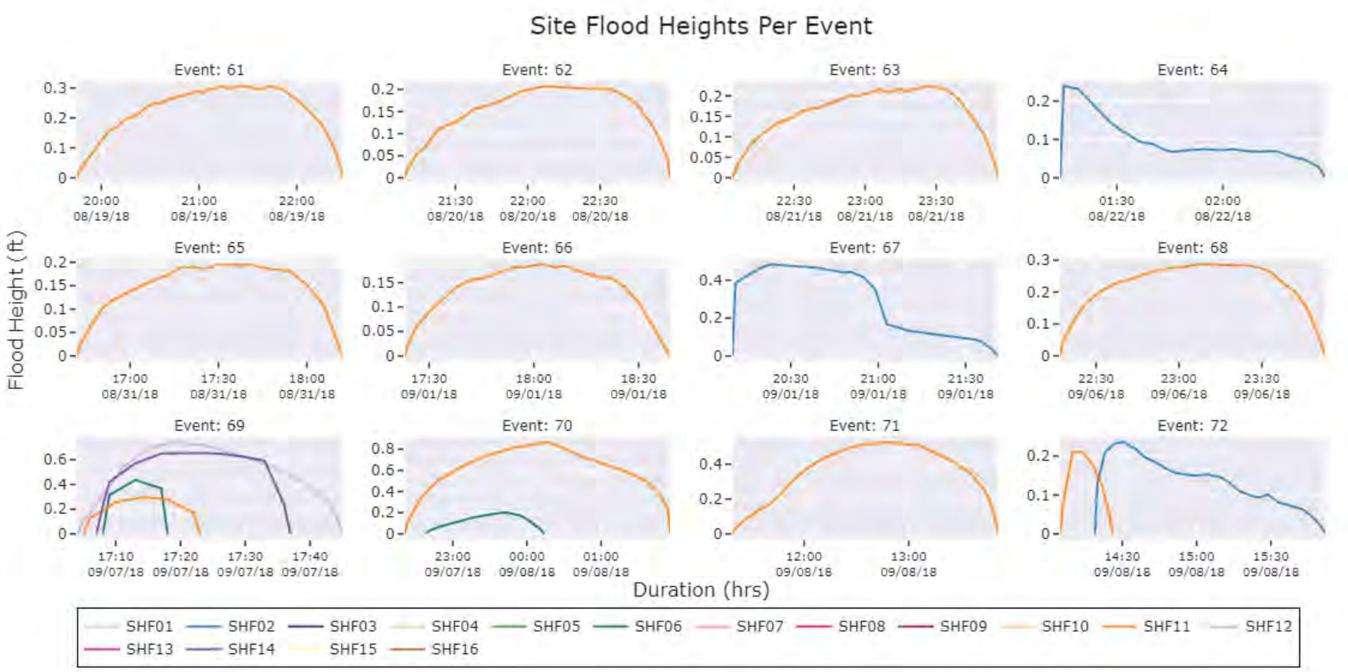


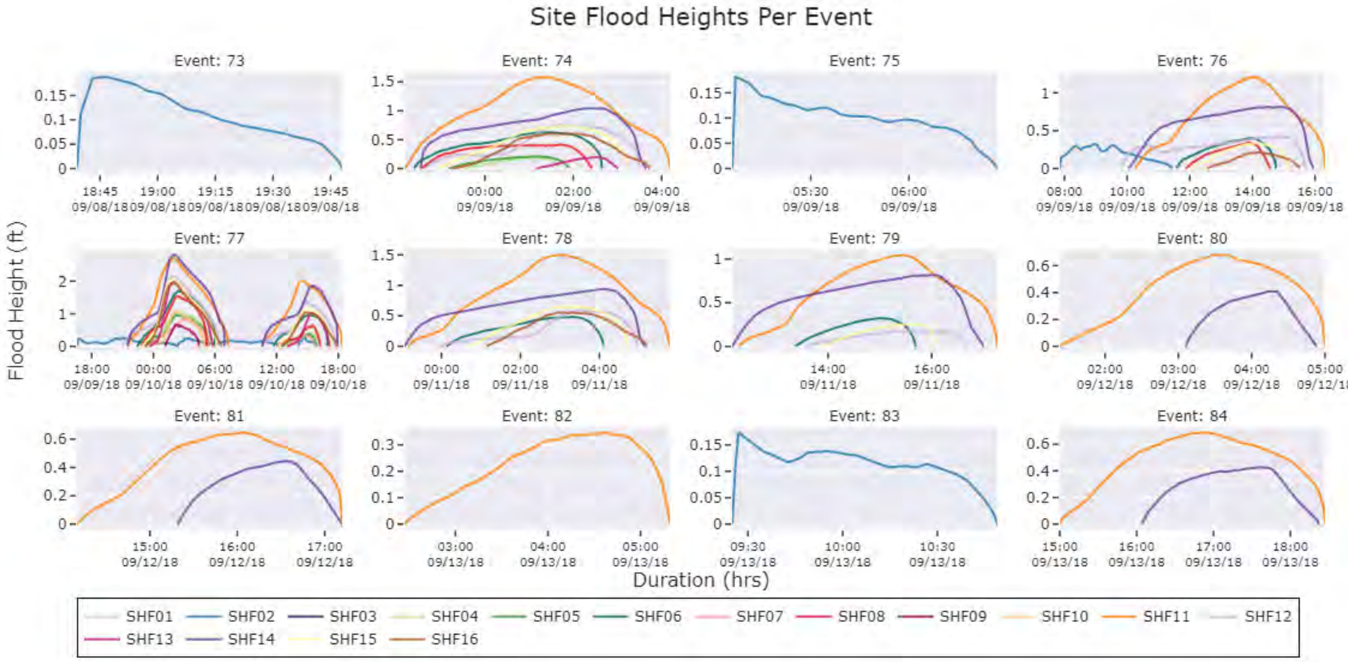


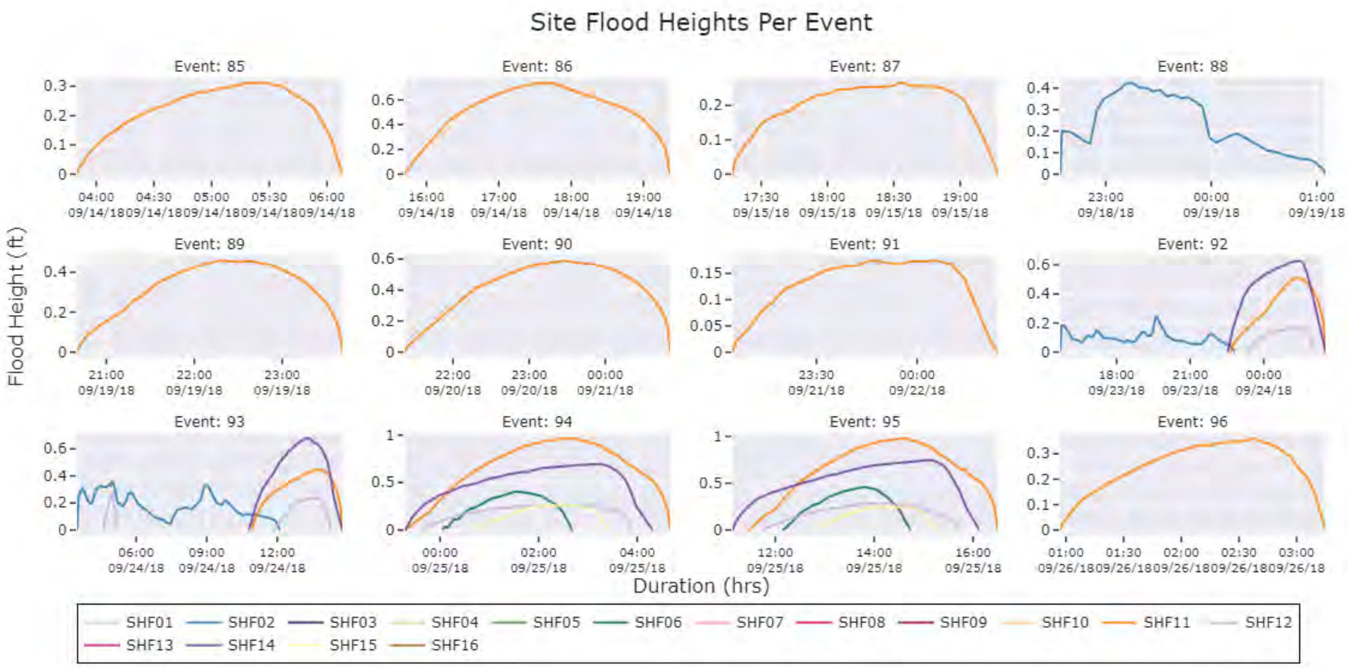

Site Flood Heights Per Event
Flood Height (ft)
Duration (hrs)
Event: 25
Event: 26
Event: 27
Event: 28
Event: 29
Event: 30
Event: 31
Event: 32
Event: 33
Event: 34
Event: 35
Event: 36
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

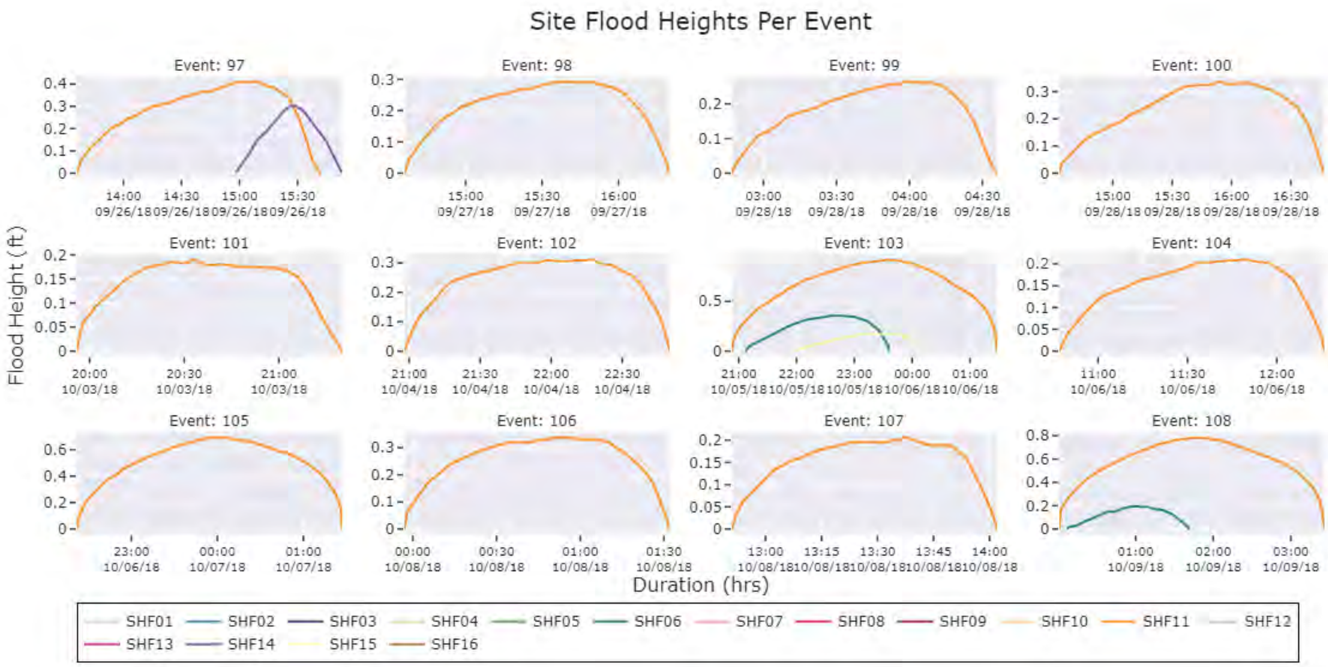

Site Flood Heights Per Event
Flood Height (ft)
Duration (hrs)
Event: 37
Event: 38
Event: 39
Event: 40
Event: 41
Event: 42
Event: 43
Event: 44
Event: 45
Event: 46
Event: 47
Event: 48
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

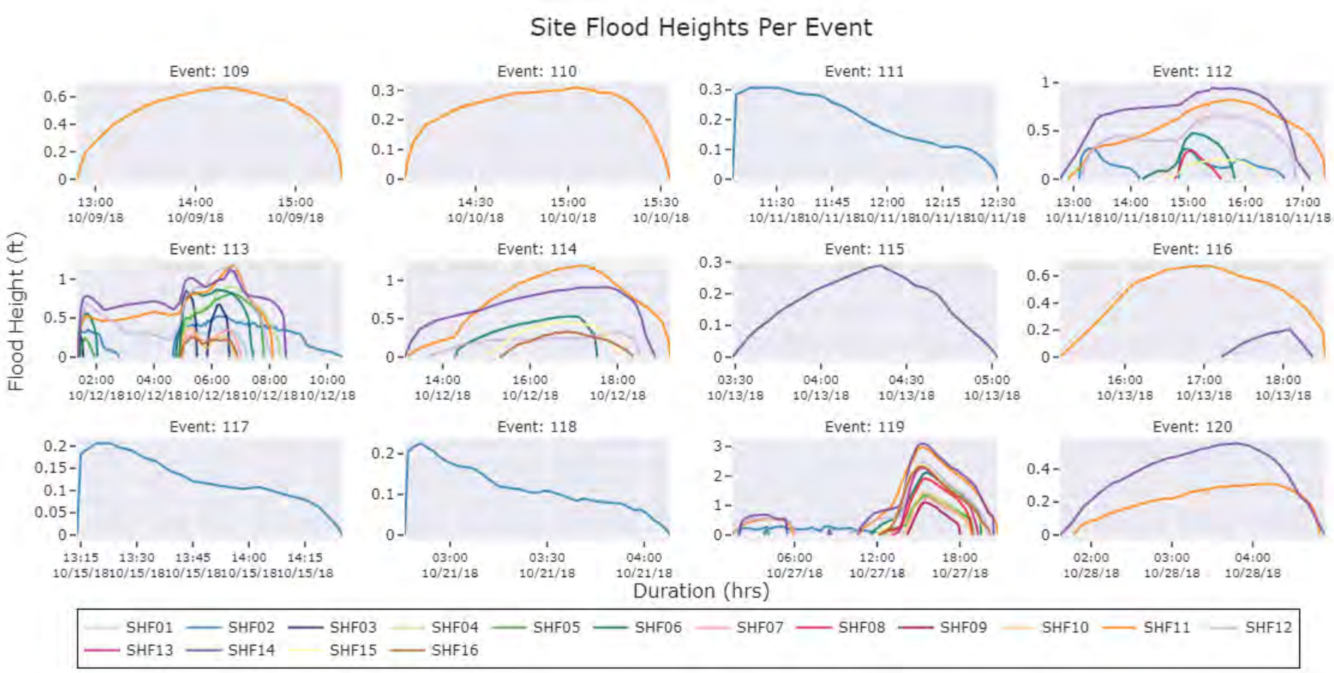

Site Flood Heights Per Event
Event: 49
Event: 50
Event: 51
Event: 52
Event: 53
Event: 54
Event: 55
Event: 56
Event: 57
Event: 58
Event: 59
Event: 60
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

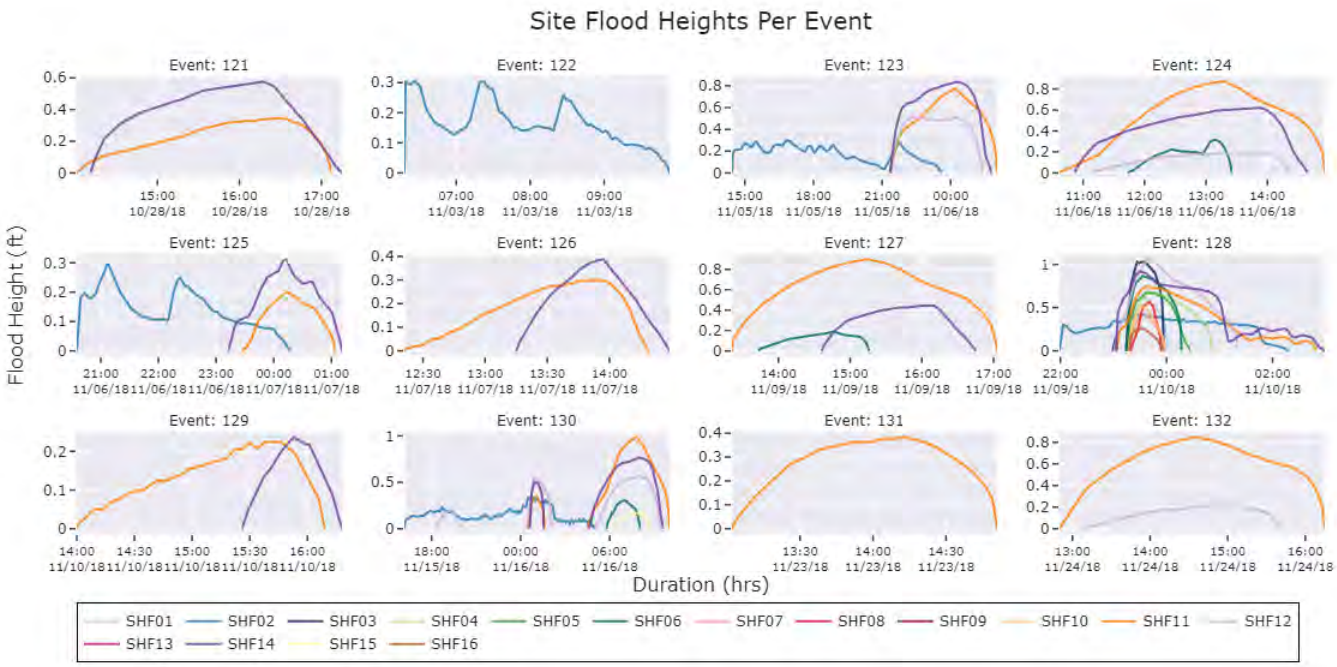

Site Flood Heights Per Event
Event: 61
Event: 62
Event: 63
Event: 64
Event: 65
Event: 66
Event: 67
Event: 68
Event: 69
Event: 70
Event: 71
Event: 72
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

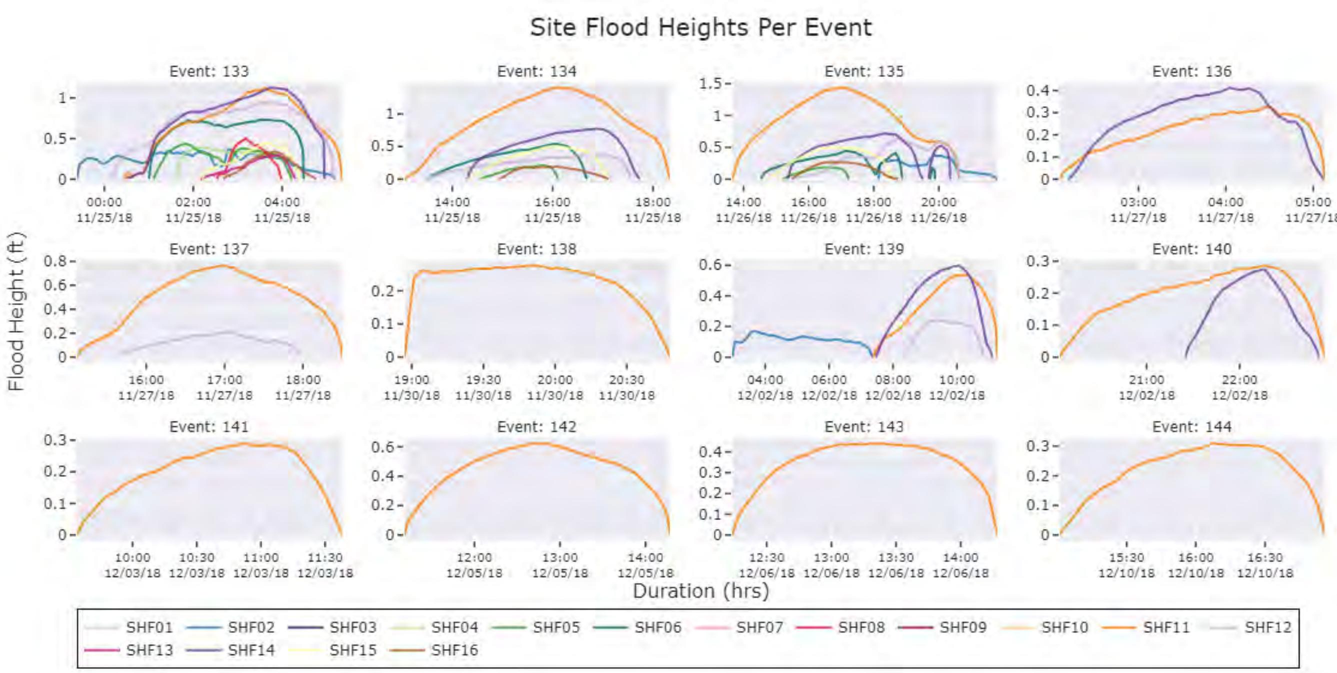

Site Flood Heights Per Event
Event: 73
Event: 74
Event: 75
Event: 76
Event: 77
Event: 78
Event: 79
Event: 80
Event: 81
Event: 82
Event: 83
Event: 84
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

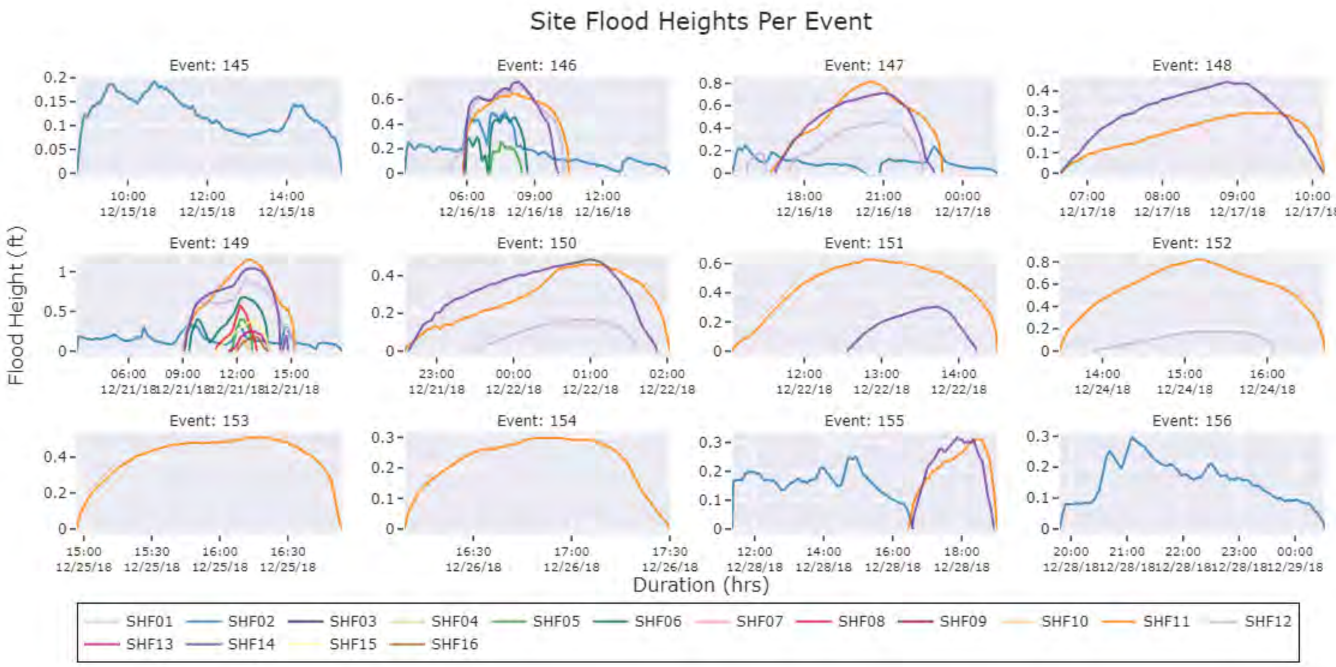

Site Flood Heights Per Event
Event: 85
Event: 86
Event: 87
Event: 88
Event: 89
Event: 90
Event: 91
Event: 92
Event: 93
Event: 94
Event: 95
Event: 96
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

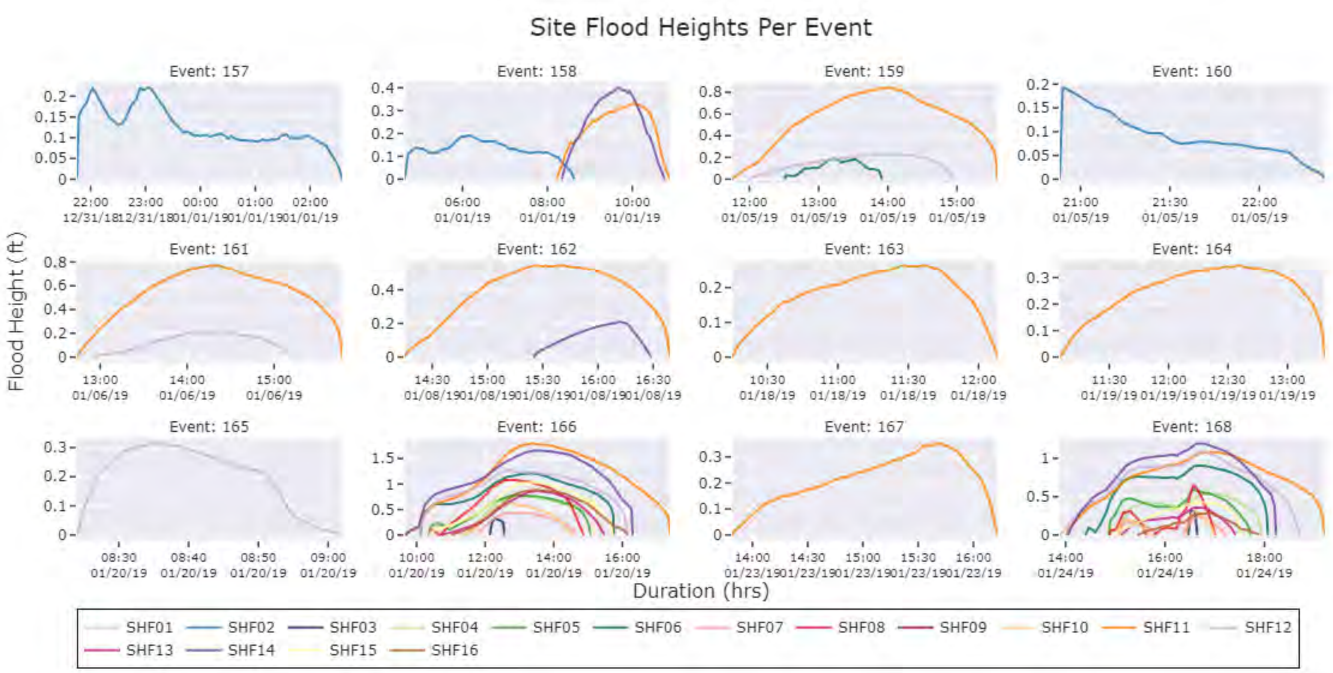

Site Flood Heights Per Event
Event: 97
Event: 98
Event: 99
Event: 100
Event: 101
Event: 102
Event: 103
Event: 104
Event: 105
Event: 106
Event: 107
Event: 108
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

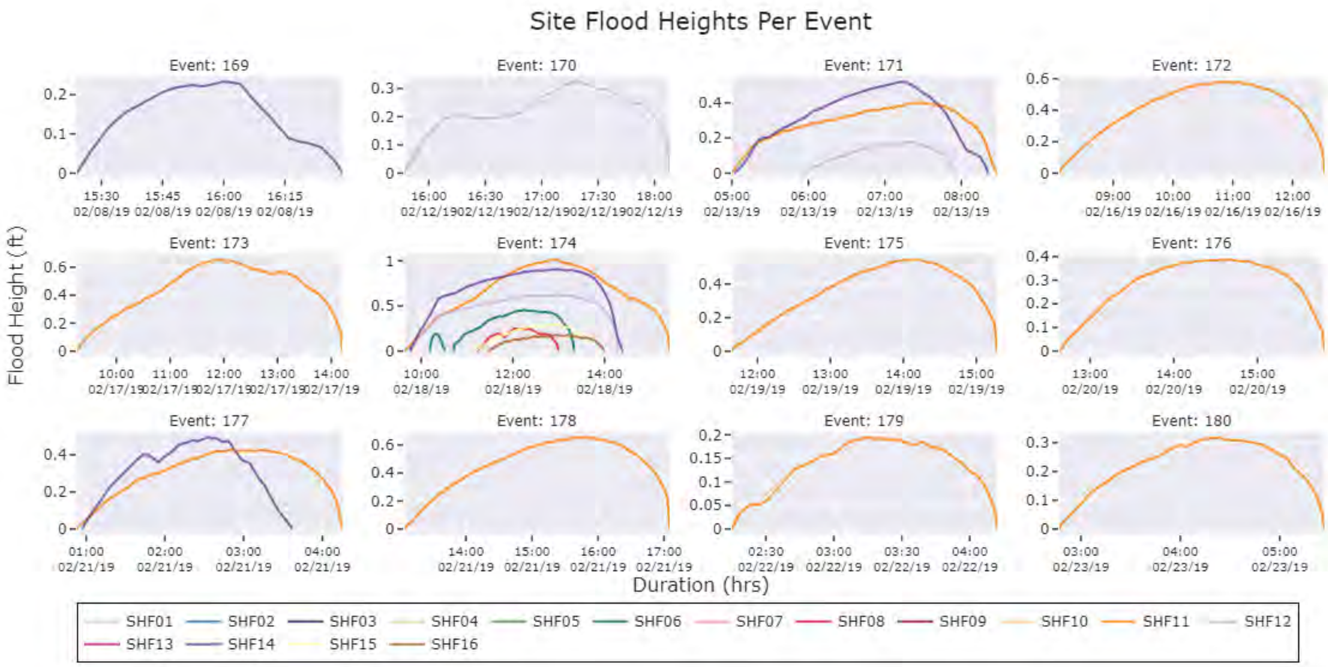

Site Flood Heights Per Event
Event: 109
Event: 110
Event: 111
Event: 112
Event: 113
Event: 114
Event: 115
Event: 116
Event: 117
Event: 118
Event: 119
Event: 120
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

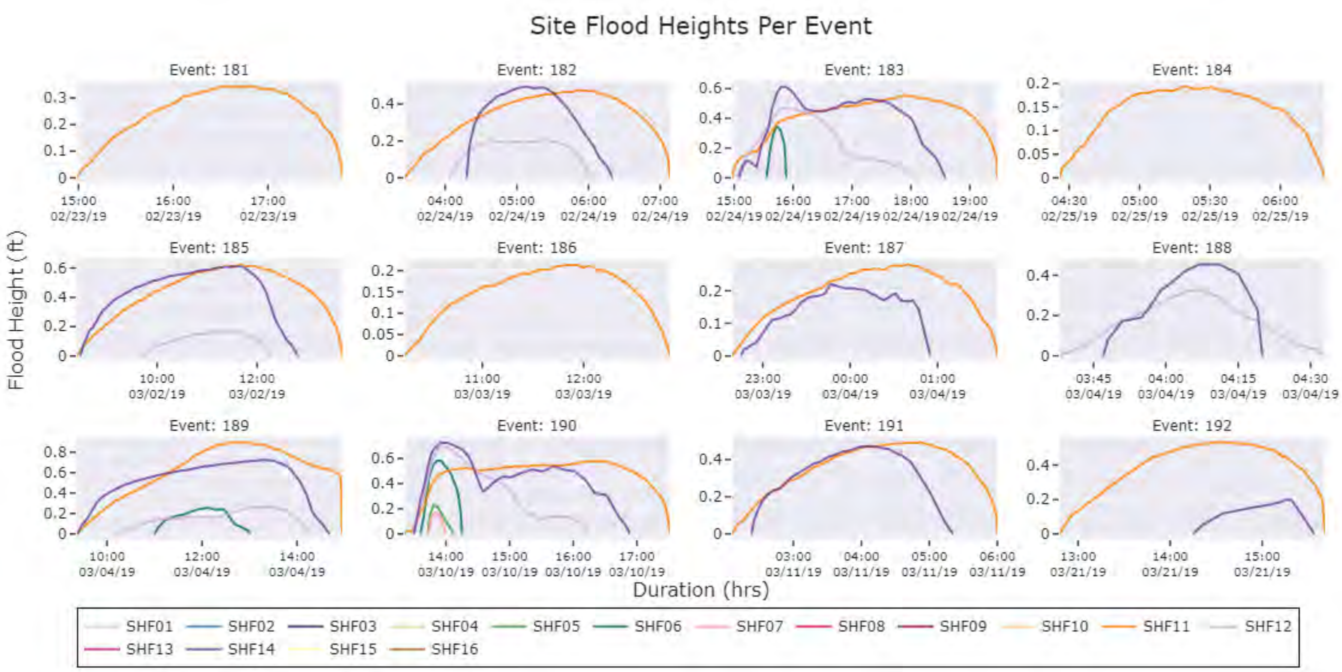

Site Flood Heights Per Event
Event: 121
Event: 122
Event: 123
Event: 124
Event: 125
Event: 126
Event: 127
Event: 128
Event: 129
Event: 130
Event: 131
Event: 132
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

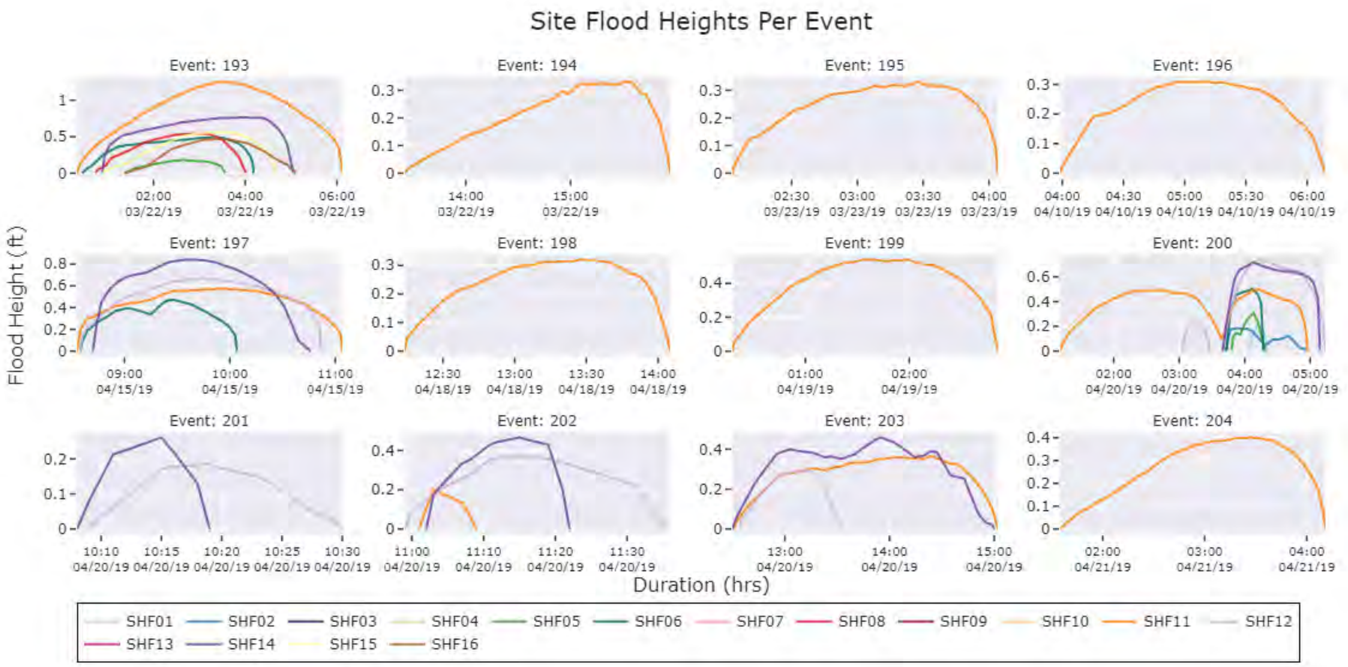

Site Flood Heights Per Event
Event: 133
Event: 134
Event: 135
Event: 136
Event: 137
Event: 138
Event: 139
Event: 140
Event: 141
Event: 142
Event: 143
Event: 144
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

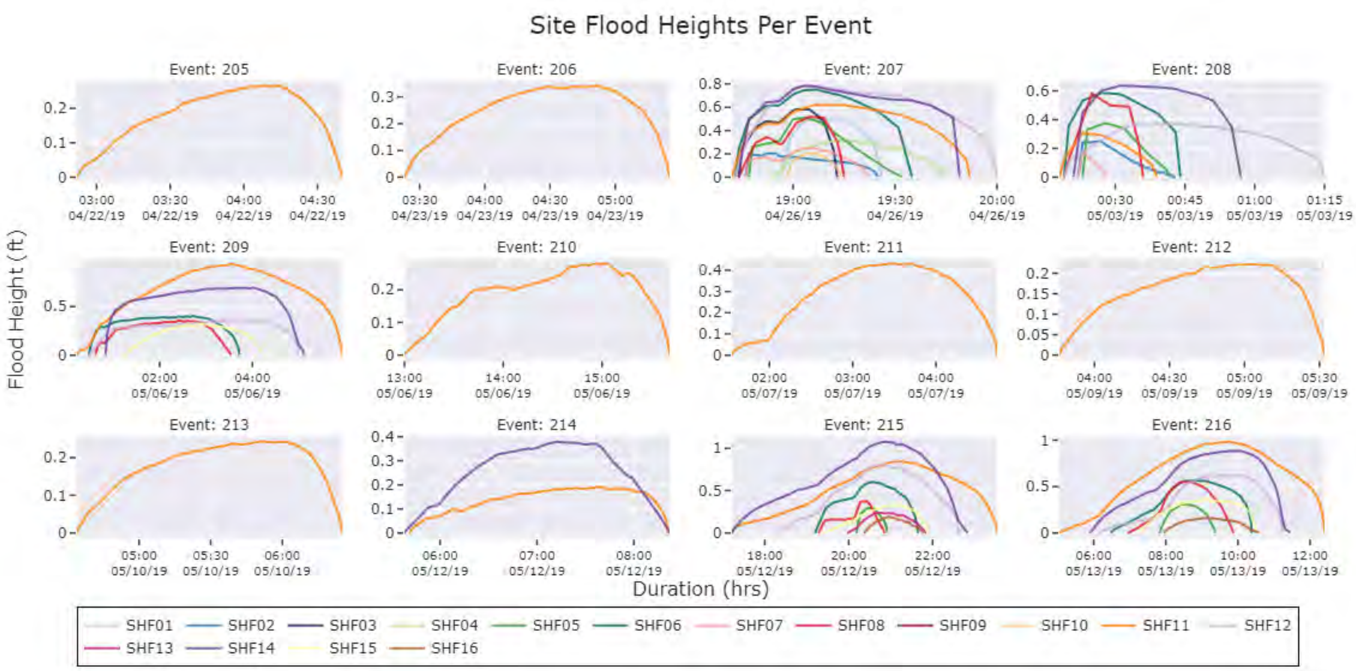

Site Flood Heights Per Event
Event: 145
Event: 146
Event: 147
Event: 148
Event: 149
Event: 150
Event: 151
Event: 152
Event: 153
Event: 154
Event: 155
Event: 156
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

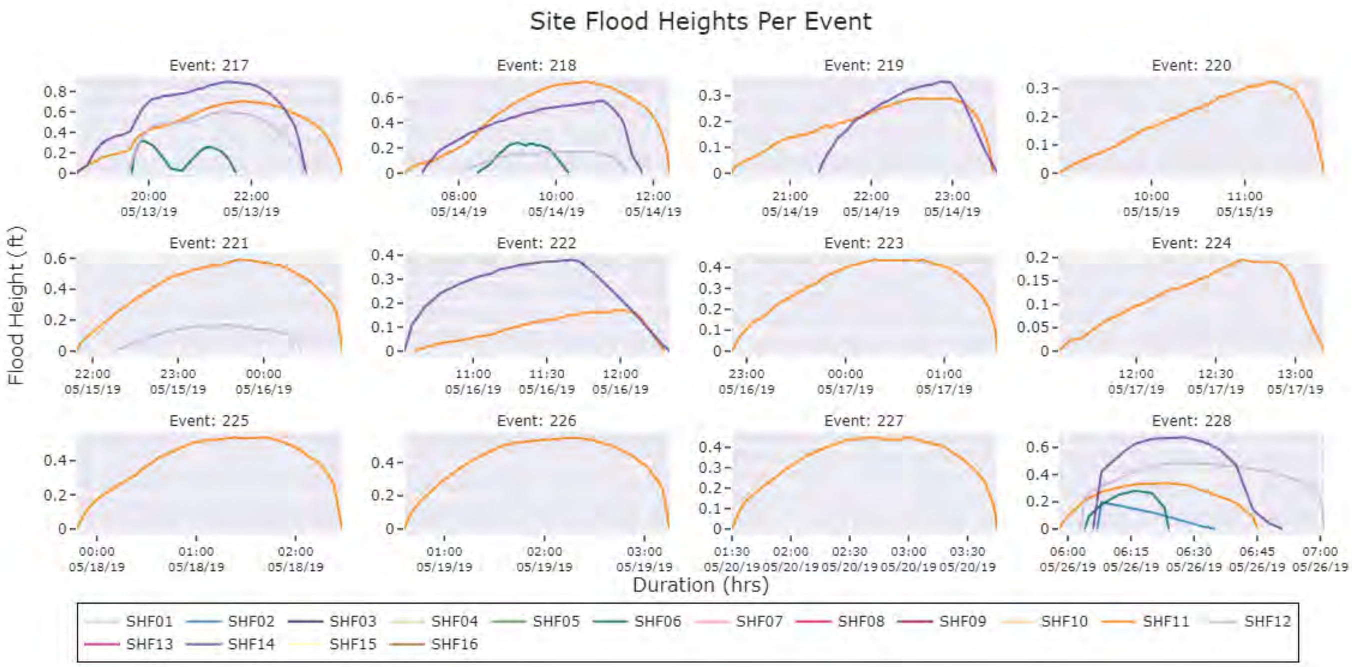

Site Flood Heights Per Event
Event: 157
Event: 158
Event: 159
Event: 160
Event: 161
Event: 162
Event: 163
Event: 164
Event: 165
Event: 166
Event: 167
Event: 168
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

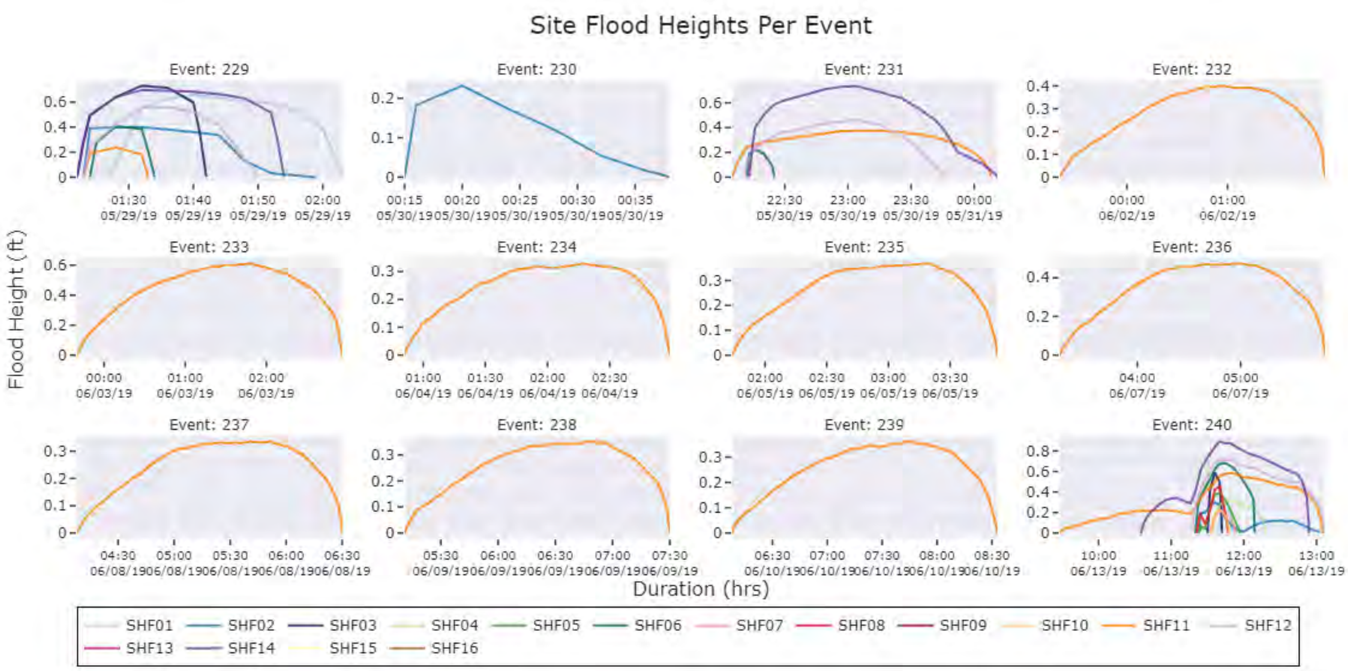

Site Flood Heights Per Event
Event: 169
Event: 170
Event: 171
Event: 172
Event: 173
Event: 174
Event: 175
Event: 176
Event: 177
Event: 178
Event: 179
Event: 180
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

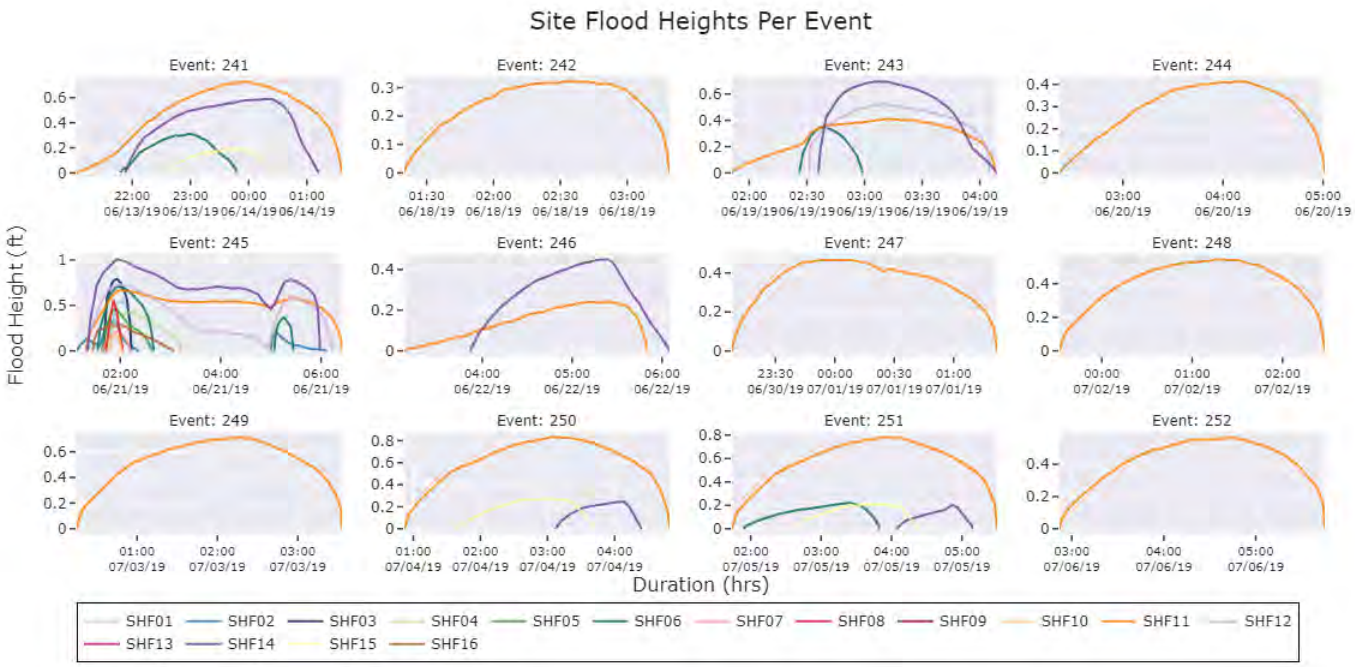

Site Flood Heights Per Event
Event: 181
Event: 182
Event: 183
Event: 184
Event: 185
Event: 186
Event: 187
Event: 188
Event: 189
Event: 190
Event: 191
Event: 192
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

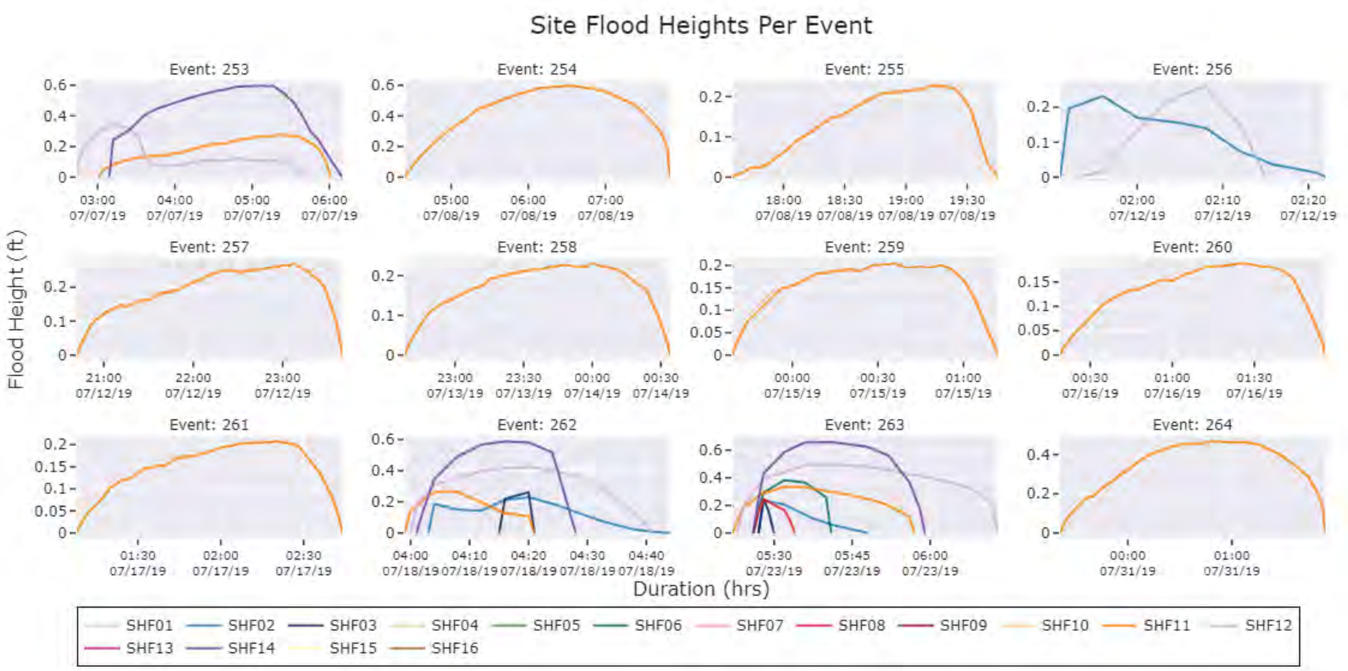

Site Flood Heights Per Event
Event: 193
Event: 194
Event: 195
Event: 196
Event: 197
Event: 198
Event: 199
Event: 200
Event: 201
Event: 202
Event: 203
Event: 204
Flood Height (ft)
Duration (hrs)
SHF01
SHF02
SHF03
SHF04
SHF05
SHF06
SHF07
SHF08
SHF09
SHF10
SHF11
SHF12
SHF13
SHF14
SHF15
SHF16

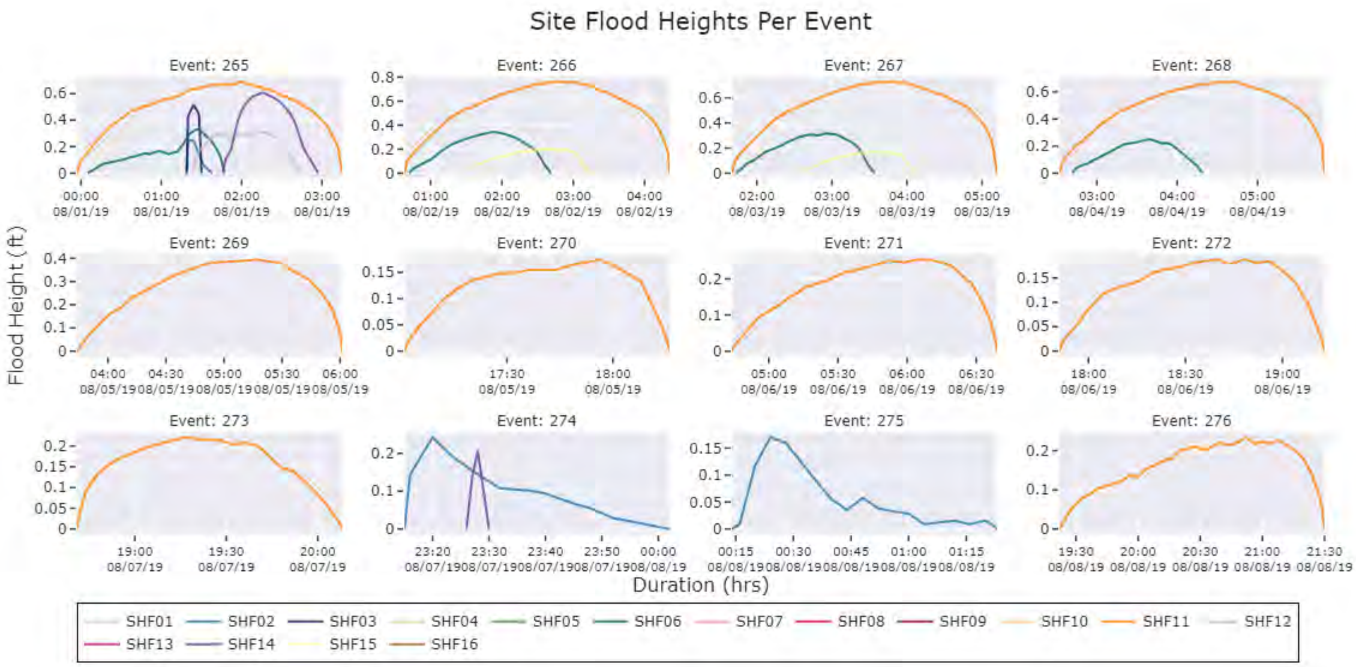

Site Flood Heights Per Event
Event: 205
Event: 206
Event: 207
Event: 208
Event: 209
Event: 210
Event: 211
Event: 212
Event: 213
Event: 214
Event: 215
Event: 216
Flood Height (ft)
Duration (hrs)
SHF01
SHF02
SHF03
SHF04
SHF05
SHF06
SHF07
SHF08
SHF09
SHF10
SHF11
SHF12
SHF13
SHF14
SHF15
SHF16

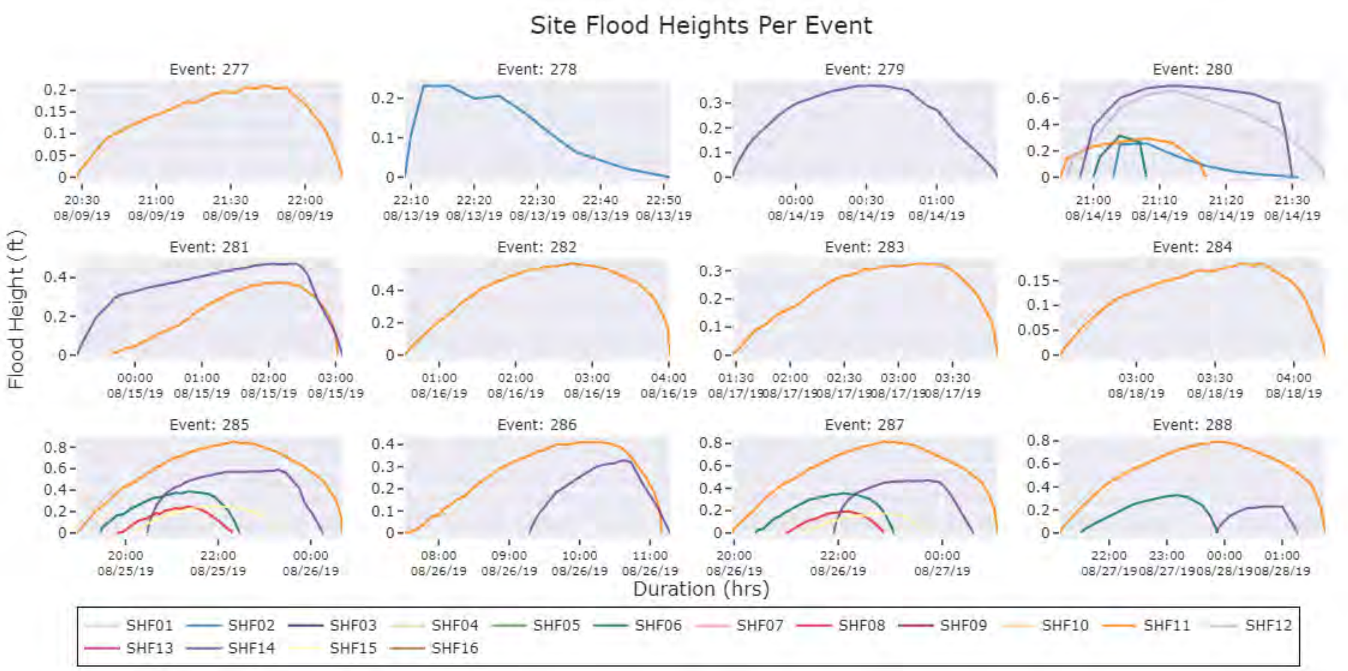

Site Flood Heights Per Event
Event: 217
Event: 218
Event: 219
Event: 220
Event: 221
Event: 222
Event: 223
Event: 224
Event: 225
Event: 226
Event: 227
Event: 228
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

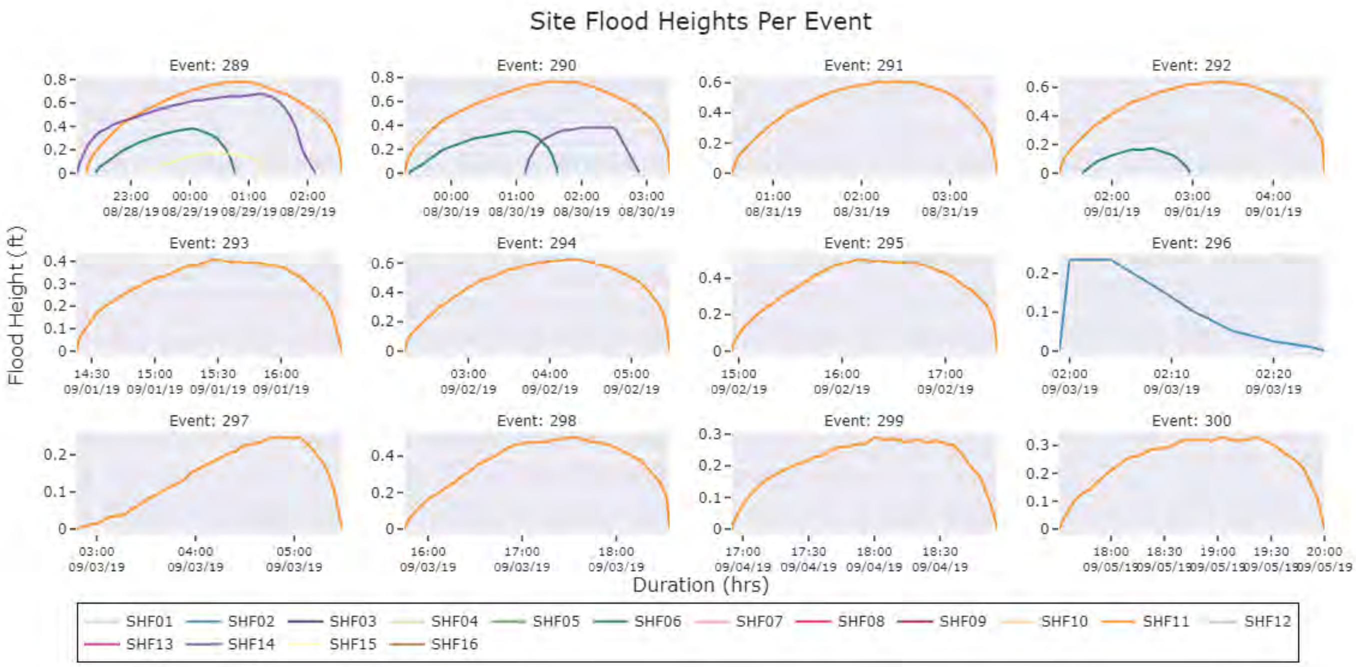

Site Flood Heights Per Event
Event: 229
Event: 230
Event: 231
Event: 232
Event: 233
Event: 234
Event: 235
Event: 236
Event: 237
Event: 238
Event: 239
Event: 240
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16


Site Flood Heights Per Event
Event: 241
Event: 242
Event: 243
Event: 244
Event: 245
Event: 246
Event: 247
Event: 248
Event: 249
Event: 250
Event: 251
Event: 252
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

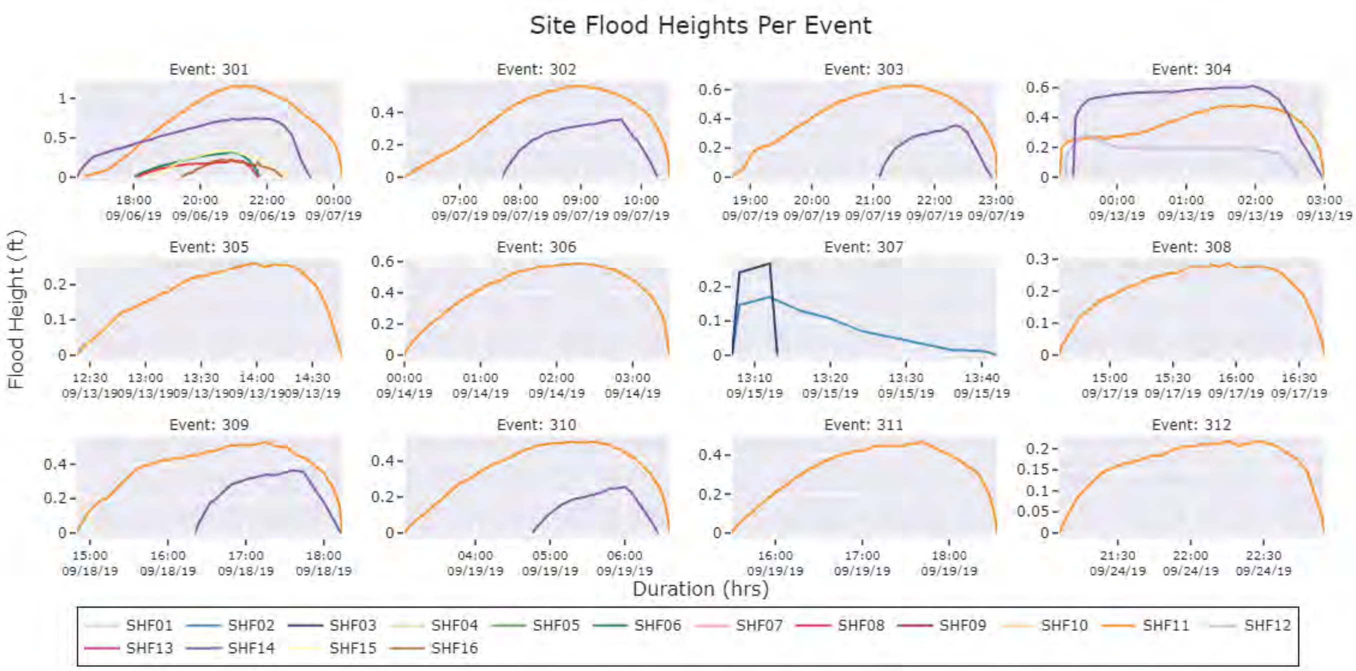

Site Flood Heights Per Event
Event: 253
Event: 254
Event: 255
Event: 256
Event: 257
Event: 258
Event: 259
Event: 260
Event: 261
Event: 262
Event: 263
Event: 264
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16


Site Flood Heights Per Event
Event: 265
Event: 266
Event: 267
Event: 268
Event: 269
Event: 270
Event: 271
Event: 272
Event: 273
Event: 274
Event: 275
Event: 276
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

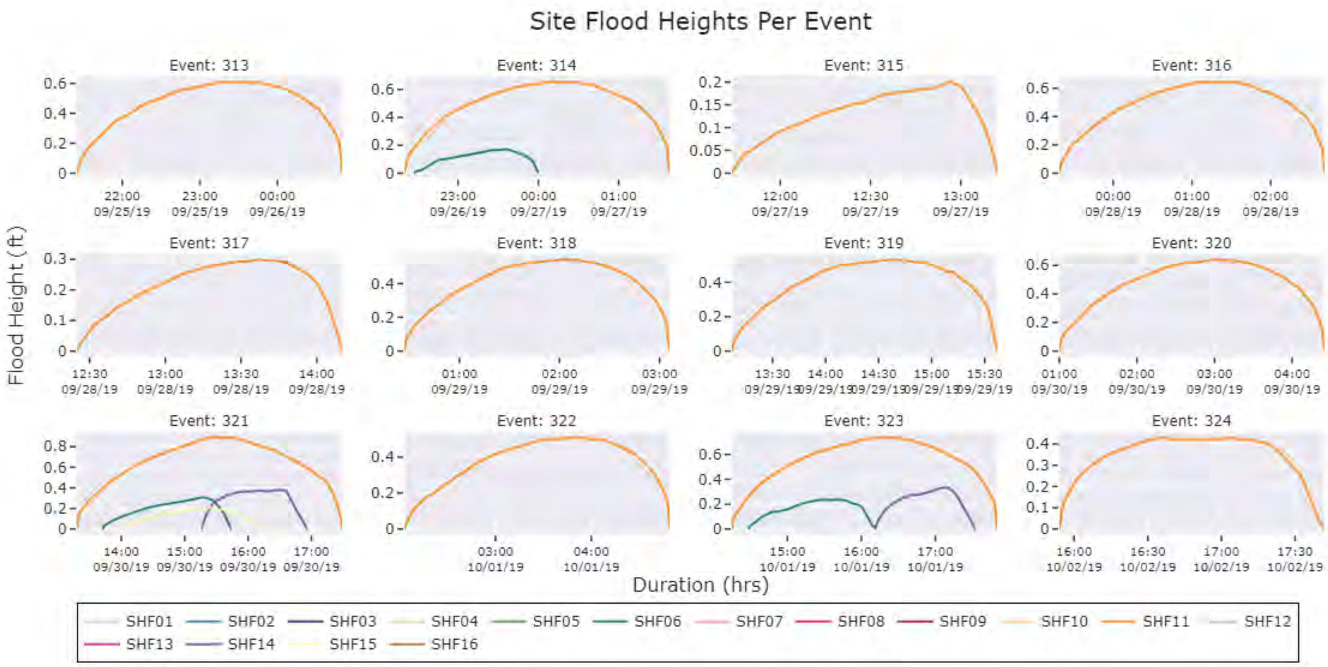

Site Flood Heights Per Event
Event: 277
Event: 278
Event: 279
Event: 280
Event: 281
Event: 282
Event: 283
Event: 284
Event: 285
Event: 286
Event: 287
Event: 288
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

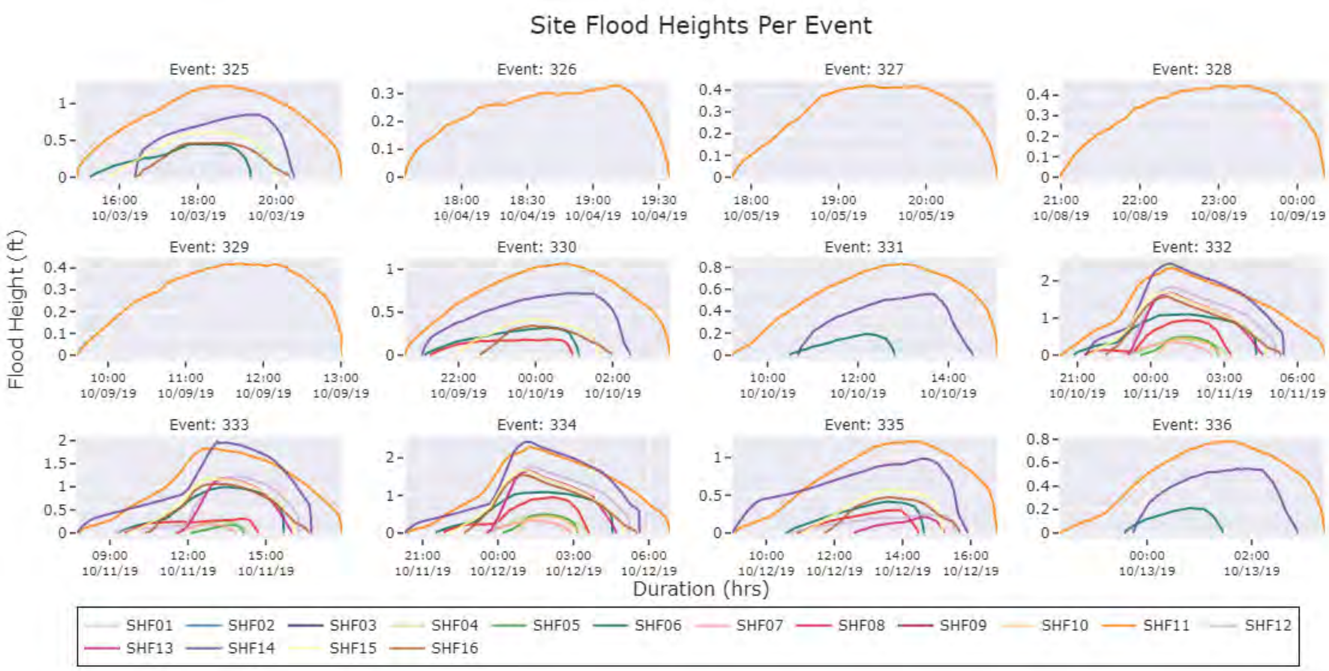


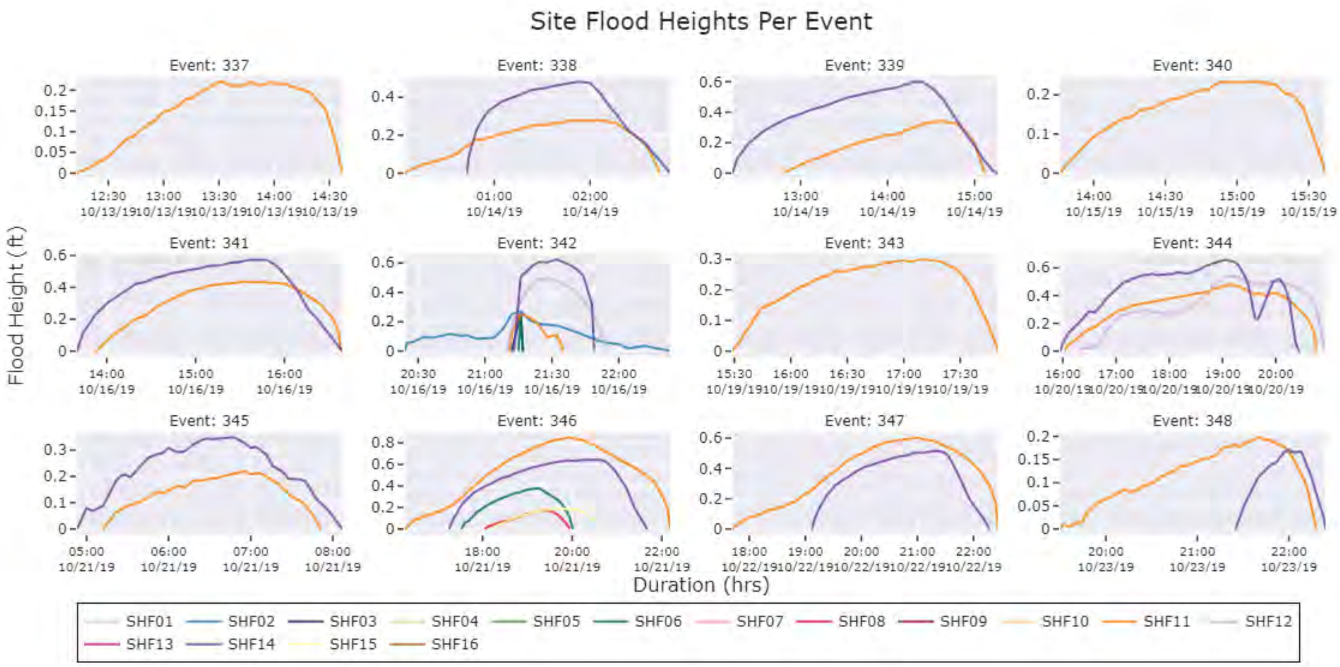
Site Flood Heights Per Event
Event: 289
Event: 290
Event: 291
Event: 292
Event: 293
Event: 294
Event: 295
Event: 296
Event: 297
Event: 298
Event: 299
Event: 300
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

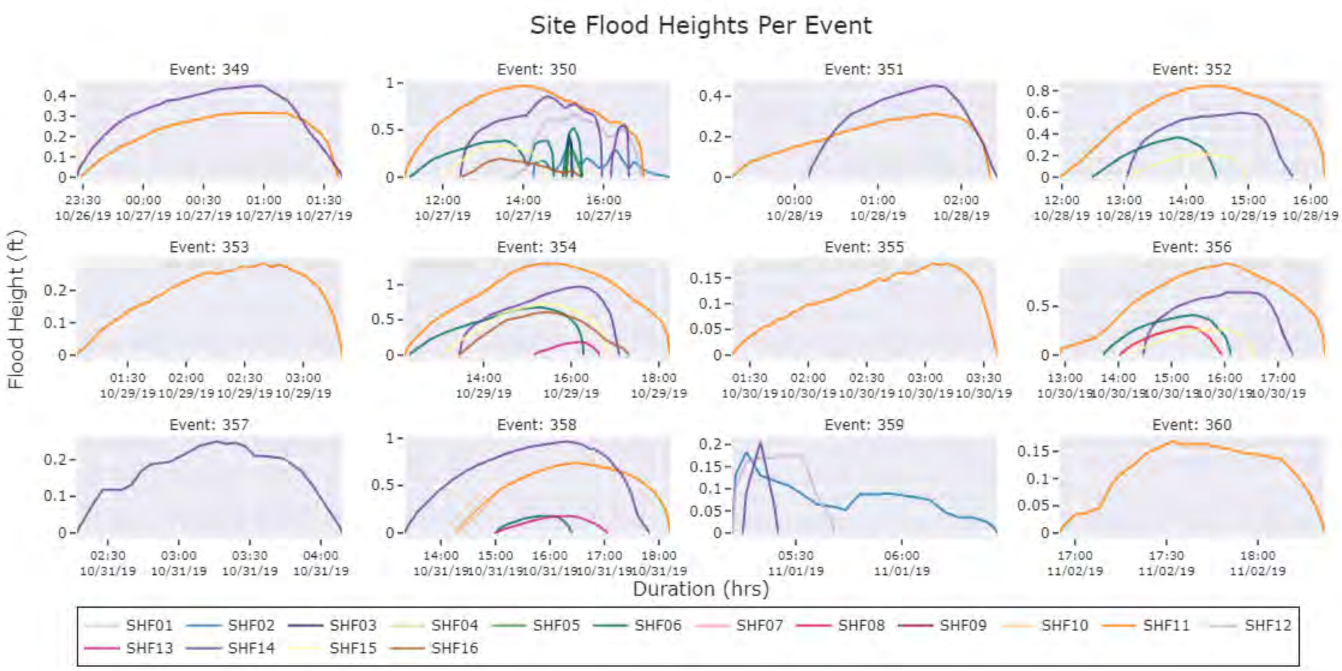


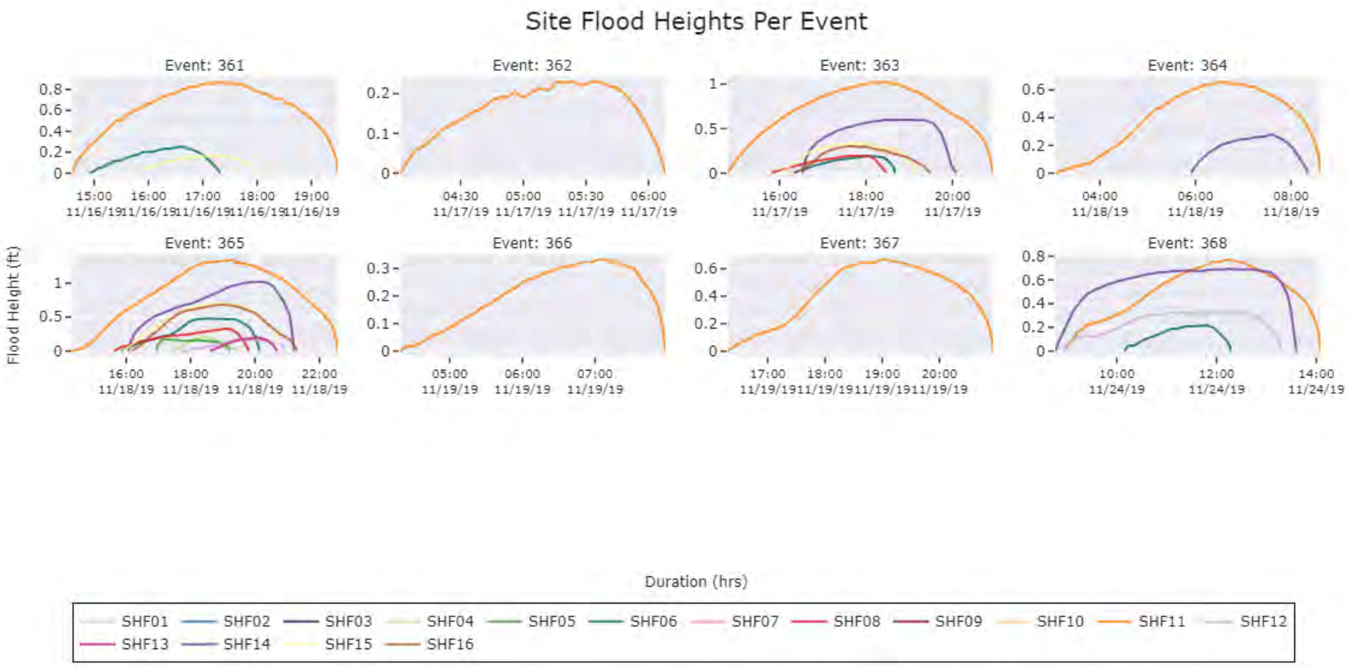
Site Flood Heights Per Event
Event: 301
Event: 302
Event: 303
Event: 304
Event: 305
Event: 306
Event: 307
Event: 308
Event: 309
Event: 310
Event: 311
Event: 312
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16


Site Flood Heights Per Event
Event: 313
Event: 314
Event: 315
Event: 316
Event: 317
Event: 318
Event: 319
Event: 320
Event: 321
Event: 322
Event: 323
Event: 324
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16


Site Flood Heights Per Event
Event: 325
Event: 326
Event: 327
Event: 328
Event: 329
Event: 330
Event: 331
Event: 332
Event: 333
Event: 334
Event: 335
Event: 336
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

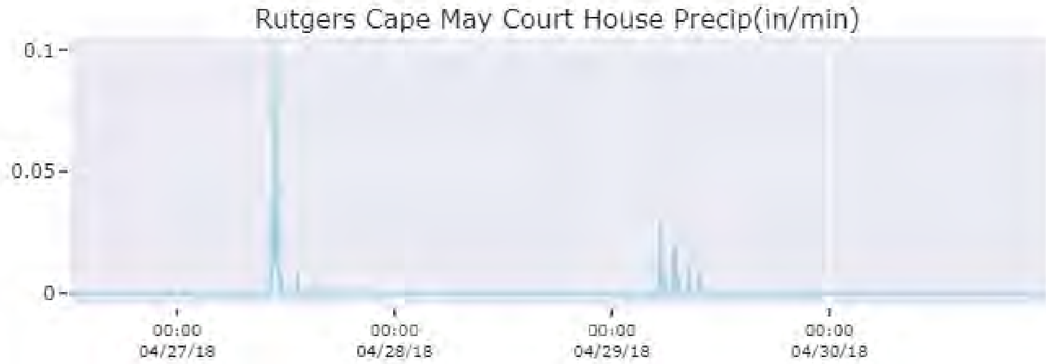

Site Flood Heights Per Event
Event: 337
Event: 338
Event: 339
Event: 340
Event: 341
Event: 342
Event: 343
Event: 344
Event: 345
Event: 346
Event: 347
Event: 348
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

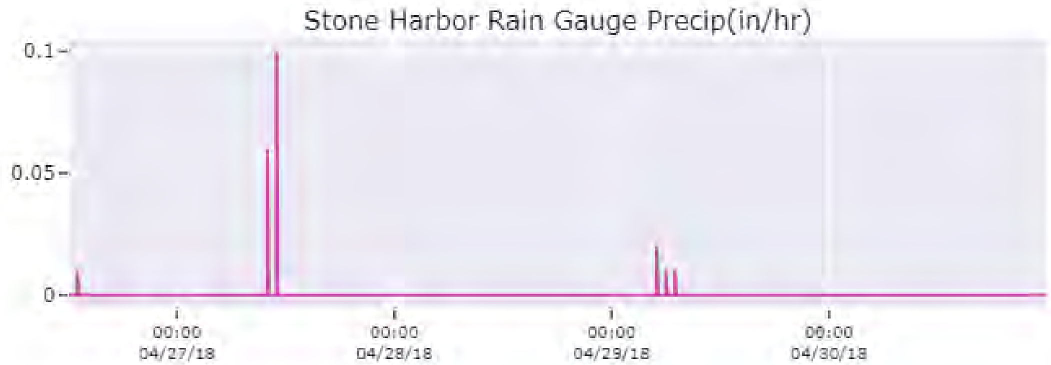

Site Flood Heights Per Event
Event: 349
Event: 350
Event: 351
Event: 352
Event: 353
Event: 354
Event: 355
Event: 356
Event: 357
Event: 358
Event: 359
Event: 360
Flood Height (ft)
Duration (hrs)
SHF01 SHF02 SHF03 SHF04 SHF05 SHF06 SHF07 SHF08 SHF09 SHF10 SHF11 SHF12
SHF13 SHF14 SHF15 SHF16

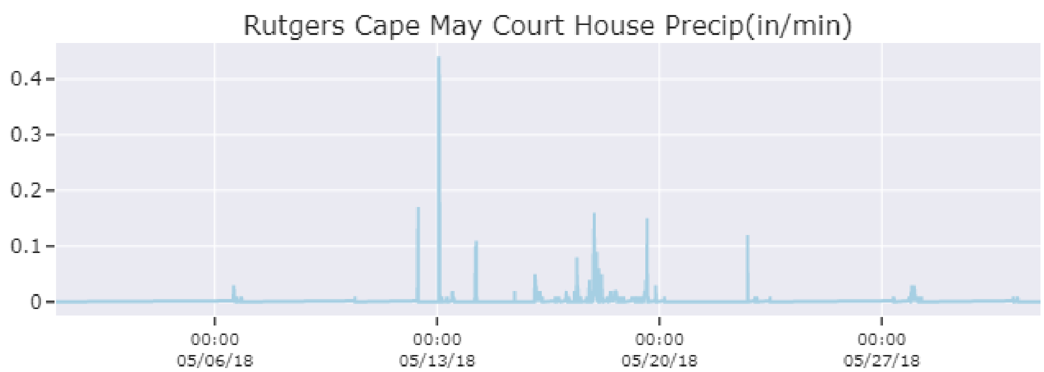

Site Flood Heights Per Event
Event: 361
Event: 362
Event: 363
Event: 364
Event: 365
Event: 366
Event: 367
Event: 368
Flood Height (ft)
Duration (hrs)
SHF01
SHF02
SHF03
SHF04
SHF05
SHF06
SHF07
SHF08
SHF09
SHF10
SHF11
SHF12
SHF13
SHF14
SHF15
SHF16

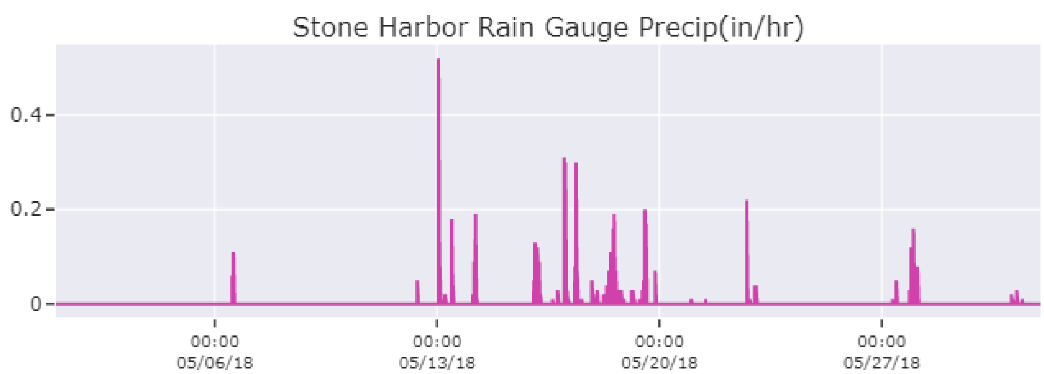
Appendix C.

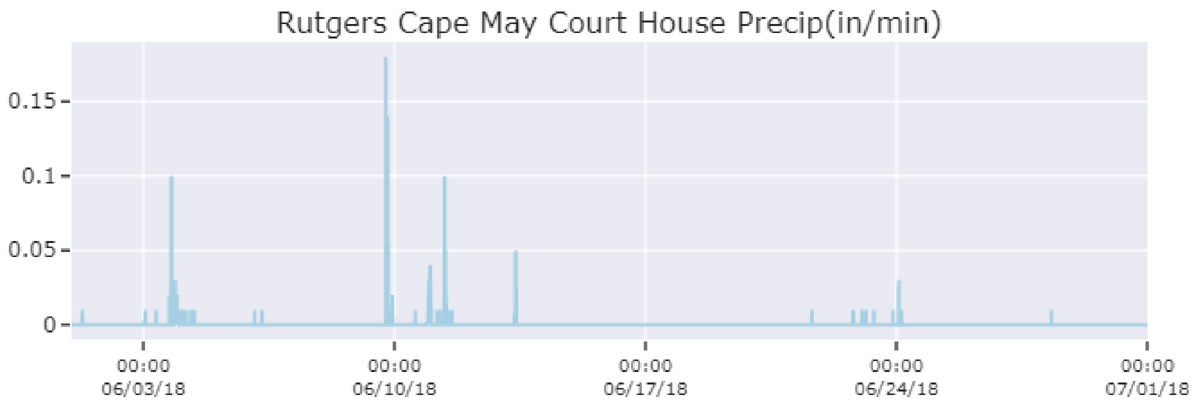
Cape May Court House Precipitation (in./min.) and Stone Harbor Rain Gauge Precipitation (in./hr.) Per Month as Graphical Illustrations:

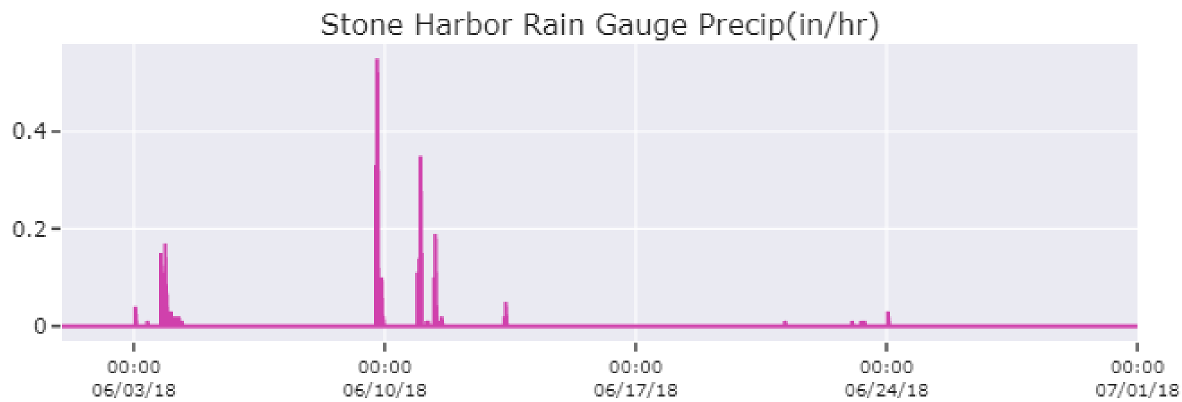


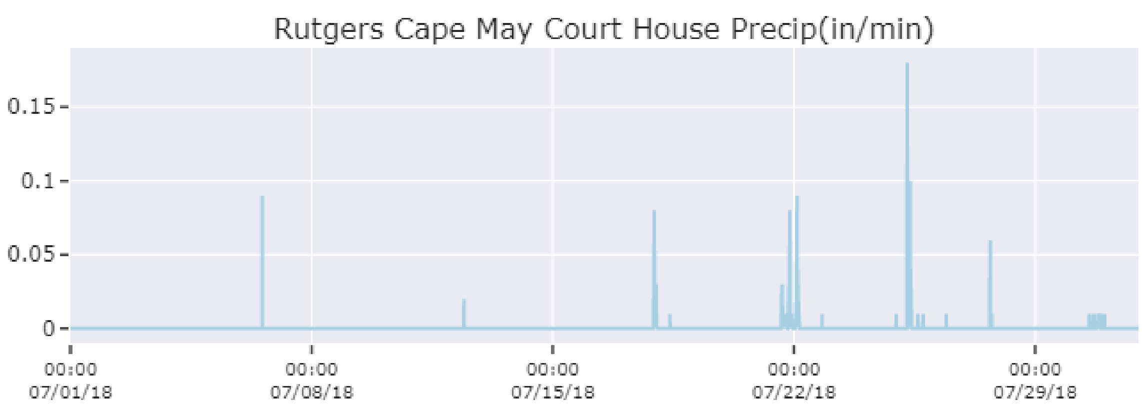


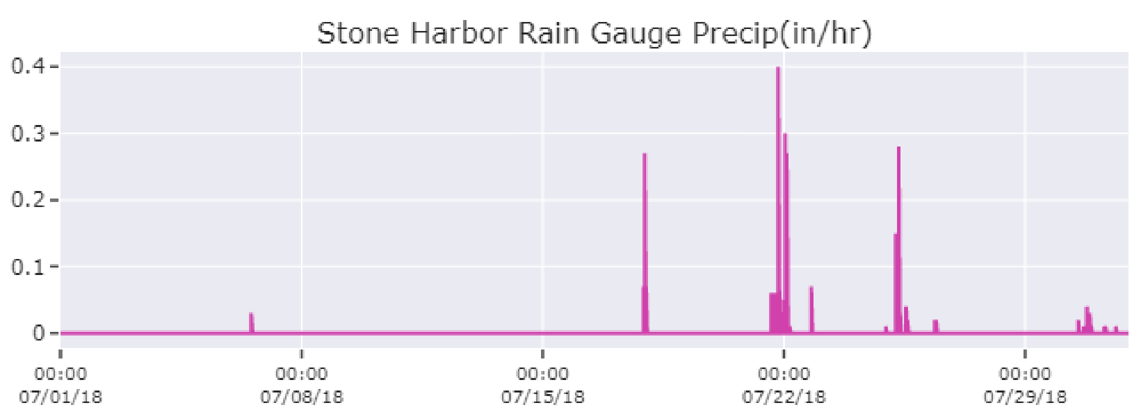


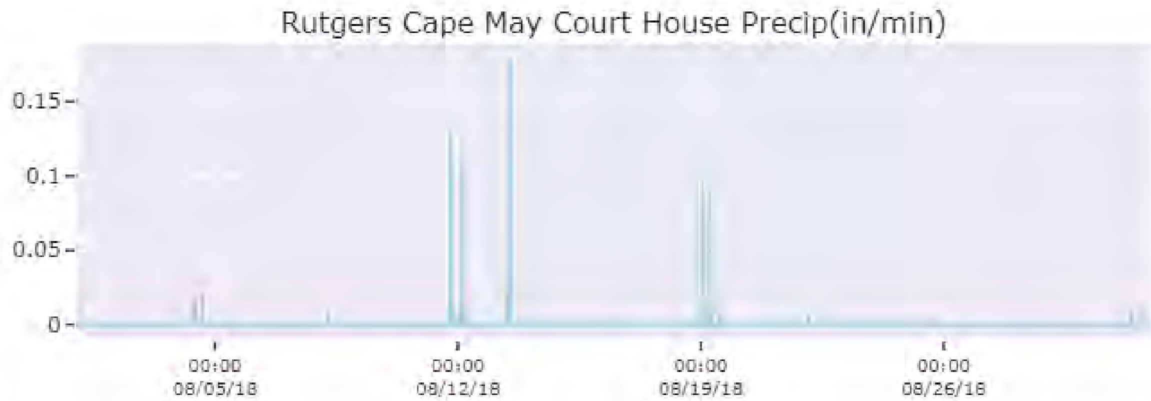


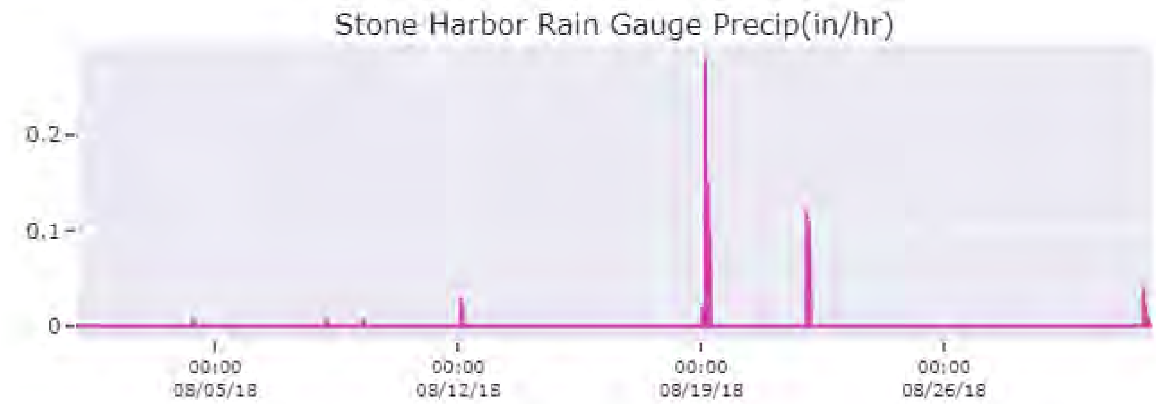

Rutgers Cape May Court House Precip(in/min)
0.15
0.1
0.05
0
00:00
06/03/18
00:00
06/10/18
00:00
06/17/18
00:00
06/24/18
00:00
07/01/18

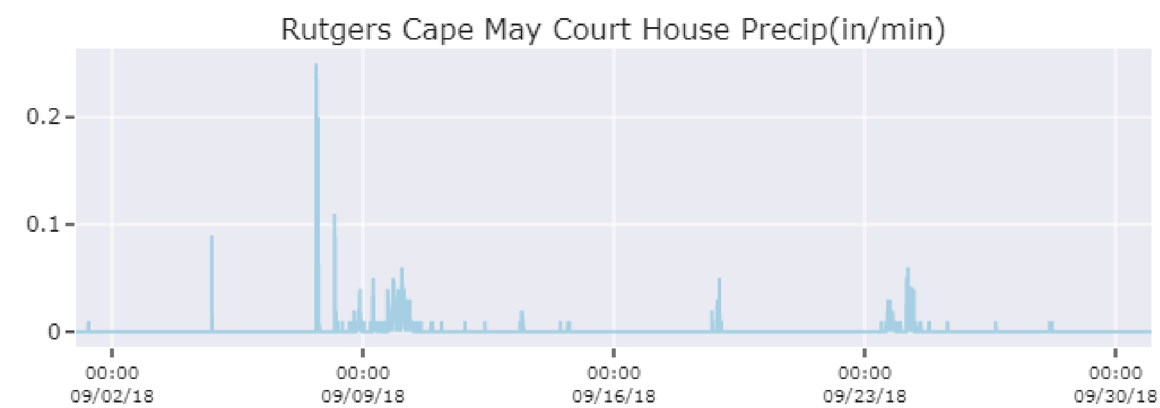

Stone Harbor Rain Gauge Precip(in/hr)
0.4
0.2
0
00:00
06/03/18
00:00
06/10/18
00:00
06/17/18
00:00
06/24/18
00:00
07/01/18

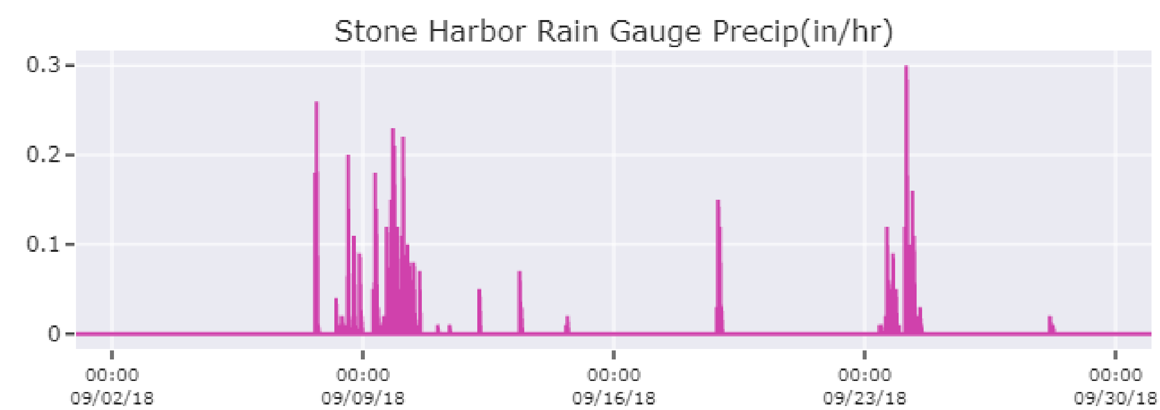

Rutgers Cape May Court House Precip(in/min)
0.15
0.1
0.05
0
00:00
07/01/18
00:00
07/08/18
00:00
07/15/18
00:00
07/22/18
00:00
07/29/18

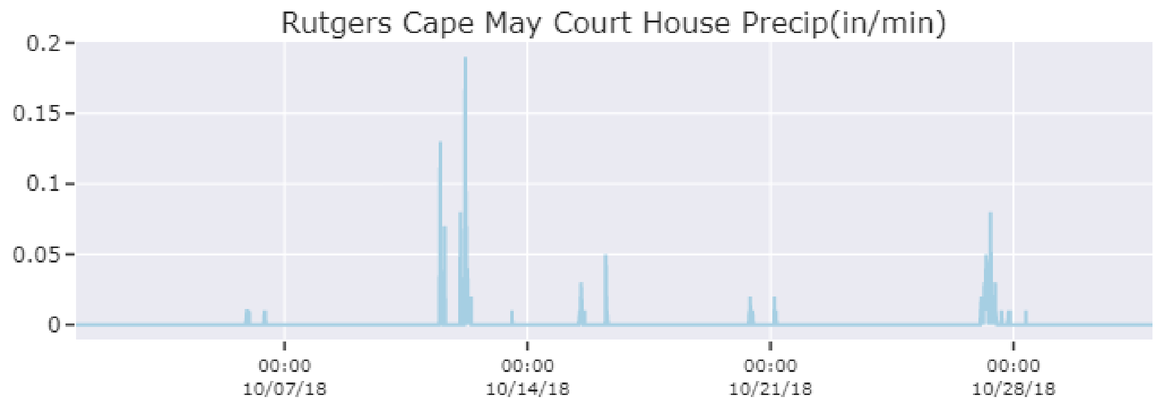

Stone Harbor Rain Gauge Precip(in/hr)
0.4
0.3
0.2
0.1
0
00:00
07/01/18
00:00
07/08/18
00:00
07/15/18
00:00
07/22/18
00:00
07/29/18

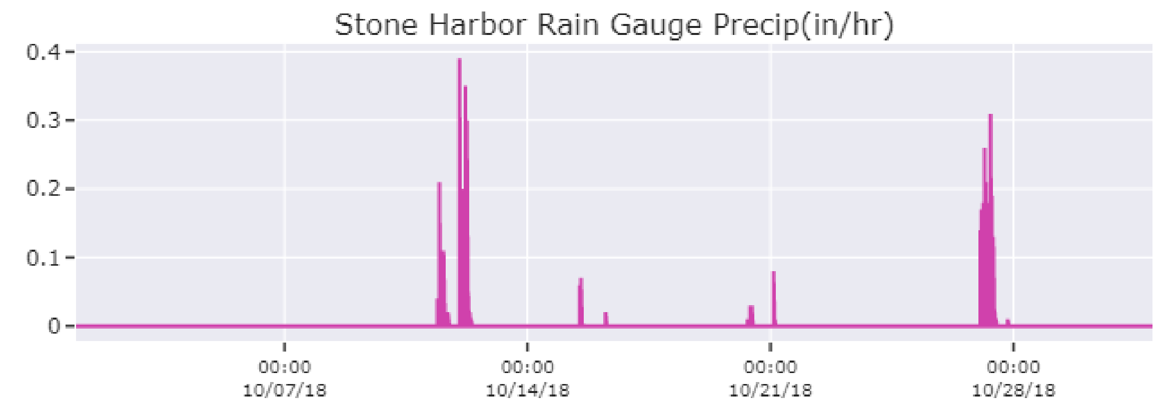

Rutgers Cape May Court House Precip(in/min)
0.15
0.1
0.05
0
00:00
08/05/18
00:00
08/12/18
00:00
08/19/18
00:00
08/26/18

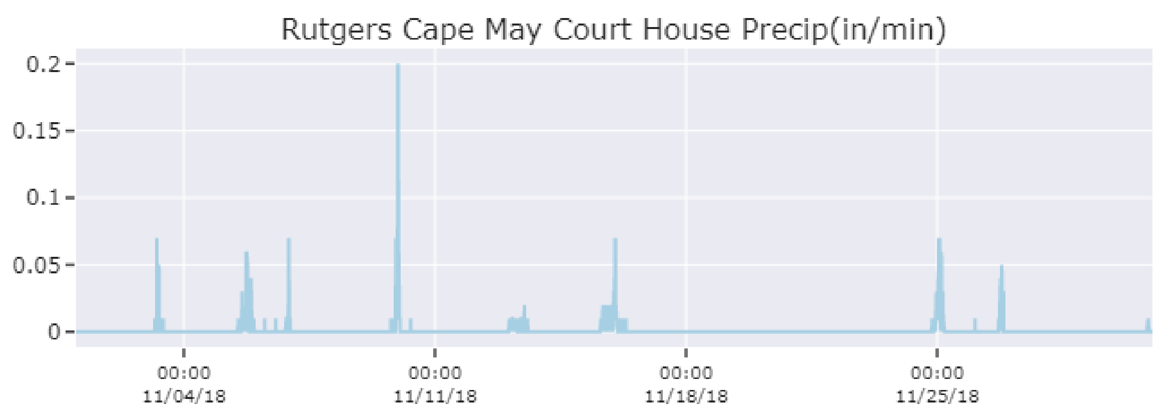

Stone Harbor Rain Gauge Precip(in/hr)
0.2
0.1
0
00:00
08/05/18
00:00
08/12/18
00:00
08/19/18
00:00
08/26/18

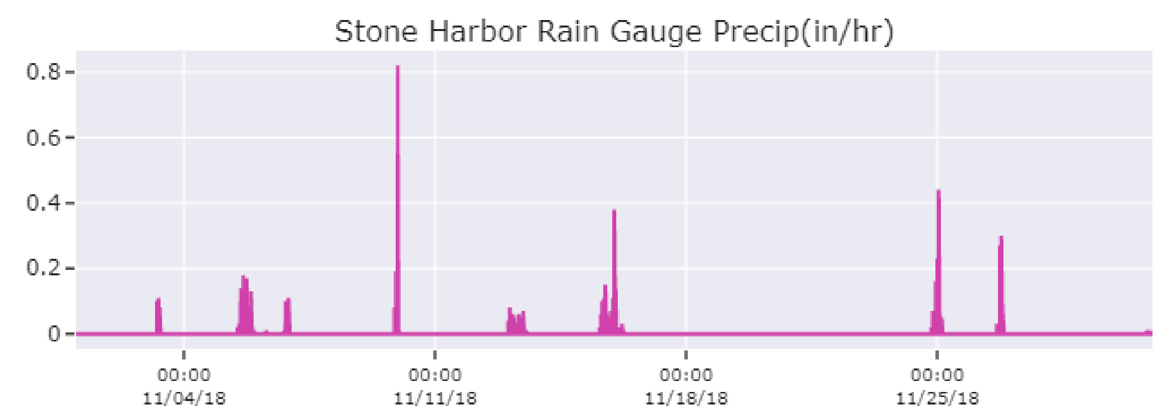

Rutgers Cape May Court House Precip(in/min)
0.2
0.1
0
00:00
09/02/18
00:00
09/09/18
00:00
09/16/18
00:00
09/23/18
00:00
09/30/18


Stone Harbor Rain Gauge Precip(in/hr)
0.3
0.2
0.1
0
00:00
09/02/18
00:00
09/09/18
00:00
09/16/18
00:00
09/23/18
00:00
09/30/18

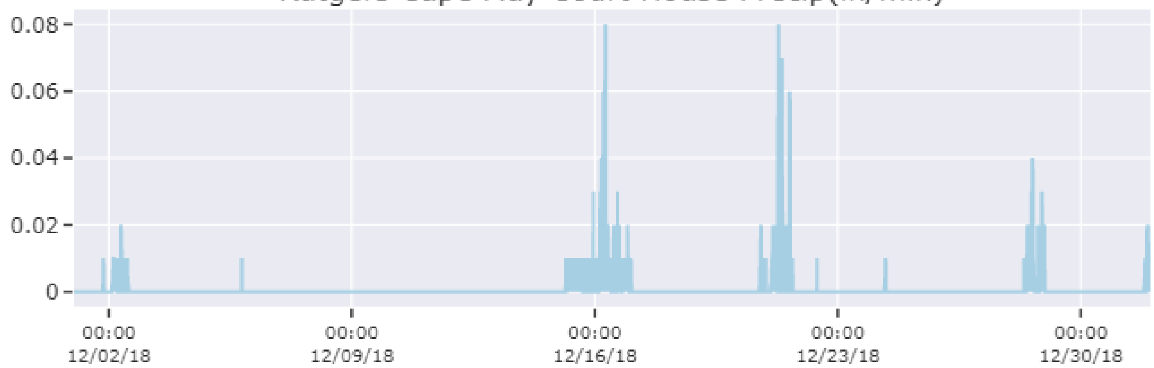

Rutgers Cape May Court House Precip(in/min)
0.2
0.15
0.1
0.05
0
00:00
10/07/18
00:00
10/14/18
00:00
10/21/18
00:00
10/28/18


Stone Harbor Rain Gauge Precip(in/hr)
0.4
0.3
0.2
0.1
0
00:00
10/07/18
00:00
10/14/18
00:00
10/21/18
00:00
10/28/18

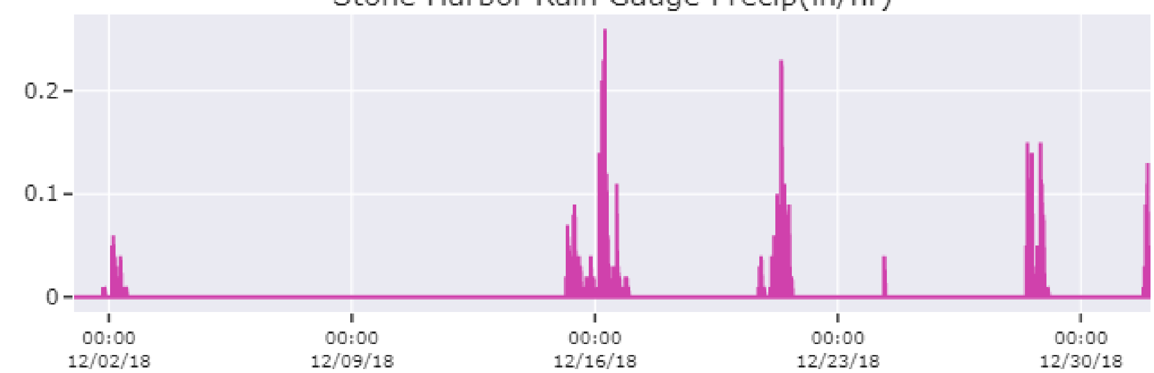

Rutgers Cape May Court House Precip(in/min)
0.2
0.15
0.1
0.05
0
00:00
11/04/18
00:00
11/11/18
00:00
11/18/18
00:00
11/25/18


Stone Harbor Rain Gauge Precip(in/hr)
0.8
0.6
0.4
0.2
0
00:00
11/04/18
00:00
11/11/18
00:00
11/18/18
00:00
11/25/18

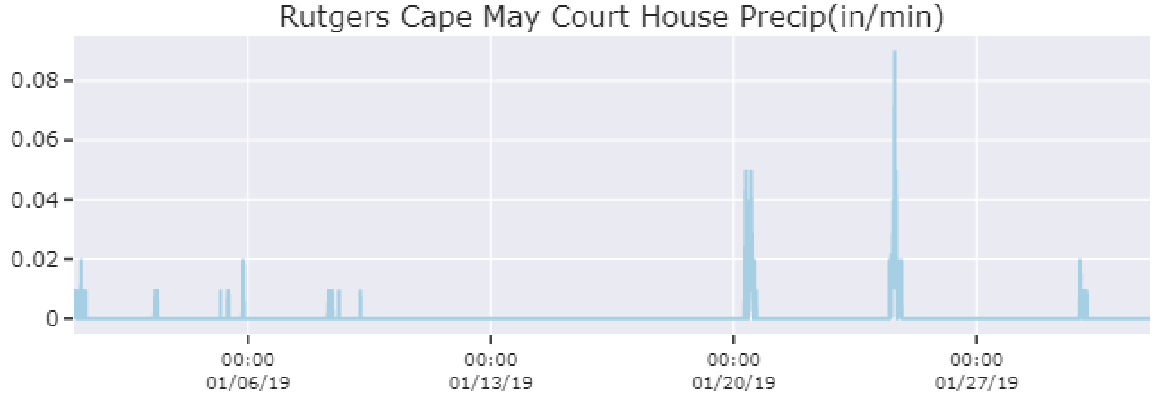
Rutgers Cape May Court House Precip(in/min)



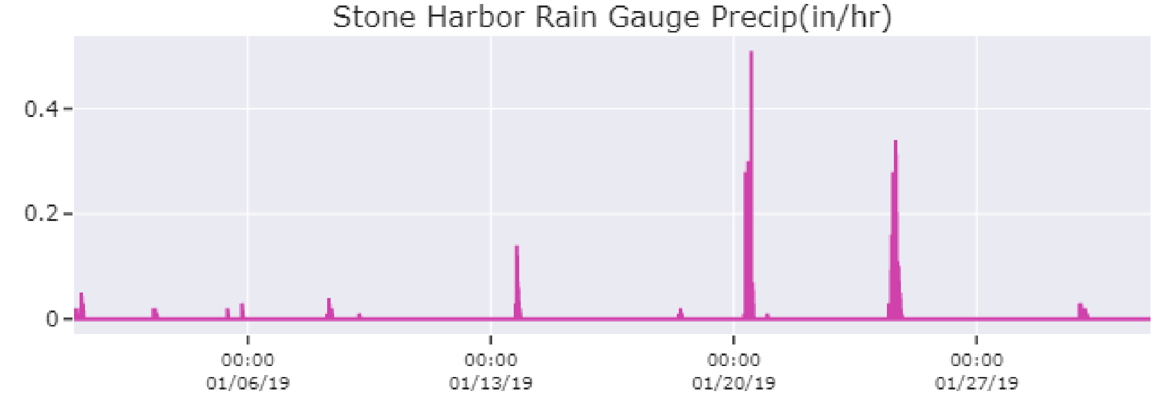
Stone Harbor Rain Gauge Precip(in/hr)

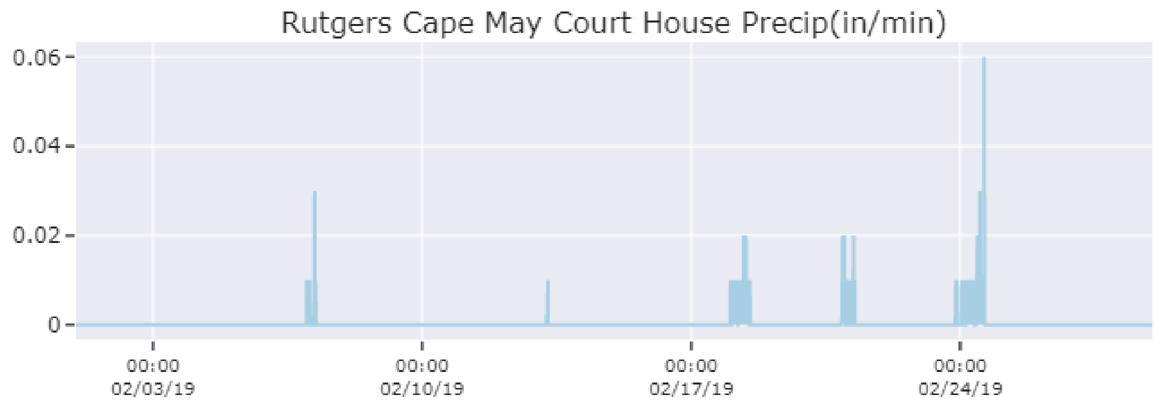


Rutgers Cape May Court House Precip(in/min)

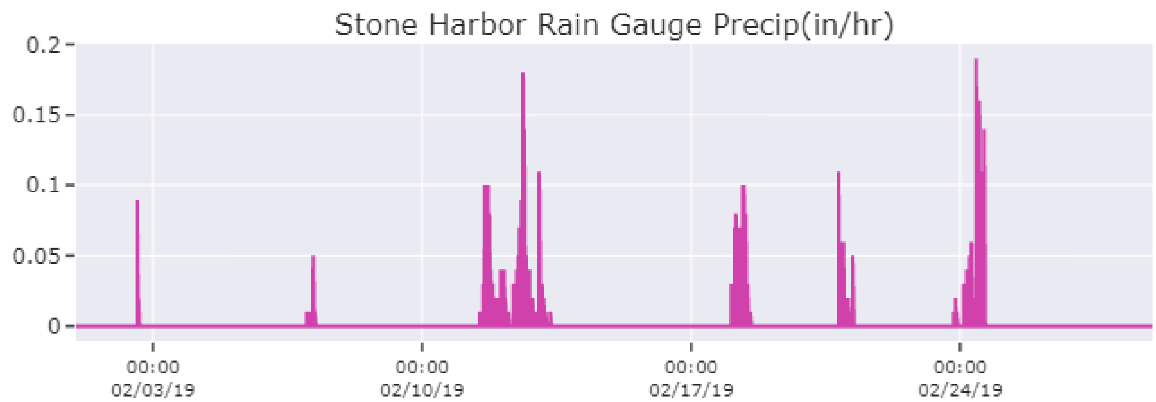


Stone Harbor Rain Gauge Precip(in/hr)

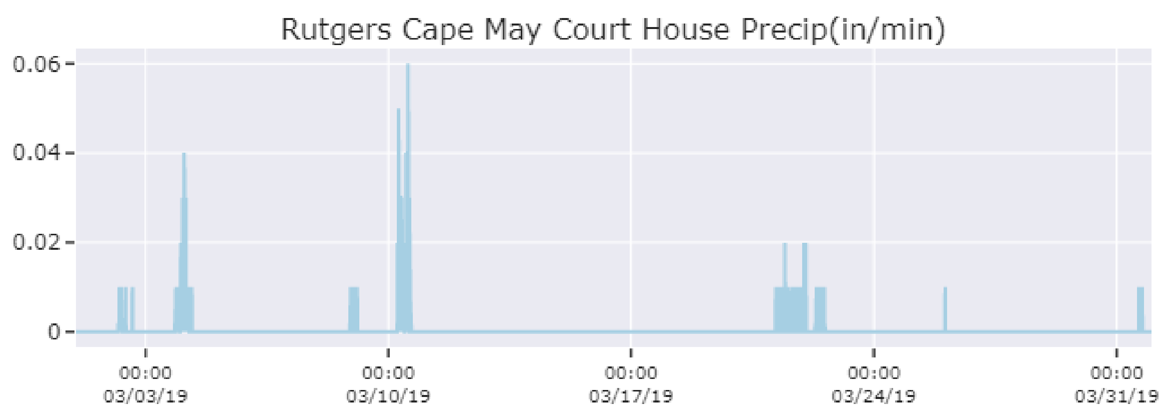




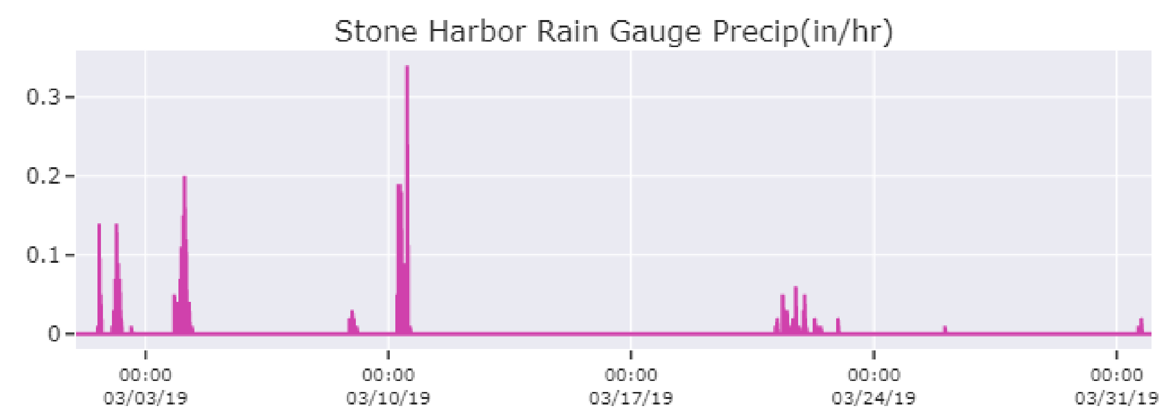
Rutgers Cape May Court House Precip(in/min)
0.06
0.04
0.02
0
00:00
02/03/19
00:00
02/10/19
00:00
02/17/19
00:00
02/24/19



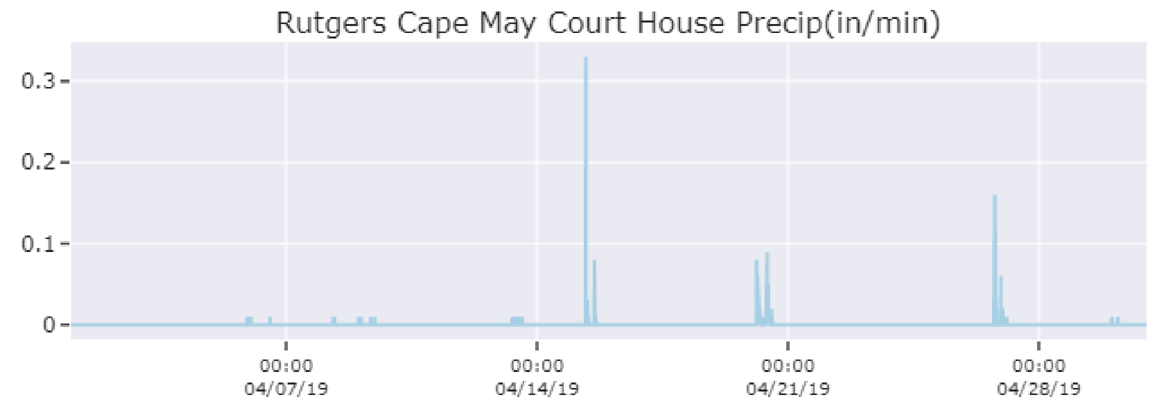
Stone Harbor Rain Gauge Precip(in/hr)
0.2
0.15
0.1
0.05
0
00:00
02/03/19
00:00
02/10/19
00:00
02/17/19
00:00
02/24/19

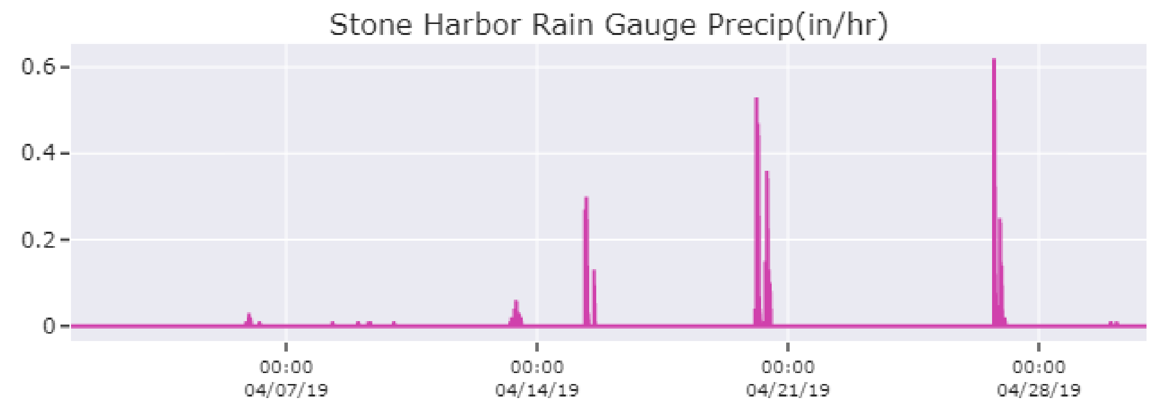


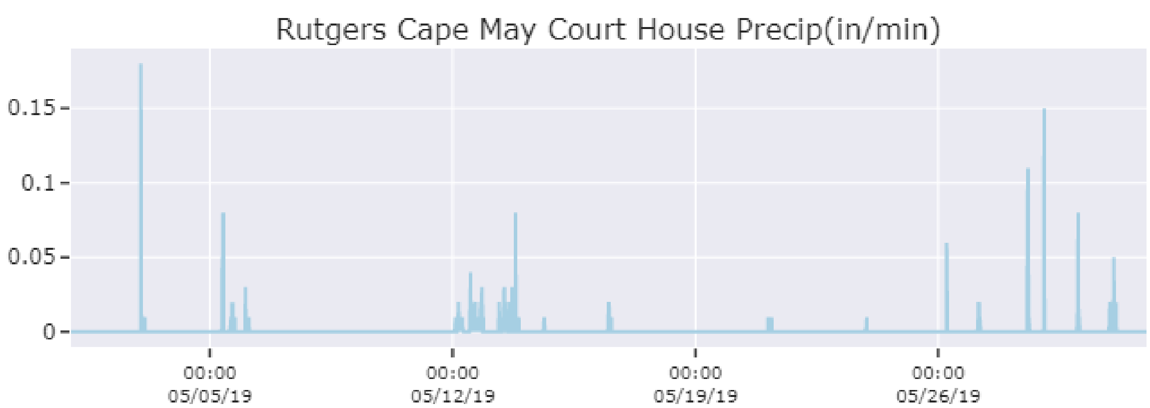
Rutgers Cape May Court House Precip(in/min)
0.06
0.04
0.02
0
00:00
03/03/19
00:00
03/10/19
00:00
03/17/19
00:00
03/24/19
00:00
03/31/19

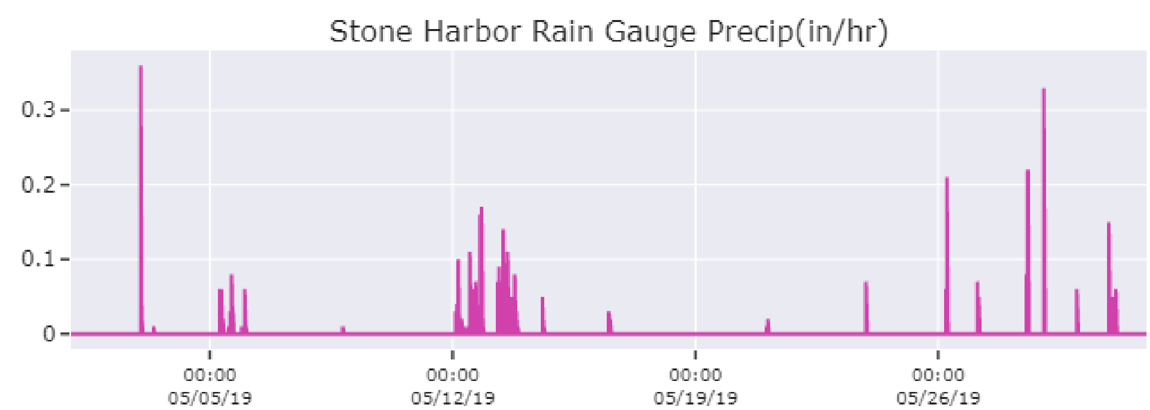


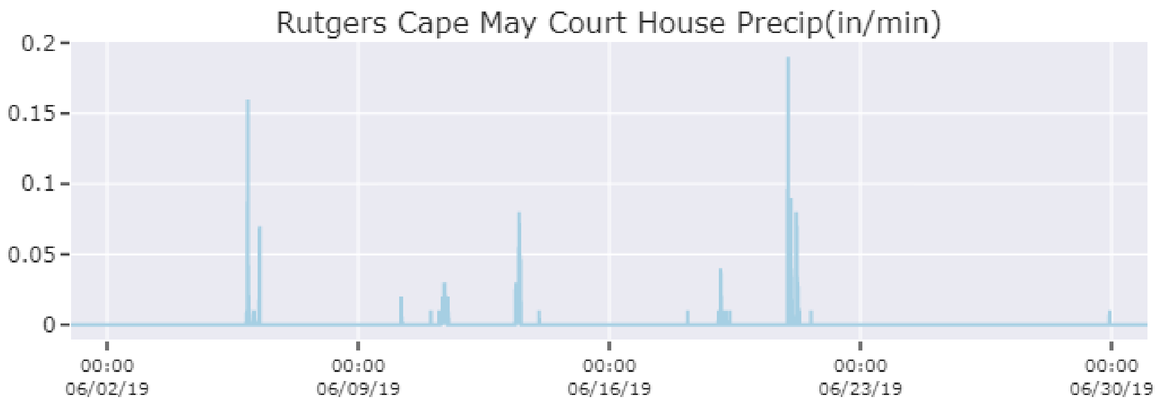
Stone Harbor Rain Gauge Precip(in/hr)
0.3
0.2
0.1
0
00:00
03/03/19
00:00
03/10/19
00:00
03/17/19
00:00
03/24/19
00:00
03/31/19

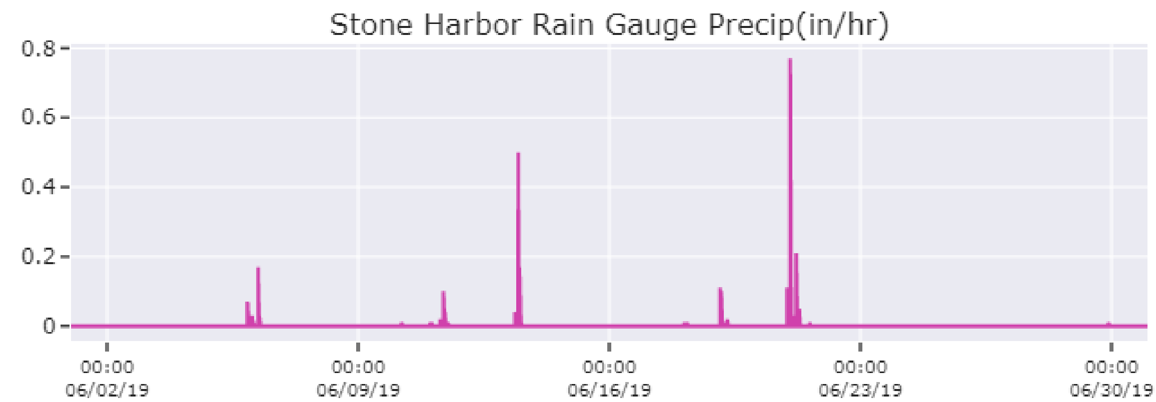

Rutgers Cape May Court House Precip(in/min)
0.3
0.2
0.1
0
00:00
04/07/19
00:00
04/14/19
00:00
04/21/19
00:00
04/28/19

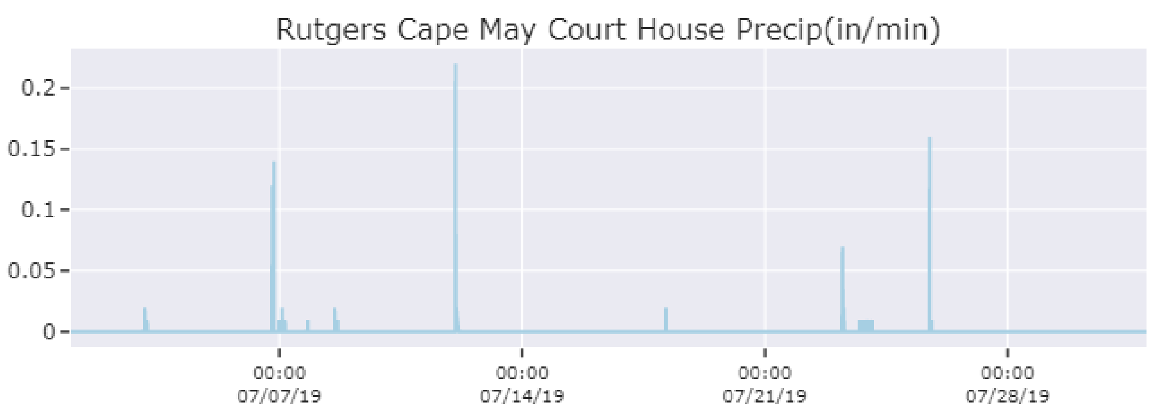

Stone Harbor Rain Gauge Precip(in/hr)
0.6
0.4
0.2
0
00:00
04/07/19
00:00
04/14/19
00:00
04/21/19
00:00
04/28/19

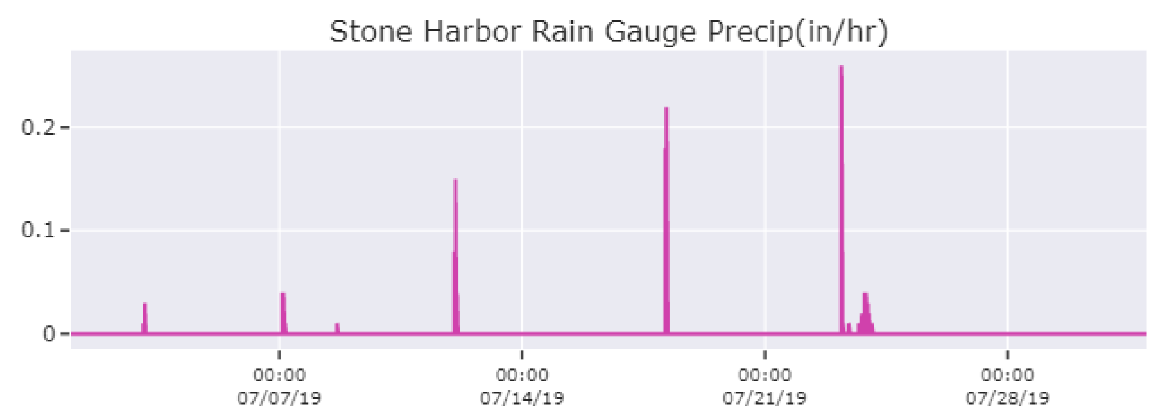

Rutgers Cape May Court House Precip(in/min)
0.15
0.1
0.05
0
00:00
05/05/19
00:00
05/12/19
00:00
05/19/19
00:00
05/26/19


Stone Harbor Rain Gauge Precip(in/hr)
0.3
0.2
0.1
0
00:00
05/05/19
00:00
05/12/19
00:00
05/19/19
00:00
05/26/19

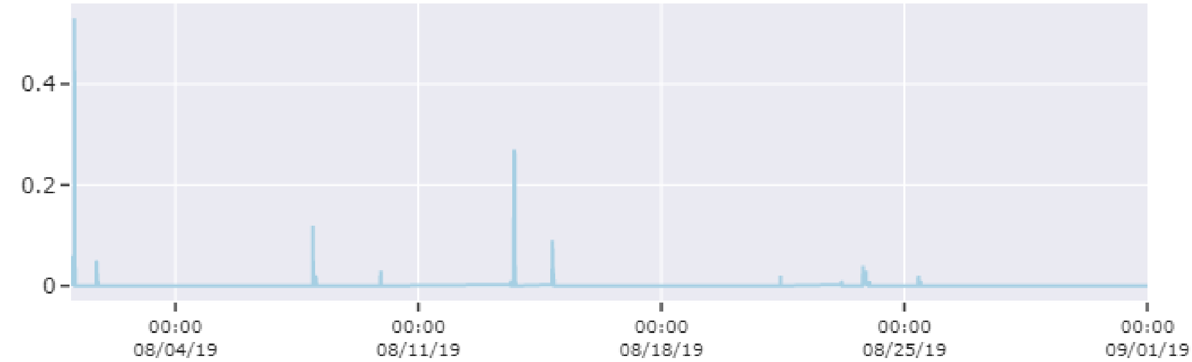

Rutgers Cape May Court House Precip(in/min)
0.2
0.15
0.1
0.05
0
00:00 06/02/19
00:00 06/09/19
00:00 06/16/19
00:00 06/23/19
00:00 06/30/19


Stone Harbor Rain Gauge Precip(in/hr)
0.8
0.6
0.4
0.2
0
00:00 06/02/19
00:00 06/09/19
00:00 06/16/19
00:00 06/23/19
00:00 06/30/19

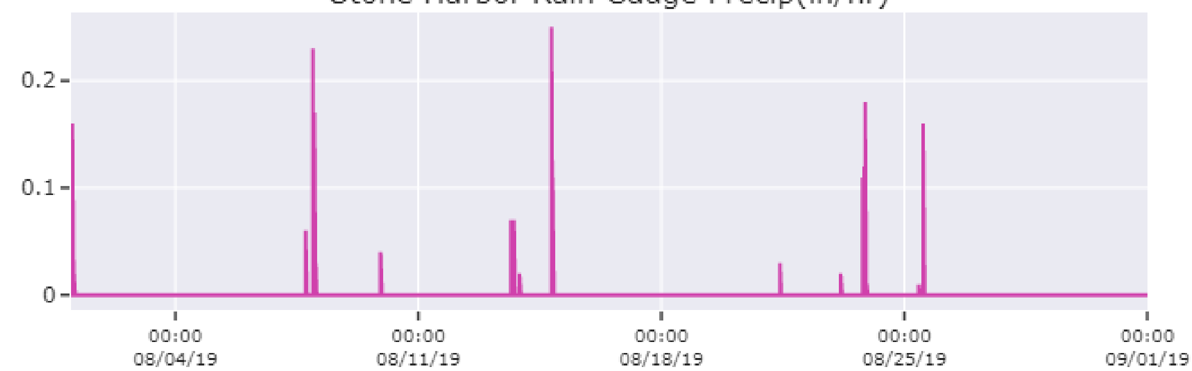

Rutgers Cape May Court House Precip(in/min)
0.2
0.15
0.1
0.05
0
00:00 07/07/19
00:00 07/14/19
00:00 07/21/19
00:00 07/28/19


Stone Harbor Rain Gauge Precip(in/hr)
0.2
0.1
0
00:00 07/07/19
00:00 07/14/19
00:00 07/21/19
00:00 07/28/19

Rutgers Cape May Court House Precip(in/min)

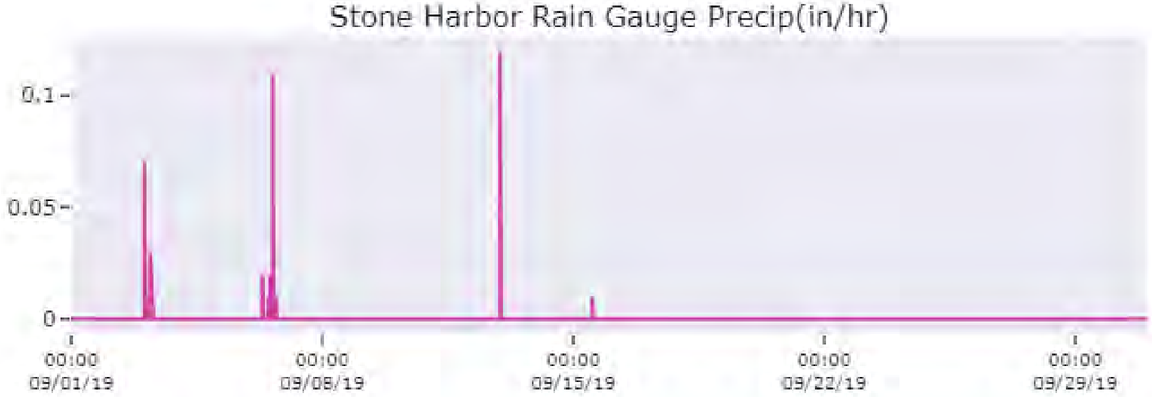


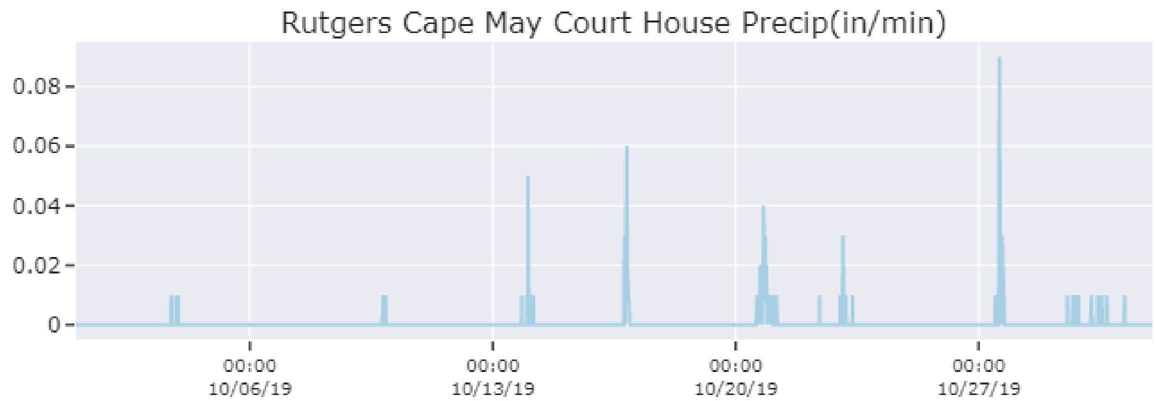
Stone Harbor Rain Gauge Precip(in/hr)

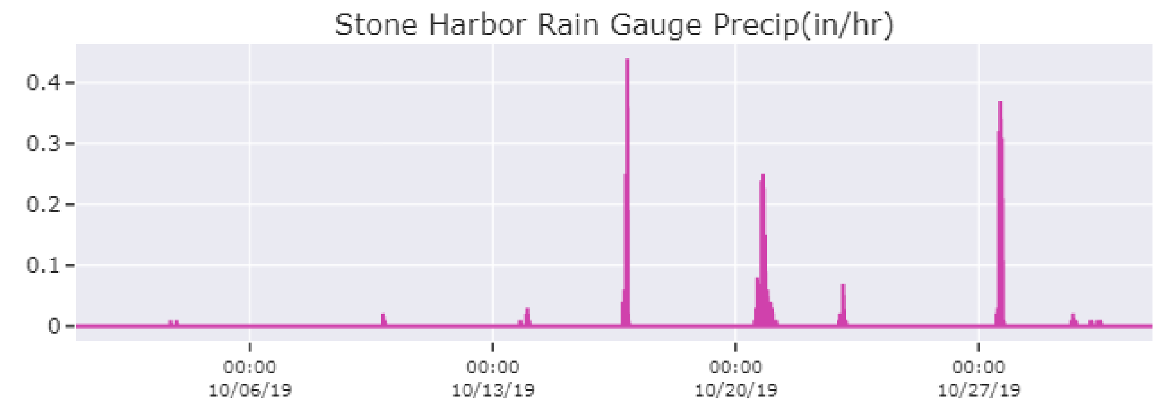


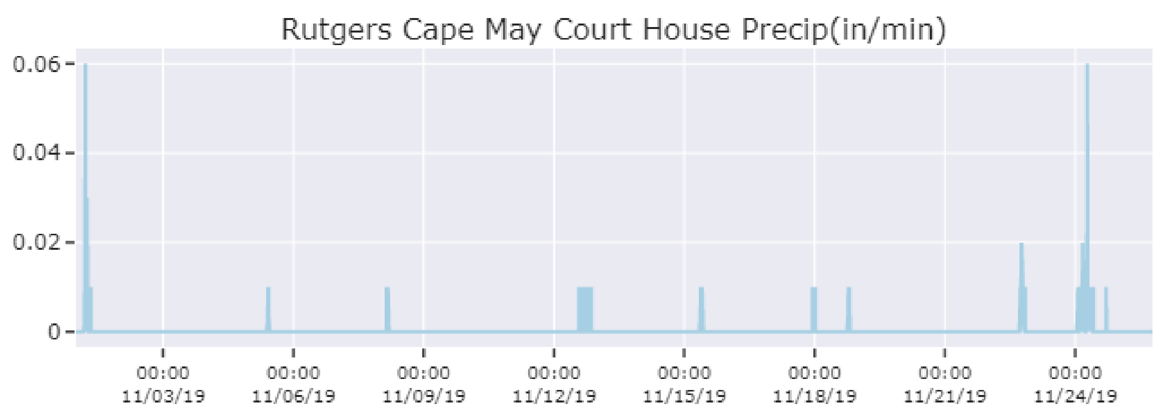
Rutgers Cape May Court House Precip(in/min)

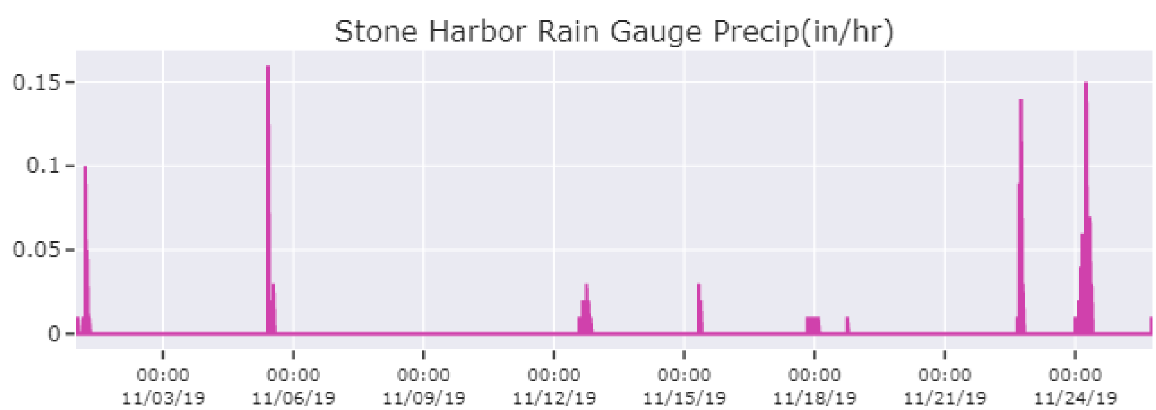
Stone Harbor Rain Gauge Precip(in/hr)




Rutgers Cape May Court House Precip(in/min)
0.08
0.06
0.04
0.02
0
00:00
10/06/19
00:00
10/13/19
00:00
10/20/19
00:00
10/27/19


Stone Harbor Rain Gauge Precip(in/hr)
0.4
0.3
0.2
0.1
0
00:00
10/06/19
00:00
10/13/19
00:00
10/20/19
00:00
10/27/19


Rutgers Cape May Court House Precip(in/min)
0.06
0.04
0.02
0
00:00
11/03/19
00:00
11/06/19
00:00
11/09/19
00:00
11/12/19
00:00
11/15/19
00:00
11/18/19
00:00
11/21/19
00:00
11/24/19


Stone Harbor Rain Gauge Precip(in/hr)
0.15
0.1
0.05
0
00:00
11/03/19
00:00
11/06/19
00:00
11/09/19
00:00
11/12/19
00:00
11/15/19
00:00
11/18/19
00:00
11/21/19
00:00
11/24/19

Tidal USGS Observation

DeBlasio & Associates
CONSULTING ENGINEERS AND PLANNERS

TIDE DATA

Elevations NAVD88
Location: Lat 39°03'25", long 74°45'54"   Stone Harbor Borough   Stone Harbor Blvd Western Edge of Stone Harbor   USGS
Maximum 6.73 ft Oct 29, 2012
To determine elevations to NGVD of 1929, add 1.31 ft
Average High Tide: 2.501

Total Observations	3781
# of occurances > Elev 2	2969
# of occurances > Elev 3	775
# of occurances > Elev 4	71
# of occurances > Elev 5	6
# of occurances > Elev 6	2
# of occurances > Elev 7	0

Date	Mean Tide Elev.	High Tide Elev.	Low Tide Elev.
Column1	Column2	Column3	Column4
1/1/2010	0.43	3.6	-2.62
1/2/2010	0.07	3.45	-2.77
1/3/2010	-1.34	1.45	-4.51
1/4/2010	-0.26	2.76	-3.04
1/5/2010	-0.13	2.46	-2.76
1/6/2010	-0.43	1.99	-2.81
1/7/2010	-0.49	1.82	-2.55
1/8/2010	-0.46	1.94	-2.77
1/9/2010	-0.3	1.98	-2.29
1/10/2010	-0.17	2.24	-2.34
1/11/2010	-0.41	2.03	-2.54
1/12/2010	-0.62	2.01	-2.67
1/13/2010	-0.49	1.99	-2.84
1/14/2010	-0.15	2.37	-2.44
1/15/2010	-0.36	2.39	-2.62
1/16/2010	-0.65	1.95	-2.93
1/17/2010	0.4	2.92	-2.45
1/18/2010	1.1	3.31	-0.92
1/19/2010	0.92	3.05	-1.15
1/20/2010	0.28	2.08	-1.74
1/21/2010	0.25	1.99	-1.44
1/22/2010	0.93	2.41	-0.61
1/23/2010	0.9	2.78	-1.04
1/24/2010	0.26	2.42	-1.61
1/25/2010	0.65	2.63	-1.94
1/26/2010	0.1	2.82	-2.78
1/27/2010	-0.42	2.13	-2.97
1/28/2010	-0.16	2.69	-2.4
1/29/2010	-0.98	2.34	-3.84
1/30/2010	-0.89	2.09	-4.5
1/31/2010	0.23	3.36	-2.84
2/1/2010	-0.68	2.48	-3.61
2/2/2010	-0.58	2.42	-3.66
2/3/2010	-0.07	2.44	-2.57
2/4/2010	-0.48	2.18	-2.82
2/5/2010	-0.38	1.88	-2.47
2/6/2010	2.25	3.94	0.25
2/7/2010		3.33	
2/8/2010			
2/9/2010			-2.12

2/10/2010	0.93	3.23	-0.41
2/11/2010	0.85	3.06	-1.19
2/12/2010	0.57	2.99	-1.52
2/13/2010	0.29	2.75	-1.92
2/14/2010	-0.55	1.8	-2.74
2/15/2010	-0.62	1.71	-3.13
2/16/2010	-0.29	2.29	-2.52
2/17/2010	-0.46	1.77	-2.64
2/18/2010	-0.55	1.51	-2.67
2/19/2010	-1.05	0.61	-3.24
2/20/2010	-0.67	1.07	-2.57
2/21/2010	-0.69	1.56	-2.5
2/22/2010	-0.04	1.66	-1.62
2/23/2010	1.15	2.82	-0.7
2/24/2010	1	3.22	-1.31
2/25/2010	0.72	3.24	-1.28
2/26/2010	-0.47	1.96	-3.46
2/27/2010	0.48	3.18	-2.47
2/28/2010	0.58	3.39	-2.53
3/1/2010	-0.17	2.72	-3.52
3/2/2010	0.61	3.33	-2.49
3/3/2010	1.66	4.25	-1.46
3/4/2010	1.09	3.35	-1.51
3/5/2010	0.85	2.48	-1.43
3/6/2010	0.55	3.1	-1.42
3/7/2010	-0.12	2.3	-1.82
3/8/2010	-0.08	1.94	-1.72
3/9/2010	-0.11	1.84	-1.74
3/10/2010	0.03	1.92	-1.61
3/11/2010	0.1	2.13	-1.75
3/12/2010	0.8	2.47	-1.21
3/13/2010	2.68	4.39	-0.27
3/14/2010	1.94	4.02	-0.26
3/15/2010	1.44	3.4	-0.77
3/16/2010	1.56	3.47	-0.7
3/17/2010	0.63	2.59	-1.87
3/18/2010	-0.07	2.46	-2.39
3/19/2010	0.02	2.54	-2.13
3/20/2010	-0.03	1.61	-2.08
3/21/2010	-0.24	2.3	-2.14
3/22/2010	0.16	2.26	-1.66
3/23/2010	0.33	2.64	-1.7
3/24/2010	-0.4	1.98	-2.39
3/25/2010	0.05	2.32	-2.4
3/26/2010	0.67	2.93	-1.83
3/27/2010	1.16	3.42	-1.37
3/28/2010	0.77	3.34	-2.12
3/29/2010	0.72	3.46	-2.3
3/30/2010	0.69	3.31	-2.36
3/31/2010	0.49	3.38	-2.48
4/1/2010	0.34	3.15	-2.32
4/2/2010	0.26	2.14	-2.17
4/3/2010	0.05	2.79	-2.13
4/4/2010	-0.17	2.46	-2.09
4/5/2010	-0.14	2.12	-2.01
4/6/2010	0.01	2.02	-1.55
4/7/2010	-0.01	1.86	-1.56
4/8/2010	0.02	1.78	-1.66
4/9/2010	0.18	1.97	-1.46
4/10/2010	-0.37	1.68	-2.46
4/11/2010	-0.68	1.33	-2.81
4/12/2010	-0.34	1.96	-2.83

4/13/2010	-0.19	2.21	-2.5
4/14/2010	-0.44	2.08	-2.7
4/15/2010	-0.59	2.4	-3.09
4/16/2010	0.32	3.25	-2.24
4/17/2010	0.5	2.89	-1.77
4/18/2010	0.14	2.54	-2.04
4/19/2010	-0.03	1.63	-2.13
4/20/2010	-0.11	2.48	-2.12
4/21/2010	0.05	2.46	-1.98
4/22/2010	0.28	2.5	-1.82
4/23/2010	0.17	2.42	-2.15
4/24/2010	0.31	2.41	-2.12
4/25/2010	0.77	3.2	-2.16
4/26/2010	1.37	4.04	-1.44
4/27/2010	1.2	3.67	-1.43
4/28/2010	0.29	2.93	-2.8
4/29/2010	-0.28	2.76	-2.93
4/30/2010	0.01	2.92	-2.69
5/1/2010	0.07	2.98	-2.49
5/2/2010	0.08	1.5	-2.03
5/3/2010	-0.2	2.57	-2.12
5/4/2010	-0.08	2.18	-1.99
5/5/2010	-0.03	2.17	-1.78
5/6/2010	-0.13	1.85	-1.7
5/7/2010	-0.14	1.68	-1.82
5/8/2010	-0.16	1.6	-1.91
5/9/2010	-0.76	1.02	-2.8
5/10/2010	-0.51	1.63	-2.57
5/11/2010	-0.16	2.1	-2.3
5/12/2010	0.11	2.68	-2.23
5/13/2010	-0.03	2.5	-2.64
5/14/2010	-0.49	2.74	-2.97
5/15/2010	-0.25	2.75	-2.7
5/16/2010	-0.12	2.8	-2.58
5/17/2010	-0.23	1.48	-2.58
5/18/2010	0.8	2.76	-1.5
5/19/2010	0.56	3.43	-1.95
5/20/2010	0.06	2.51	-2.22
5/21/2010	-0.08	2.28	-2.48
5/22/2010	0.2	2.31	-2.2
5/23/2010	0.35	2.59	-2.14
5/24/2010	0.19	2.6	-2.48
5/25/2010	0.07	2.81	-2.51
5/26/2010	0.19	3.02	-2.35
5/27/2010	0.73	3.92	-2.26
5/28/2010	0.41	3.14	-2.04
5/29/2010	0.2	2.88	-2.12
5/30/2010	0.06	2.76	-2.16
5/31/2010	0.09	1.55	-2.13
6/1/2010	-0.06	2.6	-1.95
6/2/2010	0.08	2.17	-1.94
6/3/2010	0.36	2.46	-1.31
6/4/2010	0.23	2.11	-1.56
6/5/2010	0.28	2.05	-1.47
6/6/2010	0.23	1.84	-1.63
6/7/2010	0.21	2.05	-1.69
6/8/2010	0.05	2.17	-1.88
6/9/2010	0.16	2.52	-2.05
6/10/2010	0.44	3.15	-1.91
6/11/2010	0.31	3.2	-2.1
6/12/2010	0.18	3.05	-2.37
6/13/2010	0.23	3.45	-2.39

6/14/2010	0.46	3.36	-2.08
6/15/2010	0.3	2.23	-2.27
6/16/2010	0.07	3.07	-2.4
6/17/2010	0.12	2.82	-2.5
6/18/2010	0.28	2.63	-2.26
6/19/2010	0.09	2.37	-2.43
6/20/2010	0.09	2.4	-2.35
6/21/2010	0.12	2.53	-2.31
6/22/2010	0.27	2.84	-2.14
6/23/2010	0.12	2.77	-2.35
6/24/2010	0.09	2.81	-2.23
6/25/2010	0.01	2.92	-2.23
6/26/2010	0.07	2.88	-2.23
6/27/2010	0.19	2.9	-2.01
6/28/2010	0.09	2.61	-2.08
6/29/2010	0.01	2.44	-2.12
6/30/2010	0.06	1.75	-2.07
7/1/2010	-0.19	2.15	-2.1
7/2/2010	-0.18	1.74	-2.05
7/3/2010	-0.22	1.66	-2.14
7/4/2010	-0.24	1.68	-2.21
7/5/2010	-0.13	1.91	-2.12
7/6/2010	0.15	2.19	-1.75
7/7/2010	0.18	2.42	-1.9
7/8/2010	0.27	2.74	-1.97
7/9/2010	0.34	3.06	-2.1
7/10/2010	0.37	3.37	-2.25
7/11/2010	0.4	3.43	-2.31
7/12/2010	0.27	3.4	-2.48
7/13/2010	0.26	3.23	-2.58
7/14/2010	0.25	3.07	-2.53
7/15/2010	0.53	2.88	-2.25
7/16/2010	0.36	3.13	-2.24
7/17/2010	0.17	2.54	-2.5
7/18/2010	0.1	2.46	-2.47
7/19/2010	0.24	2.53	-2.05
7/20/2010	0.19	2.54	-2.06
7/21/2010	0.24	2.63	-2.03
7/22/2010	0.03	2.52	-2.19
7/23/2010	0.04	2.65	-2.19
7/24/2010	0.01	2.78	-2.22
7/25/2010	0.15	2.67	-2.01
7/26/2010	0.02	2.38	-2.2
7/27/2010	-0.21	2.32	-2.39
7/28/2010	-0.2	2.13	-2.31
7/29/2010	-0.32	2.14	-2.38
7/30/2010	0.19	2.24	-1.94
7/31/2010	0.1	2.12	-1.86
8/1/2010	0.12	2.02	-1.86
8/2/2010	0.1	2.03	-1.75
8/3/2010	-0.04	1.94	-1.88
8/4/2010	-0.14	1.96	-2.08
8/5/2010	0.02	2.36	-2.04
8/6/2010	0.09	2.68	-2.23
8/7/2010	0.36	3	-2.14
8/8/2010	0.25	3.12	-2.6
8/9/2010	0.17	3.25	-2.78
8/10/2010	0.17	3.36	-2.76
8/11/2010	0.43	3.47	-2.56
8/12/2010	0.78	3.74	-2.16
8/13/2010	1.09	3.54	-1.66
8/14/2010	0.66	3.22	-1.91

8/15/2010	0.36	2.75	-2.12
8/16/2010	0.22	2.54	-1.93
8/17/2010	0.04	2.35	-2.11
8/18/2010	0.27	2.63	-1.75
8/19/2010	0.37	2.64	-1.58
8/20/2010	0.32	2.63	-1.64
8/21/2010	0.51	2.89	-1.6
8/22/2010	0.52	2.94	-1.67
8/23/2010	1.23	3.84	-1.3
8/24/2010	1.78	3.72	-0.25
8/25/2010	1.05	2.86	-1.16
8/26/2010	0.45	2.52	-1.69
8/27/2010	0.26	2.31	-1.88
8/28/2010	0.22	2.25	-1.92
8/29/2010	0.07	2.12	-1.88
8/30/2010	0.11	2.3	-1.78
8/31/2010	0.2	2.33	-1.75
9/1/2010	0.23	2.31	-1.59
9/2/2010	0.22	2.35	-1.57
9/3/2010	1.04	3.52	-1.25
9/4/2010	0.69	2.55	-1.46
9/5/2010	-0.13	2.61	-2.52
9/6/2010	0.36	3.4	-2.66
9/7/2010	0.09	2.91	-2.86
9/8/2010	-0.08	3.09	-3.26
9/9/2010	0.31	2.98	-2.78
9/10/2010	0.44	3.19	-2.48
9/11/2010	0.52	3.3	-2.21
9/12/2010	0.56	3.27	-2.03
9/13/2010	0.69	3.14	-1.6
9/14/2010	0.43	2.78	-1.62
9/15/2010	0.29	2.49	-1.69
9/16/2010	0.36	2.4	-1.52
9/17/2010	-0.11	2.17	-2.17
9/18/2010	0.53	2.63	-1.15
9/19/2010	0.46	2.54	-1.48
9/20/2010	0.78	3.14	-1.51
9/21/2010	0.73	2.72	-1.36
9/22/2010	-0.2	1.91	-2.36
9/23/2010	-0.01	2.58	-2.75
9/24/2010	0.35	2.56	-1.9
9/25/2010	-0.12	2.32	-2.34
9/26/2010	0.48	2.93	-2.1
9/27/2010	0.94	3.22	-1.08
9/28/2010	0.52	2.76	-1.36
9/29/2010	0.32	2.57	-1.55
9/30/2010	0.77	2.91	-0.98
10/1/2010	0.65	2.61	-1.44
10/2/2010	0.5	2.54	-1.63
10/3/2010	1.43	3.84	-0.89
10/4/2010	2.23	4.07	0.19
10/5/2010	0.94	3.13	-1.81
10/6/2010	0.58	3.08	-2.33
10/7/2010	0.19	2.98	-2.82
10/8/2010	0.02	3.06	-3.11
10/9/2010	0.13	3.11	-3.09
10/10/2010	0.65	3.63	-2.01
10/11/2010	0.2	2.94	-2.39
10/12/2010	0.56	3.17	-1.61
10/13/2010	0.71	3.02	-1.28
10/14/2010	0.68	2.71	-1.11
10/15/2010	0.22	2.16	-2.53

10/16/2010	-0.57	1.78	-2.44
10/17/2010	0.28	2.15	-1.6
10/18/2010	0.2	1.99	-1.71
10/19/2010	0.3	2.15	-1.69
10/20/2010	0.39	2.36	-1.69
10/21/2010	0.24	2.47	-1.99
10/22/2010	-0.17	2.16	-2.49
10/23/2010	-0.93	1.67	-3.52
10/24/2010	-0.24	2.38	-3.06
10/25/2010	0.1	2.7	-2.14
10/26/2010	-0.04	2.7	-2.41
10/27/2010		2.4	-2.14
10/28/2010		2.45	
10/29/2010	-0.21	2.44	-2.14
10/30/2010	-0.34	2.09	-2.44
10/31/2010	-0.88	1.52	-3.07
11/1/2010	0.08	2.28	-2.43
11/2/2010	0.13	2.25	-2.16
11/3/2010	0.25	2.6	-2.53
11/4/2010	1.12	3.6	-2.34
11/5/2010	0.8	3.93	-2.1
11/6/2010	0.21	3.31	-2.77
11/7/2010	0.16	3.31	-2.52
11/8/2010	-0.11	2.71	-2.89
11/9/2010	0.64	3.29	-1.76
11/10/2010	1.06	3.36	-1.33
11/11/2010	2.06	4.28	0.27
11/12/2010	1.94	3.73	0.04
11/13/2010	1.18	2.76	-0.65
11/14/2010	0.74	2.32	-0.95
11/15/2010	0.82	2.31	-1.02
11/16/2010	0.59	2.08	-0.92
11/17/2010	0.01	2.38	-2.9
11/18/2010	-0.96	1	-2.94
11/19/2010	-0.26	1.89	-2.05
11/20/2010	-0.44	2.29	-2.87
11/21/2010	-0.23	2.28	-3.14
11/22/2010	0.25	2.97	-2.02
11/23/2010	-0.02	2.76	-2.49
11/24/2010	-0.24	2.62	-2.64
11/25/2010	0.13	2.79	-2.61
11/26/2010	0.51	3.06	-1.99
11/27/2010	-0.31	2.08	-2.58
11/28/2010	-0.33	2.04	-2.5
11/29/2010	-0.2	1.92	-2.38
11/30/2010	0.2	2.22	-1.85
12/1/2010	0.49	2.88	-2.67
12/2/2010	-0.04	2.49	-2.67
12/3/2010	0.35	2.94	-1.96
12/4/2010	0.28	3.13	-2.35
12/5/2010	0.27	3.26	-2.44
12/6/2010	-0.63	2.55	-3.37
12/7/2010	-1.14	1.77	-3.73
12/8/2010	-0.64	2.26	-3.16
12/9/2010	-0.74	1.98	-2.94
12/10/2010	-0.41	1.98	-2.4
12/11/2010	-0.24	1.85	-1.98
12/12/2010	0.59	2.29	-1.13
12/13/2010	0.3	2.42	-2.09
12/14/2010	-0.43	1.39	-2.34
12/15/2010	-0.75	1.11	-2.7
12/16/2010	-0.42	1.15	-1.97

12/17/2010	-0.1	2.16	-2.42
12/18/2010	-0.13	2.12	-2.12
12/19/2010	0.27	2.65	-1.93
12/20/2010	0.55	3.16	-1.62
12/21/2010	0.61	3.19	-2.15
12/22/2010	0.79	3.72	-1.9
12/23/2010	0.17	2.89	-2.55
12/24/2010	0.76	3.57	-1.88
12/25/2010	0.47	3.14	-2.2
12/26/2010	0.94	3.25	-1.82
12/27/2010	0.01	3.49	-3.41
12/28/2010		0.88	-3.41
12/29/2010	-0.71	1.16	-2.75
12/30/2010	-0.15	2.39	-2.6
12/31/2010	-0.61	2.14	-3.09
1/1/2011	-0.28	2.28	-2.55
1/2/2011	-0.14	2.52	-2.76
1/3/2011	-0.37	2.61	-2.9
1/4/2011	-0.48	2.59	-2.97
1/5/2011	-0.59	2.15	-3.27
1/6/2011	0.27	2.89	-2.27
1/7/2011	0.72	3.26	-1.47
1/8/2011	0.68	3.06	-1.35
1/9/2011	-0.72	1.14	-2.73
1/10/2011	-1.13	0.72	-2.98
1/11/2011	-0.27	1.3	-2.08
1/12/2011	-0.79	1.87	-3.28
1/13/2011		-0.13	
1/14/2011		1.48	-2.16
1/15/2011	-0.42	1.78	-2.57
1/16/2011	-0.65	1.7	-2.86
1/17/2011	-0.19	2.15	-2.02
1/18/2011	0.44	3.15	-2.18
1/19/2011	0	2.97	-2.79
1/20/2011	-0.17	2.86	-3.1
1/21/2011	-0.1	2.76	-3.06
1/22/2011	-0.4	2.5	-3.53
1/23/2011		2.14	
1/24/2011			
1/25/2011		1.38	-3.16
1/26/2011	0.71	2.45	-2.02
1/27/2011	0.62	3.51	-2.3
1/28/2011	-0.18	2.08	-2.24
1/29/2011	-0.06	2.26	-2.26
1/30/2011	-0.1	2.36	-2.14
1/31/2011	-0.19	2.3	-2.42
2/1/2011	0.28	2.69	-2.17
2/2/2011	0.39	3.36	-1.96
2/3/2011	-0.63	1.92	-2.99
2/4/2011	-0.34	2.41	-2.74
2/5/2011	-0.43	1.9	-3.01
2/6/2011	-1.02	1.19	-3.47
2/7/2011	-0.39	2.25	-2.71
2/8/2011	-0.4	1.72	-2.94
2/9/2011	-1.55	0.32	-3.28
2/10/2011	-0.87	0.74	-2.36
2/11/2011	-0.48	1.36	-2.05
2/12/2011	-0.84	1.6	-2.76
2/13/2011	-0.99	1.05	-2.89
2/14/2011	-0.94	1.4	-3.6
2/15/2011	-0.8	1.52	-2.91
2/16/2011	-0.39	2.36	-2.93

2/17/2011	-0.42	2.3	-3.45
2/18/2011	-0.11	2.82	-3.24
2/19/2011	-0.78	2.44	-4.05
2/20/2011	-0.39	2.78	-3.55
2/21/2011	0.62	3.79	-2.27
2/22/2011	0.44	2.49	-2.49
2/23/2011	-0.13	2.77	-2.46
2/24/2011	-0.07	2.4	-2.22
2/25/2011	-0.26	2.62	-4.24
2/26/2011	-0.7	1.74	-2.56
2/27/2011	0.04	2.43	-2.11
2/28/2011	0.52	2.93	-1.68
3/1/2011	-0.01	2.37	-1.94
3/2/2011	-0.39	2.12	-2.58
3/3/2011	-0.42	1.99	-3.04
3/4/2011	-0.27	2.12	-2.65
3/5/2011	-0.14	2.18	-2.48
3/6/2011	0.06	2.42	-2.33
3/7/2011	-0.58	1.85	-3.1
3/8/2011	-0.3	2.19	-2.36
3/9/2011	0.33	2.86	-1.9
3/10/2011	1.11	3.39	-0.65
3/11/2011	0.65	1.82	-1.25
3/12/2011	-0.35	2.16	-2.04
3/13/2011	-0.47	1.45	-2.1
3/14/2011	-0.54	1.45	-2.29
3/15/2011	-0.15	1.86	-2.08
3/16/2011	0	2.57	-2.44
3/17/2011	-0.36	2.12	-3.14
3/18/2011	-0.3	2.4	-3.26
3/19/2011	-0.31	2.6	-3.44
3/20/2011	-0.12	2.81	-3.41
3/21/2011	-0.15	3.14	-3.25
3/22/2011	-0.06	2.17	-2.96
3/23/2011	0.72	3.1	-2.29
3/24/2011	1.08	3.97	-1.46
3/25/2011	0.28	2.79	-1.84
3/26/2011	-0.19	2.13	-2.04
3/27/2011	-0.33	1.9	-2.34
3/28/2011	-0.8	1.29	-2.74
3/29/2011	-0.5	1.38	-2.11
3/30/2011	-0.38	1.42	-2.38
3/31/2011	0.79	2.87	-1.84
4/1/2011	1.03	3.24	-1.23
4/2/2011	-0.34	1.84	-2.6
4/3/2011	-0.74	1.8	-3.24
4/4/2011	-0.01	2.48	-2.62
4/5/2011	-0.5	2.26	-3.5
4/6/2011	-0.95	1.61	-3.19
4/7/2011	-0.12	2.48	-2.45
4/8/2011	0.04	1.38	-1.86
4/9/2011	0.18	2.42	-1.6
4/10/2011	-0.09	2.37	-1.79
4/11/2011	-0.24	2.06	-2.1
4/12/2011	-0.29	1.42	-2.32
4/13/2011	0.6	2.52	-1.67
4/14/2011	0.25	2.51	-2.25
4/15/2011	0.23	2.71	-2.52
4/16/2011	1.24	4.22	-2.09
4/17/2011	0.54	3.12	-2.86
4/18/2011	-0.21	3.24	-3.46
4/19/2011	-0.15	3.33	-3.23

4/20/2011	0.14	3.11	-2.56
4/21/2011	-0.23	1.61	-2.75
4/22/2011	-0.25	2.54	-2.49
4/23/2011	-0.03	2.47	-1.97
4/24/2011	-0.48	1.97	-2.5
4/25/2011	-0.17	1.69	-1.94
4/26/2011	-0.03	1.95	-1.93
4/27/2011	-0.12	1.62	-1.9
4/28/2011	-0.23	1.64	-1.9
4/29/2011	-0.1	1.95	-2.22
4/30/2011	-0.08	2.19	-2.27
5/1/2011	-0.05	2.37	-2.23
5/2/2011	0.03	2.47	-2.22
5/3/2011	0.25	2.84	-2.17
5/4/2011	0.01	2.61	-2.18
5/5/2011	-0.36	2.39	-2.54
5/6/2011	-0.2	2.49	-2.4
5/7/2011	-0.1	1.37	-2.18
5/8/2011	0.1	2.54	-1.96
5/9/2011	0.26	2.64	-1.73
5/10/2011	0.96	2.71	-1.16
5/11/2011	1.05	2.98	-1.18
5/12/2011	1.15	3.27	-1.18
5/13/2011	0.77	2.94	-1.83
5/14/2011	0.77	3.37	-2.07
5/15/2011	0.81	3.64	-2.05
5/16/2011	0.74	3.79	-2.12
5/17/2011	0.9	4.12	-2.04
5/18/2011	0.88	3.7	-1.9
5/19/2011	0.47	3.29	-2.14
5/20/2011	0.21	2.02	-2.32
5/21/2011	0.32	3.03	-2.08
5/22/2011	0.51	2.78	-1.84
5/23/2011	0.67	2.94	-1.25
5/24/2011	0.1	2.08	-2
5/25/2011	0.36	2.09	-1.59
5/26/2011	0.43	2.1	-1.46
5/27/2011	0.17	1.91	-1.7
5/28/2011	0.06	2.14	-1.96
5/29/2011	0.02	2.23	-2.02
5/30/2011	-0.18	2.34	-2.36
5/31/2011	-0.03	2.64	-2.24
6/1/2011	-0.07	2.53	-2.23
6/2/2011	-0.37	2.42	-2.76
6/3/2011	-0.26	2.68	-2.53
6/4/2011	0.08	2.72	-2.2
6/5/2011	0.2	1.97	-1.99
6/6/2011	0.12	2.75	-2.12
6/7/2011	0.14	2.7	-2.12
6/8/2011	0.09	2.37	-2.41
6/9/2011	0.28	2.39	-2.22
6/10/2011	0.31	2.51	-2.25
6/11/2011	0.6	3.02	-1.98
6/12/2011	0.79	3.32	-1.88
6/13/2011	0.77	3.67	-1.83
6/14/2011	0.74	3.78	-1.99
6/15/2011	0.66	3.63	-2.06
6/16/2011	0.55	3.37	-2.01
6/17/2011	0.3	3.3	-2.21
6/18/2011	0.42	3.04	-2.01
6/19/2011	0.59	2.32	-1.85
6/20/2011	0.43	3.05	-1.7

6/21/2011	0.21	2.56	-1.92
6/22/2011	0.28	2.1	-1.76
6/23/2011	0.46	2.05	-1.39
6/24/2011	0.69	2.38	-0.96
6/25/2011	0.76	2.61	-0.98
6/26/2011	0.52	2.45	-1.22
6/27/2011	0.4	2.52	-1.46
6/28/2011	0.48	2.72	-1.6
6/29/2011	0.37	2.89	-1.85
6/30/2011	0.29	2.91	-1.98
7/1/2011	0.24	3.08	-2.12
7/2/2011	0.22	3.1	-2.25
7/3/2011	0.23	3.08	-2.31
7/4/2011	0.23	2.17	-2.35
7/5/2011	0.24	2.96	-2.28
7/6/2011	0.12	2.66	-2.34
7/7/2011	0.03	2.33	-2.43
7/8/2011	0.28	2.64	-2.27
7/9/2011	0.41	2.84	-1.94
7/10/2011	0.34	2.84	-2.04
7/11/2011	0.21	2.92	-2.41
7/12/2011	0.14	3.12	-2.43
7/13/2011	0.28	3.14	-2.31
7/14/2011	0.7	3.53	-2.11
7/15/2011	0.45	3.02	-2.02
7/16/2011	0.17	2.68	-2.21
7/17/2011	-0.17	2.34	-2.56
7/18/2011	-0.42	1.92	-2.71
7/19/2011	-0.13	1.86	-2.6
7/20/2011	0.35	2.43	-1.66
7/21/2011	0.06	2.14	-1.76
7/22/2011	-0.27	1.59	-2.21
7/23/2011	0.01	1.87	-1.87
7/24/2011	0.22	2.03	-1.66
7/25/2011	0.53	2.48	-1.32
7/26/2011	0.58	2.69	-1.44
7/27/2011	0.44	2.74	-1.54
7/28/2011	0.35	2.88	-1.88
7/29/2011	0.36	3.19	-2.21
7/30/2011	0.28	3.12	-2.43
7/31/2011	0.26	3.15	-2.44
8/1/2011	0.12	2.87	-2.63
8/2/2011	0.16	2.95	-2.54
8/3/2011	0.48	2.87	-2.39
8/4/2011	0.85	3.31	-1.84
8/5/2011	0.42	2.84	-2.13
8/6/2011	0.27	2.67	-2.15
8/7/2011	0.29	2.76	-2.08
8/8/2011	0.62	2.98	-1.77
8/9/2011	0.87	3.37	-1.32
8/10/2011	0.62	3.03	-1.73
8/11/2011	0.56	3.18	-1.76
8/12/2011	0.31	2.83	-2.11
8/13/2011	0.1	2.69	-2.28
8/14/2011	0.23	2.86	-2.24
8/15/2011	0.62	2.91	-1.76
8/16/2011	0.5	2.63	-1.67
8/17/2011	0.16	2.11	-1.89
8/18/2011	0	1.96	-2.02
8/19/2011	0.05	2.05	-2.04
8/20/2011	0.18	2.12	-1.67
8/21/2011	0.09	1.99	-1.58

8/22/2011	0.09	2.14	-1.53
8/23/2011	0.15	2.23	-1.5
8/24/2011	-0.02	2.18	-1.91
8/25/2011	-0.07	2.25	-2
8/26/2011	0.01	2.71	-2.37
8/27/2011	1.13	5.3	-2.1
8/28/2011	0.92	3.06	-3.44
8/29/2011	-0.22	3.06	-3.32
8/30/2011	0.26	2.8	-2.57
8/31/2011	0.2	2.95	-2.66
9/1/2011	0.32	2.99	-2.45
9/2/2011	0.61	3.33	-2.2
9/3/2011	0.37	2.91	-2.01
9/4/2011	0.11	2.58	-2.16
9/5/2011	0.16	2.58	-2.02
9/6/2011	0.53	2.99	-1.86
9/7/2011	0.88	2.97	-1.18
9/8/2011	0.86	3.14	-1.41
9/9/2011	0.83	2.88	-1.37
9/10/2011	0.57	2.92	-1.83
9/11/2011	0.83	2.98	-1.68
9/12/2011	0.59	2.66	-1.73
9/13/2011	0.36	2.51	-1.95
9/14/2011	0.34	2.54	-1.88
9/15/2011	0.24	2.48	-1.8
9/16/2011	0.43	2.64	-1.67
9/17/2011	0.29	2.28	-1.58
9/18/2011	0.97	2.95	-0.71
9/19/2011	0.97	2.69	-0.72
9/20/2011	0.36	2.27	-1.29
9/21/2011	0.28	2.24	-1.44
9/22/2011	0.3	2.37	-1.68
9/23/2011	0.33	2.57	-1.69
9/24/2011	0.25	2.63	-2.19
9/25/2011	0.28	2.87	-2.39
9/26/2011	0.45	3.09	-2.42
9/27/2011	0.57	3.15	-2.56
9/28/2011	0.88	3.66	-2.22
9/29/2011	0.84	3.93	-2.03
9/30/2011	0.47	3.43	-2.38
10/1/2011	0.71	3.56	-1.79
10/2/2011	0.41	3.04	-1.93
10/3/2011	0.3	2.75	-1.91
10/4/2011	0.32	2.56	-1.87
10/5/2011	0.41	2.56	-1.52
10/6/2011	0.55	2.53	-2.07
10/7/2011	0.37	2.57	-1.53
10/8/2011	0.02	2.06	-2.01
10/9/2011	-0.3	1.89	-2.61
10/10/2011	0.24	2.36	-2.24
10/11/2011	0.61	2.78	-1.88
10/12/2011	1.41	3.45	-1.05
10/13/2011	1.43	3.71	-0.77
10/14/2011	1.07	3.37	-0.97
10/15/2011	-0.29	2.13	-2.36
10/16/2011	-0.62	1.8	-2.56
10/17/2011	-0.17	2.31	-2.3
10/18/2011	0.33	2.54	-1.67
10/19/2011	1.28	3.48	-0.74
10/20/2011	0.14	2.33	-2.6
10/21/2011	-0.7	1.57	-2.69
10/22/2011	-0.04	2.27	-2.2

10/23/2011	0.33	2.64	-1.99
10/24/2011	0.45	2.72	-2.29
10/25/2011	0.11	2.85	-2.77
10/26/2011	0.03	2.96	-3.27
10/27/2011	0.57	3.71	-2.49
10/28/2011	0.78	4.05	-2.11
10/29/2011	1.64	4.92	-1.55
10/30/2011	0.61	3.44	-2.68
10/31/2011	0.17	3.02	-2.17
11/1/2011	0.83	3.34	-1.36
11/2/2011	0.81	2.83	-1.33
11/3/2011	0.16	2.02	-1.86
11/4/2011	0.45	2.41	-1.63
11/5/2011	1.06	2.6	-1.04
11/6/2011	0.18	2.25	-2.18
11/7/2011	-0.51	1.69	-2.52
11/8/2011	-0.15	1.85	-2.72
11/9/2011	0.26	2.45	-1.9
11/10/2011	0.61	2.99	-1.63
11/11/2011	-0.17	2.42	-2.38
11/12/2011	-1.04	1.79	-3.24
11/13/2011	-0.84	1.82	-3.28
11/14/2011	-0.48	2.09	-2.57
11/15/2011	-0.57	1.88	-2.52
11/16/2011	0.06	2.51	-1.94
11/17/2011	0.09	2.42	-1.82
11/18/2011	-0.68	1.68	-2.66
11/19/2011	-0.89	1.15	-3.14
11/20/2011	-1.03	1.02	-3.33
11/21/2011	-0.34	1.97	-2.62
11/22/2011	0.74	3.09	-1.76
11/23/2011	0.46	3.27	-2.52
11/24/2011	0.62	3.66	-2.34
11/25/2011	0.12	3.36	-2.84
11/26/2011	-0.28	2.85	-3.24
11/27/2011	0.01	3.07	-2.81
11/28/2011	-0.02	2.89	-2.53
11/29/2011	0.16	2.85	-2.19
11/30/2011	-0.12	2.46	-2.44
12/1/2011	-0.2	2.18	-2.06
12/2/2011	-0.05	1.9	-2.23
12/3/2011	-0.03	1.6	-1.82
12/4/2011	-0.08	1.76	-1.88
12/5/2011	-0.2	1.78	-2.09
12/6/2011	-0.13	1.98	-2.03
12/7/2011	0.02	2.13	-1.91
12/8/2011	-0.85	1.44	-3.54
12/9/2011	-0.45	2.02	-3.03
12/10/2011	-0.16	2.65	-2.68
12/11/2011	-0.1	2.58	-2.6
12/12/2011	-0.33	2.35	-2.78
12/13/2011	-0.34	2.41	-2.6
12/14/2011	0.18	2.78	-2.04
12/15/2011	0.09	2.63	-2.01
12/16/2011	-0.85	1.24	-2.8
12/17/2011	-0.31	2.17	-2.47
12/18/2011	0.08	2.15	-2.09
12/19/2011	-0.05	2.56	-3.13
12/20/2011	-0.73	1.49	-2.97
12/21/2011	0.13	2.8	-2.92
12/22/2011	-0.41	2.44	-3.08
12/23/2011	0.3	3.14	-2.78

12/24/2011	0.11	3.26	-2.81
12/25/2011	0.05	3.24	-2.78
12/26/2011	-0.36	2.65	-3.38
12/27/2011	0.33	3.1	-2.47
12/28/2011	-0.66	2.52	-3.36
12/29/2011	-1.08	1.4	-3.56
12/30/2011	-0.89	1.2	-2.81
12/31/2011	-0.26	1.68	-2.06
1/1/2012	-0.11	1.63	-1.97
1/2/2012	-0.89	1.18	-2.65
1/3/2012	-0.63	1.11	-2.23
1/4/2012	-0.25	1.86	-2.1
1/5/2012	-0.48	1.64	-2.32
1/6/2012	-0.54	1.83	-2.55
1/7/2012	-0.22	2.37	-2.56
1/8/2012	-0.34	2.32	-2.79
1/9/2012	-0.28	2.51	-2.83
1/10/2012	-0.38	2.54	-3.04
1/11/2012	-0.08	2.57	-2.98
1/12/2012	1.02	3.57	-1.49
1/13/2012	-0.5	1.53	-3.54
1/14/2012	-1.86	0.29	-4.12
1/15/2012	-1.1	1	-3.42
1/16/2012	-0.48	1.88	-2.75
1/17/2012	-1.32	1.08	-3.36
1/18/2012	-0.87	1.53	-3.21
1/19/2012	0.1	2.46	-2.26
1/20/2012	-0.31	2.27	-2.77
1/21/2012	0.42	2.97	-3
1/22/2012	0.73	3.44	-1.9
1/23/2012	0.49	3.26	-2.23
1/24/2012	-0.14	2.73	-2.81
1/25/2012	-0.55	2.32	-3.18
1/26/2012	-0.29	2.26	-2.96
1/27/2012	-0.12	2.47	-2.59
1/28/2012	-0.7	1.33	-2.57
1/29/2012	-1.25	0.43	-3
1/30/2012	-1.52	0.71	-3.31
1/31/2012	-0.95	0.89	-2.52
2/1/2012	-0.61	0.81	-2.01
2/2/2012	-0.13	1.38	-1.86
2/3/2012	0.02	2.08	-1.98
2/4/2012	-0.2	2.08	-2.23
2/5/2012	0.44	2.73	-1.42
2/6/2012	-0.26	2.5	-2.73
2/7/2012	-0.69	1.77	-3.51
2/8/2012	0.35	3	-2.73
2/9/2012	0.02	2.74	-2.8
2/10/2012	-0.25	2.48	-3.04
2/11/2012	0.24	2.96	-2.7
2/12/2012	-0.32	2.14	-2.95
2/13/2012	-1.18	1.82	-3.63
2/14/2012	-0.83	1.48	-3.06
2/15/2012	-0.16	2.39	-2.38
2/16/2012	-0.23	2.12	-2.38
2/17/2012	-0.14	2.44	-2.55
2/18/2012	-0.33	2.28	-2.59
2/19/2012	-0.13	2.3	-3.1
2/20/2012	0.31	2.95	-2.29
2/21/2012	0.05	2.63	-2.64
2/22/2012	-0.05	2.41	-2.7
2/23/2012	-0.06	2.32	-2.67

2/24/2012	0.75	2.88	-1.93
2/25/2012	-1.68	0.62	-4.48
2/26/2012	-2.12	0.62	-4.61
2/27/2012	-0.93	0.98	-2.76
2/28/2012	-0.97	1.05	-2.82
2/29/2012	-0.27	1.22	-1.92
3/1/2012	0.63	2.17	-0.8
3/2/2012	0.84	2.31	-0.66
3/3/2012	0.81	3.04	-1.48
3/4/2012	0.04	2.11	-2.16
3/5/2012	-0.33	1.89	-2.47
3/6/2012	-0.43	2.09	-3.08
3/7/2012	-0.96	1.65	-3.69
3/8/2012	-0.99	1.9	-3.91
3/9/2012	-1.01	2.32	-4.32
3/10/2012	-0.68	2.44	-3.95
3/11/2012	-0.86	1.88	-3.56
3/12/2012	-1.06	1.85	-3.77
3/13/2012	-0.68	2.03	-3.13
3/14/2012	-0.38	2.09	-2.65
3/15/2012	0.22	2.31	-1.84
3/16/2012	0.31	2.61	-1.88
3/17/2012	-0.15	2.27	-2.35
3/18/2012	-0.27	2.04	-2.53
3/19/2012	-0.48	1.94	-2.86
3/20/2012	-0.2	2.09	-2.83
3/21/2012	-0.51	1.92	-3.06
3/22/2012	-0.5	2.08	-3.14
3/23/2012	-0.46	2.24	-2.9
3/24/2012	0.17	2.81	-2.29
3/25/2012	0.77	3.04	-1.32
3/26/2012	0.34	2.28	-1.88
3/27/2012	0.14	1.54	-1.6
3/28/2012	-0.03	2.28	-1.8
3/29/2012	0.3	2.31	-1.37
3/30/2012	0.38	2.41	-1.4
3/31/2012	0.76	2.16	-0.84
4/1/2012	0.67	2.76	-1.35
4/2/2012	0.66	2.45	-1.33
4/3/2012	0.4	2.44	-1.94
4/4/2012	0.73	3.05	-2.05
4/5/2012	0.73	3.13	-2.09
4/6/2012	0.49	3.32	-2.56
4/7/2012	0.26	3.3	-2.78
4/8/2012	0.24	3.37	-2.78
4/9/2012	-0.36	1.76	-3.45
4/10/2012	-0.09	2.72	-2.89
4/11/2012	0.17	3	-2.32
4/12/2012	0.18	2.67	-2.12
4/13/2012	-0.03	2.46	-2.12
4/14/2012	-0.45	1.87	-2.62
4/15/2012	-0.33	1.64	-2.53
4/16/2012	-0.1	1.92	-2.32
4/17/2012	-0.21	1.89	-2.44
4/18/2012	-0.04	2.23	-2.39
4/19/2012	-0.02	2.21	-2.29
4/20/2012	0.04	2.47	-2.39
4/21/2012	0.11	2.59	-2.18
4/22/2012	0.47	3.2	-2.14
4/23/2012	0.37	2.42	-1.65
4/24/2012	-0.23	2.25	-2.35
4/25/2012	-0.04	1.53	-2.01

4/26/2012	0.11	2.3	-1.83
4/27/2012	-0.44	2.57	-2.56
4/28/2012	-0.89	1.44	-2.61
4/29/2012	-0.81	1.23	-2.82
4/30/2012	-0.31	1.42	-2.05
5/1/2012	-0.27	1.8	-2.52
5/2/2012	0.32	2.48	-2.16
5/3/2012	0.18	2.66	-2.66
5/4/2012	0.12	3.04	-2.77
5/5/2012	0.33	3.47	-2.74
5/6/2012	0.3	3.49	-2.64
5/7/2012	0.08	3.31	-2.88
5/8/2012	0.02	3.15	-2.77
5/9/2012	0.03	1.99	-2.71
5/10/2012	0.14	3.12	-2.32
5/11/2012	-0.29	2.53	-2.78
5/12/2012	-0.38	2.07	-2.59
5/13/2012	-0.44	1.72	-2.59
5/14/2012	-0.28	1.54	-2.42
5/15/2012	0.06	1.9	-1.96
5/16/2012	0.11	2.17	-1.98
5/17/2012	0.14	2.43	-2
5/18/2012	0.18	2.64	-2.11
5/19/2012	0.41	2.72	-1.59
5/20/2012	0.37	2.75	-1.78
5/21/2012	0.32	2.82	-1.83
5/22/2012	0.31	2.73	-1.75
5/23/2012	0.17	2.65	-1.85
5/24/2012	0.05	2.54	-1.94
5/25/2012	0.09	1.58	-1.83
5/26/2012	-0.24	2.4	-2.12
5/27/2012	-0.25	1.98	-2.26
5/28/2012	-0.1	2.01	-2.17
5/29/2012	-0.01	1.99	-2.18
5/30/2012	0.23	2.53	-2.18
5/31/2012	0.52	2.85	-2.1
6/1/2012	0.76	3.66	-2.07
6/2/2012	0.84	3.7	-2.21
6/3/2012	0.59	3.59	-2.39
6/4/2012	0.97	4.72	-2.4
6/5/2012	1.55	4.14	-1.26
6/6/2012	0.72	3.43	-1.98
6/7/2012	0.29	2.25	-2.42
6/8/2012	0.24	2.99	-2.37
6/9/2012	0.22	2.72	-2.24
6/10/2012	0.29	2.51	-1.96
6/11/2012	0.42	2.26	-1.79
6/12/2012	0.34	2.12	-1.76
6/13/2012	0.57	2.49	-1.68
6/14/2012	0.76	2.54	-1.26
6/15/2012	0.54	2.54	-1.48
6/16/2012	0.56	2.75	-1.4
6/17/2012	0.8	2.95	-1.06
6/18/2012	0.41	2.81	-1.62
6/19/2012	0.2	2.68	-1.92
6/20/2012	0	2.59	-2.16
6/21/2012	0.05	2.87	-2.21
6/22/2012	0.34	2.97	-1.93
6/23/2012	0.31	1.86	-1.89
6/24/2012	0.22	2.69	-1.99
6/25/2012	0.18	2.53	-2.01
6/26/2012	0.35	2.44	-1.9

6/27/2012	0.19	2.23	-2.15
6/28/2012	0.22	2.55	-2.24
6/29/2012	0.28	2.8	-2.21
6/30/2012	0.27	2.99	-2.46
7/1/2012	0.24	3.15	-2.62
7/2/2012	0.19	3.3	-2.61
7/3/2012	0.21	3.4	-2.64
7/4/2012	0.24	3.38	-2.63
7/5/2012	0.25	3.3	-2.64
7/6/2012	0.36	2.37	-2.33
7/7/2012	0.17	3.01	-2.43
7/8/2012	0.25	2.74	-2.15
7/9/2012	0.42	2.48	-1.84
7/10/2012	0.17	2.13	-1.98
7/11/2012	0.1	1.89	-1.84
7/12/2012	0.13	2.01	-1.68
7/13/2012	-0.03	1.93	-1.85
7/14/2012	-0.13	2.04	-2.07
7/15/2012	-0.14	2.17	-2.08
7/16/2012	0.09	2.52	-1.94
7/17/2012	0.19	2.78	-1.95
7/18/2012	-0.02	2.63	-2.27
7/19/2012	0.2	3.08	-2.1
7/20/2012	0.94	3.87	-1.56
7/21/2012	1	3.07	-1.55
7/22/2012	0.25	2.51	-2.04
7/23/2012	-0.03	2.12	-2.45
7/24/2012	0.04	2.28	-2.32
7/25/2012	0.43	2.82	-1.77
7/26/2012	0.03	2.42	-2.15
7/27/2012	0.2	2.59	-2.1
7/28/2012	0.39	2.96	-2.19
7/29/2012	0.54	3.11	-2.1
7/30/2012	0.56	3.43	-2.14
7/31/2012	0.66	3.56	-2.04
8/1/2012	0.45	3.23	-2.47
8/2/2012	0.41	3.06	-2.34
8/3/2012	0.13	2.81	-2.52
8/4/2012	-0.03	2.51	-2.56
8/5/2012	-0.3	1.91	-2.61
8/6/2012	-0.34	1.87	-2.82
8/7/2012	0.06	2.11	-2.2
8/8/2012	0.17	2.1	-1.74
8/9/2012	0.14	2.04	-1.74
8/10/2012	0.13	1.89	-1.54
8/11/2012	0.04	2	-1.59
8/12/2012	0.12	2.22	-1.6
8/13/2012	0.17	2.32	-1.57
8/14/2012	0.18	2.59	-1.82
8/15/2012	0.35	2.83	-1.9
8/16/2012	0.36	2.84	-2
8/17/2012	0.17	2.73	-2.3
8/18/2012	0.34	3.17	-2.42
8/19/2012	0.47	2.92	-2.14
8/20/2012	0.53	2.93	-2.08
8/21/2012	0.31	2.72	-2.18
8/22/2012	0.24	2.78	-2.29
8/23/2012	0.23	2.71	-2.19
8/24/2012	0.21	2.67	-2.12
8/25/2012	0.48	2.92	-1.86
8/26/2012	0.67	2.94	-1.73
8/27/2012	0.27	2.71	-2.19

8/28/2012	0	2.74	-2.73
8/29/2012	0.47	3.3	-2.35
8/30/2012	0.32	2.88	-2.36
8/31/2012	-0.16	2.31	-2.84
9/1/2012	-0.15	2.69	-2.95
9/2/2012	0.52	2.74	-2.01
9/3/2012	0.49	2.72	-1.85
9/4/2012	0.32	2.46	-1.71
9/5/2012	-0.14	1.97	-1.97
9/6/2012	0.18	2.27	-1.74
9/7/2012	0.17	2.09	-1.53
9/8/2012	0.11	2.05	-1.69
9/9/2012	0.3	2.17	-1.21
9/10/2012	0.35	2.33	-1.28
9/11/2012	0.26	2.08	-1.42
9/12/2012	0.02	2.12	-1.99
9/13/2012	-0.17	2.31	-2.42
9/14/2012	-0.05	2.48	-2.53
9/15/2012	0.08	2.69	-2.5
9/16/2012	0.2	2.7	-2.55
9/17/2012	0.06	2.67	-2.68
9/18/2012	0.18	3.04	-2.42
9/19/2012	0.03	3.08	-3.22
9/20/2012	0.3	3.12	-2.59
9/21/2012	0.5	2.96	-1.78
9/22/2012	0.31	2.76	-1.99
9/23/2012	0.05	2.74	-2.46
9/24/2012	0.09	2.42	-2.12
9/25/2012	-0.16	2.11	-2.39
9/26/2012	-0.52	2.02	-2.92
9/27/2012	-0.3	2.35	-2.99
9/28/2012	0.24	2.59	-2.41
9/29/2012	0.18	2.47	-2.33
9/30/2012	0.29	2.72	-2.29
10/1/2012	-0.2	2.32	-2.56
10/2/2012		2.49	-2.6
10/3/2012	0.11	2.55	-1.96
10/4/2012	0.1	2.4	-1.82
10/5/2012	0.26	2.4	-1.48
10/6/2012	0.12	2.24	-1.65
10/7/2012	0.32	2.28	-1.11
10/8/2012	0.32	2	-1.24
10/9/2012	0.94	2.71	-0.64
10/10/2012	0.91	2.46	-1.51
10/11/2012	-0.12	1.9	-1.95
10/12/2012	-0.39	1.69	-2.74
10/13/2012	0.04	2.4	-2.55
10/14/2012	-0.44	2.1	-3.23
10/15/2012	-0.29	2.44	-3.4
10/16/2012	0.1	3.01	-2.89
10/17/2012	0.2	3.34	-2.76
10/18/2012	0.28	3.25	-2.52
10/19/2012	0.65	3.42	-1.77
10/20/2012	0.41	3.06	-2.07
10/21/2012	-0.08	2.43	-2.49
10/22/2012	-0.35	2.1	-2.63
10/23/2012	-0.03	2.32	-2.17
10/24/2012	0.29	2.48	-1.78
10/25/2012	0.44	2.4	-1.81
10/26/2012	0.52	2.49	-1.8
10/27/2012	1.12	3.07	-1.73
10/28/2012	2.79	5.09	-0.29

10/29/2012	4.9	6.73	2.41
10/30/2012	1.63	3.77	-1.53
10/31/2012	0.87	3.34	-1.5
11/1/2012	0.57	2.93	-1.64
11/2/2012	0.19	2.52	-1.75
11/3/2012	0.04	2.49	-1.82
11/4/2012	0.23	2.32	-1.66
11/5/2012	0.28	2.35	-1.4
11/6/2012	0.59	2.47	-1.05
11/7/2012	2.06	3.59	0.62
11/8/2012	1.66	4.16	-2.03
11/9/2012	-0.36	1.64	-2.46
11/10/2012	0.15	2.46	-2.54
11/11/2012	-0.18	2.47	-2.68
11/12/2012	-0.16	2.53	-3.08
11/13/2012	0	3.01	-3.01
11/14/2012	0.38	3.37	-2.88
11/15/2012	0.69	3.72	-2.31
11/16/2012	0.56	3.62	-2.17
11/17/2012	0.38	3.25	-2.27
11/18/2012	0.47	3.02	-1.92
11/19/2012	0.87	3.11	-1.15
11/20/2012	0.74	2.67	-1.47
11/21/2012	0.79	2.56	-1.15
11/22/2012	0.97	2.78	-1.43
11/23/2012	0.47	2.44	-1.76
11/24/2012	-0.19	1.79	-2.71
11/25/2012	-0.73	1.54	-2.74
11/26/2012	-0.88	1.6	-3.13
11/27/2012	0	2.37	-2.81
11/28/2012	0.38	2.91	-1.78
11/29/2012	-0.19	2.46	-2.43
11/30/2012	-0.56	1.92	-2.82
12/1/2012	0.29	2.71	-1.98
12/2/2012	0.19	2.66	-1.88
12/3/2012	-0.4	1.91	-2.25
12/4/2012	-0.11	2.16	-1.97
12/5/2012	-0.35	1.73	-2.2
12/6/2012	-0.26	1.6	-2
12/7/2012	0.03	1.81	-1.99
12/8/2012	0.19	2.34	-2.02
12/9/2012	0.29	2.41	-1.98
12/10/2012	0.5	3.14	-2.57
12/11/2012	0.07	2.98	-2.61
12/12/2012	0.05	3.13	-3.22
12/13/2012	0.33	3.49	-2.96
12/14/2012	-0.06	3.27	-3.28
12/15/2012	-0.06	3.15	-3.3
12/16/2012	0.56	3.47	-2.38
12/17/2012	1.08	3.68	-1.4
12/18/2012	0.81	3.18	-1.79
12/19/2012	-0.01	2.18	-2.57
12/20/2012	0.95	2.85	-1.06
12/21/2012	1.26	4.46	-2
12/22/2012	-0.73	1.46	-2.61
12/23/2012	-0.55	1.59	-2.53
12/24/2012	-0.12	1.93	-1.91
12/25/2012	0	2.05	-1.91
12/26/2012	1.24	4.16	-2.02
12/27/2012	0.86	3.58	-1.98
12/28/2012	-0.16	2.26	-2.61
12/29/2012	0.4	2.93	-1.93

12/30/2012	-0.61	2.33	-3.26
12/31/2012	-1.27	1.41	-3.65
1/1/2013	-1.24	1.25	-3.71
1/2/2013	-0.39	2.04	-2.49
1/3/2013	-0.91	1.44	-3.02
1/4/2013	-1.11	1.12	-3.22
1/5/2013	-1.34	0.52	-3.42
1/6/2013	-0.51	1.63	-2.66
1/7/2013	-0.49	1.89	-2.79
1/8/2013	-0.42	2.45	-3.44
1/9/2013		2.23	
1/10/2013			-3.75
1/11/2013			
1/12/2013	0.49	3.56	-2.86
1/13/2013	0.48	3.54	-2.49
1/14/2013	0.15	3	-2.56
1/15/2013	0.22	2.68	-2.32
1/16/2013	0.54	2.96	-1.88
1/17/2013	-0.07	2.43	-2.29
1/18/2013	-0.1	2.28	-2.09
1/19/2013	-0.85	1.7	-3.04
1/20/2013	-1.31	0.39	-2.8
1/21/2013	-0.27	1.3	-1.84
1/22/2013	-0.63	2.09	-2.87
1/23/2013	-0.5	1.45	-2.17
1/24/2013	-0.59	1.91	-2.47
1/25/2013	-0.96	1.16	-3.27
1/26/2013	-0.51	2.14	-2.7
1/27/2013	-0.6	2.14	-3.07
1/28/2013	-0.57	2.26	-3.05
1/29/2013	-0.16	2.42	-2.89
1/30/2013	0.17	2.75	-2.2
1/31/2013	-1.12	0.87	-3.78
2/1/2013	-1.97	0.08	-4.18
2/2/2013	-0.95	1.18	-3.05
2/3/2013	-0.29	1.85	-2.51
2/4/2013	-0.8	1.91	-3.15
2/5/2013	-0.6	1.7	-2.8
2/6/2013	-0.23	2.49	-2.99
2/7/2013	-0.06	2.4	-2.64
2/8/2013	1.42	4.07	-2.52
2/9/2013	0.66	3.74	-2.58
2/10/2013	0.27	3.25	-2.83
2/11/2013	-0.07	2.97	-3.06
2/12/2013	-0.47	2.36	-3.36
2/13/2013	-0.28	2.45	-3.16
2/14/2013	0.13	2.33	-2.29
2/15/2013	-0.27	1.55	-2.27
2/16/2013	0	1.94	-1.91
2/17/2013	-0.34	2.41	-2.78
2/18/2013	-2.18	-0.09	-3.89
2/19/2013	-1.67	-0.35	-3.42
2/20/2013	-1.21	1.14	-3.62
2/21/2013	-1.41	0.58	-3.16
2/22/2013	-0.2	1.77	-1.94
2/23/2013	0.55	2.54	-1.45
2/24/2013	0.45	3.02	-1.86
2/25/2013	0.23	2.51	-2.62
2/26/2013	0.72	3.41	-2.08
2/27/2013	1.38	3.7	-1.47
2/28/2013	0.8	3.03	-1.92
3/1/2013	0.37	2.92	-2.12

3/2/2013	0.38	2.52	-1.96
3/3/2013	-0.05	2.64	-2.23
3/4/2013	-0.41	2.43	-2.67
3/5/2013	-0.14	1.78	-2.23
3/6/2013	2.67	4.7	0.82
3/7/2013	2.47	4.78	-0.46
3/8/2013	1.8	3.96	-0.89
3/9/2013	2.13	4.36	-0.55
3/10/2013	1.28	3.81	-1.48
3/11/2013	0.51	3	-2.28
3/12/2013	0.27	2.79	-2.5
3/13/2013	-0.1	2.53	-2.82
3/14/2013	-0.88	1.42	-3.41
3/15/2013	-1.01	1.52	-3.32
3/16/2013	-0.3	1.65	-2.63
3/17/2013	0.01	2.41	-1.9
3/18/2013	0.18	1.84	-1.54
3/19/2013	0.62	2.42	-0.8
3/20/2013	-0.38	1.93	-1.86
3/21/2013	-0.16	1.27	-1.89
3/22/2013	-0.23	1.66	-2.15
3/23/2013	-0.71	1.22	-2.72
3/24/2013	-0.3	2.01	-2.83
3/25/2013	1.41	3.71	-1.84
3/26/2013		3.32	-1.77
3/27/2013	-0.1	2.44	-2.82
3/28/2013	-0.29	2.85	-3.34
3/29/2013	-0.07	2.7	-2.82
3/30/2013	-0.31	1.91	-2.95
3/31/2013	-0.1	2.6	-2.82
4/1/2013	0.02	2.92	-2.44
4/2/2013	-0.41	2.39	-2.9
4/3/2013	-1.01	1.89	-3.46
4/4/2013	-0.84	1.42	-3.1
4/5/2013	-0.05	2.19	-2.49
4/6/2013	-0.14	2.13	-2.43
4/7/2013	-0.42	1.89	-3
4/8/2013	-0.45	2.24	-3.07
4/9/2013	-0.25	2.39	-2.83
4/10/2013	-0.05	2.79	-2.87
4/11/2013	0.19	3.04	-2.51
4/12/2013	0.8	3.38	-1.63
4/13/2013	0.42	2.43	-2.03
4/14/2013	0.04	1.71	-2.06
4/15/2013	-0.05	2.22	-1.86
4/16/2013	-0.1	2.13	-1.78
4/17/2013	-0.39	1.94	-1.98
4/18/2013	-0.2	1.45	-1.78
4/19/2013	0.12	1.93	-1.52
4/20/2013	-0.66	1.31	-2.73
4/21/2013	-0.39	1.59	-2.06
4/22/2013	0.59	2.79	-2.11
4/23/2013	1.32	3.21	-0.99
4/24/2013	0.41	2.59	-2.4
4/25/2013	-0.27	2.89	-3.13
4/26/2013	-0.23	2.83	-3.09
4/27/2013	-0.31	2.85	-3.13
4/28/2013	-0.28	1.86	-2.99
4/29/2013	-0.18	2.98	-2.71
4/30/2013	0.06	2.8	-2.57
5/1/2013	0.22	2.8	-2.19
5/2/2013	-0.09	2.41	-2.46

5/3/2013	0.39	2.3	-1.81
5/4/2013	0.68	2.58	-1.61
5/5/2013	0.72	2.6	-1.51
5/6/2013	0.39	2.58	-1.9
5/7/2013	0.38	2.76	-1.91
5/8/2013			
5/9/2013			
5/10/2013			
5/11/2013			
5/12/2013			
5/13/2013			
5/14/2013			
5/15/2013			
5/16/2013			
5/17/2013			
5/18/2013			
5/19/2013			
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6/14/2013			
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7/1/2013			
7/2/2013			
7/3/2013			

7/4/2013			
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7/6/2013			
7/7/2013			
7/8/2013			
7/9/2013			
7/10/2013			
7/11/2013		2.5	
7/12/2013	0.39	2.04	-1.84
7/13/2013	0.24	2.68	-1.72
7/14/2013	-0.14	1.99	-2.13
7/15/2013	-0.27	1.7	-2.42
7/16/2013	0.04	2.19	-2.14
7/17/2013	0.27	2.54	-2.04
7/18/2013	0.28	2.63	-2.14
7/19/2013	0.15	2.87	-2.44
7/20/2013	0.07	3.02	-2.82
7/21/2013	0.2	3.48	-2.77
7/22/2013	0.56	3.74	-2.48
7/23/2013	0.52	3.5	-2.5
7/24/2013	0.48	3.4	-2.4
7/25/2013	0.95	3.25	-2.17
7/26/2013	0.85	3.79	-1.81
7/27/2013	0.08	2.61	-2.58
7/28/2013	0.22	2.43	-2.14
7/29/2013	0.21	2.37	-1.89
7/30/2013	0.14	2.16	-1.83
7/31/2013	0.22	2.26	-1.62
8/1/2013	0.39	2.27	-1.36
8/2/2013	0.41	2.51	-1.44
8/3/2013	0.25	2.58	-1.75
8/4/2013	0.37	2.73	-1.7
8/5/2013	0.41	2.77	-1.7
8/6/2013	0.31	2.7	-1.94
8/7/2013	0.27	2.76	-2.06
8/8/2013	0.21	2.5	-2.06
8/9/2013	0.13	2.34	-2.08
8/10/2013	-0.03	2.15	-2.35
8/11/2013	-0.03	2.18	-2.31
8/12/2013	0.11	2.38	-2.09
8/13/2013	0.3	2.6	-1.94
8/14/2013	0.29	2.58	-2
8/15/2013	0.15	2.48	-2.03
8/16/2013	0.18	2.69	-2.23
8/17/2013	0.35	2.95	-2.25
8/18/2013	0.49	3.29	-2.2
8/19/2013	0.33	3.11	-2.62
8/20/2013	0.03	3.07	-3.04
8/21/2013	0.21	3.09	-2.68
8/22/2013	0.04	2.71	-2.87
8/23/2013	0.18	2.75	-2.72
8/24/2013	0.41	2.8	-2.34
8/25/2013	0.24	2.52	-1.97
8/26/2013	-0.31	2.03	-2.46
8/27/2013	-0.1	2.13	-2.43
8/28/2013	0.46	2.45	-1.41
8/29/2013	0.86	2.73	-0.81
8/30/2013	0.73	2.49	-1.26
8/31/2013	0	1.92	-1.69
9/1/2013	0.32	2.51	-1.49
9/2/2013	0.49	2.7	-1.46
9/3/2013			

9/4/2013		2.3	-2.13
9/5/2013	-0.02	2.46	-2.37
9/6/2013	0.48	2.66	-2.01
9/7/2013	0.18	2.42	-2.22
9/8/2013	-0.05	2.36	-2.52
9/9/2013	0.44	2.94	-1.87
9/10/2013	-0.08	2.4	-2.32
9/11/2013	-0.23	2.32	-2.59
9/12/2013	-0.09	2.34	-2.35
9/13/2013	0.3	2.73	-1.85
9/14/2013	0.38	2.7	-2.18
9/15/2013	0.11	2.62	-2.4
9/16/2013	-0.04	2.83	-2.82
9/17/2013	0.64	3.19	-2.52
9/18/2013	0.44	2.86	-2.51
9/19/2013	0.04	2.57	-2.82
9/20/2013	0.1	2.62	-2.85
9/21/2013	0.35	2.89	-2.43
9/22/2013	0.37	2.86	-2.12
9/23/2013	0.34	2.76	-1.86
9/24/2013	0.21	2.52	-1.82
9/25/2013	0.28	2.45	-1.58
9/26/2013	0.44	2.4	-1.26
9/27/2013	0.64	2.36	-0.92
9/28/2013	0.75	2.35	-0.82
9/29/2013	0.74	2.42	-0.95
9/30/2013	0.73	2.62	-0.98
10/1/2013	0.53	2.5	-1.47
10/2/2013	0.39	2.48	-1.82
10/3/2013	0.27	2.46	-2.05
10/4/2013	0.31	2.57	-2.21
10/5/2013	0.38	2.79	-2.3
10/6/2013	0.68	3.26	-1.98
10/7/2013	0.63	3.45	-1.99
10/8/2013	0.55	3.34	-2.12
10/9/2013	1.59	4.04	-0.9
10/10/2013	2.02	4.19	-0.12
10/11/2013	1.87	3.83	-0.21
10/12/2013	1.88	3.73	-0.17
10/13/2013	1.97	3.55	-0.75
10/14/2013	0.97	2.93	-1.3
10/15/2013	0.8	3.02	-1.73
10/16/2013	0.93	3.13	-1.66
10/17/2013	0.77	3.08	-1.91
10/18/2013	0.11	2.47	-2.55
10/19/2013	0.3	2.94	-2.64
10/20/2013	0.08	2.73	-2.41
10/21/2013	0	2.58	-2.41
10/22/2013	0.04	2.56	-2.06
10/23/2013	0.62	2.9	-1.46
10/24/2013	0.01	2.24	-2.14
10/25/2013	-0.56	1.54	-2.14
10/26/2013	-0.5	1.46	-2.22
10/27/2013	-0.78	1.26	-2.46
10/28/2013	-0.13	1.56	-1.98
10/29/2013	0.19	2.01	-1.58
10/30/2013	0.19	1.94	-1.62
10/31/2013	0.12	2.1	-2.14
11/1/2013	-0.07	2.24	-2.53
11/2/2013	0.23	2.73	-2.63
11/3/2013	0.36	3.08	-2.25
11/4/2013	0.69	3.5	-2.09

11/5/2013	0.34	3.29	-2.45
11/6/2013	0.18	3.12	-2.49
11/7/2013	0.07	3	-2.61
11/8/2013	-0.4	2.31	-3.1
11/9/2013	-0.49	2.17	-2.66
11/10/2013	-0.66	1.87	-3.34
11/11/2013	-0.67	1.7	-3.03
11/12/2013	-0.43	2.06	-2.67
11/13/2013	-0.03	2.23	-2.68
11/14/2013	-0.78	1.93	-3.2
11/15/2013	-0.72	1.68	-3.8
11/16/2013	-0.02	2.48	-2.68
11/17/2013	0.29	2.78	-2.37
11/18/2013	0.15	2.6	-2.29
11/19/2013	-0.37	2.22	-2.88
11/20/2013	0.1	2.68	-2.14
11/21/2013	-0.11	2.25	-2.14
11/22/2013	-0.23	2.08	-2.14
11/23/2013	-0.28	2.07	-2.04
11/24/2013	-1.27	0.62	-2.88
11/25/2013	-1.12	0.74	-2.63
11/26/2013	-0.69	1.03	-2.44
11/27/2013	0.36	2.55	-2.03
11/28/2013	-1.34	1.18	-3.49
11/29/2013	-0.88	1.19	-3.02
11/30/2013	-0.33	2.06	-2.57
12/1/2013	0	2.73	-2.68
12/2/2013	0.17	3	-3.02
12/3/2013	0.54	3.66	-2.43
12/4/2013	0.3	3.48	-2.68
12/5/2013	-0.03	3.11	-2.96
12/6/2013	0.06	3.1	-2.74
12/7/2013	0	2.93	-2.74
12/8/2013	-0.2	2.35	-2.57
12/9/2013	0.26	2.47	-2.34
12/10/2013	-0.27	1.99	-2.74
12/11/2013	-0.96	1.39	-3.25
12/12/2013	-0.78	1.46	-3.13
12/13/2013	-1.14	1.48	-3.5
12/14/2013	-0.18	2.05	-2.42
12/15/2013	0.46	3.12	-1.9
12/16/2013	-0.94	1.5	-3.18
12/17/2013	-0.36	2.25	-2.94
12/18/2013	-0.14	2.5	-2.48
12/19/2013	-0.81	2.07	-3.36
12/20/2013	-0.78	1.84	-3.18
12/21/2013	-0.41	2.02	-2.52
12/22/2013	-0.79	1.25	-2.72
12/23/2013	-0.36	1.7	-2.21
12/24/2013		2.06	
12/25/2013			
12/26/2013			
12/27/2013			-2.91
12/28/2013	-0.85	1.54	-3.22
12/29/2013	-0.39	1.99	-3.44
12/30/2013	-0.34	2.6	-2.86
12/31/2013	-0.12	3.2	-3.08
1/1/2014	-0.52	2.68	-3.78
1/2/2014	0.58	3.55	-3.3
1/3/2014	1.18	4.14	-1.86
1/4/2014	0.43	3.44	-2.61
1/5/2014	-0.39	2.34	-3.21

1/6/2014	0.16	2.71	-2.27
1/7/2014	-2.02	1.14	-4.47
1/8/2014	-1.85	0.06	-3.91
1/9/2014	-1.25	0.8	-3.29
1/10/2014	-0.43	1.66	-2.39
1/11/2014	-0.01	2.12	-1.93
1/12/2014	-0.62	1.95	-2.65
1/13/2014	-0.48	1.6	-3.12
1/14/2014	0.14	2.56	-2.15
1/15/2014	-0.03	2.44	-2.28
1/16/2014	0.22	2.77	-2.21
1/17/2014	0.12	2.8	-2.27
1/18/2014	-0.14	2.64	-2.54
1/19/2014	-0.65	2.01	-3.03
1/20/2014	-1.05	1.19	-3.36
1/21/2014	0.6	2.55	-2.02
1/22/2014	0.88	3	-1.36
1/23/2014		2.49	
1/24/2014			
1/25/2014			
1/26/2014			
1/27/2014		1.67	-3.3
1/28/2014		2.24	
1/29/2014		2.77	
1/30/2014			
1/31/2014		1.94	
2/1/2014		2.56	
2/2/2014	-0.32	2.72	-3.3
2/3/2014	0.05	2.81	-3.03
2/4/2014	-0.08	2.19	-2.63
2/5/2014	0.33	2.48	-1.98
2/6/2014	-0.17	1.9	-1.98
2/7/2014	-0.37	1.97	-2.52
2/8/2014	-0.82	1.08	-2.43
2/9/2014	-0.32	1.56	-2.18
2/10/2014	-0.44	1.58	-2.68
2/11/2014		1.74	-2.43
2/12/2014		1.85	
2/13/2014		3.94	
2/14/2014	-0.47	2.11	-3.14
2/15/2014	-0.56	1.84	-3.75
2/16/2014	-0.5	2.24	-2.95
2/17/2014	-1.03	1.5	-3.46
2/18/2014	-0.5	1.89	-3.14
2/19/2014	-0.39	1.84	-2.47
2/20/2014	-0.94	0.74	-3.04
2/21/2014	-0.45	1.86	-2.8
2/22/2014	-0.64	1.82	-2.68
2/23/2014	-0.74	1.39	-2.65
2/24/2014	-0.79	1.78	-3.44
2/25/2014	-0.98	1.7	-3.62
2/26/2014	-0.46	2.23	-3.04
2/27/2014	-0.06	2.95	-2.97
2/28/2014	-0.69	2.33	-3.82
3/1/2014	-0.42	2.61	-3.8
3/2/2014	-0.42	2.52	-3.65
3/3/2014	-0.1	2.65	-3.04
3/4/2014	-0.08	2.5	-2.64
3/5/2014	-0.25	2.26	-2.63
3/6/2014	0.22	1.84	-1.71
3/7/2014	0.54	2.59	-1.45
3/8/2014	0.22	2.78	-1.9

3/9/2014	-0.1	1.76	-1.71
3/10/2014	-0.11	1.81	-1.67
3/11/2014	0.19	1.86	-1.52
3/12/2014	0.57	2.24	-1.08
3/13/2014	-0.89	1.17	-2.7
3/14/2014	-0.87	1.28	-3.13
3/15/2014	-0.56	1.92	-3.12
3/16/2014	-0.33	2.15	-2.87
3/17/2014	0.63	2.86	-1.99
3/18/2014	0.64	2.83	-1.71
3/19/2014	0.38	2.86	-2.05
3/20/2014	-0.08	1.98	-2.48
3/21/2014	-0.77	2.15	-3.05
3/22/2014	-0.6	1.92	-2.59
3/23/2014	-0.38	2.19	-2.43
3/24/2014	-0.24	1.93	-2.19
3/25/2014	0	2.14	-2.2
3/26/2014	0.3	2.81	-2.78
3/27/2014	0.04	2.55	-2.21
3/28/2014	-1.01	1.63	-3.86
3/29/2014	-0.4	2.74	-3.87
3/30/2014	0.54	3.08	-2.5
3/31/2014	0.5	3.01	-2.29
4/1/2014	0.31	3.12	-2.51
4/2/2014	0.34	2.82	-2.18
4/3/2014	0.09	2.58	-2.2
4/4/2014	0.55	2.23	-1.57
4/5/2014	0.25	2.85	-1.85
4/6/2014	-0.47	1.6	-2.16
4/7/2014	-0.26	1.24	-2.07
4/8/2014	0.26	2.19	-1.59
4/9/2014	-0.08	1.84	-1.96
4/10/2014	-0.38	1.26	-2.23
4/11/2014	-0.63	1.21	-2.83
4/12/2014	-0.56	1.48	-2.69
4/13/2014	-0.37	1.99	-2.76
4/14/2014	-0.48	2.05	-2.87
4/15/2014	-0.46	1.98	-2.86
4/16/2014	-0.43	2.44	-3.1
4/17/2014	0.14	3.14	-2.66
4/18/2014	0.22	2.74	-2.22
4/19/2014	-0.26	1.62	-2.64
4/20/2014	-0.13	2.29	-2.64
4/21/2014	0.02	2.56	-2.07
4/22/2014	0.14	2.44	-2.07
4/23/2014	0.1	2.55	-2.34
4/24/2014	-0.17	2.37	-2.79
4/25/2014	0.58	2.99	-2.02
4/26/2014	0.73	3.05	-2.25
4/27/2014	0.51	2.93	-2.22
4/28/2014	0.1	2.89	-2.67
4/29/2014	1.15	4.4	-2.42
4/30/2014	1.52	3.57	-0.97
5/1/2014	0.32	2.64	-2.21
5/2/2014	-0.04	2.57	-2.44
5/3/2014	0.08	1.7	-2.04
5/4/2014	-0.09	2.48	-2.03
5/5/2014	-0.33	1.93	-2.3
5/6/2014	0.14	2.07	-1.58
5/7/2014	0.05	1.78	-1.64
5/8/2014	0.11	1.85	-1.72
5/9/2014	0.21	1.89	-1.76

5/10/2014	0.19	2.02	-1.94
5/11/2014	-0.25	2.02	-2.49
5/12/2014	-0.15	2.44	-2.49
5/13/2014	0.33	3.42	-2.51
5/14/2014	0.45	3.03	-2.28
5/15/2014	0.06	3.04	-2.56
5/16/2014	0.21	3.12	-2.41
5/17/2014	-0.01	2.84	-2.64
5/18/2014	-0.2	1.78	-2.86
5/19/2014	-0.22	2.64	-2.75
5/20/2014	-0.12	2.44	-2.63
5/21/2014	0.19	2.43	-2.31
5/22/2014	0.45	2.6	-2.14
5/23/2014	0.44	2.58	-2.16
5/24/2014	0.48	2.8	-2.06
5/25/2014	0.26	2.66	-2.42
5/26/2014	0	2.59	-2.54
5/27/2014	-0.07	2.91	-2.73
5/28/2014	0.68	3.74	-2.18
5/29/2014	0.97	3.03	-1.57
5/30/2014	0.2	2.67	-2.05
5/31/2014	0.17	2.67	-2.22
6/1/2014	0.1	1.65	-1.86
6/2/2014	-0.03	2.37	-1.9
6/3/2014	0	2.01	-2.04
6/4/2014	0.38	2.28	-1.48
6/5/2014	0.46	2.27	-1.19
6/6/2014	0.17	2.13	-1.69
6/7/2014	-0.07	1.81	-2.11
6/8/2014	0.06	2.14	-2.03
6/9/2014	0.15	2.43	-2.16
6/10/2014	0.2	2.71	-2.34
6/11/2014	0.59	3.52	-2.1
6/12/2014	0.72	3.53	-2.05
6/13/2014	0.69	3.6	-2.05
6/14/2014	0.33	3.31	-2.5
6/15/2014	0.13	3.15	-2.67
6/16/2014	0.14	2.21	-2.62
6/17/2014	0.16	3.1	-2.45
6/18/2014	0.09	2.74	-2.58
6/19/2014	0.28	2.59	-2.33
6/20/2014	0.28	2.56	-2.5
6/21/2014	0.45	2.68	-2.01
6/22/2014	0.55	2.83	-1.84
6/23/2014	0.36	2.68	-2.06
6/24/2014	0.19	2.65	-2.17
6/25/2014	0.03	2.64	-2.21
6/26/2014	0.11	2.71	-2.16
6/27/2014	0.47	2.86	-1.93
6/28/2014	0.16	2.66	-2.01
6/29/2014	0.02	2.44	-2.08
6/30/2014	-0.05	2.32	-2.08
7/1/2014	-0.1	1.49	-2.12
7/2/2014	-0.06	2.11	-2
7/3/2014	0	2.02	-1.81
7/4/2014	0.37	1.8	-1.7
7/5/2014	-0.17	1.97	-2.04
7/6/2014	-0.53	1.42	-2.46
7/7/2014	-0.38	1.96	-2.46
7/8/2014	-0.18	2.33	-2.56
7/9/2014	-0.06	2.61	-2.55
7/10/2014	-0.01	2.98	-2.69

7/11/2014	0.06	3.09	-2.87
7/12/2014	-0.04	3.2	-3.02
7/13/2014	-0.09	3.02	-3.02
7/14/2014	-0.13	3.07	-3.16
7/15/2014	0.04	2.43	-2.86
7/16/2014	0.18	3.05	-2.63
7/17/2014	0.12	2.76	-2.55
7/18/2014	-0.03	2.3	-2.58
7/19/2014	0.1	2.34	-2.41
7/20/2014	0.76	2.98	-1.56
7/21/2014	0.44	2.52	-1.85
7/22/2014	0.12	2.41	-2.04
7/23/2014	0.06	2.5	-2.16
7/24/2014	0.17	2.7	-2.12
7/25/2014	0.29	2.7	-1.84
7/26/2014	0.08	2.65	-2.07
7/27/2014	0.11	2.65	-2.03
7/28/2014	0.28	2.58	-1.96
7/29/2014	0.1	2.37	-2.09
7/30/2014	0.05	2.21	-1.95
7/31/2014	-0.11	1.7	-2.07
8/1/2014	-0.21	1.9	-2.32
8/2/2014	0.35	2.33	-1.83
8/3/2014	0.42	2.27	-1.46
8/4/2014	0.23	2.18	-1.73
8/5/2014	0.32	2.56	-1.84
8/6/2014	0.47	2.84	-1.79
8/7/2014	0.52	3.16	-2
8/8/2014	0.38	3.1	-2.4
8/9/2014	0.21	3.35	-2.79
8/10/2014	0.33	3.45	-2.73
8/11/2014	0.4	3.47	-2.69
8/12/2014	0.62	3.86	-2.46
8/13/2014	0.79	3.19	-2.05
8/14/2014	0.37	2.9	-2.49
8/15/2014	0.22	2.74	-2.43
8/16/2014	0.23	2.52	-2.11
8/17/2014	0.17	2.34	-2
8/18/2014	0.28	2.41	-1.68
8/19/2014	0.38	2.39	-1.5
8/20/2014	0.41	2.48	-1.61
8/21/2014	0.39	2.61	-1.7
8/22/2014	0.57	2.87	-1.51
8/23/2014	0.96	3.08	-1.27
8/24/2014	0.94	2.96	-1.08
8/25/2014	0.59	2.63	-1.51
8/26/2014	0.36	2.51	-1.88
8/27/2014	0.26	2.42	-1.92
8/28/2014	0.22	2.3	-1.93
8/29/2014	0.41	2.53	-1.79
8/30/2014	0.3	2.43	-1.76
8/31/2014	-0.05	2.1	-1.98
9/1/2014	-0.14	2.19	-2.29
9/2/2014	0.21	2.48	-1.79
9/3/2014	0.1	2.45	-1.9
9/4/2014	0.1	2.55	-2.12
9/5/2014	0.17	2.76	-2.3
9/6/2014	0.04	2.86	-2.72
9/7/2014	0.29	3.36	-2.88
9/8/2014	0.79	3.87	-2.54
9/9/2014	1.3	3.89	-1.62
9/10/2014	1.14	3.67	-1.94

9/11/2014	0.57	3.22	-2.33
9/12/2014	0.44	3.16	-2.46
9/13/2014	0.78	3.37	-1.64
9/14/2014	0.69	2.96	-1.42
9/15/2014	0.43	2.57	-1.51
9/16/2014	0.6	2.56	-1.08
9/17/2014	0.76	2.64	-0.96
9/18/2014	0.57	2.39	-1.35
9/19/2014	0.82	2.84	-0.72
9/20/2014	0.7	2.57	-1.16
9/21/2014	0.6	2.83	-1.57
9/22/2014	0.14	2.19	-2.04
9/23/2014	-0.1	2.11	-2.45
9/24/2014	0.59	2.69	-2.04
9/25/2014	1.45	3.63	-0.69
9/26/2014	0.87	2.99	-1.3
9/27/2014	0.32	2.62	-1.93
9/28/2014	0.1	2.45	-2.07
9/29/2014	0.12	2.51	-1.94
9/30/2014	0.59	2.9	-1.75
10/1/2014	1.04	3.1	-0.98
10/2/2014	1.39	3.5	-0.58
10/3/2014	1.5	3.54	-0.74
10/4/2014	1.42	3.44	-0.8
10/5/2014	0.62	3.04	-2.09
10/6/2014	0.56	3.02	-2.26
10/7/2014	0.3	2.93	-2.74
10/8/2014	0.11	2.76	-2.88
10/9/2014	-0.01	2.86	-3.1
10/10/2014	-0.08	2.83	-3.35
10/11/2014	0.62	3.26	-2
10/12/2014	0.44	2.84	-1.87
10/13/2014	0.05	2.47	-2.09
10/14/2014	-0.03	2.23	-1.96
10/15/2014	0.26	2.34	-1.48
10/16/2014	0.41	2.3	-1.36
10/17/2014	0.39	2.1	-1.61
10/18/2014	0.18	2.02	-1.93
10/19/2014	0.2	2.04	-1.59
10/20/2014	0.23	2.15	-1.66
10/21/2014	0.15	2.4	-2.32
10/22/2014	1.25	3.23	-1.65
10/23/2014	1.32	3.73	-1.17
10/24/2014	0.86	3.36	-1.55
10/25/2014	0.46	3.19	-1.88
10/26/2014	-0.06	2.49	-2.4
10/27/2014	-0.14	2.51	-2.38
10/28/2014	-0.19	2.42	-2.36
10/29/2014	0.01	2.57	-2.16
10/30/2014	0.07	2.49	-2.22
10/31/2014	0.49	2.76	-1.74
11/1/2014	2.03	4.03	-0.02
11/2/2014	1.42	3.89	-2.12
11/3/2014	-0.29	2.33	-3.64
11/4/2014	-0.63	2.18	-3.44
11/5/2014	-0.1	2.47	-2.93
11/6/2014	0.27	3.14	-3
11/7/2014	-0.09	3.08	-2.9
11/8/2014	-0.26	2.69	-2.93
11/9/2014	-0.47	2.23	-3.05
11/10/2014	0.07	2.64	-2.24
11/11/2014	0.24	2.61	-1.77

11/12/2014	0.34	2.6	-1.57
11/13/2014	0.42	2.45	-1.26
11/14/2014	0.18	1.97	-1.65
11/15/2014	-0.1	1.56	-1.89
11/16/2014	-0.08	1.47	-1.79
11/17/2014	0.28	2.36	-2.49
11/18/2014	-0.91	1.48	-3.88
11/19/2014	-1.37	0.75	-3.3
11/20/2014	-0.93	1.29	-3.41
11/21/2014	-0.82	1.64	-3.43
11/22/2014	-0.76	2.23	-3.25
11/23/2014	-1.22	1.64	-4.11
11/24/2014	0.23	3.11	-2.67
11/25/2014	-0.21	2.64	-2.91
11/26/2014	0.66	3.48	-2.63
11/27/2014	0.37	2.93	-2.58
11/28/2014	-0.32	2.18	-2.71
11/29/2014	0.11	2.53	-2.24
11/30/2014	-0.28	1.88	-2.9
12/1/2014	-0.41	1.83	-2.81
12/2/2014	0.6	2.77	-1.45
12/3/2014	0.44	3.22	-3.38
12/4/2014	-0.53	2.22	-3.18
12/5/2014	0.11	2.72	-3.06
12/6/2014	0.45	3.21	-2.12
12/7/2014	1.07	3.55	-2.22
12/8/2014	1.82	4.28	-0.61
12/9/2014	2.23	4.77	0
12/10/2014	0.59	2.83	-1.77
12/11/2014	-0.54	1.87	-2.66
12/12/2014	-0.35	1.91	-2.18
12/13/2014	-0.24	1.7	-1.94
12/14/2014	-0.01	1.73	-1.64
12/15/2014	0.2	1.77	-1.67
12/16/2014	0.2	1.8	-1.53
12/17/2014	-0.06	2.06	-2.58
12/18/2014	-0.74	1.38	-3.16
12/19/2014	-0.52	1.72	-2.59
12/20/2014	-0.06	2.54	-2.8
12/21/2014	0.06	2.9	-2.67
12/22/2014	0.22	3.12	-2.87
12/23/2014	0.86	3.85	-2.11
12/24/2014	0.71	3.73	-2.06
12/25/2014	-0.23	2.86	-3.28
12/26/2014	-0.98	1.88	-3.64
12/27/2014	-0.64	2.02	-3.13
12/28/2014	-0.49	1.75	-2.87
12/29/2014	-0.34	1.77	-2.52
12/30/2014	-0.04	2.28	-2.56
12/31/2014	-0.39	2.18	-2.83
1/1/2015	-0.91	1.6	-3.58
1/2/2015	-1.22	1.12	-3.54
1/3/2015	-0.27	2.13	-3.46
1/4/2015	0.04	2.82	-2.36
1/5/2015	-1.45	1.58	-4.05
1/6/2015	-1.23	1.44	-4.14
1/7/2015	-1.08	1.92	-3.66
1/8/2015	-1.21	1.19	-3.57
1/9/2015	-1.79	-0.08	-3.71
1/10/2015	-1.65	0.36	-3.76
1/11/2015	-1.28	0.68	-3.01
1/12/2015	-0.96	0.93	-2.82

1/13/2015	-0.32	1.25	-1.77
1/14/2015	0.4	1.97	-1.37
1/15/2015	0.03	2.28	-2.32
1/16/2015	-0.8	1.68	-2.92
1/17/2015	-0.62	1.89	-2.81
1/18/2015	-0.04	2.5	-2.52
1/19/2015	-0.36	2.66	-3.43
1/20/2015	-0.66	2.49	-3.7
1/21/2015	-0.21	2.91	-3.85
1/22/2015	-0.09	3.04	-3.16
1/23/2015	-0.16	2.83	-3.05
1/24/2015	0.53	3.5	-2.04
1/25/2015	-0.63	2.38	-3.36
1/26/2015	0.85	3.02	-1.82
1/27/2015	1.83	4.05	-0.91
1/28/2015	0.35	2.94	-2.32
1/29/2015	-0.07	2.25	-2.09
1/30/2015	-0.15	2.36	-2.85
1/31/2015	-0.92	1.23	-3.08
2/1/2015	-0.65	1.75	-2.93
2/2/2015	-0.1	2.58	-2.6
2/3/2015	-0.47	2.16	-2.82
2/4/2015	-0.83	1.86	-3.2
2/5/2015	-0.56	2.03	-3.08
2/6/2015	-0.65	1.96	-3.02
2/7/2015	-0.64	1.75	-2.84
2/8/2015	-0.09	2.33	-2.27
2/9/2015	1.01	2.67	-0.79
2/10/2015	1.53	2.97	-0.05
2/11/2015	1.63	3.27	-0.23
2/12/2015	0.71	2.8	-1.36
2/13/2015		1.69	-2.15
2/14/2015		2.12	-2.29
2/15/2015		0.97	
2/16/2015			
2/17/2015		2.33	
2/18/2015			
2/19/2015			
2/20/2015			
2/21/2015			
2/22/2015		1.98	
2/23/2015			
2/24/2015			
2/25/2015			
2/26/2015			
2/27/2015			
2/28/2015			
3/1/2015			
3/2/2015		1.61	
3/3/2015		1.17	
3/4/2015		1.51	
3/5/2015	-0.4	1.9	-3.02
3/6/2015	-0.55	1.78	-2.94
3/7/2015	-0.99	1.4	-3.28
3/8/2015	-1.24	1.54	-3.7
3/9/2015	-0.64	1.52	-2.73
3/10/2015	-0.64	1.24	-2.67
3/11/2015	-0.54	1.82	-2.35
3/12/2015	-1.02	1.41	-2.76
3/13/2015	-0.6	1.18	-2.23
3/14/2015	-0.28	1.65	-2.31
3/15/2015	-0.55	1.85	-2.91

3/16/2015	-0.06	2.14	-2.3
3/17/2015	0.42	2.92	-2.02
3/18/2015	-0.58	2.08	-3.85
3/19/2015	-0.68	2.28	-3.87
3/20/2015	0	3.43	-3.77
3/21/2015	0.42	3.08	-2.89
3/22/2015	-0.35	2.5	-3.41
3/23/2015	-0.9	1.68	-3.87
3/24/2015	-0.98	1.37	-3.75
3/25/2015	-0.6	1.97	-2.85
3/26/2015	-0.51	1.84	-2.48
3/27/2015	-0.32	1.5	-2.12
3/28/2015	-0.07	1.8	-2.01
3/29/2015	0.05	1.89	-1.71
3/30/2015	-0.51	1.32	-2.66
3/31/2015	-0.23	1.73	-2.3
4/1/2015	-0.14	1.96	-2.15
4/2/2015	-0.5	1.73	-2.54
4/3/2015	-0.96	1.5	-3.29
4/4/2015	-0.82	1.82	-3.04
4/5/2015	-0.99	1.23	-3.36
4/6/2015	-0.94	2.08	-3.8
4/7/2015	-0.61	2.47	-3.01
4/8/2015	0.53	2.13	-1.68
4/9/2015	0.6	3.09	-1.32
4/10/2015	0.2	2.64	-1.88
4/11/2015	-0.63	1.9	-2.61
4/12/2015	-0.9	1.47	-2.94
4/13/2015	-0.64	1.58	-2.75
4/14/2015	-0.52	1.84	-2.98
4/15/2015	-0.33	2.12	-3.04
4/16/2015	-0.35	2.35	-3.31
4/17/2015	-0.18	2.62	-3.21
4/18/2015	-0.33	2.72	-3.54
4/19/2015	0.08	3.3	-3.35
4/20/2015	0.73	3.55	-2.13
4/21/2015	0.3	2.97	-2.57
4/22/2015	0.06	2.14	-2.45
4/23/2015	-0.33	2.63	-2.64
4/24/2015	-0.36	1.87	-2.72
4/25/2015	-0.05	2.21	-1.9
4/26/2015	0.33	2.07	-1.49
4/27/2015	0.23	2.06	-1.54
4/28/2015	0.25	1.97	-1.59
4/29/2015	0.24	2.11	-1.68
4/30/2015	0.61	2.5	-1.69
5/1/2015	0.83	2.91	-1.23
5/2/2015	0.56	2.78	-1.59
5/3/2015	0.12	2.5	-2.22
5/4/2015	-0.28	2.26	-2.61
5/5/2015	-0.68	2.08	-3.01
5/6/2015	-0.48	2.61	-3.1
5/7/2015	-0.3	2.45	-2.6
5/8/2015	-0.31	1.37	-2.47
5/9/2015	-0.1	2.47	-2.3
5/10/2015	-0.33	2.35	-2.58
5/11/2015	-0.36	2.01	-2.71
5/12/2015	-0.06	2.15	-2.41
5/13/2015	-0.39	1.81	-2.92
5/14/2015	-0.11	2.3	-2.71
5/15/2015	-0.31	2.42	-3.37
5/16/2015	-0.31	2.64	-3.32

5/17/2015	-0.24	2.81	-3.23
5/18/2015	0	3.31	-3.06
5/19/2015	0.12	2.98	-2.64
5/20/2015	-0.19	2.57	-2.77
5/21/2015	-0.15	1.74	-2.62
5/22/2015	-0.17	2.75	-2.44
5/23/2015	-0.59	2.03	-2.65
5/24/2015	-1.01	1.35	-2.91
5/25/2015	-0.9	0.96	-2.87
5/26/2015	-0.84	1.01	-2.72
5/27/2015	-0.81	0.89	-2.72
5/28/2015	-0.82	1.1	-2.86
5/29/2015	-0.56	1.59	-2.65
5/30/2015	-0.37	1.99	-2.55
5/31/2015	-0.46	2.07	-2.83
6/1/2015	-0.07	2.83	-2.59
6/2/2015	0.71	3.38	-1.86
6/3/2015	0.72	3.21	-1.69
6/4/2015	0.61	3.36	-1.85
6/5/2015	0.49	3.09	-1.91
6/6/2015	0.08	1.82	-2.33
6/7/2015	-0.06	2.74	-2.52
6/8/2015	-0.2	2.51	-2.54
6/9/2015	-0.23	2.12	-2.76
6/10/2015	-0.03	2.17	-2.55
6/11/2015	-0.07	2.18	-2.66
6/12/2015	-0.12	2.44	-2.84
6/13/2015	-0.11	2.62	-2.92
6/14/2015	0.01	2.76	-2.72
6/15/2015	0.11	3.05	-2.63
6/16/2015	0.24	3	-2.29
6/17/2015	0.13	3.05	-2.5
6/18/2015	0.24	2.86	-2.17
6/19/2015	0.07	2.65	-2.19
6/20/2015	0.21	1.85	-2.02
6/21/2015	0.22	2.75	-1.68
6/22/2015	-0.05	2.26	-2.12
6/23/2015	-0.08	1.96	-1.86
6/24/2015	0.04	1.98	-1.79
6/25/2015	0.11	1.97	-1.76
6/26/2015	0.31	2.11	-1.52
6/27/2015	0.73	3.05	-1.25
6/28/2015	0.78	2.8	-1.45
6/29/2015	-0.02	2.6	-2.43
6/30/2015	0.13	2.94	-2.39
7/1/2015	0.17	3.02	-2.35
7/2/2015	0.25	3.4	-2.44
7/3/2015	0.32	3.26	-2.41
7/4/2015	0.42	3.33	-2.3
7/5/2015	0.23	2.27	-2.4
7/6/2015	0.15	2.9	-2.55
7/7/2015	0.2	2.78	-2.44
7/8/2015	0.06	2.4	-2.54
7/9/2015	0.31	2.61	-2.34
7/10/2015	0.39	2.87	-2.38
7/11/2015	0.39	2.82	-2.2
7/12/2015	0.28	2.78	-2.37
7/13/2015	0.34	3.02	-2.2
7/14/2015	0.5	3.18	-2.07
7/15/2015	0.62	3.26	-1.86
7/16/2015	0.86	3.2	-1.81
7/17/2015	0.33	2.76	-2.03

7/18/2015	0.13	2.54	-2.03
7/19/2015	0.19	2.47	-2.04
7/20/2015	0.24	1.98	-1.88
7/21/2015	0.48	2.39	-1.46
7/22/2015	0.47	2.45	-1.23
7/23/2015	0.28	2.12	-1.53
7/24/2015	0.18	2.11	-1.69
7/25/2015	0.21	2.11	-1.67
7/26/2015	0.05	2.06	-1.86
7/27/2015	0.02	2.36	-2.16
7/28/2015	0.06	2.56	-2.32
7/29/2015	0.06	2.78	-2.59
7/30/2015	-0.15	2.80	-2.92
7/31/2015	-0.01	3.08	-2.78
8/1/2015	-0.10	2.98	-2.96
8/2/2015	0.00	2.98	-2.90
8/3/2015	-0.04	2.37	-2.78
8/4/2015	-0.29	2.47	-3.19
8/5/2015	-0.11	2.41	-2.69
8/6/2015	0.06	2.51	-2.55
8/7/2015	0.52	2.76	-1.75
8/8/2015	0.81	2.95	-1.52
8/9/2015	0.85	3.11	-1.53
8/10/2015	0.69	2.83	-1.56
8/11/2015	0.17	2.48	-2.28
8/12/2015	0.30	2.70	-2.13
8/13/2015	0.19	2.60	-2.13
8/14/2015	-0.09	2.42	-2.41
8/15/2015	-0.19	2.30	-2.48
8/16/2015	-0.27	2.15	-2.54
8/17/2015	-0.34	1.83	-2.49
8/18/2015	-0.21	1.90	-2.33
8/19/2015	-0.11	1.82	-2.03
8/20/2015	0.18	2.09	-1.72
8/21/2015	0.22	1.98	-1.66
8/22/2015	0.28	2.30	-1.59
8/23/2015	0.35	2.40	-1.57
8/24/2015	0.36	2.39	-1.56
8/25/2015	0.39	2.61	-1.68
8/26/2015	0.32	2.77	-1.85
8/27/2015	0.19	2.91	-2.40
8/28/2015	0.12	3.02	-2.76
8/29/2015	0.02	3.02	-3.07
8/30/2015	-0.07	2.80	-3.16
8/31/2015	-0.26	2.62	-3.32
9/1/2015	-0.04	2.78	-3.23
9/2/2015	0.32	2.92	-2.54
9/3/2015	0.35	2.87	-2.25
9/4/2015	0.58	2.89	-2.11
9/5/2015	1.04	3.08	-1.28
9/6/2015	0.37	2.44	-1.76
9/7/2015	0.17	2.33	-1.99
9/8/2015	-0.18	1.95	-2.26
9/9/2015	0.15	2.65	-2.25
9/10/2015	0.34	2.69	-1.94
9/11/2015	0.59	2.98	-1.80
9/12/2015	0.59	2.82	-1.75
9/13/2015	0.43	2.53	-1.89
9/14/2015	-0.30	1.88	-2.71
9/15/2015	-0.33	1.89	-2.62
9/16/2015	-0.20	2.00	-2.30
9/17/2015	-0.05	2.16	-2.13

9/18/2015	-0.04	2.12	-1.90
9/19/2015	0.03	2.16	-1.87
9/20/2015	0.23	2.16	-1.65
9/21/2015	1.06	2.97	-0.63
9/22/2015	1.14	2.97	-0.87
9/23/2015	0.83	2.74	-1.44
9/24/2015	0.59	2.86	-1.68
9/25/2015	1.09	3.55	-1.50
9/26/2015	1.29	3.81	-1.35
9/27/2015	0.94	3.31	-2.04
9/28/2015	0.30	2.99	-2.93
9/29/2015	0.29	3.11	-2.94
9/30/2015	0.52	3.28	-2.53
10/1/2015	1.50	4.12	-1.52
10/2/2015	2.85	4.98	0.60
10/3/2015	3.02	4.77	1.15
10/4/2015	2.67	4.31	0.88
10/5/2015	1.87	3.53	-0.19
10/6/2015	1.05	2.78	-1.06
10/7/2015	0.72	2.62	-1.37
10/8/2015	0.52	2.51	-1.53
10/9/2015	0.26	2.14	-1.64
10/10/2015	0.42	2.54	-2.22
10/11/2015			
10/12/2015	0.15	2.31	-2.20
10/13/2015			
10/14/2015	0.13	2.56	-2.10
10/15/2015	0.11	2.47	-2.15
10/16/2015	-0.21	2.04	-2.28
10/17/2015	-0.23	2.24	-2.20
10/18/2015			
10/19/2015	-0.05	2.18	-1.85
10/20/2015	-1.09	1.04	-3.25
10/21/2015	-0.87	1.56	-2.78
10/22/2015	-0.17	2.13	-2.54
10/23/2015	0.04	2.51	-2.25
10/24/2015	0.49	2.90	-2.18
10/25/2015	0.33	2.88	-2.60
10/26/2015	0.34	3.05	-3.02
10/27/2015	0.55	3.28	-2.76
10/28/2015	1.11	4.06	-2.20
10/29/2015			
10/30/2015	-0.38	2.52	-3.09
10/31/2015	-0.16	2.64	-2.72
11/1/2015	-0.22	2.35	-2.38
11/2/2015	-0.18	2.17	-2.17
11/3/2015	-0.11	1.88	-1.85
11/4/2015	-0.01	1.78	-1.74
11/5/2015	-0.04	1.64	-1.91
11/6/2015			
11/7/2015	-0.35	1.50	-2.46
11/8/2015	-0.26	1.58	-2.03
11/9/2015	-0.25	1.86	-2.49
11/10/2015	0.90	3.02	-2.19
11/11/2015	0.88	3.15	-1.38
11/12/2015	1.15	3.44	-1.43
11/13/2015	-0.30	2.38	-2.80
11/14/2015	-1.15	1.36	-3.52
11/15/2015	-0.67	2.06	-2.82
11/16/2015	-0.62	1.99	-2.97
11/17/2015	0.34	2.86	-1.61
11/18/2015			

11/19/2015	0.23	2.42	-1.70
11/20/2015	0.02	2.23	-2.25
11/21/2015	0.44	2.63	-1.76
11/22/2015	0.33	2.74	-2.57
11/23/2015	0.09	2.78	-2.42
11/24/2015	-0.23	2.77	-3.22
11/25/2015	-0.34	2.64	-3.53
11/26/2015	-0.28	2.81	-3.20
11/27/2015	-0.39	2.72	-3.27
11/28/2015			
11/29/2015			
11/30/2015			
12/1/2015	0.61	2.80	-1.29
12/2/2015	0.09	2.01	-1.82
12/3/2015	-0.68	1.34	-2.83
12/4/2015	-1.01	0.60	-2.56
12/5/2015	-0.41	1.18	-2.14
12/6/2015	-0.62	1.36	-2.38
12/7/2015	-0.43	1.70	-2.51
12/8/2015	0.02	1.98	-1.95
12/9/2015	0.55	2.89	-1.60
12/10/2015	0.33	2.76	-1.94
12/11/2015	0.22	2.85	-2.10
12/12/2015	-0.08	2.67	-2.55
12/13/2015	-0.05	2.67	-2.54
12/14/2015	0.17	2.86	-2.25
12/15/2015	-0.19	2.56	-2.63
12/16/2015	0.11	2.70	-2.29
12/17/2015	0.84	3.23	-1.61
12/18/2015	0.20	2.39	-2.40
12/19/2015	-0.95	1.70	-3.85
12/20/2015	-1.33	0.74	-3.56
12/21/2015	-0.90	1.66	-3.56
12/22/2015	-0.45	2.17	-3.32
12/23/2015	0.10	2.62	-3.32
12/24/2015	-0.17	2.92	-3.06
12/25/2015	-0.17	2.75	-3.26
12/26/2015	0.30	3.04	-2.84
12/27/2015	0.03	2.99	-2.70
12/28/2015	0.17	3.06	-3.12
12/29/2015	1.20	3.37	-1.50
12/30/2015	0.27	2.29	-1.76
12/31/2015	0.17	2.39	-1.97
1/1/2016	-0.32	1.57	-2.12
1/2/2016	-0.43	1.12	-2.22
1/3/2016	-0.40	1.28	-2.34
1/4/2016	0.03	1.68	-1.48
1/5/2016	0.60	2.27	-1.51
1/6/2016	-0.15	2.27	-2.58
1/7/2016	-0.33	1.85	-2.36
1/8/2016	0.63	2.73	-2.17
1/9/2016	1.18	3.68	-1.29
1/10/2016	1.17	4.30	-1.40
1/11/2016	-0.55	2.43	-3.57
1/12/2016	-0.41	2.79	-3.03
1/13/2016	-1.33	1.54	-4.03
1/14/2016	-1.01	1.61	-3.50
1/15/2016	-0.36	2.06	-3.10
1/16/2016			
1/17/2016			
1/18/2016			
1/19/2016			

1/20/2016	-1.44	0.71	-3.69
1/21/2016	-0.47	2.15	-2.74
1/22/2016	-0.18	2.22	-3.03
1/23/2016	3.60	6.22	-0.84
1/24/2016	2.02	4.65	-0.80
1/25/2016	0.63	3.30	-2.06
1/26/2016			
1/27/2016	-0.60	1.78	-2.84
1/28/2016	-0.02	2.34	-2.35
1/29/2016	0.05	2.20	-2.31
1/30/2016	-0.35	1.53	-2.00
1/31/2016	-0.52	1.09	-1.96
2/1/2016	-0.40	1.28	-1.93
2/2/2016	-0.19	1.51	-1.83
2/3/2016	0.05	1.92	-1.98
2/4/2016	-0.23	1.98	-2.30
2/5/2016	0.00	2.35	-2.35
2/6/2016	-0.31	2.26	-2.81
2/7/2016	-0.16	2.26	-3.10
2/8/2016	2.11	4.78	-1.67
2/9/2016	2.04	4.74	-0.62
2/10/2016	0.50	3.32	-2.79
2/11/2016	-0.93	2.04	-4.00
2/12/2016	-0.99	2.20	-4.01
2/13/2016	-1.02	1.36	-3.99
2/14/2016	-1.25	1.14	-3.68
2/15/2016	-0.49	1.76	-2.60
2/16/2016	-0.12	2.07	-2.89
2/17/2016	-0.43	2.02	-2.88
2/18/2016	-0.68	1.78	-2.79
2/19/2016	-0.18	2.22	-2.42
2/20/2016	-0.35	2.28	-2.85
2/21/2016	-0.32	1.98	-3.11
2/22/2016	0.16	2.72	-2.51
2/23/2016	0.61	2.86	-2.49
2/24/2016	1.02	3.17	-1.50
2/25/2016	-0.25	2.30	-2.79
2/26/2016	-1.66	0.90	-4.00
2/27/2016	-0.82	1.30	-2.85
2/28/2016	-1.18	0.44	-2.90
2/29/2016	-1.08	0.98	-2.69
3/1/2016	-0.65	1.25	-2.33
3/2/2016	-0.56	1.86	-2.43
3/3/2016	-0.74	0.75	-2.26
3/4/2016	0.23	1.77	-1.65
3/5/2016	0.67	2.58	-1.42
3/6/2016			
3/7/2016	-0.42	2.42	-3.01
3/8/2016	-0.20	2.44	-3.70
3/9/2016	-0.15	2.63	-3.23
3/10/2016	-0.45	2.37	-3.66
3/11/2016	-0.39	2.52	-3.57
3/12/2016	-0.27	2.41	-3.15
3/13/2016	-0.46	1.76	-3.07
3/14/2016	0.68	2.57	-1.67
3/15/2016	0.94	3.42	-1.37
3/16/2016	0.25	2.58	-1.88
3/17/2016	0.45	2.54	-1.68
3/18/2016	0.07	2.32	-2.04
3/19/2016	0.24	2.19	-1.75
3/20/2016	1.04	2.97	-1.75
3/21/2016	0.67	3.05	-1.68

3/22/2016			
3/23/2016	-1.10	1.48	-3.54
3/24/2016	-0.15	2.49	-2.81
3/25/2016	-0.07	2.07	-2.40
3/26/2016	-0.02	2.29	-2.39
3/27/2016	0.16	2.48	-1.94
3/28/2016	0.30	2.06	-1.56
3/29/2016	-1.25	-0.01	-3.19
3/30/2016	-0.74	0.96	-2.31
3/31/2016	-0.57	1.53	-2.19
4/1/2016	-0.82	1.12	-2.61
4/2/2016	-0.14	1.80	-1.94
4/3/2016	-1.39	0.55	-4.14
4/4/2016	-0.52	1.94	-3.20
4/5/2016	0.47	2.82	-2.35
4/6/2016	0.27	2.84	-2.86
4/7/2016	0.22	3.04	-2.92
4/8/2016	-0.10	2.80	-3.53
4/9/2016	0.11	3.20	-3.16
4/10/2016	-0.20	2.49	-3.15
4/11/2016	-0.70	2.15	-3.18
4/12/2016	-0.67	1.20	-3.05
4/13/2016	-0.28	2.03	-2.40
4/14/2016	-0.15	2.13	-2.18
4/15/2016	0.15	2.13	-1.83
4/16/2016	0.61	2.40	-1.53
4/17/2016	0.87	2.73	-1.44
4/18/2016	0.24	2.20	-2.00
4/19/2016	0.24	2.37	-2.01
4/20/2016	0.06	2.20	-2.23
4/21/2016	-0.05	2.11	-2.40
4/22/2016			
4/23/2016	0.34	2.71	-2.10
4/24/2016	0.36	2.54	-1.88
4/25/2016	0.04	2.41	-2.06
4/26/2016			
4/27/2016	0.76	2.94	-1.27
4/28/2016	0.21	1.57	-1.88
4/29/2016	0.50	2.37	-1.51
4/30/2016	0.21	2.60	-1.92
5/1/2016	0.07	2.07	-1.91
5/2/2016	0.33	2.49	-2.05
5/3/2016	0.55	2.72	-2.15
5/4/2016	1.10	3.53	-1.92
5/5/2016	1.52	4.20	-1.51
5/6/2016	1.43	3.95	-1.56
5/7/2016	0.76	3.61	-2.44
5/8/2016	0.40	3.35	-2.76
5/9/2016	-0.13	2.71	-2.96
5/10/2016	-0.27	2.48	-2.84
5/11/2016	-0.33	1.49	-2.80
5/12/2016	-0.13	2.44	-2.32
5/13/2016	0.06	2.34	-2.05
5/14/2016	0.11	2.17	-2.00
5/15/2016	-0.41	1.73	-2.32
5/16/2016	-1.01	1.03	-3.17
5/17/2016	-0.81	1.50	-2.96
5/18/2016	-0.17	2.15	-2.38
5/19/2016			
5/20/2016	-0.34	2.09	-2.54
5/21/2016	-0.01	2.86	-2.61
5/22/2016	0.53	2.97	-1.64

5/23/2016			
5/24/2016	0.10	2.52	-2.04
5/25/2016	-0.12	2.36	-2.22
5/26/2016	-0.34	2.20	-2.48
5/27/2016	-0.34	1.26	-2.45
5/28/2016	-0.52	1.98	-2.58
5/29/2016	-0.39	1.80	-2.68
5/30/2016	-0.10	2.19	-2.36
5/31/2016	-0.21	1.97	-2.67
6/1/2016	-0.08	2.43	-2.86
6/2/2016	0.44	3.20	-2.53
6/3/2016	0.41	3.22	-2.70
6/4/2016	0.22	3.27	-2.83
6/5/2016	0.36	3.41	-2.65
6/6/2016	0.20	3.16	-2.69
6/7/2016	0.26	3.28	-2.60
6/8/2016	-0.09	2.51	-3.11
6/9/2016	-0.46	2.29	-2.87
6/10/2016	-0.28	2.29	-2.50
6/11/2016	-0.17	2.05	-2.16
6/12/2016	-0.04	1.79	-2.00
6/13/2016	0.15	1.97	-1.91
6/14/2016	0.04	1.87	-1.88
6/15/2016	-0.06	1.88	-2.02
6/16/2016	0.40	2.44	-1.58
6/17/2016	0.41	2.67	-1.83
6/18/2016	-0.04	2.29	-2.26
6/19/2016	-0.16	2.40	-2.34
6/20/2016	-0.26	2.46	-2.51
6/21/2016	-0.16	2.73	-2.51
6/22/2016	-0.16	2.66	-2.44
6/23/2016			
6/24/2016	0.17	2.76	-2.22
6/25/2016	0.18	1.96	-2.12
6/26/2016	-0.06	2.48	-2.40
6/27/2016	-0.12	2.20	-2.47
6/28/2016	-0.08	2.09	-2.51
6/29/2016	0.05	2.39	-2.46
6/30/2016	0.01	2.48	-2.59
7/1/2016	0.02	2.76	-2.92
7/2/2016	-0.08	2.77	-3.03
7/3/2016	-0.17	2.77	-3.11
7/4/2016	-0.33	2.80	-3.28
7/5/2016	-0.11	2.99	-2.91
7/6/2016	-0.01	2.84	-2.60
7/7/2016	0.08	2.72	-2.39
7/8/2016	0.33	3.01	-2.14
7/9/2016	0.76	3.01	-1.38
7/10/2016	0.43	2.72	-1.62
7/11/2016	0.28	2.12	-1.68
7/12/2016	0.02	1.78	-1.80
7/13/2016	-0.10	1.79	-1.93
7/14/2016	0.00	1.96	-1.79
7/15/2016	-0.23	1.87	-2.16
7/16/2016	-0.15	2.10	-2.26
7/17/2016	-0.12	2.32	-2.30
7/18/2016	-0.33	2.29	-2.62
7/19/2016	-0.36	2.60	-2.77
7/20/2016	-0.06	2.75	-2.63
7/21/2016	-0.20	2.57	-2.76
7/22/2016	-0.36	2.32	-2.87
7/23/2016			

7/24/2016	0.06	2.56	-2.58
7/25/2016	0.07	2.29	-2.45
7/26/2016	0.07	2.36	-2.48
7/27/2016	0.19	2.57	-2.31
7/28/2016	0.31	2.70	-2.23
7/29/2016	0.56	3.08	-2.07
7/30/2016	0.35	2.95	-2.43
7/31/2016	0.29	2.99	-2.47
8/1/2016	0.47	3.35	-2.27
8/2/2016	0.61	3.48	-2.07
8/3/2016	0.53	3.12	-2.04
8/4/2016	0.31	2.80	-2.20
8/5/2016	0.11	2.44	-2.25
8/6/2016	-0.08	2.31	-2.34
8/7/2016	0.11	2.12	-2.05
8/8/2016	0.09	1.96	-1.87
8/9/2016	-0.12	1.81	-1.85
8/10/2016	-0.38	1.59	-2.02
8/11/2016	-0.58	1.41	-2.28
8/12/2016	-0.53	1.57	-2.26
8/13/2016	-0.35	1.93	-2.27
8/14/2016			
8/15/2016	-0.17	2.38	-2.36
8/16/2016	-0.07	2.57	-2.41
8/17/2016	-0.37	2.57	-3.00
8/18/2016	0.02	3.01	-2.94
8/19/2016	0.27	3.11	-2.49
8/20/2016	0.37	3.18	-2.43
8/21/2016	0.50	2.86	-2.12
8/22/2016	0.06	2.65	-2.69
8/23/2016	-0.03	2.49	-2.43
8/24/2016			
8/25/2016	-0.30	2.26	-2.74
8/26/2016	-0.31	2.14	-2.66
8/27/2016	0.17	2.60	-2.15
8/28/2016	0.26	2.74	-2.26
8/29/2016	0.15	2.67	-2.40
8/30/2016	0.19	2.74	-2.49
8/31/2016	0.29	2.88	-2.35
9/1/2016	0.35	2.95	-2.24
9/2/2016	0.53	2.94	-2.13
9/3/2016	1.47	3.48	-1.31
9/4/2016	1.43	3.21	-0.76
9/5/2016	1.39	3.24	-0.69
9/6/2016	1.55	3.76	-0.60
9/7/2016	0.80	2.62	-0.93
9/8/2016	0.42	2.26	-1.18
9/9/2016			
9/10/2016	0.10	1.95	-1.46
9/11/2016	-0.05	1.92	-1.72
9/12/2016	0.26	2.41	-1.64
9/13/2016	0.09	2.44	-2.12
9/14/2016	0.02	2.62	-2.44
9/15/2016	0.57	3.14	-2.45
9/16/2016	0.57	3.06	-2.34
9/17/2016	0.31	2.90	-2.69
9/18/2016	0.10	2.67	-2.87
9/19/2016	0.35	3.04	-2.65
9/20/2016	0.26	2.96	-2.46
9/21/2016	0.21	2.83	-2.36
9/22/2016	0.29	2.86	-2.22
9/23/2016	0.35	2.71	-1.82

9/24/2016	0.71	3.14	-1.46
9/25/2016			
9/26/2016	0.37	2.64	-1.88
9/27/2016	0.30	2.70	-2.18
9/28/2016	0.94	3.63	-1.99
9/29/2016	2.41	4.35	-0.10
9/30/2016	2.38	4.19	0.14
10/1/2016	1.47	3.55	-0.98
10/2/2016	0.81	2.94	-1.54
10/3/2016	0.67	2.83	-1.49
10/4/2016	0.96	2.95	-1.50
10/5/2016	1.20	3.12	-0.78
10/6/2016	0.48	2.50	-1.38
10/7/2016	0.29	2.25	-1.22
10/8/2016	0.50	2.31	-1.13
10/9/2016	1.22	3.01	-0.51
10/10/2016	0.93	2.62	-1.03
10/11/2016	0.44	2.30	-1.84
10/12/2016	0.55	2.80	-1.87
10/13/2016	0.42	2.79	-1.98
10/14/2016	0.49	2.95	-2.30
10/15/2016	0.55	3.00	-2.39
10/16/2016	0.39	3.16	-2.75
10/17/2016	0.22	3.17	-2.91
10/18/2016	0.39	3.39	-2.68
10/19/2016	0.23	3.10	-2.54
10/20/2016	0.42	3.15	-2.23
10/21/2016	0.83	3.27	-1.49
10/22/2016	0.20	2.48	-2.41
10/23/2016	-1.24	0.91	-3.26
10/24/2016	-0.72	1.71	-3.05
10/25/2016			
10/26/2016	-0.13	1.94	-2.25
10/27/2016	0.22	2.28	-1.82
10/28/2016	-0.12	1.98	-2.25
10/29/2016	-0.03	2.17	-2.50
10/30/2016	0.01	2.24	-2.46
10/31/2016	0.53	2.93	-1.84
11/1/2016	0.36	2.79	-1.81
11/2/2016			
11/3/2016	0.00	2.35	-1.88
11/4/2016	0.39	2.63	-1.38
11/5/2016	0.14	2.32	-1.78
11/6/2016			
11/7/2016	0.66	2.59	-1.01
11/8/2016	0.69	2.57	-1.48
11/9/2016	0.45	2.58	-1.81
11/10/2016	0.52	2.53	-2.26
11/11/2016	-0.36	1.98	-3.16
11/12/2016	-0.05	2.47	-2.78
11/13/2016	-0.54	2.37	-3.68
11/14/2016	-0.43	2.49	-4.06
11/15/2016	0.44	3.48	-3.11
11/16/2016	0.11	3.35	-2.94
11/17/2016	0.00	3.06	-3.03
11/18/2016	0.24	3.03	-2.31
11/19/2016	0.71	3.51	-1.36
11/20/2016	-1.07	1.66	-3.89
11/21/2016	-1.97	0.16	-4.31
11/22/2016	-1.39	0.51	-3.23
11/23/2016	-0.61	1.24	-2.50
11/24/2016	-0.19	1.67	-2.22

11/25/2016	0.07	2.12	-2.04
11/26/2016			
11/27/2016	-0.01	2.26	-2.14
11/28/2016	-0.12	2.50	-2.42
11/29/2016	-0.30	2.20	-2.80
11/30/2016	0.06	2.54	-2.59
12/1/2016	0.11	2.68	-2.14
12/2/2016	-0.71	1.96	-2.82
12/3/2016	-1.06	1.25	-3.32
12/4/2016	0.06	2.43	-1.90
12/5/2016	0.22	2.40	-1.74
12/6/2016	0.56	2.48	-1.54
12/7/2016	1.11	3.35	-1.50
12/8/2016	0.09	2.21	-2.69
12/9/2016	-0.86	1.38	-3.56
12/10/2016	-0.65	1.68	-3.47
12/11/2016	-0.29	2.26	-2.94
12/12/2016	-0.06	2.96	-3.23
12/13/2016	-0.13	2.76	-3.50
12/14/2016	0.22	3.39	-2.94
12/15/2016	-0.86	2.47	-4.07
12/16/2016	-1.43	1.82	-4.77
12/17/2016	-0.48	2.74	-3.36
12/18/2016	-0.68	2.03	-3.08
12/19/2016	-0.66	1.65	-2.86
12/20/2016	-0.19	1.80	-2.04
12/21/2016	-0.43	1.49	-2.27
12/22/2016			
12/23/2016	-0.60	1.43	-2.56
12/24/2016	-0.55	1.77	-2.56
12/25/2016	-0.63	1.66	-2.64
12/26/2016	-0.10	2.00	-1.95
12/27/2016	-0.55	2.11	-3.02
12/28/2016			
12/29/2016	0.32	2.89	-2.20
12/30/2016	-0.79	1.97	-3.46
12/31/2016	-1.03	1.72	-3.34
1/1/2017	-0.82	1.92	-3.34
1/2/2017	0.08	2.62	-2.61
1/3/2017	0.94	3.30	-1.21
1/4/2017	0.13	2.50	-2.34
1/5/2017	-1.01	1.03	-3.16
1/6/2017	-0.46	1.69	-2.65
1/7/2017			
1/8/2017	-0.11	2.64	-3.25
1/9/2017	-0.71	2.14	-3.57
1/10/2017	-0.46	2.30	-3.15
1/11/2017			
1/12/2017	-0.64	2.55	-3.73
1/13/2017	-0.77	2.51	-3.94
1/14/2017	-0.51	2.52	-3.63
1/15/2017			
1/16/2017	-0.60	2.09	-2.91
1/17/2017	-0.76	1.54	-2.83
1/18/2017	0.04	2.01	-2.02
1/19/2017			
1/20/2017	0.02	1.70	-1.58
1/21/2017	0.06	1.82	-1.72
1/22/2017	0.38	1.99	-1.15
1/23/2017			
1/24/2017			
1/25/2017	0.25	2.61	-1.81

1/26/2017	0.05	2.58	-2.26
1/27/2017			
1/28/2017	-1.39	1.41	-4.16
1/29/2017	-0.69	2.09	-3.58
1/30/2017	-0.26	2.54	-2.69
1/31/2017	-0.27	2.52	-2.92
2/1/2017	-0.37	2.16	-2.99
2/2/2017	-0.61	1.82	-2.82
2/3/2017	-0.65	1.54	-2.82
2/4/2017	-0.88	1.48	-3.28
2/5/2017	-0.88	1.40	-3.19
2/6/2017	-0.88	1.64	-3.18
2/7/2017	-0.27	2.07	-2.60
2/8/2017	0.11	2.46	-2.58
2/9/2017	0.35	3.75	-2.47
2/10/2017	-0.75	2.26	-3.75
2/11/2017	-0.52	2.12	-3.55
2/12/2017	0.50	3.17	-2.79
2/13/2017	-0.87	1.56	-3.98
2/14/2017	0.25	2.90	-2.92
2/15/2017	0.56	2.65	-1.60
2/16/2017	-0.53	2.00	-2.58
2/17/2017	-0.70	1.53	-2.66
2/18/2017	-0.56	0.92	-2.24
2/19/2017	-0.36	1.51	-1.88
2/20/2017	-0.21	1.49	-1.70
2/21/2017	0.02	2.07	-1.76
2/22/2017	-0.01	2.11	-1.97
2/23/2017			
2/24/2017	-0.01	2.33	-2.30
2/25/2017	0.27	2.59	-2.40
2/26/2017	-0.39	2.42	-3.12
2/27/2017	-0.91	1.97	-3.72
2/28/2017	-0.70	2.14	-3.68
3/1/2017	-0.45	2.48	-3.12
3/2/2017	-1.58	1.02	-4.36
3/3/2017	-1.62	0.81	-4.20
3/4/2017	-1.51	0.93	-3.82
3/5/2017	-1.13	1.02	-3.34
3/6/2017	-0.51	1.86	-2.50
3/7/2017	-0.25		
3/8/2017	-0.60		
3/9/2017	-0.93		
3/10/2017	0.16		
3/11/2017	-1.03		
3/12/2017	-1.33		
3/13/2017	-0.95		
3/14/2017	0.90		
3/15/2017	-1.57		
3/16/2017	-1.98		
3/17/2017	-1.28		
3/18/2017	-0.31		
3/19/2017	0.87		
3/20/2017	0.38	2.09	-1.17
3/21/2017	0.08	2.00	-1.46
3/22/2017	-0.56	1.67	-2.46
3/23/2017	-0.86	1.22	-2.84
3/24/2017	-1.01	1.07	-3.08
3/25/2017	-0.74	1.51	-3.16
3/26/2017			
3/27/2017	0.04	2.57	-2.80
3/28/2017	0.16	2.91	-3.01

3/29/2017	0.23	2.79	-2.70
3/30/2017	-0.02	2.81	-2.90
3/31/2017	0.44	3.52	-2.51
4/1/2017	0.92	2.90	-1.57
4/2/2017	0.31	3.27	-2.03
4/3/2017	0.15	2.62	-2.08
4/4/2017	0.69	2.90	-1.60
4/5/2017	0.72	3.06	-1.49
4/6/2017	1.34	3.25	-1.36
4/7/2017	0.24	2.82	-2.88
4/8/2017	-0.43	1.94	-3.04
4/9/2017	-0.17	2.18	-2.76
4/10/2017			
4/11/2017	-0.63	1.87	-3.06
4/12/2017			
4/13/2017			
4/14/2017	-0.45	2.03	-2.63
4/15/2017	-0.38	1.86	-2.28
4/16/2017	-0.63	1.43	-2.35
4/17/2017	-0.45	0.85	-2.27
4/18/2017	-0.11	1.83	-1.74
4/19/2017	0.04	1.98	-1.42
4/20/2017	-0.14	1.86	-1.79
4/21/2017	0.44	2.11	-1.48
4/22/2017	0.57	2.64	-1.78
4/23/2017	0.35	2.42	-2.22
4/24/2017	0.46	2.85	-2.28
4/25/2017	1.08	3.73	-1.86
4/26/2017	0.94	3.45	-2.11
4/27/2017	0.28	3.13	-2.85
4/28/2017	-0.12	2.91	-3.22
4/29/2017	-0.44	2.68	-3.24
4/30/2017	-0.19	3.01	-3.04
5/1/2017	0.03	1.78	-2.24
5/2/2017	-0.28	2.43	-2.66
5/3/2017	-0.33	2.33	-2.55
5/4/2017	-0.05	2.01	-2.23
5/5/2017	0.78	2.47	-1.12
5/6/2017	0.56	2.63	-1.88
5/7/2017	0.13	2.32	-2.43
5/8/2017	-0.05	2.29	-2.53
5/9/2017			
5/10/2017	0.25	2.73	-2.21
5/11/2017	0.30	2.90	-2.16
5/12/2017	0.52	2.96	-1.80
5/13/2017	1.19	3.24	-1.23
5/14/2017	0.88	2.59	-1.35
5/15/2017	0.02	2.60	-2.09
5/16/2017	0.11	1.46	-1.74
5/17/2017	-0.17	2.10	-1.95
5/18/2017	-0.30	1.84	-2.18
5/19/2017	-0.35	1.71	-2.36
5/20/2017	0.37	2.19	-1.65
5/21/2017	0.05	2.09	-2.17
5/22/2017	0.23	2.56	-2.41
5/23/2017	0.54	3.02	-2.33
5/24/2017	0.94	3.71	-2.07
5/25/2017	1.28	4.16	-1.82
5/26/2017	0.56	3.57	-2.66
5/27/2017	0.43	3.63	-2.53
5/28/2017	0.65	3.94	-2.22
5/29/2017	0.99	3.60	-1.60

5/30/2017			
5/31/2017	0.38	2.95	-1.90
6/1/2017	0.16	2.51	-2.06
6/2/2017	0.15	2.15	-1.98
6/3/2017	0.07	2.00	-1.95
6/4/2017	0.09	2.25	-2.09
6/5/2017	0.35	2.62	-1.88
6/6/2017	0.94	3.18	-1.42
6/7/2017	1.05	3.03	-1.04
6/8/2017	0.54	3.00	-1.61
6/9/2017	0.39	2.57	-1.75
6/10/2017	-0.20	2.17	-2.26
6/11/2017	-0.33	2.36	-2.66
6/12/2017	-0.39	2.21	-2.49
6/13/2017	-0.20	2.38	-2.30
6/14/2017	0.12	2.58	-2.09
6/15/2017	0.32	1.77	-1.71
6/16/2017	0.49	2.62	-1.49
6/17/2017	0.35	2.49	-1.69
6/18/2017	0.06	2.11	-2.12
6/19/2017	-0.29	1.98	-2.68
6/20/2017	-0.16	2.34	-2.72
6/21/2017	-0.16	2.60	-3.08
6/22/2017	0.09	3.24	-3.04
6/23/2017	0.17	3.25	-2.87
6/24/2017	-0.12	3.24	-3.38
6/25/2017	0.01	3.27	-2.93
6/26/2017	0.00	2.92	-2.80
6/27/2017	0.05	2.83	-2.74
6/28/2017			
6/29/2017	-0.32	2.27	-2.65
6/30/2017	-0.46	1.73	-2.71
7/1/2017	-0.23	1.77	-2.40
7/2/2017	-0.01	1.94	-2.10
7/3/2017	-0.03	1.99	-2.05
7/4/2017	0.04	2.29	-2.07
7/5/2017	0.17	2.46	-2.00
7/6/2017	0.29	2.68	-1.94
7/7/2017	0.38	2.82	-1.84
7/8/2017	0.27	2.72	-1.91
7/9/2017	0.14	2.63	-1.98
7/10/2017	0.01	2.61	-2.21
7/11/2017	-0.06	2.45	-2.15
7/12/2017	-0.11	2.37	-2.34
7/13/2017	-0.11	2.31	-2.28
7/14/2017	0.30	2.10	-1.99
7/15/2017	0.26	2.74	-2.04
7/16/2017			
7/17/2017	0.06	2.20	-2.18
7/18/2017	0.00	2.38	-2.31
7/19/2017	0.00	2.56	-2.51
7/20/2017	0.00	2.79	-2.78
7/21/2017	0.12	3.11	-2.87
7/22/2017	0.29	3.40	-2.78
7/23/2017	0.48	3.76	-2.50
7/24/2017	0.86	3.90	-2.00
7/25/2017	0.76	3.47	-2.04
7/26/2017	0.62	3.01	-1.91
7/27/2017	0.30	2.55	-2.14
7/28/2017	0.45	2.43	-1.94
7/29/2017	1.60	3.39	-0.72
7/30/2017	1.19	3.34	-0.74

7/31/2017	0.44	2.30	-1.39
8/1/2017	0.27	2.19	-1.62
8/2/2017	0.26	2.33	-1.58
8/3/2017			
8/4/2017	0.36	2.66	-1.74
8/5/2017	0.34	2.64	-1.99
8/6/2017	0.08	2.47	-2.23
8/7/2017	0.19	2.84	-2.33
8/8/2017	0.35	2.82	-2.05
8/9/2017	0.06	2.66	-2.33
8/10/2017	-0.04	2.55	-2.40
8/11/2017	0.05	2.55	-2.42
8/12/2017	0.20	2.49	-2.24
8/13/2017	0.17	2.36	-2.12
8/14/2017	0.08	2.35	-2.30
8/15/2017	0.34	2.56	-2.09
8/16/2017	0.34	2.74	-2.14
8/17/2017	0.37	2.91	-2.19
8/18/2017	0.25	2.89	-2.41
8/19/2017	0.40	3.34	-2.61
8/20/2017	0.25	3.15	-2.63
8/21/2017	0.08	2.92	-2.90
8/22/2017	0.06	2.74	-2.76
8/23/2017	0.14	2.86	-2.84
8/24/2017	0.30	2.71	-2.27
8/25/2017	0.27	2.49	-2.03
8/26/2017	0.19	2.34	-2.10
8/27/2017	0.35	2.36	-1.88
8/28/2017	0.77	2.60	-1.06
8/29/2017	1.39	3.07	-0.68
8/30/2017	1.40	2.95	-0.62
8/31/2017	0.43	2.14	-1.26
9/1/2017	0.66	2.60	-1.38
9/2/2017	0.58	2.82	-1.41
9/3/2017	0.68	2.88	-1.28
9/4/2017	0.11	2.52	-2.26
9/5/2017	-0.08	2.42	-2.54
9/6/2017	0.21	2.72	-2.36
9/7/2017	0.22	2.47	-2.55
9/8/2017	-0.20	2.31	-2.81
9/9/2017	0.06	2.52	-2.63
9/10/2017	0.18	2.65	-2.25
9/11/2017	0.09	2.56	-2.23
9/12/2017	0.24	2.69	-2.17
9/13/2017	0.47	2.87	-1.66
9/14/2017	0.47	2.92	-1.75
9/15/2017	0.42	2.86	-1.91
9/16/2017	0.48	2.93	-2.05
9/17/2017	0.63	3.21	-2.10
9/18/2017	1.05	3.73	-1.92
9/19/2017	2.09	4.57	-1.13
9/20/2017	1.71	3.95	-1.03
9/21/2017	1.04	3.29	-1.64
9/22/2017	1.40	3.71	-1.20
9/23/2017	0.84	3.14	-1.46
9/24/2017	0.46	2.57	-1.64
9/25/2017	0.59	2.63	-1.25
9/26/2017	0.60	2.43	-1.13
9/27/2017	0.91	2.72	-0.74
9/28/2017	0.86	2.58	-0.94
9/29/2017	0.65	2.39	-1.10
9/30/2017	0.34	2.00	-1.48

10/1/2017	0.82	2.54	-1.56
10/2/2017	0.25	2.41	-1.93
10/3/2017	0.53	2.87	-1.93
10/4/2017	0.11	2.33	-2.41
10/5/2017	-0.46	2.00	-3.22
10/6/2017	0.02	2.58	-3.06
10/7/2017	0.35	3.01	-2.42
10/8/2017	0.09	2.92	-2.74
10/9/2017	-0.06	2.89	-2.64
10/10/2017	-0.07	2.76	-2.62
10/11/2017	0.27	2.82	-2.18
10/12/2017	1.76	4.12	-0.18
10/13/2017	1.24	3.18	-1.27
10/14/2017	0.57	2.62	-1.87
10/15/2017	0.23	2.42	-2.34
10/16/2017	0.00	2.45	-2.19
10/17/2017	0.48	2.70	-2.18
10/18/2017	0.06	2.44	-2.59
10/19/2017	-0.24	2.27	-2.75
10/20/2017	-0.23	2.32	-2.73
10/21/2017	-0.02	2.51	-2.53
10/22/2017	0.00	2.45	-2.20
10/23/2017	0.32	2.60	-1.85
10/24/2017	0.54	2.85	-1.33
10/25/2017	0.59	2.68	-1.16
10/26/2017	0.32	2.35	-1.29
10/27/2017	-0.22	1.48	-1.76
10/28/2017	0.07	1.91	-1.48
10/29/2017	0.99	2.80	-0.82
10/30/2017	-0.02	2.15	-2.94
10/31/2017	-0.86	1.74	-2.98
11/1/2017	0.29	2.60	-1.76
11/2/2017	0.37	2.61	-2.21
11/3/2017	0.36	2.90	-2.40
11/4/2017	0.72	3.50	-2.69
11/5/2017	1.02	3.95	-1.95
11/6/2017	0.48	3.44	-2.53
11/7/2017	0.66	3.46	-2.25
11/8/2017	1.46	4.04	-0.99
11/9/2017	1.11	3.45	-1.36
11/10/2017	0.16	2.39	-2.05
11/11/2017	-0.04	2.22	-2.34
11/12/2017	-0.01	2.14	-2.29
11/13/2017	0.33	2.40	-1.81
11/14/2017	0.66	2.63	-1.58
11/15/2017	1.12	3.04	-1.07
11/16/2017	0.67	3.18	-1.70
11/17/2017	-0.30	2.24	-2.68
11/18/2017	0.05	2.67	-2.33
11/19/2017	-0.71	1.97	-3.02
11/20/2017	-0.98	1.53	-3.23
11/21/2017	-0.92	1.55	-3.10
11/22/2017	-0.18	2.37	-2.21
11/23/2017	0.06	2.22	-1.78
11/24/2017	-0.15	1.78	-1.88
11/25/2017	0.21	2.22	-1.65
11/26/2017	-0.15	1.77	-2.11
11/27/2017	-0.65	1.17	-2.60
11/28/2017	-0.10	1.86	-2.04
11/29/2017	-0.41	1.72	-2.86
11/30/2017	0.10	2.17	-2.08
12/1/2017	0.36	2.84	-2.19

12/2/2017	0.36	2.97	-2.60
12/3/2017	0.40	3.38	-2.64
12/4/2017	0.34	3.45	-2.78
12/5/2017	0.45	3.67	-2.54
12/6/2017	-0.09	2.91	-2.95
12/7/2017	-0.34	2.71	-3.13
12/8/2017	-0.29	2.58	-2.95
12/9/2017	0.57	2.74	-1.82
12/10/2017	0.12	2.68	-2.57
12/11/2017	-0.71	1.05	-2.69
12/12/2017			
12/13/2017	-1.00	1.55	-3.37
12/14/2017	-1.08	0.96	-3.80
12/15/2017	-0.36	1.86	-2.62
12/16/2017	-1.18	1.43	-3.43
12/17/2017	-0.65	1.81	-3.86
12/18/2017	-0.21	2.33	-2.61
12/19/2017	-0.38	2.31	-2.79
12/20/2017	-0.73	1.80	-2.88
12/21/2017	-0.30	2.23	-2.47
12/22/2017	-0.15	2.36	-2.17
12/23/2017	-0.01	2.54	-1.96
12/24/2017	-0.03	2.31	-2.09
12/25/2017	-0.87	1.93	-3.61
12/26/2017			
12/27/2017	-1.22	0.77	-3.26
12/28/2017	-1.46	0.92	-4.00
12/29/2017	-0.99	1.12	-3.01
12/30/2017	-0.31	2.48	-2.84
12/31/2017	-0.47	2.40	-3.61
1/1/2018	-0.56	2.67	-3.67
1/2/2018	-0.94	2.29	-4.16
1/3/2018	-0.57	2.65	-4.24
1/4/2018	0.56	3.94	-2.52
1/5/2018			
1/6/2018			
1/7/2018			
1/8/2018			
1/9/2018			
1/10/2018			
1/11/2018			
1/12/2018			
1/13/2018			
1/14/2018			
1/15/2018			
1/16/2018	0.43	2.77	-1.76
1/17/2018			
1/18/2018			
1/19/2018			
1/20/2018	-0.53	2.14	-2.76
1/21/2018	-0.72	1.64	-2.87
1/22/2018	-0.24	1.96	-2.16
1/23/2018	0.04	2.32	-1.94
1/24/2018	-0.74	1.87	-2.96
1/25/2018	-0.83	1.27	-2.77
1/26/2018	-0.99	1.37	-3.18
1/27/2018	-0.75	1.74	-3.44
1/28/2018	-0.85	1.75	-3.43
1/29/2018	0.42	2.7	-2.18
1/30/2018	1.16	4.25	-1.6
1/31/2018	0.22	3.39	-2.93
2/1/2018	-0.76	2.29	-3.89

2/2/2018	-0.6	2.83	-3.69
2/3/2018	-1.07	2.03	-3.88
2/4/2018	-0.69	2.25	-3.71
2/5/2018	-0.75	1	-2.96
2/6/2018	-0.88	1.36	-2.97
2/7/2018	-0.26	1.67	-2.24
2/8/2018	-0.73	1.11	-2.63
2/9/2018	-0.8	0.73	-2.23
2/10/2018	-0.48	1.54	-2.21
2/11/2018	-0.42	1.85	-2.59
2/12/2018	-0.78	1.29	-2.93
2/13/2018	-0.54	1.71	-2.07
2/14/2018	-0.63	1.94	-2.71
2/15/2018	-0.5	2.09	-3.12
2/16/2018	-0.06	2.43	-2.63
2/17/2018	-0.12	2.39	-2.64
2/18/2018	-0.45	1.98	-3.16
2/19/2018	-0.3	2.17	-2.85
2/20/2018	-0.84	1.3	-3.14
2/21/2018	-1.08	0.96	-3.17
2/22/2018	-0.48	1.37	-2.68
2/23/2018	-0.06	2.44	-2.21
2/24/2018	-0.51	2	-2.79
2/25/2018	0.15	2.16	-1.83
2/26/2018	0.15	2.82	-2.73
2/27/2018	-0.3	2.51	-2.94
2/28/2018	-0.33	2.44	-3.36
3/1/2018	0.24	2.92	-3.28
3/2/2018	0.53	3.41	-3.06
3/3/2018	1.72	4.31	-1.36
3/4/2018	2.1	4.42	-0.36
3/5/2018	1.68	4.13	-0.84
3/6/2018	1.92	3.64	-0.28
3/7/2018	1.95	4.09	-0.44
3/8/2018	0.94	3.46	-1.37
3/9/2018	-0.26	2.11	-1.96
3/10/2018	-0.79	1.03	-2.34
3/11/2018	-0.55	1.22	-2.23
3/12/2018	0.73	2.19	-1.2
3/13/2018	1.27	3.22	-1.08
3/14/2018	-0.39	2.03	-2.49
3/15/2018	-1.51	0.65	-3.81
3/16/2018	-0.8	1.67	-3.08
3/17/2018	-0.85	1.83	-3.54
3/18/2018	-0.14	2.48	-3.35
3/19/2018	-0.03	2.6	-2.76
3/20/2018	0.84	3.85	-2.54
3/21/2018	2.13	4.15	-0.16
3/22/2018	1.08	2.72	-1.53
3/23/2018	0.13	2.96	-2.3
3/24/2018	-0.27	1.95	-2.38
3/25/2018	0.47	2.32	-1.74
3/26/2018	0.88	3.02	-1.52
3/27/2018	0.5	2.79	-1.98
3/28/2018	0.69	2.93	-1.9
3/29/2018	0.38	2.8	-2.51
3/30/2018	-0.09	2.48	-2.97
3/31/2018	-0.31	2.32	-3.22
4/1/2018	-0.55	2.18	-3.42
4/2/2018	0.14	2.62	-3.01
4/3/2018	0.16	2.72	-2.4
4/4/2018	-0.24	1.8	-2.73

4/5/2018	-1.08	0.52	-3.11
4/6/2018	-0.7	1.38	-2.57
4/7/2018	-0.38	1.4	-2.31
4/8/2018	0.18	1.82	-1.15
4/9/2018	-0.21	1.74	-1.69
4/10/2018	-0.46	1.34	-2.11
4/11/2018	-0.06	1.77	-1.86
4/12/2018	-0.28	1.84	-2.4
4/13/2018	-0.79	1.44	-3.1
4/14/2018	-0.63	2	-3.22
4/15/2018	1.28	4.05	-2.45
4/16/2018	1.33	3.75	-1.55
4/17/2018	0.08	2.47	-2.9
4/18/2018	-0.4	2.63	-3.28
4/19/2018	-0.03	2.36	-2.53
4/20/2018	-0.56	2.24	-3
4/21/2018	-0.64	1.17	-2.82
4/22/2018	-0.67	1.94	-2.88
4/23/2018	-0.52	1.87	-2.66
4/24/2018	-0.13	2.08	-2.44
4/25/2018	0.6	2.71	-1.76
4/26/2018	0.2	2.57	-2.49
4/27/2018	0.32	2.66	-2.55
4/28/2018	0.34	2.76	-2.42
4/29/2018	-0.08	2.38	-2.8
4/30/2018	-0.48	2.41	-3.1
5/1/2018	-0.29	2.34	-2.68
5/2/2018	-0.44	2.18	-2.84
5/3/2018	-0.71	1.81	-2.92
5/4/2018	-0.49	1.84	-2.65
5/5/2018	-0.55	1.75	-2.57
5/6/2018	-0.16	1.75	-2.05
5/7/2018	0.01	2.18	-1.58
5/8/2018	0.04	1.8	-1.63
5/9/2018	-0.05	1.6	-1.68
5/10/2018	-0.04	1.75	-1.86
5/11/2018	-0.06	1.91	-2.31
5/12/2018	0.02	2.24	-2.43
5/13/2018	0.38	2.71	-2.18
5/14/2018	0.29	2.81	-2.46
5/15/2018	0.03	2.94	-2.82
5/16/2018	0.03	3.34	-2.9
5/17/2018	0.33	3.24	-2.5
5/18/2018	0.5	3.87	-2.57
5/19/2018	0.61	2.95	-2.02
5/20/2018	-0.27	1.41	-2.59
5/21/2018	-0.22	2.44	-2.62
5/22/2018	0.12	2.5	-2.16
5/23/2018	0.22	2.46	-2.14
5/24/2018	0.12	2.22	-2.34
5/25/2018	-0.05	2.16	-2.71
5/26/2018	-0.38	2.22	-2.98
5/27/2018	0.45	3.21	-2.52
5/28/2018	0.66	2.86	-1.93
5/29/2018	0.13	2.73	-2.23
5/30/2018	0.15	2.87	-2.22
5/31/2018	0.3	2.8	-1.82
6/1/2018	0.26	2.75	-1.84
6/2/2018	0.35	2.72	-1.66
6/3/2018	1.39	3.51	-0.89
6/4/2018	1.27	2.34	-0.7
6/5/2018	0.68	2.84	-1.08

6/6/2018	0.9	2.58	-0.83
6/7/2018	0.51	2.5	-1.34
6/8/2018	0.12	2	-1.89
6/9/2018	0.05	2.12	-2.19
6/10/2018	0.39	2.69	-2.26
6/11/2018	0.92	3.23	-1.76
6/12/2018	0.36	3.1	-2.6
6/13/2018	0.04	3.06	-2.97
6/14/2018	-0.11	3.28	-3.1
6/15/2018	0.35	3.58	-2.56
6/16/2018	0.15	3.11	-2.76
6/17/2018	-0.04	2.89	-2.79
6/18/2018	-0.04	2	-2.62
6/19/2018	-0.28	2.46	-2.84
6/20/2018	0.14	2.35	-2.38
6/21/2018	0.42	2.46	-1.96
6/22/2018	0.71	2.76	-1.38
6/23/2018	0.83	2.88	-1.5
6/24/2018	0.48	2.72	-1.92
6/25/2018	0.27	2.74	-2.03
6/26/2018	0.24	2.64	-2
6/27/2018	0.18	2.8	-2.07
6/28/2018	0.2	2.87	-2.01
6/29/2018	0.19	2.63	-1.95
6/30/2018	0.03	2.58	-2.01
7/1/2018	0.03	2.47	-1.96
7/2/2018	0.1	2.38	-1.89
7/3/2018	-0.07	2.1	-1.96
7/4/2018	-0.2	1.23	-2.04
7/5/2018	-0.27	1.84	-2.16
7/6/2018	-0.45	1.61	-2.41
7/7/2018	0.31	2.19	-1.44
7/8/2018	0.19	2.25	-2.05
7/9/2018	-0.02	2.35	-2.4
7/10/2018	-0.02	2.76	-2.69
7/11/2018			
7/12/2018	0.42	3.47	-2.65
7/13/2018	0.18	3.32	-2.82
7/14/2018	0.02	3.1	-2.96
7/15/2018	0.06	3.11	-2.9
7/16/2018	0.17	2.86	-2.54
7/17/2018	0.03	2.2	-2.64
7/18/2018	0.28	2.75	-2.23
7/19/2018	0.24	2.4	-2.07
7/20/2018	0.17	2.23	-2.03
7/21/2018	0.99	3.23	-1.51
7/22/2018	0.7	2.77	-1.57
7/23/2018	0.38	2.5	-1.67
7/24/2018	0.31	2.62	-1.87
7/25/2018	0.28	2.74	-2.04
7/26/2018	0.14	2.57	-2.07
7/27/2018	0.06	2.57	-2.06
7/28/2018	0.19	2.7	-1.9
7/29/2018	0.11	2.48	-1.95
7/30/2018	0.05	2.4	-2.17
7/31/2018	0.25	2.52	-1.87
8/1/2018	0.1	2.01	-1.78
8/2/2018	-0.27	1.82	-2.35
8/3/2018	-0.25	1.7	-2.21
8/4/2018	-0.16	1.75	-2.21
8/5/2018	0	2.15	-2.13
8/6/2018			

8/7/2018	0	2.46	-2.36
8/8/2018	0.28	3.02	-2.35
8/9/2018	0.37	3.36	-2.58
8/10/2018	0.48	3.6	-2.65
8/11/2018	0.42	3.59	-2.7
8/12/2018	0.43	3.44	-2.69
8/13/2018	0.51	3.22	-2.42
8/14/2018	0.22	2.65	-2.5
8/15/2018	-0.03	2.38	-2.71
8/16/2018	-0.04	2.23	-2.48
8/17/2018	0	2.19	-2.28
8/18/2018	0.07	2.21	-1.94
8/19/2018	0.81	2.89	-1.3
8/20/2018	0.98	2.82	-1.05
8/21/2018	0.84	2.77	-1.02
8/22/2018	0.53	2.56	-1.26
8/23/2018	0.4	2.69	-1.58
8/24/2018	0.3	2.65	-1.77
8/25/2018	0.21	2.6	-1.97
8/26/2018	0.13	2.44	-2.05
8/27/2018	-0.03	2.47	-2.45
8/28/2018	0.06	2.29	-2.22
8/29/2018	-0.02	2.2	-2.23
8/30/2018	0.04	2.34	-2.26
8/31/2018	0.73	2.84	-1.91
9/1/2018	0.73	2.77	-1.3
9/2/2018	0.33	2.45	-1.61
9/3/2018			
9/4/2018	0.03	2.35	-2.12
9/5/2018	0.29	2.73	-2.01
9/6/2018	0.24	2.88	-2.44
9/7/2018	0.4	3.35	-2.47
9/8/2018	1.3	4.19	-1.93
9/9/2018	2.06	5.04	-1.11
9/10/2018	2.19	4.39	-0.46
9/11/2018	1.07	3.51	-1.86
9/12/2018	0.64	3.03	-2
9/13/2018	0.87	3.12	-1.72
9/14/2018	1.02	3.22	-1.13
9/15/2018	0.77	2.8	-1.14
9/16/2018	0.44	2.42	-1.42
9/17/2018	0.5	2.45	-1.16
9/18/2018	0.33	2.18	-1.36
9/19/2018	0.94	2.96	-0.91
9/20/2018	1.38	3.06	-0.71
9/21/2018	0.84	2.71	-1
9/22/2018	0.33	2.74	-1.73
9/23/2018	0.72	3.03	-1.67
9/24/2018	1.28	3.55	-1.16
9/25/2018	1.38	3.52	-1.12
9/26/2018	0.67	2.88	-1.7
9/27/2018	0.62	2.86	-2.1
9/28/2018	0.82	2.88	-1.58
9/29/2018	0.36	2.59	-1.89
9/30/2018	0.37	2.73	-1.73
10/1/2018	0.2	2.5	-1.81
10/2/2018	0.18	2.61	-1.85
10/3/2018	0.4	2.75	-1.68
10/4/2018			
10/5/2018	0.97	3.55	-1.34
10/6/2018	0.91	3.19	-1.62
10/7/2018	0.47	2.94	-2.39

10/8/2018	0.65	3.32	-2.47
10/9/2018	0.59	3.12	-2.32
10/10/2018	0.26	2.92	-2.52
10/11/2018	0.68	3.28	-2.21
10/12/2018	1.31	3.78	-1.23
10/13/2018	0.7	3.2	-1.56
10/14/2018	0.35	2.66	-1.61
10/15/2018	0.01	2.06	-1.62
10/16/2018	-0.26	2.03	-2.11
10/17/2018	-0.6	1.3	-2.41
10/18/2018	-0.66	1.08	-2.44
10/19/2018	-0.4	1.35	-2.69
10/20/2018	-0.46	2	-2.38
10/21/2018	0.01	2.18	-2
10/22/2018	0.08	2.23	-2.24
10/23/2018	-0.06	2.23	-2.69
10/24/2018	-0.03	2.24	-2.62
10/25/2018	0.09	2.76	-2.57
10/26/2018	0.3	2.83	-2.43
10/27/2018	2.1	5.27	-0.51
10/28/2018	0.39	2.86	-2.18
10/29/2018	-0.28	2.11	-2.6
10/30/2018	-0.23	2.28	-2.44
10/31/2018	0.1	2.63	-2.12
11/1/2018	-0.03	2.37	-2.31
11/2/2018	0.06	2.3	-2.06
11/3/2018			
11/4/2018	-0.74	1.8	-3.4
11/5/2018	0.75	3.16	-1.61
11/6/2018	0.71	3.33	-1.94
11/7/2018	-0.08	2.73	-2.8
11/8/2018	-0.13	2.62	-3.04
11/9/2018	0.72	3.38	-2.24
11/10/2018	-0.25	2.7	-3
11/11/2018	-0.79	1.93	-3.16
11/12/2018	-0.43	1.98	-2.27
11/13/2018	-0.06	1.72	-1.82
11/14/2018	-0.82	1	-2.54
11/15/2018	0.43	1.81	-1.9
11/16/2018	0.75	3.36	-1.64
11/17/2018	-0.53	1.44	-2.28
11/18/2018	-0.1	1.98	-1.94
11/19/2018	0.42	2.26	-1.66
11/20/2018	0.36	2.66	-2.05
11/21/2018	-0.06	2.63	-2.53
11/22/2018	-0.4	2.44	-2.97
11/23/2018	0.1	2.97	-2.8
11/24/2018	0.57	3.79	-2.35
11/25/2018	0.89	3.91	-2.41
11/26/2018	1.27	4.06	-1.92
11/27/2018	0.3	3.12	-2.27
11/28/2018	-0.58	2.08	-2.87
11/29/2018	-0.4	2.17	-2.79
11/30/2018	0.54	2.7	-1.75
12/1/2018	0.76	2.63	-1.5
12/2/2018	0.9	2.95	-1.65
12/3/2018	0.43	2.83	-2.52
12/4/2018	0.04	2.32	-2.38
12/5/2018	0.57	3.19	-2.31
12/6/2018	0.03	2.99	-2.66
12/7/2018	-0.49	2.24	-3.15
12/8/2018	-0.19	2.69	-2.65

12/9/2018	-0.02	2.64	-2.43
12/10/2018			
12/11/2018	0.29	2.57	-1.51
12/12/2018	-0.07	2.25	-1.81
12/13/2018	0.16	2.23	-1.51
12/14/2018			
12/15/2018	0.2	1.69	-1.35
12/16/2018	1.66	3.17	-0.48
12/17/2018	0.66	2.74	-2.19
12/18/2018	-0.42	1.72	-2.64
12/19/2018	-0.14	2.03	-2.46
12/20/2018	0.16	2.43	-2.26
12/21/2018	1.07	3.55	-1.7
12/22/2018	0	3.09	-3.32
12/23/2018	-0.6	2.5	-3.87
12/24/2018	-0.08	3.28	-3.02
12/25/2018	-0.26	2.95	-3.24
12/26/2018			
12/27/2018	-0.35	2.39	-2.89
12/28/2018	0.08	2.57	-2.52
12/29/2018	-0.31	1.96	-3.07
12/30/2018	-0.14	1.88	-2.19
12/31/2018	0.34	2.46	-1.83
1/1/2019	0.06	2.58	-2.67
1/2/2019	-0.03	1.99	-2.14
1/3/2019	0.25	2.54	-2.18
1/4/2019	0.31	2.65	-2.19
1/5/2019	0.58	3.35	-2.08
1/6/2019	0.28	3.15	-2.41
1/7/2019	0	2.54	-2.36
1/8/2019	0.53	3	-1.58
1/9/2019	-0.23	2.46	-2.62
1/10/2019	-0.88	1.23	-2.84
1/11/2019	-0.24	1.94	-1.98
1/12/2019	-0.41	1.53	-2.26
1/13/2019	0.23	1.92	-1.9
1/14/2019	0.88	2.5	-1.15
1/15/2019	0.39	2.3	-1.72
1/16/2019	-0.06	2.31	-2.58
1/17/2019	-0.16	1.93	-2.17
1/18/2019	0.36	2.91	-2.54
1/19/2019	0.5	3.01	-2.17
1/20/2019	0.84	4.12	-2.23
1/21/2019	-1.22	2.34	-4.72
1/22/2019	-1.34	1.95	-4.98
1/23/2019	-0.49	2.73	-3.64
1/24/2019	-0.26	3.17	-3.71
1/25/2019	-0.82	2.08	-3.76
1/26/2019	-0.52	1.9	-3
1/27/2019	-0.04	2.33	-2.43
1/28/2019	0.15	2.11	-1.88
1/29/2019	0.54	2.5	-1.62
1/30/2019			
1/31/2019	-1.29	1.05	-3.41
2/1/2019	-0.96	1.19	-3
2/2/2019	-0.66	1.96	-2.78
2/3/2019	-0.9	1.36	-3.32
2/4/2019	0.01	2.49	-2.45
2/5/2019	0.04	2.63	-2.21
2/6/2019	0.06	2.55	-2.24
2/7/2019	0.37	2.68	-1.98
2/8/2019	-0.02	2.51	-2.41

2/9/2019	-1.58	0.54	-3.6
2/10/2019	-1.2	0.89	-3.09
2/11/2019	-0.75	1.02	-2.73
2/12/2019	0.59	2.14	-1.05
2/13/2019	0.15	2.77	-2.38
2/14/2019	-1	1.16	-2.83
2/15/2019	-0.06	1.99	-1.98
2/16/2019	0.41	2.89	-2.2
2/17/2019	0.45	3.14	-2.12
2/18/2019	0.27	3.55	-2.54
2/19/2019	-0.26	2.89	-3.46
2/20/2019	-0.16	2.75	-3.69
2/21/2019	0.02	2.94	-3.08
2/22/2019			
2/23/2019	0.03	2.72	-2.83
2/24/2019	0.58	2.72	-1.65
2/25/2019	-1.65	-0.51	-4.21
2/26/2019	-1.85	0.05	-4.11
2/27/2019	-0.5	1.43	-2.19
2/28/2019	0.24	2.08	-1.48
3/1/2019	0.57	2.29	-1.19
3/2/2019	0.93	3.03	-1.51
3/3/2019	0.73	2.5	-1.32
3/4/2019	0.96	3.44	-1.01
3/5/2019	0.2	2.5	-2.19
3/6/2019	-0.49	2.07	-2.94
3/7/2019	-0.48	2.05	-2.9
3/8/2019	-0.35	1.97	-2.78
3/9/2019	-0.25	2.06	-2.61
3/10/2019	0.51	2.79	-1.88
3/11/2019	-0.05	1.88	-2.47
3/12/2019	-0.5	1.18	-2.48
3/13/2019	-0.27	1.85	-1.99
3/14/2019	-0.17	2.02	-1.93
3/15/2019	-0.45	1.93	-2.42
3/16/2019	-0.7	1.61	-3
3/17/2019	-0.58	1.88	-3.07
3/18/2019	-0.1	2.6	-2.62
3/19/2019	-0.26	2.45	-3.21
3/20/2019	-0.13	2.6	-3.51
3/21/2019	0.74	4.05	-3.14
3/22/2019	0.62	2.96	-2.48
3/23/2019	-1.33	1.59	-4.41
3/24/2019	-0.84	2.18	-3.93
3/25/2019	-0.36	1.55	-3
3/26/2019	0.4	2.59	-1.58
3/27/2019	0	2.28	-1.69
3/28/2019	-0.27	1.9	-1.84
3/29/2019	-0.45	1.6	-1.96
3/30/2019	-0.21	1.7	-1.95
3/31/2019	-0.14	2.01	-2.44
4/1/2019	-0.78	1.25	-2.54
4/2/2019	-0.15	2.04	-2.76
4/3/2019	0.15	2.47	-2.04
4/4/2019	-0.74	1.69	-2.93
4/5/2019	-0.6	2.12	-3.72
4/6/2019	-0.24	2.26	-2.61
4/7/2019	-0.31	2.32	-2.7
4/8/2019	-0.22	2.46	-2.58
4/9/2019	0.6	3.12	-1.96
4/10/2019	0.48	2.56	-1.7
4/11/2019	0.27	2.56	-1.51

4/12/2019	-0.04	2.44	-1.88
4/13/2019	-0.25	2.26	-2.24
4/14/2019	-0.02	2.17	-2.21
4/15/2019	-0.13	2.76	-2.98
4/16/2019	-0.75	2.05	-3.66
4/17/2019	-0.03	2.66	-3.58
4/18/2019	0.52	3.12	-2.68
4/19/2019	0.26	3.06	-2.82
4/20/2019	0.22	3.02	-2.7
4/21/2019	0.13	2.92	-2.61
4/22/2019	0.22	2.96	-2.36
4/23/2019	0.07	2.59	-2.3
4/24/2019	0.08	1.46	-2.13
4/25/2019	0.22	2.46	-1.9
4/26/2019	0.57	2.52	-1.2
4/27/2019	-0.16	2.14	-1.75
4/28/2019	0.12	1.6	-1.49
4/29/2019	-0.04	1.79	-1.98
4/30/2019	-0.12	1.77	-2.26
5/1/2019	-0.07	1.83	-2.26
5/2/2019	-0.05	2.17	-2.34
5/3/2019	0.46	2.67	-1.87
5/4/2019	0.37	2.9	-2.09
5/5/2019	0.96	3.74	-1.91
5/6/2019	1.02	3.17	-1.78
5/7/2019	0.34	2.85	-2.08
5/8/2019	0.11	2.91	-2.31
5/9/2019	0.22	2.91	-2.16
5/10/2019	0.08	1.7	-2.09
5/11/2019	-0.13	2.48	-2.47
5/12/2019	1.43	3.31	-1.04
5/13/2019	1.65	3.78	-0.62
5/14/2019	1.16	3.46	-1.59
5/15/2019	0.89	3.14	-1.6
5/16/2019	0.59	3.05	-2.18
5/17/2019	0.49	3.08	-2.37
5/18/2019	0.4	3.13	-2.39
5/19/2019	0.22	3.04	-2.48
5/20/2019	-0.02	2.64	-2.67
5/21/2019	-0.1	2.61	-2.67
5/22/2019	-0.18	2.38	-2.49
5/23/2019	-0.1	1.34	-2.14
5/24/2019	-0.23	2.36	-2.2
5/25/2019	0.41	2.29	-1.48
5/26/2019	0.06	2.3	-1.86
5/27/2019	0.25	1.93	-1.7
5/28/2019	0.43	2.07	-1.29
5/29/2019	0.5	2.21	-1.48
5/30/2019	0.79	2.85	-1.4
5/31/2019	0.51	2.69	-1.8
6/1/2019	0.62	3.04	-1.81
6/2/2019	0.67	3.2	-1.85
6/3/2019	0.41	3	-2.21
6/4/2019	0.12	3.03	-2.52
6/5/2019	-0.18	2.66	-2.73
6/6/2019	-0.09	3.1	-2.75
6/7/2019	0.26	3.04	-2.24
6/8/2019	0.32	2.1	-2.2
6/9/2019	0.54	3.02	-1.96
6/10/2019			
6/11/2019	0.38	2.67	-2.4
6/12/2019	0.42	2.73	-2.1

6/13/2019	1.05	3.44	-1.58
6/14/2019	0.08	2.48	-2.88
6/15/2019	-0.05	2.61	-2.66
6/16/2019	-0.26	2.66	-2.78
6/17/2019	0.05	2.98	-2.66
6/18/2019	0.25	2.95	-2.12
6/19/2019	0.35	3.04	-2.06
6/20/2019	0.52	2.85	-1.76
6/21/2019	0.46	2.88	-1.45
6/22/2019	0.28	2.3	-1.71
6/23/2019	0.12	1.58	-1.72
6/24/2019	0.09	1.93	-1.86
6/25/2019	0.41	2.22	-1.42
6/26/2019	0.32	2.06	-1.57
6/27/2019	0.21	2.08	-1.76
6/28/2019	0.19	2.21	-1.8
6/29/2019	0.18	2.54	-2.08
6/30/2019	0.33	3.08	-2.2
7/1/2019	0.57	3.2	-2.01
7/2/2019	0.32	3.27	-2.36
7/3/2019	0.38	3.46	-2.35
7/4/2019	0.42	3.46	-2.4
7/5/2019	0.27	3.18	-2.44
7/6/2019	0.08	2.84	-2.58
7/7/2019	0.38	2.4	-2.43
7/8/2019	0.72	3.22	-1.85
7/9/2019	0.3	2.77	-2.12
7/10/2019	0.07	2.38	-2.42
7/11/2019	0.34	2.67	-2.11
7/12/2019			
7/13/2019	0.38	2.86	-2.03
7/14/2019	0.19	2.8	-2.25
7/15/2019	0.22	2.84	-2.11
7/16/2019	0.06	2.8	-2.33
7/17/2019	0.06	2.69	-2.25
7/18/2019	0.08	2.77	-2.23
7/19/2019			
7/20/2019	0.04	2.46	-2.17
7/21/2019	0.14	2.42	-1.98
7/22/2019	0.26	1.83	-1.68
7/23/2019	0.22	2.15	-1.72
7/24/2019	0.63	2.4	-1.31
7/25/2019	0.31	2.11	-1.54
7/26/2019	0.15	2.02	-1.72
7/27/2019	0.18	2.29	-1.89
7/28/2019	0.04	2.4	-2.21
7/29/2019	0.05	2.76	-2.43
7/30/2019	0.18	3.07	-2.57
7/31/2019	0.17	3.32	-2.75
8/1/2019	0.29	3.45	-2.67
8/2/2019	0.28	3.42	-2.73
8/3/2019	0.36	3.34	-2.53
8/4/2019	0.34	3.03	-2.5
8/5/2019	0.44	2.75	-2.37
8/6/2019	0.52	2.91	-2.02
8/7/2019	0.39	2.67	-1.99
8/8/2019	0.58	2.84	-1.74
8/9/2019	0.48	2.77	-1.7
8/10/2019	0.36	2.59	-1.82
8/11/2019	0.26	2.52	-1.86
8/12/2019	0.04	2.56	-2.18
8/13/2019	-0.08	2.56	-2.34

8/14/2019	0.41	3	-1.91
8/15/2019	0.72	3.2	-1.49
8/16/2019	0.65	2.98	-1.58
8/17/2019	0.53	2.78	-1.62
8/18/2019	0.39	2.52	-1.65
8/19/2019	0.31	2.22	-1.64
8/20/2019	0.26	2.17	-1.7
8/21/2019	0.13	1.97	-1.6
8/22/2019			
8/23/2019	0.21	2.28	-1.77
8/24/2019	0.59	2.73	-1.3
8/25/2019	1.4	3.52	-0.66
8/26/2019	1.58	3.5	-0.79
8/27/2019	1.11	3.46	-1.34
8/28/2019	0.9	3.54	-1.8
8/29/2019	0.67	3.53	-2.32
8/30/2019	0.35	3.24	-2.81
8/31/2019	0.21	3.3	-2.92
9/1/2019	0.53	3.23	-2.5
9/2/2019	0.58	3.04	-2.16
9/3/2019	0.57	3.08	-2.22
9/4/2019	0.4	2.88	-2.01
9/5/2019	0.61	2.95	-1.68
9/6/2019	1.63	3.79	-0.52
9/7/2019	1.49	3.25	-0.77
9/8/2019	0.56	2.39	-2.13
9/9/2019	0.16	2.7	-2.05
9/10/2019			
9/11/2019	0.04	2.34	-2.12
9/12/2019	0.33	3.06	-2.2
9/13/2019	1.32	3.22	-0.71
9/14/2019	0.49	2.51	-1.84
9/15/2019	0.24	2.49	-2.04
9/16/2019	0.41	2.45	-1.8
9/17/2019	0.78	2.87	-1.3
9/18/2019	1.25	3.15	-1.04
9/19/2019	1.18	3.09	-0.86
9/20/2019	0.37	2.5	-1.38
9/21/2019	0.01	2.32	-1.95
9/22/2019	0.31	2.5	-1.46
9/23/2019	0.11	2.32	-2.03
9/24/2019	0.24	2.82	-2.02
9/25/2019	0.81	3.27	-1.95
9/26/2019	0.59	3.32	-2.13
9/27/2019	0.64	3.33	-2.47
9/28/2019	0.47	3.16	-2.7
9/29/2019	0.61	3.3	-2.61
9/30/2019	0.85	3.59	-2.22
10/1/2019	0.54	3.35	-2.27
10/2/2019	0.14	2.93	-2.53
10/3/2019	1.39	4.16	-1.14
10/4/2019	0.63	2.83	-1.42
10/5/2019	0.93	3.04	-0.95
10/6/2019	0.34	2.3	-1.65
10/7/2019	0.08	2.01	-1.74
10/8/2019	1.02	3.02	-0.44
10/9/2019	2.07	3.98	0.41
10/10/2019	2.59	4.75	0.31
10/11/2019	3.03	4.76	1.03
10/12/2019	2.07	4.04	-0.24
10/13/2019	0.89	2.8	-1.44
10/14/2019	0.76	2.92	-1.62

10/15/2019	0.58	2.83	-1.81
10/16/2019	0.69	3.04	-1.6
10/17/2019	-0.86	1.7	-3.42
10/18/2019	-0.47	2.17	-3.25
10/19/2019	0.3	2.63	-1.55
10/20/2019	0.75	2.72	-1.55
10/21/2019	1.42	3.49	-0.55
10/22/2019	1.1	3.17	-0.9
10/23/2019	0.62	2.7	-2.05
10/24/2019	0.23	2.68	-2.49
10/25/2019	0.11	2.68	-2.66
10/26/2019	0.44	2.98	-2.68
10/27/2019	1	3.75	-2.1
10/28/2019	0.69	3.51	-2.46
10/29/2019	1.08	4.22	-1.88
10/30/2019	0.7	3.6	-2.08
10/31/2019	0.6	3.31	-1.68
11/1/2019	-0.68	1.96	-3.59
11/2/2019	0.08	2.7	-2.19
11/3/2019	0.38	2.57	-1.45
11/4/2019	0.31	2.26	-1.36
11/5/2019	0.24	2.12	-1.59
11/6/2019	-0.03	1.84	-2.09
11/7/2019	-0.17	1.68	-2.14
11/8/2019	-0.02	1.86	-2.1
11/9/2019	0.36	2.36	-1.48
11/10/2019	0.1	2.31	-2.08
11/11/2019	0.15	2.38	-2.34
11/12/2019	-0.09	2.41	-3.21
11/13/2019	-0.12	2.39	-2.63
11/14/2019	0.05	2.79	-2.33
11/15/2019	-0.07	2.73	-2.36
11/16/2019	0.89	3.47	-2.16
11/17/2019	1.71	3.8	-0.39
11/18/2019	2.09	4.19	0.07
11/19/2019	1.13	3.18	-1.2
11/20/2019	0.26	2.32	-1.98
11/21/2019	0.66	2.74	-1.72
11/22/2019	0.25	2.68	-2.9
11/23/2019	-0.03	2.29	-2.68
11/24/2019	0.27	3.43	-2.74
11/25/2019	-0.13	2.61	-3.17
11/26/2019	0.2	3.37	-2.79
11/27/2019	0.11	3.34	-2.76
11/28/2019	-0.78	2.48	-3.73
11/29/2019	0.81	3.55	-2.12
11/30/2019	0.84	3.24	-1.47
12/1/2019	1.04	3.12	-1.31
12/2/2019	1.77	3.74	-0.07
12/3/2019	1.3	2.86	-0.7
12/4/2019			
12/5/2019	-0.19	1.66	-2.3
12/6/2019	-0.44	1.21	-2.65
12/7/2019	-0.37	1.27	-2.23
12/8/2019	-0.1	2.15	-2.37
12/9/2019	-0.26	2.12	-2.54
12/10/2019	-0.63	1.88	-2.82
12/11/2019	-0.66	2.21	-3.39
12/12/2019	-0.55	2.34	-3.66
12/13/2019	0.19	2.97	-2.54
12/14/2019	0.79	3.8	-1.55
12/15/2019	-1.04	2.09	-3.84

12/16/2019	-1.06	1.7	-3.92
12/17/2019	-0.05	2.52	-2.44
12/18/2019	-0.32	2.35	-3.18
12/19/2019	-1.23	1.02	-3.8
12/20/2019	-0.91	1.16	-3
12/21/2019	-0.1	2.17	-2.54
12/22/2019	-0.11	2.57	-3.05
12/23/2019	-0.34	2.28	-2.85
12/24/2019	0.24	2.72	-2.97
12/25/2019	0.45	3.25	-2.24
12/26/2019	0.35	3.19	-2.33
12/27/2019	0.29	3.1	-2.21
12/28/2019	-0.06	2.74	-2.5
12/29/2019	0.1	2.57	-2.13
12/30/2019	1.15	3.26	-1.2
12/31/2019	1.45	3.45	-1
1/1/2020	-0.11	1.92	-1.98
1/2/2020	-0.32	1.43	-2.08
1/3/2020	-0.01	1.49	-1.57
1/4/2020	0.47	2.18	-1.43
1/5/2020	-0.34	1.57	-2.36
1/6/2020	-0.05	1.88	-2.23
1/7/2020	0.08	2.17	-2.26
1/8/2020	-0.45	2.62	-2.57
1/9/2020	-1.06	1.51	-3.85
1/10/2020	-0.54	2.52	-3.28
1/11/2020	-0.48	2.66	-3.53
1/12/2020	-0.99	2.08	-4.08
1/13/2020	-0.14	2.87	-3.41
1/14/2020	0.19	2.97	-2.42
1/15/2020	0	2.63	-2.43
1/16/2020	-0.43	2.27	-3.37
1/17/2020	-0.56	1.56	-2.88
1/18/2020	0.48	2.67	-1.7
1/19/2020	-0.22	2.35	-2.73
1/20/2020	0.11	2.43	-2.29
1/21/2020			
1/22/2020	0.15	2.73	-2.25
1/23/2020	-0.1	2.45	-2.57
1/24/2020	0.09	2.72	-2.48
1/25/2020	0.93	3.65	-1.97
1/26/2020	0.3	3.08	-2.14
1/27/2020	-0.21	2.42	-2.48
1/28/2020	0.01	2.33	-2.21
1/29/2020	0.33	2.39	-1.51
1/30/2020	0.35	2.26	-1.46
1/31/2020	0.19	2.02	-1.42
2/1/2020	0.37	2.01	-1.22
2/2/2020	0.55	2.24	-1.01
2/3/2020	0.08	2.15	-1.77
2/4/2020	0.13	2.34	-2.01
2/5/2020	0.57	2.51	-1.45
2/6/2020	0.86	3.05	-1.28
2/7/2020	0.15	3.65	-2.66
2/8/2020	-1.48	1.49	-4.52
2/9/2020	-0.47	2.59	-4.1
2/10/2020	-0.33	2.84	-3.51
2/11/2020	-0.07	2.93	-3.34
2/12/2020	-0.19	2.69	-3.1
2/13/2020	-0.08	2.53	-2.55
2/14/2020	-0.64	2.19	-2.81
2/15/2020	-0.32	2.21	-2.42

2/16/2020	-0.72	1.89	-2.75
2/17/2020	-0.31	1.87	-2.19
2/18/2020	0.4	2.45	-1.63
2/19/2020	-0.25	2.43	-2.83
2/20/2020	-0.69	1.65	-2.78
2/21/2020	-0.19	2.2	-2.84
2/22/2020	-0.58	2.12	-2.98
2/23/2020	-0.55	1.85	-3.26
2/24/2020	-0.02	2.42	-2.44
2/25/2020	0.23	2.58	-2.09
2/26/2020	0.49	2.7	-1.89
2/27/2020	-0.34	1.71	-2.92
2/28/2020	-1.54	0.8	-3.63
2/29/2020	-0.78	0.86	-2.69
3/1/2020	-0.45	1.53	-2.04
3/2/2020	-0.26	1.77	-1.84
3/3/2020	0.01	1.76	-1.66
3/4/2020	-0.55	1.58	-2.59
3/5/2020	-0.5	1.58	-2.59
3/6/2020	0.41	2.36	-1.77
3/7/2020	1.43	3.75	-1.32
3/8/2020	0.66	3.58	-2.26
3/9/2020	-0.43	2.47	-3.52
3/10/2020	-0.39	2.5	-3.8
3/11/2020	0	2.93	-3.53
3/12/2020	0.35	3.36	-2.68
3/13/2020	0.43	2.8	-2.41
3/14/2020	-0.49	2.6	-2.94
3/15/2020	-0.5	2.07	-2.62
3/16/2020	0.05	2.11	-2.02
3/17/2020	0.36	2.53	-1.74
3/18/2020	-0.27	1.94	-2.21
3/19/2020	0.1	2.39	-1.98
3/20/2020	-0.02	2.4	-2.27
3/21/2020	-0.35	2.04	-2.52
3/22/2020	0.21	2.24	-2.58
3/23/2020	0.85	2.88	-1.72
3/24/2020	0.31	2.53	-2.08
3/25/2020	1.14	3.3	-1.86
3/26/2020	1.02	2.87	-1.23
3/27/2020	0.68	2.76	-1.6
3/28/2020	0.32	2.76	-1.78
3/29/2020	0.85	2.32	-1.13
3/30/2020	0.65	3.03	-1.24
3/31/2020	1.09	2.64	-0.58
4/1/2020	1.46	3.35	-0.27
4/2/2020	0.77	2.74	-1
4/3/2020	1.26	2.89	-0.84
4/4/2020	2.01	4.22	-0.84
4/5/2020	0.92	3.45	-1.77
4/6/2020	0.48	2.93	-2.49
4/7/2020	0.53	3.28	-2.66
4/8/2020	0.74	3.72	-2.63
4/9/2020	0.72	3.66	-2.45
4/10/2020	-0.68	2.12	-4.22
4/11/2020	-0.73	2.67	-3.76
4/12/2020	-0.16	1.76	-2.67
4/13/2020	-0.04	2.54	-2.28
4/14/2020	-0.5	1.96	-2.52
4/15/2020	-0.11	1.97	-1.84
4/16/2020	-0.4	2.11	-2.39
4/17/2020	-0.47	1.79	-2.64

4/18/2020	0.04	1.93	-1.97
4/19/2020	0.05	2.12	-2.32
4/20/2020	0.59	2.66	-1.77
4/21/2020	0.38	2.45	-1.86
4/22/2020	-0.22	1.9	-2.68
4/23/2020	-0.21	2.57	-2.97
4/24/2020	0.54	3.11	-1.76
4/25/2020	0.37	2.78	-1.88
4/26/2020	0.62	3.18	-1.69
4/27/2020	0.45	2.59	-1.71
4/28/2020	0.42	2.54	-1.46
4/29/2020	0.47	2.54	-1.45
4/30/2020	0.95	2.81	-0.92
5/1/2020	0.72	2.88	-1.21
5/2/2020	0.18	2.47	-2.07
5/3/2020	0.12	2.46	-2.33
5/4/2020	0.47	2.87	-2.12
5/5/2020	0.32	2.97	-2.8
5/6/2020	0.75	3.89	-2.7
5/7/2020	0.55	3.5	-2.66
5/8/2020	0.41	3.62	-2.73
5/9/2020	-0.62	1.82	-3.35
5/10/2020	-1.54	1.54	-4.26
5/11/2020	-0.82	2.4	-3.52
5/12/2020	-0.55	0.97	-2.58
5/13/2020	-0.68	1.87	-2.6
5/14/2020	-0.74	1.35	-2.76
5/15/2020	-0.55	1.54	-2.57
5/16/2020	-0.48	1.22	-2.54
5/17/2020	0.17	1.92	-1.71
5/18/2020	0.36	2.22	-1.76
5/19/2020	1.26	3.25	-0.88
5/20/2020	0.9	2.66	-1.22
5/21/2020	0.13	2.33	-2.11
5/22/2020	-0.22	2.31	-2.45
5/23/2020	-0.01	2.85	-2.44
5/24/2020	0.83	3.2	-1.36
5/25/2020	0.37	2.81	-1.82
5/26/2020	0.07	2.8	-2.17
5/27/2020	0.04	2.63	-2.02
5/28/2020	0.06	1.56	-1.94
5/29/2020	-0.11	2.51	-2.24
5/30/2020	-0.01	2.31	-2.42
5/31/2020	0.16	2.44	-2.24
6/1/2020	0.26	2.47	-2.51
6/2/2020	0.21	2.83	-2.59
6/3/2020	0.56	3.3	-2.38
6/4/2020	0.46	3.39	-2.62
6/5/2020	0.29	3.25	-2.63
6/6/2020	0.21	3.36	-2.68
6/7/2020	0.22	3.27	-2.47
6/8/2020	0.2	2.86	-2.25
6/9/2020	-0.02	2.65	-2.42
6/10/2020	0.09	2.4	-2.12
6/11/2020	-0.21	2.4	-2.22
6/12/2020	-0.15	1.98	-2.27
6/13/2020	0.12	1.96	-1.87
6/14/2020	0.34	1.99	-1.37
6/15/2020	0.69	2.4	-1.18
6/16/2020	0.53	2.36	-1.37
6/17/2020	0.53	2.47	-1.45
6/18/2020	0.2	2.42	-1.97

6/19/2020	0.01	2.46	-2.29
6/20/2020	0	2.71	-2.32
6/21/2020	0.19	2.98	-2.21
6/22/2020	0.18	2.99	-2.16
6/23/2020	0.29	3.12	-2.09
6/24/2020	0.23	3.05	-2.06
6/25/2020	0.23	2.98	-2.17
6/26/2020	0.24	2.98	-2.04
6/27/2020	0.25	2.68	-2.18
6/28/2020	0.51	2.62	-1.87
6/29/2020	0.67	2.8	-1.75
6/30/2020	0.64	3.01	-1.93
7/1/2020	0.52	2.98	-2.23
7/2/2020	0.43	3.17	-2.36
7/3/2020	0.48	3.44	-2.4
7/4/2020	0.8	3.67	-1.91
7/5/2020	0.48	3.28	-2.18
7/6/2020	0.29	3.22	-2.23
7/7/2020	0.51	3.14	-2
7/8/2020	0.45	2.95	-1.81
7/9/2020	0.5	2.86	-1.68
7/10/2020	1.05	3.23	-1.17
7/11/2020	0.37	2.42	-1.43
7/12/2020	0.16	2.06	-1.67
7/13/2020	0.23	1.94	-1.63
7/14/2020	0.24	2.01	-1.57
7/15/2020	0.47	2.47	-1.46
7/16/2020	0.51	2.54	-1.3
7/17/2020	0.24	2.43	-1.81
7/18/2020	0.24	2.73	-1.97
7/19/2020	0.32	2.96	-2.02
7/20/2020	0.24	3.11	-2.37
7/21/2020	0.32	3.34	-2.3
7/22/2020	0.32	3.08	-2.37
7/23/2020	0.28	2.98	-2.36
7/24/2020	0.27	2.98	-2.42
7/25/2020	0.26	2.44	-2.19
7/26/2020	-0.14	2.49	-2.56
7/27/2020			
7/28/2020	0.15	2.61	-2.26
7/29/2020	0.23	2.69	-2.15
7/30/2020			
7/31/2020	0.59	3.36	-1.86
8/1/2020	0.42	3.16	-2.19
8/2/2020	0.26	2.92	-2.18
8/3/2020	-0.04	2.77	-2.57
8/4/2020	0.22	3.11	-3.06
8/5/2020	0	2.86	-2.52
8/6/2020	0.37	2.79	-1.9
8/7/2020	0.41	2.66	-1.67
8/8/2020	0.28	2.21	-1.79
8/9/2020	-0.01	1.66	-1.86
8/10/2020	-0.18	1.7	-2.06
8/11/2020	-0.07	1.78	-1.79
8/12/2020	-0.04	1.84	-1.7
8/13/2020	0.11	2.05	-1.66
8/14/2020	0.59	2.69	-1.41
8/15/2020	1.06	3.32	-1.04
8/16/2020	1.79	4.1	-0.22
8/17/2020	1.16	3.36	-1.44
8/18/2020	0.69	3.55	-1.99
8/19/2020	0.62	3.56	-2.33

8/20/2020	0.56	3.37	-2.37
8/21/2020	0.28	2.82	-2.62
8/22/2020	0.07	2.7	-2.78
8/23/2020	0.15	2.63	-2.52
8/24/2020	0.09	2.56	-2.44
8/25/2020	0.07	2.62	-2.34
8/26/2020	0.28	2.68	-1.77
8/27/2020	0.17	2.53	-2.06
8/28/2020	0.19	2.64	-2.11
8/29/2020	0.48	2.93	-1.78
8/30/2020	0.28	2.82	-2.03
8/31/2020	0.38	2.91	-2.17
9/1/2020	0.58	3.25	-2.04
9/2/2020	0.68	2.94	-1.8
9/3/2020	0.38	2.81	-2.03
9/4/2020	0.41	2.59	-1.9
9/5/2020	0.4	2.54	-1.85
9/6/2020	0.07	2.16	-1.92
9/7/2020	0.21	2.23	-1.68
9/8/2020	0.29	2.25	-1.44
9/9/2020	0.33	2.24	-1.41
9/10/2020	0.2	2.1	-1.48
9/11/2020	0.43	2.42	-1.5
9/12/2020	1.22	3.15	-0.47
9/13/2020			
9/14/2020	0.44	2.99	-1.89
9/15/2020	0.85	3.37	-1.82
9/16/2020	0.52	3.15	-2.49
9/17/2020	0.33	3.16	-2.82
9/18/2020	0.77	3.71	-2.5
9/19/2020	1.22	3.98	-1.64
9/20/2020	1.01	3.6	-1.88
9/21/2020	1.34	3.93	-1.38
9/22/2020	1.15	3.68	-1.23
9/23/2020	1.22	3.82	-1.03
9/24/2020	0.2	2.4	-1.8
9/25/2020	0.38	2.55	-1.72
9/26/2020	0.46	2.68	-1.51
9/27/2020	0.52	2.86	-1.58
9/28/2020	0.47	2.76	-1.74
9/29/2020	0.65	3.08	-1.86
9/30/2020	0.2	2.46	-2.34
10/1/2020	0.1	2.57	-2.49
10/2/2020	0.44	2.5	-1.96
10/3/2020	0.15	2.34	-2.08
10/4/2020	0.22	2.3	-2.02
10/5/2020			
10/6/2020	0.27	2.45	-1.49
10/7/2020	-0.12	2.12	-1.82
10/8/2020	-0.54	1.55	-2.12
10/9/2020	-0.28	1.76	-1.88
10/10/2020	-0.51	1.59	-2.35
10/11/2020	-0.06	2.2	-1.97
10/12/2020	1.94	4.2	-0.1
10/13/2020	1.29	3.25	-1.59
10/14/2020	0.52	2.85	-2.16
10/15/2020	0.44	2.93	-2.57
10/16/2020	0.64	3.36	-2.65
10/17/2020	0.62	3.54	-2.27
10/18/2020	0.41	3.41	-2.95
10/19/2020	0.58	3.6	-2.19
10/20/2020	0.38	3.26	-2.19

10/21/2020	0.21	2.84	-1.99
10/22/2020	0.23	2.68	-1.81
10/23/2020	0.4	2.67	-1.55
10/24/2020	0.55	2.6	-1.56
10/25/2020	0.87	2.78	-0.87
10/26/2020	1.12	2.87	-1.45
10/27/2020	0.36	2.36	-1.94
10/28/2020	0.19	2.35	-2.1
10/29/2020	0.89	3.14	-1.84
10/30/2020	2.12	4.52	-0.38
10/31/2020	0.94	3.19	-1.39
11/1/2020	0.37	2.67	-1.75
11/2/2020	-0.94	1.55	-3.45
11/3/2020	-1.45	0.69	-3.5
11/4/2020	-0.13	2.37	-2.5
11/5/2020	-0.29	2.22	-2.12
11/6/2020	-0.37	2	-2.19
11/7/2020	-0.41	1.82	-2.13
11/8/2020	-0.07	2.1	-1.85
11/9/2020	0.11	2.28	-2.07
11/10/2020	-0.13	2	-2.43
11/11/2020	0.12	2.31	-2.52
11/12/2020	0.42	2.95	-2.48

Rutgers University: New Jersey's Rising Seas and Changing Coastal Storms

NEW JERSEY'S RISING SEAS AND CHANGING COASTAL STORMS:
Report of the 2019 Science and Technical Advisory Panel

November 2019

RUTGERS
THE STATE UNIVERSITY
OF NEW JERSEY

New Jersey's Rising Seas and Changing Coastal Storms: Report of the 2019 Science and Technical Advisory Panel

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Contents

Executive Summary

The first New Jersey Science and Technical Advisory Panel (STAP) on Sea-Level Rise and Coastal Storms was convened by Rutgers University on behalf of the NJ Climate Change Alliance in 2015, culminating in a 2016 report that identified planning options for practitioners to enhance the resilience of New Jersey's people, places, and assets to sea-level rise, coastal storms, and the resulting flood risk (Kopp et al., 2016). An innovative approach used to inform the 2016 report was the complementary convening of a panel of practitioners to offer insights on the application of the STAP science to state and local planning and decision-making. Following the same process, the same team at Rutgers University was engaged by the State of New Jersey Department of Environmental Protection to update the 2016 report based on the most current scientific information. Similar to the inaugural work, the 2019 STAP was charged with identifying and evaluating the most current science on sea-level rise projections and changing coastal storms, considering the implications for the practices and policies of local and regional stakeholders, and providing practical options for stakeholders to incorporate science into risk-based decision processes.

The 2019 STAP process recommended the following key updates to the 2016 STAP report:

1. Making available historical sea-level rise (SLR) information for New Jersey to provide a frame of reference for future projections;
2. Updating information on ice sheet dynamics;
3. Expanding consideration of tidal flooding; and
4. Expanding consideration of storm tide-related flooding.

This report integrates the 2019 key STAP updates and should be considered the most recent reference in this series.

Summary of STAP Outcomes

Sea-level rise:

Table ES-1: New Jersey Sea-Level Rise above the year 2000 (1991-2009 average) baseline (ft)*

		2030	2050	2070			2100			2150		
				Emissions								
	Chance SLR Exceeds			Low	Mod.	High	Low	Mod.	High	Low	Mod.	High
Low End	> 95% chance	0.3	0.7	0.9	1	1.1	1.0	1.3	1.5	1.3	2.1	2.9
Likely Range	> 83% chance	0.5	0.9	1.3	1.4	1.5	1.7	2.0	2.3	2.4	3.1	3.8
	~50 % chance	0.8	1.4	1.9	2.2	2.4	2.8	3.3	3.9	4.2	5.2	6.2
	<17% chance	1.1	2.1	2.7	3.1	3.5	3.9	5.1	6.3	6.3	8.3	10.3
High End	< 5% chance	1.3	2.6	3.2	3.8	4.4	5.0	6.9	8.8	8.0	13.8	19.6

**2010 (2001-2019 average) Observed = 0.2 ft*

Notes: All values are 19-year means of sea-level measured with respect to a 1991-2009 baseline centered on the year indicated in the top row of the table. Projections are based on Kopp et al. (2014), Rasmussen et al. (2018), and Bamber et al. (2019). Near-term projections (through 2050) exhibit only minor sensitivity to different emissions scenarios (<0.1 feet). Low and high emissions scenarios correspond to global-mean warming by 2100 of 2°C and 5°C above early Industrial (1850-1900) levels, respectively, or equivalently, about 1°C and 4°C above the current global-mean temperature. Moderate (Mod.) emissions are interpolated as the midpoint between the high- and low-emissions scenarios and approximately correspond to the warming expected under current global policies. Rows correspond to different projection probabilities. There is at least a 95% chance of SLR exceeding the values in the 'Low End' row, while there is less than a 5% chance of exceeding the values in the 'High End' row. There is at least a 66% chance that SLR will fall within the values in the 'Likely Range'. Note that alternative methods may yield higher or lower estimates of the chance of low-end and high-end outcomes.

The STAP has reached the following conclusions on SLR:

1. From 1911 (the start of the Atlantic City tide-gauge record) to 2019, sea-level rose 17.6 inches (1.5 feet) along the New Jersey coast, compared to a 7.6-inch (0.6 feet) total change in the global mean sea-level.
2. Over the last forty years, from 1979-2019, sea-level rose 8.2 inches (0.7 feet) along the New Jersey coast, compared to a 4.3-inch (0.4 feet) change in global mean sea-level.
3. New Jersey coastal areas are likely (at least a 66% chance) to experience SLR of 0.5 to 1.1 ft between 2000 and 2030, and 0.9 to 2.1 ft between 2000 and 2050. It is extremely unlikely (less than 5% chance) that SLR will exceed 1.3 ft by 2030 and 2.6 ft by 2050.
4. While near-term SLR projections through 2050 exhibit only minor sensitivity to different emissions scenarios (<0.1 feet), SLR projections after 2050 increasingly depend upon the pathway of future global greenhouse gas emissions.
    a. Under a high-emissions scenario, consistent with the strong, continued growth of fossil fuel consumption, coastal areas of New Jersey are likely (at least a 66% chance) to see SLR of 1.5 to 3.5 ft between 2000 and 2070, and 2.3 to 6.3 ft between 2000 and 2100. It is extremely unlikely (less than a 5% chance) that SLR will exceed 4.4 ft by 2070 and 8.8 ft by 2100.
    b. Under a moderate-emissions scenario, roughly consistent with current global policies, coastal areas of New Jersey are likely (at least a 66% chance) to see SLR of 1.4 to 3.1 ft between 2000 and 2070, and 2.0 to 5.2 ft between 2000 and 2100. It is extremely unlikely (less than a 5% chance) that SLR will exceed 3.8 ft by 2070 and 6.9 ft by 2100.
    c. Under a low-emissions scenario, consistent with the global goal of limiting warming to 2°C above early industrial (1850-1900) levels, coastal areas of New Jersey are likely (at least a 66% chance) to see SLR of 1.3 to 2.7 ft between 2000 and 2070, and 1.7 to 4.0 ft between 2000 and 2100. It is extremely unlikely (less than a 5% chance) that SLR will exceed 3.2 ft by 2070 and 5.0 ft by 2100.

In addition to the magnitude of SLR, the STAP also evaluated local rates of SLR in response to practitioner interest. SLR rates are especially important in determining whether ecological systems and habitats, such as marshes, will be able to adapt to rising seas. Left unconstrained by nearby development, these ecological systems — important for services, such as flood control — could collapse, or they could adapt to SLR by migrating inland or retaining sediment. Additionally, the rate of SLR is also an important consideration in the design and management of nature-based solutions for coastal protection (United States Army Corps of Engineers, 2015), which, depending on site-specific conditions, may reduce flood exposure as sea levels rise.

The STAP has reached the following conclusions on rates of SLR:

1. Over the last forty years, from 1979-2019, sea-level rose at an average rate of 0.2 in/yr along the New Jersey coast, compared to an average rate of 0.1 in/yr in global mean sea-level.
2. New Jersey coastal areas are *likely* (at least a 66% chance) to experience average SLR rates of 0.2 to 0.5 in/yr over 2010–2050. It is *extremely unlikely* (less than 5% chance) that average SLR rates will exceed 0.7 in/yr over 2010–2050.
3. Rates of SLR are increasingly dependent upon global greenhouse gas emissions later in the 21st century.
    a. Under a high-emissions scenario, coastal areas of New Jersey are *likely* (at least a 66% chance) to see SLR rates of 0.3 to 1.1 in/yr over 2060-2100. It is *extremely unlikely* (less than a 5% chance) that SLR rates will exceed 1.7 in/yr over 2060-2100.

b. Under a moderate-emissions scenario, coastal areas of New Jersey are *likely* (at least a 66% chance) to see SLR rates of 0.2 to 0.8 in/yr over 2060-2100. It is *extremely unlikely* (less than a 5% chance) that SLR rates will exceed 1.3 in/yr over 2060-2100.

c. Under a low-emissions scenario (2.0°C), coastal areas of New Jersey are *likely* (at least a 66% chance) to see SLR rates of 0.2 to 0.6 in/yr over 2060-2100. It is *extremely unlikely* (less than a 5% chance) that SLR rates will exceed 0.8 in/yr over 2060-2100.

The STAP *likely* ranges of SLR estimates are consistent with recent SLR guidance proposed by an interagency working group that included the National Oceanic and Atmospheric Administration (NOAA), the United States Army Corps of Engineers (USACE), the United States Geological Survey (USGS), and other agency and academic partners (Sweet et al., 2017).

Coastal Storms

Higher sea-levels will increase the baseline for flooding from high tides and coastal storms (i.e., tropical cyclones and extratropical cyclones) and, therefore, the impacts of coastal storms. STAP members concluded that there was no clear basis for planning guidance for New Jersey to deviate from the most recent examinations of the issues by the New York City Panel on Climate Change (Orton et al., 2019) and by the Intergovernmental Panel on Climate Change (IPCC), including the IPCC's conclusions regarding the need for further research to understand regional changes in future tropical cyclones and extratropical cyclones (Collins et al., 2019).

Tropical Cyclones

The STAP deliberations focused on three issues with respect to tropical cyclones: frequency, intensity and precipitation:

- Frequency: Most studies do not project an increase in the global frequency of tropical cyclones (*medium agreement, medium confidence*).
- Intensity: Maximum wind speeds will *likely* increase (*medium- to high-confidence*).
- Precipitation: Rate of precipitation during tropical cyclones is *likely* to increase (*high confidence*).

Changes in the frequency, intensity (wind speed), and tracks of tropical cyclones remain an area of active research, and the STAP concluded there is no definitive consensus regarding such changes specific to New Jersey.

Extratropical Cyclones

Frequency: The global frequency of extratropical cyclones is not likely to change substantially. There is some evidence for a decrease in frequency of extratropical cyclones over the North Atlantic as a whole, but not near the coast (Bengtsson et al., 2006; Chang et al., 2013; Colle et al., 2013; Zappa et al., 2013).

Changes to extratropical storm tracks in the North Atlantic are possible (Roberts et al., 2017), but have not been reliably established (Stocker et al., 2013). Changes in the frequency, intensity (wind speed), precipitation rate, and tracks of extratropical cyclones remain an area of active research, and the STAP concluded that, at this time, there is no definitive consensus regarding such changes.

Tidal Flooding

The number of days that New Jersey residents have experienced high-tide floods in the absence of an associated storm has increased in recent years. High-tide flooding can have detrimental impacts on infrastructure and community function in the absence of a major storm. Over 2007-2016, there was an average of 8 high-tide flood events in Atlantic City, NJ, with annual event totals ranging between 4 events in 2007 and 18 events in 2009. This frequency has grown from an average of less than one high-tide flood event per year in the 1950's (Sweet et al., 2018). The frequency of high tides exceeding the current high-tide flood threshold will continue to increase with sea-level rise. For example, based on the *likely* range of SLR projections, Atlantic City will experience 17-75 days per year of expected high-tide flooding per year in 2030, and 45-255 days per year of expected high-tide flooding in 2050.

Application of STAP Science

Both the STAP and the practitioner panel discussed the use of the STAP science to inform future flood levels for exposure assessment. Each panel recognized that users' planning situations will range from assessing community assets for which there is little vulnerability or consequence related to flood exposure to assessing exposures of highly consequential or vulnerable community assets. In 2016, the STAP specifically advised practitioners to use a variety of SLR estimates, given the range of future exposures and vulnerabilities that exist among people, places, and assets in New Jersey communities. It suggested that flood exposures include at least one estimate in the 'likely range' and an additional estimate that represents high-end outcomes. This report illustrates an example scenario-based planning application of the revised SLR projections. Practitioners will need to consider integrating this information into their current professional framework, recognizing different tolerances for risk and critical flood event thresholds among different community actors.

Additionally, the STAP recommends that SLR projections be revisited periodically, preferably shortly after the releases of any relevant reports from the Intergovernmental Panel on Climate Change (IPCC) or the U.S. National Climate Assessment, to assure that the estimates remain consistent with scientific advances.

Statement of Purpose

The first New Jersey Science and Technical Advisory Panel (STAP) on Sea-Level Rise and Coastal Storms was convened by Rutgers University on behalf of the New Jersey Climate Change Alliance in 2015, culminating in a 2016 report that identified planning options for practitioners to enhance the resilience of New Jersey's people, places, and assets to sea-level rise, coastal storms, and the resulting flood risk (Kopp et al., 2016). Following the same process, the same team at Rutgers University was engaged by the State of New Jersey Department of Environmental Protection to update the 2016 report based on the most current scientific information. Similar to the inaugural work, the 2019 STAP was charged with identifying and evaluating the most current science on sea-level rise projections and changing coastal storms, considering the implications for the practices and policies of local and regional stakeholders, and providing practical options for stakeholders to incorporate science into risk-based decision processes.

Dr. Robert Kopp (Rutgers University, Professor of Earth and Planetary Sciences and Director, Rutgers Institute of Earth, Ocean, and Atmospheric Sciences), chair of the 2016 STAP, again chaired the 2019 Science and Technical Advisory Panel. The 2019 panel included many of the 2016 members and was expanded to include additional experts. The STAP considered its charge with the goal of reaching consensus on the following questions:

1. How much has sea-level risen in New Jersey?
2. What is the range of future estimates of sea-level rise for New Jersey? How probable are different estimates of sea-level rise for New Jersey?
3. How are coastal storm characteristics and impacts projected to change in New Jersey and the Atlantic Basin?
4. What are the estimated changes in flood hazards for New Jersey from coastal storms and sea-level rise, and how probable are those estimates?
    a. How will different estimates of sea-level rise impact the frequency with which communities experience coastal flooding from storm events in New Jersey?
    b. How will different estimates of sea-level rise impact the frequency with which communities experience tidal flooding events in New Jersey?

5. How can efforts to apply current science recognize scientific uncertainties and the ongoing nature of scientific learning and how often should stakeholders reassess advances in scientific information for the purposes of applying the latest science into practice?
6. How can practitioners, decision-makers, and other stakeholders consider sea-level rise and changes in coastal storms in light of different planning horizons, project types, and risk tolerances?

As in the inaugural STAP process, Rutgers University also convened a meeting of resilience practitioners, chaired by Dr. Clinton Andrews (Rutgers University, Edward J. Bloustein School of Planning and Public Policy), to provide insights on barriers and opportunities for integrating the STAP's conclusions into practice. The purpose of the meeting of practitioners was to gather input on the scientists' initial recommendations for planning and decision-making. The STAP integrated the insights from the practitioner discussion in developing the findings outlined in this report.

How to Use This Document

The panel recommends that planners, engineers, elected officials, land managers and other practitioners use the guidance herein to consider community asset exposure to various levels of flooding, such as permanent inundation, tidal flooding, and extreme coastal flooding, both in the near and long-term.

Throughout the report, when describing local or regional sea-level rise (SLR), the panel refers specifically to relative sea-level rise, which is the rise in the height of the sea surface relative to the height of the land. Relative sea-level rise can be caused both by a rising sea surface and by a falling land surface (Gregory et al., 2019).

The panel uses likelihood terminology (see Table 1) and confidence terminology (see Figure 1) consistent with that of the Intergovernmental Panel on Climate Change in this report (Mastrandrea et al., 2010).

Table 1. Likelihood Scale

Likelihood Scale	
Extremely likely	At least a 95% chance
Very likely	At least a 90% chance
Likely	At least a 66% chance
Very unlikely	Less than a 10% chance
Extremely unlikely	Less than a 5% chance

Modified from Mastrandrea et al. (2010)

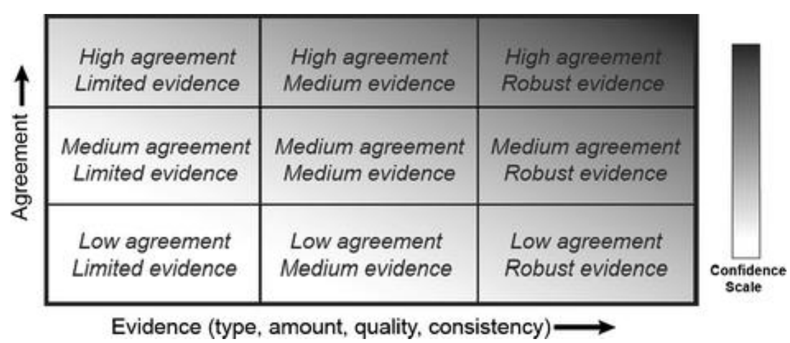


Figure 1. IPCC Fifth Assessment Report Confidence Guidance. Evidence robust when there are multiple, consistent independent lines of high-quality evidence. Confidence generally increases towards the top-right corner as suggested by darker shading. (Mastrandrea et al., 2010)

Practitioners can use the STAP panel conclusions on projected SLR estimates and probabilities in conjunction with methods to project resulting flood levels. An updated example to demonstrate one of many possible options for integrating SLR projections into practice to predict future water levels associated with permanent inundation, tidal flooding, and coastal storms is included in this report. The example is illustrative and has been provided for consideration and discussion purposes as per the STAP charge to provide practical options for stakeholders to incorporate science into risk-based decision processes. The STAP recognizes that some practitioners may desire more detailed planning methods, for example, using Geographic Information Systems to project the spatial extent of Federal Emergency Management Agency (FEMA) flood zones or equivalent hydrodynamic modeling.

Consensus Science to Support Planning for Sea-Level Rise in New Jersey

Important Assumptions and Limitations

The STAP analyzed two critical drivers of future coastal hazards facing New Jersey residents: changing local relative sea-levels and changing coastal storms. The panel considered literature prior to October 2019. The following section details the key factors, assumptions, and limitations related to the projections of future SLR and coastal storm conditions considered by the STAP.

Sea-Level Change Budget and Processes in New Jersey

Global mean sea-level (GMSL) and local relative sea-level (RSL) are determined by several factors (Gregory et al., 2019; Kopp et al., 2015). Global factors include:

1. Thermal expansion of ocean water;
2. Mass loss from glaciers, ice caps, and ice sheets; and
3. Changes in terrestrial water storage.

Additional factors relevant in New Jersey include:

1. Glacial isostatic adjustment (GIA) (the ongoing adjustment of the solid Earth to the loss of the North American ice sheet at the end of the last ice age), leading to SLR of about 0.5 in/decade across the region;
2. Vertical land motion due to natural sediment compaction and groundwater withdrawal along the Coastal Plain and in the Meadowlands, reaching up to about 0.4 in/decade along the Coastal Plain;
3. Dynamic sea-level changes due to changes in ocean circulation, temperature, and salinity, which may add as much as 1 ft/century in the U.S. Northeast under high-emissions scenarios; and
4. Gravitational, rotational and deformational effects (changes in the height of Earth's gravitational field and crust associated with the large shifts of mass from ice to the ocean), which diminish the effect of Greenland ice sheet and Arctic glacier melt and increase the effect of Antarctic ice sheet melt.

Global Mean Sea-level

Global mean sea-level (GMSL) is determined by the volume of water in the ocean. It is estimated to have risen at an average rate of 0.6 ± 0.2 in/decade (1.6 ± 0.4 mm/yr) over 1900-2015 (Dangendorf et al., 2019), with human-caused climate change being the dominant driver since at least 1970 (Oppenheimer et al., 2019). The rate of GMSL rise has been accelerating since the 1960s (Dangendorf et al., 2019). Satellite observations of GMSL, which began in 1993, confirm this acceleration. The average rate of GMSL rise over 1993-2017 was 1.2 ± 0.2 in/decade (3.1 ± 0.4 mm/yr), and increased from about 0.8 in/decade (2.1 mm/yr) at the start of this period to about 1.6 in/decade (4.1 mm/yr) today (WCRP Global Sea Level Budget Group, 2018). The three major processes contributing to GMSL change on human timescales are thermal expansion, land ice mass loss, and changes in terrestrial water storage.

Thermal expansion is the increase in the volume of seawater that occurs because of the warming of the ocean. Over 1993-2017, it was responsible for about 40% of observed GMSL rise (about 0.5 ± 0.2 in/decade [1.3 ± 0.4 mm/yr]; WCRP Global Sea Level Budget Group, 2018).

Land ice mass loss *(from ice sheets and glaciers)* increases GMSL when ice sheets and glaciers lose more mass via melting than they accumulate and when chunks of ice break off and flow into the ocean. Alpine and circumpolar glaciers are currently responsible for about 20% of observed GMSL rise (0.3 ± 0.1 in/decade [0.65 ± 0.15 mm/yr]; WCRP Global Sea Level Budget Group, 2018).

The rates at which both the Greenland ice sheet and Antarctic ice sheet are losing mass are currently increasing (e.g., Harig & Simons, 2012, 2015; Mouginot et al., 2019; Rignot et al., 2019; Shepherd et al., 2012). The Greenland ice sheet was approximately stable in the 1970s (Mouginot et al., 2019), and has been shrinking at an accelerating rate since then due to warming Arctic temperatures (contributing about 15% of observed GMSL rise (0.2 ± 0.04 in/decade [0.5 ± 0.1 mm/yr] over 1993-2017; WCRP Global Sea Level Budget Group, 2018) (Mouginot et al., 2019). The Antarctic ice sheet, whose loss is also accelerating (Rignot et al., 2019) contributed to GMSL at a rate of 0.1 ± 0.04 in/decade (0.3 ± 0.1 mm/yr) (about 8% of observed GMSL rise) from 1993-2017 (WCRP Global Sea Level Budget Group, 2018). Antarctic mass loss is currently localized near the ice sheet margins of West Antarctica. However, the marine-based sectors of the ice sheet are subject to dynamic instability (e.g., Schoof, 2007), and some evidence suggests that parts of the West Antarctic ice sheet may already be committed to long-term retreat (Joughin et al., 2014; Rignot et al., 2014). Gravitational instability of marine ice cliffs may also accelerate future mass loss of the West Antarctic Ice Sheet and some parts of the East Antarctic Ice Sheet (DeConto & Pollard, 2016). On centennial timescales, the behavior of the Antarctic ice sheet is the dominant source of uncertainty in GMSL rise projections (Kopp et al., 2014; WCRP Global Sea Level Budget Group, 2018).

Terrestrial water storage is a minor contributor to GMSL change. These changes arise from natural variability in the amount of water stored in lakes, the filling of dams (driving GMSL fall), and groundwater extraction (driving GMSL rise). The terrestrial water storage component is poorly constrained prior to the 21st century. Over 2002-2015, model-based estimates suggest a contribution of about 0.0-0.1 in/decade (0.0-0.3 mm/yr) to GMSL rise, while measurements of Earth's gravity field suggest a small terrestrial water storage-driven reduction in GMSL (WCRP Global Sea Level Budget Group, 2018).

Relative Sea-Level in New Jersey

Relative sea-level (RSL) is defined as the difference in height between the sea surface and the height of the solid Earth. The factors affecting RSL can be divided into (1) those affecting GMSL, discussed above; (2) those affecting the height of the sea surface relative to a globally uniform change; and (3) those affecting the height of the solid Earth (i.e., causing vertical land motion) (e.g., Kopp et al., 2015).

Dynamic sea-level (DSL) changes affect only the height of the sea surface. They arise from ocean-atmosphere interactions and from ocean circulation changes that alter ocean density and the distribution of mass in the ocean (Kopp et al., 2015). Dynamic sea-level exhibits rich spatiotemporal variability that is associated with both greenhouse gas forcing and internal climate modes.

Studies of observed DSL change in the early part of this decade focused on an observed regional "hotspot" of sea-level acceleration in the U.S. Northeast, beginning in about 1975 (e.g., Andres et al., 2013; Ezer & Corlett, 2012; Kopp, 2013; Sallenger et al., 2012). Drivers were variously suggested to be related to Gulf Stream variability and/or changes in alongshore wind stress (Andres et al., 2013; Ezer et al., 2013; Yin & Goddard, 2013). However, over the past decade, the Southeast US coast has experienced SLR rates of up to three times the global mean, far larger than New Jersey (e.g., Domingues et al., 2018; Valle-Levinson et al., 2017). The long timescales of internal variability hinder the identification of the causal drivers of observed decadal to multidecadal "hotspots" (Kopp et al., 2015). Most recent analyses have related DSL variability, and the differences between locations north and south of Cape Hatteras, to climate modes, including the North Atlantic

Oscillation, Atlantic Multidecadal Variability, and El Niño Southern Oscillation (e.g., McCarthy et al., 2015; Valle-Levinson et al., 2017).

Future changes in the position and strength of the Gulf Stream associated with 21st century climate changes and weakening of the Atlantic Meridional Overturning Circulation (AMOC) may significantly influence DSL along the coast of New Jersey (Yin & Goddard, 2013), with some models projecting >1 ft (30 cm) of DSL rise over the course of the century. However, the spatial pattern and amplitude of DSL change associated with AMOC weakening varies widely across climate models. The connection between future changes and observed decadal to multidecadal variability, and their underlying drivers, is currently unclear (Little et al., 2019). DSL thus remains a major contributor to uncertainty in 21st century sea-level changes in the U.S. Northeast (Kopp et al., 2014).

Gravitational, rotational and deformational (GRD) effects, arising in response to the shifting of mass between land ice, terrestrial water storage, and the ocean, affect both the height of the sea surface and the height of the solid Earth. In addition to altering the height of GMSL, the movement of mass from land ice into the ocean deforms the Earth's gravitational field and crust and alters the planet's rotation. These processes cause the regional expression of sea-level rise associated with land ice mass loss to differ, sometimes substantially, from the global mean. Near a melting ice sheet, SLR is suppressed relative to GMSL change, with an RSL fall occurring in those areas within ~2000 km of the ice sheet. Distal from a melting ice sheet, SLR is enhanced relative to GMSL. For example, along the Jersey Shore, the SLR associated with Greenland ice sheet melt is ~50% of the global mean, while that associated with West Antarctic Ice Sheet melt is ~120% of the global mean, and that associated with East Antarctic Ice Sheet melt ~105% of the global mean (Kopp et al., 2014; Mitrovica et al., 2011).

Glacial isostatic adjustment (GIA) arises from the ongoing, multimillennial response of Earth's mantle to past glaciations. Like GRD effects arising in response to contemporary changes in land ice, GIA affects both the height of the solid Earth and Earth's gravitational field and rotation (and thus the height of the sea surface). The land under the former cores of shrunken ice masses rebounds upward, lowering RSL, while land at the periphery of former ice sheets (that was raised high as a bulge while the ice sheet depressed neighboring land downwards) subsides (raising RSL). The mid-Atlantic region, which sits on the former peripheral bulge of the Laurentide Ice Sheet, is currently experiencing GIA-associated subsidence and SLR at a rate of about 0. 5-0. 6 in/decade (1.3-1.5 mm/yr) (e.g., Kopp, 2013; Kopp, Kemp, et al., 2016).

Sediment compaction affects the height of the solid Earth in areas that are located on unconsolidated sediments such as the mid-Atlantic Coastal Plain (as opposed to bedrock, such as that on which Manhattan sits). Compaction occurs naturally as a result of mass loading; since the early 20th century, it has been substantially enhanced along the Jersey Shore by groundwater withdrawal, and currently contributes about 0. 4 in/decade (1 mm/yr) of SLR (Johnson et al., 2018; Miller et al., 2013).

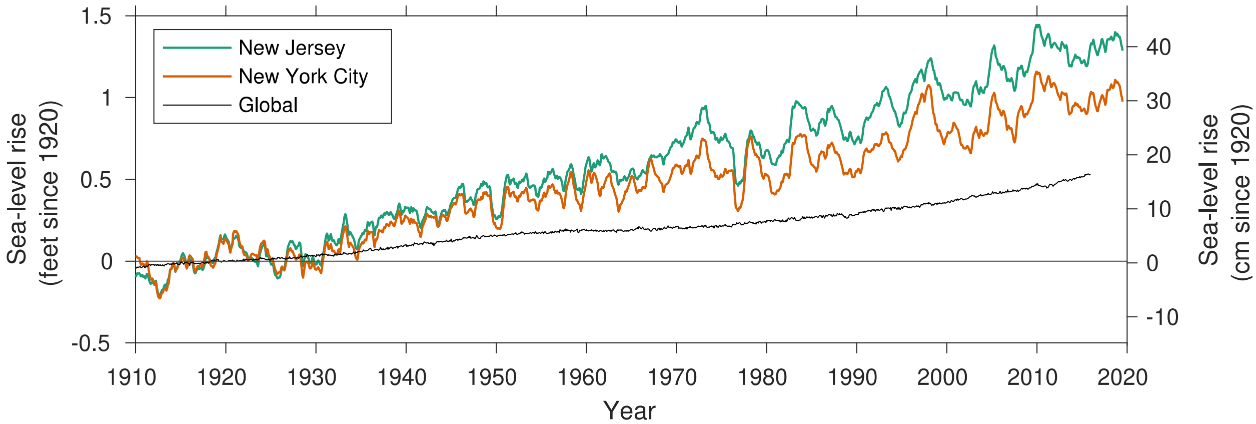
Tide gauge data indicate that GIA contributes 0. 5 ± 0.1 in/decade (1.3 ± 0.2 mm/yr) to SLR at the Battery (e.g., Kopp (2013); Kopp et al. (2014)), while geological data indicate that GIA and natural sediment compaction combined contribute 0.6 ± 0.04 in/decade (1.5 ± 0.1 mm/yr) along the Jersey Shore. Thus, about 20% of the approximately 0.4 in/decade (1 mm/yr) difference between the Battery and the Jersey Shore observed in the 20th and 21st centuries is attributable to natural processes, while the remaining 80% is due to local anthropogenic processes, such as groundwater withdrawal-induced compaction.

Historical Sea-Level Changes in New Jersey

Twenty thousand years ago, a giant ice sheet covered much of North America, extending as far south as northern New Jersey. Between about eighteen thousand years ago and seven thousand years ago, this giant ice sheet disappeared, and other glaciers and ice sheets around the world shrunk considerably, leading to a rapid rise in global average sea-level that was also experienced here in New Jersey. Over the last four thousand years, the dominant long-term driver of SLR in New Jersey has been the sinking of the land as part of the ongoing response to the disappearance of the North American ice sheet.

Geological data indicate that, primarily as a result of land subsidence, sea-level in New Jersey rose about 6 inches/century (1.6 ± 0.1 mm/yr) from 0-1900 CE (Kemp et al., 2013; Kopp, Kemp, et al., 2016). Rates in the 20th and 21st centuries recorded by tide gauges are significantly higher, reflecting a growing contribution from processes related to current, greenhouse gas-driven climate changes. SLR along the Jersey Shore has been consistently faster than at The Battery over this period, a difference predominantly attributed to subsidence associated with groundwater withdrawal (Figure 2b).

- From 1911 (the start of the Atlantic City tide-gauge record) to 2019, sea-level rose 17.6 inches along the New Jersey coast (average rate of 1.7 in/decade [4.2 ± 0.1 mm/yr]) in New Jersey. Sea-level rose 13.3 inches at the Battery (average rate of 1.2 in/decade [3.1 ± 0.1 mm/yr]). Comparatively, GMSL rose 7.6 inches (average rate of 0.7 in/decade [1.8 mm/yr]) (Dangendorf et al., 2019; WCRP Global Sea Level Budget Group, 2018).
- Over the last forty years, from 1979 to 2019, sea-level rose 8.2 inches along the New Jersey coast (average rate of 2.0 in/decade [5.2 ± 0.2 mm/yr]). Sea-level rose 6.5 inches at the Battery over the same period (average rate of 1.6 in/decade [4.1 ± 0.2 mm/yr]). Comparatively, GMSL rose 4.3 inches (average rate of 1.1 in/decade [2.7 mm/yr]) (Dangendorf et al., 2019; WCRP Global Sea Level Budget Group, 2018) (see Figure 2).
- Between the 19-year period centered on the year 2000 (1991-2009) and the 19-year period centered on the year 2010 (2001-2019), sea level rose by 1.5 in (3.8 cm) at The Battery, 1.7 in (4.2 cm) at Atlantic City, 2.0 in (5.2 cm) at Cape May, and 2.1 in (5.4 cm) at Sandy Hook.



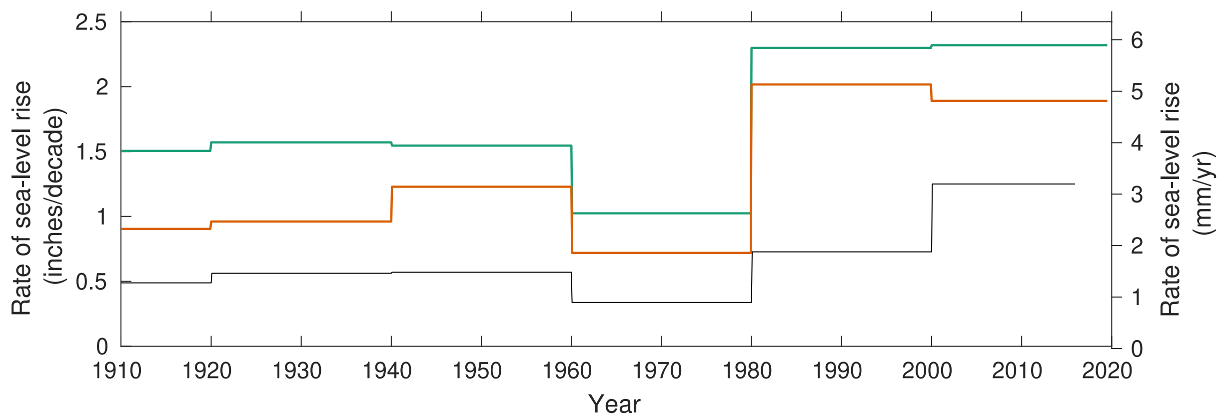


Figure 2. a) Comparison of coastal 'New Jersey' with New York, NY (The Battery). The 'New Jersey' curve is the average of Sandy Hook, Atlantic City, and Cape May. The zero sea-level datum on the upper graph is the estimated mean sea-level over 1911-1929. Individual lines represent annual averages of sea-level along the New Jersey coast and New York, NY (The Battery), based on tide gauge data. The global curve is based on Dangendorf et al. (2019). b) Comparison of coastal 'New Jersey' rate of change with New York, NY (The Battery), and global mean sea-level. Individual lines represent the rate of sea-level change over 20-year periods based on the linear trends.

Table 2. Global and New Jersey Sea-Level Budgets, 1993-2017 (in/decade [mm/yr])

	Global	New Jersey
Total observed	1.2 ± 0.1 [3.07 ± 0.37]	1.9 ± 0.1 [4.8 ± 0.2]
Global-mean thermal expansion	0.5 ± 0.2 [1.3 ± 0.4]	0.5 ± 0.2 [1.3 ± 0.4]
Glaciers	0.26 ± 0.06 [0.65 ± 0.15]	0.16 ± 0.04 [0.4 ± 0.1]
Greenland Ice Sheet	0.19 ± 0.04 [0.48 ± 0.10]	0.09 ± 0.02 [0.23 ± 0.05]
Antarctic Ice Sheet	0.10 ± 0.04 [0.25 ± 0.10]	0.12 ± 0.04 [0.3 ± 0.1]
Terrestrial water storage	(poorly constrained)	(poorly constrained)
Dynamic sea level	–	(poorly constrained)
Glacial isostatic adjustment and natural sediment compaction	–	0.6 ± 0.04 [1.5 ± 0.1]
Other subsidence	–	0.3 ± 0.1 [0.7 ± 0.2]
Total of well-characterized components	1.1 ± 0.2 [2.7 ± 0.5]	1.7 ± 0. 2 [4.4 ± 0.5]

Notes: Global budget for 1993-2017 based on WCRP Global Sea Level Budget Group (2018). New Jersey budget based on using the GRD fingerprint factors from Kopp et al. (2014) for glacier and ice sheet contributions, GIA and other natural subsidence from geological records (Kopp et al., 2016), and other subsidence from both a comparison of long-term trends and the analysis of Johnson et al. (2018). Uncertainties are one standard error.

Future Sea-Level Rise Projections

The local SLR projections of Kopp et al. (2014), used in the 2016 STAP report, are broadly consistent with the GMSL projections of the Intergovernmental Panel on Climate Change's 2013 Fifth Assessment Report (IPCC AR5) (Church et al., 2013). Since IPCC AR5, there has been increasing attention in the scientific literature to the potential instability of the polar ice sheets, particularly the Antarctic ice sheet. For example, as the 2016 STAP noted, at the time that report was written, one new study (DeConto and Pollard, 2016) "suggested that physics involving ice cliffs and ice shelves, not previously incorporated into ice sheet models, could render the Antarctic ice sheet significantly more vulnerable to melt within the current century than ice sheet models had previously indicated." Similarly, evidence has accumulated that parts of the West Antarctic Ice Sheet may already be committed to long-term collapse (e.g., Joughin et al., 2014; Rignot et al., 2014). Accordingly, in this report update, the 2019 STAP revisits the ice-sheet projections used in Kopp et al. (2014) and the 2016 STAP report.

Projections considered: The STAP deliberated upon four different studies that provide probabilistic SLR projections for sites around the world, including New Jersey. All these studies are built upon the LocalizeSL framework (https://github.com/bobkopp/LocalizeSL), first developed in Kopp et al. (2014). These studies differ in their treatment of the polar ice sheets, as well as (in some cases) the climate scenarios considered. These studies are:

1. Kopp et al. (2014) [referred to herein as K14] – This study is the framework used by the 2016 STAP. It is based upon the Representative Concentration Pathway (RCP) climate scenarios (van Vuuren et al., 2011) and yields projections of *likely* GMSL changes broadly consistent with IPCC AR5.
2. Rasmussen et al. (2018) [referred to herein as R18] – This study is entirely consistent with the framework and basic set of assumptions K14, but employs different climate scenarios. This study filters the projections of K14 based on temperature projections for 2100, so that R18 projections are (for example) for 1.5°C and 2.0°C global mean warming scenarios rather than for the RCPs.

3. Kopp et al. (2017) [referred to herein as DP16] – This study replaced the original Antarctic ice-sheet mass loss projections of K14 with those from the Antarctic ice-sheet modeling study of DeConto and Pollard (2016). The ice-sheet model used incorporated (for the first time in a continental-scale model) the gravitational instability of ice cliffs and exhibited high sensitivity to increasing atmospheric temperatures.
4. Bamber et al. (2019) [referred to herein as B19] – This study replaced the Greenland and Antarctic ice-sheet projections of K14 with projections based on a structured expert judgment (SEJ) study of ice-sheet changes associated with climate scenarios leading to 2°C and 5°C of warming by 2100, and it produced sea-level rise projections consistent with these scenarios. These sea-level rise projections were extended into local SLR projections using the LocalizeSL framework.

Structured expert judgment (SEJ) is a formal hazard analysis method that combines probabilistic expert assessments in a calibrated manner and has been widely used in a variety of fields including volcano, earthquake, and nuclear waste hazard assessments (Werner et al., 2017). Practitioners can view the ice-sheet projections from B19 as an integrated assessment of the state of the scientific literature when the study was conducted (early 2018). This study found moderately higher median contributions from the polar ice sheets than IPCC AR5 and considerable high-end risk.

SEJ is, however, not fully accepted by the ice-sheet modeling community, as it relies on the calibrated mental models of the participating experts rather than explicit physical models. Accordingly, rather than reject the IPCC AR5 projections entirely in favor of B19 or of a single ice-sheet modeling study such as that of DeConto and Pollard (2016), the STAP chose to combine the original IPCC AR5-consistent K14 methodology for SLR projection and the B19 projection methodology. To do so, it employed an approach similar to that used by Horton et al. (2018) to provide summary assessments across a broad suite of GMSL projections. This summary assessment method is described in detail below.

Climate scenarios: The 2016 STAP used the highest and lowest RCP-based SLR projections (i.e., RCP 8.5 and RCP 2.6, respectively) from K14. RCP 8.5 represents a fossil-fuel intensive growth trajectory, leading to a *likely* global mean warming of 3.2-5.4°C between the late nineteenth century and the late 21st century. RCP 2.6 represents a rapid decline in global greenhouse gas emissions, leading to net-negative carbon dioxide emissions in the last quarter of this century and a *likely* global mean warming of 0.9-2.3°C (Collins et al., 2013). The 2019 STAP has revised the 2016 climate scenario assumptions to focus upon two temperature-based scenarios – a 2°C increase in global average air temperature from early industrial (1850-1900) temperatures as the low-emissions scenario and a 5°C change high-emissions scenario – as well as a 'moderate' scenario that falls between the low and high-emissions scenarios. (Current global mean temperatures are about 1°C above early industrial levels.)

Revised low-emissions scenario: B19 use slightly different scenarios for their SEJ study, and so the STAP uses slightly different scenarios than in 2016 for this current report. In particular, the low scenario in B19 is a 2°C temperature stabilization scenario, consistent with the primary temperature target of the 2015 Paris Agreement. For consistency, we combine the B19 2°C projections with the R18 2°C projections in place of the K14 RCP 2.6 projection

High-emissions scenario: The B19 high scenario is a 5°C temperature stabilization scenario. Through 2100, it is broadly consistent with RCP 8.5, though toward the high end of climate model projections; after 2100, it stabilizes whereas RCP 8.5 continues to warm. B19 treats RCP 8.5 and their 5°C expert judgment scenario as adequately similar to combine non-ice sheet projections for RCP 8.5 with ice-sheet projections for 5°C, and the STAP agreed to use the same modeling approach for SLR projections.

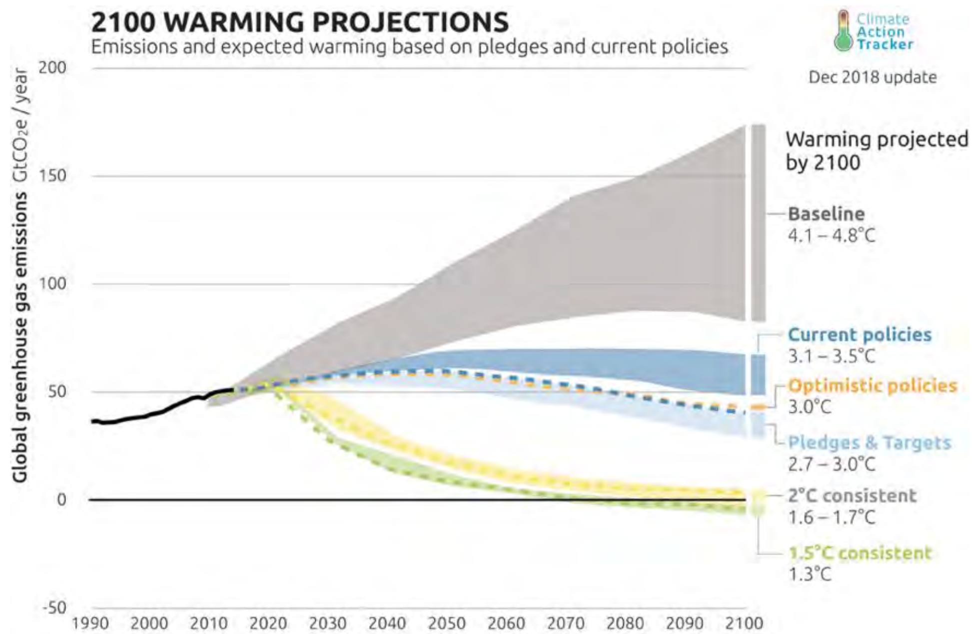


Figure 3. Policy analysis and long-term warming projections from the Global Climate Action Tracker (Potsdam Institute).

Moderate emissions scenarios: The 5°C high-emissions projection is warmer than the global-mean surface temperatures anticipated in this century if current climate policies are maintained and no large, unexpected surprises amplify the expected effects of greenhouse gas emissions. Climate Action Tracker, an independent research consortium associated with the Potsdam Institute for Climate Impact Research (Figure 3), estimates that the *likely* outcome of long-term adherence by all countries to current national policies is an average of 3.1°C - 3.5°C of warming by the end of the century. (Adherence to the pledges and targets nations have committed to under the Paris Agreement would further lower this level of warming to about 2.7°C - 3.0°C). This level of warming associated with current policies falls roughly halfway between that associated with the low-emissions 2°C scenario and that associated with the high-emissions 5°C scenario. Therefore, the STAP also provides a moderate-emissions scenario that estimates an outcome halfway between the low (2°C) the high (5°C) emissions sea-level projections as an option for users to consider in their analysis. The methodology for creating the projections associated with the moderate emissions scenario follows in the composite projection methodology section. It is important to note that, consistent with the prior 2016 report, the STAP suggests analyzing more than one climate scenario, as it is uncertain where emissions and warming will trend in the future, with uncertain global policy responses playing a significant role in long-term outcomes (Jackson et al., 2017; Riahi et al., 2017). More explicitly, assessing the likelihood of different emissions scenarios requires projecting future economic, technological, and policy developments, and the STAP therefore advises that users should exercise extreme caution if they wish to infer an associated likelihood in their assumptions about future emissions, and the associated global temperature change, when using sea-level projections.

Composite Projection Methodology: In the approach used by Horton et al. (2018) and by the 2019 STAP, summary assessments employ the lowest of considered projections for quantiles below the median, the mean of median projections, and the highest of considered projections for quantiles above the median. This approach is conservative: it implies, for example, that all the integrated studies will concur that there is at least a 66% chance that the real outcome will fall between the composite 17th and 83rd percentiles.

SLR projections through 2050 represent merged low- and high-emissions scenario projections, because differences in SLR projections between emissions scenarios are minor in the first half of the century (with low-emissions projections for 2050 being about 0.1 feet lower than high-emissions projections). Thus, to produce summary 50th percentile assessment for projections through 2050, the STAP agreed to average all median projections from the R18 2°C, B19 2°C, K14 RCP 8.5, and B19 5°C studies; to produce summary percentiles above and below the median, the STAP agreed to use the most extreme high/low percentile projections across the R18 2°C, B19 2°C, K14 RCP 8.5, and B19 5°C studies.

After 2050, the STAP projections are broken out by climate scenarios:

- For low-emissions, the STAP combines the 2°C projections of R18 and B19. The result is a composite low-emissions SLR projection.
- For high-emissions, the STAP uses the K14 RCP 8.5 projections and the B19 5°C SEJ projections. The result is a composite high-emissions SLR projection.

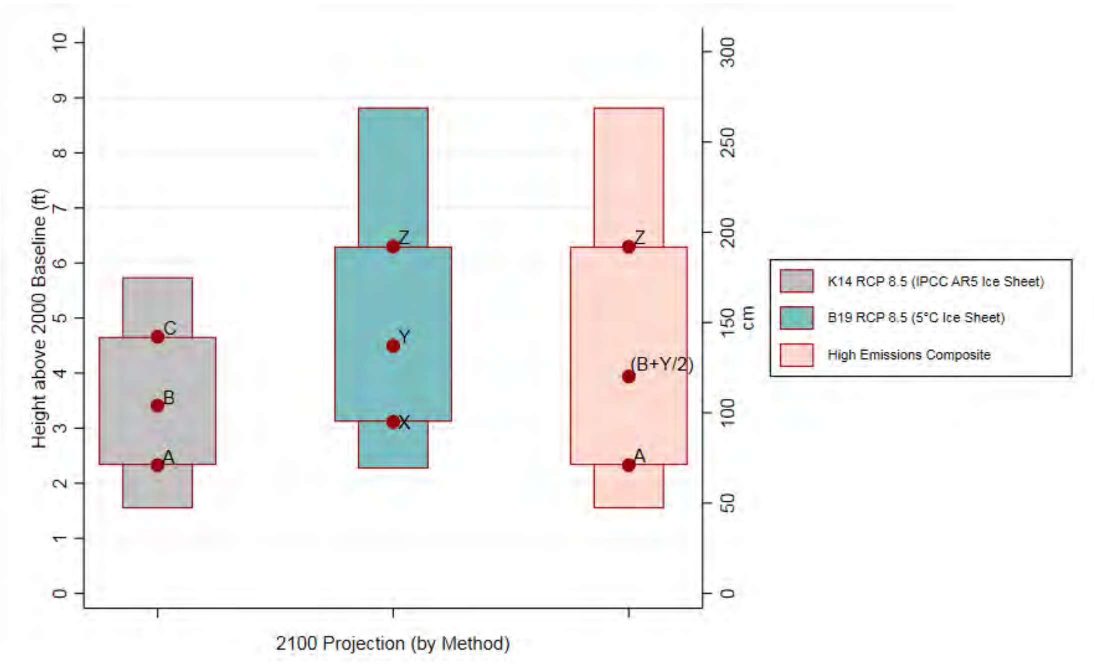


Figure 4. Composite Projection Illustration for high emissions. Gray box plots (with red outlines) represent single-study K14 high-emissions projections. Teal box plots (with red outlines) represent single-study B19 high-emissions projections. The thickest part of the K14 and B19 box plots each represents the *likely* range (17th to 83rd percentile) for the individual probabilistic models, and the narrowest part of each plot shows the *very likely* range (5th to 95th percentile) for the individual models. The red composite shows the *likely* (at least a 66% chance) and *very likely* (at least a 90% chance) ranges generated for the high-emissions composite projection as described in the text.

Figure 4 illustrates the process for creating the high-emissions composite projection. To create the projection, the STAP averages the median projections from the K14 RCP8.5 and B19 RCP8.5 studies to produce a summary median assessment, and takes the most extreme low/high percentile projections from the K14 RCP8.5 and B19 RCP8.5 studies for summary percentiles below/above the median. In other words, suppose that for a high-emissions scenario in New Jersey in a given decade, K14 projects A, B, and C, for the 17th, 50th, and 83rd percentiles respectively, while B19 projects X, Y, Z for these same percentiles. If A is lower than X, and Z is higher than C, (as they are in the above example for 2100), the STAP high-emissions composite projection uses A as the 17th percentile, ((B+Y)/2) as the 50th percentile (median), and Z as the 83rd percentile to create a *likely* range that combines results from K14 and B19. The 5th and 95th percentiles are assessed and added to the composite in a similar fashion to create the *very likely* range for the high-emissions projection. The STAP used this same process to derive the low-emissions composite projection using R18 and B19 2°C projections that represent a low warming future.

The composite approach is consistent with the use of likelihood language by the IPCC; in IPCC terminology, *likely* means a probability of *at least* two-thirds; both the K14 and B19 projections concur that there is at least a two-thirds chance that the correct value lies between A and Z, as do the R18 and B19 projections for low emissions.

Moderate Emissions Composite Projection Methodology: The full set of RCPs include two scenarios – RCP 4.5 and RCP 6.0 – in between the RCP 2.6 and 8.5 scenarios considered by the 2016 STAP. RCP 4.5 has a *likely* global mean warming of 1.7-3.3°C between the late nineteenth century and the late 21st century (Collins et al., 2013), which overlaps with but is centered below estimates of warming associated with current global policies. RCP 6.0 has quirks in its construction that make it ill-suited for comparative 21st century SLR projections. (Specifically, it exhibits temperatures below those of RCP 4.5 until the third quarter of the century.)

K14 and DP16 produce projections for RCP 4.5, while R18 computes comparable projections for a 2.5°C temperature scenario. However, B19 does not include a commensurate set of projections of future ice-sheet dynamics under moderate emissions, and instead includes only 2°C (low-emissions) and 5°C (high-emissions) scenarios. Therefore, the STAP discussed potential methodologies that would allow projections to reflect the most recent knowledge of ice-sheets under a moderate emissions scenario consistent with current global policies.

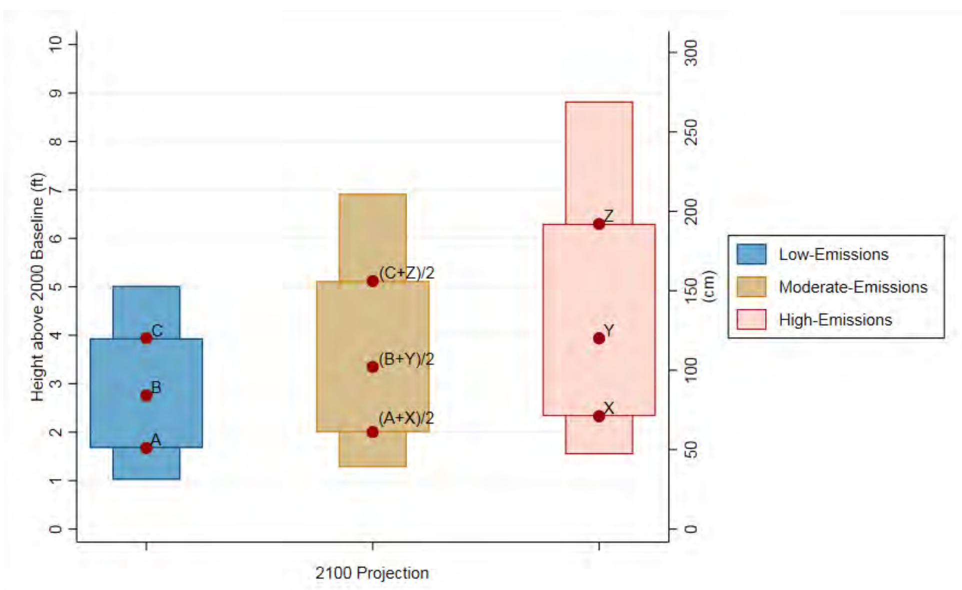


Figure 5. Interpolating a Moderate Emissions Projection. Box plots represent composite projections in 2100 for high-emissions (red) and low-emissions (blue). The thickest part of each plot represents the *likely* range (at least a 66% chance), followed by the *very likely* range (at least a 90% chance). The moderate emissions composite (gold) is generated for each decadal interval by using the midpoint between the high- and low-emissions composite projection medians [(B+Y)/2] and the midpoints between the 17th percentile [(A+X)/2] and 83rd percentile [(C+Z)/2] values of the *likely* ranges. The process is similar for the end-points of the *very likely* ranges.

For the purposes of this report, the STAP chose to interpolate a 'moderate emissions' scenario by assuming that, at each percentile, the associated projection is the average of the high and low scenario (See Figure 5). This approach is justified under the assumption that the physical uncertainties that would lead to a high or low sea-level response would be consistent across trajectories: a world that would respond to a high-emissions trajectory at the high end of SLR projections for that trajectory would most likely similarly respond at the high end for low- and moderate-emissions trajectories. The assumption that a temperature projection roughly halfway between the 2°C and 5°C scenarios would yield a sea-level outcome also halfway between is comparable to that used by Bamber et al. (2019) to compare projections associated with different scenarios.

The assumptions used by the STAP to generate a moderate emissions scenario are consistent with a moderate scenario that roughly corresponds to a warming of about 3.5°C by 2100, which would be higher than RCP 4.5 projections from prior studies. This can be confirmed when comparing the results of prior sea-level modeling for RCP 4.5 for K14 and DP16. While not a perfect approach, it is the judgment of the STAP that this is a reasonable approach in the absence of a moderate emissions scenario consistently modeled or elicited across studies, and that the interpolated 'moderate' trajectory provides a reasonable estimate of potential future SLR in New Jersey if current global climate mitigation policies are maintained but not strengthened.

Maximum Planning Horizon of 2150: The panel selected 2150 as the maximum planning horizon to accommodate both near-term and long-term asset lifecycles for infrastructure consistent with feedback from the practitioner panel. The panel selected 2030, 2050, 2070, 2100, and 2150 as periods representative of near-, mid-, and long-term projections for SLR affirmed as relevant by discussions with practitioners. Appendix A provides all decadal projections for 2010 through 2150 for practitioner reference.

2000 Baseline: Scientists measure sea-level with respect to a geodetic datum. For the U.S. National Spatial Reference System, this datum is the North American Vertical Datum of 1988 (NAVD88). NOAA measures tidal datum levels such as Mean Sea-level (MSL), Mean Higher High Water (MHHW), and Mean Lower Low Water (MLLW) in relation to the NAVD88 geodetic datum over a 19-year tidal cycle referred to as a tidal datum epoch. The current National Tidal Datum Epoch is 1983 – 2001. There are several different tidal datum levels that practitioners use within their professions to communicate flood forecasts (MLLW), coastal boundaries (for NJ, MHHW), and other information as points of reference for coastal communities and ecosystems.

For consistency with the sea-level projection literature, including most recent federal and state sea-level assessments, the baseline tidal epoch for the projections in this report is different from the National Tidal Datum Epoch. It is instead centered on the year 2000; more specifically, it is the average sea-level over 1991-2009. Based on an average rate of change over 1983-2009 of 1.8 ± 0.2 in/decade [4.6 ± 0.4 mm/yr], the 1991-2009 average for New Jersey was 1.4 ± 0.1 inches above the 1983-2001 tidal epoch, so users can adjust the STAP projection to the 1983-2001 National Tidal Datum Epoch (centered on the year 1992) by adding 1.4 inches (0.1 ft). For example, the STAP central estimate projection for 2050 is 1.4 ft above the 2000 baseline. This is equivalent to 1.5 ft above the 1983-2001 National Tidal Datum Epoch (1992). Due to atmosphere and ocean dynamics, the annual average sea-level can vary by up to 0.2 ft around the 19-year average sea-level centered in the same year.

How Much Will Sea-Level Rise in New Jersey?

Table 3. New Jersey Sea-Level Rise above the year 2000 (1991-2009 average) baseline (ft)*

		2030	2050	2070			2100			2150		
				Emissions								
	Chance SLR Exceeds			Low	Mod.	High	Low	Mod.	High	Low	Mod.	High
Low End	> 95% chance	0.3	0.7	0.9	1	1.1	1.0	1.3	1.5	1.3	2.1	2.9
Likely Range	> 83% chance	0.5	0.9	1.3	1.4	1.5	1.7	2.0	2.3	2.4	3.1	3.8
	~50 % chance	0.8	1.4	1.9	2.2	2.4	2.8	3.3	3.9	4.2	5.2	6.2
	<17% chance	1.1	2.1	2.7	3.1	3.5	3.9	5.1	6.3	6.3	8.3	10.3
High End	< 5% chance	1.3	2.6	3.2	3.8	4.4	5.0	6.9	8.8	8.0	13.8	19.6

**2010 (2001-2019 average) Observed = 0.2 ft*

Notes: All values are 19-year means of sea-level measured with respect to a 1991-2009 baseline centered on the year indicated in the top row of the table. Projections are based on Kopp et al. (2014), Rasmussen et al. (2018), and Bamber et al. (2019). Near-term projections (through 2050) exhibit only minor sensitivity to different emissions scenarios (<0.1 feet). Low and high emissions scenarios correspond to global-mean warming by 2100 of 2°C and 5°C above early Industrial (1850-1900) levels, respectively, or equivalently, about 1°C and 4°C above the current global-mean temperature. Moderate (Mod.) emissions are interpolated as the midpoint between the high- and low-emissions scenarios and approximately correspond to the warming expected under current global policies. Rows correspond to different projection probabilities. There is at least a 95% chance of SLR exceeding the values in the 'Low End' row, while there is less than a 5% chance of exceeding the values in the 'High End' row. There is at least a 66% chance that SLR will fall within the values in the 'Likely Range'. Note that alternative methods may yield higher or lower estimates of the chance of low-end and high-end outcomes.

The STAP has produced a set of probabilistic SLR projections for the years 2030 and 2050 and three sets of projections for 2070, 2100, and 2150.

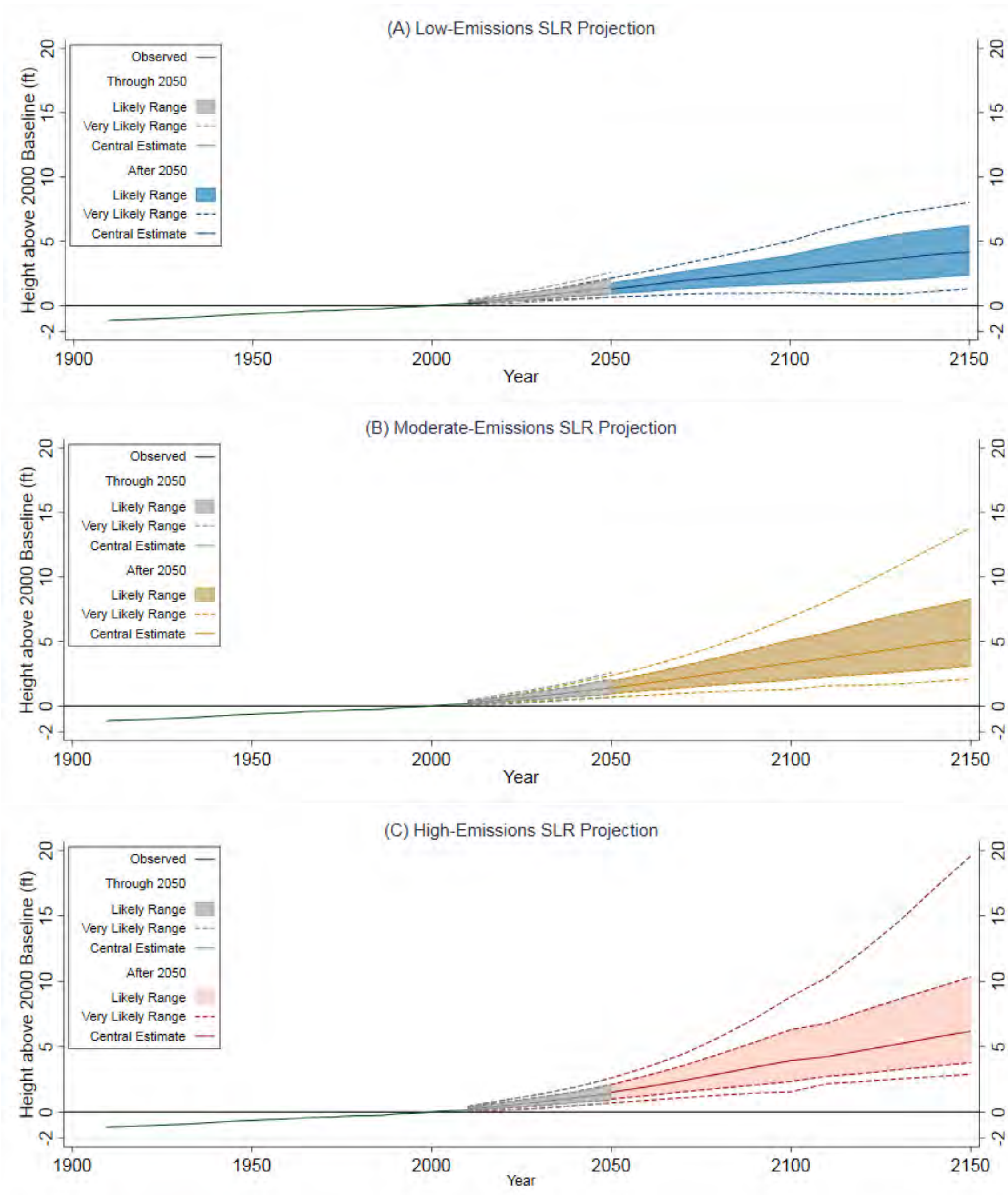


Figure 6: Time series of tide-gauge measurements (dark green) and projections for low-emissions (A), moderate emissions (B) and high-emissions scenarios (C). All Observation and SLR values are expressed as 19-year means of tide-gauge measurements and are measured with respect to a 1991-2009 (2000) baseline. Projections are 19-year averages based on Kopp et al. (2014), Rasmussen et al. (2018), and Bamber et al. (2019). Solid Lines = ~50% chance estimates; Shaded Area = *likely* range (at least a 66% chance); dotted lines denote the *very likely* range (at least a 90% chance), (Mastrandrea et al., 2010). Note that alternative methods may yield higher or lower estimates of the chance of low-end and high-end outcomes.

Considering the prior discussion of historical changes and the projections set forth by the STAP, as summarized in Figure 6 and in Table 1, the STAP has reached the following conclusions:

1. From 1911 (the start of the Atlantic City tide-gauge record) to 2019, sea-level rose 17.6 inches along the New Jersey coast, compared to a 7.2-inch total change in the global mean sea-level.
2. Over the last forty years, from 1979-2019, sea-level rose 8.2 inches along the New Jersey coast, compared to a 4.5-inch change in global mean sea-level.
3. New Jersey coastal areas are *likely* (at least a 66% chance) to experience SLR of 0.5 to 1.1 ft between 2000 and 2030, and 0.9 to 2.1 ft between 2000 and 2050. It is *extremely unlikely* (less than a 5% chance) that SLR will exceed 1.3 ft by 2030 and 2.6 ft by 2050.
4. While near-term SLR projections through 2050 exhibit only minor sensitivity to different emissions scenarios (<0.1 feet), SLR projections <u>after</u> 2050 increasingly depend upon the pathway of future global greenhouse gas emissions.
    a. Under a high-emissions scenario, consistent with the strong, continued growth of fossil fuel consumption, coastal areas of New Jersey are *likely* (at least a 66% chance) to see SLR of 1.5 to 3.5 ft between 2000 and 2070, and 2.3 to 6.3 ft between 2000 and 2100. It is *extremely unlikely* (less than a 5% chance) that SLR will exceed 4.4 ft by 2070 and 8.8 ft by 2100.
    b. Under a moderate-emissions scenario, consistent with current global policies, coastal areas of New Jersey are *likely* (at least a 66% chance) to see SLR of 1.4 to 3.1 ft between 2000 and 2070, and 2.0 to 5.2 ft between 2000 and 2100. It is *extremely unlikely* (less than a 5% chance) that SLR will exceed 3.8 ft by 2070 and 6.9 ft by 2100.
    c. Under a low-emissions scenario, consistent with the global goal of limiting warming to 2°C above early industrial (1850-1900) levels, coastal areas of New Jersey are *likely* (at least a 66% chance) to see SLR of 1.3 to 2.7 ft between 2000 and 2070, and 1.7 to 4.0 ft between 2000 and 2100. It is *extremely unlikely* (less than a 5% chance) that SLR will exceed 3.2 ft by 2070 and 5.0 ft by 2100.

These results represent one consistent, scientifically justifiable way of estimating the chance of different levels of SLR. Alternative methods or new science may yield higher or lower estimates of the chance of high-end outcomes. Practitioners will need to consider if SLR values in the lower or upper part of the range best reflect their risk tolerance. For example, higher estimates may be more appropriate for long-lived, difficult to modify assets, or highly vulnerable places or people. Appendix A provides decadal projections for all emissions scenarios in both metric and imperial units.

How Fast Will Sea-Level Rise in New Jersey?

The rate of SLR is particularly important to understand in order to assess the adaptability of ecological systems, such as the capacity of coastal marshes to keep pace with SLR. Marshes provide critical functions including flood and storm protection; habitat for fisheries; and carbon and nitrogen storage, among other functions. However, the adaptability of these systems is locally dependent on other factors, including sediment accretion, accommodation space, and organic matter accumulation from plant production (Haaf et al., 2015; Kirwan & Megonigal, 2013; Schuerch et al., 2018). Globally, salt marshes have been able to adapt to a widely varying range of rates of SLR, based on available sediment, nutrients, and other local conditions (Kirwan & Megonigal, 2013; Schuerch et al., 2018). Therefore, practitioners felt that information about rates of SLR for New Jersey would be a helpful outcome of the STAP, especially related to monitoring future responses of salt marshes and other natural resources to be able to better understand adaptation thresholds and make management decisions as resources continue to degrade.

Recent National Climate Assessments find that many wetlands in the Mid-Atlantic will become stressed at a SLR rate of 0.2 to 0.25 inches/year, and will likely not survive a SLR rate of 0.4 inches/year (CCSP, 2009; Dupigny-Giroux et al., 2018). Coastal wetlands in New Jersey are already experiencing a SLR rate of 0.2 inches/year, and this is expected to continue to increase under both low and high-emissions scenarios. Over 2010-2050, average SLR rates are *likely* to be between 0.2 and 0.5 inches/year. Intensive marsh monitoring for sites in New Jersey indicates that sediment rich riverine systems, such as some coastal wetlands in the uppermost Delaware Bay, may be able to keep pace or there are available retreat pathways at the current rate of SLR. However, in Barnegat Bay, a lagoonal system which lacks in sediment supply, the marshes are not expected to keep pace at the current rate of SLR and they have limited options in terms of retreat due to extensive land development (Haaf et al., 2019). There is also increasing evidence that the sediment supply that is sustaining some (vertical) marsh accretion in the Delaware Estuary may be derived from marshes that are eroding along their seaward edge. The Delaware Estuary is currently losing about an acre of marsh per day, which may be associated with increasing rates of SLR as a result of increases in fetch that promote more erosive wave energy and increases in tidal flushing volumes that promote more erosive hydrodynamics (Kreeger, 2016; Miller et al., 2012).

Changes in SLR versus time are used to compute rates. Based on these changes, the STAP has reached the following conclusions about rates of SLR in New Jersey:

1. Over the last forty years, from 1979-2019, sea-level rose at an average rate of 0.2 in/yr along the New Jersey coast, compared to an average rate of 0.1 in/yr in global mean sea-level.
2. New Jersey coastal areas are *likely* (at least a 66% chance) to experience average SLR rates of 0.2 to 0.5 in/yr over 2010–2050. It is *extremely unlikely* (less than a 5% chance) that average SLR rates will exceed 0.7 in/yr over 2010–2050.
3. Rates of SLR are increasingly dependent upon global greenhouse gas emissions later in the 21st century.
   a. Under a high-emissions scenario, coastal areas of New Jersey are *likely* (at least a 66% chance) to see SLR rates of 0.3 to 1.1 in/yr over 2060-2100. It is *extremely unlikely* (less than a 5% chance) that SLR rates will exceed 1.7 in/yr over 2060-2100.
   b. Under a moderate-emissions scenario, coastal areas of New Jersey are *likely* (at least a 66% chance) to see SLR rates of 0.2 to 0.8 in/yr over 2060-2100. It is *extremely unlikely* (less than a 5% chance) that SLR rates will exceed 1.3 in/yr over 2060-2100.
   c. Under a low-emissions scenario (2.0°C), coastal areas of New Jersey are *likely* (at least a 66% chance) to see SLR rates of 0.2 to 0.6 in/yr over 2060-2100. It is *extremely unlikely* (less than a 5% chance) that SLR rates will exceed 0.8 in/yr over 2060-2100.

The impacts on coastal areas will be highly dependent on local environmental dynamics. Nonetheless, it is important to consider SLR rate in understanding how the adaptability of natural systems will be affected, especially in the design of natural infrastructure alternatives. Decadal projections for all emissions scenarios are provided in Appendix A in both metric and imperial units.

When is Sea-Level Rise Going to Exceed X. Feet in New Jersey?

In addition to the projected *likely* range of SLR for a given year, practitioners stated that it would also be helpful to be able to communicate when a particular level of SLR is projected to occur. More specifically, practitioners must be able to respond to the question, "When is sea-level going to exceed X ft over the 2000 baseline in New Jersey?" Table 4 presents probabilities that reflect SLR exceeding stated thresholds from 1 ft through 10 ft above the 2000 baseline (Bamber et al., 2019; Kopp et al., 2014; Rasmussen et al., 2018). It is not possible to give precise probabilities in answer to such a question; disagreements among different methodologies lead the STAP to use the composite methodology described above for projecting bounds on probabilities over time. Instead, a range of probabilities for high-emissions and low-emissions scenarios is presented based on probabilities derived from different methodologies that go into calculating the summary SLR projections. This information can help practitioners communicate the strength of evidence to support incorporating a given amount of SLR over time into their decision.

Table 4. Range of Probabilities that SLR along the New Jersey coast will Exceed Stated Values in Stated Years (ft above 2000 baseline)

High-emissions (5°C)

	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	7 ft	8 ft	9 ft	10 ft
2030	23-29%									
2040	57-68%	1-4%								
2050	83-90%	10-22%	0-2%							
2060	92-97%	34-57%	3-11%	0-2%						
2070	96-99%	59-80%	13-35%	2-9%	0-3%	0-1%				
2080	98-99%	76-91%	30-60%	7-26%	1-9%	0-4%	0-2%	0-1%		
2090	98-100%	85-95%	50-77%	18-47%	5-22%	1-10%	1-6%	0-3%	0-2%	0-1%
2100	98-100%	89-97%	64-85%	32-63%	12-38%	4-20%	1-11%	1-7%	0-5%	0-3%
2110	100%	97-99%	77-94%	40-75%	15-49%	5-28%	2-16%	1-11%	1-8%	0-6%
2120	100%	98-100%	83-96%	52-83%	23-60%	9-38%	4-23%	2-15%	1-11%	1-9%
2130	100%	99-100%	88-98%	63-89%	36-71%	16-50%	7-33%	4-21%	2-15%	1-12%
2140	100%	99-100%	92-98%	72-93%	47-79%	25-60%	12-42%	6-28%	3-20%	2-15%
2150	100%	99-100%	94-99%	79-95%	57-85%	35-69%	19-52%	10-36%	5-25%	3-18%

Low-emissions (2°C)

	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	7 ft	8 ft	9 ft	10 ft
2030	5-9%									
2040	47-58%	0-1%								
2050	74-83%	3-8%								
2060	88-93%	16-27%	1-2%							
2070	93-96%	38-53%	4-8%	1%						
2080	95-97%	54-69%	11-20%	2-4%	1%					
2090	95-98%	64-78%	22-33%	5-9%	1-2%	1%				
2100	95-98%	73-85%	34-48%	10-16%	3-5%	1-2%	1%			
2110	96-98%	78-87%	47-61%	20-30%	7-11%	3-4%	1-2%	1%		
2120	97-98%	82-89%	55-68%	28-40%	11-18%	5-8%	2-3%	1%	1%	
2130	97-98%	83-91%	60-74%	36-49%	18-26%	8-12%	4-6%	2-3%	1%	0-1%
2140	97-99%	86-93%	66-80%	42-57%	23-33%	11-17%	6-8%	3-4%	2%	1%
2150	97-99%	89-94%	70-83%	46-62%	26-39%	13-21%	6-11%	4-5%	2-3%	1%

The data in Table 4 present similar information about SLR to that illustrated in Table 3 above, but in a fundamentally different way. Instead of providing a range of projected SLR for a given future year

(Table 3), Table 4 presents a range of timings for a given level of SLR. For example, under a high-emissions scenario, there is a 10-22% chance SLR will exceed 2 ft by 2050, a 59-80% chance it will do so by 2070, and an 89-97% chance it will do so by 2100. The spread in probabilities arises from different ways of assessing the sensitivity of ice-sheets to warming that serve as the basis for our composite sea-level projections (i.e., Bamber et al., 2019; Kopp et al., 2014). Under a low-emissions scenario, there is a 38-53% chance SLR will exceed 2 ft by 2070 and a 73-85% chance it will do so by 2100 (i.e., Bamber et al., 2019; Rasmussen et al., 2018).

The approach used to generate moderate-emissions projections do not lend themselves as readily to presentation in this manner, but associated probabilities would be intermediate between those for the low- and high-emissions projections. In other words, if there is an 89-97% chance that SLR will exceed 2 ft by 2100 under a high-emissions scenario, and a 73-85% chance that SLR will exceed 2 ft by 2100 under a low-emissions scenario (2°C), the probability SLR will exceed 2 ft by 2100 under a moderate-emissions scenario would fall between 73 and 97%.

How do the Consensus Sea-Level Rise Projections for New Jersey Compare with Other Regional and National Projections?

Federal climate projections rely on the study Sweet et al. (2017) available through the USACE Sea-Level Change Curve Calculator along with curves established for USACE guidance. The calculator is a tool that practitioners use to generate local SLR projections based on a tide gauge location and different assumptions about future climate impacts. Generally, the higher federal curves and scenarios are consistent with higher emissions and more extreme climatic responses to emissions (i.e., faster ice sheet melt), while the lowest curve represents a constant linear trend over time. The federal scenarios do not have associated probability estimates, whereas the projections of K14, R18, and B19 do provide probability estimates based on a variety of underlying data sources.

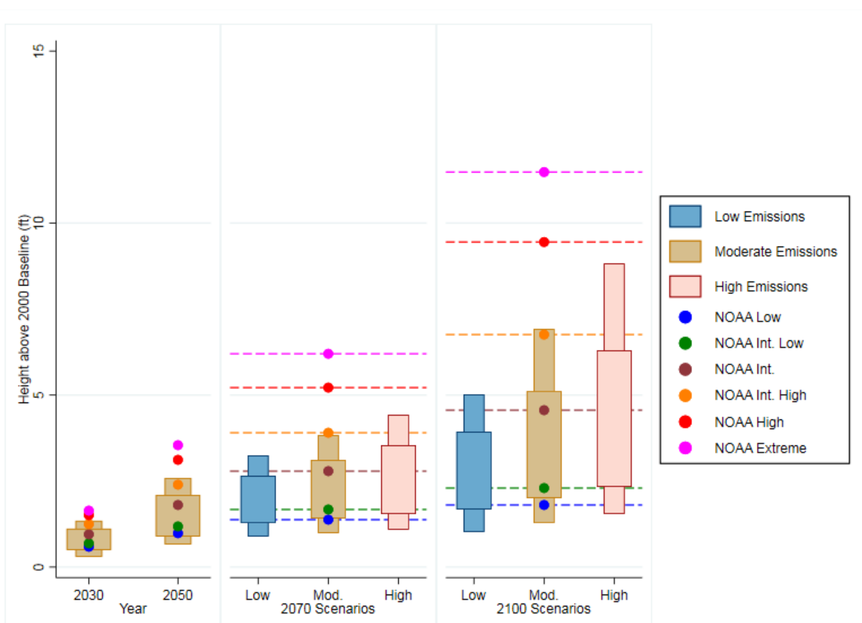


Figure 7. STAP Emissions projections compared with Federal scenario projections for Atlantic City, NJ. The thickest part of each box plot represents the *likely* range (17th to 83rd percentile), while the narrower part of the plot represents the *very likely* range (5th to 95th percentile). Dots and dashed lines denote the median SLR projection for each federal planning scenario in a given year

The STAP *likely* ranges of NJ SLR estimates are comparable to the recent SLR guidance proposed by an interagency working group that included the National Oceanic and Atmospheric Administration (NOAA), the United States Army Corps of Engineers (USACE), the United States Geological Survey (USGS), and other agency and academic partners (Sweet et al., 2017). Figure 7 presents a comparison of the NJ STAP emissions projections and the Atlantic City, NJ federal scenario projections for 2030, 2050, 2070 and 2100. When compared with the NJ STAP projections:

- For 2030 and 2050, the federal Low, Int. Low, and Intermediate scenario projections are all in the likely range; the federal Int. High scenario is unlikely, while the federal High and Extreme scenarios are extremely unlikely.
- Beyond 2050, for low-emissions projections, the federal Low and Int. Low scenarios are in the likely range, the federal Intermediate scenario is unlikely, and the federal Int. High, High and Extreme scenarios are all extremely unlikely in 2070 and 2100.
- Beyond 2050, for moderate emissions, the federal Low scenario is in the likely range in 2070 but unlikely in 2100; the federal Int. Low and Intermediate scenarios are in the likely range; the federal Int. High is extremely unlikely in 2070, but only unlikely in 2100; and the federal High and Extreme scenarios are both extremely unlikely in 2070 and 2100.
- Beyond 2050, for high-emissions, the federal low scenario is unlikely, the federal Int. Low and Intermediate scenarios are in the likely range, the federal Int. High is unlikely, and the federal High and Extreme scenarios are extremely unlikely in 2070 and 2100.

NJ practitioners preferring the federal data can compare projections and, for example, select the intermediate federal scenario to prepare for SLR that falls within the *likely* range of the NJ STAP moderate emissions projection. Despite this consistency, the STAP reminds practitioners that alternative methods or new science may yield higher or lower estimates of the probability of high-end outcomes.

Future Coastal Storms

Higher mean sea-levels will increase the baseline for flooding from coastal storms, and therefore their impacts. In addition, climate change may change the characteristics of storm systems. The STAP discussed many of the aspects of both tropical (i.e., hurricane) and extratropical (i.e., nor'easter) coastal storm systems, as well as hybrid storms such as Sandy. The STAP noted the following conclusions of the 2019 IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC) that are relevant for planning in New Jersey (Collins et al., 2019):

> Tropical cyclone [TC] projections for the late 21st century are summarized as follows: 1) there is medium confidence that the proportion of TCs that reach Category 4–5 levels will increase, that the average intensity of TCs will increase (by roughly 1-10%, assuming a 2 degree global temperature rise), and that average tropical cyclone precipitation rates (for a given storm) will increase by at least 7% per degree Celsius sea surface temperature (SST) warming, owing to higher atmospheric water vapour content, 2) there is low confidence (low agreement, medium evidence) in how global TC frequency will change, although most modelling studies project some decrease in global TC frequency and 3) sea-level rise will lead to higher [water] levels for the TCs that do occur, assuming all other factors are unchanged (very high confidence).
>
> AR5 concluded that the global number of ETCs is not expected to decrease by more than a few percent due to anthropogenic change… AR5 also found a low confidence in the magnitude of regional storm track changes and the impact of such changes on

> regional surface climate (Christensen et al., 2013). A number of new studies have found links between Arctic amplification, blocking events and various types of weather extremes in NH midlatitudes in recent decades. However, the sensitivity of results to analysis technique and the generally short record with respect to internal variability means that at this stage there is low confidence in these connections. Consistent with the AR5, projected changes to NH storm tracks exhibit large differences between responses, causal mechanisms and ocean basins and so there remains low confidence in future changes in blocking and storm tracks in the NH.

STAP members concluded that there was no clear basis for planning guidance for New Jersey to deviate from the most recent examinations of the issues by the New York City Panel on Climate Change (Orton et al., 2019) and by the Intergovernmental Panel on Climate Change (IPCC), including the IPCC's conclusions regarding the need for further research to understand regional changes in future tropical cyclones and extratropical cyclones (Collins et al., 2019).

Some recent studies have focused more specifically on conditions in the region, but more work will be required to assess their conclusions. For example, while it is largely accepted that rising sea levels will increase the flood heights associated with storm surge events, models disagree on whether changes in tropical cyclone characteristics will increase the height of storm surges in the New York area above their contemporary mean sea-level (Garner et al., 2017; Lin et al., 2012). Some results suggest that the climate conditions of the late 20th and early 21st centuries have a greater propensity to generate tropical cyclones with extreme storm surges in the New York area than did conditions of the preceding millennium (Reed et al., 2015). A number of studies suggest that conditions in the future will be conducive to more intense tropical cyclones (Garner et al., 2017; Knutson et al., 2019; Marsooli et al., 2019). A recent study found that the potential changes in tropical cyclone activity may have relatively small effect on the coastal flood levels compared to the effect of SLR for high latitude regions including New Jersey (Marsooli et al., 2019). Potential changes to storm tracks could result in little change to storm surges in our region (Garner et al., 2017). Regardless of whether storm surges increase, higher sea levels will lead to higher overall water levels associated with storm surge. In addition, there is high confidence that precipitation rates during both tropical and extratropical cyclones are *likely* to increase (e.g., Bacmeister et al., 2018; Hawcroft et al., 2018; Knutson et al., 2019).

Future changes in the frequency, intensity (wind speed), precipitation rate, and tracks of extratropical storms remain an area of active research, and the STAP concluded there is no definitive consensus regarding such changes at this time. The need to better understand projected changes to coastal storms has spurred several areas of active research that could influence scientific understanding of future projections, including changes in the Gulf Stream, changes in sea surface temperatures, changes in blocking patterns, feedbacks involving latent heat release, and possible evidence of a poleward shift in storm tracks (e.g., Bhatia et al., 2018; Catalano et al., 2019; Colle et al., 2013; Emanuel, 2007; Garner et al., 2017; Harvey et al., 2015; Maloney et al., 2014; Marciano et al., 2015; Michaelis et al., 2017; Overland et al., 2015; Reed et al., 2015; Roberts et al., 2017; Woollings et al., 2012). A recent study projected a relatively small effect of climate change on extratropical cyclone storm surges in the Northeast coast, although uncertainties exist among the climate models applied in the analysis (Lin et al., 2019). The STAP cautions planners and decision-makers that ongoing and emerging research in these areas may revise current projections.

Despite lingering uncertainty pertaining to future changes to storm characteristics, such as frequency, intensity (wind speed), and tracks, it is *virtually certain* (*high confidence*) that future SLR will cause greater overall storm flood levels. Thus, it is of utmost importance to keep in mind that SLR will exacerbate future coastal storm impacts for the state of New Jersey, even if there is little or no systematic change in the frequency, intensity (wind speed), and tracks of storms.

Tidal Flooding

Certain coastal areas of New Jersey, experience tidal flooding on sunny days. The number of days that New Jersey residents have experienced these high tide floods in the absence of an associated storm has increased in recent years. High-tide flooding can have detrimental impacts on infrastructure and community function in the absence of a major storm. Over 2007-2016, there were an average of 8 high-tide flood events in Atlantic City, NJ, with annual event totals ranging between 4 events in 2007 and 18 events in 2009. This frequency has grown from an average of less than one high-tide flood event per year in the 1950s (see Figure 8) (Sweet et al., 2018).

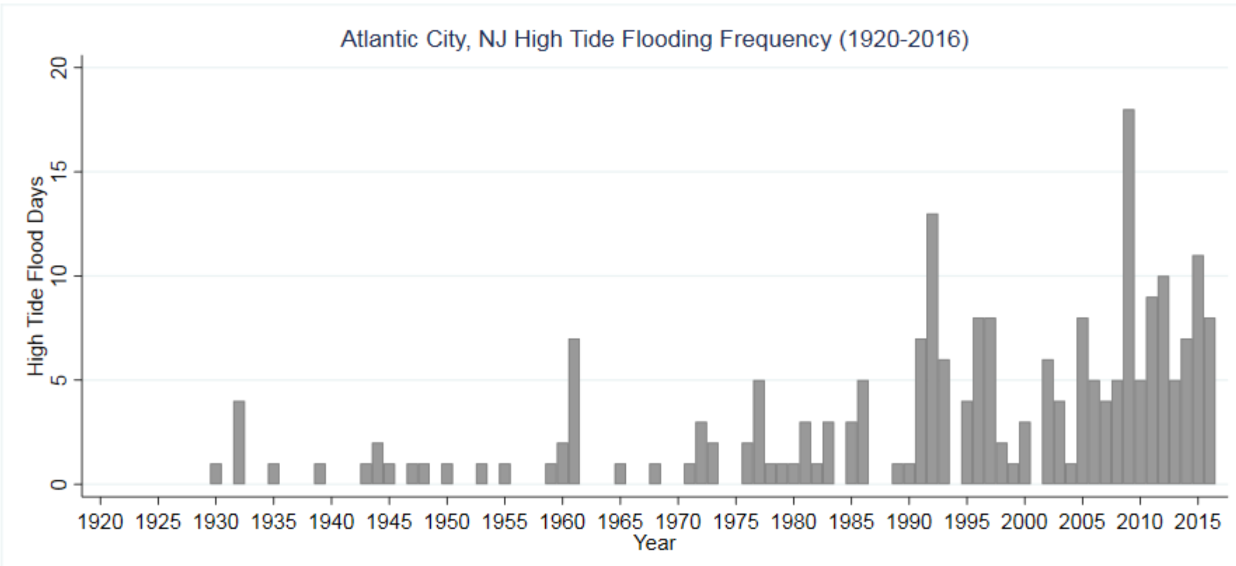


Figure 8. Historical High Tide Flood Frequency (# of flood days) for Atlantic City, NJ (Sweet et al., 2018)

Using the STAP estimates of New Jersey SLR, the STAP used a methodology consistent with Sweet et al. (2018) to calculate tidal flood frequency levels for New Jersey tide gauges corresponding to the projected sea-level changes. The high-tide flood threshold values at each of the 5 gauges suitable for New Jersey analysis are approximately 2 ft (0.56 m - 0.58 m) above MHHW in the year 2000. The high tide flood threshold values are derived using a consistent standard for high tide flooding nationwide by NOAA (Sweet et al., 2018), but are not the same as the local National Weather Service 'minor tidal flood' thresholds. Under the Sweet et al. (2018) approach, the frequency reflects that the high tide flooding threshold is exceeded at least once in a given day, but does not indicate the duration of exceedance, or multiple exceedances, for a high tide flooding event.

Table 5. Expected high-tide flooding days in Atlantic City, NJ, through 2150 for a Moderate Emissions projection

Year	Low End > 95% Chance	*Likely* Range >83% Chance	*Likely* Range ~50% chance	*Likely* Range < 17% chance	High End < 5% chance
2000			5 days		
2010			7 days		
2020	6 days	9 days	17 days	30 days	45 days
2030	10 days	17 days	35 days	75 days	110 days
2040	17 days	30 days	70 days	150 days	220 days
2050	24 days	45 days	120 days	255 days	325 days
2060	40 days	85 days	190 days	315 days	350 days
2070	55 days	120 days	265 days	350 days	**
2080	75 days	165 days	320 days	**	**
2090	85 days	200 days	345 days	**	**
2100	95 days	240 days	355 days	**	**
2110	150 days	285 days	360 days	**	**
2120	155 days	305 days	**	**	**
2130	175 days	325 days	**	**	**
2140	220 days	340 days	**	**	**
2150	255 days	350 days	**	**	**

*Notes: ** indicates high-tide flooding expected every day of the year. Note that expected number of days of flooding per year will differ from the actual number experienced in a specific year; the expected number reflects the average that would be seen were sea-level stable at the projected level for a given year.*

An example of the tidal flood frequencies is provided for Atlantic City, NJ, in Table 5. It is *likely* that the expected number of high tide flooding days will be between 120 and 350 by the year 2070 under a moderate emissions scenario, but this analysis does not include the year-to-year variation around the expected number of days. It is *extremely likely* (more than a 95% chance) that the expected number of high tide flooding days will exceed 55 flood days by the year 2070 under a moderate emissions scenario. By 2100, it is *likely* that high tide flooding will exceed 240 days per year, and could become a daily occurrence under a moderate emissions scenario. A table of decadal high tide flooding frequency projections for each tide gauge used in this report is included in Appendix B.

Critical Future Research Focus: Likelihood and Impacts of Compound Events

As part of the STAP deliberations, the panel discussed the state of available science and modeling with the capability to reflect combined hazards from rainfall and flooding. Such compound events occur through a combination of multiple drivers and/or hazards that contribute to societal or environmental risks (IPCC, 2019; Zscheischler et al., 2018). While flood risks are often modeled as independent precipitation, wind, and storm surge events, recent research efforts have undertaken the task of modeling compound flood events (Hendry et al., 2019; Orton et al., 2018; Orton et al., 2012; Wahl et al., 2015). Recently, Orton et al. (2018) that combined rainfall and storm tide modeling approaches to create a probabilistic flood hazard assessment for the Hudson River. Wahl et al. (2015) modeled the risk of flooding from co-occurring rainfall and storm surge on several US cities, finding that shifting weather patterns could lead to an increased likelihood for co-occurring storm surge and high precipitation events for New York City. Both the STAP members and the practitioner panel discussed the need to move toward integrated models that represent such conditions in order to plan for more comprehensive adaptation and resilience strategies.

Using the Science: Illustrating the Effects of SLR on Future Flood Exposure Assessment in New Jersey

In 2016 and, again in 2019, the STAPs and practitioner panels discussed how the STAP science can inform the assessment of future coastal flood exposures resulting from SLR. The 2016 STAP report for New Jersey (Kopp et al., 2016) outlined several approaches for assessing exposure of people, places and assets to coastal flood hazards resulting from SLR. This included an approach that, at the time was emerging, using the concept of 'SLR allowances' in Atlantic City, NJ (Buchanan et al., 2016), and an approach that is referred to as a "Total Water Level" approach (Campo & Auermuller, 2018; Eastern Research Group Inc., 2013). The latter has been advanced by practitioners at Rutgers University and is reflected on the web-based data visualization and mapping platform New Jersey Floodmapper.

While it is outside the purview of the STAP to endorse any single approach for application of STAP science for use in exposure assessment, in this section of the report, the STAP outlines a "use case" to illustrate one example of how the STAP science can be integrated into a planning and decision-making framework. For the purpose of this "use case," a fictional practitioner is created who is working in Brigantine, New Jersey, on a comprehensive land-use plan. The case is intended to simulate one of many ways in which practitioners can use the updated projections in this document, and other ancillary tools, to begin to present SLR information to other planning stakeholders and decision-makers.

In the example use case, the practitioner will ask 4 questions:

1. What tide gauge will be used as a reference?
2. What planning horizon will be used?
3. What emissions scenario will be used?
4. What SLR estimates will be used?

After answering these four questions, the practitioner will be able to summarize potential SLR impacts for consideration into the development of the comprehensive land-use plan.

Table 6, below, is provided to assist practitioners with applying the outcomes of the STAP and is applied to illustrate the Brigantine "use case."

Table 6. New Jersey Sea-Level Rise above the year 2000 (1991-2009 average) baseline (ft)*

		2030	2050	2070			2100			2150		
				Emissions								
	Chance SLR Exceeds			Low	Mod.	High	Low	Mod.	High	Low	Mod.	High
Low End	> 95% chance	0.3	0.7	0.9	1	1.1	1.0	1.3	1.5	1.3	2.1	2.9
Likely Range	> 83% chance	0.5	0.9	1.3	1.4	1.5	1.7	2.0	2.3	2.4	3.1	3.8
	~50 % chance	0.8	1.4	1.9	2.2	2.4	2.8	3.3	3.9	4.2	5.2	6.2
	<17% chance	1.1	2.1	2.7	3.1	3.5	3.9	5.1	6.3	6.3	8.3	10.3
High End	< 5% chance	1.3	2.6	3.2	3.8	4.4	5.0	6.9	8.8	8.0	13.8	19.6

**2010 (2001-2019 average) Observed = 0.2 ft*

Notes: All values are 19-year means of sea-level measured with respect to a 1991-2009 baseline centered on the year indicated in the top row of the table. Projections are based on Kopp et al. (2014), Rasmussen et al. (2018), and Bamber et al. (2019). Near-term projections (through 2050) exhibit only minor sensitivity to different emissions *scenarios (<0.1 feet). Low and high emissions scenarios correspond to global-mean warming by 2100 of 2°C and 5°C above early Industrial (1850-1900) levels, respectively, or equivalently, about 1°C and 4°C above the current global-mean temperature. Moderate (Mod.) emissions are interpolated as the midpoint between the high- and low-emissions scenarios and approximately correspond to the warming expected under current global policies. Rows correspond to different projection probabilities. There is at least a 95% chance of SLR exceeding the values in the 'Low End' row, while there is less than a 5% chance of exceeding the values in the 'High End' row. There is at least a 66% chance that SLR will fall within the values in the 'Likely Range'. Note that alternative methods may yield higher or lower estimates of the chance of low-end and high-end outcomes.*

First, the practitioner selects one of five tide gauge locations for the basis of their analysis. While the different tide-gauge locations in New Jersey will experience comparable SLR, those same locations will experience different magnitudes of flooding based on local hydrology and morphology (Pugh, 1996). The nearest tide gauge location is usually, but not always, the most suitable choice to represent local tide and flood event characteristics. Practitioners are advised to consult with local and state agencies to determine the tide gauge that best represents local conditions. In the case a tide-gauge choice is not clear, the practitioner can perform analyses for the nearest two tide-gauges and use the tide-gauge that provides more conservative (i.e., higher) water levels for planning.

2. Using a Planning Horizon

Next, the practitioner identifies the appropriate planning horizon. Practitioners can select a decade from 2020 through 2150 in order to estimate SLR impacts over the life of their decision. Practitioners may wish to analyze several decades in order to understand how the risk of flooding from different types of events increases over time. Some practitioners have suggested considering the timeframe of 20-30 years, which is the period when the public thinks about making investments in their homes and when public sector agencies complete long-range master plans for land use or transportation. However, it is important to recognize that land use, transportation, and other infrastructure decisions can have consequences lasting substantially longer than this time frame.

3. Using Emissions Scenarios

The practitioner then considers the SLR estimates. For context, the STAP indicates that SLR projections through 2050 are not dependent on assumptions about future global emissions and the commensurate change in global mean temperature. In other words, coastal communities are locked into the range of SLR that we will see by the year 2050 regardless of whether emissions increase or decrease. For planning horizons after 2050, however, practitioners are advised to estimate the sensitivity of their decision to situations where global emissions will follow a low-, moderate-, or high-emissions pathway through the end of the century.

The STAP has not assigned a likelihood that society will achieve any particular emissions outcome. To ensure that their project decisions account for a variety of future planning situations, practitioners can analyze the sensitivity of their analysis using both the moderate and high-emissions scenarios when developing adaptation strategies and assessing the risks that future flood hazards could pose to people, places, and assets in New Jersey based on current global policy. Additionally, practitioners could use the low-emissions scenario to demonstrate the potential benefits that emissions reductions actions can have on adaptive strategies toward the end of the century.

4. Using SLR Rise Estimates

Once a practitioner has selected a low, moderate and/or high-emissions scenario, they will need to select from within the range of SLR that is possible under each emissions future. Each emissions future has a low-end, *likely* range, and high-end estimate.

When considering individual assets, practitioners will want to consider that:

- Damages to community assets that are highly consequential have larger social, environmental, and economic impacts associated with their failure or impairment than those that are less consequential. For such highly consequential assets, the STAP advises that practitioners use the high-end estimate indicated in Table 6.
- Community assets for which loss or impairment would not cause significant societal losses, using a value within the *likely* range of future sea-level from Table 6 may be adequate for planning.
- While low-end projections are provided in Table 6 to illustrate the full range of *very likely* outcomes, the low-end projections are *extremely unlikely* to be sufficient for managing future exposure risk from increases in flooding.

When considering community-wide adaptation and resilience planning in which multiple assets are involved, practitioners may wish to consider SLR estimates in both the *likely* range and a high-end range in order to assess the variety of critical and non-critical assets in the community. For example, a road that has a high vulnerability may not have high consequences of failure if it only serves as access to a recreational facility. On the other hand, a pier may serve to transfer cargo for nationwide distribution and, thus, have comparatively higher consequences. In these ways, planning for resilience represents community values and necessitates transparency and community engagement.

With regard to planning for both individual assets and community-wide adaptation and resilience planning, an additional benefit of using high-end projections is that doing so accounts for additional flood attributes that are not quantified using this methodology (e.g., changes in shoreline, wave action, development patterns, etc.) and to account for uncertainty related to advances in climate science that may result in an increase in the magnitude of high-end outcomes.

OUTCOME: Summarizing SLR Impacts

In summary, a practitioner is working with decision-makers in Brigantine, NJ, on a comprehensive land-use plan. The practitioner answers the four key questions outlined above as follows:

1. **What tide gauge will be used as a reference?** The practitioner chooses to use the nearby Atlantic City tide-gauge.
2. **What planning horizon will be used?** The practitioner chooses to use a 2050 planning horizon.
3. **What emissions scenario will be used?** The practitioner analyzes their project's sensitivity to moderate and high emissions scenarios.
4. **What SLR estimates will be used?** Since this is a community-level assessment and not an exposure assessment of an individual asset, there is a mix of people, places, and assets with different levels of criticality. The practitioner chooses to analyze both a *likely* range estimate and a 'high-end' estimate for sea-level rise associated with a moderate emissions scenario.

Using the answers to these questions and the decadal SLR projection tables in Appendix A and Appendix B, the practitioner can present the following:

A. A statement about recent SLR from a 2000 baseline year which reflects consensus among STAP participants and is included in this report:

   a. From 1979-2019, sea-level rose 0.7 feet along the New Jersey coast.

B. The practitioner reviews Table A2 for the appropriate year (2050) and the commensurate columns to represent both the likely range (columns 2, 3, and 4) and 'high end' estimates (column 5) for SLR.

a. Residents and businesses in the town are *likely* (at least a 66% chance) to experience SLR of 0.9 to 2.1 ft between 2000 and 2050, indicating that the town intends to plan for 1.4 ft, the central estimate. While it is *extremely unlikely* (less than a 5% chance) that SLR will exceed 2.6 ft by 2050, the town also wants to understand if there any critical or highly vulnerable facilities exposed in the case the unlikely occurs. (See Table 6)

b. Looking past 2050 for long-lived investments, residents and businesses in the town are *likely* (at least a 66% chance) to experience SLR of 2.0 to 5.2 ft between 2000 and 2100, indicating that the town intends to plan for 3.3 ft, the central estimate. While it is *extremely unlikely* (less than a 5% chance) that SLR will exceed 6.9 ft by 2100, the town also wants to understand if there any contingencies needed for long-lived decisions to allow for future adaptive measures. (See Table 6)

C. The practitioner recognizes from interviews that high tide flooding is problematic in this community and will be exacerbated by SLR. The practitioner reviews Table B2 for the *likely* range (columns 2, 3, and 4) and 'high end' estimates (column 5) of high tide flooding frequency.

a. In 2016, there were 8 high tide flooding events in Atlantic City, NJ, with annual event totals ranging between 4 high tide flood events (2007) and 18 high tide flood events (2009) over the past decade (see Figure 8) (Sweet et al., 2018). By 2050, there is approximately a 50% chance that SLR will exceed 1.4 feet, and so town residents and businesses might commensurately expect to see 120 high tide flooding days during an average year by that point in time. (See Appendix B, Table B2)

D. The practitioner recognizes that changes in SLR will not only impact communities during future tides, but also could increase the heights of **all** future flood events. Using information resources from NOAA, the practitioner decides to compute Table 7 to project how SLR would impact the following events:

a. 100-year flood (1% AEP)

b. Historical Sandy Storm Tide

c. Annual Flood (99% AEP)

d. High Tide Flooding Threshold

e. Permanent Inundation (MHHW)

Table 7. Future Projections of Current and Historical Flood Event Heights (ft relative to 2000 MHHW)

Scenario / Year	2000	2030	2050	2070	2100
Moderate Emissions *Likely* (3.3 ft SLR by 2100)					
100-year flood (1% AEP)	4.8	5.6	6.2	7.0	8.1
Sandy Storm Tide	4.1	4.9	5.5	6.3	7.4
10-year flood (10% AEP)	3.3	4.1	4.7	5.5	6.6
Annual Flood (99% AEP)	2.5	3.3	3.9	4.7	5.8
High Tide Flooding Threshold	1.8	2.6	3.2	4.0	5.1
Permanent Inundation (MHHW)	0.0	0.8	1.4	2.2	3.3
Moderate Emissions High End (6.9 ft SLR by 2100)					
100-year flood (1% AEP)	4.8	6.1	7.4	8.6	11.7
Sandy Storm Tide	4.1	5.4	6.7	7.9	11.0
10-year flood (10% AEP)	3.3	4.6	5.9	7.1	10.2
Annual Flood (99% AEP)	2.5	3.8	5.1	6.3	9.4
High Tide Flooding Threshold	1.8	3.1	4.4	5.6	8.7
Permanent Inundation (MHHW)	0.0	1.3	2.6	3.8	6.9

Notes: All values are based on information from the Atlantic City tide gauge. Values in the table refer to total flood event height projections, given in ft. The 100-year flood (1% AEP), 10-year flood (10% AEP), and Sandy Storm Tide all derive from ***NOAA CO-OPS Extreme Water Levels*** *data. The Annual Flood (99% AEP) is generated from an empirical kernel fit provided by NOAA Co-Ops for this report. The high tide flooding threshold for Atlantic City, NJ is from Sweet et al. (2018). Note that alternative methods for measuring flood events and critical event thresholds are available from several different resources (e.g., from the* ***USACE Sea-Level Change Curve Calculator****) and may yield higher or lower estimates of future hazard exposure.*

Table 7 summarizes an example of the total flood event height projections through 2100 for two SLR scenarios in the event of permanent inundation, high tide flooding, and various coastal storm event types. Based on Table 7, the practitioner can begin to understand potential future flood events that include projected SLR. For example, the practitioner might wish to communicate the following:

1. Assuming a *likely* moderate emissions scenario, the highest of daily high tides (permanent inundation) will begin to surpass the current high tide flooding threshold (1.8 ft) between 2050 and 2070, and may be equivalent to the current 10-year flood event by 2100.
2. Assuming a *likely* moderate emissions scenario, 2050 water levels from 'nuisance' or 'sunny day' flood events (high tide flooding threshold) may be equivalent to a current 10-year flood event.
3. Assuming a *likely* moderate emissions scenario, the water level associated with an Annual Flood (99% AEP) by 2070 would surpass the Sandy Storm Tide and be roughly equivalent (0.1 ft different) to the current 100-year flood (1% AEP).

Summary

STAP members identified a consensus communication of historical observations of SLR, along with a distribution of future SLR projections for New Jersey through the year 2150. Decadal projection information is available in Appendix A for practitioner reference. STAP members concluded that there was no clear basis for deviating from the IPCC's conclusions when projecting changes in future coastal storms (i.e., tropical and extratropical cyclones) for New Jersey. They also concluded that higher sea-levels will increase the baseline for flooding from coastal storms, thus increasing their impacts. The STAP has provided an illustration for using the SLR estimates in a planning context. However, practitioners should use these SLR estimates as a consistent basis for accepted estimates and integrate this information into their preferred planning or design methods to account for unique geographic or professional considerations. The STAP recommends that practitioners and scientists review these estimates on a regular basis, not to exceed 5 years as well as after the publication of any global (i.e., IPCC) or national (i.e., National Climate Assessment) assessments related to SLR and coastal storms relevant to New Jersey.

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Appendix A: New Jersey Sea-Level Rise Appendices

Table A1. Low-emissions SLR (ft above 2000 [1991 – 2009 avg.] baseline)

Year	Low End	At least a 66% chance between			High End
	Greater than a 95% chance SLR exceeds	*Greater than an 83% chance SLR exceeds*	*~50% chance SLR exceeds*	*Less than a 17% chance SLR exceeds*	*Less than a 5% chance SLR exceeds*
2000			0		
2010			0.2 ft		
2020	0.1 ft	0.3 ft	0.5 ft	0.7 ft	0.9 ft
2030	0.3 ft	0.5 ft	0.8 ft	1.1 ft	1.3 ft
2040	0.5 ft	0.7 ft	1.1 ft	1.5 ft	1.9 ft
2050	0.7 ft	0.9 ft	1.4 ft	2.1 ft	2.6 ft
2060	0.8 ft	1.1 ft	1.6 ft	2.2 ft	2.7 ft
2070	0.9 ft	1.3 ft	1.9 ft	2.7 ft	3.2 ft
2080	1.0 ft	1.4 ft	2.2 ft	3.1 ft	3.8 ft
2090	1.0 ft	1.5 ft	2.5 ft	3.5 ft	4.4 ft
2100	1.0 ft	1.7 ft	2.8 ft	3.9 ft	5.0 ft
2110	1.0 ft	1.8 ft	3.1 ft	4.6 ft	5.9 ft
2120	0.9 ft	1.9 ft	3.4 ft	5.1 ft	6.6 ft
2130	0.9 ft	2.0 ft	3.7 ft	5.6 ft	7.2 ft
2140	1.1 ft	2.2 ft	4.0 ft	5.9 ft	7.6 ft
2150	1.3 ft	2.4 ft	4.2 ft	6.3 ft	8.0 ft

Table A2. Moderate-emissions SLR (ft above 2000 [1991 – 2009 avg.] baseline)

Year	Low End	At least a 66% chance between			High End
	Greater than a 95% chance SLR exceeds	*Greater than an 83% chance SLR exceeds*	*~50% chance SLR exceeds*	*Less than a 17% chance SLR exceeds*	*Less than a 5% chance SLR exceeds*
2000			0		
2010			0.2 ft		
2020	0.1 ft	0.3 ft	0.5 ft	0.7 ft	0.9 ft
2030	0.3 ft	0.5 ft	0.8 ft	1.1 ft	1.3 ft
2040	0.5 ft	0.7 ft	1.1 ft	1.5 ft	1.9 ft
2050	0.7 ft	0.9 ft	1.4 ft	2.1 ft	2.6 ft
2060	0.8 ft	1.2 ft	1.8 ft	2.5 ft	3.1 ft
2070	1.0 ft	1.4 ft	2.2 ft	3.1 ft	3.8 ft
2080	1.1 ft	1.6 ft	2.6 ft	3.8 ft	4.8 ft
2090	1.2 ft	1.8 ft	3.0 ft	4.4 ft	5.8 ft
2100	1.3 ft	2.0 ft	3.3 ft	5.1 ft	6.9 ft
2110	1.6 ft	2.3 ft	3.7 ft	5.7 ft	8.1 ft
2120	1.6 ft	2.4 ft	4.1 ft	6.4 ft	9.4 ft
2130	1.7 ft	2.6 ft	4.5 ft	7.1 ft	10.9 ft
2140	1.9 ft	2.9 ft	4.9 ft	7.7 ft	12.4 ft
2150	2.1 ft	3.1 ft	5.2 ft	8.3 ft	13.8 ft

Table A3. High-emissions SLR (ft above 2000 [1991 – 2009 avg.] baseline)

Year	Low End	At least a 66% chance between			High End
	Greater than a 95% chance SLR exceeds	*Greater than an 83% chance SLR exceeds*	*~50% chance SLR exceeds*	*Less than a 17% chance SLR exceeds*	*Less than a 5% chance SLR exceeds*
2000					
2010			0.2 ft		
2020	0.1 ft	0.3 ft	0.5 ft	0.7 ft	0.9 ft
2030	0.3 ft	0.5 ft	0.8 ft	1.1 ft	1.3 ft
2040	0.5 ft	0.7 ft	1.1 ft	1.5 ft	1.9 ft
2050	0.7 ft	0.9 ft	1.4 ft	2.1 ft	2.6 ft
2060	0.9 ft	1.2 ft	1.9 ft	2.8 ft	3.4 ft
2070	1.1 ft	1.5 ft	2.4 ft	3.5 ft	4.4 ft
2080	1.3 ft	1.8 ft	2.9 ft	4.4 ft	5.7 ft
2090	1.4 ft	2.1 ft	3.4 ft	5.3 ft	7.2 ft
2100	1.5 ft	2.3 ft	3.9 ft	6.3 ft	8.8 ft
2110	2.2 ft	2.7 ft	4.2 ft	6.8 ft	10.3 ft
2120	2.3 ft	3.0 ft	4.7 ft	7.7 ft	12.3 ft
2130	2.5 ft	3.2 ft	5.2 ft	8.6 ft	14.6 ft
2140	2.7 ft	3.5 ft	5.7 ft	9.5 ft	17.1 ft
2150	2.9 ft	3.8 ft	6.2 ft	10.3 ft	19.6 ft

Table A4. Low-emissions SLR (cm above 2000 [1991 – 2009 avg.] baseline)

Year	Low End	At least a 66% chance between			High End
	Greater than a 95% chance SLR exceeds	*Greater than an 83% chance SLR exceeds*	*~50% chance SLR exceeds*	*Less than a 17% chance SLR exceeds*	*Less than a 5% chance SLR exceeds*
2000			0 cm		
2010			5 cm		
2020	4 cm	9 cm	15 cm	22 cm	27 cm
2030	9 cm	15 cm	23 cm	34 cm	41 cm
2040	15 cm	22 cm	33 cm	47 cm	58 cm
2050	20 cm	27 cm	43 cm	64 cm	79 cm
2060	23 cm	33 cm	49 cm	67 cm	81 cm
2070	27 cm	39 cm	59 cm	81 cm	99 cm
2080	29 cm	44 cm	67 cm	94 cm	116 cm
2090	29 cm	47 cm	75 cm	107 cm	134 cm
2100	31 cm	51 cm	84 cm	120 cm	153 cm
2110	29 cm	54 cm	95 cm	139 cm	179 cm
2120	27 cm	57 cm	103 cm	155 cm	200 cm
2130	27 cm	60 cm	112 cm	170 cm	219 cm
2140	34 cm	66 cm	121 cm	181 cm	231 cm
2150	40 cm	72 cm	127 cm	191 cm	245 cm

Table A5. Moderate Emissions SLR (cm above 2000 [1991 – 2009 avg.] baseline)

Year	Low End	At least a 66% chance between			High End
	Greater than a 95% chance SLR exceeds	*Greater than an 83% chance SLR exceeds*	*~50% chance SLR exceeds*	*Less than a 17% chance SLR exceeds*	*Less than a 5% chance SLR exceeds*
2000			0 cm		
2010			5 cm		
2020	4 cm	9 cm	15 cm	22 cm	27 cm
2030	9 cm	15 cm	23 cm	34 cm	41 cm
2040	15 cm	22 cm	33 cm	47 cm	58 cm
2050	20 cm	27 cm	43 cm	64 cm	79 cm
2060	25 cm	36 cm	54 cm	76 cm	93 cm
2070	30 cm	43 cm	66 cm	95 cm	117 cm
2080	34 cm	50 cm	78 cm	115 cm	145 cm
2090	37 cm	55 cm	90 cm	135 cm	176 cm
2100	39 cm	61 cm	102 cm	156 cm	211 cm
2110	48 cm	69 cm	112 cm	173 cm	247 cm
2120	49 cm	74 cm	124 cm	196 cm	288 cm
2130	52 cm	80 cm	136 cm	217 cm	332 cm
2140	58 cm	87 cm	148 cm	235 cm	377 cm
2150	64 cm	94 cm	158 cm	253 cm	421 cm

Table A6. High-emissions Sea-Level Rise (cm above 2000 [1991 – 2009 avg.] baseline)

Year	Low End	At least a 66% chance between			High End
	Greater than a 95% chance SLR exceeds	*Greater than an 83% chance SLR exceeds*	*~50% chance SLR exceeds*	*Less than a 17% chance SLR exceeds*	*Less than a 5% chance SLR exceeds*
2000			0 cm		
2010			5 cm		
2020	4 cm	9 cm	15 cm	22 cm	27 cm
2030	9 cm	15 cm	23 cm	34 cm	41 cm
2040	15 cm	22 cm	33 cm	47 cm	58 cm
2050	20 cm	27 cm	43 cm	64 cm	79 cm
2060	27 cm	38 cm	59 cm	85 cm	105 cm
2070	33 cm	47 cm	73 cm	108 cm	135 cm
2080	39 cm	55 cm	89 cm	135 cm	174 cm
2090	44 cm	63 cm	105 cm	163 cm	218 cm
2100	47 cm	71 cm	120 cm	192 cm	269 cm
2110	66 cm	83 cm	129 cm	207 cm	314 cm
2120	71 cm	90 cm	144 cm	236 cm	375 cm
2130	77 cm	99 cm	159 cm	263 cm	444 cm
2140	82 cm	107 cm	174 cm	289 cm	522 cm
2150	88 cm	115 cm	188 cm	315 cm	597 cm

Appendix B: Tidal Flooding Projections and Frequencies

Table B1. Atlantic City, NJ High Tide Flood Days - Low-Emissions Scenario

Year	Low End	*Likely* Range			High End
	> 95% Chance	*>83% Chance*	*~50% chance*	*< 17% chance*	*< 5% chance*
2000			5 days		
2010			7 days		
2020	6 days	9 days	17 days	30 days	45 days
2030	10 days	17 days	35 days	75 days	110 days
2040	17 days	30 days	70 days	150 days	220 days
2050	24 days	45 days	120 days	255 days	325 days
2060	35 days	70 days	155 days	270 days	330 days
2070	45 days	95 days	225 days	330 days	355 days
2080	55 days	125 days	270 days	350 days	**
2090	55 days	145 days	310 days	360 days	**
2100	60 days	170 days	335 days	**	**
2110	55 days	190 days	350 days	**	**
2120	45 days	210 days	360 days	**	**
2130	45 days	230 days	360 days	**	**
2140	75 days	265 days	**	**	**
2150	105 days	295 days	**	**	**

*Notes: ** indicates at least high tide flooding expected every day of the year. Note that expected number of days of flooding per year will differ from the actual number experienced in a specific year; the expected number reflects the average that would be seen were sea-level stable at the projected level for a given year.*

Table B2. Atlantic City, NJ High Tide Flood Days – Moderate-Emissions Scenario

Year	Low End	*Likely* Range			High End
	> 95% Chance	*>83% Chance*	*~50% chance*	*< 17% chance*	*< 5% chance*
2000			5 days		
2010			7 days		
2020	6 days	9 days	17 days	30 days	45 days
2030	10 days	17 days	35 days	75 days	110 days
2040	17 days	30 days	70 days	150 days	220 days
2050	24 days	45 days	120 days	255 days	325 days
2060	40 days	85 days	190 days	315 days	350 days
2070	55 days	120 days	265 days	350 days	**
2080	75 days	165 days	320 days	**	**
2090	85 days	200 days	345 days	**	**
2100	95 days	240 days	355 days	**	**
2110	150 days	285 days	360 days	**	**
2120	155 days	305 days	**	**	**
2130	175 days	325 days	**	**	**
2140	220 days	340 days	**	**	**
2150	255 days	350 days	**	**	**

*Notes: ** indicates at least high tide flooding expected every day of the year. Note that expected number of days of flooding per year will differ from the actual number experienced in a specific year; the expected number reflects the average that would be seen were sea-level stable at the projected level for a given year.*

Table B3. Atlantic City, NJ High Tide Flood Days - High-Emissions Scenario

Year	Low End	*Likely* Range			High End
	> 95% Chance	*>83% Chance*	*~50% chance*	*< 17% chance*	*< 5% chance*
2000			5 days		
2010			7 days		
2020	6 days	9 days	17 days	30 days	45 days
2030	10 days	17 days	35 days	75 days	110 days
2040	17 days	30 days	70 days	150 days	220 days
2050	24 days	45 days	120 days	255 days	325 days
2060	45 days	90 days	225 days	340 days	360 days
2070	70 days	145 days	300 days	360 days	**
2080	95 days	200 days	345 days	**	**
2090	125 days	250 days	360 days	**	**
2100	145 days	290 days	**	**	**
2110	265 days	335 days	**	**	**
2120	290 days	345 days	**	**	**
2130	315 days	355 days	**	**	**
2140	330 days	360 days	**	**	**
2150	345 days	**	**	**	**

*Notes: ** indicates at least high tide flooding expected every day of the year. Note that expected number of days of flooding per year will differ from the actual number experienced in a specific year; the expected number reflects the average that would be seen were sea-level stable at the projected level for a given year.*

Table B4. New York, NY (The Battery) High Tide Flood Days - Low-Emissions Scenario

Year	Low End	*Likely* Range			High End
	> 95% Chance	*>83% Chance*	*~50% chance*	*< 17% chance*	*< 5% chance*
2000			5 days		
2010			7 days		
2020	5 days	8 days	15 days	30 days	40 days
2030	9 days	15 days	30 days	70 days	105 days
2040	15 days	30 days	65 days	145 days	215 days
2050	21 days	40 days	115 days	255 days	320 days
2060	30 days	65 days	155 days	270 days	330 days
2070	40 days	95 days	220 days	330 days	355 days
2080	50 days	120 days	270 days	350 days	365 days
2090	50 days	140 days	310 days	360 days	**
2100	55 days	165 days	335 days	365 days	**
2110	50 days	185 days	350 days	**	**
2120	40 days	205 days	360 days	**	**
2130	40 days	230 days	360 days	**	**
2140	70 days	265 days	365 days	**	**
2150	100 days	295 days	365 days	**	**

*Notes: ** indicates at least high tide flooding expected every day of the year. Note that expected number of days of flooding per year will differ from the actual number experienced in a specific year; the expected number reflects the average that would be seen were sea-level stable at the projected level for a given year.*

Table B5. New York, NY (The Battery) High Tide Flood Days - Moderate-Emissions Scenario

Year	Low End	*Likely* Range			High End
	> 95% Chance	*>83% Chance*	*~50% chance*	*< 17% chance*	*< 5% chance*
2000			5 days		
2010			7 days		
2020	5 days	8 days	15 days	30 days	40 days
2030	9 days	15 days	30 days	70 days	105 days
2040	15 days	30 days	65 days	145 days	215 days
2050	21 days	40 days	115 days	255 days	320 days
2060	35 days	80 days	185 days	315 days	350 days
2070	50 days	115 days	265 days	350 days	365 days
2080	70 days	160 days	320 days	360 days	**
2090	85 days	195 days	345 days	**	**
2100	95 days	235 days	355 days	**	**
2110	145 days	280 days	360 days	**	**
2120	155 days	305 days	365 days	**	**
2130	175 days	325 days	**	**	**
2140	215 days	340 days	**	**	**
2150	255 days	350 days	**	**	**

*Notes: ** indicates at least high tide flooding expected every day of the year. Note that expected number of days of flooding per year will differ from the actual number experienced in a specific year; the expected number reflects the average that would be seen were sea-level stable at the projected level for a given year.*

Table B6. New York, NY (The Battery) High Tide Flood Days - High-Emissions Scenario

Year	Low End	*Likely* Range			High End
	> 95% Chance	*>83% Chance*	*~50% chance*	*< 17% chance*	*< 5% chance*
2000			5 days		
2010			7 days		
2020	5 days	8 days	15 days	30 days	40 days
2030	9 days	15 days	30 days	70 days	105 days
2040	15 days	30 days	65 days	145 days	215 days
2050	21 days	40 days	115 days	255 days	320 days
2060	40 days	90 days	220 days	340 days	360 days
2070	65 days	140 days	300 days	360 days	**
2080	95 days	195 days	345 days	**	**
2090	120 days	245 days	360 days	**	**
2100	140 days	290 days	365 days	**	**
2110	265 days	335 days	**	**	**
2120	290 days	345 days	**	**	**
2130	315 days	355 days	**	**	**
2140	330 days	360 days	**	**	**
2150	345 days	360 days	**	**	**

*Notes: ** indicates at least high tide flooding expected every day of the year. Note that expected number of days of flooding per year will differ from the actual number experienced in a specific year; the expected number reflects the average that would be seen were sea-level stable at the projected level for a given year.*

Table B7. Sandy Hook, NJ High Tide Flood Days - Low-Emissions Scenario

Year	Low End	*Likely* Range			High End
	> 95% Chance	*>83% Chance*	*~50% chance*	*< 17% chance*	*< 5% chance*
2000			5 days		
2010			7 days		
2020	6 days	9 days	17 days	30 days	45 days
2030	10 days	17 days	35 days	70 days	105 days
2040	17 days	30 days	65 days	145 days	205 days
2050	24 days	45 days	115 days	245 days	320 days
2060	35 days	65 days	150 days	265 days	325 days
2070	45 days	95 days	215 days	325 days	355 days
2080	50 days	120 days	265 days	350 days	365 days
2090	50 days	135 days	305 days	360 days	**
2100	60 days	160 days	335 days	365 days	**
2110	50 days	180 days	350 days	**	**
2120	45 days	200 days	355 days	**	**
2130	45 days	220 days	360 days	**	**
2140	70 days	260 days	365 days	**	**
2150	100 days	290 days	365 days	**	**

*Notes: ** indicates at least high tide flooding expected every day of the year. Note that expected number of days of flooding per year will differ from the actual number experienced in a specific year; the expected number reflects the average that would be seen were sea-level stable at the projected level for a given year.*

Table B8. Sandy Hook, NJ High Tide Flood Days - Moderate-Emissions Scenario

Year	Low End	*Likely* Range			High End
	> 95% Chance	*>83% Chance*	*~50% chance*	*< 17% chance*	*< 5% chance*
2000			5 days		
2010			7 days		
2020	6 days	9 days	17 days	30 days	45 days
2030	10 days	17 days	35 days	70 days	105 days
2040	17 days	30 days	65 days	145 days	205 days
2050	24 days	45 days	115 days	245 days	320 days
2060	40 days	80 days	180 days	310 days	350 days
2070	55 days	115 days	260 days	350 days	365 days
2080	70 days	155 days	315 days	365 days	**
2090	85 days	190 days	345 days	**	**
2100	95 days	225 days	355 days	**	**
2110	145 days	275 days	360 days	**	**
2120	150 days	300 days	365 days	**	**
2130	170 days	320 days	**	**	**
2140	205 days	340 days	**	**	**
2150	245 days	350 days	**	**	**

*Notes: ** indicates at least high tide flooding expected every day of the year. Note that expected number of days of flooding per year will differ from the actual number experienced in a specific year; the expected number reflects the average that would be seen were sea-level stable at the projected level for a given year.*

Table B9. Sandy Hook, NJ High Tide Flood Days - High-Emissions Scenario

Year	Low End	*Likely* Range			High End
	> 95% Chance	*>83% Chance*	*~50% chance*	*< 17% chance*	*< 5% chance*
2000			5 days		
2010			7 days		
2020	6 days	9 days	17 days	30 days	45 days
2030	10 days	17 days	35 days	70 days	105 days
2040	17 days	30 days	65 days	145 days	205 days
2050	24 days	45 days	115 days	245 days	320 days
2060	45 days	90 days	215 days	335 days	360 days
2070	65 days	135 days	295 days	360 days	**
2080	95 days	190 days	345 days	**	**
2090	120 days	240 days	360 days	**	**
2100	135 days	285 days	365 days	**	**
2110	260 days	330 days	**	**	**
2120	285 days	345 days	**	**	**
2130	310 days	355 days	**	**	**
2140	330 days	360 days	**	**	**
2150	340 days	365 days	**	**	**

*Notes: ** indicates at least high tide flooding expected every day of the year. Note that expected number of days of flooding per year will differ from the actual number experienced in a specific year; the expected number reflects the average that would be seen were sea-level stable at the projected level for a given year.*

Table B10. Cape May, NJ High Tide Flood Days - Low-Emissions Scenario

Year	Low End	*Likely* Range			High End
	> 95% Chance	*>83% Chance*	*~50% chance*	*< 17% chance*	*< 5% chance*
2000			5 days		
2010			7 days		
2020	4 days	7 days	13 days	25 days	40 days
2030	7 days	13 days	30 days	70 days	105 days
2040	13 days	25 days	65 days	150 days	220 days
2050	19 days	40 days	120 days	260 days	330 days
2060	30 days	65 days	155 days	280 days	335 days
2070	40 days	95 days	230 days	335 days	355 days
2080	45 days	125 days	280 days	355 days	365 days
2090	45 days	145 days	315 days	360 days	**
2100	55 days	170 days	340 days	365 days	**
2110	45 days	195 days	355 days	**	**
2120	40 days	215 days	360 days	**	**
2130	40 days	235 days	365 days	**	**
2140	70 days	275 days	365 days	**	**
2150	100 days	305 days	**	**	**

*Notes: ** indicates at least high tide flooding expected every day of the year. Note that expected number of days of flooding per year will differ from the actual number experienced in a specific year; the expected number reflects the average that would be seen were sea-level stable at the projected level for a given year.*

Table B11. Cape May, NJ High Tide Flood Days - Moderate-Emissions Scenario

Year	Low End	*Likely* Range			High End
	> 95% Chance	*>83% Chance*	*~50% chance*	*< 17% chance*	*< 5% chance*
2000			5 days		
2010			7 days		
2020	4 days	7 days	13 days	25 days	40 days
2030	7 days	13 days	30 days	70 days	105 days
2040	13 days	25 days	65 days	150 days	220 days
2050	19 days	40 days	120 days	260 days	330 days
2060	35 days	80 days	195 days	320 days	355 days
2070	50 days	120 days	275 days	355 days	365 days
2080	70 days	165 days	325 days	365 days	**
2090	85 days	200 days	350 days	**	**
2100	95 days	240 days	360 days	**	**
2110	150 days	290 days	365 days	**	**
2120	155 days	310 days	365 days	**	**
2130	180 days	330 days	**	**	**
2140	220 days	345 days	**	**	**
2150	260 days	355 days	**	**	**

*Notes: ** indicates at least high tide flooding expected every day of the year. Note that expected number of days of flooding per year will differ from the actual number experienced in a specific year; the expected number reflects the average that would be seen were sea-level stable at the projected level for a given year.*

Table B12. Cape May, NJ High Tide Flood Days - High-Emissions Scenario

Year	Low End	*Likely* Range			High End
	> 95% Chance	*>83% Chance*	*~50% chance*	*< 17% chance*	*< 5% chance*
2000			5 days		
2010			7 days		
2020	4 days	7 days	13 days	25 days	40 days
2030	7 days	13 days	30 days	70 days	105 days
2040	13 days	25 days	65 days	150 days	220 days
2050	19 days	40 days	120 days	260 days	330 days
2060	40 days	90 days	230 days	340 days	360 days
2070	65 days	145 days	305 days	360 days	**
2080	95 days	200 days	350 days	**	**
2090	125 days	255 days	360 days	**	**
2100	145 days	300 days	365 days	**	**
2110	275 days	340 days	**	**	**
2120	300 days	350 days	**	**	**
2130	320 days	355 days	**	**	**
2140	335 days	360 days	**	**	**
2150	345 days	365 days	**	**	**

*Notes: ** indicates at least high tide flooding expected every day of the year. Note that expected number of days of flooding per year will differ from the actual number experienced in a specific year; the expected number reflects the average that would be seen were sea-level stable at the projected level for a given year.*

Table B13. Philadelphia, PA High Tide Flood Days - Low-Emissions Scenario

Year	Low End	*Likely* Range			High End
	> 95% Chance	>83% Chance	~50% chance	< 17% chance	< 5% chance
2000			5 days		
2010			7 days		
2020	3 days	5 days	8 days	15 days	25 days
2030	5 days	8 days	17 days	45 days	85 days
2040	8 days	15 days	45 days	130 days	205 days
2050	11 days	25 days	95 days	250 days	320 days
2060	17 days	45 days	140 days	265 days	325 days
2070	25 days	70 days	215 days	325 days	355 days
2080	30 days	100 days	265 days	350 days	360 days
2090	30 days	125 days	305 days	360 days	365 days
2100	35 days	155 days	335 days	360 days	**
2110	30 days	175 days	350 days	365 days	**
2120	25 days	200 days	355 days	**	**
2130	25 days	220 days	360 days	**	**
2140	45 days	260 days	360 days	**	**
2150	75 days	295 days	365 days	**	**

*Notes: ** indicates at least high tide flooding expected every day of the year. Note that expected number of days of flooding per year will differ from the actual number experienced in a specific year; the expected number reflects the average that would be seen were sea-level stable at the projected level for a given year.*

Table B14. Philadelphia, PA High Tide Flood Days - Moderate-Emissions Scenario

Year	Low End	*Likely* Range			High End
	> 95% Chance	>83% Chance	~50% chance	< 17% chance	< 5% chance
2000			5 days		
2010			7 days		
2020	3 days	5 days	8 days	15 days	25 days
2030	5 days	8 days	17 days	45 days	85 days
2040	8 days	15 days	45 days	130 days	205 days
2050	11 days	25 days	95 days	250 days	320 days
2060	21 days	55 days	175 days	310 days	345 days
2070	35 days	95 days	260 days	350 days	360 days
2080	45 days	145 days	315 days	360 days	**
2090	60 days	185 days	345 days	365 days	**
2100	70 days	230 days	355 days	**	**
2110	130 days	280 days	360 days	**	**
2120	140 days	300 days	365 days	**	**
2130	160 days	325 days	365 days	**	**
2140	205 days	340 days	**	**	**
2150	250 days	350 days	**	**	**

*Notes: ** indicates at least high tide flooding expected every day of the year. Note that expected number of days of flooding per year will differ from the actual number experienced in a specific year; the expected number reflects the average that would be seen were sea-level stable at the projected level for a given year.*

Table B15. Philadelphia, PA High Tide Flood Days - High-Emissions Scenario

Year	Low End	*Likely* Range			High End
	> 95% Chance	*>83% Chance*	*~50% chance*	*< 17% chance*	*< 5% chance*
2000			5 days		
2010			7 days		
2020	3 days	5 days	8 days	15 days	25 days
2030	5 days	8 days	17 days	45 days	85 days
2040	8 days	15 days	45 days	130 days	205 days
2050	11 days	25 days	95 days	250 days	320 days
2060	25 days	65 days	215 days	335 days	355 days
2070	45 days	125 days	300 days	360 days	365 days
2080	70 days	185 days	340 days	365 days	**
2090	100 days	245 days	355 days	**	**
2100	125 days	290 days	360 days	**	**
2110	260 days	330 days	365 days	**	**
2120	290 days	345 days	**	**	**
2130	315 days	355 days	**	**	**
2140	330 days	360 days	**	**	**
2150	340 days	360 days	**	**	**

*Notes: ** indicates at least high tide flooding expected every day of the year. Note that expected number of days of flooding per year will differ from the actual number experienced in a specific year; the expected number reflects the average that would be seen were sea-level stable at the projected level for a given year.*

Appendix C: Members of the Science and Technical Advisory Panel

LAST NAME	FIRST NAME	ORGANIZATION
Kopp	Robert	Rutgers University, Dept. of Earth and Planetary Sciences
Andrews	Clinton	Rutgers University, Edward J. Bloustein School of Planning and Public Policy
Broccoli	Anthony	Rutgers University, Dept. of Environmental Sciences
Garner	Andra	Rowan University, Dept. of Environmental Science
Kreeger	Danielle	Drexel University, Dept. of Biodiversity, Earth and Environmental Sciences
Leichenko	Robin	Rutgers University, Dept. of Geography
Lin	Ning	Princeton University, Dept. of Civil and Environmental Engineering
Little	Chris	Atmospheric and Environmental Research
Miller	John	NJ Association for Floodplain Management
Miller	Jon	Stevens Institute of Technology, Dept. of Civil, Environmental and Ocean Engineering
Miller	Kenneth	Rutgers University, Dept. of Earth and Planetary Sciences
Moss	Richard	Princeton University, Andlinger Center for Energy and the Environment
Orton	Philip	Stevens Institute of Technology, Dept. of Civil, Environmental and Ocean Engineering
Parris	Adam	New York City Mayor's Office of Resiliency
Robinson	David	Rutgers University, Dept. of Geography
Sweet	William	National Oceanic and Atmospheric Administration, National Ocean Service, Center for Operational Oceanographic Products and Services
Walker	Jennifer	Rutgers University, Dept. of Earth and Planetary Sciences
Weaver	Chris	U.S. Environmental Protection Agency
White	Kathleen	U.S. Army Corps of Engineers, Headquarters, Engineering and Construction

Appendix D: Rutgers University Technical Support Team

LAST NAME	FIRST NAME	ORGANIZATION
Auermuller	Lisa	Jacques Cousteau Coastal Education Center
Campo	Matthew	Rutgers University, Edward J. Bloustein School of Planning and Public Policy
Herb	Jeanne	Rutgers University, Edward J. Bloustein School of Planning and Public Policy
Kaplan	Marjorie	Rutgers Climate Institute

NOAA: 2019 State of US High Tide Flooding with a 2020 Outlook

NOAA Technical Report NOS CO-OPS 092

2019 State of U.S. High Tide Flooding with a 2020 Outlook

Photo Credit: New York Sea Grant

Silver Spring, Maryland
July 2020

noaa National Oceanic and Atmospheric Administration

U.S. DEPARTMENT OF COMMERCE
National Ocean Service
Center for Operational Oceanographic Products and Services

Center for Operational Oceanographic Products and Services
National Ocean Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

The National Ocean Service (NOS) Center for Operational Oceanographic Products and Services (CO-OPS) provides the National infrastructure, science, and technical expertise to collect and distribute observations and predictions of water levels and currents to ensure safe, efficient and environmentally sound maritime commerce. The Center provides the set of water level and tidal current products required to support NOS' Strategic Plan mission requirements, and to assist in providing operational oceanographic data/products required by NOAA's other Strategic Plan themes. For example, CO-OPS provides data and products required by the National Weather Service to meet its flood and tsunami warning responsibilities. The Center manages the National Water Level Observation Network (NWLON), a national network of Physical Oceanographic Real-Time Systems (PORTS®) in major U. S. harbors, and the National Current Observation Program consisting of current surveys in near shore and coastal areas utilizing bottom mounted platforms, subsurface buoys, horizontal sensors and quick response real time buoys. The Center: establishes standards for the collection and processing of water level and current data; collects and documents user requirements, which serve as the foundation for all resulting program activities; designs new and/or improved oceanographic observing systems; designs software to improve CO-OPS' data processing capabilities; maintains and operates oceanographic observing systems; performs operational data analysis/quality control; and produces/disseminates oceanographic products.

NOAA Technical Report NOS CO-OPS 092

2019 State of U.S. High Tide Flooding with a 2020 Outlook

William Sweet

Gregory Dusek

Greg Carbin

John Marra

Doug Marcy

Steven Simon

July 2020

U.S. DEPARTMENT OF COMMERCE
Wilbur L. Ross, Jr., Secretary

National Oceanic and Atmospheric Administration
Dr. Neil Jacobs, Assistant Secretary of Commerce for Environmental Observation and Prediction, performing the duties of Under Secretary of Commerce for Oceans and Atmosphere

National Ocean Service
Nicole LeBoeuf, Acting Assistant Administrator

Center for Operational Oceanographic Products and Services
Richard Edwing, Director

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EXECUTIVE SUMMARY

Sea level rise flooding of U.S. coastlines is happening now, and it is becoming more frequent each year. This flooding typically occurs when ocean waters reach 0.5 meter (m) to 0.65 m above the daily average high tide and starts spilling onto streets or bubbling up from storm drains. Evidence of a rapid increase in sea level rise related flooding started to emerge about two decades ago, and it is now very clear. This type of coastal flooding will continue to grow in extent, frequency, and depth as sea levels continue to rise over the coming years and decades.

Observations from NOAA's national tide gauge network calibrated to the national set of coastal flood thresholds used by local emergency managers are tracking this phenomenon. NOAA's National Ocean Service calls such flooding high tide flooding (HTF), and its cumulative toll is damaging to subsurface and ground-level infrastructure and is disrupting lives and livelihoods. As the frequency of HTF increases, NOAA's National Weather Service is issuing record numbers of watches/warnings for coastal flooding, often with no storm in sight. This will become the new normal unless coastal flood mitigation strategies are implemencted or enhanced. Communities are investing in coastal infrastructure upgrades and adaptation strategies to address current flooding issues, but concerns regarding property access and future valuation/exposure, business disruption, public health, and other such concerns are growing.

In 2019 (May 2019–April 2020), the national (outside of Alaska) median HTF frequency of 4 days tied its second highest value, and its decadal trend continues to accelerate. The U.S. annual HTF frequency now is more than twice that in the year 2000 due to rising relative sea levels (RSL), which in 2019 rose to a record-setting 0.34 m (1.1 ft) nationally relative to1920 levels. Individual RSL records were set along most (57 of 62) East and Gulf Coast locations, where annually HTF is now occurring at upwards of twice the national rate or more. Nineteen locations also broke or tied their all-time HTF records (median of 13 days) in 2019 along the East and Gulf Coasts including multiple locations along the Texas coastline, as well as at Miami, Savannah, Charleston and Annapolis. Annual HTF frequencies are accelerating (increasing nonlinearly) at 75% of East and Gulf Coast locations with nearly all others rising but not (yet) accelerating. For perspective, it was not until 1979 (more than 50 years of observations) that Charleston, S.C. experienced 13 total days of HTF; in 2019, 13 days of HTF occurred[1].

Next year (May 2020–April 2021), acceleration in HTF and its impacts are expected to continue under near-neutral conditions of the El Niño Southern Oscillation. Nationally, the HTF outlook is 2–6 days (likely range). The Northeast Atlantic and Western Gulf outlook is 6–11 days and 5–11 HTF days, respectively. The outlook for the Southeast Atlantic, the Eastern Gulf, and the Northwestern and Southwestern Pacific coastlines are less: 3–6 days, 2–5 days, 0–7 days and 0–3 days, respectively. No HTF flooding (relative to the threshold applied here) is projected for U.S. Island coastlines. This outlook does not consider wave and local rain effects.

Under current floodplain management practices, by 2030 the national HTF frequency trend is likely to further increase by about 2–3 fold (national median of 7–15 days). In 30 years (by 2050), it is likely to be 5–15 fold higher (national median of 25–75 days), which could, in some places, imply HTF flooding would become the new high tide (~180 days/year).

[1] For more information, please visit https://tidesandcurrents.noaa.gov/HighTideFlooding_AnnualOutlook.html.

1. INTRODUCTION

Tide gauges of the National Oceanic and Atmospheric Administration (NOAA) are sentinels along the U.S. coastline, supporting safe shipping operations and emergency responses during the fiercest of storms. For over a century, they also have been observing a rise in relative sea level (RSL) and the loss of coastal freeboard. Paired with coastal flood thresholds for local impacts used when issuing contemporary weather/water level warnings (NOAA, 2020; Sweet et al., 2018), NOAA tide gauges show that a rapid growth in coastal flood risk is now occurring within many U.S. coastal communities (Sweet and Park, 2014; Figure 1). Flooding that decades ago happened only during a severe storm can now occur during a full-moon tide or with a change in prevailing winds or currents. Such high tide flooding (HTF) is becoming common and is of growing concern within U.S. coastal communities.

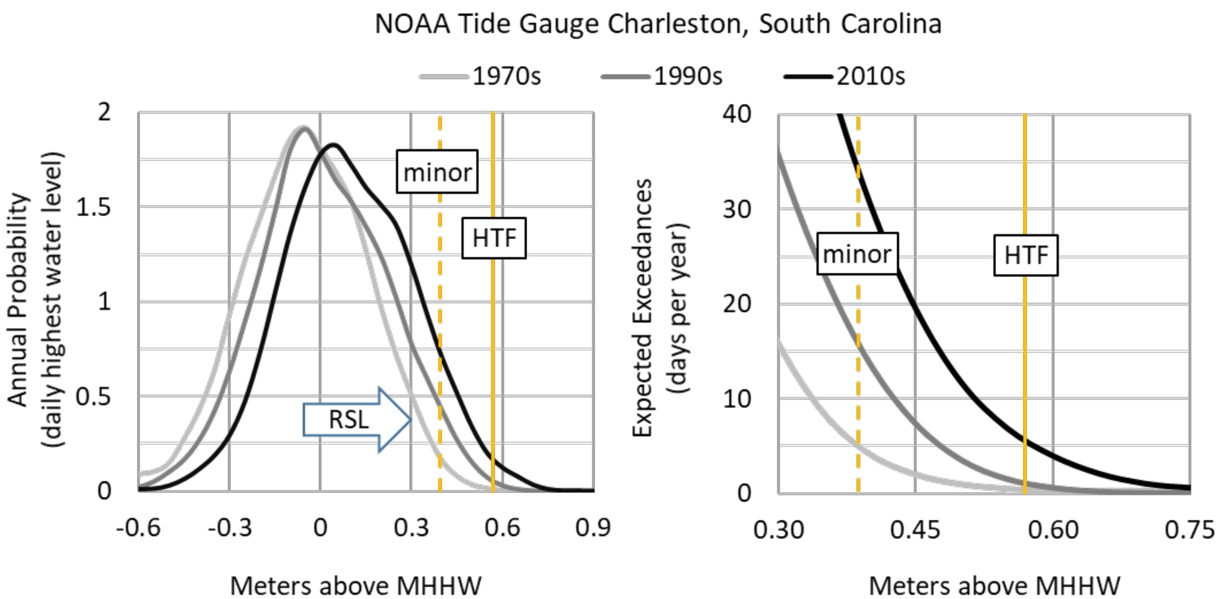

Figure 1. Decadal empirical probability distributions (left) and expected exceedances (right: 1-cumulative distribution) for daily highest water levels in Charleston, S.C. during the 1970s, 1990s, and 2010s changing due to relative sea level (RSL) rise. Shown are the NOAA National Ocean Service (NOS) HTF threshold (Sweet et al., 2018) and the local NOAA NWS Weather Forecasting Office (WFO) minor flood threshold (https://water.weather.gov/ahps2/hydrograph.php?wfo=chs&gage=chts1).

HTF begins to occur when coastal water levels reach heights between 0.5 meter (m) and 0.65 m above the mean higher high water (MHHW) level (Figure 2a). HTF thresholds vary with tide range, as do the NOS-defined moderate and major flooding thresholds that begin to occur at about 0.8 m and 1.2 m above MHHW, respectively (Sweet et al., 2018). The HTF thresholds are based upon the coastal flood thresholds set by NOAA National Weather Service (NWS) Weather Forecasting Offices (WFOs) and on-the-ground local emergency managers who prepare for response to impending conditions (NOAA, 2020). WFOs will typically issue a *coastal flood advisory* when NWS minor flooding is expected. NWS flood thresholds are calibrated empirically from years of impact monitoring, but they are valid usually for only particular parts of a city or region that has variable topography, urbanization, and storm-proofing. As a best-fit solution to the NWS thresholds (Figure 2b: regressed with tide range), the NOS HTF thresholds provide a nationally consistent height that broadly defines infrastructure vulnerabilities to flooding that can be mapped along U.S. coastlines (Figure 2c). It is acknowledged that in some locations (e.g., Miami, Fla.; Charleston, S.C.; Honolulu, Hawaii), some obvious (but spatially more limited) flooding might occur before water levels reach the local HTF threshold used here. Conversely, in some locations (e.g., directly behind the seawalls of Galveston, Tex.; St. Petersburg, Fla.; and New York City), water levels reaching the HTF threshold may not cause obvious flooding (but still may affect subsurface infrastructure like storm-water infiltration).

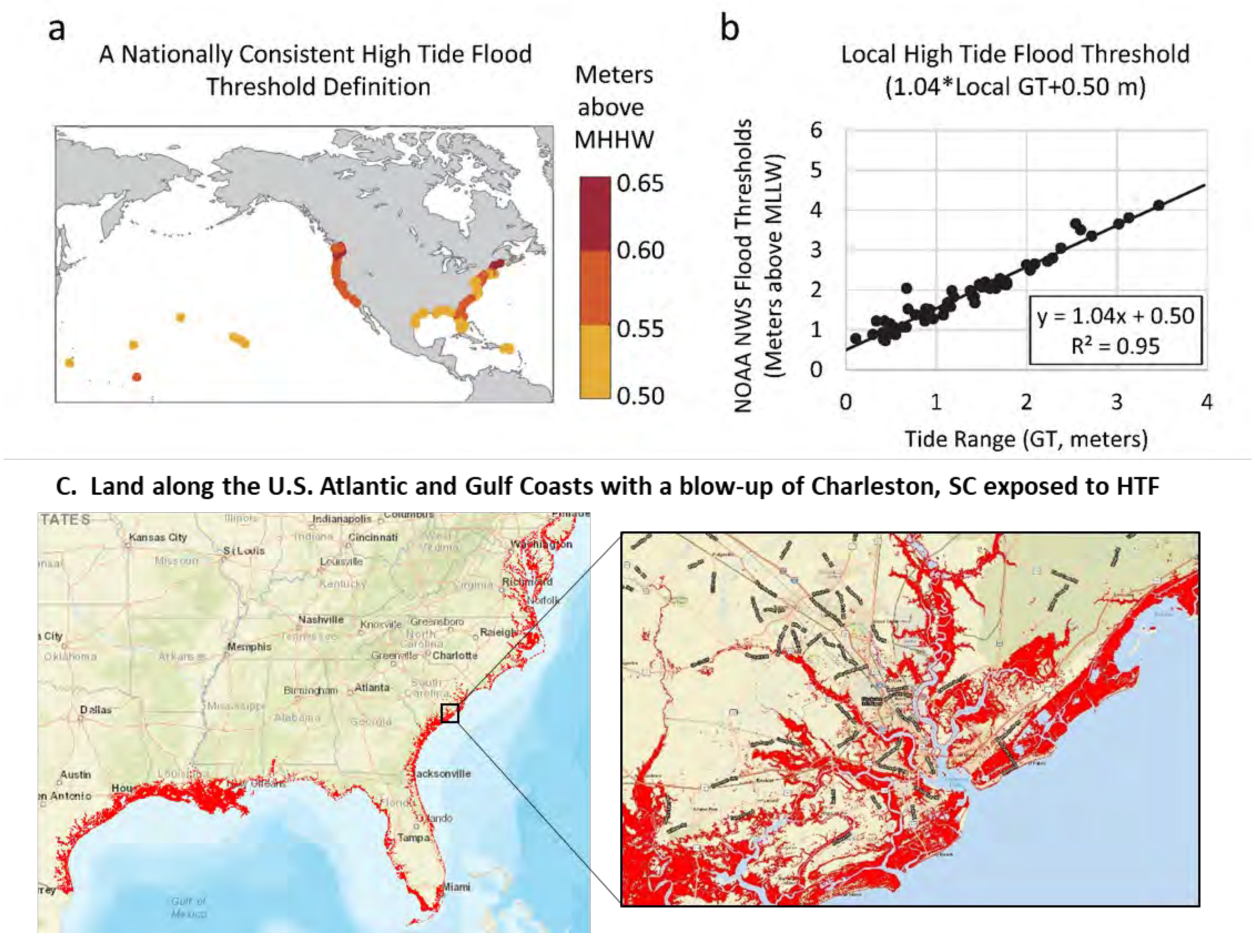

Figure 2. a) HTF height thresholds established at NOAA tide gauges based upon the regression relationship shown in b) as a scatter plot of a national set (about 60 locations) of NOAA NWS flood thresholds for minor impacts (y-axis) shown relative to the mean lower low water (MLLW) tidal datum versus the local great diurnal tide range (GT) on the x-axis. Adapted from Sweet et al. (2018). In c) is a map of the areas (red) at or below the HTF threshold interpolated between locations for the U.S. East and Gulf Coasts with a zoom-in of the Charleston, S.C. region. (Data accessible from NOAA's Sea Level Rise Viewer: https://coast.noaa.gov/slr/)

HTF is called by many names: sunny-day, nuisance, recurrent, king-tide, tidal, or sea level rise flooding. One thing they all have in common is that the cumulative toll of impacts are becoming disruptive and damaging within many coastal communities. HTF impacts are increasing in frequency and spatial extent and threaten a myriad of coastal infrastructure. In 2019, there were numerous media reports of ongoing impacts and related concerns of the future, including 1) access to homes and important transportation links due to flooding and erosion of roadways[2], 2) flooding of homes[3], as well as unforeseen consequences to recent mitigation efforts[4], 3) the cost of replacing antiquated combined storm and wastewater systems being impacted by rising seas and groundwater tables[5], 4) the health effects of such combined systems[6], and 5) the negative pressure on real estate values[7]. There was also reporting about efforts underway to help address the impacts, including 1) holding public 'Flood Stat' meetings[8] and 2) using social media technology to better discern where and when HTF is occurring[9].

This report is the sixth in an annual series to look back at HTF over the past year and to look forward to the years to come with annual and multi-decadal HTF projections building upon past studies (Sweet and Park, 2014; Sweet et al., 2018). The report provides 1) an assessment of HTF that occurred in 2019 relative to measured flood-frequency trends, 2) maps of areas potentially exposed to HTF, and 3) a 2020 outlook based upon temporal trends and predicted strength of the El Niño Southern Oscillation (ENSO). This report and accompanying NOAA website[10] also continue to provide projections of HTF by Sweet et al. (2018) based upon the range of RSL rise *likely* to occur by 2030 and 2050 using projections of the Fourth National Climate Assessment[11]. This information is intended to raise awareness of the growing impact of RSL rise through HTF and inform decision-making not only next year (e.g., budgeting and allocating for necessary coastal flood responses) but over the longer term (e.g., major infrastructure upgrades and land-use planning) to ensure resilience to sea level rise impacts.

2. 2019 CONDITIONS

In 2019[12] the national (median) HTF occurrence along U.S. coastlines as a whole was 4 days. This is 1 day less than the record reached in 2018 as measured by 98 NOAA tide gauges[13] (Figure 3a). Assessed over several decades, the national trend in HTF frequency is accelerating, and HTF is more than twice as likely now as it was in 2000. The rapid growth is in response to RSL rise, which is occurring along most U.S. coastlines. (Our study does not include Alaska, where land-based ice melt is contributing to land rebound[14]). In 2019, RSL along U.S. coastlines (median value) reached an all-time record of 0.34 m since 1920 (last 100 years), which is about 4

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[2] https://www.hawaiinewsnow.com/2020/01/08/collapse-highway-hauula-latest-example-sea-level-rise-impacts/; https://www.nytimes.com/2019/12/04/climate/florida-keys-climate-change.html
[3] https://www.nj.com/news/2020/01/our-homes-flood-monthly-and-we-need-help-jersey-shore-residents-say.html
[4] https://www.miamiherald.com/news/local/environment/article239486308.html
[5] https://www.miamiherald.com/news/local/environment/article239005633.html
[6] https://www.sun-sentinel.com/local/broward/fort-lauderdale/fl-ne-sewage-spills-health-risks-20200102-5hgi2hjsffea7cbjaoyhw3il3q-story.html
[7] https://www.miamiherald.com/news/local/environment/article239285848.html; https://www.nytimes.com/2020/06/19/climate/climate-seas-30-year-mortgage.html
[8] https://www.postandcourier.com/news/charleston-and-the-south-carolina-coast-flooded-record-times-in/article_7c18ee5e-2e3b-11ea-8784-23ddbc8d4e0c.html
[9] https://www.cnn.com/2020/02/05/us/sea-level-rise-flooding-twitter-study/index.html
[10] https://tidesandcurrents.noaa.gov/HighTideFlooding_AnnualOutlook.html
[11] https://scenarios.globalchange.gov/sea-level-rise
[12] Unless otherwise noted, a year in this report is defined as a meteorological year spanning May-April.
[13] Following the reasoning of Sweet et al. (2018), Alaska and locations with tide ranges greater than 4 meters and where RSL trends are decreasing are not included in this report.
[14] https://tidesandcurrents.noaa.gov/sltrends/

centimeters (1.5 inches) higher than it was in 2018. The national RSL (linear) trend along U.S. coastlines examined here is 2.8 millimeters/year over this period (not shown). Inherent to the RSL measurement in Figure 3a is the effect of land subsidence, which nationally (median plus or minus standard deviation value of the 98 tide gauges monitored) is occurring at a rate of 0.7 ±1.4 mm/year, but can be as high as 7 mm/year along the coastline of Louisiana (Zervas et al., 2013; Sweet et al., 2017). Annual mean RSLs at most East and Gulf Coast tide gauges (57 of the 62) broke their historical records (Figure 3b) in 2019 by (median value) 2.6 cm (about 1 inch).

Locally, these record RSLs (and the underlying RSL trends) are a primary factor of HTF occurrence rates in 2019 as shown for Charleston, S.C. (Figure 3c). For example, the combination of predicted (astronomic) tide and the monthly nontidal residual (sea level anomaly) in Charleston together account for about 75% of the record-breaking HTF days in 2019. Although water level variance (e.g., typical frequency of and response magnitude to windstorms) is a factor in annual HTF frequencies locally in any given year (Figure 3c) and helps explain regional HTF patterns, it exhibits few long-term trends around U.S. coastlines (Sweet and Park, 2014). HTF flooding is occurring more often now than in the past because of RSL rise and not changes in 'storminess.'

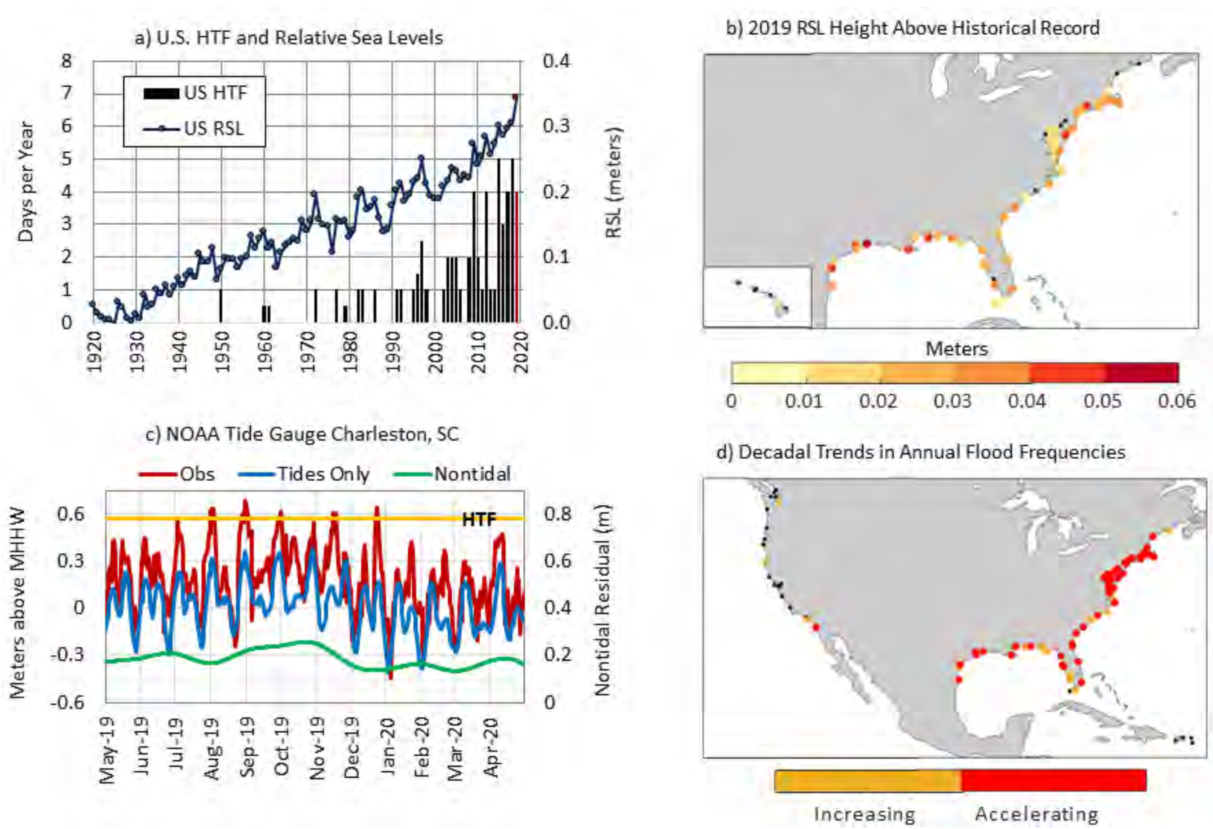

Figure 3. a) Median HTFs per year (black bars) from 1920–2019 with the annual-median rise in RSL (blue line). 2019 sea level and flood frequency values are shown in red. In b) are the individual tide gauge locations that broke historical RSL records in 2019. In c) is a time series of 2019 daily highest water level observation (red line) and its tide component only (blue line) with monthly average nontidal residual levels (green line: observations – tide only) at the NOAA tide gauge in Charleston, S.C. In d) is the characterization of the trends in annual HTF frequencies, with 49 locations now accelerating and 19 increasing linearly. Trends are significant at the 90% level (p value <0.1) or higher.

The acceleration in the national HTF frequency (Figure 3a) is a reflection of the acceleration occurring at most (48 of 68) U.S. East and Gulf Coast tide gauges (Figure 3d) with the remainder (except Key West, Fla.) increasing linearly. Nationally, there are 49 locations where HTF frequencies are accelerating and 19 that are linearly increasing. HTF acceleration is to be expected as RSL rises and flood-management or mitigation efforts are limited or insufficient (Sweet and Park, 2014; Sweet et al., 2018). Tide gauges will continue to measure higher sea levels and tide heights, but more flooding and impacts will not necessarily occur if flood management (mitigation, adaptation, etc.) efforts keep pace.

HTF in 2019 occurred the most along the Western Gulf of Mexico coastline with 18 ±19 (median ±1 standard deviation or 0–37 days at 1 standard deviation) days, with the Northeast (9 ±5 days) and the Southeast (7 ±4 days) Atlantic coastlines also experiencing relatively high number of HTF days (Figure 4). The Eastern Gulf experienced several (3 ±4 or 0–7 days at 1 standard deviation) HTF days with the remainder of the U.S. experiencing relatively few, if any, HTF days. Thus, HTF occurred more often along the Southeast Atlantic and Gulf Coasts in 2019 where record-breaking RSL also occurred (Figure 3b).

The frequency of HTF in 2019 was within the range predicted by the NOAA 2019 HTF outlook (Sweet et al., 2019) at about 60% of locations, and it was above and below prediction at about 25% and 15% of locations, respectively. The U.S. West Coast was largely over-predicted due in part to a weakened El Niño (Oceanic Niño Index [ONI] of about 0.4 °C[15] and as compared to what was predicted and used in the 2019 outlook (ONI value of 0.75 °C, Sweet et al., 2019).

[15] https://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php

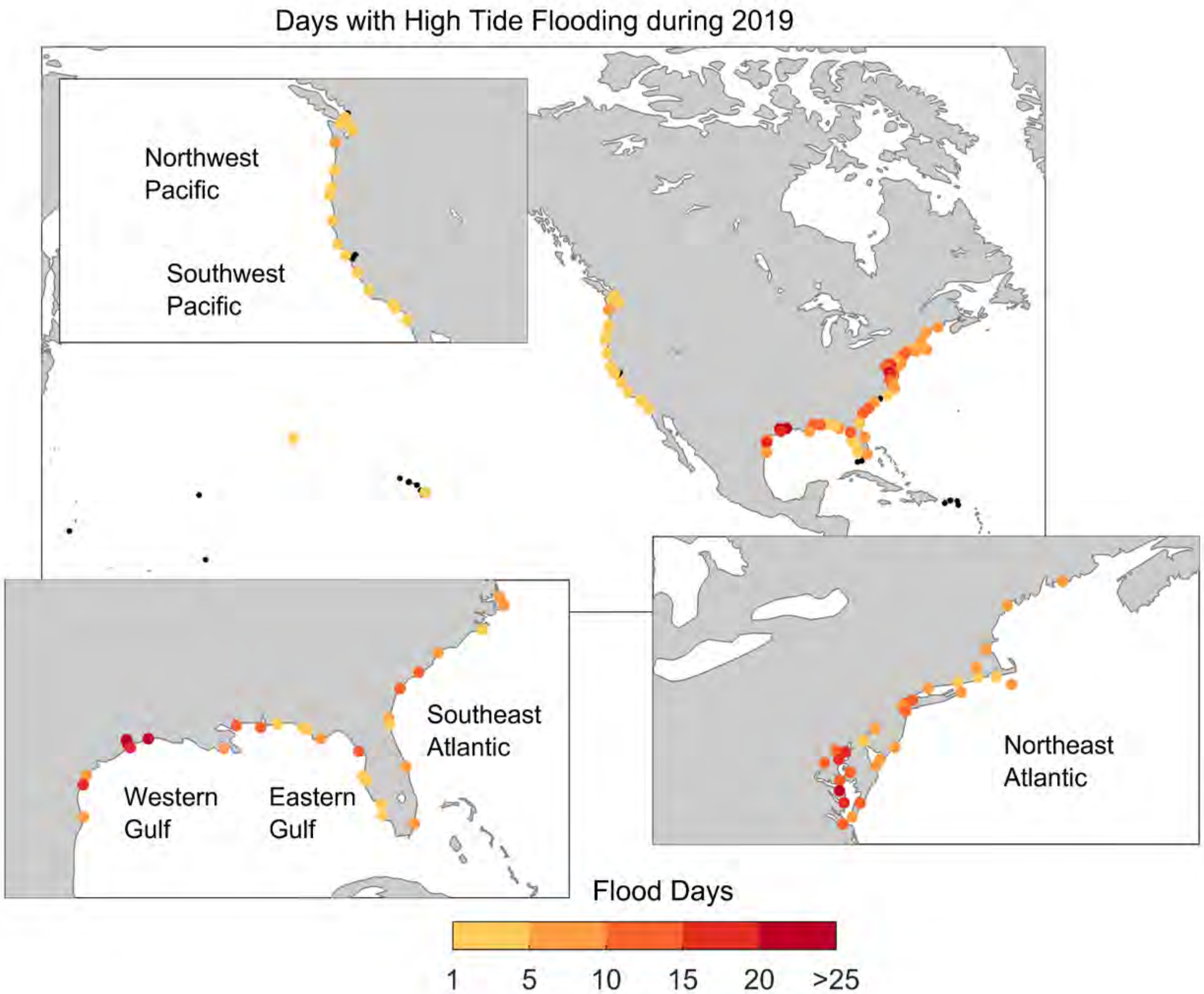

Figure 4. Number of days with HTF in 2019 at 98 NOAA tide gauge locations with values listed in Appendix 1. Black dots identify locations where HTF did not occur during 2019.

Of the 25 locations where HTF in 2019 was above the predicted range, 19 broke their all-time records. Records were set throughout the Chesapeake Bay region and along the Southeast Atlantic coastlines, as well as both the Eastern and Western Gulf of Mexico coastlines. HTF occurred most frequently (64 days) at Eagle Point, Tex., which is within Galveston Bay. This location has been an anomaly over the last two decades[16] presumably in response to localized land subsidence with RSL rise rates of 1.4 cm/year over the last 26 years (>1 ft)[17]. It is unclear whether any localized impacts associated with HTF are apparent or disruptive within this community. Other notable locations setting records include (see Appendix 1 for complete list) Annapolis, Md. (18 days) where HTF often causes parking and transportation disruption in the downtown area (Hino et al., 2019), Charleston, S.C. and Savannah, Ga. (13 days each), Virginia Key in the Miami region (9 days), Dauphin Island, Ala. (10 days) and Galveston, Tex. (18 days).

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[16]https://tidesandcurrents.noaa.gov/publications/techrpt86_PaP_of_HTFlooding.csv
[17]See monthly sea level data at https://tidesandcurrents.noaa.gov/waterlevels.html?id=8771013.

Compared to HTF frequencies typical in 2000 assessed with an accelerating or linearly increasing significant trend (e.g., Figure 3d), HTF in 2019 was extraordinary. Flood days occurred 100–150% more frequently than in 2000 along the Northeast Atlantic and Eastern Gulf coastlines (e.g., 14 HTF days in 2019 at Norfolk, Va. is >150% higher than the trend value of about 5 days in 2000). Even higher percentage increases (>300%) occurred along the Southeast Atlantic (e.g., >500% increase in Charleston with 13 HTF days in 2019 compared to about 2 days in 2000). Percentage increases compared to 2000 were the greatest in the Western Gulf (>500%). For example, Sabine Pass and Corpus Christi, Tex. had 21 and 18 HTF days in 2019, and in 2000 the trend values were about 1 and 3 days (>1000% and 500% increase), respectively. This increase is in part driven by about a 0.15 m (0.5 ft) rise in RSL[18]. Five out of Texas's seven NOAA tide gauges broke records last year, and it is likely that both the rise in RSL and HTF are affecting groundwater levels and contributing to poor coastal water quality along many Texas coastlines, which have showed elevated bacteria counts over the last year[19] (personal communication with Jason Pinchback, Manager of the Texas Coastal Resources/Water Resources Program).

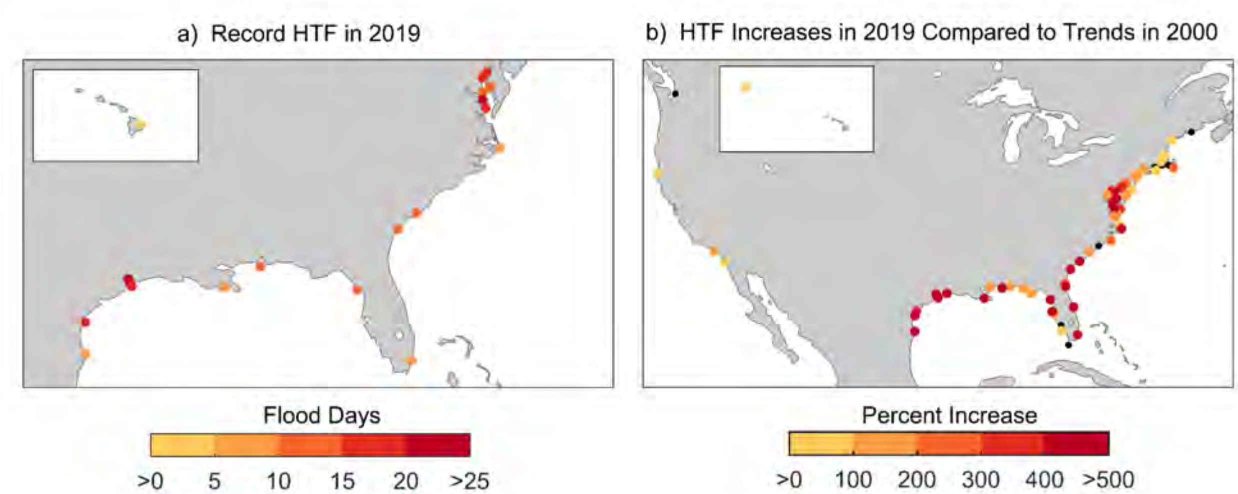

Figure 5. a) Locations where HTF either tied or broke all-time records and b) the percent increase in 2019 HTF days as compared to trend values for year 2000 for locations shown in Figure 3d.

In terms of public communication of possible coastal (HTF) flooding, NOAA NWS WFOs issue *coastal flood advisories* if minor coastal flooding is expected; if moderate or major coastal flooding is imminent, *coastal flood warnings* are issued (NOAA, 2020)[20]. HTF flood threshold by design (best-fit regression, Sweet et al., 2018) align closely with NWS minor flood thresholds, but counts of HTF also include less-frequent moderate and major flooding when they occur. Not surprisingly, as frequencies of HTF increase, the frequency of WFOs coastal flood advisory/warning issuances increase as well (Sweet et al., 2019). This upward trend in WFO

[18] https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8770570, https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8775870
[19] https://cgis.glo.texas.gov/Beachwatch/index.html
[20] The NOAA NOS definition of moderate and major flooding uses similar regression analysis as with NWS minor coastal flooding (Figure 2b). Moderate and major flooding equate to heights of about 0.8–0.9 m and 1.15–1.3 m above MHHW (Sweet et al., 2018).

coastal flood guidance continued into 2019 (May 2019–April 2020). Half of the 22 coastal WFOs along the East and Gulf Coasts[21] issue more coastal advisories and warnings every year (significant positive trend from 2008–2019, not shown). In 2019, about a third (7 of 22) of the coastal WFOs issued a combined number of coastal flood advisories and warnings that tied (two WFOs) or exceeded (five WFOs) previous records. The NWS WFOs (map of the WFOs[22]) that set records include three East Coast WFOs (Wakefield, Charleston, and Jacksonville) and four Gulf Coast WFOs (Mobile, Lake Charles, Corpus Christi, and Brownsville). Similarly, about a third of the NOAA tide gauges along the East and Gulf Coast (19 of 62) set/tied their HTF records in 2019 (Figure 5a).

Histories of annual HTF at four NOAA tide gauges along the U.S. Atlantic and Gulf Coasts and the coastal flood advisories and warning from their surrounding WFOs are shown in Figure 6 to illustrate this relationship. All tied/broke their records in 2019, except for the count of HTF days at Norfolk (Sewells Point), Va. and Sabine Pass, Tex., which were both second highest on record. HTF flooding and coastal flood advisories/warnings at these four locations are correlated (r-value of 0.75–0.8) and accelerating through time. These results demonstrate the direct effects of RSL rise affecting coastal flood risk and weather/water level forecasting that is guiding day-to-day decision making.

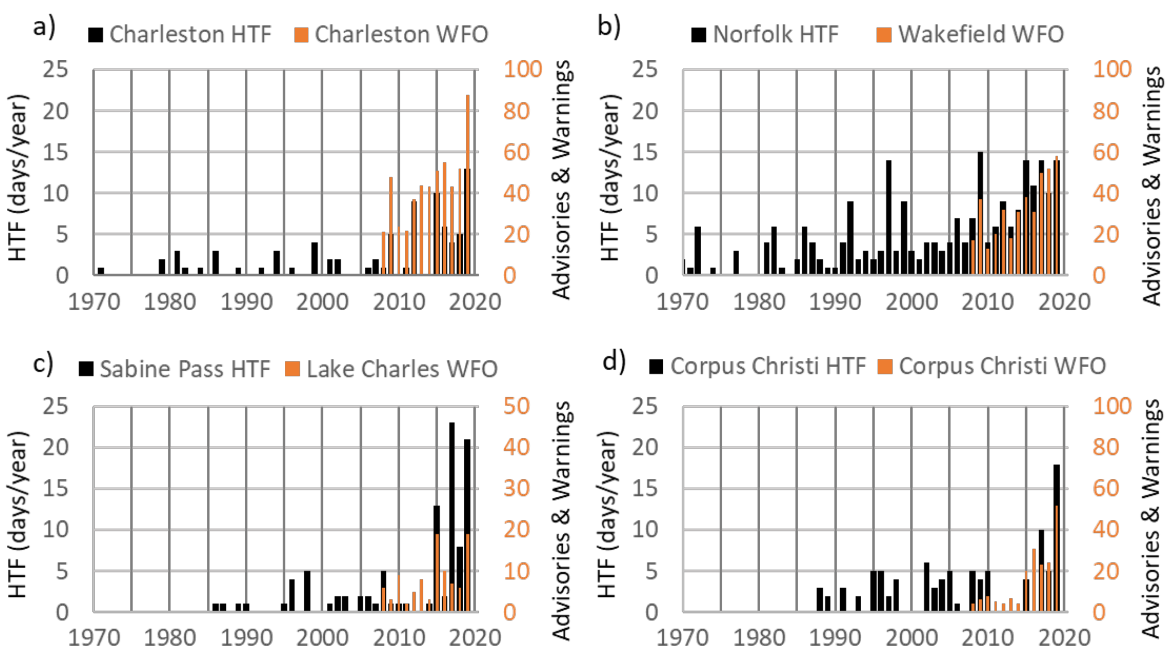

Figure 6. Annual (meteorological year: May–April) HTF frequencies measured at NOAA tide gauges at a) Charleston, S.C., b) Norfolk, Va. (Sewells Point), c) Sabine Pass, Tex. and d) Corpus Christi, Tex. with the number of annual coastal flood advisories and warnings from the encompassing coastal WFO[23] since 2008. Note: coastal flood advisories/warnings were issued prior to 2008, but only those with a valid time event code starting about 2008 are readily obtainable via archives by the University of Iowa.

[21] https://mesonet.agron.iastate.edu/archive/
[22] https://www.weather.gov/srh/nwsoffices
[23] https://www.weather.gov/srh/nwsoffices

3. 2020 HIGH TIDE FLOOD OUTLOOK

The 2020 outlook is a projected range of likely HTF days (expected value ±1 standard deviation) based upon the underlying statistical model. The projections are based on either: 1) a 19-year (2001–2019) climatological average where no trends exist, 2) an extrapolated linear or quadratic temporal regression trend fit, and/or 3) an extrapolated statistical fit that also uses the strength of ENSO quantified by the Oceanic Niño Index[24] in a bivariate regression. Statistical fits use data from 1950 (or the start of hourly observations) through 2019. All trend fits are significant above the 90% level (p value <0.1). Multi-model ensemble predictions of ENSO strength for 2020 and 2021 are obtained from the International Research Institute for Climate and Society in May 2020[25].

ENSO neutral conditions (ONI value of 0.07 °C) are predicted into 2021. As such, the 39 locations whose HTF frequency reveal significant dependence upon influence of El Niño (Figure 7a) are not projected to deviate much (i.e., above long-term average or temporal trend projected values). The annual HTF frequency history, quadratic trend characterization and the additional dependence upon ENSO is illustrated for San Diego, Calif. and Norfolk, Va. in Figure 7b. The 2020 outlook is also shown as the red shade, with 9–13 HTF days for Norfolk and 4–7 days for San Diego.

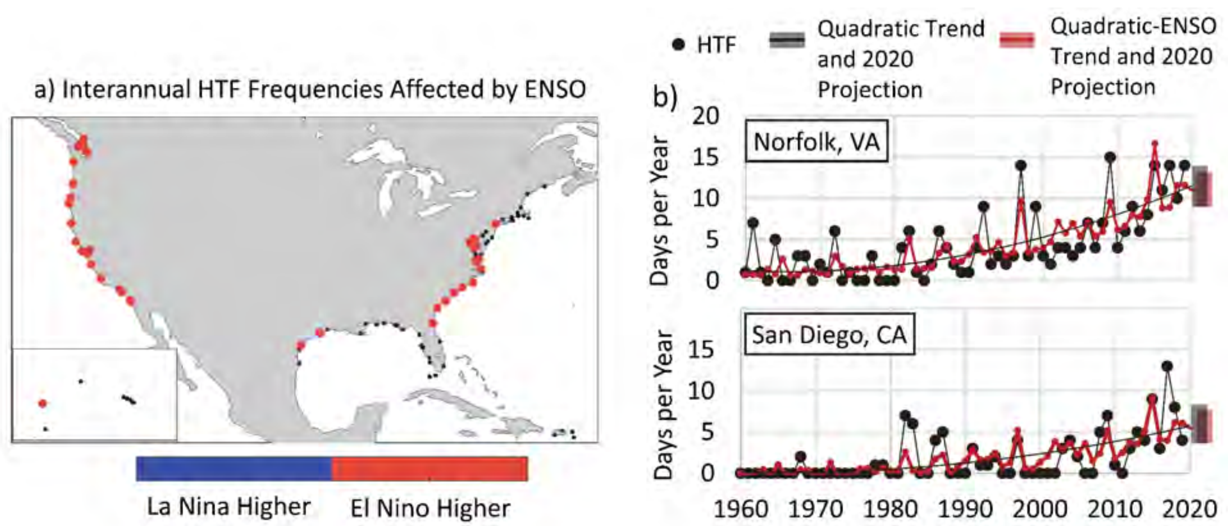

Figure 7. a) Locations where annual HTF frequencies from 1950 (or data start)–2019 are influenced by phases of the ENSO and b) annual HTF occurrence (black dots) with quadratic regression fits (black line) projected through 2020 (grey shading) in Norfolk, Va. and San Diego and bivariate regressions (red line-dot) that include ENSO effects (ONI) in addition to the temporal changes. The 2020 ENSO-based outlooks (red shading) include the 2020 ONI predicted value of about 0.07 °C.

The 2020 HTF outlook is shown in Figure 8, listed in Appendix 1, and displayed on a NOAA website[26]. The Northeast Atlantic and Western Gulf coastlines are projected to experience the most HTF in 2020 (median range values of 6–11 days and 5–11 HTF days, respectively), e.g., 9–

[24]ONI: https://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php
[25]Dynamical and statistical El Niño average of 0.07 predicted for the rest of 2020 meteorological year https://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/?enso_tab=enso-sst_table.
[26] https://tidesandcurrents.noaa.gov/HighTideFlooding_AnnualOutlook.html

14 days in the New York City region and about the same (9–13 days) in Norfolk, Va., 9–17 days at Sabine Pass, Tex. and 7–12 days in Galveston, Tex. The Southeast Atlantic, Eastern Gulf, and Northwestern Pacific coastlines are projected to experience fewer overall HTF days (median range values of 3–6 days, 2–5 days, and 0–7 days, respectively), e.g., 3–6 days at Virginia Key (Miami, Fla. region), 2–5 days projected at Pensacola, Fla., and 1–5 days in Seattle, Wash. The Southwestern Pacific coastline is projected to experience 0–3 days of HTF, e.g., with 0–2 days at San Francisco and locally higher projections (4–7 days) for San Diego, Calif., which is unique for this region in that its HTF frequencies have begun to accelerate (Figures 3b, 7b). HTF flooding is not projected to occur along the Hawaiian Islands or the U.S. Caribbean or U.S. Pacific Island territories; the exceptions are Midway Island (0–2 days) and Kwajalein Atoll (0–1 days). This outlook does not consider wave and local rain effects. It should be noted that the predicted active (i.e., above average) Atlantic hurricane season[27] has the potential to affect some East and Gulf Coast locations with major (HTF) flooding.

[27] https://www.noaa.gov/media-release/busy-atlantic-hurricane-season-predicted-for-2020

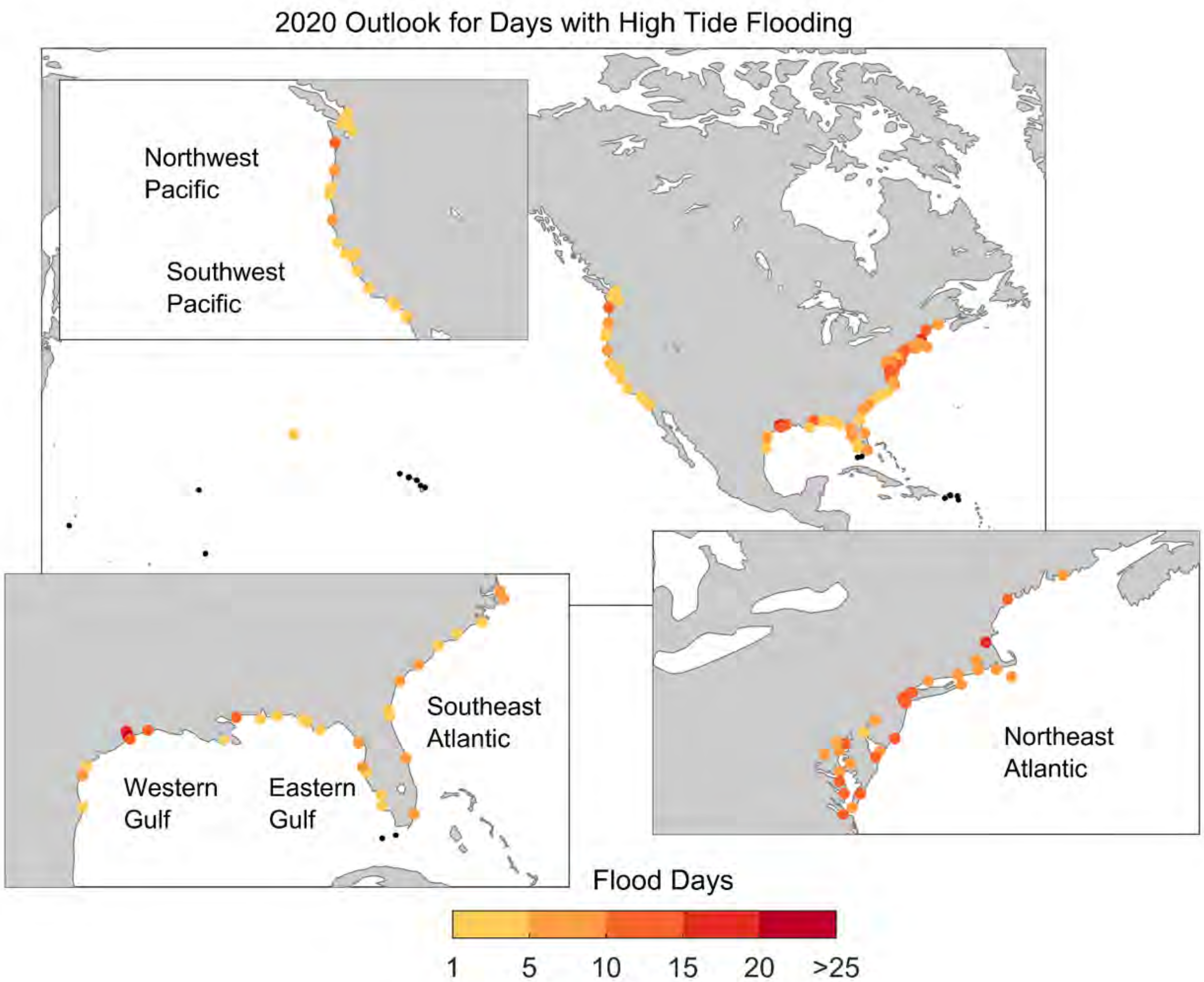

Figure 8. Outlook for number of HTF days projected to occur in 2020 (May 2020–April 2021) with color-codes associated with the 'expected' value, whereas the actual outlooks are given as a likely range (expected value ±1 standard deviation).

4. SUMMARY

NOAA tide gauges are measuring rapid changes in coastal flooding along U.S. coastlines due to RSL rise. The most noticeable impact of RSL rise is the increasing frequency of HTF, whose cumulative impacts are damaging to infrastructure and cause other economic impacts (transportation delays, businesses closed, tourism impacts, etc.) in coastal communities. Thus, HTF is of a growing concern to coastal residents, emergency managers, community planners and resource managers. In response, NOAA will continue to provide not only projections for the coming decades (e.g., Sweet et al., 2018) but also for the coming year to support planning and preparedness.

The national median HTF occurrence was 4 days in 2019, and the trend continues to accelerate (a nonlinear rise). The median number of HTF along U.S. coastlines was more than twice what it was in 2000 due to rising RSL, which nationally reached an all-time high of 0.34 m (1.1 ft) as measured since 1920 (last 100 years). Currently HTF is affecting mostly U.S. East and Gulf coastlines where annual HTF frequencies are upwards of twice the national rate. This is due to relatively high rates of RSL rise (57 of 62 locations broke records in 2019), propensity for storm surge/set up and flat and low-lying coastal elevations (Sweet and Park, 2014). Nineteen locations broke or tied their all-time HTF records (median of 13 days) in 2019, including most locations along the Texas coastline and at Miami, Savannah, Charleston and Annapolis to name a few. The trend in annual frequencies of HTF is accelerating (increasing nonlinearly) in 75% of East and Gulf Coast locations with most of the others linearly increasing. To put these records in perspective, as an example, it took the first 58 years of operation (since 1921) of the NOAA tide gauge in Charleston to record 13 HTFs; in 2019, it had that many alone.

Next year (May 2020–April 2021), acceleration in HTF and its impacts are expected to continue. Near-neutral ENSO conditions are not likely to substantially affect the number of flood days. Nationally, the median HTF outlook is 2–6 days (likely range). Regionally, the 2020 HTF outlook is:

- 6–11 days along the Northeast Atlantic
- 5–11 days along the Western Gulf
- 3–6 days along the Southeast Atlantic
- 2–5 days along the Eastern Gulf
- 0–7 days along the Northwestern Pacific
- 0–3 days along the Southwestern Pacific

By 2030, the national HTF frequency is likely to increase about 2–3 fold (national median of 7–15 days) compared to today without additional flood-management efforts (Sweet et al., 2018; Appendix 1). By 2050, HTF is likely to be 5- to 15-fold higher (national median of 25–75 days), and potentially in some locations reaching nearly 180 days per year, effectively becoming the new high tide.

5. ACKNOWLEDGEMENTS

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APPENDIX 1

Location-specific high tide flooding occurrences and projections. U.S. Regions, NOAA tide gauges, NOAA NOS high tide flood (HTF) threshold (meters above MHHW), annual HTF record through 2019, HTF frequency typical of year 2000 based upon trend fits, HTF measured in 2019 (May 2019–April 2020), the 2020 Outlook, peak HTF season and HTF range considered likely by 2030 and 2050 (Sweet et al., 2018).

Region	Tide Gauge Location	NOAA ID	HTF Height (m, MHHW)	Record HTF (days/year)	Year of Record	Typical HTF days in 2000	HTF days in 2019	2020 HTF Outlook	Peak HTF Season	2030 HTF Projection	2050 HTF Projection
Pacific Islands	Nawiliwili, HI	1611400	0.52	1	1992	0	0	0	---	0-0	1-30
	Honolulu, HI	1612340	0.52	0	---	0	0	0	---	0-0	2-30
	Mokuoloe, HI	1612480	0.53	0	---	0	0	0	---	0-0	3-30
	Kahului, HI	1615680	0.53	1	1963	0	0	0	---	0-0	4-55
	Kawaihae, HI	1617433	0.53	0	---	0	0	0	---	0-0	0-15
	Hilo, HI	1617760	0.53	1	1963, 2019	0	1	0	---	0-1	10-65
	Midway Island	1619910	0.52	6	2004	1	1	0-2	winter	3-4	7-55
	Apra Harbor, Guam	1630000	0.53	1	1992	0	0	0	winter	0-0	2-45
	Pago Pago, Am. Samoa	1770000	0.53	0	---	0	0	0	---	0-0	0-2
	Kwajalein Island	1820000	0.55	2	2017	0	0	0-1	winter	7-15	35-90
	Wake Island	1890000	0.53	2	2004	0	0	0	summer	0-2	6-55
Northeast Atlantic	Bar Harbor, ME	8413320	0.64	30	1977	6	6	3-14	winter	20-35	45-90
	Portland, ME	8418150	0.62	21	2009	5	5	7-13	winter	15-30	35-80
	Boston, MA	8443970	0.63	22	2017	6	7	11-18	winter	20-35	45-95
	Woods Hole, MA	8447930	0.53	10	2017	2	2	3-6	winter	8-20	35-135
	Nantucket Island, MA	8449130	0.54	11	2017	2	6	3-7	winter	7-15	30-125
	Newport, RI	8452660	0.55	11	2017	2	1	3-7	fall	10-25	40-120
	Providence, RI	8454000	0.56	15	2017	3	6	5-10	spring	15-30	40-105
	New London, CT	8461490	0.54	10	2017	2	2	3-7	fall	8-15	25-120
	Bridgeport, CT	8467150	0.59	11	2017	3	6	6-11	fall	15-30	35-105
	Montauk, NY	8510560	0.53	11	2017	3	5	3-7	fall	10-25	40-150
	Kings Point, NY	8516945	0.60	15	2012	5	10	8-14	fall	20-35	40-110
	The Battery, NY	8518750	0.56	15	2017	5	10	9-14	fall	20-40	50-135
	Bergen Point, NY	8519483	0.57	13	2017	3	8	8-13	fall	15-35	45-130
	Sandy Hook, NJ	8531680	0.56	20	2017	5	11	10-15	fall	25-45	70-160
	Atlantic City, NJ	8534720	0.56	22	2017	5	9	8-14	fall	20-35	65-155
	Cape May, NJ	8536110	0.57	14	2009	3	7	6-11	fall	15-30	55-135
	Philadelphia, PA	8545240	0.58	12	2011	3	9	4-8	fall	10-20	30-105
	Reedy Point, DE	8551910	0.57	5	2012	1	3	2-4	spring	6-15	25-100
	Lewes, DE	8557380	0.56	15	2017	4	9	7-12	fall	15-30	50-135
	Cambridge, MD	8571892	0.53	11	2019	1	11	5-8	fall	9-20	40-150
	Tolchester Beach, MD	8573364	0.52	17	2019	2	17	7-12	fall	15-25	50-160
	Baltimore, MD	8574680	0.52	12	2018	3	11	5-9	fall	15-25	50-155
	Annapolis, MD	8575512	0.52	18	2019	2	18	6-10	fall	15-25	55-170
	Solomons Island, MD	8577330	0.52	11	2019	1	11	6-9	fall	10-20	45-165
	Washington, DC	8594900	0.54	22	2018	3	10	6-11	spring	10-20	35-120
	Wachapreague, VA	8631044	0.56	17	2017	3	13	8-15	fall	15-25	40-120
	Kiptopeke, VA	8632200	0.54	11	1997	3	9	4-8	fall	10-20	40-120
	Lewisetta, VA	8635750	0.52	20	2019	2	20	9-14	fall	15-25	50-170
	Windmill Point, VA	8636580	0.53	17	2019	2	17	10-16	fall	15-25	45-160
	Sewells Point, VA	8638610	0.53	15	2009	5	14	9-13	fall	20-25	65-170
Southeast Atlantic	Duck, NC	8651370	0.55	18	2009	5	9	6-11	fall	20-30	55-135
	Oregon Inlet, NC	8652587	0.51	8	2009, 2019	1	8	4-7	fall	7-15	35-165
	Beaufort, NC	8656483	0.54	10	2015	1	4	1-3	fall	6-15	25-100
	Wilmington, NC	8658120	0.56	14	2018	1	0	2-5	fall	4-9	15-65
	Springmaid Pier, SC	8661070	0.57	11	2015	3	6	2-6	fall	10-20	30-75
	Charleston, SC	8665530	0.57	13	2019	2	13	4-7	fall	10-20	35-90
	Fort Pulaski, GA	8670870	0.59	13	2019	2	13	4-8	fall	15-25	40-95
	Fernandina Beach, FL	8720030	0.58	9	2015	3	7	3-6	fall	9-15	25-70
	Mayport, FL	8720218	0.56	6	2015	1	4	1-3	fall	5-10	20-65
	Trident Pier, FL	8721604	0.54	12	2015	0	8	7-12	fall	7-15	20-65
	Virginia Key, FL	8723214	0.52	9	2019	0	9	3-6	fall	2-5	10-55
	Vaca Key, FL	8723970	0.51	1	2017	0	0	0	fall	1-3	9-65
	Key West, FL	8724580	0.52	2	1944	0	0	0	fall	0-2	8-60

Region	Tide Gauge Location	NOAA ID	HTF Height (m, MHHW)	Record HTF (days/year)	Year of Record	Typical HTF days in 2000	HTF days in 2019	2020 HTF Outlook	Peak HTF Season	2030 HTF Projection	2050 HTF Projection
Eastern Gulf	Naples, FL	8725110	0.54	3	2017	1	1	0-2	fall	2-4	9-55
	Fort Myers, FL	8725520	0.52	6	2017	1	1	1-4	fall	3-6	15-80
	St. Petersburg, FL	8726520	0.53	4	2016, 2018	1	3	2-3	fall	3-7	15-85
	Clearwater, FL	8726724	0.54	5	2018	0	4	4-6	fall	2-4	10-55
	Cedar Key, FL	8727520	0.55	11	2019	2	11	4-7	fall	5-10	20-70
	Apalachicola, FL	8728690	0.52	10	2018	2	5	2-6	fall	4-8	10-50
	Panama City, FL	8729108	0.52	7	2005	1	2	1-4	fall	4-7	10-65
	Panama City Beach, FL	8729210	0.52	8	2005	1	3	1-5	fall	4-6	10-50
	Pensacola, FL	8729840	0.52	10	2005	1	3	2-5	fall	4-8	15-70
	Dauphin Island, AL	8735180	0.52	10	2019	2	10	2-6	fall	5-10	30-95
	Bay Waveland, MS	8747437	0.52	14	2017	3	10	7-13	fall	25-40	110-205
Western Gulf	Grand Isle, LA	8761724	0.43	6	2008, 2019	1	6	2-5	fall	9-20	145-270
	Sabine Pass, TX	8770570	0.52	23	2017	0	21	9-17	fall	8-15	60-160
	Morgans Point, TX	8770613	0.52	22	2019	3	22	11-19	fall	30-45	110-215
	Eagle Point, TX	8771013	0.51	64	2019	0	64	32-48	fall	---	---
	Galveston Pier 21, TX	8771450	0.52	18	2017, 2019	3	18	7-12	fall	15-30	100-215
	Rockport, TX	8774770	0.50	7	2010, 2018	1	5	1-4	fall	7-15	60-160
	Corpus Christi, TX	8775870	0.52	18	2019	2	18	2-9	fall	10-20	55-150
	Port Isabel, TX	8779770	0.52	9	2019	1	9	1-4	fall	7-15	40-135
Southwest Pacific	San Diego, CA	9410170	0.57	13	2017	2	4	4-7	winter	10-15	30-60
	La Jolla, CA	9410230	0.57	8	2015	2	0	1-4	winter	10-15	25-55
	Los Angeles, CA	9410660	0.57	6	2015	1	3	1-3	winter	6-10	15-40
	Santa Monica, CA	9410840	0.57	7	2015	2	2	0-3	winter	7-15	20-50
	Port San Luis, CA	9412110	0.57	6	1982	1	1	0-2	winter	3-5	8-25
	Monterey, CA	9413450	0.57	7	1982	1	1	0-2	winter	3-5	10-30
	San Francisco, CA	9414290	0.57	6	1982	0	0	0-1	winter	2-3	6-25
	Alameda, CA	9414750	0.58	10	1982	1	0	0-2	winter	1-2	3-15
	Point Reyes, CA	9415020	0.57	8	2016	2	1	0-3	winter	4-7	15-40
	Port Chicago, CA	9415144	0.56	15	1982	1	0	0-3	winter	2-2	4-15
	Arena Cove, CA	9416841	0.57	14	1997	2	1	0-4	winter	5-7	10-30
Northwest Pacific	Humboldt Bay, CA	9418767	0.58	15	2016	4	4	4-10	winter	15-20	45-80
	Port Orford, CA	9431647	0.59	23	1997	5	1	0-8	winter	9-15	15-40
	Charleston, OR	9432780	0.59	27	1997	6	2	0-8	winter	9-15	15-35
	South Beach, OR	9435380	0.60	25	1997	7	1	1-10	winter	15-20	30-50
	Toke Point, WA	9440910	0.61	33	1997	12	7	4-17	winter	15-20	20-35
	Port Angeles, WA	9444090	0.59	12	1982	4	1	0-5	winter	5-7	8-15
	Port Townsend, WA	9444900	0.60	13	1982	3	1	0-4	winter	5-6	9-20
	Seattle, WA	9447130	0.64	11	1997	2	1	1-5	winter	4-6	9-20
	Cherry Point, WA	9449424	0.61	15	1982	3	0	0-5	winter	4-5	5-10
	Friday Harbor, WA	9449880	0.60	17	1982	4	1	0-6	winter	6-7	9-20
Caribbean	Lime Tree Bay, VI	9751401	0.51	1	1999	0	0	0	fall	0-0	0-3
	Charlotte Amalie, VI	9751639	0.51	1	1995	0	0	0	fall	0-0	0-7
	San Juan, PR	9755371	0.52	1	2017	0	0	0	fall	0-0	0-9
	Magueyes Island, PR	9759110	0.51	1	1998	0	0	0	fall	0-0	0-3

ACRONYMS

cm	Centimeter
°C	degree Celsius
ENSO	El Niño Southern Oscillation
GT	Great Diurnal Range
HTF	high tide flooding
m	meter
mm	millimeter
MHHW	mean higher high water
MLLW	mean lower low water
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NWS	National Weather Service
ONI	Oceanic Niño Index
RSL	relative sea level
WFO	Weather Forecasting Offices

Stockton University Coastal Research Center: Bulkhead Report, Survey Data and Maps

Stone Harbor Bulkhead Elevations

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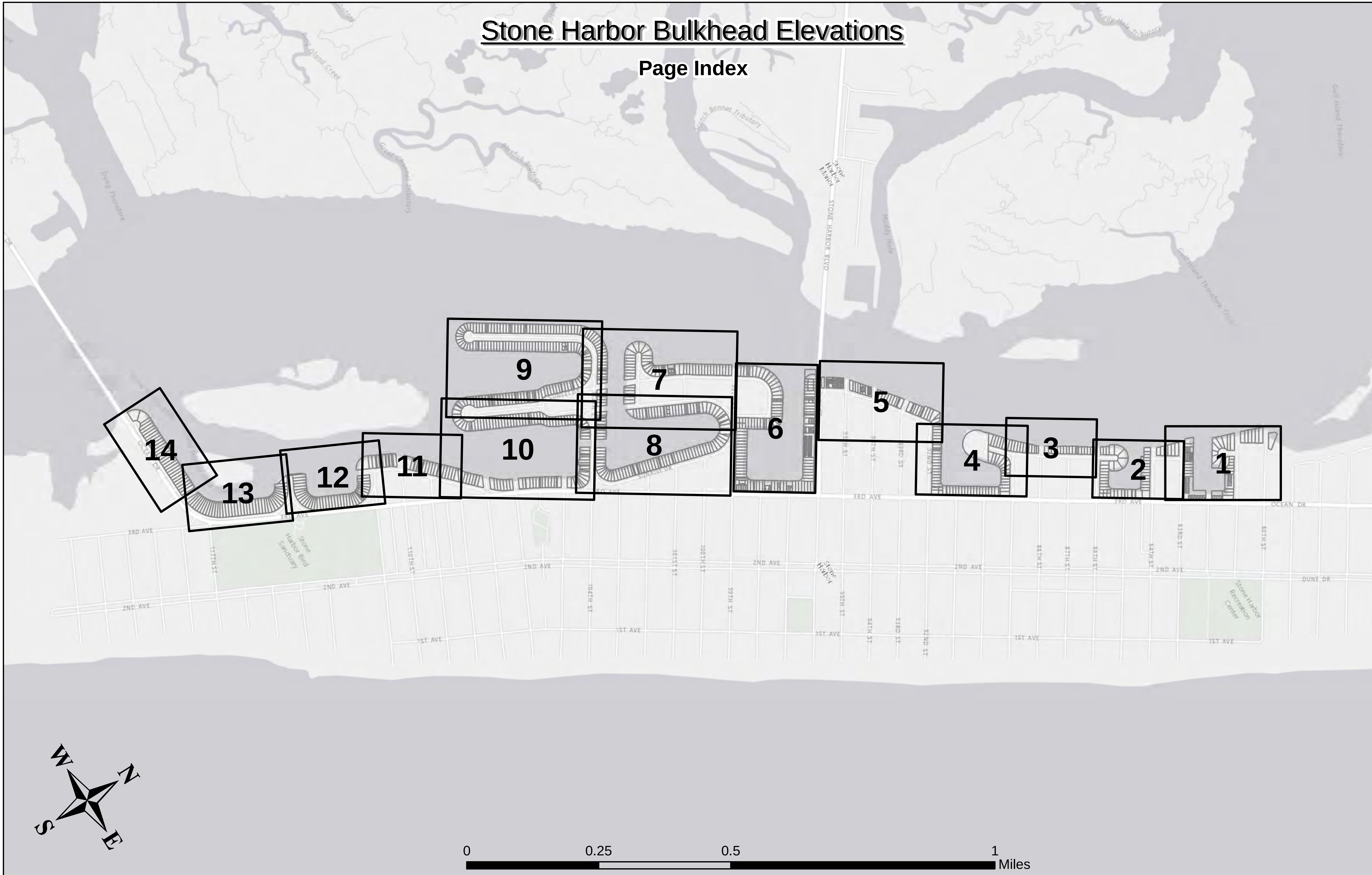

Stone Harbor Bulkhead Elevations

Page: 1

Stone Harbor Bulkhead Elevations
South Basin
N
SUNSET DR
SUNSET DR
86TH ST
84TH ST
83RD ST
6.1
6.0
6.2
6.0
4.6
5.9
4.5
4.9
4.9
4.9
4.8
4.7
5.8
5.8
5.0
5.9
4.3
6.0
6.0
4.7
5.9
4.8
4.7
6.0
5.9
6.0
6.0
6.0
6.1
5.1
5.9
5.1
5.7
5.8
6.0
6.0
6.2
4.2
4.3
4.3
4.3
7.3
5.9
5.9
5.9
6.2
5.9
5.6
5.8
5.9
5.8
5.6
6.1
0
50
100
200
Feet
Page: 2


Stone Harbor Bulkhead Elevations
86th to 89th Street
N
5.9
6.3
5.8
6.2
5.8
6.3
6.2
6.6
6.2
6.5
6.2
6.1
6.0
6.1
6.0
6.3
5.9
5.6
5.4
5.9
6.0
6.1
SUNSET DR
89TH ST
88TH ST
87TH ST
0
50
100
200
Feet
Page: 3

Stone Harbor Bulkhead Elevations
Snug Harbor
N
SUNSET DR
SUNSET DR
89TH ST
6.2
6.0
4.8
6.2
5.0
5.0
4.8
4.8
6.2
4.5
4.6
6.2
6.1
6.2
6.2
6.2
6.5
6.5
6.3
5.8
6.3
6.0
5.0
4.5
5.1
4.7
4.6
4.4
7.4
4.1
6.7
4.0
6.8
3.9
4.1
4.2
3.5
3.5
6.2
6.5
6.4
6.4
6.1
6.5
6.4
6.4
6.0
6.6
5.9
6.3
5.8
6.2
5.8
6.3
0
50
100
200
Feet

Stone Harbor Bulkhead Elevations

92nd to 96th Street

Stone Harbor Bulkhead Elevations
Shelter Haven
CORINTHIAN DR
N
6.3
6.5
6.4
6.5
6.4
6.2
6.1
3.9
4.0
5.0
6.3
5.0
6.2
5.9
5.5
2.3
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6.1
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6.6
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5.6
6.4
5.6
5.7
4.9
5.8
4.9
5.3
5.2
7.3
7.3
6.0
6.0
5.8
6.7
0
50
100
200
Feet


Stone Harbor Bulkhead Elevations
Stone Harbor 1 of 2
CORINTHIAN DR
CORINTHIAN DR
CORINTHIAN DR
104TH ST
BERKLEY RD
CHARLES ST
99TH ST
6.0
5.2
6.1
6.2
6.0
6.0
5.3
5.3
5.8
5.5
5.6
5.6
5.1
5.0
5.4
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6.2
5.9
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5.0
6.2
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4.7
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5.8
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5.1
5.2
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6.2
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6.9
6.1
6.2
4.3
6.2
4.3
5.9
5.8
5.9
0
50
100
200
Feet

Stone Harbor Bulkhead Elevations
Stone Harbor 2 of 2
CORINTHIAN DR
SUNRISE DR
104TH ST
102ND ST
101ST ST
100TH ST
CAPE MAY COUNTY 619
N
0 50 100 200
Feet
Page: 8

Stone Harbor Bulkhead Elevations
Pleasure Bay
SUNSET DR
104TH ST
CORINTHIAN DR
0
50
100
200
Feet
N

Stone Harbor Bulkhead Elevations
Carnival Bay
CORINTHIAN DR
SUNSET DR
107TH ST
106TH ST
105TH ST
104TH ST
CAPE MAY COUNTY 619
N
0 50 100 200
Feet

Page: 10

Stone Harbor Bulkhead Elevations

108th to 111th Street

Stone Harbor Bulkhead Elevations

Sanctuary Bay

Stone Harbor Bulkhead Elevations
Paradise Bay 1 of 2
N
7.2
7.3
7.2
7.1
7.0
7.1
7.0
7.0
7.8
7.8
7.8
7.8
7.9
7.8
7.8
7.9
7.9
7.9
7.9
7.9
8.0
8.0
8.0
8.0
8.0
8.0
7.9
7.9
7.9
7.9
7.8
7.8
7.7
7.6
7.7
7.7
7.6
7.9
7.9
7.7
7.8
8.5
8.8
8.5
8.5
8.5
118TH ST
3RD AV
117TH ST
PARADISE DR
CAPE MAY COUNTY 619
FR 3RD AVE TO CO 619 NB
0
50
100
200
Feet

Stone Harbor Bulkhead Elevations

Paradise Bay 2 of 2

Bulkhead Height Assessment

Dr. Lenore Tedesco

Executive Director

The Wetlands Institute

Prepared Using Data from Report from
Stockton Coastal Research Center 12/1/2017
Natural Resources Report to Council 3/20/2018

Stockton Study Data Structure

- Data set = 831 individual points with each property having at least1 point
- Added 455 points to define extent of individual bulkheads
  - Many properties have 2 minimum with one at each end of bulkhead
  - Some have multiple points on one property
- Where several properties cooperated to erect continuous bulkhead – assigned same elevation (supplemental) rather than shoot multiple points
- Total data set = 1398 points

Example of Data

PAMS PIN	Municipal code	BLOCK	LOT	QCODE	Block_Lot	Owners Name	Owner Address 1	Owner Address 2	ZipCode	Property Location	X (NJSP Coordinate System)	Y (NJSP Coordinate System)	Elevation (NAVD88)	Latitude	Longitude	origin of GPS point	Page on GPS point Maps	Note
0501_79.05_1.07_C-H	501	79.05	1.07	C-H	79.05_1.07				0		0	0	4.651	0	0	Supplemental	1	*Su
0510_80.05_147	510	80.05	147		80.05_147	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	STONE HARBOR, NJ	8247		0	0	6.632	0	0	Supplemental	1	GPS
0510_80.05_148	510	80.05	148		80.05_148	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	STONE HARBOR, NJ	8247		0	0	6.632	0	0	Supplemental	1	bulk
0510_80.05_149	510	80.05	149		80.05_149	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	STONE HARBOR, NJ	8247		419889.205	84662.613	6.73	39.06552806	-74.75442641	1200 GPS	1	sam
0510_80.05_150	510	80.05	150		80.05_150	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	STONE HARBOR, NJ	8247		0	0	6.73	0	0	Supplemental	1	
0510_80.05_151	510	80.05	151		80.05_151	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	STONE HARBOR, NJ	8247		0	0	6.73	0	0	Supplemental	1	
0510_80.05_152	510	80.05	152		80.05_152	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	STONE HARBOR, NJ	8247		0	0	6.73	0	0	Supplemental	1	
0510_81.04_119	510	81.04	119		81.04_119	STONE HARBOR BAY CLUB CONDOMINIUM	8129 THIRD AVENUE	STONE HARBOR, NJ	8247		420118.489	83900.574	4.63	39.06343743	-74.75361136	1200 GPS	1	
0510_81.04_119	510	81.04	119		81.04_119	STONE HARBOR BAY CLUB CONDOMINIUM	8129 THIRD AVENUE	STONE HARBOR, NJ	8247		420085.348	83840.352	4.135	39.06327182	-74.75372749	1200 GPS	1	
0510_81.04_119	510	81.04	119		81.04_119	STONE HARBOR BAY CLUB CONDOMINIUM	8129 THIRD AVENUE	STONE HARBOR, NJ	8247		420059.303	83832.902	3.9	39.06325116	-74.75381914	1200 GPS	1	
0510_81.04_119.01	510	81.04	119.01		81.04_119.01				0		420059.303	83832.902	3.9	39.06325116	-74.75381914	1200 GPS	1	
0510_81.04_119.02	510	81.04	119.02		81.04_119.02				0		420059.303	83832.902	3.9	39.06325116	-74.75381914	1200 GPS	1	
0510_81.04_119.03	510	81.04	119.03		81.04_119.03				0		420059.303	83832.902	3.9	39.06325116	-74.75381914	1200 GPS	1	
0510_81.04_119.04	510	81.04	119.04		81.04_119.04				0		420059.303	83832.902	3.9	39.06325116	-74.75381914	1200 GPS	1	
0510_81.04_119.05	510	81.04	119.05		81.04_119.05				0		420059.303	83832.902	3.9	39.06325116	-74.75381914	1200 GPS	1	
0510_81.04_119.06	510	81.04	119.06		81.04_119.06				0		420059.303	83832.902	3.9	39.06325116	-74.75381914	1200 GPS	1	
0510_81.04_119.07	510	81.04	119.07		81.04_119.07				0		420059.303	83832.902	3.9	39.06325116	-74.75381914	1200 GPS	1	
0510_81.04_119.08	510	81.04	119.08		81.04_119.08				0		420059.303	83832.902	3.9	39.06325116	-74.75381914	1200 GPS	1	
0510_81.04_119.09	510	81.04	119.09		81.04_119.09				0		420059.303	83832.902	3.9	39.06325116	-74.75381914	1200 GPS	1	
0510_81.04_119.1	510	81.04	119.1		81.04_119.10				0		420059.303	83832.902	3.9	39.06325116	-74.75381914	1200 GPS	1	
0510_81.04_119.11	510	81.04	119.11		81.04_119.11				0		420118.489	83900.574	4.63	39.063437	-74.753611	1200 GPS	1	
0510_81.04_119.12	510	81.04	119.12		81.04_119.12				0		420118.489	83900.574	4.63	39.063437	-74.753611	1200 GPS	1	
0510_81.04_119.13	510	81.04	119.13		81.04_119.13				0		420118.489	83900.574	4.63	39.063437	-74.753611	1200 GPS	1	
0510_81.04_119.14	510	81.04	119.14		81.04_119.14				0		420118.489	83900.574	4.63	39.063437	-74.753611	1200 GPS	1	
0510_81.04_119.15	510	81.04	119.15		81.04_119.15				0		420118.489	83900.574	4.63	39.063437	-74.753611	1200 GPS	1	
0510_81.04_119.16	510	81.04	119.16		81.04_119.16				0		420118.489	83900.574	4.63	39.063437	-74.753611	1200 GPS	1	
0510_81.04_119.19	510	81.04	119.19		81.04_119.19				0		420085.348	83840.352	4.135	39.063272	-74.753727	1200 GPS	1	
0510_81.04_119.2	510	81.04	119.2		81.04_119.20				0		420085.348	83840.352	4.135	39.063272	-74.753727	1200 GPS	1	
0510_81.04_119.21	510	81.04	119.21		81.04_119.21				0		420085.348	83840.352	4.135	39.063272	-74.753727	1200 GPS	1	
0510_81.04_119.22	510	81.04	119.22		81.04_119.22				0		420085.348	83840.352	4.135	39.063272	-74.753727	1200 GPS	1	
0510_81.04_119.23	510	81.04	119.23		81.04_119.23				0		420085.348	83840.352	4.135	39.063272	-74.753727	1200 GPS	1	
0510_81.04_119.24	510	81.04	119.24		81.04_119.24				0		420085.348	83840.352	4.135	39.063272	-74.753727	1200 GPS	1	
0510_81.04_133	510	81.04	133		81.04_133	PHILLIPS,DENNIS M & LINDA LEE	950 PARKS RUN LN	VILLANOVA, PA	19085		0	0	5.932	0	0	Supplemental	1	
0510_81.04_135	510	81.04	135		81.04_135	Smugglers Cove Inc	370 85rd St	Stone Harbor , NJ	8247		419907.032	83939.32	5.932	39.06354219	-74.75435649	1200 GPS	1	
0510_81.04_137	510	81.04	137		81.04_137	Smugglers Cove Inc	370 85rd St	Stone Harbor , NJ	8247		0	0	4.704	0	0	Supplemental	1	
0510_81.04_139	510	81.04	139		81.04_139	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	STONE HARBOR, NJ	8247		0	0	4.704	0	0	Supplemental	1	
0510_81.04_141_C000A	510	81.04	141	C000A	81.04_141	SUMMERS, DEBRA A & DANIEL TRUSTEES	301 STELLA MARIS DR S	NAPLES, FL	34114		419833.673	83986.339	4.704	39.06367073	-74.75461533	1200 GPS	1	
0510_81.04_143_C000A	510	81.04	143	C000A	81.04_143	VICTORIAN HOUSE AT STONE HARBOR	378 83RD SR	STONE HARBOR, NJ	8210		419808.659	84005.114	5.772	39.06372209	-74.75470362	1200 GPS	1	
0510_81.04_143_C000A	510	81.04	143	C000A	81.04_143	VICTORIAN HOUSE AT STONE HARBOR	378 83RD SR	STONE HARBOR, NJ	8210		419808.659	84005.114	5.772	39.06372209	-74.75470362	1200 GPS	1	
0510_81.04_143_C000A	510	81.04	143	C000A	81.04_143	VICTORIAN HOUSE AT STONE HARBOR	378 83RD SR	STONE HARBOR, NJ	8210		419808.659	84005.114	5.772	39.06372209	-74.75470362	1200 GPS	1	

Converting Bulkhead Point Data to Property Data

- Property defined by block/lot.
- Some block/lot entries have multiple points
- Some owners combined several adjacent lots into one property for construction.
  - These each have a separate block/lot identifier.
- Both of these situations needed to be converted to one entry
- Assigned the LOWEST elevation to the entry
- Assigned a BLIND PROPERTY NUMBER to the resultant parcel for Confidentiality
- Converted 1398 bulkhead data points to 427 properties


Stone Harbor Bulkhead Elevations
North Basin
4.3
4.3
6.7
6.6
6.6
4.7
6.6
6.7
5.9
6.7
6.1
6.0
6.0
6.0
6.0
6.0
3.2
6.2
3.5
6.1
6.0
6.2
81ST ST
80TH ST

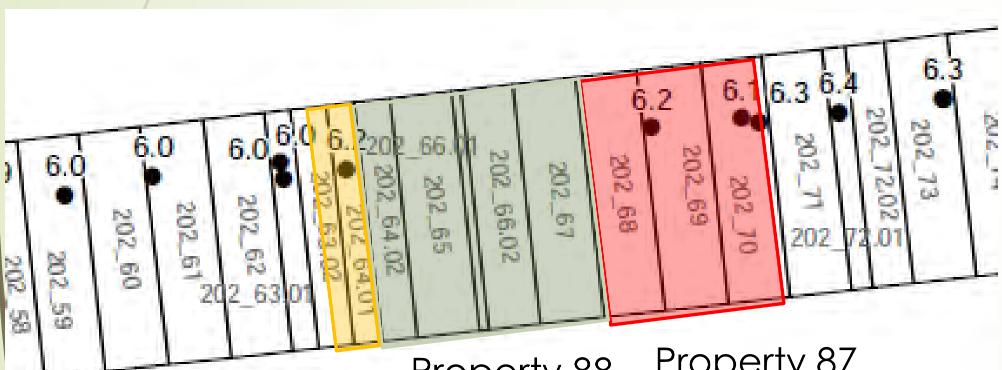
Challenges with Data Assignment and Analyses

- For some properties, constructed one bulkhead along several properties
  - Report measured one elevation and assigned it to adjacent properties (Supplemental)
  - At times the assignment to adjacent property is not accurate so have incidences of low elevation assigned to higher bulkhead and high elevation assigned to low elevation.
- Data compression at times combined multiple parcels with same owner into one point and assigned lowest.
  - For some owners, they do own several parcels that are separate properties so slight under assignment and picked the lowest for all.
  - Able to identify some if they occurred in different basins by secondary basin analysis.
- Data compression did not combine parcels accurately if the ownership name was not consistent
  - Eg: added middle initial, added spouse
  - Can occur when additional adjacent parcels added through time.

One owner, multiple lots, same page

Logic models merged into 2 properties but because of name difference of ownership when added adjacent parcels did not assign to same owner and link parcels and assigned lowest elevation across two different properties

Basin 1

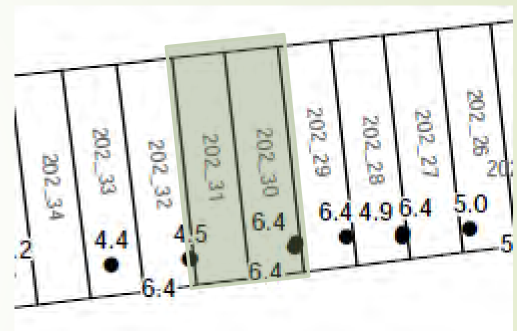


Property 89

Property 88

Property 87

Basin 2

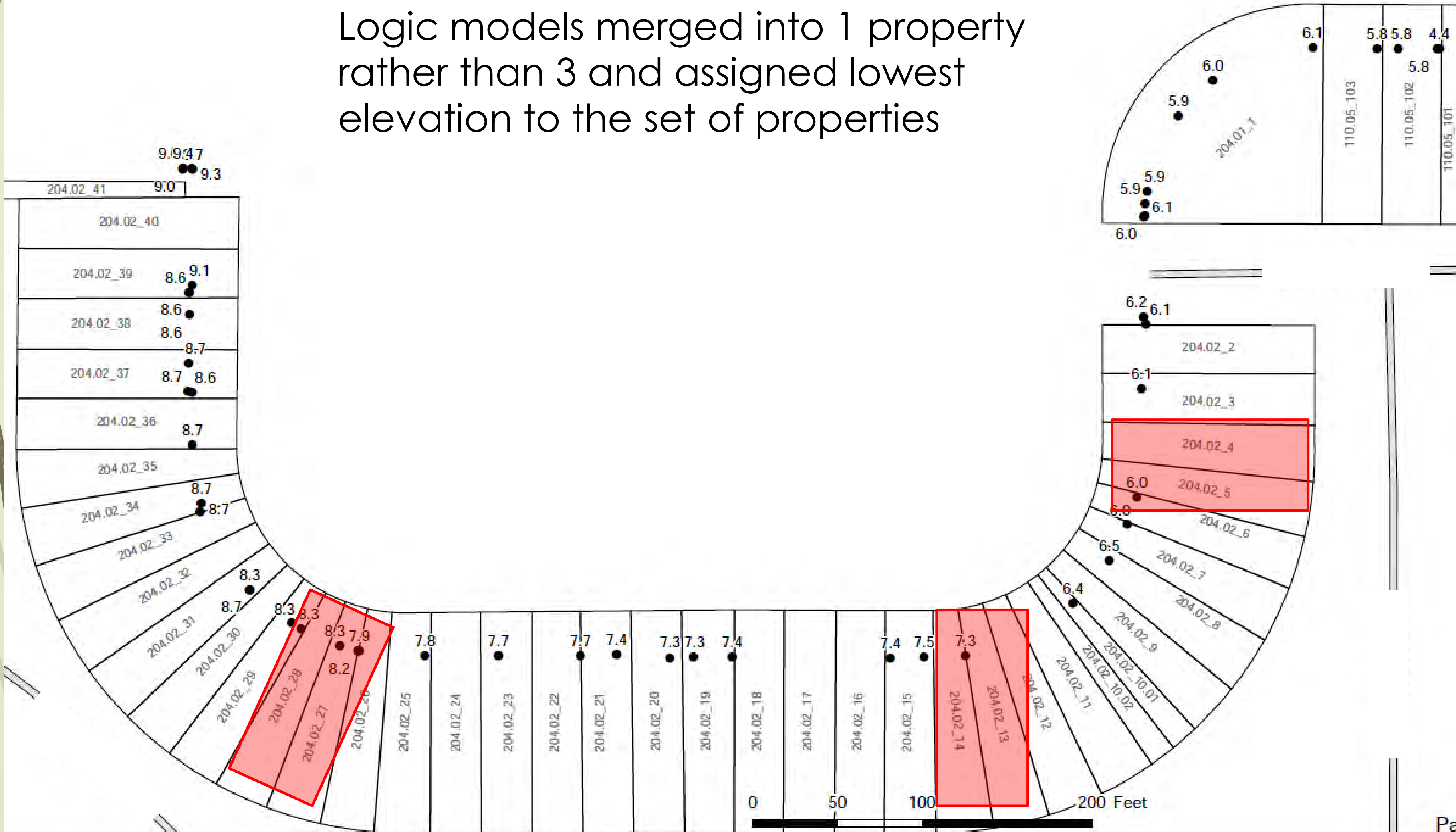


Property 88

- No property location information so cant add additional logic tests
- Different page numbers allowed for identification of challenge

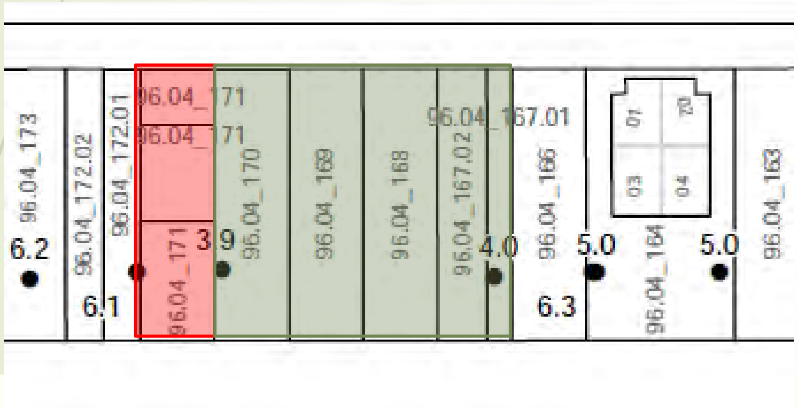
One owner, multiple lots, same page

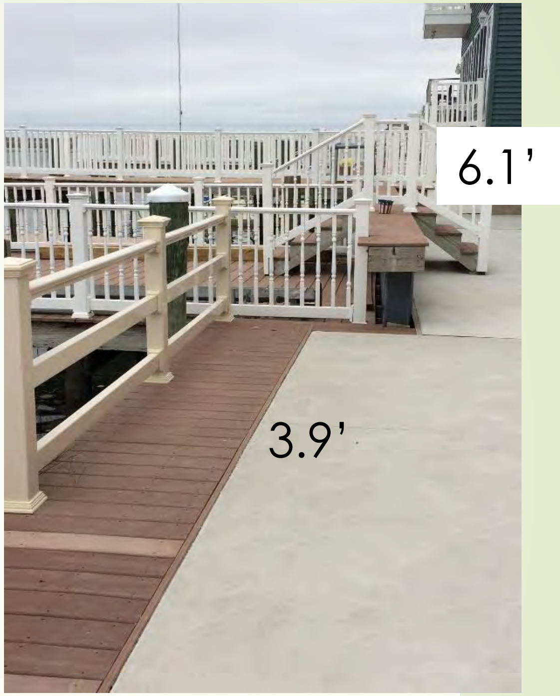
Logic models merged into 1 property rather than 3 and assigned lowest elevation to the set of properties



Two owners on adjacent properties assigned same elevation

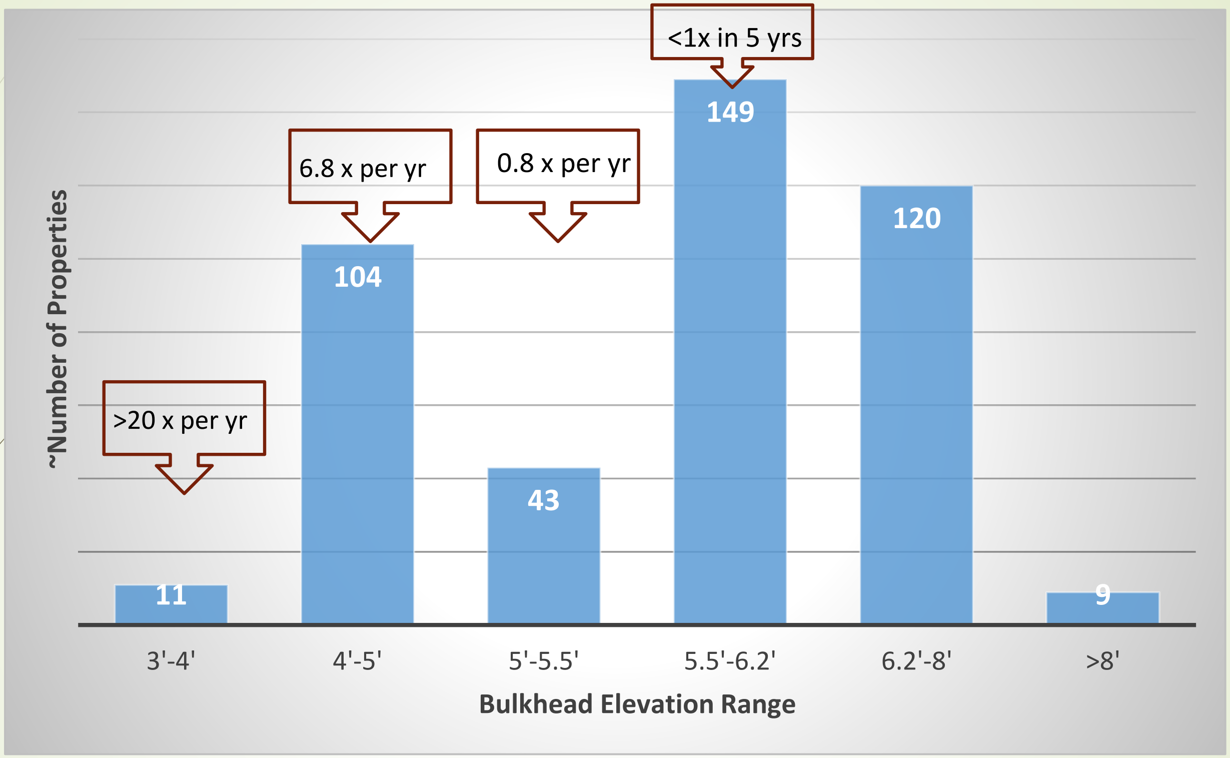
Supplemental data assignment linked point to adjacent property and charged both properties with elevation.





PAMS PIN	[redacted]	Blind Property	Property Location	Elevation (NAVD88)	Latitude	Longitude	origin of GPS point	Page on GPS point Maps
0510_96.04_171_C000F		337		3.888	0	0	Supplemental	6
0510_96.04_171_C000R		337		3.888	0	0	Supplemental	6
0510_96.04_171_C000U		337		3.888	0	0	Supplemental	6
0510_96.04_167.02		384		3.974	0	0	Supplemental	6
0510_96.04_168		384		3.974	0	0	Supplemental	6
0510_96.04_169		384		3.974	0	0	Supplemental	6
0510_96.04_170		384		3.888	39.05568	-74.76361200	GPS	6

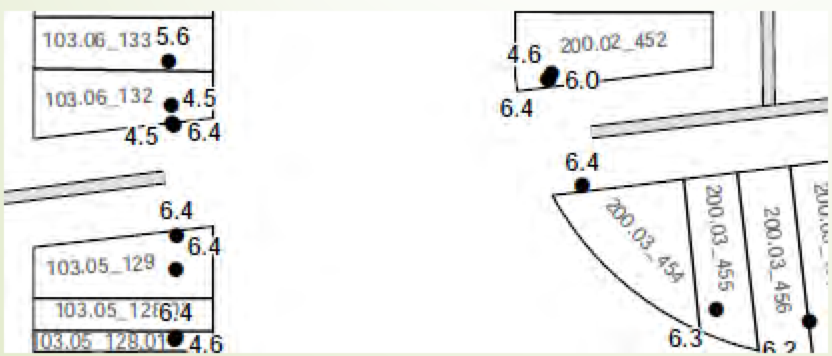
Number of Properties with Bulkhead Elevations of Different NAVD88 Elevations and Current Flood Frequency



- 158 Properties with Bulkheads <5.5’ NAVD88
- 149 Properties with Bulkheads 5.5’ – 6.2’NAVD88
- 307 Properties with Bulkheads <6.2’ NAVD88 – current ordinance
- 4 of 11 3’-4’ bin bulkheads are boat ramps

Borough and Street Ends

- Borough of Stone Harbor has 37 parcels and more than 63 points
  - Manually adjusted 37 parcels to 4 and assigned lowest
- Street Ends are NOT included in the excel spreadsheets
  - No ownership?
  - Some are low
  - Difficult to understand where points shot and what really mean



Location		Elevation (NAVD88)
	80	4.3
	81	6.6
	83	6.1
	84	5.8
	86	6.2
	88	6.2
	93	6.1
	94	6.1
	95	6.1
	99	5.7
Corinthian		6.4
Corinthian (104)		4.5
	104	4.8
104/Carnival		5.4
	105	6.2
	106	6.4
	107	5.2
	110	5.9
Sunset/111		6.0
	114	9.0
	118	7.0

Needs & Considerations

- Need additional data checking but think balanced and overall assessment wont change much about distribution but will change specifics of individual properties
  - Some bins underrepresented because merged with non-adjacent parcels and assigned one value
  - Some bins overrepresented because assigned elevations to adjacent parcel
- Where do need physical bulkhead check?
- How does Borough capture failing bulkheads that aren't reflected by height but are contributing to nuisance flooding issues?
- Need to develop a process for accepting owner supplied bulkhead height information
- Consideration of bulkheads that were spec'd to ordinance but are slightly lower
  - Error in survey
  - Error in construction
- Communication
  - Plan regarding communication and information sharing

STOCKTON UNIVERSITY COASTAL RESEARCH CENTER

SURVEY CONDUCTED OCTOBER 3 - OCTOBER 6, 2017

CLIENT: BOROUGH OF STONE HARBOR

PROJECT NAME: STORM SEWER EVALUATION & FLOOD MITIGATION MASTER PLAN

BLOCK	LOT	Owners Name	Owners Name2	Owner Address 1	Owner Address 2	Elevation (NAVD88)
80.05	147	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.632
80.05	148	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.632
80.05	149	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.73
80.05	150	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.73
80.05	151	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.73
80.05	152	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.73
81.04	139	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	4.704
81.04	153	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	4.493
81.04	153	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.007
81.04	155	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.187
81.04	149	HARBOR POINT CONDOMINIUM	HARBOR POINT CONDOMINIUM	388-394 83RD ST	STONE HARBOR, NJ	4.45
81.04	149.01		HARBOR POINT CONDOMINIUM			4.45
81.04	149.02		HARBOR POINT CONDOMINIUM			4.45
81.04	149.03		HARBOR POINT CONDOMINIUM			4.45
81.04	149.04		HARBOR POINT CONDOMINIUM			4.45
81.04	133	PHILLIPS,DENNIS M & LINDA LEE	PHILLIPS,DENNIS M & LINDA LEE	950 PARKS RUN LN	VILLANOVA, PA	5.932
81.04	137	Smugglers Cove Inc	Smugglers Cove Inc	370 85rd St	Stone Harbor , NJ	4.704
81.04	135	Smugglers Cove Inc	Smugglers Cove Inc	370 85rd St	Stone Harbor , NJ	5.932
81.04	119	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM	8129 THIRD AVENUE	STONE HARBOR, NJ	3.9
81.04	119.01	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			3.9
81.04	119.02	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			3.9
81.04	119.03	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			3.9
81.04	119.04	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			3.9
81.04	119.05	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			3.9
81.04	119.06	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			3.9
81.04	119.07	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			3.9
81.04	119.08	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			3.9
81.04	119.09	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			3.9
81.04	119.1	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			3.9
81.04	119	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM	8129 THIRD AVENUE	STONE HARBOR, NJ	4.135
81.04	119.19	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			4.135
81.04	119.2	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			4.135
81.04	119.21	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			4.135
81.04	119.22	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			4.135
81.04	119.23	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			4.135
81.04	119.24	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			4.135
81.04	119	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM	8129 THIRD AVENUE	STONE HARBOR, NJ	4.63
81.04	119.11	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			4.63
81.04	119.12	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			4.63
81.04	119.13	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			4.63
81.04	119.14	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			4.63
81.04	119.15	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			4.63
81.04	119.16	STONE HARBOR BAY CLUB CONDOMINIUM	STONE HARBOR BAY CLUB CONDOMINIUM			4.63
81.04	141	SUMMERS, DEBRA A & DANIEL TRUSTEES	SUMMERS, DEBRA A & DANIEL TRUSTEES	301 STELLA MARIS DR S	NAPLES, FL	4.704
81.04	143	VICTORIAN HOUSE AT STONE HARBOR	VICTORIAN HOUSE AT STONE HARBOR	378 83RD SR	STONE HARBOR, NJ	4.476
81.04	143	VICTORIAN HOUSE AT STONE HARBOR	VICTORIAN HOUSE AT STONE HARBOR	378 83RD SR	STONE HARBOR, NJ	4.583
81.04	143	VICTORIAN HOUSE AT STONE HARBOR	VICTORIAN HOUSE AT STONE HARBOR	378 83RD SR	STONE HARBOR, NJ	5.772
81.04	143	VICTORIAN HOUSE AT STONE HARBOR	VICTORIAN HOUSE AT STONE HARBOR	378 83RD SR	STONE HARBOR, NJ	5.772
81.04	143	VICTORIAN HOUSE AT STONE HARBOR	VICTORIAN HOUSE AT STONE HARBOR	378 83RD SR	STONE HARBOR, NJ	5.772
81.04	143	VICTORIAN HOUSE AT STONE HARBOR	VICTORIAN HOUSE AT STONE HARBOR	378 83RD SR	STONE HARBOR, NJ	5.772
81.04	143	VICTORIAN HOUSE AT STONE HARBOR	VICTORIAN HOUSE AT STONE HARBOR	378 83RD SR	STONE HARBOR, NJ	5.772
81.04	143	VICTORIAN HOUSE AT STONE HARBOR	VICTORIAN HOUSE AT STONE HARBOR	378 83RD SR	STONE HARBOR, NJ	5.772
81.04	143	VICTORIAN HOUSE AT STONE HARBOR	VICTORIAN HOUSE AT STONE HARBOR	378 83RD SR	STONE HARBOR, NJ	5.772
81.04	143	VICTORIAN HOUSE AT STONE HARBOR	VICTORIAN HOUSE AT STONE HARBOR	378 83RD SR	STONE HARBOR, NJ	5.772
81.04	143	VICTORIAN HOUSE AT STONE HARBOR	VICTORIAN HOUSE AT STONE HARBOR	378 83RD SR	STONE HARBOR, NJ	5.772
81.04	143	VICTORIAN HOUSE AT STONE HARBOR	VICTORIAN HOUSE AT STONE HARBOR	378 83RD SR	STONE HARBOR, NJ	5.772
81.04	143	VICTORIAN HOUSE AT STONE HARBOR	VICTORIAN HOUSE AT STONE HARBOR	378 83RD SR	STONE HARBOR, NJ	5.772
81.04	143.01		VICTORIAN HOUSE AT STONE HARBOR			5.772
81.04	143.02		VICTORIAN HOUSE AT STONE HARBOR			5.772
81.04	143.04		VICTORIAN HOUSE AT STONE HARBOR			5.772
81.04	143.05		VICTORIAN HOUSE AT STONE HARBOR			5.772
81.04	143.06		VICTORIAN HOUSE AT STONE HARBOR			5.772
81.04	143.07		VICTORIAN HOUSE AT STONE HARBOR			5.772
81.05	167.01	96th Street, LLC %John Sprandio, MD	96th Street, LLC %John Sprandio, MD	30 Lawrence RD, STE. 201	Broomall, PA	5.961
81.05	167.02		96th Street, LLC %John Sprandio, MD			5.961
81.05	167.03		96th Street, LLC %John Sprandio, MD			5.961
81.05	167.04		96th Street, LLC %John Sprandio, MD			5.961
81.05	167.05		96th Street, LLC %John Sprandio, MD			5.961
81.05	167	BERMUDA CLUB CONDOMINIUM	BERMUDA CLUB CONDOMINIUM	8129 THIRD AVE	STONE HARBOR, NJ	5.961
81.05	167	BERMUDA CLUB CONDOMINIUM	BERMUDA CLUB CONDOMINIUM	8129 THIRD AVE	STONE HARBOR, NJ	6.125
81.05	120	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.306
81.05	122	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.221
81.05	122	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.306
81.05	124	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.306
81.05	136	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.036
81.05	138	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	3.461
81.05	138	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.149
81.05	138	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.187
81.05	140	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	5.901
81.05	142	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	3.155
81.05	142	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.01
81.05	144	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.01
81.05	144.01	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.01
81.05	146	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.01
81.05	146	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.035
81.05	148	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.005
81.05	150	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.005
81.05	152	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.042
81.05	154	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.05
81.05	156	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.078
81.05	158	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.696
81.05	160	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.658
81.05	162	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.658
81.05	164	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.658
81.05	166	BOROUGH OF STONE HARBOR	95TH & SECOND AVE	95TH & SECOND AVE	STONE HARBOR, NJ	6.658
81.05	126	FLAGSHIP CONDOMINIUM	FLAGSHIP CONDOMINIUM	321-327 81ST ST	STONE HARBOR, NJ	6.127
81.05	126.01		FLAGSHIP CONDOMINIUM			6.183
81.05	126.02		FLAGSHIP CONDOMINIUM			6.263
81.05	126.03		FLAGSHIP CONDOMINIUM			6.263
81.05	126.04		FLAGSHIP CONDOMINIUM			6.263
81.05	126.05		FLAGSHIP CONDOMINIUM			6.263
81.05	126.06		FLAGSHIP CONDOMINIUM			6.263
81.05	126.07		FLAGSHIP CONDOMINIUM			6.263

BLOCK	LOT	Owners Name	Owners Name2	Owner Address 1	Owner Address 2	Elevation (NAVD88)
83.05	139	CATANELLA, CHERYL	8319 SUNSET DRIVE	707 BRANDYWINE DR	MOORESTOWN, NJ	5.903
83.05	140	CATANELLA, CHERYL	8319 SUNSET DRIVE	707 BRANDYWINE DR	MOORESTOWN, NJ	5.903
83.05	141	HARRIS, DOROTHY L	8315 SUNSET DR	4 FAWN DR	SEWELL, NJ	5.795
83.05	143	SPARKS, ANN D & WILLIAM DONALD	8307 SUNSET DR	219 N. AZALEA CT.	GLEN MILLS,PA	5.795
83.05	142	STITZINGER, JAMES F & ROBERT H	8311 SUNSET DR	P.O. BOX 1329	LANSDALE, PA	5.795
83.05	144	YOUST,JEFFREY T & YOUST,J BRADLEY	387 83RD ST	30 S MUHLENBERG ST	ALLENTOWN, PA	5.641
84.04	149.05	CASTALDO, GREGORY M	CASTALDO, GREGORY M	3776 STEVEN JAMES DR	GARNET VALLEY, PA	5.826
84.04	149.05	CASTALDO, GREGORY M	CASTALDO, GREGORY M	3776 STEVEN JAMES DR	GARNET VALLEY, PA	5.827
84.04	120.01	CONLIN, MARTHA P	CONLIN, MARTHA P	301 84TH ST	STONE HARBOR, NJ	5.979
84.04	163.02	CONNOLLY FAMILY PARTNERSHIP	CONNOLLY FAMILY PARTNERSHIP	405 EASTERN AVE.	PITTSBURGH, PA	5.064
84.04	165.01	CONNOLLY FAMILY PARTNERSHIP	CONNOLLY FAMILY PARTNERSHIP	405 EASTERN AVE.	PITTSBURGH, PA	5.112
84.04	165.01	CONNOLLY FAMILY PARTNERSHIP	CONNOLLY FAMILY PARTNERSHIP	405 EASTERN AVE.	PITTSBURGH, PA	5.694
84.04	124.01	COOGAN, TIMOTHY P & JILL B	COOGAN, TIMOTHY P & JILL B	458 NOTRE DAME DR	WARRINGTON, PA	5.979
84.04	126.01	COOGAN, TIMOTHY P & JILL B	COOGAN, TIMOTHY P & JILL B	458 NOTRE DAME DR	WARRINGTON, PA	6.2
84.04	163.01	DEL VECCHIO, DEAN	DEL VECCHIO, DEAN	111 MUIRFIELD CT	MOORESTOWN, NJ	5.937
84.04	84.04	DEL VECCHIO, DEAN	DEL VECCHIO, DEAN	111 MUIRFIELD CT	MOORESTOWN, NJ	6.072
84.04	159.02	DEL VECCHIO, DEAN	DEL VECCHIO, DEAN	111 MUIRFIELD CT	MOORESTOWN, NJ	6.072
84.04	149.03	DIGREGORIO,KENNETH & GAIL	8521 SUNSET DR	27 MILESTONE DR	RINGOES, NJ	4.927
84.04	149.06	FOSCHINI, VICTOR JR	FOSCHINI, VICTOR JR	8524 SUNSET DR	STONE HARBOR, NJ	5.826
84.04	121.02	GEBERT, JOHN M & MARIE M	GEBERT, JOHN M & MARIE M	700 BELFRY DR	BLUE BELL, PA	4.746
84.04	119.02	GEBERT, JOHN M & MARIE M	GEBERT, JOHN M & MARIE M	700 BELFRY DR	BLUE BELL, PA	5.888
84.04	121.02	GEBERT, JOHN M & MARIE M	GEBERT, JOHN M & MARIE M	700 BELFRY DR	BLUE BELL, PA	5.888
84.04	132	GORDON, PETER S & JANET L	GORDON, PETER S & JANET L	10 WOOD RD.	WILMINGTON, DE	4.289
84.04	134	GORDON, PETER S & JANET L	GORDON, PETER S & JANET L	10 WOOD RD.	WILMINGTON, DE	4.305
84.04	132	GORDON, PETER S & JANET L	GORDON, PETER S & JANET L	10 WOOD RD.	WILMINGTON, DE	4.314
84.04	144.01	HOTZ, JOHN C JR & KAREN A, TRUSTEES	HOTZ, JOHN C JR & KAREN A, TRUSTEES	327 84TH STREET	STONE HARBOR, NJ	5.901
84.04	144.02	HOTZ, JOHN C JR & KAREN A, TRUSTEES	HOTZ, JOHN C JR & KAREN A, TRUSTEES	327 84TH STREET	STONE HARBOR, NJ	5.901
84.04	146	HOTZ, JOHN C JR & KAREN A, TRUSTEES	HOTZ, JOHN C JR & KAREN A, TRUSTEES	327 84TH STREET	STONE HARBOR, NJ	5.901
84.04	133	KEOWN, THOMAS M & DENISE M	KEOWN, THOMAS M & DENISE M	348 86TH STREET	STONE HARBOR, NJ	4.975
84.04	135	KEOWN, THOMAS M & DENISE M	KEOWN, THOMAS M & DENISE M	348 86TH STREET	STONE HARBOR, NJ	4.975
84.04	135	KEOWN, THOMAS M & DENISE M	KEOWN, THOMAS M & DENISE M	348 86TH STREET	STONE HARBOR, NJ	5.895
84.04	155	KRAPF, DREW & STEPHANIE	KRAPF, DREW & STEPHANIE	8453 BLIND PASS DR	TREASURE ISLAND, FL	5.972
84.04	157	KRAPF, DREW & STEPHANIE	KRAPF, DREW & STEPHANIE	8453 BLIND PASS DR	TREASURE ISLAND, FL	5.972
84.04	159.01	KRAPF, DREW & STEPHANIE	KRAPF, DREW & STEPHANIE	8453 BLIND PASS DR	TREASURE ISLAND, FL	6.027
84.04	140	MARCH, EMILY M	MARCH, EMILY M	3 HEATHER LA	DOUGLASSVILLE, PA	5.885
84.04	142	MARCH, EMILY M	MARCH, EMILY M	3 HEATHER LA	DOUGLASSVILLE, PA	5.885
84.04	140	MARCH, EMILY M	MARCH, EMILY M	3 HEATHER LA	DOUGLASSVILLE, PA	7.341
84.04	149.02	MASTRANGELO, BARRY D & FRANCES T	8523 SUNSET DR	8523 SUNSET DR	STONE HARBOR, NJ	4.92
84.04	149.02	MASTRANGELO, BARRY D & FRANCES T	8523 SUNSET DR	8523 SUNSET DR	STONE HARBOR, NJ	4.936
84.04	119.01	MCMAHON, PATRICK	MCMAHON, PATRICK	11205 PRESCOTT PL	GLEN ALLEN, VA	5.888
84.04	121.01	MCMAHON, PATRICK	MCMAHON, PATRICK	11205 PRESCOTT PL	GLEN ALLEN, VA	5.888
84.04	149.04	NASELLI,FRANCIS & CHRISTY	NASELLI,FRANCIS & CHRISTY	22 BEECH TREE DR	GLEN MILLS, PA	4.653
84.04	149.04	NASELLI,FRANCIS & CHRISTY	NASELLI,FRANCIS & CHRISTY	22 BEECH TREE DR	GLEN MILLS, PA	4.828
84.04	149.01	NEEDLES,MARC & MARITA	8525 SUNSET DR	1127 PEBBLE SPRING DR	BERWYN, PA	4.525
84.04	121.03	NUFRIO, ROBERT & SUSAN	NUFRIO, ROBERT & SUSAN	3 ANVIL CT	GLEN MILLS, PA	4.735
84.04	119.03	NUFRIO, ROBERT & SUSAN	NUFRIO, ROBERT & SUSAN	3 ANVIL CT	GLEN MILLS, PA	4.777
84.04	121.03	NUFRIO, ROBERT & SUSAN	NUFRIO, ROBERT & SUSAN	3 ANVIL CT	GLEN MILLS, PA	4.777
84.04	148	PALADINO,F. & EVERSON, E. TRUSTEES	331 84TH ST	L PALADINO 1222 PLEASANT	UTICA, NY	5.887
84.04	150	PALADINO,F. & EVERSON, E. TRUSTEES	331 84TH ST	L PALADINO 1222 PLEASANT	UTICA, NY	5.887
84.04	145	ROSSER, JOHN E JR & RUTH F	8533 SUNSET DR	8533 SUNSET DR	STONE HARBOR, NJ	4.592
84.04	145	ROSSER, JOHN E JR & RUTH F	8533 SUNSET DR	8533 SUNSET DR	STONE HARBOR, NJ	5.942
84.04	147	ROSSER, JOHN E JR & RUTH F	8533 SUNSET DR	8533 SUNSET DR	STONE HARBOR, NJ	6.01
84.04	145	ROSSER, JOHN E JR & RUTH F	8533 SUNSET DR	8533 SUNSET DR	STONE HARBOR, NJ	6.029
84.04	123	SCHAEBERLE, THOMAS D & CAROLYN B	SCHAEBERLE, THOMAS D & CAROLYN B	2002 DERRY RD	YORK, PA	5.964
84.04	143	SCHMALZRIED, A THOMAS	8527 SUNSET DR	8527 SUNSET DR	STONE HARBOR, NJ	4.592
84.04	129	SEIDMAN, MARC	SEIDMAN, MARC	22 OLD BARN DR	WEST CHESTER, PA	4.319
84.04	131	SEIDMAN, MARC	SEIDMAN, MARC	22 OLD BARN DR	WEST CHESTER, PA	4.319
84.04	120.02	SLOBODNIK,ROBERT & ROBERTS,ANASTASI	SLOBODNIK,ROBERT & ROBERTS,ANASTASI	2715 S 10TH AVE	ALTOONA, PA	5.84
84.04	137	THOMAS, CLAYTON H JR	THOMAS, CLAYTON H JR	2124 DELANCEY PL	PHILADELPHIA, PA	5.895
84.04	139	THOMAS, CLAYTON H JR	THOMAS, CLAYTON H JR	2124 DELANCEY PL	PHILADELPHIA, PA	5.895
84.04	153	VOLPE, DANTE F SR & MARIBETH A	VOLPE, DANTE F SR & MARIBETH A	420 WALMORE WY	BLUE BELL, PA	5.886
84.04	153	VOLPE, DANTE F SR & MARIBETH A	VOLPE, DANTE F SR & MARIBETH A	420 WALMORE WY	BLUE BELL, PA	5.97
84.04	151	VOLPE, DANTE F SR & MARIBETH A	VOLPE, DANTE F SR & MARIBETH A	420 WALMORE WY	BLUE BELL, PA	5.987
84.04	125	WEBSTER, DAVID A & DEBORAH L	WEBSTER, DAVID A & DEBORAH L	324 86TH STREET	STONE HARBOR, NJ	5.964
84.04	127	WEBSTER, DAVID A & DEBORAH L	WEBSTER, DAVID A & DEBORAH L	324 86TH STREET	STONE HARBOR, NJ	6.021
84.04	128	WINTER, BRIAN & MELISSA A	WINTER, BRIAN & MELISSA A	2344 FAIRWAY RD	HUNTINGDON VALLEY, PA	4.213
84.04	130	WINTER, BRIAN & MELISSA A	WINTER, BRIAN & MELISSA A	2344 FAIRWAY RD	HUNTINGDON VALLEY, PA	4.213
84.04	136	WRIGHT, CARL D & LOGIUDICE,LAUREN	WRIGHT, CARL D & LOGIUDICE,LAUREN	20 S OLIVE ST UNIT 203	MEDIA, PA	4.305
84.04	138	WRIGHT, CARL D & LOGIUDICE,LAUREN	WRIGHT, CARL D & LOGIUDICE,LAUREN	20 S OLIVE ST UNIT 203	MEDIA, PA	4.305
86.05	150	BOWEN, FRANCES	8625 SUNSET DR	310 WOODLAND AVE	HADDONFIELD, NJ	5.387
86.05	149.02	BOWEN, FRANCES	8625 SUNSET DR	310 WOODLAND AVE	HADDONFIELD, NJ	5.572
86.05	140	CALVITTI, JOSEPH & HILDA M	8727 SUNSET DR	524 MARKS RD	ORELAND, PA	6.109
86.05	151	GRIMS,MARTIN S & LAURIE	8613 SUNSET DR	2419 WHITE HORSE RD	BERWYN, PA	5.874
86.05	152	GRIMS,MARTIN S & LAURIE	8613 SUNSET DR	2419 WHITE HORSE RD	BERWYN, PA	5.874
86.05	153	HARLAN,GEORGE F & HARLAN,KATHLEEN F	8601 SUNSET DR	907 SORRELL HILL DR	MALVERN, PA	5.987
86.05	154	HARLAN,GEORGE F & HARLAN,KATHLEEN F	8601 SUNSET DR	907 SORRELL HILL DR	MALVERN, PA	5.987
86.05	139	HUMES, GAIL & OAKFORD, RANDY S	8731 SUNSET DR	252 SLOAN CT	WILMINGTON, DE	6.159
86.05	144	MITCHELL, EUGENE F & ANGELIA	8707 SUNSET DR	632 OVERHILL RD	ARDMORE, PA	5.957
86.05	145	MOYER, FIORA N	8701 SUNSET DR	1124 PEBBLE SPRING DR	BERWYN, PA	6.344
86.05	146	MOYER, FIORA N	8701 SUNSET DR	1124 PEBBLE SPRING DR	BERWYN, PA	6.344
86.05	147	PAUL, JAMES K & DENISE M	8631 SUNSET DR	786 BRUSHTOWN ROAD	LOWER GWYNEDD, PA	5.926
86.05	148	PAUL, JAMES K & DENISE M	8631 SUNSET DR	786 BRUSHTOWN ROAD	LOWER GWYNEDD, PA	5.926
86.05	149.01	PAUL, JAMES K & DENISE M	8631 SUNSET DR	786 BRUSHTOWN ROAD	LOWER GWYNEDD, PA	5.926
86.05	141	TREVISAN, DAVID E & AMBER G	8717 SUNSET DR	118 PRENTIS PL	LANCASTER, PA	6.005
86.05	142	TREVISAN, DAVID E & AMBER G	8717 SUNSET DR	118 PRENTIS PL	LANCASTER, PA	6.005
86.05	143	TREVISAN, DAVID E & AMBER G	8717 SUNSET DR	118 PRENTIS PL	LANCASTER, PA	6.128
90.91	154	8921 THIRD LLC	8921 THIRD LLC	2414 W 18TH ST	WILMINGTON, DE	4.615
90.91	156.02	8921 THIRD LLC	8921 THIRD LLC	2414 W 18TH ST	WILMINGTON, DE	4.615
90.91	158.02	8921 THIRD LLC	8921 THIRD LLC	2414 W 18TH ST	WILMINGTON, DE	4.615
90.91	167	ALLINGHAM II, THOS J & PAMELA	382 92ND ST	927 WESTOVER RD.	WILMINGTON, DE	5.802
90.91	169	ALLINGHAM II, THOS J & PAMELA	382 92ND ST	927 WESTOVER RD.	WILMINGTON, DE	5.802
90.91	165.02	ALLINGHAM II, THOS J & PAMELA	382 92ND ST	927 WESTOVER RD.	WILMINGTON, DE	5.846
90.91	171	BRAUTIGAM, JAYNE DAWN & ROBERT TODD	9201 SUNSET DR	1331A VIRGINIA AVE	CAPE MAY, NJ	4.11
90.91	173	BRAUTIGAM, JAYNE DAWN & ROBERT TODD	9201 SUNSET DR	1331A VIRGINIA AVE	CAPE MAY, NJ	4.11
90.91	175.01	BRAUTIGAM, JAYNE DAWN & ROBERT TODD	9201 SUNSET DR	1331A VIRGINIA AVE	CAPE MAY, NJ	4.261
90.91	127	BROSS, JEFFREY & HILKERT, ANN L	BROSS, JEFFREY & HILKERT, ANN L	98 WAYLAND ROAD	WILMINGTON, DE	6.205
90.91	129	BROSS, JEFFREY & HILKERT, ANN L	BROSS, JEFFREY & HILKERT, ANN L	98 WAYLAND ROAD	WILMINGTON, DE	6.226
90.91	228	CAPOZZOLI, JOSEPH A	8825 SUNSET DR	8825 SUNSET DR	STONE HARBOR, NJ	6.278
90.91	230	CAPOZZOLI, JOSEPH A	8825 SUNSET DR	8825 SUNSET DR	STONE HARBOR, NJ	6.278
90.91	149	COFFEY,WILLIAM & MAYER,MARK	COFFEY,WILLIAM & MAYER,MARK	10600 WHISKEY RD	IJAMSVILLE, MD	4.814
90.91	147.02	COFFEY,WILLIAM & MAYER,MARK	COFFEY,WILLIAM & MAYER,MARK	10600 WHISKEY RD	IJAMSVILLE, MD	4.838
90.91	151	COFFEY,WILLIAM & MAYER,MARK	COFFEY,WILLIAM & MAYER,MARK	10600 WHISKEY RD	IJAMSVILLE, MD	5.023
90.91	147.02	COFFEY,WILLIAM & MAYER,MARK	COFFEY,WILLIAM & MAYER,MARK	10600 WHISKEY RD	IJAMSVILLE, MD	6.16
90.91	119.02	DELUCA,VINCENT G & JOAN	DELUCA,VINCENT G & JOAN	140 GOLF VIEW DR	IVYLAND, PA	6.495
90.91	121.03	DELUCA,VINCENT G & JOAN	DELUCA,VINCENT G & JOAN	140 GOLF VIEW DR	IVYLAND, PA	6.495
90.91	121.03	DELUCA,VINCENT G & JOAN	DELUCA,VINCENT G & JOAN	140 GOLF VIEW DR	IVYLAND, PA	6.495
90.91	120.01	DELUCA,VINCENT G & JOAN	DELUCA,VINCENT G & JOAN	140 GOLF VIEW DR	IVYLAND, PA	6.506
90.91	119.01	DURR,HARRY & MELISSA	DURR,HARRY & MELISSA	2522 LOCKLEIGH RD	JAMISON, PA	6.495
90.91	121.01	DURR,HARRY & MELISSA	DURR,HARRY & MELISSA	2522 LOCKLEIGH RD	JAMISON, PA	6.495
90.91	153	FSAF, LLC	FSAF, LLC	P O BOX 335	LINWOOD, NJ	5.042
90.91	155	FSAF, LLC	FSAF, LLC	P O BOX 335	LINWOOD, NJ	5.042
90.91	139	GAC PROPERTIES LLC	GAC PROPERTIES LLC	6419 GAME PRESERVE RD	SCHNECKSVILLE, PA	4.595
90.91	139	GAC PROPERTIES LLC	GAC PROPERTIES LLC	6419 GAME PRESERVE RD	SCHNECKSVILLE, PA	6.158

BLOCK	LOT	Owners Name	Owners Name2	Owner Address 1	Owner Address 2	Elevation (NAVD88)
90.91	182	GRIMES, THOMAS L & JEANNE	GRIMES, THOMAS L & JEANNE	307 RHOADS AVE	HADDONFIELD, NJ	4.111
90.91	184	GRIMES, THOMAS L & JEANNE	GRIMES, THOMAS L & JEANNE	307 RHOADS AVE	HADDONFIELD, NJ	4.224
90.91	141	HARDY,MICHAEL W & DEBORAH Y	HARDY,MICHAEL W & DEBORAH Y	PO BOX 54	BIRCHRUNVILLE, PA	4.484
90.91	143	HARDY,MICHAEL W & DEBORAH Y	HARDY,MICHAEL W & DEBORAH Y	PO BOX 54	BIRCHRUNVILLE, PA	6.16
90.91	145	HARDY,MICHAEL W & DEBORAH Y	HARDY,MICHAEL W & DEBORAH Y	PO BOX 54	BIRCHRUNVILLE, PA	6.16
90.91	147.01	HARDY,MICHAEL W & DEBORAH Y	HARDY,MICHAEL W & DEBORAH Y	PO BOX 54	BIRCHRUNVILLE, PA	6.16
90.91	141	HARDY,MICHAEL W & DEBORAH Y	HARDY,MICHAEL W & DEBORAH Y	PO BOX 54	BIRCHRUNVILLE, PA	6.205
90.91	124	HEALY, KAREN F, TRUSTEE	HEALY, KAREN F, TRUSTEE	44 HILL RD	WILMINGTON, DE	6.337
90.91	126	HEALY, KAREN F, TRUSTEE	HEALY, KAREN F, TRUSTEE	44 HILL RD	WILMINGTON, DE	6.337
90.91	120.02	HEALY, KAREN F, TRUSTEE	HEALY, KAREN F, TRUSTEE	44 HILL RD	WILMINGTON, DE	6.506
90.91	122	HEALY, KAREN F, TRUSTEE	HEALY, KAREN F, TRUSTEE	44 HILL RD	WILMINGTON, DE	6.506
90.91	224	HENDEE, LINDA H	8909 SUNSET DR	8909 SUNSET DR	STONE HARBOR, NJ	5.95
90.91	226	HENDEE, LINDA H	8909 SUNSET DR	8909 SUNSET DR	STONE HARBOR, NJ	5.95
90.91	163	HIRSCH,ERIK R & MCALLISTER,M A	372 92ND ST	17 DARTMOUTH LN	HAVERFORD, PA	5.895
90.91	165.01	HIRSCH,ERIK R & MCALLISTER,M A	372 92ND ST	17 DARTMOUTH LN	HAVERFORD, PA	5.895
90.91	144	JBM REALTY INC @ J MEHAN	JBM REALTY INC @ J MEHAN	1735 N.ORCHID ISLAND CIRC	VERO BEACH, FL	4.545
90.91	144	JBM REALTY INC @ J MEHAN	JBM REALTY INC @ J MEHAN	1735 N.ORCHID ISLAND CIRC	VERO BEACH, FL	4.99
90.91	144	JBM REALTY INC @ J MEHAN	JBM REALTY INC @ J MEHAN	1735 N.ORCHID ISLAND CIRC	VERO BEACH, FL	5.133
90.91	142	JBM REALTY INC @ J MEHAN	JBM REALTY INC @ J MEHAN	1735 N.ORCHID ISLAND CIRC	VERO BEACH, FL	5.968
90.91	236	JONES, ELEANOR F & QUINCEY T ETAL	8813 SUNSET DR	481 WOODLAND DR	RADNOR, PA	6.251
90.91	238	JONES, ELEANOR F & QUINCEY T ETAL	8813 SUNSET DR	481 WOODLAND DR	RADNOR, PA	6.251
90.91	240	JONES, ELEANOR F & QUINCEY T ETAL	8813 SUNSET DR	481 WOODLAND DR	RADNOR, PA	6.251
90.91	242	JONES, ELEANOR F & QUINCEY T ETAL	8813 SUNSET DR	481 WOODLAND DR	RADNOR, PA	6.251
90.91	176	KAPLAN, ALAN M & STABERT, MARGARET	KAPLAN, ALAN M & STABERT, MARGARET	361 89TH ST	STONE HARBOR, NJ	3.888
90.91	174	KAPLAN, ALAN M & STABERT, MARGARET	KAPLAN, ALAN M & STABERT, MARGARET	361 89TH ST	STONE HARBOR, NJ	4.04
90.91	174	KAPLAN, ALAN M & STABERT, MARGARET	KAPLAN, ALAN M & STABERT, MARGARET	361 89TH ST	STONE HARBOR, NJ	6.75
90.91	160	KSM IRREVOCABLE TRUST	KSM IRREVOCABLE TRUST	200 LANSDOWNE AVE	WAYNE, PA	4.386
90.91	160	KSM IRREVOCABLE TRUST	KSM IRREVOCABLE TRUST	200 LANSDOWNE AVE	WAYNE, PA	7.394
90.91	162	KSM IRREVOCABLE TRUST	KSM IRREVOCABLE TRUST	200 LANSDOWNE AVE	WAYNE, PA	7.394
90.91	179	KUCHLER, JOSEPH A & PATRICIA A	9209 SUNSET DR	2 TANBARK CT	VOORHEES, NJ	4.349
90.91	181.01	KUCHLER, JOSEPH A & PATRICIA A	9209 SUNSET DR	2 TANBARK CT	VOORHEES, NJ	4.349
90.91	168	MAJEWSKI,JAMES & BARBARA	MAJEWSKI,JAMES & BARBARA	18 ELM LN	PRINCETON, NJ	4.064
90.91	168	MAJEWSKI,JAMES & BARBARA	MAJEWSKI,JAMES & BARBARA	18 ELM LN	PRINCETON, NJ	6.727
90.91	170	MAJEWSKI,JAMES & BARBARA	MAJEWSKI,JAMES & BARBARA	18 ELM LN	PRINCETON, NJ	6.727
90.91	172	MAJEWSKI,JAMES & BARBARA	MAJEWSKI,JAMES & BARBARA	18 ELM LN	PRINCETON, NJ	6.727
90.91	218	MAY, JAMES S & ELIZABETH LOUISE	8919 SUNSET DR	120 W ROSE VALLEY RD	WALLINGFORD, PA	6.374
90.91	214	MAY, JAMES S & ELIZABETH LOUISE	8919 SUNSET DR	120 W ROSE VALLEY RD	WALLINGFORD, PA	6.392
90.91	216	MAY, JAMES S & ELIZABETH LOUISE	8919 SUNSET DR	120 W ROSE VALLEY RD	WALLINGFORD, PA	6.392
90.91	134	MOYER,JEFFREY GLENN & TONI P	MOYER,JEFFREY GLENN & TONI P	34 JOHN BEAL DR	GARNET VALLEY, PA	5.968
90.91	132	MOYER,JEFFREY GLENN & TONI P	MOYER,JEFFREY GLENN & TONI P	34 JOHN BEAL DR	GARNET VALLEY, PA	6.301
90.91	121.02	NARZIKUL, SIED J & CAROLYN M	NARZIKUL, SIED J & CAROLYN M	200 WHITE TAIL LN	MEDIA, PA	6.205
90.91	123	NARZIKUL, SIED J & CAROLYN M	NARZIKUL, SIED J & CAROLYN M	200 WHITE TAIL LN	MEDIA, PA	6.205
90.91	125	NARZIKUL, SIED J & CAROLYN M	NARZIKUL, SIED J & CAROLYN M	200 WHITE TAIL LN	MEDIA, PA	6.205
90.91	138	R & R STONE HARBOR LLC	R & R STONE HARBOR LLC	1100 ASHBRIDGE RD	BRYN MAWR, PA	5.968
90.91	140	R & R STONE HARBOR LLC	R & R STONE HARBOR LLC	1100 ASHBRIDGE RD	BRYN MAWR, PA	5.968
90.91	164	ROGACHENKO, WALTER A & NANCY L	ROGACHENKO, WALTER A & NANCY L	3180 ZACHARIAS RD	COLLEGEVILLE, PA	7.394
90.91	166	ROGACHENKO, WALTER A & NANCY L	ROGACHENKO, WALTER A & NANCY L	3180 ZACHARIAS RD	COLLEGEVILLE, PA	7.394
90.91	152	ROSELL, CECILE V QPR TRUST	ROSELL, CECILE V QPR TRUST	8931 THIRD AVE	STONE HARBOR, NJ	4.615
90.91	150	ROSELL, CECILE V QPR TRUST	ROSELL, CECILE V QPR TRUST	8931 THIRD AVE	STONE HARBOR, NJ	4.706
90.91	222	RUDAWSKY FAMILY, LLC	8913 SUNSET DR	715 PRINCETON RD	WILMINGTON, DE	5.95
90.91	220	RUDAWSKY FAMILY, LLC	8913 SUNSET DR	715 PRINCETON RD	WILMINGTON, DE	6.374
90.91	222	RUDAWSKY FAMILY, LLC	8913 SUNSET DR	715 PRINCETON RD	WILMINGTON, DE	6.562
90.91	181.02	SAMII, ALI & JEAN M	400 93RD ST	201 LUZERNE ST	JOHNSTOWN, PA	4.608
90.91	183	SAMII, ALI & JEAN M	400 93RD ST	201 LUZERNE ST	JOHNSTOWN, PA	6.012
90.91	133	SCHIFFMAN, THEODORE & LYSSY, MANJA	SCHIFFMAN, THEODORE & LYSSY, MANJA	22A W 16TH STREET	NEW YORK, NY	6.097
90.91	131	SCHIFFMAN, THEODORE & LYSSY, MANJA	SCHIFFMAN, THEODORE & LYSSY, MANJA	22A W 16TH STREET	NEW YORK, NY	6.225
90.91	146	SCOTT, ROBERT H & DEBORAH ENGLE	SCOTT, ROBERT H & DEBORAH ENGLE	8989 THIRD AVE	STONE HARBOR, NJ	4.545
90.91	148	SCOTT, ROBERT H & DEBORAH ENGLE	SCOTT, ROBERT H & DEBORAH ENGLE	8989 THIRD AVE	STONE HARBOR, NJ	4.545
90.91	232	SHEPHERD,RICHARD H JR,TRUSTEE	8821 SUNSET DR	7051 CAMP HILL RD, #200	FORT WASHINGTON, PA	5.837
90.91	234	SHEPHERD,RICHARD H JR,TRUSTEE	8821 SUNSET DR	7051 CAMP HILL RD, #200	FORT WASHINGTON, PA	5.837
90.91	178	SHERRY,DANIEL J & JUDITH A	SHERRY,DANIEL J & JUDITH A	725 GOVERNOR CIR	NEWTOWN SQUARE, PA	3.888
90.91	180	SHERRY,DANIEL J & JUDITH A	SHERRY,DANIEL J & JUDITH A	725 GOVERNOR CIR	NEWTOWN SQUARE, PA	4.111
90.91	175.02	SIMONS, DOROTHY D	9205 SUNSET DR	138 BEACON CIRCLE	BOALSBURG, PA	4.274
90.91	177	SIMONS, DOROTHY D	9205 SUNSET DR	138 BEACON CIRCLE	BOALSBURG, PA	4.274
90.91	157	SNUG HARBOR INVESTMENTS LLC	366 92ND ST	17 DARTMOUTH LN	HAVERFORD, PA	4.778
90.91	157	SNUG HARBOR INVESTMENTS LLC	366 92ND ST	17 DARTMOUTH LN	HAVERFORD, PA	5.042
90.91	90.91	SNUG HARBOR INVESTMENTS LLC	366 92ND ST	17 DARTMOUTH LN	HAVERFORD, PA	6.19
90.91	159	SNUG HARBOR INVESTMENTS LLC	366 92ND ST	17 DARTMOUTH LN	HAVERFORD, PA	6.19
90.91	157	SNUG HARBOR INVESTMENTS LLC	366 92ND ST	17 DARTMOUTH LN	HAVERFORD, PA	6.231
90.91	156.01	SNYDER, EDWARD SCOTT & CATHY JO	SNYDER, EDWARD SCOTT & CATHY JO	17 RICH AVENUE	GLENSIDE, PA	4.615
90.91	158.01	SNYDER, EDWARD SCOTT & CATHY JO	SNYDER, EDWARD SCOTT & CATHY JO	17 RICH AVENUE	GLENSIDE, PA	4.615
90.91	128	SORENSEN, GRETCHEN W	SORENSEN, GRETCHEN W	9027 THIRD AVE	STONE HARBOR, NJ	5.754
90.91	130	SORENSEN, GRETCHEN W	SORENSEN, GRETCHEN W	9027 THIRD AVE	STONE HARBOR, NJ	5.754
90.91	135	WALTER, SUSAN M	WALTER, SUSAN M	587 MCKENDIMEN AVE	MEDFORD, NJ	6.097
90.91	137	WALTER, SUSAN M	WALTER, SUSAN M	587 MCKENDIMEN AVE	MEDFORD, NJ	6.158
90.91	244	WENZ, FRIEDRICH J & LORNA	8803 SUNSET DR	904 GYPSY HILL RD	AMBLER, PA	6.554
90.91	246.01	WENZ, FRIEDRICH J & LORNA	8803 SUNSET DR	904 GYPSY HILL RD	AMBLER, PA	6.554
90.91	246.02	WENZ, JOHN F & BEANS, HEIDI E	8801 SUNSET DR	904 GYPSY HILL RD	AMBLER, PA	6.554
90.91	136	WOLF, JOSEPH L & MARIELLEN	WOLF, JOSEPH L & MARIELLEN	P.O. BOX 435	PILGRIM GARDENS STA, PA	5.968
90.91	184.01	Yacht Club of Stone Harbor	Yacht Club of Stone Harbor	9001 Sunset Dr	Stone Harbor, NJ	3.477
90.91	184.01	Yacht Club of Stone Harbor	Yacht Club of Stone Harbor	9001 Sunset Dr	Stone Harbor, NJ	3.538
90.91	184.01	Yacht Club of Stone Harbor	Yacht Club of Stone Harbor	9001 Sunset Dr	Stone Harbor, NJ	6.246
90.91	184.01	Yacht Club of Stone Harbor	Yacht Club of Stone Harbor	9001 Sunset Dr	Stone Harbor, NJ	6.348
90.91	184.01	Yacht Club of Stone Harbor	Yacht Club of Stone Harbor	9001 Sunset Dr	Stone Harbor, NJ	6.416
90.91	184.01	Yacht Club of Stone Harbor	Yacht Club of Stone Harbor	9001 Sunset Dr	Stone Harbor, NJ	6.455
90.91	184.01	Yacht Club of Stone Harbor	Yacht Club of Stone Harbor	9001 Sunset Dr	Stone Harbor, NJ	6.47
93.05	171	BARRETT, SUSAN M	9321 SUNSET DR	213 BURRWOOD AVE	HADDON TOWNSHIP, NJ	4.209
93.05	169	HOPKINS,RICHARD W & MELANIE %RUTT	9315 SUNSET DR	20 HEGGAN LANE	BLUE ANCHOR, NJ	4.31
93.05	170	HOPKINS,RICHARD W & MELANIE %RUTT	9315 SUNSET DR	20 HEGGAN LANE	BLUE ANCHOR, NJ	4.31
93.05	166	KLEBER, JOHN L SR & NANCY M	9301 SUNSET DR	47 REDWOOD DR	READING, PA	6.113
93.05	167.01	KLEBER, JOHN L SR & NANCY M	9301 SUNSET DR	47 REDWOOD DR	READING, PA	6.113
93.05	172	TIMBERS, JEANNETTE M	9323 SUNSET DR	1 KRYGIER LANE	WILMINGTON, DE	5.663
93.05	173	TIMBERS, JEANNETTE M	9323 SUNSET DR	1 KRYGIER LANE	WILMINGTON, DE	5.663
93.05	174	TIMBERS, JEANNETTE M	9323 SUNSET DR	1 KRYGIER LANE	WILMINGTON, DE	6.075
93.05	167.02	VORIS,JAMES & JOHN	9311 SUNSET DR	1326 GLENSIDE RD	DOWNINGTOWN, PA	6.113
93.05	168	VORIS,JAMES & JOHN	9311 SUNSET DR	1326 GLENSIDE RD	DOWNINGTOWN, PA	6.157
94.05	178.02	9411 SUNSET DRIVE CONDOMINIUM	9411 SUNSET DRIVE CONDOMINIUM	9411 SUNSET DRIVE	STONE HARBOR, NJ	4.072
94.05	178.02	9411 SUNSET DRIVE CONDOMINIUM	9411 SUNSET DRIVE CONDOMINIUM	9411 SUNSET DRIVE	STONE HARBOR, NJ	4.072
94.05	178.02	9411 SUNSET DRIVE CONDOMINIUM	9411 SUNSET DRIVE CONDOMINIUM	9411 SUNSET DRIVE	STONE HARBOR, NJ	4.072
94.05	179	9411 SUNSET DRIVE CONDOMINIUM	9411 SUNSET DRIVE CONDOMINIUM	9411 SUNSET DRIVE	STONE HARBOR, NJ	4.072
94.05	180	ARROW POINT CONDOMINIUM	ARROW POINT CONDOMINIUM	9401 SUNSET DRIVE	STONE HARBOR, NJ	5.842
94.05	180	ARROW POINT CONDOMINIUM	ARROW POINT CONDOMINIUM	9401 SUNSET DRIVE	STONE HARBOR, NJ	5.842
94.05	180	ARROW POINT CONDOMINIUM	ARROW POINT CONDOMINIUM	9401 SUNSET DRIVE	STONE HARBOR, NJ	5.842
94.05	180	ARROW POINT CONDOMINIUM	ARROW POINT CONDOMINIUM	9401 SUNSET DRIVE	STONE HARBOR, NJ	5.842
94.05	180	ARROW POINT CONDOMINIUM	ARROW POINT CONDOMINIUM	9401 SUNSET DRIVE	STONE HARBOR, NJ	5.842
94.05	180	ARROW POINT CONDOMINIUM	ARROW POINT CONDOMINIUM	9401 SUNSET DRIVE	STONE HARBOR, NJ	5.842
94.05	180	ARROW POINT CONDOMINIUM	ARROW POINT CONDOMINIUM	9401 SUNSET DRIVE	STONE HARBOR, NJ	5.842
94.05	181	ARROW POINT CONDOMINIUM	ARROW POINT CONDOMINIUM	9401 SUNSET DRIVE	STONE HARBOR, NJ	5.842
94.05	174	BALACI,ALEXANDRE & LISA	9425 SUNSET DR	615 LINCOLN DR	WERNERSVILLE, PA	5.78
94.05	175.01	BALACI,ALEXANDRE & LISA	9425 SUNSET DR	615 LINCOLN DR	WERNERSVILLE, PA	5.8
94.05	175.02	GERACI REAL ESTATE, LLC-JANA GERACI	9421 SUNSET DR	1676 SOUTH OCEAN BLVD.	PALM BEACH, FL	5.778
94.05	178.01	SCARPA,JANA GERACI & GERACI,JAMES C	9415 SUNSET DR	1676 S. OCEANB BLVD.	PALM BEACH, FL	4.072
94.05	176	SCARPA,JANA GERACI & GERACI,JAMES C	9415 SUNSET DR	1676 S. OCEANB BLVD.	PALM BEACH, FL	4.708

BLOCK	LOT	Owners Name	Owners Name2	Owner Address 1	Owner Address 2	Elevation (NAVD88)
94.05	177	SCARPA,JANA GERACI & GERACI,JAMES C	9415 SUNSET DR	1676 S. OCEANB BLVD.	PALM BEACH, FL	4.708
95.05	260	HARBOR TOWER CONDOMINIUM	HARBOR TOWER CONDOMINIUM	9511 SUNSET DRIVE	STONE HARBOR, NJ	5.839
95.05	260.01		HARBOR TOWER CONDOMINIUM			5.839
95.05	260.02		HARBOR TOWER CONDOMINIUM			5.839
95.05	260.03		HARBOR TOWER CONDOMINIUM			5.839
95.05	260.04		HARBOR TOWER CONDOMINIUM			5.839
95.05	260.05		HARBOR TOWER CONDOMINIUM			5.839
95.05	260.06		HARBOR TOWER CONDOMINIUM			5.839
95.05	260.07		HARBOR TOWER CONDOMINIUM			5.839
95.05	260.08		HARBOR TOWER CONDOMINIUM			5.839
95.05	260.09		HARBOR TOWER CONDOMINIUM			5.839
95.05	260.1		HARBOR TOWER CONDOMINIUM			5.839
95.05	260.11		HARBOR TOWER CONDOMINIUM			5.839
95.05	260.12		HARBOR TOWER CONDOMINIUM			5.839
95.05	260.13		HARBOR TOWER CONDOMINIUM			5.839
95.05	260.14		HARBOR TOWER CONDOMINIUM			5.839
95.05	260.15		HARBOR TOWER CONDOMINIUM			5.839
95.05	260.16		HARBOR TOWER CONDOMINIUM			5.839
95.05	260.17		HARBOR TOWER CONDOMINIUM			5.839
95.05	95	SUNSET DRIVE CONDOMINIUM	SUNSET DRIVE CONDOMINIUM	9501 SUNSET DRIVE	STONE HARBOR, NJ	6.202
95.05	95.01		SUNSET DRIVE CONDOMINIUM			6.202
95.05	95.02		SUNSET DRIVE CONDOMINIUM			6.202
95.05	95.03		SUNSET DRIVE CONDOMINIUM			6.202
95.05	95.04		SUNSET DRIVE CONDOMINIUM			6.202
95.05	95.05		SUNSET DRIVE CONDOMINIUM			6.202
95.05	95.06		SUNSET DRIVE CONDOMINIUM			6.202
95.05	95.07		SUNSET DRIVE CONDOMINIUM			6.202
95.05	95.08		SUNSET DRIVE CONDOMINIUM			6.202
95.05	95.09		SUNSET DRIVE CONDOMINIUM			6.202
95.05	95.1		SUNSET DRIVE CONDOMINIUM			6.202
95.05	95.11		SUNSET DRIVE CONDOMINIUM			6.202
95.05	95.12		SUNSET DRIVE CONDOMINIUM			6.202
95.05	95.13		SUNSET DRIVE CONDOMINIUM			6.202
95.05	95.14		SUNSET DRIVE CONDOMINIUM			6.202
95.05	95.15		SUNSET DRIVE CONDOMINIUM			6.202
95.05	95.16		SUNSET DRIVE CONDOMINIUM			6.202
95.06	1	Bridge Commission	Bridge Commission	4 Moore Road	Cape May Court House, NJ	5.983
96.04	138	100th Street LLC	100th Street LLC	9601 Third Ave	Stone Harbor, NJ	5.896
96.04	139	100th Street LLC	100th Street LLC	9601 Third Ave	Stone Harbor, NJ	5.896
96.04	140	100th Street LLC	100th Street LLC	9601 Third Ave	Stone Harbor, NJ	5.896
96.04	141	100th Street LLC	100th Street LLC	9601 Third Ave	Stone Harbor, NJ	5.896
96.04	142	100th Street LLC	100th Street LLC	9601 Third Ave	Stone Harbor, NJ	5.896
96.04	143	100th Street LLC	100th Street LLC	9601 Third Ave	Stone Harbor, NJ	5.896
96.04	144	100th Street LLC	100th Street LLC	9601 Third Ave	Stone Harbor, NJ	5.896
96.04	164	365 96TH STREET CONDOMINIUM	365 96TH STREET CONDOMINIUM	365 96TH STREET	STONE HARBOR, NJ	5.036
96.04	164	365 96TH STREET CONDOMINIUM	365 96TH STREET CONDOMINIUM	365 96TH STREET	STONE HARBOR, NJ	5.041
96.04	164	365 96TH STREET CONDOMINIUM	365 96TH STREET CONDOMINIUM	365 96TH STREET	STONE HARBOR, NJ	6.274
96.04	128.03		96.04_128.03			4.554
96.04	128.04		96.04_128.04			4.554
96.04	128.05		96.04_128.05			4.554
96.04	152		96.04_152			6.091
96.04	161		96.04_161			6.179
96.04	161		96.04_161			6.179
96.04	161		96.04_161			6.179
96.04	161		96.04_161			6.179
96.04	161		96.04_161			6.179
96.04	161		96.04_161			6.179
96.04	161		96.04_161			6.179
96.04	161		96.04_161			6.179
96.04	161		96.04_161			6.179
96.04	161		96.04_161			6.179
96.04	161		96.04_161			6.179
96.04	161		96.04_161			6.179
96.04	161		96.04_161			6.179
96.04	164.01		96.04_164.01			5.036
96.04	164.02		96.04_164.02			5.036
96.04	164.03		96.04_164.03			5.036
96.04	164.04		96.04_164.04			5.036
96.04	174		96.04_174			6.353
96.04	148	96TH STREET LANDING LLC	96TH STREET LANDING LLC	9601 THIRD AVE	STONE HARBOR, NJ	5.957
96.04	149	96TH STREET LANDING LLC	96TH STREET LANDING LLC	9601 THIRD AVE	STONE HARBOR, NJ	5.957
96.04	150	96TH STREET LANDING LLC	96TH STREET LANDING LLC	9601 THIRD AVE	STONE HARBOR, NJ	5.957
96.04	151	96TH STREET LANDING LLC	96TH STREET LANDING LLC	9601 THIRD AVE	STONE HARBOR, NJ	6.071
96.04	145	96th Street Parlor LLC	96th Street Parlor LLC	9601 3rd Ave	Stone Harbor, NJ	5.896
96.04	146	96th Street Parlor LLC	96th Street Parlor LLC	9601 3rd Ave	Stone Harbor, NJ	6.047
96.04	167.01	96th Street, LLC %John Sprandio, MD	96th Street, LLC %John Sprandio, MD	30 Lawrence RD, STE. 201	Broomall, PA	3.974
96.04	166	96th Street, LLC %John Sprandio, MD	96th Street, LLC %John Sprandio, MD	30 Lawrence RD, STE. 201	Broomall, PA	6.274
96.04	133	9709 THIRD AVENUE CONDOMINIUM	9709 THIRD AVENUE CONDOMINIUM	9709 THIRD AVENUE	STONE HARBOR, NJ	4.954
96.04	133.01		9709 THIRD AVENUE CONDOMINIUM			4.954
96.04	133.02		9709 THIRD AVENUE CONDOMINIUM			4.954
96.04	126	9803 LLC	9803 LLC	18 W Olive St	Westville, NJ	5.666
96.04	125.02	9803 LLC	9803 LLC	18 W Olive St	Westville, NJ	5.694
96.04	128.01	Anderson H&S&Winnick, T&J	Anderson H&S&Winnick, T&J	317 Rockingham Rd	Rosemont, PA	4.299
96.04	127	Anderson H&S&Winnick, T&J	Anderson H&S&Winnick, T&J	317 Rockingham Rd	Rosemont, PA	5.666
96.04	128.01	Anderson H&S&Winnick, T&J	Anderson H&S&Winnick, T&J	317 Rockingham Rd	Rosemont, PA	5.667
96.04	161	Anderson, John E & Judith C	Anderson, John E & Judith C	1420 Locust St., STE.410	Philadelphia, PA	6.179
96.04	224	ANDREADIS, KONSTANTINOS & ANNA L	9815 SUNSET DR	110-A W BALTIMORE PK	SPRINGFIELD, PA	5.752
96.04	191	BERGMAN, HARRY J & LISA J	BERGMAN, HARRY J & LISA J	358 99TH STREET	STONE HARBOR, NJ	6.244
96.04	190.02	BERGMAN, HARRY J & LISA J	BERGMAN, HARRY J & LISA J	358 99TH STREET	STONE HARBOR, NJ	6.315
96.04	192	BERGMAN, HARRY J & LISA J	BERGMAN, HARRY J & LISA J	358 99TH STREET	STONE HARBOR, NJ	6.378
96.04	208	BISIRRI, DOMINIC & ALISON	BISIRRI, DOMINIC & ALISON	1326 ROYAL LN	THOROFARE, NJ	6.292
96.04	209	BISIRRI, DOMINIC & ALISON	BISIRRI, DOMINIC & ALISON	1326 ROYAL LN	THOROFARE, NJ	6.292
96.04	210	BISIRRI, DOMINIC & ALISON	BISIRRI, DOMINIC & ALISON	1326 ROYAL LN	THOROFARE, NJ	6.292
96.04	213	BURKE, WILLIAM & MARGARET M	BURKE, WILLIAM & MARGARET M	105 CEDAR GLEN DR	NEW HOPE, PA	4.584
96.04	214	BURKE, WILLIAM & MARGARET M	BURKE, WILLIAM & MARGARET M	105 CEDAR GLEN DR	NEW HOPE, PA	4.612
96.04	215.01	BURKE, WILLIAM & MARGARET M	BURKE, WILLIAM & MARGARET M	105 CEDAR GLEN DR	NEW HOPE, PA	4.612
96.04	213	BURKE, WILLIAM & MARGARET M	BURKE, WILLIAM & MARGARET M	105 CEDAR GLEN DR	NEW HOPE, PA	6.202
96.04	161	Carlson, Russell J & Vitoria	Carlson, Russell J & Vitoria	33 Gallant Fox Dr	Media, PA	6.179
96.04	198	CASSEL, EVERETT	CASSEL, EVERETT	277 MC INTOSH RD	WEST CHESTER, PA	4.497
96.04	199	CASSEL, EVERETT	CASSEL, EVERETT	277 MC INTOSH RD	WEST CHESTER, PA	4.527
96.04	198	CASSEL, EVERETT	CASSEL, EVERETT	277 MC INTOSH RD	WEST CHESTER, PA	6.288
96.04	188	CHEATLE, ROBERT S & NANCY A	CHEATLE, ROBERT S & NANCY A	1398 LAMPLIGHTER CIRCLE	NORTH WALES, PA	6.279
96.04	189	CHEATLE, ROBERT S & NANCY A	CHEATLE, ROBERT S & NANCY A	1398 LAMPLIGHTER CIRCLE	NORTH WALES, PA	6.279
96.04	190.01	CHEATLE, ROBERT S & NANCY A	CHEATLE, ROBERT S & NANCY A	1398 LAMPLIGHTER CIRCLE	NORTH WALES, PA	6.279
96.04	190.01	CHEATLE, ROBERT S & NANCY A	CHEATLE, ROBERT S & NANCY A	1398 LAMPLIGHTER CIRCLE	NORTH WALES, PA	6.315
96.04	195.02	CLEARY, TIMOTHY F & PATRICIA A	CLEARY, TIMOTHY F & PATRICIA A	5709 CHESHIRE DR	BETHESDA, MD	6.288
96.04	196.02	CLEARY, TIMOTHY F & PATRICIA A	CLEARY, TIMOTHY F & PATRICIA A	5709 CHESHIRE DR	BETHESDA, MD	6.288
96.04	197.02	CLEARY, TIMOTHY F & PATRICIA A	CLEARY, TIMOTHY F & PATRICIA A	5709 CHESHIRE DR	BETHESDA, MD	6.288
96.04	200	COLEMAN, SHAWN	COLEMAN, SHAWN	6060 SAWMILL RD	DOYLESTOWN, PA	4.527
96.04	200	COLEMAN, SHAWN	COLEMAN, SHAWN	6060 SAWMILL RD	DOYLESTOWN, PA	6.112
96.04	201	COLEMAN, SHAWN	COLEMAN, SHAWN	6060 SAWMILL RD	DOYLESTOWN, PA	6.228
96.04	161	Conte, Perry & Diane	Conte, Perry & Diane	359 96th Street, Unit 103	Stone Harbor, NJ	6.179
96.04	161	Conte, Perry & Diane	Conte, Perry & Diane	359 96th Street, Unit 103	Stone Harbor, NJ	6.179

BLOCK	LOT	Owners Name	Owners Name2	Owner Address 1	Owner Address 2	Elevation (NAVD88)
96.04	223	CRAFTS, NANCY C	9813 SUNSET DR	9813 SUNSET DR	STONE HARBOR, NJ	5.572
96.04	222.02	CRAFTS, NANCY C	9813 SUNSET DR	9813 SUNSET DR	STONE HARBOR, NJ	5.621
96.04	223	CRAFTS, NANCY C	9813 SUNSET DR	9813 SUNSET DR	STONE HARBOR, NJ	5.68
96.04	222.02	CRAFTS, NANCY C	9813 SUNSET DR	9813 SUNSET DR	STONE HARBOR, NJ	6.382
96.04	178.01	FALESE, ROBERT & JO-ANNE	FALESE, ROBERT & JO-ANNE	3 BROOKWOOD DR	MEDFORD, NJ	4.735
96.04	181	FALESE, ROBERT & JO-ANNE	FALESE, ROBERT & JO-ANNE	3 BROOKWOOD DR	MEDFORD, NJ	5.991
96.04	178.02	FALESE, ROBERT & JO-ANNE	FALESE, ROBERT & JO-ANNE	3 BROOKWOOD DR	MEDFORD, NJ	6.012
96.04	179	FALESE, ROBERT & JO-ANNE	FALESE, ROBERT & JO-ANNE	3 BROOKWOOD DR	MEDFORD, NJ	6.012
96.04	180	FALESE, ROBERT & JO-ANNE	FALESE, ROBERT & JO-ANNE	3 BROOKWOOD DR	MEDFORD, NJ	6.012
96.04	178.01	FALESE, ROBERT & JO-ANNE	FALESE, ROBERT & JO-ANNE	3 BROOKWOOD DR	MEDFORD, NJ	6.043
96.04	163	GAUL, DENNIS A & GAUL, CAROL J	GAUL, DENNIS A & GAUL, CAROL J	761 WESTFIELD RD	MOORESTOWN, NJ	6.179
96.04	123	GFY of Collier County VII, LLC	GFY of Collier County VII, LLC	134 West Main St	Leola, PA	4.682
96.04	194	GIVNISH, JOHN F	GIVNISH, JOHN F	1010 FOX CHASE RD	ROCKLEDGE, PA	6.37
96.04	193	GIVNISH, JOHN F	GIVNISH, JOHN F	1010 FOX CHASE RD	ROCKLEDGE, PA	6.423
96.04	193	GIVNISH, JOHN F	GIVNISH, JOHN F	1010 FOX CHASE RD	ROCKLEDGE, PA	6.487
96.04	194	GIVNISH, JOHN F	GIVNISH, JOHN F	1010 FOX CHASE RD	ROCKLEDGE, PA	6.489
96.04	207	GRIESSER, JOSEPH M & BETHANN	GRIESSER, JOSEPH M & BETHANN	PO BOX 1420	WEST CHESTER, PA	6.021
96.04	206	GRIESSER, JOSEPH M & BETHANN	GRIESSER, JOSEPH M & BETHANN	PO BOX 1420	WEST CHESTER, PA	6.032
96.04	204.02	GRIESSER, JOSEPH M & BETHANN	GRIESSER, JOSEPH M & BETHANN	PO BOX 1420	WEST CHESTER, PA	6.176
96.04	207	GRIESSER, JOSEPH M & BETHANN	GRIESSER, JOSEPH M & BETHANN	PO BOX 1420	WEST CHESTER, PA	6.373
96.04	205	GRIESSER, JOSEPH M & BETHANN	GRIESSER, JOSEPH M & BETHANN	PO BOX 1420	WEST CHESTER, PA	6.971
96.04	206	GRIESSER, JOSEPH M & BETHANN	GRIESSER, JOSEPH M & BETHANN	PO BOX 1420	WEST CHESTER, PA	6.971
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	2.326
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.473
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	5.896
96.04	154	HALL HARBOR CONDOMINIUM	HALL HARBOR CONDOMINIUM	351 96TH STREET	STONE HARBOR, NJ	6.114
96.04	128.02	Hallman, Carlyn P	Hallman, Carlyn P	946 Anders Rd	Lansdale, PA	4.284
96.04	128.02	Hallman, Carlyn P	Hallman, Carlyn P	946 Anders Rd	Lansdale, PA	4.554
96.04	128.02	Hallman, Carlyn P	Hallman, Carlyn P	946 Anders Rd	Lansdale, PA	4.567
96.04	128.02	Hallman, Carlyn P	Hallman, Carlyn P	946 Anders Rd	Lansdale, PA	5.489
96.04	175.03	JACOBS, ROBERT H & BARBARA J	JACOBS, ROBERT H & BARBARA J	1721 HIBBERD LANE	WEST CHESTER, PA	6.411
96.04	195.01	JOHNSON, KELLY LYN	JOHNSON, KELLY LYN	1830 FOUNTAIN DR,#1305	RESTON, VA	6.288
96.04	196.01	JOHNSON, KELLY LYN	JOHNSON, KELLY LYN	1830 FOUNTAIN DR,#1305	RESTON, VA	6.288
96.04	197.01	JOHNSON, KELLY LYN	JOHNSON, KELLY LYN	1830 FOUNTAIN DR,#1305	RESTON, VA	6.288
96.04	187	KROHN, GARY R & JANET M	KROHN, GARY R & JANET M	10 WINDY ACRES DR	SEWELL, NJ	5.647
96.04	187	KROHN, GARY R & JANET M	KROHN, GARY R & JANET M	10 WINDY ACRES DR	SEWELL, NJ	5.679
96.04	227	LARKIN, WILLIAM P JR & PATRICIA A	9825 SUNSET DR	9 POLO RD	LANGHORNE, PA	5.207
96.04	228.01	LARKIN, WILLIAM P JR & PATRICIA A	9825 SUNSET DR	9 POLO RD	LANGHORNE, PA	7.255
96.04	228.01	LARKIN, WILLIAM P JR & PATRICIA A	9825 SUNSET DR	9 POLO RD	LANGHORNE, PA	7.315
96.04	147	Macconi, Mary M	Macconi, Mary M	9 Jefferson Ave	Pennsville, NJ	5.938
96.04	147	Macconi, Mary M	Macconi, Mary M	9 Jefferson Ave	Pennsville, NJ	6.074
96.04	221	MANNEY, JAMES J & KATHLEEN	MANNEY, JAMES J & KATHLEEN	9811 SUNSET DRIVE	STONE HARBOR, NJ	6.382
96.04	222.01	MANNEY, JAMES J & KATHLEEN	MANNEY, JAMES J & KATHLEEN	9811 SUNSET DRIVE	STONE HARBOR, NJ	6.382
96.04	182	MARTIN,DONALD & LANI, ETAL	MARTIN,DONALD & LANI, ETAL	420 HIDDEN VALLEY CT	WYCKOFF, NJ	5.991
96.04	183	MARTIN,DONALD & LANI, ETAL	MARTIN,DONALD & LANI, ETAL	420 HIDDEN VALLEY CT	WYCKOFF, NJ	5.991
96.04	185	MC CARTHY, FRANCIS DONALD & MAUREEN	MC CARTHY, FRANCIS DONALD & MAUREEN	1005 CALIFORNIA PL	ISLAND PARK, NY	5.679
96.04	184	MC CARTHY, FRANCIS DONALD & MAUREEN	MC CARTHY, FRANCIS DONALD & MAUREEN	1005 CALIFORNIA PL	ISLAND PARK, NY	6.051
96.04	136	MMS CONDOMINIUM	MMS CONDOMINIUM	9629 THIRD AVENUE	STONE HARBOR, NJ	4.6
96.04	136.01		MMS CONDOMINIUM			4.6
96.04	136.02		MMS CONDOMINIUM			4.6
96.04	136.03		MMS CONDOMINIUM			4.6
96.04	136.04		MMS CONDOMINIUM			4.6
96.04	136.05		MMS CONDOMINIUM			4.6
96.04	228.02	MOTTOLA, STEPHEN J	9827 SUNSET DR	P.O. BOX 4664	WILMINGTON, DE	7.255

BLOCK	LOT	Owners Name	Owners Name2	Owner Address 1	Owner Address 2	Elevation (NAVD88)
96.04	229	MOTTOLA, STEPHEN J	9827 SUNSET DR	P.O. BOX 4664	WILMINGTON, DE	7.255
96.04	226	MYERS, JOHN V JR & MARY ANN	9821 SUNSET DR	9821 SUNSET DR.	STONE HARBOR, NJ	5.338
96.04	171	Parks, Norman W & Margaret	Parks, Norman W & Margaret	379 96th St	Stone Harbor, NJ	3.888
96.04	171	Parks, Norman W & Margaret	Parks, Norman W & Margaret	379 96th St	Stone Harbor, NJ	3.888
96.04	171	Parks, Norman W & Margaret	Parks, Norman W & Margaret	379 96th St	Stone Harbor, NJ	3.888
96.04	175.04	PATTERSON, WILLIAM E, TRUSTEE	PATTERSON, WILLIAM E, TRUSTEE	93 E HAYDEN CT, #18	EVANSTON, WY	6.411
96.04	172	PIER 96 MARINA CONDOMINIUM	PIER 96 MARINA CONDOMINIUM	401 96TH STREET	STONE HARBOR, NJ	6.097
96.04	173	PIER 96 MARINA CONDOMINIUM	PIER 96 MARINA CONDOMINIUM	401 96TH STREET	STONE HARBOR, NJ	6.226
96.04	177.01	PIER 96 MARINA CONDOMINIUM	PIER 96 MARINA CONDOMINIUM	401 96TH STREET	STONE HARBOR, NJ	6.301
96.04	176.01	PIER 96 MARINA CONDOMINIUM	PIER 96 MARINA CONDOMINIUM	401 96TH STREET	STONE HARBOR, NJ	6.411
96.04	177	PIER 96 MARINA CONDOMINIUM	PIER 96 MARINA CONDOMINIUM	401 96TH STREET	STONE HARBOR, NJ	6.411
96.04	177.01	PIER 96 MARINA CONDOMINIUM	PIER 96 MARINA CONDOMINIUM	401 96TH STREET	STONE HARBOR, NJ	6.451
96.04	175	PIER 96 MARINA CONDOMINIUM	PIER 96 MARINA CONDOMINIUM	401 96TH STREET	STONE HARBOR, NJ	6.481
96.04	176	PIER 96 MARINA CONDOMINIUM	PIER 96 MARINA CONDOMINIUM	401 96TH STREET	STONE HARBOR, NJ	6.481
96.04	177.02	PIER 96 MARINA CONDOMINIUM	PIER 96 MARINA CONDOMINIUM	401 96TH STREET	STONE HARBOR, NJ	
96.04	202	RADWELL,BRIAN & KARLA	RADWELL,BRIAN & KARLA	1 MILLENIUM DRIVE	WILLINGBORO, NJ	6.12
96.04	203	RADWELL,BRIAN & KARLA	RADWELL,BRIAN & KARLA	1 MILLENIUM DRIVE	WILLINGBORO, NJ	6.181
96.04	204.01	RADWELL,BRIAN & KARLA	RADWELL,BRIAN & KARLA	1 MILLENIUM DRIVE	WILLINGBORO, NJ	6.181
96.04	217	RAKESTRAW, JANE E	RAKESTRAW, JANE E	440 98TH STREET	STONE HARBOR, NJ	6.561
96.04	218	RAKESTRAW, JANE E	RAKESTRAW, JANE E	440 98TH STREET	STONE HARBOR, NJ	6.561
96.04	124	Reber, Nana Y C/O John Reber	Reber, Nana Y C/O John Reber	12 Tracey Terraace	Cherry Hill, NJ	5.655
96.04	125.01	Reber, Nana Y C/O John Reber	Reber, Nana Y C/O John Reber	12 Tracey Terraace	Cherry Hill, NJ	5.803
96.04	119	REGATTA BAY MARKETPLACE CONDOMINIUM	REGATTA BAY MARKETPLACE CONDOMINIUM	9815-25 THIRD AVE	STONE HARBOR, NJ	4.724
96.04	119.01		REGATTA BAY MARKETPLACE CONDOMINIUM			4.724
96.04	119.02		REGATTA BAY MARKETPLACE CONDOMINIUM			4.724
96.04	119.03		REGATTA BAY MARKETPLACE CONDOMINIUM			4.724
96.04	119.04		REGATTA BAY MARKETPLACE CONDOMINIUM			4.724
96.04	119.05		REGATTA BAY MARKETPLACE CONDOMINIUM			4.724
96.04	119.06		REGATTA BAY MARKETPLACE CONDOMINIUM			4.724
96.04	119.07		REGATTA BAY MARKETPLACE CONDOMINIUM			4.724
96.04	123		REGATTA BAY MARKETPLACE CONDOMINIUM			5.655
96.04	175.02	ROACH, TIMOTHY L & CINDY E	ROACH, TIMOTHY L & CINDY E	228 S FAIRFIELD AVE	DEVON, PA	6.481
96.04	170	Schmollinger, Robert	Schmollinger, Robert	PO BOX 264	Stone Harbor, NJ	3.888
96.04	167.02	Schmollinger, Robert	Schmollinger, Robert	PO BOX 264	Stone Harbor, NJ	3.974
96.04	168	Schmollinger, Robert	Schmollinger, Robert	PO BOX 264	Stone Harbor, NJ	3.974
96.04	169	Schmollinger, Robert	Schmollinger, Robert	PO BOX 264	Stone Harbor, NJ	3.974
96.04	231	SCOCCA,JOSEPH E & EHLERS TRUSTEES	9835 SUNSET DR	1729 TOWNE DR	WEST CHESTER, PA	5.999
96.04	230	SCOCCA,JOSEPH E & EHLERS TRUSTEES	9835 SUNSET DR	1729 TOWNE DR	WEST CHESTER, PA	6.014
96.04	230	SCOCCA,JOSEPH E & EHLERS TRUSTEES	9835 SUNSET DR	1729 TOWNE DR	WEST CHESTER, PA	7.255
96.04	225	STONE,DAVID B III & DONNA S	9817 SUNSET DR	1003 LOMBARD ST	PHILADELPHIA, PA	4.888
96.04	225	STONE,DAVID B III & DONNA S	9817 SUNSET DR	1003 LOMBARD ST	PHILADELPHIA, PA	4.897
96.04	225	STONE,DAVID B III & DONNA S	9817 SUNSET DR	1003 LOMBARD ST	PHILADELPHIA, PA	5.752
96.04	131	Turney, Randall J & Margaret M	Turney, Randall J & Margaret M	1351 Troon LN	West Chester, PA	5.489
96.04	132	Turney, Randall J & Margaret M	Turney, Randall J & Margaret M	1351 Troon LN	West Chester, PA	5.489
96.04	134	Vail, Julie R	Vail, Julie R	315 Windfiled Rd	Devon, PA	6.317
96.04	135	Vail, Julie R	Vail, Julie R	315 Windfiled Rd	Devon, PA	6.317
96.04	186	VILLANOVA,EMILIO J & LILLIAN M,ETAL	VILLANOVA,EMILIO J & LILLIAN M,ETAL	10 PRINCETON AVE	GLOUCESTER HEIGHTS, NJ	5.679
96.04	215.02	WALSH III,EDWARD ETALS	WALSH III,EDWARD ETALS	251 SENECA DR	MALVERN, PA	4.612
96.04	215.02	WALSH III,EDWARD ETALS	WALSH III,EDWARD ETALS	251 SENECA DR	MALVERN, PA	6.449
96.04	216	WALSH III,EDWARD ETALS	WALSH III,EDWARD ETALS	251 SENECA DR	MALVERN, PA	6.561
96.04	175.01	WERMUTH, WILLIAM C & JENNIFER ROSS	WERMUTH, WILLIAM C & JENNIFER ROSS	1525 COUNTY LINE RD	BRYN MAWR, PA	6.481
96.04	220	WILLETT, JOHN A & SUSAN F	WILLETT, JOHN A & SUSAN F	430 E 57TH ST #10A	NEW YORK, NY	6.483
96.04	219	WILLETT, JOHN A & SUSAN F	WILLETT, JOHN A & SUSAN F	430 E 57TH ST #10A	NEW YORK, NY	6.534
96.04	219	WILLETT, JOHN A & SUSAN F	WILLETT, JOHN A & SUSAN F	430 E 57TH ST #10A	NEW YORK, NY	6.561
96.04	211	ZIMMER, KENNETH & LYNN	ZIMMER, KENNETH & LYNN	733 JAMIE DR	MOORESTOWN, NJ	6.202
96.04	212	ZIMMER, KENNETH & LYNN	ZIMMER, KENNETH & LYNN	733 JAMIE DR	MOORESTOWN, NJ	6.202
103.05	128.02	386 104TH STREET SH LLC	386 104TH STREET SH LLC	60 OAK RIDGE AVE	SUMMIT, NJ	6.43
103.05	129	386 104TH STREET SH LLC	386 104TH STREET SH LLC	60 OAK RIDGE AVE	SUMMIT, NJ	6.43
103.05	129	386 104TH STREET SH LLC	386 104TH STREET SH LLC	60 OAK RIDGE AVE	SUMMIT, NJ	6.441
103.05	125.01	BROWN, MARGARET H	BROWN, MARGARET H	400 RING NECK LA	LANCASTER, PA	4.995
103.05	121	BROWN, MARGARET H	BROWN, MARGARET H	400 RING NECK LA	LANCASTER, PA	6.239
103.05	122	BROWN, MARGARET H	BROWN, MARGARET H	400 RING NECK LA	LANCASTER, PA	6.239
103.05	123	BROWN, MARGARET H	BROWN, MARGARET H	400 RING NECK LA	LANCASTER, PA	6.239
103.05	124.01	BROWN, MARGARET H	BROWN, MARGARET H	400 RING NECK LA	LANCASTER, PA	6.239
103.05	124.02	BROWN, MARGARET H	BROWN, MARGARET H	400 RING NECK LA	LANCASTER, PA	6.248
103.05	125.01	BROWN, MARGARET H	BROWN, MARGARET H	400 RING NECK LA	LANCASTER, PA	6.248
103.05	127.02	RAPINE, WAYNE & PAMELA	RAPINE, WAYNE & PAMELA	309 NORTH STAR RD	NEWARK, DE	4.639
103.05	128.01	RAPINE, WAYNE & PAMELA	RAPINE, WAYNE & PAMELA	309 NORTH STAR RD	NEWARK, DE	4.639
103.05	128.01	RAPINE, WAYNE & PAMELA	RAPINE, WAYNE & PAMELA	309 NORTH STAR RD	NEWARK, DE	6.421
103.05	127.01	ROBINSON,JOHN B IRR GRANTOR TRUST	ROBINSON,JOHN B IRR GRANTOR TRUST	3715 RAMSEY DR	EDGEWATER, MD	4.639
103.05	125.02	ROBINSON,JOHN B IRR GRANTOR TRUST	ROBINSON,JOHN B IRR GRANTOR TRUST	3715 RAMSEY DR	EDGEWATER, MD	4.816
103.05	126	ROBINSON,JOHN B IRR GRANTOR TRUST	ROBINSON,JOHN B IRR GRANTOR TRUST	3715 RAMSEY DR	EDGEWATER, MD	4.816
103.06	133	BARTON, DON & SANDRA E	BARTON, DON & SANDRA E	1062 BEAUMONT RD	BERWYN, PA	5.629
103.06	134	BARTON, DON & SANDRA E	BARTON, DON & SANDRA E	1062 BEAUMONT RD	BERWYN, PA	5.707
103.06	134	BARTON, DON & SANDRA E	BARTON, DON & SANDRA E	1062 BEAUMONT RD	BERWYN, PA	5.925
103.06	135	CLEARKIN,ANDREA P & BIDDICK,KENNETH	CLEARKIN,ANDREA P & BIDDICK,KENNETH	P.O. BOX 8550	TURNERSVILLE, NJ	5.89
103.06	136	CLEARKIN,ANDREA P & BIDDICK,KENNETH	CLEARKIN,ANDREA P & BIDDICK,KENNETH	P.O. BOX 8550	TURNERSVILLE, NJ	5.89
103.06	132	SEABURY, RICHARD WILLIAMS & SUSAN S	SEABURY, RICHARD WILLIAMS & SUSAN S	16 HILLCREST RD BOX 97	TOWACO, NJ	4.537
103.07	141.02	DIPPOLD, JULIE ANN, ETAL	DIPPOLD, JULIE ANN, ETAL	1171 DUNSINANE HILL	CHESTER SPRINGS, PA	6.258
103.07	142.01	DIPPOLD, JULIE ANN, ETAL	DIPPOLD, JULIE ANN, ETAL	1171 DUNSINANE HILL	CHESTER SPRINGS, PA	6.258
103.07	142.02	DIPPOLD,JULIE ETAL, TRUSTEES	DIPPOLD,JULIE ETAL, TRUSTEES	1171 DUNSINANE HILL	CHESTER SPRINGS, PA	6.258
103.07	143	DIPPOLD,JULIE ETAL, TRUSTEES	DIPPOLD,JULIE ETAL, TRUSTEES	1171 DUNSINANE HILL	CHESTER SPRINGS, PA	6.258
103.07	144.01	DIPPOLD,JULIE ETAL, TRUSTEES	DIPPOLD,JULIE ETAL, TRUSTEES	1171 DUNSINANE HILL	CHESTER SPRINGS, PA	6.282
103.07	146	GREAVES, JEAN	GREAVES, JEAN	8 PALMER DR	MOORESTOWN, NJ	5.631
103.07	140	HUNTER, JOHN G JR & DIANE M	HUNTER, JOHN G JR & DIANE M	416 104TH ST	STONE HARBOR, NJ	6.171
103.07	141.01	HUNTER, JOHN G JR & DIANE M	HUNTER, JOHN G JR & DIANE M	416 104TH ST	STONE HARBOR, NJ	6.258
103.07	145	TURNER, ROBERT C & ETAL TRUSTEE	TURNER, ROBERT C & ETAL TRUSTEE	106 N.BACTON HILL ROAD	MALVERN, PA	5.478
103.07	144.02	TURNER, ROBERT C & ETAL TRUSTEE	TURNER, ROBERT C & ETAL TRUSTEE	106 N.BACTON HILL ROAD	MALVERN, PA	5.568
103.07	145	TURNER, ROBERT C & ETAL TRUSTEE	TURNER, ROBERT C & ETAL TRUSTEE	106 N.BACTON HILL ROAD	MALVERN, PA	5.568
104.04	125	CIFALOGLIO, THOMAS H	CIFALOGLIO, THOMAS H	P O BOX 523	BUENA, NJ	4.3882
104.04	123.02	COLLINS, MATTHEW M III	COLLINS, MATTHEW M III	112 DEERFIELD DR	CHERRY HILL, NJ	5.8031
104.04	124	COLLINS, MATTHEW M III	COLLINS, MATTHEW M III	112 DEERFIELD DR	CHERRY HILL, NJ	5.9168
104.04	121.01	GREENLEE, STEPHEN M & DONNA M	GREENLEE, STEPHEN M & DONNA M	1023 BARONRIDGE	SEABROOK, TX	5.9435
104.04	121	GREENLEE, STEPHEN M & DONNA M	GREENLEE, STEPHEN M & DONNA M	1023 BARONRIDGE	SEABROOK, TX	6.2348
104.04	122	JURAS, DAVID M	JURAS, DAVID M	6004 NW 124TH ST	GAINESVILLE, FL	5.9435
104.04	123.01	JURAS, DAVID M	JURAS, DAVID M	6004 NW 124TH ST	GAINESVILLE, FL	5.9435
104.04	126	PETTIT,DONALD & COOKE,SUZANNE A	PETTIT,DONALD & COOKE,SUZANNE A	275 HOTHORPE LANE	VILLANOVA, PA	4.3089
104.04	127.01	PETTIT,DONALD & COOKE,SUZANNE A	PETTIT,DONALD & COOKE,SUZANNE A	275 HOTHORPE LANE	VILLANOVA, PA	4.3446
104.04	134	SEEFRIED, GRETCHEN & PHILIP W JR	SEEFRIED, GRETCHEN & PHILIP W JR	9151 E. HARVARD AVE	DENVER, CO	6.6186
104.04	132.02	SEEFRIED, GRETCHEN & PHILIP W JR	SEEFRIED, GRETCHEN & PHILIP W JR	9151 E. HARVARD AVE	DENVER, CO	6.7487
104.04	133	SEEFRIED, GRETCHEN & PHILIP W JR	SEEFRIED, GRETCHEN & PHILIP W JR	9151 E. HARVARD AVE	DENVER, CO	6.7487
104.04	127.02	SPARTA, IRENE F, TRUSTEE	SPARTA, IRENE F, TRUSTEE	335 104TH STREET	STONE HARBOR, NJ	4.3094
104.04	129.01	SPARTA, IRENE F, TRUSTEE	SPARTA, IRENE F, TRUSTEE	335 104TH STREET	STONE HARBOR, NJ	4.4
104.04	128	SPARTA, IRENE F, TRUSTEE	SPARTA, IRENE F, TRUSTEE	335 104TH STREET	STONE HARBOR, NJ	4.4241
104.04	129.02	SUNSET SH GROUP, LLC	SUNSET SH GROUP, LLC	P.O.BOX 482	STONE HARBOR, NJ	4.3332
104.04	129.02	SUNSET SH GROUP, LLC	SUNSET SH GROUP, LLC	P.O.BOX 482	STONE HARBOR, NJ	6.5176
104.04	130	SUNSET SH GROUP, LLC	SUNSET SH GROUP, LLC	P.O.BOX 482	STONE HARBOR, NJ	6.5176
104.04	131	SUNSET SH GROUP, LLC	SUNSET SH GROUP, LLC	P.O.BOX 482	STONE HARBOR, NJ	6.5176
104.04	132.01	SUNSET SH GROUP, LLC	SUNSET SH GROUP, LLC	P.O.BOX 482	STONE HARBOR, NJ	6.7108
105.04	136.02	10553 3RD AVE LLC	10553 3RD AVE LLC	10551 CORINTHIAN DR	STONE HARBOR, NJ	4.6251
105.04	137	10553 3RD AVE LLC	10553 3RD AVE LLC	10551 CORINTHIAN DR	STONE HARBOR, NJ	4.6251
105.04	138	10553 3RD AVE LLC	10553 3RD AVE LLC	10551 CORINTHIAN DR	STONE HARBOR, NJ	4.7466
105.04	138	10553 3RD AVE LLC	10553 3RD AVE LLC	10551 CORINTHIAN DR	STONE HARBOR, NJ	6.6667

BLOCK	LOT	Owners Name	Owners Name2	Owner Address 1	Owner Address 2	Elevation (NAVD88)
105.04	144	BAY FRONT CAPITAL, LLC	BAY FRONT CAPITAL, LLC	80 OLD MILL DR	MEDIA, PA	5.5107
105.04	143	BAY FRONT CAPITAL, LLC	BAY FRONT CAPITAL, LLC	80 OLD MILL DR	MEDIA, PA	5.5467
105.04	144	BAY FRONT CAPITAL, LLC	BAY FRONT CAPITAL, LLC	80 OLD MILL DR	MEDIA, PA	6.7528
105.04	136.01	CALVITTI, MARIE L	CALVITTI, MARIE L	454 NEW GALENA ROAD	CHALFONT, PA	4.6251
105.04	136.01	CALVITTI, MARIE L	CALVITTI, MARIE L	454 NEW GALENA ROAD	CHALFONT, PA	6.355
105.04	135	CALVITTI, MARIE L	CALVITTI, MARIE L	454 NEW GALENA ROAD	CHALFONT, PA	6.3943
105.04	141.02	DAY, BARRY	DAY, BARRY	10521 THIRD AVE	STONE HARBOR, NJ	6.1606
105.04	142	DAY, BARRY	DAY, BARRY	10521 THIRD AVE	STONE HARBOR, NJ	6.1606
105.04	141.01	GEORGE, MICHAEL & AMY	GEORGE, MICHAEL & AMY	2036 BUTTONWOOD RD	BERWYN, PA	6.1606
105.04	139	GEORGE, MICHAEL & AMY	GEORGE, MICHAEL & AMY	2036 BUTTONWOOD RD	BERWYN, PA	6.6667
105.04	140	GEORGE, MICHAEL & AMY	GEORGE, MICHAEL & AMY	2036 BUTTONWOOD RD	BERWYN, PA	6.7365
105.04	140	GEORGE, MICHAEL & AMY	GEORGE, MICHAEL & AMY	2036 BUTTONWOOD RD	BERWYN, PA	6.7622
105.04	141.01	GEORGE, MICHAEL & AMY	GEORGE, MICHAEL & AMY	2036 BUTTONWOOD RD	BERWYN, PA	6.8237
105.04	145	JOHNSON,A DAVID JR & JOANNA R.	JOHNSON,A DAVID JR & JOANNA R.	721 WARREN AVE	MALVERN, PA	6.7528
105.04	146.01	JOHNSON,A DAVID JR & JOANNA R.	JOHNSON,A DAVID JR & JOANNA R.	721 WARREN AVE	MALVERN, PA	6.785
105.04	146.02	O'NEIL JAMES & JANICE TRUST	O'NEIL JAMES & JANICE TRUST	212 CREST AVE	HADDON HEIGHTS, NJ	6.0438
105.04	147	O'NEIL JAMES & JANICE TRUST	O'NEIL JAMES & JANICE TRUST	212 CREST AVE	HADDON HEIGHTS, NJ	6.1627
106.04	120	10611 THIRD AVENUE,LLC@SELECT CAPIT	10611 THIRD AVENUE,LLC@SELECT CAPIT	4732 GETTYSBURG RD,#401	MECHANICSBURG, PA	6.2511
106.04	120	10611 THIRD AVENUE,LLC@SELECT CAPIT	10611 THIRD AVENUE,LLC@SELECT CAPIT	4732 GETTYSBURG RD,#401	MECHANICSBURG, PA	6.3221
106.04	121	10611 THIRD AVENUE,LLC@SELECT CAPIT	10611 THIRD AVENUE,LLC@SELECT CAPIT	4732 GETTYSBURG RD,#401	MECHANICSBURG, PA	6.3221
106.04	119	BURST,MARIE R,ETAL,TTS %C.RAUB	BURST,MARIE R,ETAL,TTS %C.RAUB	1809 E. BROOKWOOD CT	PHOENIX, AZ	6.2056
106.04	119	BURST,MARIE R,ETAL,TTS %C.RAUB	BURST,MARIE R,ETAL,TTS %C.RAUB	1809 E. BROOKWOOD CT	PHOENIX, AZ	6.3782
106.04	122	REINHOLD,JEFFREY A & LISTER,KATHLEE	REINHOLD,JEFFREY A & LISTER,KATHLEE	2029 DELANCEY PL	PHILADELPHIA, PA	5.5847
106.04	123	REINHOLD,JEFFREY A & LISTER,KATHLEE	REINHOLD,JEFFREY A & LISTER,KATHLEE	2029 DELANCEY PL	PHILADELPHIA, PA	5.7024
106.04	122	REINHOLD,JEFFREY A & LISTER,KATHLEE	REINHOLD,JEFFREY A & LISTER,KATHLEE	2029 DELANCEY PL	PHILADELPHIA, PA	5.974
106.04	122	REINHOLD,JEFFREY A & LISTER,KATHLEE	REINHOLD,JEFFREY A & LISTER,KATHLEE	2029 DELANCEY PL	PHILADELPHIA, PA	6.6295
106.04	125	VAD PROPERTIES, LLC % A.CALVITTI	VAD PROPERTIES, LLC % A.CALVITTI	5701 PRIVATE DR	DOYLESTOWN, PA	5.7042
106.04	124	VAD PROPERTIES, LLC % A.CALVITTI	VAD PROPERTIES, LLC % A.CALVITTI	5701 PRIVATE DR	DOYLESTOWN, PA	5.7108
106.04	124	VAD PROPERTIES, LLC % A.CALVITTI	VAD PROPERTIES, LLC % A.CALVITTI	5701 PRIVATE DR	DOYLESTOWN, PA	5.9855
106.04	125	VAD PROPERTIES, LLC % A.CALVITTI	VAD PROPERTIES, LLC % A.CALVITTI	5701 PRIVATE DR	DOYLESTOWN, PA	6.4268
106.04	125	VAD PROPERTIES, LLC % A.CALVITTI	VAD PROPERTIES, LLC % A.CALVITTI	5701 PRIVATE DR	DOYLESTOWN, PA	6.4575
107.04	96	ACCARDI, SAMUEL J & REGINA A	10809 SUNSET DR	10809 SUNSET DR	STONE HARBOR, NJ	5.9954
107.04	95	ACCARDI, SAMUEL J & REGINA A	10809 SUNSET DR	10809 SUNSET DR	STONE HARBOR, NJ	6.005
107.04	95	ACCARDI, SAMUEL J & REGINA A	10809 SUNSET DR	10809 SUNSET DR	STONE HARBOR, NJ	6.0263
107.04	96	ACCARDI, SAMUEL J & REGINA A	10809 SUNSET DR	10809 SUNSET DR	STONE HARBOR, NJ	6.1102
107.04	99	BLANK, IRA B & LUCINDA C	10825 SUNSET DR	300 SPRUCE ST	PHILADELPHIA, PA	6.1532
107.04	99	BLANK, IRA B & LUCINDA C	10825 SUNSET DR	300 SPRUCE ST	PHILADELPHIA, PA	6.1711
107.04	99	BLANK, IRA B & LUCINDA C	10825 SUNSET DR	300 SPRUCE ST	PHILADELPHIA, PA	6.1976
107.04	100.01	BLANK, IRA B & LUCINDA C	10825 SUNSET DR	300 SPRUCE ST	PHILADELPHIA, PA	6.2494
107.04	97	BUSHNER, CARL & RANDI	10817 SUNSET DR	31 SPRING VALLEY RD	MALVERN, PA	6.1326
107.04	97	BUSHNER, CARL & RANDI	10817 SUNSET DR	31 SPRING VALLEY RD	MALVERN, PA	6.1455
107.04	98	BUSHNER, CARL & RANDI	10817 SUNSET DR	31 SPRING VALLEY RD	MALVERN, PA	6.1532
107.04	108.02	CALLAHAN, JOSEPH M & DORREN A	10911 SUNSET DR	1306 PINE RD	BRYN MAWR, PA	4.6597
107.04	109	CALLAHAN, JOSEPH M & DORREN A	10911 SUNSET DR	1306 PINE RD	BRYN MAWR, PA	4.6597
107.04	89.01	CONRAD, W WAYNE & SUZANNE P	10711 SUNSET DR	10711 SUNSET DR	STONE HARBOR, NJ	6.006
107.04	88	CONRAD, W WAYNE & SUZANNE P	10711 SUNSET DR	10711 SUNSET DR	STONE HARBOR, NJ	6.0072
107.04	88	CONRAD, W WAYNE & SUZANNE P	10711 SUNSET DR	10711 SUNSET DR	STONE HARBOR, NJ	6.046
107.04	91	FENKEL, JOSEPH & MARY	10725 SUNSET DR	1111 WAVERLY RD	GLADWYNE, PA	6.0413
107.04	92	FENKEL, JOSEPH & MARY	10725 SUNSET DR	1111 WAVERLY RD	GLADWYNE, PA	6.0858
107.04	106.02	FISCHER,MAUREEN & ROWLAND,JAMES JR	10907 SUNSET DR	1913 CONESTOGA RD	CHESTER SPRINGS, PA	4.5161
107.04	107.01	FISCHER,MAUREEN & ROWLAND,JAMES JR	10907 SUNSET DR	1913 CONESTOGA RD	CHESTER SPRINGS, PA	4.7135
107.04	87	GRIESBACK, RUSSELL JR & RUTH E	10707 SUNSET DR	113 FARMINGTON ROAD	CHERRY HILL, NJ	5.1786
107.04	87	GRIESBACK, RUSSELL JR & RUTH E	10707 SUNSET DR	113 FARMINGTON ROAD	CHERRY HILL, NJ	6.0807
107.04	110	HAMMOND, DAVID M & LYNN M	10913 SUNSET DR	10913 SUNSET DR	STONE HARBOR, NJ	4.6597
107.04	110	HAMMOND, DAVID M & LYNN M	10913 SUNSET DR	10913 SUNSET DR	STONE HARBOR, NJ	6.6987
107.04	110	HAMMOND, DAVID M & LYNN M	10913 SUNSET DR	10913 SUNSET DR	STONE HARBOR, NJ	6.7224
107.04	110	HAMMOND, DAVID M & LYNN M	10913 SUNSET DR	10913 SUNSET DR	STONE HARBOR, NJ	6.9278
107.04	107.02	HOWARD, BARBARA, ETAL %JEAN ZARTMAN	10909 SUNSET DR	10909 SUNSET DR	STONE HARBOR, NJ	4.7135
107.04	108.01	HOWARD, BARBARA, ETAL %JEAN ZARTMAN	10909 SUNSET DR	10909 SUNSET DR	STONE HARBOR, NJ	4.7135
107.04	108.01	HOWARD, BARBARA, ETAL %JEAN ZARTMAN	10909 SUNSET DR	10909 SUNSET DR	STONE HARBOR, NJ	6.6386
107.04	93.02	JACOB, GEORGE J	10805 SUNSET DR	10805 SUNSET DR	STONE HARBOR, NJ	5.9257
107.04	94	JACOB, GEORGE J	10805 SUNSET DR	10805 SUNSET DR	STONE HARBOR, NJ	6.0263
107.04	104	MC GLONE FAMILY PARTNERSHIP	10901 SUNSET DR	1162 BARBARA DR	CHERRY HILL, NJ	4.4382
107.04	103	MC GLONE FAMILY PARTNERSHIP	10901 SUNSET DR	1162 BARBARA DR	CHERRY HILL, NJ	4.5206
107.04	103	MC GLONE FAMILY PARTNERSHIP	10901 SUNSET DR	1162 BARBARA DR	CHERRY HILL, NJ	5.9958
107.04	105	MC GLONE, MARIE L	10905 SUNSET DR	PO BOX 220	BARRINGTON, NJ	4.3862
107.04	106.01	MC GLONE, MARIE L	10905 SUNSET DR	PO BOX 220	BARRINGTON, NJ	4.5161
107.04	102	MISCHLER,JOSEPH & SUSAN	10835 SUNSET DR	15806 SEURAT DR	NORTH POTOMAC, MD	4.5675
107.04	102	MISCHLER,JOSEPH & SUSAN	10835 SUNSET DR	15806 SEURAT DR	NORTH POTOMAC, MD	6.0432
107.04	93.01	ORQUIZA, KAAREN B	10801 SUNSET DR	204 EVANS AVE	WYOMISSING, PA	5.9455
107.04	100.02	ROTH,STEVEN E SR & MARGIE,TTEES	10829 SUNSET DR	905 NORWAY AVE	PITMAN, NJ	4.3853
107.04	101	ROTH,STEVEN E SR & MARGIE,TTEES	10829 SUNSET DR	905 NORWAY AVE	PITMAN, NJ	4.5675
107.04	100.02	ROTH,STEVEN E SR & MARGIE,TTEES	10829 SUNSET DR	905 NORWAY AVE	PITMAN, NJ	6.2494
107.04	89.02	TIMMS, DANIEL G & MARILYN H	10723 SUNSET DR	1104 COOPER ST	DEPTFORD, NJ	6.006
107.04	90	TIMMS, DANIEL G & MARILYN H	10723 SUNSET DR	1104 COOPER ST	DEPTFORD, NJ	6.0413
110.05	103	11101 SUNSET, LLC	11101 SUNSET DR	1300 WESTELLEN RD	TOWSON, MD	5.8055
110.05	103	11101 SUNSET, LLC	11101 SUNSET DR	1300 WESTELLEN RD	TOWSON, MD	5.8704
110.05	103	11101 SUNSET, LLC	11101 SUNSET DR	1300 WESTELLEN RD	TOWSON, MD	5.8914
110.05	103	11101 SUNSET, LLC	11101 SUNSET DR	1300 WESTELLEN RD	TOWSON, MD	5.9392
110.05	103	11101 SUNSET, LLC	11101 SUNSET DR	1300 WESTELLEN RD	TOWSON, MD	5.9512
110.05	103	11101 SUNSET, LLC	11101 SUNSET DR	1300 WESTELLEN RD	TOWSON, MD	6.034
110.05	103	11101 SUNSET, LLC	11101 SUNSET DR	1300 WESTELLEN RD	TOWSON, MD	6.0882
110.05	103	11101 SUNSET, LLC	11101 SUNSET DR	1300 WESTELLEN RD	TOWSON, MD	6.1291
110.05	99.01	CONTI, CHRISTOPHER M	11013 SUNSET DR	101 IRONSTONE LANE	KENNETT SQUARE, PA	5.9535
110.05	98.02	CONTI, CHRISTOPHER M	11013 SUNSET DR	101 IRONSTONE LANE	KENNETT SQUARE, PA	5.9585
110.05	95.01	EBERLY, LEE F	11019 SUNSET DR	511 LILLY LANE	MECHANICSBURG, PA	4.414
110.05	101	EBERLY, LEE F	11019 SUNSET DR	511 LILLY LANE	MECHANICSBURG, PA	4.414
110.05	102	FIOCCO,DIANE M	11021 SUNSET DR	3647 CESI AVE	NEW SMYRNA BEACH, FL	4.414
110.05	102	FIOCCO,DIANE M	11021 SUNSET DR	3647 CESI AVE	NEW SMYRNA BEACH, FL	5.8155
110.05	102	FIOCCO,DIANE M	11021 SUNSET DR	3647 CESI AVE	NEW SMYRNA BEACH, FL	5.8172
110.05	98.01	FISCHER,GEORGE & HEATHER	11015 SUNSET DR	745 OLD QUAKER RD	LEWISBERRY, PA	4.2998
110.05	97	FISCHER,GEORGE & HEATHER	11015 SUNSET DR	745 OLD QUAKER RD	LEWISBERRY, PA	4.3142
110.05	97	FISCHER,GEORGE & HEATHER	11015 SUNSET DR	745 OLD QUAKER RD	LEWISBERRY, PA	4.341
110.05	98.01	FISCHER,GEORGE & HEATHER	11015 SUNSET DR	745 OLD QUAKER RD	LEWISBERRY, PA	5.9585
110.05	100.02	PERELLA, JAMES B & DIANA W	11001 SUNSET DR	820 VALLEY CREEK RD	WEST CHESTER, PA	5.9086
110.05	99.02	PERELLA, JAMES B & DIANA W	11001 SUNSET DR	820 VALLEY CREEK RD	WEST CHESTER, PA	5.9303
110.05	100.01	PERELLA, JAMES B & DIANA W	11001 SUNSET DR	820 VALLEY CREEK RD	WEST CHESTER, PA	5.9303
110.05	100.02	PERELLA, JAMES B & DIANA W	11001 SUNSET DR	820 VALLEY CREEK RD	WEST CHESTER, PA	5.9413
110.05	96	THE HUNSBERGER COMPANY	11017 SUNSET DR	2 CHURCH ROAD	DALLAS, PA	4.2874
110.05	96	THE HUNSBERGER COMPANY	11017 SUNSET DR	2 CHURCH ROAD	DALLAS, PA	4.2977
110.05	95.02	THE HUNSBERGER COMPANY	11017 SUNSET DR	2 CHURCH ROAD	DALLAS, PA	4.414
200.01	406.02	10009 SUNSET BAY CONDOMINIUM	10009 SUNSET BAY CONDOMINIUM	10009 SUNSET DRIVE	STONE HARBOR, NJ	6.049
200.01	406.02	10009 SUNSET BAY CONDOMINIUM	10009 SUNSET BAY CONDOMINIUM	10009 SUNSET DRIVE	STONE HARBOR, NJ	6.123
200.01	406.03		10009 SUNSET BAY CONDOMINIUM			6.123
200.01	406.04		10009 SUNSET BAY CONDOMINIUM			6.123
200.01	406.05		10009 SUNSET BAY CONDOMINIUM			6.123
200.01	406.06		10009 SUNSET BAY CONDOMINIUM			6.123
200.01	406.07		10009 SUNSET BAY CONDOMINIUM			6.123
200.01	406.08		10009 SUNSET BAY CONDOMINIUM			6.123
200.01	439	551 BERKLEY TRUST	551 BERKLEY TRUST	1468 RHOADES DR	HUNTINGDON VALLEY, PA	6.528
200.01	440	551 BERKLEY TRUST	551 BERKLEY TRUST	1468 RHOADES DR	HUNTINGDON VALLEY, PA	6.554
200.01	439	551 BERKLEY TRUST	551 BERKLEY TRUST	1468 RHOADES DR	HUNTINGDON VALLEY, PA	6.921
200.01	441	551 BERKLEY TRUST	551 BERKLEY TRUST	1468 RHOADES DR	HUNTINGDON VALLEY, PA	7.141
200.01	436	557 BERKLEY ROAD LLC	557 BERKLEY ROAD LLC	1200 GULPH CREEK DR	WAYNE, PA	6.921

BLOCK	LOT	Owners Name	Owners Name2	Owner Address 1	Owner Address 2	Elevation (NAVD88)
200.01	437	557 BERKLEY ROAD LLC	557 BERKLEY ROAD LLC	1200 GULPH CREEK DR	WAYNE, PA	6.921
200.01	438	557 BERKLEY ROAD LLC	557 BERKLEY ROAD LLC	1200 GULPH CREEK DR	WAYNE, PA	6.921
200.01	418	ALLEVA, DREW & THOMAS, MARJORIE	556 BERKLEY RD	2 HONEYSUCKLE LN	CHESTER SPRINGS, PA	7.735
200.01	312	BINDER,JOHN A III & CYNTHIA	9923 SUNSET DR	5 HARBOR COVE	CAPE MAY, NJ	5.812
200.01	313	BINDER,JOHN A III & CYNTHIA	9923 SUNSET DR	5 HARBOR COVE	CAPE MAY, NJ	5.817
200.01	302	CAHILL, ELIZABETH A	9903 SUNSET DR	2107 GILPIN AVENUE	WILMINGTON, DE	5.658
200.01	301	CAHILL, ELIZABETH A	9903 SUNSET DR	2107 GILPIN AVENUE	WILMINGTON, DE	5.672
200.01	301	CAHILL, ELIZABETH A	9903 SUNSET DR	2107 GILPIN AVENUE	WILMINGTON, DE	6.716
200.01	413.02	HANKOWSKY, WILLIAM & ROSEMARY	550 BERKLEY RD	7201 WAYNE AVE	PHILADELPHIA, PA	6.251
200.01	414.01	HANKOWSKY, WILLIAM & ROSEMARY	550 BERKLEY RD	7201 WAYNE AVE	PHILADELPHIA, PA	7.657
200.01	415.01	HANKOWSKY, WILLIAM & ROSEMARY	550 BERKLEY RD	7201 WAYNE AVE	PHILADELPHIA, PA	7.657
200.01	416.02	HANKOWSKY, WILLIAM & ROSEMARY	550 BERKLEY RD	7201 WAYNE AVE	PHILADELPHIA, PA	7.657
200.01	409.02	JAWORSKI, RONALD V & ELIZABETH A	10021 SUNSET DR	18 BROOKWOOD DR.	MEDFORD, NJ	6.7
200.01	410	JAWORSKI, RONALD V & ELIZABETH A	10021 SUNSET DR	18 BROOKWOOD DR.	MEDFORD, NJ	6.7
200.01	303	KENNEDY, EDWARD	9913 SUNSET DR	560 WARWICK RD	HADDONFIELD, NJ	5.658
200.01	304	KENNEDY, EDWARD	9913 SUNSET DR	560 WARWICK RD	HADDONFIELD, NJ	5.672
200.01	305	KENNEDY, EDWARD	9913 SUNSET DR	560 WARWICK RD	HADDONFIELD, NJ	5.672
200.01	306	KENNEDY, EDWARD	9913 SUNSET DR	560 WARWICK RD	HADDONFIELD, NJ	5.672
200.01	303	KENNEDY, EDWARD	9913 SUNSET DR	560 WARWICK RD	HADDONFIELD, NJ	5.68
200.01	413.01	KENWORTHY,GERARD & STUART, TRUSTEES	10025 SUNSET DR	833 ROBERT DEAN DRIVE	DOWNINGTOWN, PA	6.251
200.01	414.02	KENWORTHY,GERARD & STUART, TRUSTEES	10025 SUNSET DR	833 ROBERT DEAN DRIVE	DOWNINGTOWN, PA	6.251
200.01	412	KENWORTHY,GERARD & STUART, TRUSTEES	10025 SUNSET DR	833 ROBERT DEAN DRIVE	DOWNINGTOWN, PA	6.441
200.01	408	KRAFCZEK, CHARLES C & KARA L	10017 SUNSET DR	10017 SUNSET DR	STONE HARBOR, NJ	6.058
200.01	409.01	KRAFCZEK, CHARLES C & KARA L	10017 SUNSET DR	10017 SUNSET DR	STONE HARBOR, NJ	6.595
200.01	408	KRAFCZEK, CHARLES C & KARA L	10017 SUNSET DR	10017 SUNSET DR	STONE HARBOR, NJ	6.725
200.01	318	KULLMAN, ELLEN J & MICHAEL E, TTS	10005 SUNSET DR	1116 BERKLEY RD	WILMINGTON, DE	6.049
200.01	404	KULLMAN, ELLEN J & MICHAEL E, TTS	10005 SUNSET DR	1116 BERKLEY RD	WILMINGTON, DE	6.049
200.01	406.01	KULLMAN, ELLEN J & MICHAEL E, TTS	10005 SUNSET DR	1116 BERKLEY RD	WILMINGTON, DE	6.049
200.01	309	LEISURE, RANDALL H & BRADLEY C	9921 SUNSET DR	1689 NORTH STATE RTE. 934	ANNVILLE, PA	5.829
200.01	310	LEISURE, RANDALL H & BRADLEY C	9921 SUNSET DR	1689 NORTH STATE RTE. 934	ANNVILLE, PA	5.993
200.01	443	LUBKER, FREDERICK G JR & JOANNE M	LUBKER, FREDERICK G JR & JOANNE M	531 BERKELY RD	STONE HARBOR, NJ	6.416
200.01	442	LUBKER, FREDERICK G JR & JOANNE M	LUBKER, FREDERICK G JR & JOANNE M	531 BERKELY RD	STONE HARBOR, NJ	7.141
200.01	316	MASCI, THOMAS A JR	9929 SUNSET DR	14 KNIGHTS WAY	NEWTOWN SQUARE, PA	5.838
200.01	316	MASCI, THOMAS A JR	9929 SUNSET DR	14 KNIGHTS WAY	NEWTOWN SQUARE, PA	5.842
200.01	317	MASCI, THOMAS A JR	9929 SUNSET DR	14 KNIGHTS WAY	NEWTOWN SQUARE, PA	6.049
200.01	307	NASELLI, DIANA M & JOSEPH V SR	9917 SUNSET DR	306 ORCHARD LANE	NEWTOWN SQUARE, PA	5.78
200.01	308	NASELLI, DIANA M & JOSEPH V SR	9917 SUNSET DR	306 ORCHARD LANE	NEWTOWN SQUARE, PA	5.8
200.01	418.04	NERNEY, JILL CHAMBERS	558 BERKLEY RD	451 BELROSE LANE	RADNOR, PA	6.862
200.01	418.04	NERNEY, JILL CHAMBERS	558 BERKLEY RD	451 BELROSE LANE	RADNOR, PA	6.924
200.01	418.05	NERNEY, JILL CHAMBERS	558 BERKLEY RD	451 BELROSE LANE	RADNOR, PA	6.959
200.01	418.05	NERNEY, JILL CHAMBERS	558 BERKLEY RD	451 BELROSE LANE	RADNOR, PA	6.986
200.01	418.06	NERNEY, JILL CHAMBERS	558 BERKLEY RD	451 BELROSE LANE	RADNOR, PA	7.009
200.01	418.06	NERNEY, JILL CHAMBERS	558 BERKLEY RD	451 BELROSE LANE	RADNOR, PA	7.074
200.01	418.04	NERNEY, JILL CHAMBERS	558 BERKLEY RD	451 BELROSE LANE	RADNOR, PA	7.808
200.01	315	PARZYCH, RAYMOND W & BERNADETTE M	9925 SUNSET DR	9925 SUNSET DR	STONE HARBOR, NJ	5.838
200.01	314	PARZYCH, RAYMOND W & BERNADETTE M	9925 SUNSET DR	9925 SUNSET DR	STONE HARBOR, NJ	5.883
200.01	411	RYAN, JOHN PAUL & MOTZ, MARY P	10023 SUNSET DR	1224 GENERAL MERCER ROAD	WASHINGTON CROSSING, PA	6.378
200.01	411	RYAN, JOHN PAUL & MOTZ, MARY P	10023 SUNSET DR	1224 GENERAL MERCER ROAD	WASHINGTON CROSSING, PA	6.7
200.01	418.01	SMITH, JOHN H & FAYE Z, TRUSTEES	560 BERKLEY RD	55 MANOR DR	DILLSBURG, PA	7.69
200.01	418.01	SMITH, JOHN H & FAYE Z, TRUSTEES	560 BERKLEY RD	55 MANOR DR	DILLSBURG, PA	7.719
200.01	418.01	SMITH, JOHN H & FAYE Z, TRUSTEES	560 BERKLEY RD	55 MANOR DR	DILLSBURG, PA	7.735
200.01	418.02	SMITH, JOHN H & FAYE Z, TRUSTEES	560 BERKLEY RD	55 MANOR DR	DILLSBURG, PA	7.741
200.01	418.03	SMITH, JOHN H & FAYE Z, TRUSTEES	560 BERKLEY RD	55 MANOR DR	DILLSBURG, PA	7.808
200.01	415.02	TERRANOVA, JAMES J TRUS & JILL A TR	554 BERKLEY RD	1103 DANIEL DAVIS LN	WEST CHESTER PA	7.657
200.01	416.01	TERRANOVA, JAMES J TRUS & JILL A TR	554 BERKLEY RD	1103 DANIEL DAVIS LN	WEST CHESTER PA	7.657
200.01	417.01	TERRANOVA, JAMES J TRUS & JILL A TR	554 BERKLEY RD	1103 DANIEL DAVIS LN	WEST CHESTER PA	7.657
200.01	417.02	TERRANOVA, JAMES J TRUS & JILL A TR	554 BERKLEY RD	1103 DANIEL DAVIS LN	WEST CHESTER PA	7.657
200.02	452	PARTRIDGE, JOAN B, TRUSTEE	PARTRIDGE, JOAN B, TRUSTEE	5555 GLF OF MEXICO DR#104	LONGBOAT KEY, FL	4.557
200.02	451	PARTRIDGE, JOAN B, TRUSTEE	PARTRIDGE, JOAN B, TRUSTEE	5555 GLF OF MEXICO DR#104	LONGBOAT KEY, FL	6.017
200.02	452	PARTRIDGE, JOAN B, TRUSTEE	PARTRIDGE, JOAN B, TRUSTEE	5555 GLF OF MEXICO DR#104	LONGBOAT KEY, FL	6.017
200.02	452	PARTRIDGE, JOAN B, TRUSTEE	PARTRIDGE, JOAN B, TRUSTEE	5555 GLF OF MEXICO DR#104	LONGBOAT KEY, FL	6.413
200.02	450	REED, MILDRED F EST.% FNBM T&I SERV	REED, MILDRED F EST.% FNBM T&I SERV	260 SUNBURY STREET	MINERSVILLE, PA	4.718
200.02	450	REED, MILDRED F EST.% FNBM T&I SERV	REED, MILDRED F EST.% FNBM T&I SERV	260 SUNBURY STREET	MINERSVILLE, PA	4.735
200.02	450	REED, MILDRED F EST.% FNBM T&I SERV	REED, MILDRED F EST.% FNBM T&I SERV	260 SUNBURY STREET	MINERSVILLE, PA	5.987
200.02	449	STILES, WILLIAM H & KELLY A	STILES, WILLIAM H & KELLY A	13 AMESBURY PARKS	MEDFORD, NJ	5.987
200.02	447	WADE, MARTIN R III & DIANE M	WADE, MARTIN R III & DIANE M	421 BERKLEY RD	STONE HARBOR, NJ	6.123
200.02	448	WADE, MARTIN R III & DIANE M	WADE, MARTIN R III & DIANE M	421 BERKLEY RD	STONE HARBOR, NJ	6.123
200.03	480	BERGER, CHARLES A & CHERYL	BERGER, CHARLES A & CHERYL	5693 CABRERA COURT	SARASOTA, FL	6.164
200.03	473	BLOSENSKI,ANTHONY & COLLEEN	BLOSENSKI,ANTHONY & COLLEEN	71 BRIARWOOD DR	ELVERSON, PA	5.627
200.03	474	BLOSENSKI,ANTHONY & COLLEEN	BLOSENSKI,ANTHONY & COLLEEN	71 BRIARWOOD DR	ELVERSON, PA	5.627
200.03	472.02	BLOSENSKI,ANTHONY & COLLEEN	BLOSENSKI,ANTHONY & COLLEEN	71 BRIARWOOD DR	ELVERSON, PA	5.714
200.03	474	BLOSENSKI,ANTHONY & COLLEEN	BLOSENSKI,ANTHONY & COLLEEN	71 BRIARWOOD DR	ELVERSON, PA	6.111
200.03	507.02	BRUNO,VICTOR & MURPHY,KATHLEEN TT'S	BRUNO,VICTOR & MURPHY,KATHLEEN TT'S	1535 RIVER RD E.	BEDMINSTER, NJ	3.924
200.03	509	BRUNO,VICTOR & MURPHY,KATHLEEN TT'S	BRUNO,VICTOR & MURPHY,KATHLEEN TT'S	1535 RIVER RD E.	BEDMINSTER, NJ	3.994
200.03	508	BRUNO,VICTOR & MURPHY,KATHLEEN TT'S	BRUNO,VICTOR & MURPHY,KATHLEEN TT'S	1535 RIVER RD E.	BEDMINSTER, NJ	4.064
200.03	507.02	BRUNO,VICTOR & MURPHY,KATHLEEN TT'S	BRUNO,VICTOR & MURPHY,KATHLEEN TT'S	1535 RIVER RD E.	BEDMINSTER, NJ	5.624
200.03	459.02	CLEARY,MAUREEN P & RICHEY,THOMAS K	CLEARY,MAUREEN P & RICHEY,THOMAS K	6420 ELMWOOD RD	CHEVY CHASE, MD	4.591
200.03	460	CLEARY,MAUREEN P & RICHEY,THOMAS K	CLEARY,MAUREEN P & RICHEY,THOMAS K	6420 ELMWOOD RD	CHEVY CHASE, MD	6.108
200.03	482	CWIK, TIMOTHY J, ETAL	CWIK, TIMOTHY J, ETAL	9906 CORINTHIAN DR	STONE HARBOR, NJ	4.282
200.03	483.01	CWIK, TIMOTHY J, ETAL	CWIK, TIMOTHY J, ETAL	9906 CORINTHIAN DR	STONE HARBOR, NJ	4.282
200.03	483.01	CWIK, TIMOTHY J, ETAL	CWIK, TIMOTHY J, ETAL	9906 CORINTHIAN DR	STONE HARBOR, NJ	5.918
200.03	529	DEEGAN, MARIE P	DEEGAN, MARIE P	8 BERRYWOOD RD	MALVERN, PA	4.607
200.03	530	DEEGAN, MARIE P	DEEGAN, MARIE P	8 BERRYWOOD RD	MALVERN, PA	4.607
200.03	528	DEEGAN, MARIE P	DEEGAN, MARIE P	8 BERRYWOOD RD	MALVERN, PA	4.704
200.03	528	DEEGAN, MARIE P	DEEGAN, MARIE P	8 BERRYWOOD RD	MALVERN, PA	6.003
200.03	470	DENT,JOHN & MCBRIDE,PATRICIA	DENT,JOHN & MCBRIDE,PATRICIA	3547 N NOTTINGHAM ST	ARLINGTON, VA	4.364
200.03	470	DENT,JOHN & MCBRIDE,PATRICIA	DENT,JOHN & MCBRIDE,PATRICIA	3547 N NOTTINGHAM ST	ARLINGTON, VA	5.764
200.03	501	DONOHOE,THOMAS F & DONOHOE,META B	DONOHOE,THOMAS F & DONOHOE,META B	974 N PENN DR	WEST CHESTER, PA	6.077
200.03	465.02	DUNBAR CONDOMINIUM	DUNBAR CONDOMINIUM	10020 CORINTHIAN DR	STONE HARBOR, NJ	4.7
200.03	465.02	DUNBAR CONDOMINIUM	DUNBAR CONDOMINIUM	10020 CORINTHIAN DR	STONE HARBOR, NJ	4.719
200.03	465.02	DUNBAR CONDOMINIUM	DUNBAR CONDOMINIUM	10020 CORINTHIAN DR	STONE HARBOR, NJ	4.719
200.03	466	DUNBAR CONDOMINIUM	DUNBAR CONDOMINIUM	10020 CORINTHIAN DR	STONE HARBOR, NJ	4.719
200.03	467	DUNBAR CONDOMINIUM	DUNBAR CONDOMINIUM	10020 CORINTHIAN DR	STONE HARBOR, NJ	4.719
200.03	521.02	FISHER, JAMES M & MARY JO	FISHER, JAMES M & MARY JO	10211 SUNRISE DR	STONE HARBOR, NJ	6.024
200.03	522	FISHER, JAMES M & MARY JO	FISHER, JAMES M & MARY JO	10211 SUNRISE DR	STONE HARBOR, NJ	6.024
200.03	505	GRIFFIN, THOMAS D & PATRICIA C	GRIFFIN, THOMAS D & PATRICIA C	741 HUNT LA	FLOURTOWN, PA	3.924
200.03	506	GRIFFIN, THOMAS D & PATRICIA C	GRIFFIN, THOMAS D & PATRICIA C	741 HUNT LA	FLOURTOWN, PA	3.924
200.03	507.01	GRIFFIN, THOMAS D & PATRICIA C	GRIFFIN, THOMAS D & PATRICIA C	741 HUNT LA	FLOURTOWN, PA	3.924
200.03	523	HERZOG REVOCABLE LIVING TRUST	HERZOG REVOCABLE LIVING TRUST	78 OLD MILL DR	MEDIA, PA	6.02
200.03	524	HERZOG REVOCABLE LIVING TRUST	HERZOG REVOCABLE LIVING TRUST	78 OLD MILL DR	MEDIA, PA	6.02
200.03	456	HODGES MARTHA Z,TTEE @GTB FAMILY OF	HODGES MARTHA Z,TTEE @GTB FAMILY OF	P.O. BOX 385	HUNTINGDON, PA	6.239
200.03	454	HODGES MARTHA Z,TTEE @GTB FAMILY OF	HODGES MARTHA Z,TTEE @GTB FAMILY OF	P.O. BOX 385	HUNTINGDON, PA	6.256
200.03	455	HODGES MARTHA Z,TTEE @GTB FAMILY OF	HODGES MARTHA Z,TTEE @GTB FAMILY OF	P.O. BOX 385	HUNTINGDON, PA	6.256
200.03	518	HYMANS, WILLIAM E & KATHRYN S	HYMANS, WILLIAM E & KATHRYN S	4 BREWSTER COURT	PENNINGTON, NJ	6.022
200.03	519.01	HYMANS, WILLIAM E & KATHRYN S	HYMANS, WILLIAM E & KATHRYN S	4 BREWSTER COURT	PENNINGTON, NJ	6.022
200.03	457	KILROY, BRUCE G & CYNTHIA L	KILROY, BRUCE G & CYNTHIA L	1490 WETHERSFIELD DR	ALLENTOWN, PA	4.542
200.03	458	KILROY, BRUCE G & CYNTHIA L	KILROY, BRUCE G & CYNTHIA L	1490 WETHERSFIELD DR	ALLENTOWN, PA	4.718
200.03	459.01	KILROY, BRUCE G & CYNTHIA L	KILROY, BRUCE G & CYNTHIA L	1490 WETHERSFIELD DR	ALLENTOWN, PA	4.718
200.03	457	KILROY, BRUCE G & CYNTHIA L	KILROY, BRUCE G & CYNTHIA L	1490 WETHERSFIELD DR	ALLENTOWN, PA	6.239
200.03	510	KOCHENOUR, KENNETH K @ GF MGMT,INC	KOCHENOUR, KENNETH K @ GF MGMT,INC	8 PENN CNT,1628 JFK BLVD	PHILADELPHIA, PA	3.994
200.03	511	KOCHENOUR, KENNETH K @ GF MGMT,INC	KOCHENOUR, KENNETH K @ GF MGMT,INC	8 PENN CNT,1628 JFK BLVD	PHILADELPHIA, PA	5.942
200.03	512.01	KOCHENOUR, KENNETH K @ GF MGMT,INC	KOCHENOUR, KENNETH K @ GF MGMT,INC	8 PENN CNT,1628 JFK BLVD	PHILADELPHIA, PA	5.942
200.03	510	KOCHENOUR, KENNETH K @ GF MGMT,INC	KOCHENOUR, KENNETH K @ GF MGMT,INC	8 PENN CNT,1628 JFK BLVD	PHILADELPHIA, PA	6.057

BLOCK	LOT	Owners Name	Owners Name2	Owner Address 1	Owner Address 2	Elevation (NAVD88)
200.03	465.01	LEYDEN,JAY S & SARA M	LEYDEN,JAY S & SARA M	808 DERSHER WAY	WAYNE, PA	4.642
200.03	462	LEYDEN,JAY S & SARA M	LEYDEN,JAY S & SARA M	808 DERSHER WAY	WAYNE, PA	6.108
200.03	462	LEYDEN,JAY S & SARA M	LEYDEN,JAY S & SARA M	808 DERSHER WAY	WAYNE, PA	6.136
200.03	463	LEYDEN,JAY S & SARA M	LEYDEN,JAY S & SARA M	808 DERSHER WAY	WAYNE, PA	6.137
200.03	464	LEYDEN,JAY S & SARA M	LEYDEN,JAY S & SARA M	808 DERSHER WAY	WAYNE, PA	6.137
200.03	465.01	LEYDEN,JAY S & SARA M	LEYDEN,JAY S & SARA M	808 DERSHER WAY	WAYNE, PA	6.137
200.03	519.02	LORNDALE, ROBERT & LINDA	LORNDALE, ROBERT & LINDA	5928 OAKDALE RD	MCLEAN, VA	6.022
200.03	519.02	LORNDALE, ROBERT & LINDA	LORNDALE, ROBERT & LINDA	5928 OAKDALE RD	MCLEAN, VA	6.061
200.03	520	LORNDALE, ROBERT & LINDA	LORNDALE, ROBERT & LINDA	5928 OAKDALE RD	MCLEAN, VA	6.161
200.03	521.01	LORNDALE, ROBERT & LINDA	LORNDALE, ROBERT & LINDA	5928 OAKDALE RD	MCLEAN, VA	6.161
200.03	468	LOWELL, JAMES A & CAROL ANN	LOWELL, JAMES A & CAROL ANN	12 PACE DR	WYCKOFF, NJ	6.077
200.03	487	MAGRANN,JOAN TRUSTEE	MAGRANN,JOAN TRUSTEE	P.O. BOX 2033	MEDFORD, NJ	5.465
200.03	488	MAGRANN,JOAN TRUSTEE	MAGRANN,JOAN TRUSTEE	P.O. BOX 2033	MEDFORD, NJ	5.465
200.03	513	MALLOY, TERRENCE R @ A NELSON	MALLOY, TERRENCE R @ A NELSON	P.O. BOX 38	GLADWYNE, PA	5.253
200.03	514	MALLOY, TERRENCE R @ A NELSON	MALLOY, TERRENCE R @ A NELSON	P.O. BOX 38	GLADWYNE, PA	5.253
200.03	512.02	MALLOY, TERRENCE R @ A NELSON	MALLOY, TERRENCE R @ A NELSON	P.O. BOX 38	GLADWYNE, PA	5.942
200.03	496	MAST, NANCY E	MAST, NANCY E	PO BOX 4053	VAIL, CO	4.912
200.03	495	MAST, NANCY E	MAST, NANCY E	PO BOX 4053	VAIL, CO	4.931
200.03	495	MAST, NANCY E	MAST, NANCY E	PO BOX 4053	VAIL, CO	6.21
200.03	479	MC AREE, FRANCIS E JR & JUDITH M	MC AREE, FRANCIS E JR & JUDITH M	13560 BROWNING DR	FISHERS, IN	6.137
200.03	478	MC AREE, FRANCIS E JR & JUDITH M	MC AREE, FRANCIS E JR & JUDITH M	13560 BROWNING DR	FISHERS, IN	6.166
200.03	479	MC AREE, FRANCIS E JR & JUDITH M	MC AREE, FRANCIS E JR & JUDITH M	13560 BROWNING DR	FISHERS, IN	6.166
200.03	535	MCCONNELL, GAIL H	MCCONNELL, GAIL H	264 MONTGOMERY AVE #302	HAVERFORD, PA	4.817
200.03	536	MCCONNELL, GAIL H	MCCONNELL, GAIL H	264 MONTGOMERY AVE #302	HAVERFORD, PA	4.817
200.03	537.01	MCCONNELL, GAIL H	MCCONNELL, GAIL H	264 MONTGOMERY AVE #302	HAVERFORD, PA	4.817
200.03	537.02	MCCONNELL, GAIL H	MCCONNELL, GAIL H	264 MONTGOMERY AVE #302	HAVERFORD, PA	4.817
200.03	538	MCCONNELL, GAIL H	MCCONNELL, GAIL H	264 MONTGOMERY AVE #302	HAVERFORD, PA	4.906
200.03	531	NAIBERK, JOSEPH M & MARIAM E	NAIBERK, JOSEPH M & MARIAM E	807 NEWPORTVILLE RD	CROYDEN, PA	4.607
200.03	534	NAIBERK, JOSEPH M & MARIAM E	NAIBERK, JOSEPH M & MARIAM E	807 NEWPORTVILLE RD	CROYDEN, PA	4.857
200.03	531	NAIBERK, JOSEPH M & MARIAM E	NAIBERK, JOSEPH M & MARIAM E	807 NEWPORTVILLE RD	CROYDEN, PA	6.137
200.03	531	NAIBERK, JOSEPH M & MARIAM E	NAIBERK, JOSEPH M & MARIAM E	807 NEWPORTVILLE RD	CROYDEN, PA	6.19
200.03	532	NAIBERK, JOSEPH M & MARIAM E	NAIBERK, JOSEPH M & MARIAM E	807 NEWPORTVILLE RD	CROYDEN, PA	6.389
200.03	533	NAIBERK, JOSEPH M & MARIAM E	NAIBERK, JOSEPH M & MARIAM E	807 NEWPORTVILLE RD	CROYDEN, PA	6.389
200.03	534	NAIBERK, JOSEPH M & MARIAM E	NAIBERK, JOSEPH M & MARIAM E	807 NEWPORTVILLE RD	CROYDEN, PA	6.389
200.03	481	NUGENT, ANNA SEIZ	NUGENT, ANNA SEIZ	9914 CORINTHIAN DRIVE	STONE HARBOR, NJ	4.292
200.03	481	NUGENT, ANNA SEIZ	NUGENT, ANNA SEIZ	9914 CORINTHIAN DRIVE	STONE HARBOR, NJ	6.153
200.03	499	OTTON, J CRAIG & LAUREN	OTTON, J CRAIG & LAUREN	10003 SUNRISE DR	STONE HARBOR, NJ	5
200.03	483.02	PANZARELLA, BARBARA	PANZARELLA, BARBARA	413 99TH STREET	STONE HARBOR, NJ	5.892
200.03	484	PANZARELLA, BARBARA	PANZARELLA, BARBARA	413 99TH STREET	STONE HARBOR, NJ	5.892
200.03	485.01	PANZARELLA, BARBARA	PANZARELLA, BARBARA	413 99TH STREET	STONE HARBOR, NJ	5.892
200.03	502	RHODES, MARK S & LUCY F	RHODES, MARK S & LUCY F	3515 SAWMILL RD	NEWTOWN SQUARE, PA	6.068
200.03	476.01	RIEGER, TAMARA & GLENN	RIEGER, TAMARA & GLENN	600 LONGCHAMPS DR	DEVON, PA	5.089
200.03	475	RIEGER, TAMARA & GLENN	RIEGER, TAMARA & GLENN	600 LONGCHAMPS DR	DEVON, PA	6.874
200.03	476.01	RIEGER, TAMARA & GLENN	RIEGER, TAMARA & GLENN	600 LONGCHAMPS DR	DEVON, PA	6.874
200.03	525	ROOHAN, WILLIAM S & LYNN D	ROOHAN, WILLIAM S & LYNN D	18 IVY REACH COURT	COCKEYSVILLE, MD	6.003
200.03	526	ROOHAN, WILLIAM S & LYNN D	ROOHAN, WILLIAM S & LYNN D	18 IVY REACH COURT	COCKEYSVILLE, MD	6.003
200.03	527	ROOHAN, WILLIAM S & LYNN D	ROOHAN, WILLIAM S & LYNN D	18 IVY REACH COURT	COCKEYSVILLE, MD	6.003
200.03	476.02	SCHREINER, FRANK J & ROBERTA L	SCHREINER, FRANK J & ROBERTA L	124 BRIDLE LA	LOWER GWYNEDD, PA	5.185
200.03	477	SCHREINER, FRANK J & ROBERTA L	SCHREINER, FRANK J & ROBERTA L	124 BRIDLE LA	LOWER GWYNEDD, PA	5.185
200.03	477	SCHREINER, FRANK J & ROBERTA L	SCHREINER, FRANK J & ROBERTA L	124 BRIDLE LA	LOWER GWYNEDD, PA	6.138
200.03	486	SEMMER, JEFFREY J & ANN T	SEMMER, JEFFREY J & ANN T	462 INVERARAY RD	VILLANOVA, PA	5.465
200.03	485.02	SEMMER, JEFFREY J & ANN T	SEMMER, JEFFREY J & ANN T	462 INVERARAY RD	VILLANOVA, PA	5.81
200.03	489	SNACK SHACK LLC	SNACK SHACK LLC	221 LINBROOK LN	ALTOONA, PA	5.465
200.03	489	SNACK SHACK LLC	SNACK SHACK LLC	221 LINBROOK LN	ALTOONA, PA	6.236
200.03	490	SNACK SHACK LLC	SNACK SHACK LLC	221 LINBROOK LN	ALTOONA, PA	6.258
200.03	491	SNACK SHACK LLC	SNACK SHACK LLC	221 LINBROOK LN	ALTOONA, PA	6.258
200.03	539	SNOWDEN, STEPHEN L & DIANE H	SNOWDEN, STEPHEN L & DIANE H	P O BOX 12	LUMBERTON, NJ	4.783
200.03	540	SNOWDEN, STEPHEN L & DIANE H	SNOWDEN, STEPHEN L & DIANE H	P O BOX 12	LUMBERTON, NJ	4.783
200.03	517	STEEDLE, J RICHARD & HOLLY CHAMBERS	STEEDLE, J RICHARD & HOLLY CHAMBERS	131 LITTLE LANE	HAVERFORD, PA	4.796
200.03	517	STEEDLE, J RICHARD & HOLLY CHAMBERS	STEEDLE, J RICHARD & HOLLY CHAMBERS	131 LITTLE LANE	HAVERFORD, PA	4.828
200.03	517	STEEDLE, J RICHARD & HOLLY CHAMBERS	STEEDLE, J RICHARD & HOLLY CHAMBERS	131 LITTLE LANE	HAVERFORD, PA	6.083
200.03	517	STEEDLE, J RICHARD & HOLLY CHAMBERS	STEEDLE, J RICHARD & HOLLY CHAMBERS	131 LITTLE LANE	HAVERFORD, PA	6.114
200.03	469	STIPE, LEROY JR & ANDES, ELIZABETH	STIPE, LEROY JR & ANDES, ELIZABETH	210 N. CONCORD STREET	LANCASTER, PA	4.618
200.03	469	STIPE, LEROY JR & ANDES, ELIZABETH	STIPE, LEROY JR & ANDES, ELIZABETH	210 N. CONCORD STREET	LANCASTER, PA	4.744
200.03	504	SZAFARA, STEVEN J & JACQUELINE J	SZAFARA, STEVEN J & JACQUELINE J	363 N. SPRING MILL RD	VILLANOVA, PA	3.924
200.03	503	SZAFARA, STEVEN J & JACQUELINE J	SZAFARA, STEVEN J & JACQUELINE J	363 N. SPRING MILL RD	VILLANOVA, PA	3.964
200.03	503	SZAFARA, STEVEN J & JACQUELINE J	SZAFARA, STEVEN J & JACQUELINE J	363 N. SPRING MILL RD	VILLANOVA, PA	3.984
200.03	503	SZAFARA, STEVEN J & JACQUELINE J	SZAFARA, STEVEN J & JACQUELINE J	363 N. SPRING MILL RD	VILLANOVA, PA	6.068
200.03	492	TAYLOR,JOSEPH S & BUDNY,HILARY A	TAYLOR,JOSEPH S & BUDNY,HILARY A	15 GREENBRIAR CIR	NEWTOWN, PA	6.21
200.03	493	TAYLOR,JOSEPH S & BUDNY,HILARY A	TAYLOR,JOSEPH S & BUDNY,HILARY A	15 GREENBRIAR CIR	NEWTOWN, PA	6.21
200.03	494	TAYLOR,JOSEPH S & BUDNY,HILARY A	TAYLOR,JOSEPH S & BUDNY,HILARY A	15 GREENBRIAR CIR	NEWTOWN, PA	6.21
200.03	500	TYDEMAN, DONALD M & PATRICIA	TYDEMAN, DONALD M & PATRICIA	3025 DUNCAN LANE	PITTSBURGH, PA	5
200.03	461	VERREKIA, LAURA D, ETAL%J.HAMPEL	VERREKIA, LAURA D, ETAL%J.HAMPEL	312 LARCHWOOD RD	WEST CHESTER, PA	6.108
200.03	515	WALBORN, NANCY J	WALBORN, NANCY J	300 RIVER BEND DRIVE	ENOLA, PA	5.253
200.03	516	WALBORN, NANCY J	WALBORN, NANCY J	300 RIVER BEND DRIVE	ENOLA, PA	6.083
200.03	515	WALBORN, NANCY J	WALBORN, NANCY J	300 RIVER BEND DRIVE	ENOLA, PA	6.126
200.03	471	WILSON, JOSHUA & DANIELLE	WILSON, JOSHUA & DANIELLE	107 W COUNTRY CLUB LN	WALLINGFORD, PA	5.714
200.03	472.01	WILSON, JOSHUA & DANIELLE	WILSON, JOSHUA & DANIELLE	107 W COUNTRY CLUB LN	WALLINGFORD, PA	5.714
200.03	497	ZAPF, SUSAN M	ZAPF, SUSAN M	1108 FOULDEWAYS,APT. L8	GWYNEDD, PA	4.912
200.03	498	ZAPF, SUSAN M	ZAPF, SUSAN M	1108 FOULDEWAYS,APT. L8	GWYNEDD, PA	5
200.03	497	ZAPF, SUSAN M	ZAPF, SUSAN M	1108 FOULDEWAYS,APT. L8	GWYNEDD, PA	6.085
201	34	10529 GOLDEN GATE, LLC %C.EISENBEIS	10529 GOLDEN GATE RD	135 RIDGE RD.	PITTSBURGH, PA	6.5845
201	33.02	10529 GOLDEN GATE, LLC %C.EISENBEIS	10529 GOLDEN GATE RD	135 RIDGE RD.	PITTSBURGH, PA	6.7001
201	94.01	BAUMANN, THOMAS C & CAROLYN J	BAUMANN, THOMAS C & CAROLYN J	20 AMESBURY PARKE	MEDFORD, NJ	6.7462
201	25	CASPER, STEVEN J & ROBIN L	10515 GOLDEN GATE RD	10515 GOLDEN GATE RD	STONE HARBOR, NJ	6.3791
201	26	CASPER, STEVEN J & ROBIN L	10515 GOLDEN GATE RD	10515 GOLDEN GATE RD	STONE HARBOR, NJ	6.4054
201	27	CASPER, STEVEN J & ROBIN L	10515 GOLDEN GATE RD	10515 GOLDEN GATE RD	STONE HARBOR, NJ	6.4054
201	94.04	CEULEERS SALAZAR, BARBARA	CEULEERS SALAZAR, BARBARA	1590 SOUTH CONGRESS AVE	WEST PALM BEACH, FL	6.7462
201	30	CHAMBERS, CAROL % C.V.CHAMBERS,POA	10523 GOLDEN GATE RD	247 N. WYNNWOOD AVE.	NARBERTH, PA	6.2684
201	31	CHAMBERS, CAROL % C.V.CHAMBERS,POA	10523 GOLDEN GATE RD	247 N. WYNNWOOD AVE.	NARBERTH, PA	6.5871
201	30	CHAMBERS, CAROL % C.V.CHAMBERS,POA	10523 GOLDEN GATE RD	247 N. WYNNWOOD AVE.	NARBERTH, PA	6.6828
201	88	CLARKE, GILBERT G & BARBARA M	CLARKE, GILBERT G & BARBARA M	1416 SPRINGTON LANE	WEST CHESTER. PA	5.7483
201	86	CLARKE, GILBERT G & BARBARA M	CLARKE, GILBERT G & BARBARA M	1416 SPRINGTON LANE	WEST CHESTER. PA	6.7915
201	87	CLARKE, GILBERT G & BARBARA M	CLARKE, GILBERT G & BARBARA M	1416 SPRINGTON LANE	WEST CHESTER. PA	6.7915
201	88	CLARKE, GILBERT G & BARBARA M	CLARKE, GILBERT G & BARBARA M	1416 SPRINGTON LANE	WEST CHESTER. PA	6.7915
201	50	COLSON, FRANK E & LINDA A	10625 GOLDEN GATE RD	P.O. BOX 3	STONE HARBOR, NJ	5.4641
201	84	CORTEZI, NICHOLAS D & LOUISE M	CORTEZI, NICHOLAS D & LOUISE M	1300 WESTELLEN RD	TOWSON, MD	5.4295
201	85	CORTEZI, NICHOLAS D & LOUISE M	CORTEZI, NICHOLAS D & LOUISE M	1300 WESTELLEN RD	TOWSON, MD	5.4295
201	85	CORTEZI, NICHOLAS D & LOUISE M	CORTEZI, NICHOLAS D & LOUISE M	1300 WESTELLEN RD	TOWSON, MD	6.2834
201	13	DADDO PROPERTIES, LP	10401 GOLDEN GATE RD	P.O. BOX 2188	DOYLESTOWN, PA	5.2934
201	14	DADDO PROPERTIES, LP	10401 GOLDEN GATE RD	P.O. BOX 2188	DOYLESTOWN, PA	6.0811
201	15	DADDO PROPERTIES, LP	10401 GOLDEN GATE RD	P.O. BOX 2188	DOYLESTOWN, PA	6.0811
201	16	DADDO PROPERTIES, LP	10401 GOLDEN GATE RD	P.O. BOX 2188	DOYLESTOWN, PA	6.0811
201	13	DADDO PROPERTIES, LP	10401 GOLDEN GATE RD	P.O. BOX 2188	DOYLESTOWN, PA	6.1074
201	48	DRECHSEL, DAVID C & SANDRA L	10623 GOLDEN GATE RD	5 ARBOR LEW CIRCLE	DOYLESTOWN, PA	5.4641
201	49	DRECHSEL, DAVID C & SANDRA L	10623 GOLDEN GATE RD	5 ARBOR LEW CIRCLE	DOYLESTOWN, PA	5.4641
201	44	DRESLIN, SHARON A, TRUSTEE	10603 GOLDEN GATE RD	1304 HOLLOW RD	COLLEGEVILLE, PA	5.2879
201	43	DRESLIN, SHARON A, TRUSTEE	10603 GOLDEN GATE RD	1304 HOLLOW RD	COLLEGEVILLE, PA	5.3232
201	43	DRESLIN, SHARON A, TRUSTEE	10603 GOLDEN GATE RD	1304 HOLLOW RD	COLLEGEVILLE, PA	6.4404
201	59	F.WILSON JACKSON	10704 GOLDEN GATE RD	610 ALLEN GRANGE CT	MECHANICSBURG, PA	6.5681
201	60	F.WILSON JACKSON	10704 GOLDEN GATE RD	610 ALLEN GRANGE CT	MECHANICSBURG, PA	6.5681
201	57.02	F.WILSON JACKSON	10704 GOLDEN GATE RD	610 ALLEN GRANGE CT	MECHANICSBURG, PA	6.5745
201	58	F.WILSON JACKSON	10704 GOLDEN GATE RD	610 ALLEN GRANGE CT	MECHANICSBURG, PA	6.5745

BLOCK	LOT	Owners Name	Owners Name2	Owner Address 1	Owner Address 2	Elevation (NAVD88)
201	61	F.WILSON JACKSON	10704 GOLDEN GATE RD	610 ALLEN GRANGE CT	MECHANICSBURG, PA	6.6244
201	61	F.WILSON JACKSON	10704 GOLDEN GATE RD	610 ALLEN GRANGE CT	MECHANICSBURG, PA	6.6434
201	89	FAMERSHAM ASSOCIATES, LP	FAMERSHAM ASSOCIATES, LP	9310 SECOND AVE	STONE HARBOR, NJ	5.7364
201	90	FAMERSHAM ASSOCIATES, LP	FAMERSHAM ASSOCIATES, LP	9310 SECOND AVE	STONE HARBOR, NJ	5.7364
201	91	FAMERSHAM ASSOCIATES, LP	FAMERSHAM ASSOCIATES, LP	9310 SECOND AVE	STONE HARBOR, NJ	5.7364
201	68	FLORIO, DALE & LESLIE	FLORIO, DALE & LESLIE	1125 MAXWELL LN, UNIT 330	HOBOKEN, NJ	5.6528
201	66.02	FLORIO, DALE & LESLIE	FLORIO, DALE & LESLIE	1125 MAXWELL LN, UNIT 330	HOBOKEN, NJ	6.3847
201	67	FLORIO, DALE & LESLIE	FLORIO, DALE & LESLIE	1125 MAXWELL LN, UNIT 330	HOBOKEN, NJ	6.3847
201	67	FLORIO, DALE & LESLIE	FLORIO, DALE & LESLIE	1125 MAXWELL LN, UNIT 330	HOBOKEN, NJ	6.453
201	1	GLIELMI, LYNN D	GLIELMI, LYNN D	1151 COUNTRY CLUB LA	LANCASTER, PA	5.847
201	2	GLIELMI, LYNN D	GLIELMI, LYNN D	1151 COUNTRY CLUB LA	LANCASTER, PA	5.986
201	1	GLIELMI, LYNN D	GLIELMI, LYNN D	1151 COUNTRY CLUB LA	LANCASTER, PA	7.412
201	94.02	GLIGOR, JOHN & ANNA MAY	GLIGOR, JOHN & ANNA MAY	101 WESTWOOD HILL	WEST DEPTFORD, NJ	6.7462
201	94	GOLDEN GATE CONDOMINIUM	GOLDEN GATE CONDOMINIUM	10506 GOLDEN GATE ROAD	STONE HARBOR, NJ	6.7462
201	75.01	GUSHUE, JUDITH A	GUSHUE, JUDITH A	18 GREAT HILLS RD	NEW HOPE, PA	6.3827
201	74	GUSHUE, JUDITH A	GUSHUE, JUDITH A	18 GREAT HILLS RD	NEW HOPE, PA	6.429
201	74	GUSHUE, JUDITH A	GUSHUE, JUDITH A	18 GREAT HILLS RD	NEW HOPE, PA	7.2905
201	11	HENISEE, L GEORGE JR & CHRISTINE A	474 104TH ST	131 CHESWOLD LA	HAVERFORD, PA	5.2092
201	12	HENISEE, L GEORGE JR & CHRISTINE A	474 104TH ST	131 CHESWOLD LA	HAVERFORD, PA	5.2934
201	11	HENISEE, L GEORGE JR & CHRISTINE A	474 104TH ST	131 CHESWOLD LA	HAVERFORD, PA	6.0139
201	80	JACKSON, BARRY R, TRUSTEE	JACKSON, BARRY R, TRUSTEE	194 PRINCE GEORGE ST	ANNAPOLIS, MD	5.8334
201	81	JACKSON, BARRY R, TRUSTEE	JACKSON, BARRY R, TRUSTEE	194 PRINCE GEORGE ST	ANNAPOLIS, MD	5.8334
201	71	JARDEN, MARTHA & RICHARDS IRR TRUST	JARDEN, MARTHA & RICHARDS IRR TRUST	579 FLETCHER RD.	WAYNE, PA	5.2846
201	69	JARDEN, MARTHA & RICHARDS IRR TRUST	JARDEN, MARTHA & RICHARDS IRR TRUST	579 FLETCHER RD.	WAYNE, PA	5.6528
201	70	JARDEN, MARTHA & RICHARDS IRR TRUST	JARDEN, MARTHA & RICHARDS IRR TRUST	579 FLETCHER RD.	WAYNE, PA	5.6548
201	72	JARDEN,R.H. I.V.TR %F.SCOTT JARDEN	JARDEN,R.H. I.V.TR %F.SCOTT JARDEN	579 FLETCHER RD	WAYNE, PA	5.2846
201	73	JARDEN,R.H. I.V.TR %F.SCOTT JARDEN	JARDEN,R.H. I.V.TR %F.SCOTT JARDEN	579 FLETCHER RD	WAYNE, PA	5.3205
201	66.01	JOHNSON, MELISSA ANNE & LORENTZ, C	10700 GOLDEN GATE RD	718 MILLDAM RD	TOWSON, MD	6.3847
201	65	JOHNSON, MELISSA ANNE & LORENTZ, C	10700 GOLDEN GATE RD	718 MILLDAM RD	TOWSON, MD	6.6386
201	62	JOHNSON, MELISSA ANNE & LORENTZ, C	10700 GOLDEN GATE RD	718 MILLDAM RD	TOWSON, MD	6.6837
201	63	JOHNSON, MELISSA ANNE & LORENTZ, C	10700 GOLDEN GATE RD	718 MILLDAM RD	TOWSON, MD	6.6837
201	64	JOHNSON, MELISSA ANNE & LORENTZ, C	10700 GOLDEN GATE RD	718 MILLDAM RD	TOWSON, MD	6.6837
201	75.02	KELLY, PAUL K & JEANNE	KELLY, PAUL K & JEANNE	14725 WATERCHASE BLVD	TAMPA, FL	6.3827
201	76	KELLY, PAUL K & JEANNE	KELLY, PAUL K & JEANNE	14725 WATERCHASE BLVD	TAMPA, FL	6.3827
201	77	KELLY, PAUL K & JEANNE	KELLY, PAUL K & JEANNE	14725 WATERCHASE BLVD	TAMPA, FL	6.3827
201	77	KELLY, PAUL K & JEANNE	KELLY, PAUL K & JEANNE	14725 WATERCHASE BLVD	TAMPA, FL	6.5177
201	94.03	KRAMAR, JON A & JOAN T	KRAMAR, JON A & JOAN T	10506 GOLDEN GATE RD	STONE HARBOR, NJ	6.7462
201	93	LAMANNA, VINCENT L JR	LAMANNA, VINCENT L JR	10510 GOLDEN GATE RD	STONE HARBOR, NJ	5.6368
201	92	LAMANNA, VINCENT L JR	LAMANNA, VINCENT L JR	10510 GOLDEN GATE RD	STONE HARBOR, NJ	6.8973
201	93	LAMANNA, VINCENT L JR	LAMANNA, VINCENT L JR	10510 GOLDEN GATE RD	STONE HARBOR, NJ	6.8973
201	38.02	LEIDHEISER, KENNETH M & KATHLEEN	10539 GOLDEN GATE RD	1196 AVONLEA CIR	GLEN MILLS, PA	6.3128
201	39	LEIDHEISER, KENNETH M & KATHLEEN	10539 GOLDEN GATE RD	1196 AVONLEA CIR	GLEN MILLS, PA	7.4344
201	38.02	LEIDHEISER, KENNETH M & KATHLEEN	10539 GOLDEN GATE RD	1196 AVONLEA CIR	GLEN MILLS, PA	7.5596
201	83	LEISER,PAUL& NANCY	LEISER,PAUL& NANCY	141 PARKVIEW RD	STRATFORD, NJ	5.4535
201	82	LEISER,PAUL& NANCY	LEISER,PAUL& NANCY	141 PARKVIEW RD	STRATFORD, NJ	5.8334
201	83	LEISER,PAUL& NANCY	LEISER,PAUL& NANCY	141 PARKVIEW RD	STRATFORD, NJ	5.9496
201	10	LIDE, MELVILLE D & MARY E	470 104TH ST	470 104TH ST	STONE HARBOR, NJ	6.1228
201	8	LIDE, MELVILLE D & MARY E	470 104TH ST	470 104TH ST	STONE HARBOR, NJ	6.1748
201	9	LIDE, MELVILLE D & MARY E	470 104TH ST	470 104TH ST	STONE HARBOR, NJ	6.1748
201	17	MCDERMOTT JR,JAMES & MAUREEN	10415 GOLDEN GATE RD	10415 GOLDEN GATE DR	STONE HARBOR, NJ	6.0811
201	18	MCDERMOTT JR,JAMES & MAUREEN	10415 GOLDEN GATE RD	10415 GOLDEN GATE DR	STONE HARBOR, NJ	6.7054
201	19	MCDERMOTT JR,JAMES & MAUREEN	10415 GOLDEN GATE RD	10415 GOLDEN GATE DR	STONE HARBOR, NJ	6.7054
201	78	MCKEE,FRANK A & EILEEN,TRUSTEES	MCKEE,FRANK A & EILEEN,TRUSTEES	406 LANTERN LANE	BERWYN, PA	6.4862
201	79	MCKEE,FRANK A & EILEEN,TRUSTEES	MCKEE,FRANK A & EILEEN,TRUSTEES	406 LANTERN LANE	BERWYN, PA	6.4862
201	46.02	MCKENNA, WILLIAM F & VICTORIA	10617 GOLDEN GATE RD	116 COVE LN	MEDIA, PA	5.6637
201	47	MCKENNA, WILLIAM F & VICTORIA	10617 GOLDEN GATE RD	116 COVE LN	MEDIA, PA	5.6901
201	99	MEAGHER FAMILY TRUST	MEAGHER FAMILY TRUST	914 TALAMORE DR	AMBLER, PA	5.7725
201	100	MEAGHER FAMILY TRUST	MEAGHER FAMILY TRUST	914 TALAMORE DR	AMBLER, PA	5.7725
201	101	MEAGHER FAMILY TRUST	MEAGHER FAMILY TRUST	914 TALAMORE DR	AMBLER, PA	5.7725
201	102	MEAGHER FAMILY TRUST	MEAGHER FAMILY TRUST	914 TALAMORE DR	AMBLER, PA	5.7725
201	103.01	MEAGHER FAMILY TRUST	MEAGHER FAMILY TRUST	914 TALAMORE DR	AMBLER, PA	5.7725
201	33.01	NARZIKUL, GREGORY T & THERES M	10525 GOLDEN GATE RD	510 MILLBROOK RD	DEVON, PA	6.7001
201	32	NARZIKUL, GREGORY T & THERES M	10525 GOLDEN GATE RD	510 MILLBROOK RD	DEVON, PA	6.7054
201	3	NAYLOR, RUSSELL & SUZANNE	448 104TH ST	639 CHURCH RD	MALVERN, PA	5.986
201	4	NAYLOR, RUSSELL & SUZANNE	448 104TH ST	639 CHURCH RD	MALVERN, PA	6.042
201	5	NAYLOR, RUSSELL & SUZANNE	448 104TH ST	639 CHURCH RD	MALVERN, PA	6.042
201	20	NERNEY, THOMAS	10501 GOLDEN GATE RD	1190 DEVON PARK DR	WAYNE, PA	6.7798
201	21	NERNEY, THOMAS	10501 GOLDEN GATE RD	1190 DEVON PARK DR	WAYNE, PA	6.7798
201	22	NERNEY, THOMAS	10501 GOLDEN GATE RD	1190 DEVON PARK DR	WAYNE, PA	6.7798
201	23	NERNEY, THOMAS	10501 GOLDEN GATE RD	1190 DEVON PARK DR	WAYNE, PA	6.7798
201	24	NERNEY, THOMAS	10501 GOLDEN GATE RD	1190 DEVON PARK DR	WAYNE, PA	6.7798
201	40	PIKE,RICHARD O, ETAL	10601 GOLDEN GATE RD	10601 GOLDEN GATE DR	STONE HARBOR, NJ	6.4382
201	42	PIKE,RICHARD O, ETAL	10601 GOLDEN GATE RD	10601 GOLDEN GATE DR	STONE HARBOR, NJ	6.4404
201	41	PIKE,RICHARD O, ETAL	10601 GOLDEN GATE RD	10601 GOLDEN GATE DR	STONE HARBOR, NJ	6.4488
201	40	PIKE,RICHARD O, ETAL	10601 GOLDEN GATE RD	10601 GOLDEN GATE DR	STONE HARBOR, NJ	7.4344
201	37	PISCOPO, JOAN M	10537 GOLDEN GATE RD	3061 E VINA DEL MAR BLVD	ST PETE BEACH, FL	6.3128
201	38.01	PISCOPO, JOAN M	10537 GOLDEN GATE RD	3061 E VINA DEL MAR BLVD	ST PETE BEACH, FL	6.3128
201	97	ROBERTS, JOSEPH F & KATHRYN AMES	ROBERTS, JOSEPH F & KATHRYN AMES	1804 RITTENHOUSE SQUARE	PHILADELPHIA, PA	5.4597
201	98	ROBERTS, JOSEPH F & KATHRYN AMES	ROBERTS, JOSEPH F & KATHRYN AMES	1804 RITTENHOUSE SQUARE	PHILADELPHIA, PA	5.6993
201	98	ROBERTS, JOSEPH F & KATHRYN AMES	ROBERTS, JOSEPH F & KATHRYN AMES	1804 RITTENHOUSE SQUARE	PHILADELPHIA, PA	6.2627
201	97	ROBERTS, JOSEPH F & KATHRYN AMES	ROBERTS, JOSEPH F & KATHRYN AMES	1804 RITTENHOUSE SQUARE	PHILADELPHIA, PA	6.6809
201	29	SAUNDERS, RONALD A & GAIL M	10521 GOLDEN GATE RD	10521 GOLDEN GATE DRIVE	STONE HARBOR, NJ	6.2684
201	28	SAUNDERS, RONALD A & GAIL M	10521 GOLDEN GATE RD	10521 GOLDEN GATE DRIVE	STONE HARBOR, NJ	6.2831
201	28	SAUNDERS, RONALD A & GAIL M	10521 GOLDEN GATE RD	10521 GOLDEN GATE DRIVE	STONE HARBOR, NJ	6.4054
201	45	SHAW, PAMELA A & HOWARD A	10605 GOLDEN GATE RD	3521 THORNBURY LANE	BONITA SPRING, FL	5.2879
201	45	SHAW, PAMELA A & HOWARD A	10605 GOLDEN GATE RD	3521 THORNBURY LANE	BONITA SPRING, FL	5.6115
201	46.01	SHAW, PAMELA A & HOWARD A	10605 GOLDEN GATE RD	3521 THORNBURY LANE	BONITA SPRING, FL	5.6637
201	100.02	SHIHADEH, AIMEE	SHIHADEH, AIMEE	1950 STANDIFORD DR	MALVERN, PA	5.2978
201	103.02	SHIHADEH, AIMEE	SHIHADEH, AIMEE	1950 STANDIFORD DR	MALVERN, PA	5.2978
201	104	SHIHADEH, AIMEE	SHIHADEH, AIMEE	1950 STANDIFORD DR	MALVERN, PA	5.2978
201	105	SHIHADEH, AIMEE	SHIHADEH, AIMEE	1950 STANDIFORD DR	MALVERN, PA	5.2978
201	53.01	TIFFAN,ANNETTE K & GERALD L,TTEES	10701 GOLDEN GATE RD	1061 GALLEON DRIVE	NAPLES, FL	5.0016
201	54	TIFFAN,ANNETTE K & GERALD L,TTEES	10701 GOLDEN GATE RD	1061 GALLEON DRIVE	NAPLES, FL	5.0016
201	54	TIFFAN,ANNETTE K & GERALD L,TTEES	10701 GOLDEN GATE RD	1061 GALLEON DRIVE	NAPLES, FL	6.3186
201	56	TIFFAN,ANNETTE K & GERALD L,TTEES	10701 GOLDEN GATE RD	1061 GALLEON DRIVE	NAPLES, FL	6.4102
201	57.01	TIFFAN,ANNETTE K & GERALD L,TTEES	10701 GOLDEN GATE RD	1061 GALLEON DRIVE	NAPLES, FL	6.4139
201	55	TIFFAN,ANNETTE K & GERALD L,TTEES	10701 GOLDEN GATE RD	1061 GALLEON DRIVE	NAPLES, FL	6.4582
201	35	TOMLINSON, ALBERT B	10533 GOLDEN GATE RD	508 S BELLEVUE AVE	LANGHORNE, PA	6.3128
201	36	TOMLINSON, ALBERT B	10533 GOLDEN GATE RD	508 S BELLEVUE AVE	LANGHORNE, PA	6.3128
201	6	TOSCANI, GERARD M & TINA M	460 104TH ST	711 GARWOOD RD	MOORESTOWN, NJ	6.042
201	7	TOSCANI, GERARD M & TINA M	460 104TH ST	711 GARWOOD RD	MOORESTOWN, NJ	6.042
201	51	TSENG, JACK & FAY	10627 GOLDEN GATE RD	6029 ATKINSON RD	NEW HOPE, PA	4.9361
201	53.02	TSENG, JACK & FAY	10627 GOLDEN GATE RD	6029 ATKINSON RD	NEW HOPE, PA	5.0016
201	52	TSENG, JACK & FAY	10627 GOLDEN GATE RD	6029 ATKINSON RD	NEW HOPE, PA	5.0314
202	26	AFH PARTNERS, LLC	AFH PARTNERS, LLC	1301 OXFORD LN	GLENVIEW, IL	4.9521
202	27	AFH PARTNERS, LLC	AFH PARTNERS, LLC	1301 OXFORD LN	GLENVIEW, IL	4.9521
202	84	BAZIK, ANNE	BAZIK, ANNE	2225 KERR RD	HARLEYSVILLE, PA	5.9438
202	81	BAZIK, ANNE	BAZIK, ANNE	2225 KERR RD	HARLEYSVILLE, PA	5.9891
202	82	BAZIK, ANNE	BAZIK, ANNE	2225 KERR RD	HARLEYSVILLE, PA	5.9891
202	83	BAZIK, ANNE	BAZIK, ANNE	2225 KERR RD	HARLEYSVILLE, PA	6.1619
202	70	BREEN, EDWARD & LYNN	BREEN, EDWARD & LYNN	180 STREET ROAD	NEW HOPE, PA	6.1069
202	69	BREEN, EDWARD & LYNN	BREEN, EDWARD & LYNN	180 STREET ROAD	NEW HOPE, PA	6.2038
202	68	BREEN, EDWARD & LYNN	BREEN, EDWARD & LYNN	180 STREET ROAD	NEW HOPE, PA	6.2065

BLOCK	LOT	Owners Name	Owners Name2	Owner Address 1	Owner Address 2	Elevation (NAVD88)
202	70	BREEN, EDWARD & LYNN	BREEN, EDWARD & LYNN	180 STREET ROAD	NEW HOPE, PA	6.3167
202	64.02	BREEN, EDWARD D & LYNN M	BREEN, EDWARD D & LYNN M	180 STREET RD	NEW HOPE, PA	6.2065
202	65	BREEN, EDWARD D & LYNN M	BREEN, EDWARD D & LYNN M	180 STREET RD	NEW HOPE, PA	6.2065
202	66.01	BREEN, EDWARD D & LYNN M	BREEN, EDWARD D & LYNN M	180 STREET RD	NEW HOPE, PA	6.2065
202	66.02	BREEN, EDWARD D & LYNN M	BREEN, EDWARD D & LYNN M	180 STREET RD	NEW HOPE, PA	6.2065
202	67	BREEN, EDWARD D & LYNN M	BREEN, EDWARD D & LYNN M	180 STREET RD	NEW HOPE, PA	6.2065
202	30	BREEN, EDWARD D & LYNN M	BREEN, EDWARD D & LYNN M	180 STREET RD	NEW HOPE, PA	6.3575
202	31	BREEN, EDWARD D & LYNN M	BREEN, EDWARD D & LYNN M	180 STREET RD	NEW HOPE, PA	6.3575
202	30	BREEN, EDWARD D & LYNN M	BREEN, EDWARD D & LYNN M	180 STREET RD	NEW HOPE, PA	6.3884
202	63.02	BREEN,EDWARD D & LYNN M	BREEN,EDWARD D & LYNN M	180 STREET RD	NEW HOPE, PA	6.0127
202	64.01	BREEN,EDWARD D & LYNN M	BREEN,EDWARD D & LYNN M	180 STREET RD	NEW HOPE, PA	6.2065
202	53.01	BRUDER,JAMES J JR IRR TR.@SAGEWORTH	10727 CORINTHIAN PL	1861 SANTA BARBARA DR	LANCASTER, PA	6.0157
202	52	BRUDER,JAMES J JR IRR TR.@SAGEWORTH	10727 CORINTHIAN PL	1861 SANTA BARBARA DR	LANCASTER, PA	6.1001
202	53.01	BRUDER,JAMES J JR IRR TR.@SAGEWORTH	10727 CORINTHIAN PL	1861 SANTA BARBARA DR	LANCASTER, PA	6.2738
202	23	CARRIGAN,JAMES T & JOANNE M	CARRIGAN,JAMES T & JOANNE M	62 HARGRAVE LN	MEDIA, PA	5.7684
202	24.01	CARRIGAN,JAMES T & JOANNE M	CARRIGAN,JAMES T & JOANNE M	62 HARGRAVE LN	MEDIA, PA	5.7684
202	23	CARRIGAN,JAMES T & JOANNE M	CARRIGAN,JAMES T & JOANNE M	62 HARGRAVE LN	MEDIA, PA	6.4843
202	34	CARTER, BRIAN C & LAUREN	CARTER, BRIAN C & LAUREN	400 PARK LN	MOORESTOWN, NJ	4.3656
202	35	CARTER, BRIAN C & LAUREN	CARTER, BRIAN C & LAUREN	400 PARK LN	MOORESTOWN, NJ	7.1707
202	74	CARUSO, MICHAEL J & LORRAINE	CARUSO, MICHAEL J & LORRAINE	10551 CORINTHIAN PLACE	STONE HARBOR, NJ	5.1453
202	75	CARUSO, MICHAEL J & LORRAINE	CARUSO, MICHAEL J & LORRAINE	10551 CORINTHIAN PLACE	STONE HARBOR, NJ	5.1453
202	76.01	CARUSO, MICHAEL J & LORRAINE	CARUSO, MICHAEL J & LORRAINE	10551 CORINTHIAN PLACE	STONE HARBOR, NJ	5.1892
202	76.01	CARUSO, MICHAEL J & LORRAINE	CARUSO, MICHAEL J & LORRAINE	10551 CORINTHIAN PLACE	STONE HARBOR, NJ	6.1088
202	33	CHRISTOS, NICHOLAS J & M SANDRA	CHRISTOS, NICHOLAS J & M SANDRA	529 RUTGERS AVE	SWARTHMORE, PA	4.3656
202	32	CHRISTOS, NICHOLAS J & M SANDRA	CHRISTOS, NICHOLAS J & M SANDRA	529 RUTGERS AVE	SWARTHMORE, PA	4.4849
202	32	CHRISTOS, NICHOLAS J & M SANDRA	CHRISTOS, NICHOLAS J & M SANDRA	529 RUTGERS AVE	SWARTHMORE, PA	6.4418
202	61	COMERFORD,PHILIP & DIANA,TRUSTEES	COMERFORD,PHILIP & DIANA,TRUSTEES	815 ASHBURTON DR	NAPLES, FL	6.0126
202	62	COMERFORD,PHILIP & DIANA,TRUSTEES	COMERFORD,PHILIP & DIANA,TRUSTEES	815 ASHBURTON DR	NAPLES, FL	6.0126
202	63.01	COMERFORD,PHILIP & DIANA,TRUSTEES	COMERFORD,PHILIP & DIANA,TRUSTEES	815 ASHBURTON DR	NAPLES, FL	6.0127
202	63.01	COMERFORD,PHILIP & DIANA,TRUSTEES	COMERFORD,PHILIP & DIANA,TRUSTEES	815 ASHBURTON DR	NAPLES, FL	6.0197
202	60	COMERFORD,PHILIP & DIANA,TRUSTEES	COMERFORD,PHILIP & DIANA,TRUSTEES	815 ASHBURTON DR	NAPLES, FL	6.0391
202	16	DE NOFA, ERNESTO M & ANGELINA D	DE NOFA, ERNESTO M & ANGELINA D	3816 LOOP RD	HUNTINGDON VALLEY, PA	6.193
202	17	DE NOFA, ERNESTO M & ANGELINA D	DE NOFA, ERNESTO M & ANGELINA D	3816 LOOP RD	HUNTINGDON VALLEY, PA	6.2217
202	15	DE NOFA, ERNESTO M & ANGELINA D	DE NOFA, ERNESTO M & ANGELINA D	3816 LOOP RD	HUNTINGDON VALLEY, PA	6.2266
202	15	DE NOFA, ERNESTO M & ANGELINA D	DE NOFA, ERNESTO M & ANGELINA D	3816 LOOP RD	HUNTINGDON VALLEY, PA	6.4352
202	47	FRANCISCO, RICHARD J & MARY ANNE	10726 CORINTHIAN PL	1383 HELLER DR	YARDLEY, PA	6.0963
202	48	FRANCISCO, RICHARD J & MARY ANNE	10726 CORINTHIAN PL	1383 HELLER DR	YARDLEY, PA	6.1257
202	49	FRANCISCO, RICHARD J & MARY ANNE	10726 CORINTHIAN PL	1383 HELLER DR	YARDLEY, PA	6.1257
202	47	FRANCISCO, RICHARD J & MARY ANNE	10726 CORINTHIAN PL	1383 HELLER DR	YARDLEY, PA	6.4633
202	44.02	GIACOBBE, ROBERT & DOROTHEA	10724 CORINTHIAN PL	29 DITMAR BLVD.	WHITE HOUSE, NJ	6.4883
202	46	GIACOBBE, ROBERT & DOROTHEA	10724 CORINTHIAN PL	29 DITMAR BLVD.	WHITE HOUSE, NJ	6.4892
202	45	GIACOBBE, ROBERT & DOROTHEA	10724 CORINTHIAN PL	29 DITMAR BLVD.	WHITE HOUSE, NJ	6.5027
202	85	GOWEN, GEORGE M JR & M PAULA	GOWEN, GEORGE M JR & M PAULA	P O BOX 198	WESTTOWN, PA	5.9438
202	87.01	GOWEN, GEORGE M JR & M PAULA	GOWEN, GEORGE M JR & M PAULA	P O BOX 198	WESTTOWN, PA	6.1611
202	87.01	GOWEN, GEORGE M JR & M PAULA	GOWEN, GEORGE M JR & M PAULA	P O BOX 198	WESTTOWN, PA	6.1674
202	86	GOWEN, GEORGE M JR & M PAULA	GOWEN, GEORGE M JR & M PAULA	P O BOX 198	WESTTOWN, PA	6.3039
202	5.02	GREENE, MICHAEL	GREENE, MICHAEL	442 MICHIGAN RD	NEW CANAAN, CT	6.4836
202	6.01	GREENE, MICHAEL	GREENE, MICHAEL	442 MICHIGAN RD	NEW CANAAN, CT	6.4836
202	7	GREENE, MICHAEL	GREENE, MICHAEL	442 MICHIGAN RD	NEW CANAAN, CT	6.4836
202	8.01	GREENE, MICHAEL	GREENE, MICHAEL	442 MICHIGAN RD	NEW CANAAN, CT	6.4836
202	8.02	GREENE, MICHAEL	GREENE, MICHAEL	442 MICHIGAN RD	NEW CANAAN, CT	6.4836
202	9	GREENE, MICHAEL	GREENE, MICHAEL	442 MICHIGAN RD	NEW CANAAN, CT	6.4836
202	36	GRIMES, DAVID S	GRIMES, DAVID S	10620 CORINTHIAN DR	STONE HARBOR, NJ	4.6865
202	37	GRIMES, DAVID S	GRIMES, DAVID S	10620 CORINTHIAN DR	STONE HARBOR, NJ	4.6865
202	36	GRIMES, DAVID S	GRIMES, DAVID S	10620 CORINTHIAN DR	STONE HARBOR, NJ	7.196
202	10	HANNA, JAMES R & ROSEMARY M	HANNA, JAMES R & ROSEMARY M	539 TIMBER LA	DEVON, PA	5.0945
202	11	HANNA, JAMES R & ROSEMARY M	HANNA, JAMES R & ROSEMARY M	539 TIMBER LA	DEVON, PA	5.0945
202	12.01	HANNA, JAMES R & ROSEMARY M	HANNA, JAMES R & ROSEMARY M	539 TIMBER LA	DEVON, PA	5.0945
202	91.02	HEIM, WILLIAM J & FRANCES G	HEIM, WILLIAM J & FRANCES G	1139 COUNTRY CLUB RD	CLARKS SUMMIT, PA	5.1514
202	93	HEIM, WILLIAM J & FRANCES G	HEIM, WILLIAM J & FRANCES G	1139 COUNTRY CLUB RD	CLARKS SUMMIT, PA	5.2189
202	92	HEIM, WILLIAM J & FRANCES G	HEIM, WILLIAM J & FRANCES G	1139 COUNTRY CLUB RD	CLARKS SUMMIT, PA	5.251
202	92	HEIM, WILLIAM J & FRANCES G	HEIM, WILLIAM J & FRANCES G	1139 COUNTRY CLUB RD	CLARKS SUMMIT, PA	5.3261
202	98.02	HIRSHMAN, KENNETH & SUSAN E	HIRSHMAN, KENNETH & SUSAN E	671 MOUNT VIEW RD	BERWYN, PA	5.1376
202	99	HIRSHMAN, KENNETH & SUSAN E	HIRSHMAN, KENNETH & SUSAN E	671 MOUNT VIEW RD	BERWYN, PA	5.1376
202	100.01	HIRSHMAN, KENNETH & SUSAN E	HIRSHMAN, KENNETH & SUSAN E	671 MOUNT VIEW RD	BERWYN, PA	5.3468
202	55	HOUPT,GEORGE ALLEN IV, ETAL	10713 CORINTHIAN PL	93 GLENDALE RD	EXTON, PA	5.9816
202	55	HOUPT,GEORGE ALLEN IV, ETAL	10713 CORINTHIAN PL	93 GLENDALE RD	EXTON, PA	6.2421
202	54	HOUPT,GEORGE ALLEN IV, ETAL	10713 CORINTHIAN PL	93 GLENDALE RD	EXTON, PA	6.269
202	53.02	HOUPT,GEORGE ALLEN IV, ETAL	10713 CORINTHIAN PL	93 GLENDALE RD	EXTON, PA	6.2738
202	42	KENNEDY, DAVID E & BEVERLY A, TTEES	10720 CORINTHIAN PL	623 OWEN RD	YORK, PA	6.3428
202	43	KENNEDY, DAVID E & BEVERLY A, TTEES	10720 CORINTHIAN PL	623 OWEN RD	YORK, PA	6.3428
202	44.01	KENNEDY, DAVID E & BEVERLY A, TTEES	10720 CORINTHIAN PL	623 OWEN RD	YORK, PA	6.4609
202	44.01	KENNEDY, DAVID E & BEVERLY A, TTEES	10720 CORINTHIAN PL	623 OWEN RD	YORK, PA	6.4883
202	78.01	LECKY, CATHERINE M & MIRAGLIA, V P	LECKY, CATHERINE M & MIRAGLIA, V P	10549 CORINTHIAN PLACE	STONE HARBOR, NJ	6.0829
202	76.02	LECKY, CATHERINE M & MIRAGLIA, V P	LECKY, CATHERINE M & MIRAGLIA, V P	10549 CORINTHIAN PLACE	STONE HARBOR, NJ	6.1088
202	77	LECKY, CATHERINE M & MIRAGLIA, V P	LECKY, CATHERINE M & MIRAGLIA, V P	10549 CORINTHIAN PLACE	STONE HARBOR, NJ	6.1088
202	12.02	LEWIS, CECIL C & PATRICIA L	LEWIS, CECIL C & PATRICIA L	PO BOX 448	WORCESTER, PA	5.103
202	12.02	LEWIS, CECIL C & PATRICIA L	LEWIS, CECIL C & PATRICIA L	PO BOX 448	WORCESTER, PA	6.4623
202	13	LEWIS, CECIL C & PATRICIA L	LEWIS, CECIL C & PATRICIA L	PO BOX 448	WORCESTER, PA	6.4623
202	14	LEWIS, CECIL C & PATRICIA L	LEWIS, CECIL C & PATRICIA L	PO BOX 448	WORCESTER, PA	6.4623
202	5.01	MAGEE, JOAN	MAGEE, JOAN	741 S. CHADWICK ST.	PHILADLEPHIA, PA	6.4836
202	6.02	MAGEE, JOAN	MAGEE, JOAN	741 S. CHADWICK ST.	PHILADLEPHIA, PA	6.4836
202	4.02	MAGEE, JOAN	MAGEE, JOAN	741 S. CHADWICK ST.	PHILADLEPHIA, PA	6.5
202	18	MANNING, LYNN Z & CHARLES R	MANNING, LYNN Z & CHARLES R	520 S SYDBURY LN	WYNNEWOOD, PA	6.2762
202	18	MANNING, LYNN Z & CHARLES R	MANNING, LYNN Z & CHARLES R	520 S SYDBURY LN	WYNNEWOOD, PA	6.4016
202	94	MATTOS,JOHN F & MARJORIE R,TRUSTEES	MATTOS,JOHN F & MARJORIE R,TRUSTEES	1121 N GAILLARD ST	ALEXANDRIA, VA	4.8697
202	95.01	MATTOS,JOHN F & MARJORIE R,TRUSTEES	MATTOS,JOHN F & MARJORIE R,TRUSTEES	1121 N GAILLARD ST	ALEXANDRIA, VA	4.8697
202	80	MATTOS,JOSEPH G, TRUSTEE	MATTOS,JOSEPH G, TRUSTEE	8269 HAMMOND BRANCH WY	LAUREL, MD	6.0445
202	78.02	MATTOS,JOSEPH G, TRUSTEE	MATTOS,JOSEPH G, TRUSTEE	8269 HAMMOND BRANCH WY	LAUREL, MD	6.0829
202	79	MATTOS,JOSEPH G, TRUSTEE	MATTOS,JOSEPH G, TRUSTEE	8269 HAMMOND BRANCH WY	LAUREL, MD	6.1209
202	80	MATTOS,JOSEPH G, TRUSTEE	MATTOS,JOSEPH G, TRUSTEE	8269 HAMMOND BRANCH WY	LAUREL, MD	6.1413
202	97.02	MAY, JOSEPH & DEBRA	MAY, JOSEPH & DEBRA	2542 WHITEHORSE RD	BERWYN, PA	5.0339
202	98.01	MAY, JOSEPH & DEBRA	MAY, JOSEPH & DEBRA	2542 WHITEHORSE RD	BERWYN, PA	5.0339
202	96.02	MAY, JOSEPH & DEBRA	MAY, JOSEPH & DEBRA	2542 WHITEHORSE RD	BERWYN, PA	5.3505
202	24.02	MC CAFFREY, JAMES K & MARY	MC CAFFREY, JAMES K & MARY	86 CHRISTOPHER DR	HOLLAND, PA	5.7684
202	25	MC CAFFREY, JAMES K & MARY	MC CAFFREY, JAMES K & MARY	86 CHRISTOPHER DR	HOLLAND, PA	5.8822
202	87.02	MCBREARTY, DOUGLAS & CHERYL S	MCBREARTY, DOUGLAS & CHERYL S	231 ATLEE RD	WAYNE, PA	6.1611
202	88	MCBREARTY, DOUGLAS & CHERYL S	MCBREARTY, DOUGLAS & CHERYL S	231 ATLEE RD	WAYNE, PA	6.1611
202	89	MCBREARTY, DOUGLAS & CHERYL S	MCBREARTY, DOUGLAS & CHERYL S	231 ATLEE RD	WAYNE, PA	6.1611
202	95.02	MCFADDEN, DANIEL & EMILY	MCFADDEN, DANIEL & EMILY	9228 DARLINGTON RD	PHILADELPHIA, PA	4.8697
202	95.02	MCFADDEN, DANIEL & EMILY	MCFADDEN, DANIEL & EMILY	9228 DARLINGTON RD	PHILADELPHIA, PA	5.0539
202	96.01	MCFADDEN, DANIEL & EMILY	MCFADDEN, DANIEL & EMILY	9228 DARLINGTON RD	PHILADELPHIA, PA	5.3505
202	97.01	MCFADDEN, DANIEL & EMILY	MCFADDEN, DANIEL & EMILY	9228 DARLINGTON RD	PHILADELPHIA, PA	5.3505
202	51	MINE RD PARTNERS, LP	10729 CORINTHIAN PL	160 N. POINT BLVD. STE200	LANCASTER, PA	6.1053
202	51	MINE RD PARTNERS, LP	10729 CORINTHIAN PL	160 N. POINT BLVD. STE200	LANCASTER, PA	6.1149
202	50	MINE RD PARTNERS, LP	10729 CORINTHIAN PL	160 N. POINT BLVD. STE200	LANCASTER, PA	6.1257
202	19	MYERS, GEORGE & JANINE	MYERS, GEORGE & JANINE	10314 FAWCETT ST	KENSINGTON, MD	6.4214
202	19	MYERS, GEORGE & JANINE	MYERS, GEORGE & JANINE	10314 FAWCETT ST	KENSINGTON, MD	6.4232
202	20	MYERS, GEORGE & JANINE	MYERS, GEORGE & JANINE	10314 FAWCETT ST	KENSINGTON, MD	6.4232
202	39	PFEIFFER, DAVID & ANINA M	PFEIFFER, DAVID & ANINA M	405 FOOTHILL DR	BLUE BELL, PA	4.1589
202	38	PFEIFFER, DAVID & ANINA M	PFEIFFER, DAVID & ANINA M	405 FOOTHILL DR	BLUE BELL, PA	4.6702
202	4.01	RHYNE, GEORGE W	RHYNE, GEORGE W	420 CHEWS LANDING RD	HADDONFIELD, NJ	6.3948
202	3.02	RHYNE, GEORGE W	RHYNE, GEORGE W	420 CHEWS LANDING RD	HADDONFIELD, NJ	6.448

BLOCK	LOT	Owners Name	Owners Name2	Owner Address 1	Owner Address 2	Elevation (NAVD88)
202	4.01	RHYNE, GEORGE W	RHYNE, GEORGE W	420 CHEWS LANDING RD	HADDONFIELD, NJ	6.4836
202	58	ROBERTSON, CAROLYN H, ETAL	10707 CORINTHIAN PL	174 NASSAU ST, #148	PRINCETON, NJ	5.913
202	57	ROBERTSON, CAROLYN H, ETAL	10707 CORINTHIAN PL	174 NASSAU ST, #148	PRINCETON, NJ	5.97
202	56	ROBERTSON, CAROLYN H, ETAL	10707 CORINTHIAN PL	174 NASSAU ST, #148	PRINCETON, NJ	5.9798
202	59	ROBERTSON, CAROLYN H, ETAL	10707 CORINTHIAN PL	174 NASSAU ST, #148	PRINCETON, NJ	6.0391
202	28	SCANLAN, GEORGENA S	SCANLAN, GEORGENA S	6 TODMORDEN LN	ROSE VALLEY, PA	4.8654
202	29	SCANLAN, GEORGENA S	SCANLAN, GEORGENA S	6 TODMORDEN LN	ROSE VALLEY, PA	6.379
202	28	SCANLAN, GEORGENA S	SCANLAN, GEORGENA S	6 TODMORDEN LN	ROSE VALLEY, PA	6.4496
202	3.01	SMITH, LAWRENCE J & CYNTHIA A	SMITH, LAWRENCE J & CYNTHIA A	7812 RUXWOOD RD	BALTIMORE, MD	6.448
202	2	SMITH, LAWRENCE J & CYNTHIA A	SMITH, LAWRENCE J & CYNTHIA A	7812 RUXWOOD RD	BALTIMORE, MD	6.4789
202	3.01	SMITH, LAWRENCE J & CYNTHIA A	SMITH, LAWRENCE J & CYNTHIA A	7812 RUXWOOD RD	BALTIMORE, MD	6.5268
202	1	SMITH, LAWRENCE J & CYNTHIA A	SMITH, LAWRENCE J & CYNTHIA A	7812 RUXWOOD RD	BALTIMORE, MD	6.6214
202	71	SNYDER FAMILY LTD PARTNERSHIP	SNYDER FAMILY LTD PARTNERSHIP	135 E ORANGE ST	LANCASTER, PA	6.3167
202	72.01	SNYDER FAMILY LTD PARTNERSHIP	SNYDER FAMILY LTD PARTNERSHIP	135 E ORANGE ST	LANCASTER, PA	6.3909
202	73	SNYDER, KEARNEY A & SUSIE T	SNYDER, KEARNEY A & SUSIE T	135 E ORANGE ST	LANCASTER, PA	5.1453
202	73	SNYDER, KEARNEY A & SUSIE T	SNYDER, KEARNEY A & SUSIE T	135 E ORANGE ST	LANCASTER, PA	6.2979
202	72.02	SNYDER, KEARNEY A & SUSIE T	SNYDER, KEARNEY A & SUSIE T	135 E ORANGE ST	LANCASTER, PA	6.3909
202	91.01	ULICHNEY, ANDREW & ANNIE	ULICHNEY, ANDREW & ANNIE	226 UPLAND WAY	WAYNE, PA	5.1514
202	91.01	ULICHNEY, ANDREW & ANNIE	ULICHNEY, ANDREW & ANNIE	226 UPLAND WAY	WAYNE, PA	6.1583
202	90	ULICHNEY, ANDREW & ANNIE	ULICHNEY, ANDREW & ANNIE	226 UPLAND WAY	WAYNE, PA	6.1611
202	91.01	ULICHNEY, ANDREW & ANNIE	ULICHNEY, ANDREW & ANNIE	226 UPLAND WAY	WAYNE, PA	6.1762
202	21	WHITING JR,RICHARD & DEBRA	WHITING JR,RICHARD & DEBRA	5 CAMBRIDGE RD	DOWNINGTOWN, PA	6.4017
202	21	WHITING JR,RICHARD & DEBRA	WHITING JR,RICHARD & DEBRA	5 CAMBRIDGE RD	DOWNINGTOWN, PA	6.4034
202	22	WHITING JR,RICHARD & DEBRA	WHITING JR,RICHARD & DEBRA	5 CAMBRIDGE RD	DOWNINGTOWN, PA	6.4034
202	40	WILKES, JAMES C & SANDRA L	WILKES, JAMES C & SANDRA L	9440 COLONNADE TRAIL	ALPHARETTA, GA	4.537
202	40	WILKES, JAMES C & SANDRA L	WILKES, JAMES C & SANDRA L	9440 COLONNADE TRAIL	ALPHARETTA, GA	6.3428
202	41	WILKES, JAMES C & SANDRA L	WILKES, JAMES C & SANDRA L	9440 COLONNADE TRAIL	ALPHARETTA, GA	6.3428
204.02	41	BOROUGH OF STONE HARBOR	114TH ST	95TH & SECOND AVE	STONE HARBOR, NJ	9
204.02	41	BOROUGH OF STONE HARBOR	114TH ST	95TH & SECOND AVE	STONE HARBOR, NJ	9.4
204.02	16	COHEN, ROBERT M & DEBORAH F	11201 THIRD AVE	1414 S. PENN SQUARE,#35D	PHILADELPHIA, PA	7.3823
204.02	15	COHEN, ROBERT M & DEBORAH F	11201 THIRD AVE	1414 S. PENN SQUARE,#35D	PHILADELPHIA, PA	7.3959
204.02	15	COHEN, ROBERT M & DEBORAH F	11201 THIRD AVE	1414 S. PENN SQUARE,#35D	PHILADELPHIA, PA	7.5122
204.02	25	ESTILL, ROBERT I	11219 THIRD AVE	2026 S QUEEN ST	YORK, PA	7.8085
204.02	26	ESTILL, ROBERT I	11219 THIRD AVE	2026 S QUEEN ST	YORK, PA	7.8545
204.02	10.02	GLATFELTER, GEO. H& ANNA	301 111TH ST	5715 COLONIAL VALLEY RD	SPRING GROVE, PA	7.3333
204.02	11	GLATFELTER, GEO. H& ANNA	301 111TH ST	5715 COLONIAL VALLEY RD	SPRING GROVE, PA	7.3333
204.02	12	GLATFELTER, GEO. H& ANNA	301 111TH ST	5715 COLONIAL VALLEY RD	SPRING GROVE, PA	7.3333
204.02	4	GRACE,JOHN C & MARY E	313 111TH ST	40 HARLOW CIR	MEDFORD, NJ	6.0157
204.02	5	GRACE,JOHN C & MARY E	313 111TH ST	40 HARLOW CIR	MEDFORD, NJ	6.0157
204.02	13	GRACE,JOHN C JR & MARY E	11113 THIRD AVE	40 HARLOW CIR	MEDFORD, NJ	7.3333
204.02	14	GRACE,JOHN C JR & MARY E	11113 THIRD AVE	40 HARLOW CIR	MEDFORD, NJ	7.3333
204.02	27	GRACE,JOHN C JR & MARY E	300 114TH ST	40 HARLOW CIR	MEDFORD, NJ	8.2452
204.02	28	GRACE,JOHN C JR & MARY E	300 114TH ST	40 HARLOW CIR	MEDFORD, NJ	8.3
204.02	27	GRACE,JOHN C JR & MARY E	300 114TH ST	40 HARLOW CIR	MEDFORD, NJ	8.3164
204.02	22	HAMILTON,B & L,&US TRUST,COTRUSTEES	11215 THIRD AVE	11215 THIRD AVENUE	STONE HARBOR, NJ	7.733
204.02	23	HAMILTON,B & L,&US TRUST,COTRUSTEES	11215 THIRD AVE	11215 THIRD AVENUE	STONE HARBOR, NJ	7.7416
204.02	24	HAMILTON,B & L,&US TRUST,COTRUSTEES	11215 THIRD AVE	11215 THIRD AVENUE	STONE HARBOR, NJ	7.8085
204.02	6	IVES, TERRENCE G	311 111TH ST	314 FRANKLIN COURT	MALVERN, PA	6.0157
204.02	7	IVES, TERRENCE G	311 111TH ST	314 FRANKLIN COURT	MALVERN, PA	6.0157
204.02	39	LAUTH, WILLIAM C & ANNA	318 114TH ST	318 114TH ST	STONE HARBOR, NJ	8.5818
204.02	39	LAUTH, WILLIAM C & ANNA	318 114TH ST	318 114TH ST	STONE HARBOR, NJ	8.5934
204.02	40	LAUTH, WILLIAM C & ANNA	318 114TH ST	318 114TH ST	STONE HARBOR, NJ	8.7213
204.02	39	LAUTH, WILLIAM C & ANNA	318 114TH ST	318 114TH ST	STONE HARBOR, NJ	9.0524
204.02	17	LIM, JAMES & ANN	11205 THIRD AVE	1294 FARM LN	BERWYN, PA	7.3823
204.02	18	LIM, JAMES & ANN	11205 THIRD AVE	1294 FARM LN	BERWYN, PA	7.3823
204.02	30	PESCATORE, SUSAN C	304 114TH ST	1820 REVERE RD	SOUTHAMPTON, PA	8.2589
204.02	29	PESCATORE, SUSAN C	304 114TH ST	1820 REVERE RD	SOUTHAMPTON, PA	8.2591
204.02	29	PESCATORE, SUSAN C	304 114TH ST	1820 REVERE RD	SOUTHAMPTON, PA	8.3
204.02	37	SALVO, JOHN P & ALICE E	314 114TH ST	344 KINGS HIGHWAY WEST	HADDONFIELD, NJ	8.584
204.02	38	SALVO, JOHN P & ALICE E	314 114TH ST	344 KINGS HIGHWAY WEST	HADDONFIELD, NJ	8.6238
204.02	37	SALVO, JOHN P & ALICE E	314 114TH ST	344 KINGS HIGHWAY WEST	HADDONFIELD, NJ	8.6705
204.02	37	SALVO, JOHN P & ALICE E	314 114TH ST	344 KINGS HIGHWAY WEST	HADDONFIELD, NJ	8.6725
204.02	2	SCOTT,ROBERT A & DIANA M, TTS	315 111TH ST	130 S 18TH ST #2302	PHILADELPHIA, PA	6.1404
204.02	3	SCOTT,ROBERT A & DIANA M, TTS	315 111TH ST	130 S 18TH ST #2302	PHILADELPHIA, PA	6.1404
204.02	31	SPRAGUE, THOMAS A & JUDITH A	308 114TH ST	725 WAVERLY ROAD	BRYN MAWR, PA	8.2589
204.02	31	SPRAGUE, THOMAS A & JUDITH A	308 114TH ST	725 WAVERLY ROAD	BRYN MAWR, PA	8.7049
204.02	32	SPRAGUE, THOMAS A & JUDITH A	308 114TH ST	725 WAVERLY ROAD	BRYN MAWR, PA	8.7243
204.02	33	SPRAGUE, THOMAS A & JUDITH A	308 114TH ST	725 WAVERLY ROAD	BRYN MAWR, PA	8.7243
204.02	20	VOGT, GARY PAUL, ETAL	11211 THIRD AVE	P.O.BOX 5	NEWTOWN SQUARE, PA	7.3148
204.02	19	VOGT, GARY PAUL, ETAL	11211 THIRD AVE	P.O.BOX 5	NEWTOWN SQUARE, PA	7.3394
204.02	19	VOGT, GARY PAUL, ETAL	11211 THIRD AVE	P.O.BOX 5	NEWTOWN SQUARE, PA	7.3823
204.02	21	VOGT, GARY PAUL, ETAL	11211 THIRD AVE	P.O.BOX 5	NEWTOWN SQUARE, PA	7.4357
204.02	9	WETTY, WM L & JUDITH P	307 111TH ST	868 SCHOLL RD	POTTSTOWN, PA	6.426
204.02	10.01	WETTY, WM L & JUDITH P	307 111TH ST	868 SCHOLL RD	POTTSTOWN, PA	6.426
204.02	8	WETTY, WM L & JUDITH P	307 111TH ST	868 SCHOLL RD	POTTSTOWN, PA	6.476
204.02	35	WINFIELD DEVELOPERS LLC	312 114TH ST	359 POND VIEW DR	DEVON, PA	8.6504
204.02	36	WINFIELD DEVELOPERS LLC	312 114TH ST	359 POND VIEW DR	DEVON, PA	8.6504
204.02	34	WINFIELD DEVELOPERS LLC	312 114TH ST	359 POND VIEW DR	DEVON, PA	8.6987
204.02	34	WINFIELD DEVELOPERS LLC	312 114TH ST	359 POND VIEW DR	DEVON, PA	8.7243
208	9	11701 PARADISE, LLC	11701 PARADISE DR	2022 W JOPPA RD	LUTHERVILLE, MD	7.8419
208	10	11701 PARADISE, LLC	11701 PARADISE DR	2022 W JOPPA RD	LUTHERVILLE, MD	7.9045
208	9	11701 PARADISE, LLC	11701 PARADISE DR	2022 W JOPPA RD	LUTHERVILLE, MD	7.9286
208	39	313 114TH STREET, LLC	313 114TH ST	63 FARRIER LN	NEWTOWN SQUARE, PA	8.4642
208	40	313 114TH STREET, LLC	313 114TH ST	63 FARRIER LN	NEWTOWN SQUARE, PA	8.4642
208	37	313 114TH STREET, LLC	313 114TH ST	63 FARRIER LN	NEWTOWN SQUARE, PA	8.5163
208	38	313 114TH STREET, LLC	313 114TH ST	63 FARRIER LN	NEWTOWN SQUARE, PA	8.5163
208	37	313 114TH STREET, LLC	313 114TH ST	63 FARRIER LN	NEWTOWN SQUARE, PA	8.7749
208	24	BEVEVINO, MARK A & LYNN	11513 PARADISE DR	10 TREBLE LANE	MALVERN, PA	7.9114
208	23	BEVEVINO, MARK A & LYNN	11513 PARADISE DR	10 TREBLE LANE	MALVERN, PA	7.9142
208	30	BIRKETT,J & VICK,N,TTEES,ETAL	11501 PARADISE DR	1369 E OREGON RD	LITITZ, PA	7.6147
208	29	BIRKETT,J & VICK,N,TTEES,ETAL	11501 PARADISE DR	1369 E OREGON RD	LITITZ, PA	7.7092
208	30	BIRKETT,J & VICK,N,TTEES,ETAL	11501 PARADISE DR	1369 E OREGON RD	LITITZ, PA	7.7271
208	41	BOROUGH OF STONE HARBOR	114TH ST	95TH & SECOND AVE	STONE HARBOR, NJ	8.5
208	5	COSTANZA,JOHN A & DONNA M,TTEES	11709 PARADISE DR	215 WESTMONT AVE	HADDONFIELD, NJ	7.7895
208	6	COSTANZA,JOHN A & DONNA M,TTEES	11709 PARADISE DR	215 WESTMONT AVE	HADDONFIELD, NJ	7.9226
208	18	DOAN, RICHARD A & JOAN H, TRUSTEES	11605 PARADISE DR	122 LAKESHORE DR,APT. 532	NORTH PALM BEACH, FL	7.9709
208	17	DOAN, RICHARD A & JOAN H, TRUSTEES	11605 PARADISE DR	122 LAKESHORE DR,APT. 532	NORTH PALM BEACH, FL	8.0161
208	21	FROST, STEPHEN	11517 PARADISE DR	1061 DEKALB PIKE,STE 102	BLUE BELL, PA	7.9226
208	22	FROST, STEPHEN	11517 PARADISE DR	1061 DEKALB PIKE,STE 102	BLUE BELL, PA	7.9392
208	33	GOLDBERG, CY & CATHERINE M	305 114TH ST	305 114TH STREET	STONE HARBOR, NJ	7.7202
208	34	GOLDBERG, CY & CATHERINE M	305 114TH ST	305 114TH STREET	STONE HARBOR, NJ	7.75
208	19	HAND, ARDEN W EST.OF & ANNE P	11601 PARADISE DR	11601 PARADISE DR	STONE HARBOR, NJ	7.9887
208	20	HAND, ARDEN W EST.OF & ANNE P	11601 PARADISE DR	11601 PARADISE DR	STONE HARBOR, NJ	8.0234
208	15	KOCHANSKI, GERALD J JR & GRACE D	11609 PARADISE DR	54 MOHAWK TR	WESTFIELD, NJ	7.9529
208	15	KOCHANSKI, GERALD J JR & GRACE D	11609 PARADISE DR	54 MOHAWK TR	WESTFIELD, NJ	7.9586
208	16	KOCHANSKI, GERALD J JR & GRACE D	11609 PARADISE DR	54 MOHAWK TR	WESTFIELD, NJ	7.9586
208	13	MARKLE, THOMAS TRUSTEE	11613 PARADISE DR	15141 CAPTIVA DR, POB 866	CAPTIVA, FL	7.8976
208	14	MARKLE, THOMAS TRUSTEE	11613 PARADISE DR	15141 CAPTIVA DR, POB 866	CAPTIVA, FL	7.9437
208	28	MAY,JOSEPH & DEBRA	11505 PARADISE DR	2542 WHITEHORSE RD	BERWYN, PA	7.6326
208	27	MAY,JOSEPH & DEBRA	11505 PARADISE DR	2542 WHITEHORSE RD	BERWYN, PA	7.699
208	2	MYERS, MARTIN L JR & PATRICIA A	11717 PARADISE DR	310 MONROE ST	MECHANICSBURG, PA	7.7634
208	1	MYERS, MARTIN L JR & PATRICIA A	11717 PARADISE DR	310 MONROE ST	MECHANICSBURG, PA	7.7756
208	32	OUNSWORTH, JOHN	301 114TH ST	301 114TH ST	STONE HARBOR, NJ	7.8819

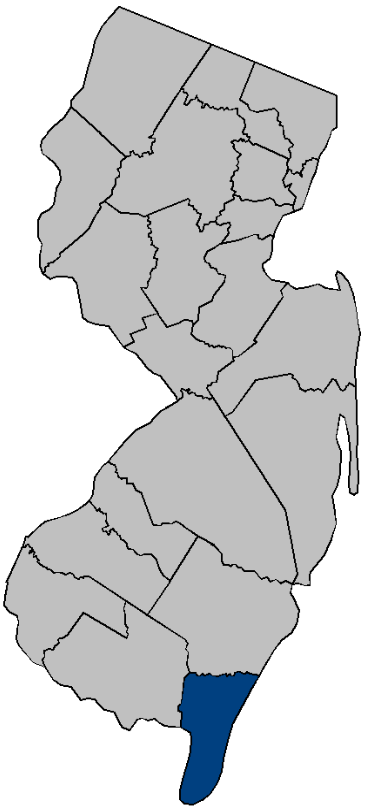
BLOCK	LOT	Owners Name	Owners Name2	Owner Address 1	Owner Address 2	Elevation (NAVD88)
208	31	OUNSWORTH, JOHN	301 114TH ST	301 114TH ST	STONE HARBOR, NJ	7.9478
208	3	PARADISE BAY, LLC	11713 PARADISE DR	510 FEHELEY DR	KING OF PRUSSIA, PA	7.7853
208	4	PARADISE BAY, LLC	11713 PARADISE DR	510 FEHELEY DR	KING OF PRUSSIA, PA	7.7853
208	11	PETERS,JOHN & CHERYL	11617 PARADISE DR	2615 HOUGHTON LN	MACUNGIE, PA	7.9045
208	12	PETERS,JOHN & CHERYL	11617 PARADISE DR	2615 HOUGHTON LN	MACUNGIE, PA	7.939
208	7	REGER, PHYLLIS	11705 PARADISE DR	11705 PARADISE DR	STONE HARBOR, NJ	7.847
208	8	REGER, PHYLLIS	11705 PARADISE DR	11705 PARADISE DR	STONE HARBOR, NJ	7.847
208	35	SANDMEYER, RONALD P JR & ALICE CARR	309 114TH ST	340 KINGS HIGHWAY WEST	HADDONFIELD, NJ	8.4578
208	36	SANDMEYER, RONALD P JR & ALICE CARR	309 114TH ST	340 KINGS HIGHWAY WEST	HADDONFIELD, NJ	8.4578
208	26	SCHELLENGER, HENRY E II & JULIE J	11509 PARADISE DR	1 JORROCKS LANE	MALVERN, PA	7.7536
208	26	SCHELLENGER, HENRY E II & JULIE J	11509 PARADISE DR	1 JORROCKS LANE	MALVERN, PA	7.7954
208	25	SCHELLENGER, HENRY E II & JULIE J	11509 PARADISE DR	1 JORROCKS LANE	MALVERN, PA	7.9114
209	8	CALIO, NICHOLAS A & ROSELYNN	11845 PARADISE DR	14 BOMACA DR	DOYLESTOWN, PA	6.7739
209	7	CALIO, NICHOLAS A & ROSELYNN	11845 PARADISE DR	14 BOMACA DR	DOYLESTOWN, PA	6.8153
209	1	CARACCIOLO,KATHRYN F,ETAL,CO-TTEES	11861 PARADISE DR	11861 PARADISE DR	STONE HARBOR, NJ	7.3515
209	1	CARACCIOLO,KATHRYN F,ETAL,CO-TTEES	11861 PARADISE DR	11861 PARADISE DR	STONE HARBOR, NJ	7.4103
209	1	CARACCIOLO,KATHRYN F,ETAL,CO-TTEES	11861 PARADISE DR	11861 PARADISE DR	STONE HARBOR, NJ	7.4942
209	16	COONEY,JOHN W & JUDITH M,TTEES	11829 PARADISE DR	13627 UNION VILLAGE CIR	CLIFTON, VA	6.7387
209	15	COONEY,JOHN W & JUDITH M,TTEES	11829 PARADISE DR	13627 UNION VILLAGE CIR	CLIFTON, VA	6.7451
209	16	COONEY,JOHN W & JUDITH M,TTEES	11829 PARADISE DR	13627 UNION VILLAGE CIR	CLIFTON, VA	7.5369
209	3	FOX, MARYANN	11853 PARADISE DR	58 GUN CLUB DRIVE	SHELDON, SC	7.2743
209	4	FOX, MARYANN	11853 PARADISE DR	58 GUN CLUB DRIVE	SHELDON, SC	7.2773
209	4	FOX, MARYANN	11853 PARADISE DR	58 GUN CLUB DRIVE	SHELDON, SC	7.3141
209	25	GUBANICH, JOHN A & ALMA D	11809 PARADISE DR	6 GALICIA DR	PHOENIXVILLE, PA	7.2031
209	26	GUBANICH, JOHN A & ALMA D	11809 PARADISE DR	6 GALICIA DR	PHOENIXVILLE, PA	7.259
209	6	HARR, KATHLEEN K & J HUGH	11849 PARADISE DR	158 MEADOWVIEW CT	LANGHORNE, PA	6.8153
209	5	HARR, KATHLEEN K & J HUGH	11849 PARADISE DR	158 MEADOWVIEW CT	LANGHORNE, PA	7.2773
209	6	HARR, KATHLEEN K & J HUGH	11849 PARADISE DR	158 MEADOWVIEW CT	LANGHORNE, PA	7.2971
209	10	HAUCH, ELIZABETH J, TRUSTEE	11841 PARADISE DR	15628 WHITNEY LN	NAPLES, FL	6.7248
209	9	HAUCH, ELIZABETH J, TRUSTEE	11841 PARADISE DR	15628 WHITNEY LN	NAPLES, FL	6.7739
209	28	HEILIG, WILLIAM W & LOUISE H	11805 PARADISE DR	924 WINDING LA	MEDIA, PA	7.211
209	27	HEILIG, WILLIAM W & LOUISE H	11805 PARADISE DR	924 WINDING LA	MEDIA, PA	7.259
209	13	HOOPES, KEVIN D & BARBARA J	11833 PARADISE DR	306 WESTMONT AVE	WESTMONT, NJ	6.6397
209	14	HOOPES, KEVIN D & BARBARA J	11833 PARADISE DR	306 WESTMONT AVE	WESTMONT, NJ	6.7451
209	2	MAYER, LAWRENCE J & DOREEN M	11857 PARADISE DR	617 ANDOVER RD	NEWTOWN SQUARE, PA	7.399
209	2	MAYER, LAWRENCE J & DOREEN M	11857 PARADISE DR	617 ANDOVER RD	NEWTOWN SQUARE, PA	7.4592
209	2	MAYER, LAWRENCE J & DOREEN M	11857 PARADISE DR	617 ANDOVER RD	NEWTOWN SQUARE, PA	7.4831
209	2	MAYER, LAWRENCE J & DOREEN M	11857 PARADISE DR	617 ANDOVER RD	NEWTOWN SQUARE, PA	7.4865
209	11	MIRAGLIA, JULIAN V & BETSY J	11837 PARADISE DR	11837 PARADISE DRIVE	STONE HARBOR, NJ	6.7248
209	12	MIRAGLIA, JULIAN V & BETSY J	11837 PARADISE DR	11837 PARADISE DRIVE	STONE HARBOR, NJ	6.7248
209	21	PARADISE DRIVE LLC @ N. GASSAWAY	11817 PARADISE DR	6800 30TH AVE NE	SEATTLE, WA	7.5136
209	22	PARADISE DRIVE LLC @ N. GASSAWAY	11817 PARADISE DR	6800 30TH AVE NE	SEATTLE, WA	7.5136
209	17	STONE HARBOR LAND HOLDINGS LLC	11825 PARADISE DR	745 W MONTGOMERY AVE	WILDWOOD, NJ	7.5278
209	18	STONE HARBOR LAND HOLDINGS LLC	11825 PARADISE DR	745 W MONTGOMERY AVE	WILDWOOD, NJ	7.5769
209	30	WARREN, VANETTA B	11801 PARADISE DR	219 S VIEW DR	CHERRY HILL, NJ	7.0218
209	29	WARREN, VANETTA B	11801 PARADISE DR	219 S VIEW DR	CHERRY HILL, NJ	7.1086
209	30	WARREN, VANETTA B	11801 PARADISE DR	219 S VIEW DR	CHERRY HILL, NJ	7.1207
209	19	WEAVER,JEAN W & JUDITH W QUINN	11821 PARADISE DR	4460 SE COVENTRY LANE	STUART, FL	7.5737
209	20	WEAVER,JEAN W & JUDITH W QUINN	11821 PARADISE DR	4460 SE COVENTRY LANE	STUART, FL	7.6053
209	24	WEISSENBERGER,GUNTRAM/WESTOVER CO	11813 PARADISE DR	550 AMERICAN AVE, STE.1	KING OF PRUSSIA, PA	7.4491
209	23	WEISSENBERGER,GUNTRAM/WESTOVER CO	11813 PARADISE DR	550 AMERICAN AVE, STE.1	KING OF PRUSSIA, PA	7.4938

FEMA: Flood Insurance Study

FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUME 1 OF 1



CAPE MAY COUNTY, NEW JERSEY

(ALL JURISDICTIONS)

COMMUNITY NAME	COMMUNITY NUMBER
AVALON, BOROUGH OF	345279
CAPE MAY, CITY OF	345288
CAPE MAY POINT, BOROUGH OF	345289
DENNIS, TOWNSHIP OF	340552
MIDDLE, TOWNSHIP OF	340154
NORTH WILDWOOD, CITY OF	345308
OCEAN CITY, CITY OF	345310
SEA ISLE CITY, CITY OF	345318
STONE HARBOR, BOROUGH OF	345323
UPPER, TOWNSHIP OF	340159
WEST CAPE MAY, BOROUGH OF	340160
WEST WILDWOOD, BOROUGH OF	345328
WILDWOOD, CITY OF	345329
WILDWOOD CREST, BOROUGH OF	345330
WOODBINE, BOROUGH OF	340164

U.S. DEPARTMENT OF HOMELAND SECURITY

FEMA

Effective:

OCTOBER 5, 2017

FLOOD INSURANCE STUDY NUMBER

34009CV000A

Version Number 2.1.3.0

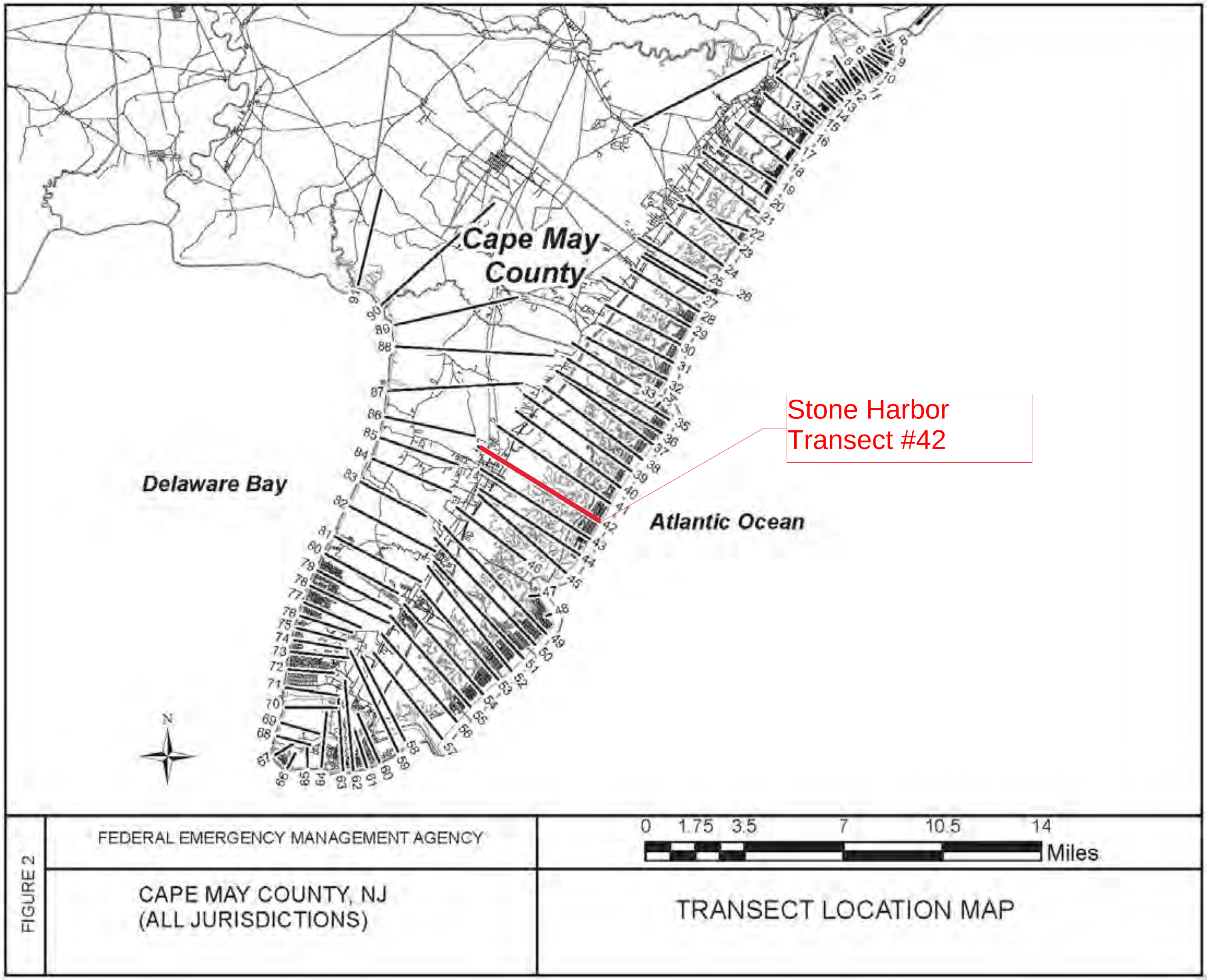


FIGURE 2 – TRANSECT LOCATION MAP

TABLE 2 – TRANSECT DATA TABLE - continued

Flood Source	Transect		Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations[1] (ft NAVD88) Range of Stillwater Elevations[2] (ft NAVD88)			
	Number	Coordinates	Significant Wave Height	Peak Wave Period	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Intracoastal Waterway	33	N 39.120479 W 74.721435	2.73	6.58	6.3 6.2 - 7.3	8.1 7.8 - 8.3	8.8 8.7 – 9.0	10.6 10.2 - 10.7
Atlantic Ocean	34	N 39.113737 W 74.712414	5.88	11.00	6.5 5.1 - 6.5	8.2 7.8 - 8.2	9.0 8.4 - 9	11.2 10 - 11.2
Atlantic Ocean	35	N 39.105007 W 74.706657	10.01	12.87	6.5 5.6 - 6.5	8.4 7.7 - 8.4	9.3 8.4 - 9.3	12.0 9.9 – 12.0
Atlantic Ocean	36	N 39.098274 W 74.711759	10.48	13.01	6.5 5.8 - 7.2	8.4 7.3 - 8.6	9.2 8.3 - 9.4	12.0 9.8 - 12.1
Atlantic Ocean	37	N 39.092219 W 74.717624	11.76	12.44	6.5 5 - 7.1	8.4 7.3 - 8.4	9.2 8.3 - 9.2	12.0 9.7 - 12.3
Atlantic Ocean	38	N 39.084966 W 74.725178	11.72	12.12	6.4 5.5 - 7.4	8.3 7.6 - 9.8	9.1 8.2 - 9.7	11.9 9.9 - 16.4
Atlantic Ocean	39	N 39.078778 W 74.731654	11.30	12.25	6.4 5.7 - 6.5	8.3 7.3 - 8.8	9.1 8.1 - 9.8	11.9 9.7 - 12.6
Atlantic Ocean	40	N 39.070762 W 74.739830	11.52	12.40	6.5 5.4 - 7.2	8.4 7.4 - 8.5	9.2 8.1 - 9.3	12.0 9.7 - 12.2
Atlantic Ocean	41	N 39.062590 W 74.746335	12.55	12.48	6.6 10-YEAR	8.5 50-YEAR	9.2 100-YEAR	12.1 500-YEAR
Atlantic Ocean	42	N 39.053152 W 74.753522	12.82	12.45	6.5 5.8 - 7.3	8.4 7.5 - 8.4	9.2 8.2 - 9.2	12.1 9.5 - 12.1
Atlantic Ocean	43	N 39.044690 W 74.760575	12.76	12.39	6.6 5.7 - 6.8	8.4 7.5 - 8.4	9.2 8.1 - 9.2	12.1 9.6 - 12.1
Atlantic Ocean	44	N 39.036715 W 74.767478	12.12	13.01	6.6 4.9 - 6.9	8.4 7.2 - 8.5	9.2 8.1 - 9.3	12.1 9.6 - 12.2
Atlantic Ocean	45	N 39.027683 W 74.777048	7.21	13.61	6.5 6.1 - 7.2	8.3 7.8 - 8.3	9.1 8.6 - 9.1	11.6 10.2 - 11.6
Grassy Sound Channel	46	N 39.034533 W 74.803068	2.72	2.52	6.3 6.1 - 7.3	8.1 7.9 - 8.3	8.8 8.8 – 9.0	10.6 10.4 - 10.8
Atlantic Ocean	47	N 39.016614 W 74.794122	4.16	14.70	6.6 5.9 - 6.6	8.4 7.4 - 8.4	9.2 8.2 - 9.2	11.9 9.7 - 11.9
Atlantic Ocean	48	N 39.006725 W 74.787193	6.06	13.62	6.6 6.4 - 6.7	8.4 8 - 8.5	9.1 8.7 - 9.3	11.8 10.9 - 12
Atlantic Ocean	49	N 38.996845 W 74.790953	7.78	13.75	6.3 5.7 - 7.9	8.1 7.7 - 8.4	8.9 8.4 - 9.1	11.8 9.8 - 11.9

[1]Stillwater elevations include the contribution from wave setup.

[2]For transects with a constant stillwater elevation, only one number is provided to represent both the starting value and the range.

FEMA NFIP: Community Rating System

National Flood Insurance Program

Community Rating System

A Local Official's Guide to
Saving Lives, Preventing Property Damage, and
Reducing the Cost of Flood Insurance

FEMA B 573 / 2018

FEMA

The Community Rating System Works

Every year, flooding causes hundreds of millions of dollars' worth of damage to homes and businesses around the country. Standard homeowners and commercial property insurance policies do not cover flood losses. To meet the need for this vital coverage, the Federal Emergency Management Agency (FEMA) administers the National Flood Insurance Program (NFIP).

The NFIP offers reasonably priced flood insurance to all properties in communities that comply with minimum standards for floodplain management.

The NFIP's Community Rating System (CRS) credits community efforts beyond those minimum standards by reducing flood insurance premiums for the community's property owners. The CRS is similar to—but separate from—the private insurance industry's programs that grade communities on the effectiveness of their fire suppression and building code enforcement efforts.

CRS discounts on flood insurance premiums range from 5% up to 45% (see Table 1), based on CRS credit points that are awarded to communities. The discounts provide an incentive for communities to implement new flood protection activities that can help save lives and property when a flood occurs.

The CRS provides credit under 19 public information and floodplain management activities described in the *CRS Coordinator's Manual.*

You're probably already doing many of these activities. To get credit, community officials will need to prepare documentation that verifies these efforts.

The CRS assigns credit points for each activity. Table 2 lists the activities and the possible number of credit points for each one. The table also shows the average number of credit points communities earn for each activity. These averages may give you a better indication than the maximums of what your community can expect.

To be eligible for a CRS discount, your community must do Activity 310, Elevation Certificates. If you're a designated repetitive loss community, you must also do Activity 510, Floodplain Management Planning. All other activities are optional.

Based on the total number of points your community earns, the CRS assigns you to one of ten classes. Your discount on flood insurance premiums is based on your class.

For example, if your community earns 4,500 points or more, it qualifies for Class 1, and property owners in the in the Special Flood Hazard Area (SFHA) get a 45% discount on their insurance premiums. If your community earns as little as 500 points, it's in Class 9, and property owners in the SFHA get a 5% discount. If a community does not apply or fails to receive at least 500 points, it's in Class 10, and property owners get no discount.

Table 1, below, shows the number of points required for each class and the corresponding discount.

Table 1.

How much discount property owners in your community can get

Rate Class	Discount for SFHA*	Discount for Non-SFHA**	Credit Points Required
1	45%	10%	4,500 +
2	40%	10%	4,000–4,499
3	35%	10%	3,500–3,999
4	30%	10%	3,500–3,499
5	25%	10%	3,000–2,999
6	20%	10%	2,500–2,499
7	15%	5%	1,500–1,999
8	10%	5%	1,000–1,499
9	5%	5%	500–999
10	0	0	0–499

* Special Flood Hazard Area

** Preferred Risk Policies are available only in B, C, and X Zones for properties that are shown to have a minimal risk of flood damage. The Preferred Risk Policy does not receive premium rate credits under the CRS because it already has a lower premium than other policies. Although they are in SFHAs, Zones AR and A99 are limited to a 5% discount. Premium reductions are subject to change.

Table 2.

What You Can Do to Get Credit

The CRS grants credit for 19 different activities that fall into four series:

Series 300	Public Information	Maximum Points*	Average Points *
	This series credits programs that advise people about the flood hazard, flood insurance, and ways to reduce flood damage. The activities also provide data insurance agents need for accurate flood insurance rating.		
310	**Elevation Certificates** • Maintain FEMA elevation certificates for new construction in the floodplain. (At a minimum, a community must maintain certificates for buildings built after the date of its CRS application.)	116	38
320	**Map Information Service** • Provide Flood Insurance Rate Map information to those who inquire, and publicize this service.	90	73
330	**Outreach Projects** • Distribute outreach projects with messages about flood hazards, flood insurance, flood protection measures, and/or the natural and beneficial functions of floodplains.	350	87
340	**Hazard Disclosure** • Real estate agents advise potential purchasers of flood-prone property about the flood hazard. • Regulations require notice of the hazard.	80	14
350	**Flood Protection Information** • The public library and/or community's website maintains references on flood insurance and flood protection.	125	38
360	**Flood Protection Assistance** • Give inquiring property owners technical advice on how to protect their buildings from flooding, and publicize this service.	110	55
370	**Flood Insurance Promotion** • Assess flood insurance coverage within the community and implement a plan to promote flood insurance.	110	39
	Series 300 Total	981	3448

*Maximum and average points are subject to change. See the current *CRS Coordinator's Manual* for the latest information.

Series 400	Mapping & Regulations	Maximum Points*	Average Points *
	This series credits programs that limit floodplain development or provide increased protection to new and existing development.		
410	**Floodplain Mapping** • Develop new flood elevations, floodway delineations, wave heights, or other regulatory flood hazard data for an area not mapped in detail by the flood insurance study. • Have a more restrictive mapping standard.	802	60
420	**Open Space Preservation** • Guarantee that currently open public or private floodplain parcels will be kept free from development. • Zone the floodplain for minimum lot sizes of 5 acres or larger.	2,020	509
430	**Higher Regulatory Standards** • Limit new buildings and/or fill in the floodplain. • Require freeboard. • Require soil tests or engineered foundations. • Require compensatory storage. • Require coastal construction standards in AE Zones. • Have regulations tailored to protect critical facilities or areas subject to special flood hazards (for example, alluvial fans, ice jams, subsidence, or coastal erosion).	2,042	270
440	**Flood Data Maintenance** • Keep flood and property data on computer records. • Use better base maps. • Maintain elevation reference marks.	222	115
450	**Stormwater Management** • Regulate new development throughout the watershed to ensure that post-development runoff is no greater than pre-development runoff. • Regulate new construction to minimize soil erosion and protect or improve water quality.	755	132
	Series 400 Total	5,841	1,086

Series 500	Flood Damage Reduction	Maximum Points*	Average Points *
	This series credits programs that reduce the flood risk to existing development.		
510	**Floodplain Management Planning** • Prepare, adopt, implement, and update a comprehensive flood hazard mitigation plan using a standard planning process. • Prepare an analysis of the repetitive flood loss areas within the community. *Note: category C repetitive loss communities must receive credit for either the floodplain management plan or the repetitive loss area analysis, above.* • Prepare, adopt, implement, and update a plan to protect natural functions within the community's floodplain.	622	175
520	**Acquisition and Relocation** • Acquire and/or relocate floodprone buildings so that they are out of the floodplain.	2,250	195
530	**Flood Protection** • Protect existing floodplain development by floodproofing, elevation, or minor flood control projects.	1,600	73
540	**Drainage System Maintenance** • Have a program for and conduct annual inspections of all channels and detention basins; remove debris as needed.	570	218
	Series 500 Total	5,042	661

Series 600	Flood Preparedness	Maximum Points*	Average Points *
	This series credits flood warning, levee safety, and dam safety projects.		
610	**Flood Warning and Response** • Provide early flood warnings to the public, and have a detailed flood response plan keyed to flood crest predictions.	395	254
620	**Levees** • Annually inspect and maintain existing levees; have a system for recognizing the threat of levee failure and/or overtopping, disseminating warnings, and providing emergency response; and coordinate with operators of critical facilities.	235	157
630	**Dams** • Have a high-hazard-potential dam that could affect the community; have a system for recognizing the threat of dam failure, disseminating warnings, planning and practicing emergency responses; and coordinating with operators of critical facilities.	160	35
	Series 600 Total	790	446
	All Series Total	12,654	2,537

Additional Credit

Your community can get additional credit for regulating development outside the SFHA to the same standards as development inside the SFHA. There is also credit for assessing future flood conditions, including the impacts of future development, urbanization, and changing weather patterns. See the *CRS Coordinator's Manual* for full details.

Many communities can qualify for what the CRS calls "state-based credit," based on the activities or regulations a state or regional agency implements within communities. For example, some states have disclosure laws eligible for credit under Activity 340 (Hazard Disclosure). Any community in those states can receive the state-based credit.

Your community may want to consider floodplain management activities not listed in the *CRS Coordinator's Manual.* You should evaluate these activities for their ability to increase public safety, reduce property damage, avoid economic disruption and loss, and protect the environment. In addition, you can request a review of these activities to determine whether they could be eligible for CRS credit. FEMA welcomes innovative ways to prevent or reduce flood damage.

How to Apply

Participation in the CRS is voluntary. If your community is in full compliance with the rules and regulations of the NFIP, you may apply. There's no application fee, and all CRS publications are free.

Your community's chief executive officer (your mayor, city manager, or other top official) must appoint a CRS coordinator to serve as the liaison between the community and FEMA. The coordinator should know the operations of all departments that deal with floodplain management and public information. And the coordinator should be able to speak for the community's chief executive officer.

To begin the application process, your community submits a letter of interest to your FEMA Regional Office and documents that you are implementing floodplain management activities that warrant at least 500 CRS credit points. On the CRS Resources website (www.CRSresources.org) you can find a sample letter; the CRS Quick Check, a tool that helps you assess your community's possible credit points; and further instructions.

You may also want to download from that website a copy of the *CRS Coordinator's Manual,* which describes the program in full and provides specific information, including eligible activities, required documentation, and resources for assistance.

Help is also available through the contact information below.

CRS-related materials and many more resources are available at the CRS Resources website and on FEMA's website (https://www.fema.gov/national-flood-insurance-program-community-rating-system).

After your community applies for a CRS classification, the CRS will verify the information and arrange for flood insurance premium discounts.

For more info, write, phone, or fax:

NFIP/CRS
P.O. Box 501016
Indianapolis, IN 46250-1016
(317) 848-2898
Fax: (201) 748-1936
e-mail: nfipcrs@iso.com

Bulkhead Ordinance

Chapter 200

BULKHEADS, CONSTRUCTION AND REPAIR OF

GENERAL REFERENCES

Building Construction — See Ch. 178.

Bulkhead and Dock Construction — See Ch. 199.

§ 200-1. Purpose.

It is the purpose and intent of this chapter to establish uniform regulations for the construction, reconstruction, renovation or repair of existing or new bulkheads within the Borough of Stone Harbor.

§ 200-2. Compliance.

A. All bulkheads that are newly constructed, reconstructed, replaced, renovated and repaired shall be done in accordance with the requirements of this chapter.

B. Additionally, any property owner that demolishes an existing building or proposes to make a substantial improvement to an existing building shall be required to bring the existing bulkhead into compliance with this chapter. "Substantial improvement" means any reconstruction, rehabilitation, addition or other improvement to a structure, the total cost of which equals or exceeds 40% of the market value of the structure before the start of construction of the improvement.

§ 200-3. Permits.

A. Permit required. No person or legal entity shall construct, reconstruct, renovate or repair any bulkhead within the Borough of Stone Harbor without first obtaining and having in possession a valid permit to do such work that has been issued by the office of the Construction Code Official upon approval of the Borough Engineer.

B. Permit application.

(1) Applications for bulkhead permits shall be made on an application form obtained from the Construction Code Official. Completed applications shall be returned to the Construction Code Official with the required fee along with the following items in quadruplicate:

(a) Plans and specifications of the bulkhead that have been prepared, signed and sealed by a New Jersey licensed professional engineer.

(b) A property survey, prepared, signed and sealed by a New Jersey licensed professional land surveyor.

(c) Authorization for the New Jersey Department of Environmental Protection and any other state or federal agency having jurisdiction over the property affected by the proposed work.

(d) Proof of notice of application to adjoining property owners.

(2) The Borough Engineer may relax or waive any or all of the requirements that are set forth above within the application for a permit pertains to reconstruction, renovation or repair work for which the cost of completion is less than $5,000; however, in relaxing or waiving any such requirements, the Borough Engineer shall have the authority to require the submission of such plans, drawings and contract documents as the Engineer, in his sole and absolute discretion, determines will accurately depict the reconstruction, renovations or repair work to be performed.

(3) The Borough Engineer shall review the application and plans and grant or deny the application within 20 business days upon receipt of a complete application.

C. Notice of application.

(1) Notice of application for a bulkhead permit, the form of which is to be obtained from the Construction Code Official, shall be given by the applicant to the owners of all real property, as shown on the current tax duplicate, within 100 feet and whose property is adjacent to the same or similar tidal waters as is the applicant's property; provided that this requirement shall be deemed satisfied by notice to the condominium association, in the case of any unit owner whose unit has a unit above or below it; or horizontal property regime, in the case of any co-owner whose apartment has an apartment above or below it. Notice shall be given by mailing a copy thereof by regular, first-class mail and by certified mail to the property owner at his address as shown on the said current tax duplicate. Notice to a partnership owner may be made by service upon any partner. Notice to a corporate owner may be made by service upon its president, a vice president, secretary or other person authorized by appointment or by law to accept service on behalf of the corporation. Notice to a condominium association, horizontal property regime, community trust or homeowners' association because of its ownership of common elements or areas located within 100 feet of the property which is the subject of the bulkhead application may be made in the same manner as to a corporation without further notice to unit owners, co-owners or homeowners on account of such common elements or areas.

(2) Upon written request of an applicant, the Tax Assessor, within seven days, shall make and certify a list from said current tax duplicate of names and addresses of owners to whom the applicant

is required to give notice pursuant to this section. A sum not to exceed $0.25 per name or $10, whichever is greater, may be charged for preparation of such list. The Tax Assessor shall also verify the certified mailing costs.

D. Permit issuance. Upon receipt by the Construction Code Official of an application for a bulkhead permit, the Construction Code Official immediately shall transmit copies of the application and all accompanying documents to the Borough Engineer for review. No permit shall be issued by the Construction Code Official unless the permit is approved for issuance by the Borough Engineer. In the event that, upon review of the permit application, deficiencies are noted by the Borough Engineer, the Construction Code Official shall be informed of the nature of the deficiencies and the Construction Code Official shall provide written notice, by regular first-class mail, of the deficiencies to the applicant at the address set forth on the application and the applicant then shall be afforded the opportunity to correct any application deficiencies.

E. Permit fee. The permit fee shall be calculated in the following manner:

(1) For new construction: $250 for the first 50 feet of bulkhead to be constructed, and thereafter, $15 per foot or any portion thereof.

(2) For renovation, reconstruction and repairs: $250 for the first 50 feet of bulkhead to be constructed, and thereafter, $15 per foot or any portion thereof.

F. Inspection fee escrow. The inspection fee shall be 5% of the estimated project cost (as determined by the Borough Engineer) or $500, whichever is greater. However, said inspection fee escrow shall not be charged if the bulkhead project is part of a Zoning or Planning Board approval for which an escrow is already required.

G. Appeal of permit denial. Any applicant aggrieved by the denial of a bulkhead permit may appeal the permit denial to Borough Council by submitting to the Construction Code Official written correspondence appealing the permit denial. Such written appeal correspondence briefly shall describe the reason for the appeal. Such written appeal correspondence shall be submitted to the Construction Code Official within 20 days of the permit denial. Upon receipt of the appeal correspondence, the Construction Code Official shall transmit to Borough Council copies of the permit application, all attachments thereto and any copies of any documents that have been generated by the Borough Engineer in connection with review of the permit application. Thereafter, the Construction Code Official shall schedule a date for the hearing of the appeal, and notice of the hearing date shall be provided to the permit applicant. In all instances the Construction Code Official shall endeavor to schedule the appeal hearing date not later than 30 days after receipt of the appeal correspondence. The hearing of the appeal shall be conducted by the Borough Council at a public meeting. The applicant shall be permitted to produce evidence to Borough Council in support of the permit application. Borough Council may consider evidence presented to it by the Borough Engineer or any other individual that Borough Council deems to have relevant information. The decision of Borough Council to approve or deny the permit application shall be through adoption of a formal resolution.

§ 200-4. Notification of commencement of construction; inspections.

A. The permittee shall provide to the Borough Engineer and to the Borough Zoning Officer notice of commencement of construction not less than two business days in advance of said commencement of construction. Not less than 14 days in advance of commencement of construction, the permittee shall provide notice of commencement of construction, on a form to be obtained from the Construction Code Official, to all property owners to whom the permittee would be required to provide notice of bulkhead permit application if the permittee were, at the time, making application for a bulkhead permit. Such notice shall be given in the same manner as is required for notices of permit application.

B. The Borough Engineer shall inspect the materials delivered to the job and verify that they are in conformance with the permit issued for that work, in size, quantity and quality. If such materials do not conform to permit requirements, they shall be marked as "rejected" and removed from the job site by the permittee and shall not be incorporated into the bulkhead construction.

C. The Borough Engineer shall make periodic visits to the job site to verify that the work is proceeding in accordance with permit requirements.

§ 200-5. Final inspection.

Prior to the backfilling of any bulkhead construction, reconstruction, renovation or repair, the Borough Engineer shall perform an inspection to ascertain that the bulkhead has been built pursuant to the plans that were submitted with the permit application. Written notice of project completion shall be given to the Borough Engineer and to the Borough Zoning Official within seven business days of substantial completion of the project, but prior to backfilling, and that written notification shall be accompanied by a certification from a licensed engineer or land surveyor of the elevations of the completed bulkhead height. If the Borough Engineer determines that the work that was performed pursuant to the bulkhead permit and the subject bulkhead fail to comply with the plans, drawings or documents that were submitted with the permit application or fail to comply with the provisions of this chapter, then written notice of final inspection failure shall be transmitted by the Borough Engineer by regular first-class mail to the permittee at the address set forth on the permit application. The notice of final inspection failure shall detail the reasons for inspection failure.

Permittees shall correct all deficiencies that resulted in final inspection failure within 20 days of the date of the written notice of final inspection failure. If, upon the expiration of those 20 days, the bulkhead is not approved upon inspection by the Borough Engineer then the permittee is deemed to be in violation of the duty to maintain and repair the subject bulkhead as established by this chapter.

§ 200-6. Bulkhead specification.

All bulkheads constructed, reconstructed, renovated or repaired within the Borough of Stone Harbor shall conform to the following minimum specifications:

A. All new bulkheads shall be designed by a New Jersey licensed professional engineer.

B. All piles shall have a butt diameter of not less than 12 inches and a tip diameter of eight inches.

C. All piles will be Douglas Fir or Southern Yellow Pine and shall be treated with an acceptable preservative for marine construction according to the latest American Wood Preservers' Association (AWPA) specifications.

D. Sheet piles shall be wood, steel or vinyl. Wales shall be Douglas Fir or Southern Yellow Pine. Wood sheet piles shall be a minimum of two inches thick. Wood sheet piles shall be constructed in two rows with staggered joints. All timber materials shall be treated with an acceptable preservative designed for use in a salt-water environment.

E. All components of the bulkhead system up to the minimum required elevation shall be constructed to be watertight. Watertight may include backfilling up against the landward side of the bulkhead, water stop sealants for steel and PVC sheet piles, continuous and solid landward capping and any other methods approved by the Borough Engineer.

F. All hardware shall be hot-dipped galvanized steel in accordance with latest standards for saltwater applications.

G. All outfall piping shall be fitted with a tide-control device that is approved by the Borough Engineer.

H. The means and methods for outfall piping extensions that are required to accommodate the new bulkhead shall be approved by the Borough Engineer.

I. Bulkhead construction, reconstruction, renovation or repair shall not adversely affect adjoining property.

J. All existing utilities shall be protected from damage during any work performed pursuant to a bulkhead permit. The bulkhead permittee shall be responsible for obtaining current utility markout from all appropriate state and local agencies prior to commencement of work.

K. Deviations from construction materials set forth herein are allowed so long as all specifications and technical data concerning the proposed construction material are submitted to the Borough and are approved in writing by the Borough Engineer. The use of any construction material that is not specifically set forth above or approved by the Borough Engineer is strictly prohibited.

L. All design materials herein shall be subject to the requirements of the NJDEP and USACOE.

§ 200-7. Height of bulkheads.

The top elevation of any bulkhead to be constructed or reconstructed shall be set at a minimum elevation of 8 feet NAVD 1988.

§ 200-8. Maintenance; duty to repair.

All bulkheads within the Borough of Stone Harbor shall be maintained in such a condition so that they shall pose no danger to the health, safety or welfare of the residents of the Borough of Stone Harbor or to public or private property within the Borough of Stone Harbor. Bulkheads shall be kept in a state of repair so as to prevent erosion or damage to abutting, adjacent or adjoining properties. Whenever a bulkhead has deteriorated or suffered damage to such a degree that a danger to the property or adjoining properties is present, the Borough Engineer or Zoning Official or Code Enforcement Officer shall notify the property owner, in writing, by regular first-class mail to the address that is set forth on the Borough's tax records, of the nature of the deterioration or damage and require the owner to make the necessary repairs. When notified by the Borough Engineering Inspector of a deteriorated bulkhead, a property owner shall submit a plan of corrective action to the Borough no later than 30 days from the receipt of this notice. Upon approval of the plan of corrective action by the Borough Bulkhead Engineer, the property owner shall complete all necessary repairs within 120 days. If permits are required from state or federal government agencies, such permits shall be immediately applied for upon receipts of Borough approval. Upon issuance of the bulkhead permit and approval of the plan of corrective action, the property owner immediately shall complete all necessary repairs. In the event that the property owner fails to submit a corrective action plan, fails to obtain a bulkhead permit to implement the corrective action plan or fails to implement the corrective action plan, the property owner shall be subject to the penalties set forth herein.

§ 200-9. Existing nonconforming bulkheads. [Amended 10-16-2018 by Ord. No. 1531]

A. Every bulkhead within the Borough of Stone Harbor shall be constructed to a minimum elevation of 8.00 feet NAVD 1988 no later than January 2050.

B. All existing nonconforming bulkheads will be required to be replaced or repaired per the duty to repair. An elevation survey was completed by the Stockton University Costal Research Center to determine bulkhead heights and will be used as a basis for bringing the nonconforming bulkheads into compliance. All bulkheads below elevation 5.5 feet NAVD 88 pose a significant threat to the flood frequency of the Borough and will be required to be structurally extended to elevation 6.2 feet NAVD 88, where possible, or replaced in accordance with the standards set forth in this chapter. Bulkheads requiring replacement will be completed in accordance with the following timetable (all elevations are in NAVD 88):

Height (feet)	**Years**
4.0 and below	2
4.1 to 4.5	4
4.6 to 5.0	6
5.1 to 5.5	8

§ 200-10. Violations and penalties. [Amended 10-16-2018 by Ord. No. 1531]

Any person violating any provision of this chapter, upon conviction thereof, shall be punished by a fine not exceeding $1,250 or by imprisonment for a term not exceeding 90 days, or both. A separate offense shall be deemed to be committed on each and every day during or on which a violation occurs or continues.

Lot Grading Ordinance

560 50 **Lot grading.**

[Added 10 16 2018 by Ord. No. 1532]

This § **560 50** shall not apply to any application for development which undergoes site plan review pursuant to Chapter **345**.

A. All lots shall be graded to prevent the accumulation of stormwater. Topsoil shall be provided and/or redistributed on the surface as cover and shall be stabilized with stones, seeding or planting. Grading plans shall be submitted with all zoning permit applications involving new construction; any alterations which increase the total impervious coverage by 5% or more of the total lot area and result in total impervious coverage that is 80% or more of the maximum permitted impervious coverage; installation of any impervious improvements of within four feet of a side or rear property line; any change in grade which alters the course of stormwater; or construction of any retention wall; for review and approval by the Borough's engineer. The plan shall conform to the following requirements:

(1) Wherever possible, the land shall be graded to maintain all existing drainage paths while directing stormwater to the street. In the event directing stormwater to the street will interfere with existing drainage paths involving adjacent properties, stormwater shall be directed to an existing drainage path or interior yard collection system designed in accordance with this chapter. Stormwater will not be permitted to run directly onto an adjacent property unless a preexisting drainage path is present; provided that in no event shall any construction result in an increase in runoff to adjacent properties.

(2) The minimum slope for lawns and disturbed areas shall be 1 1/2% and for smooth, hard-finished surfaces shall be 4/10 of 1%.

(3) The maximum grade for lawns and disturbed areas within five feet of a building shall be 10%, and for lawns and disturbed areas more than five feet from a building, 25%; except that, for the driveway the maximum grade shall be 15%.

(4) Retaining walls installed in slope-controlled areas shall be constructed of reinforced concrete or other reinforced masonry and shall be adequately designed by a New Jersey licensed professional engineer and detailed in the plan to carry all earth pressures, including any surcharges. The retaining walls shall be finished on all exposed faces. Where retaining walls are constructed of poured concrete or cinder block, they shall be faced with brick, stone, or stucco. The heights of retaining walls shall not exceed 1/3 of the horizontal distance from the foundation wall of any building to the face of the retaining wall.
[Amended 4-20-2021 by Ord. No. 1586]

(5) All new construction and substantial improvements as defined in Chapter **300** will be required to furnish and install an underground stormwater recharge system to limit the amount of runoff generated by the construction. The system shall conform to the following requirements:

(a) The applicant shall install five linear feet of underground storage (Detail S-2) for every 500 square feet of the total impervious and semi-pervious coverage or provide and install a system equivalent to the recommended design as approved by the Borough's Engineer.
[Amended 4-20-2021 by Ord. No. 1586]

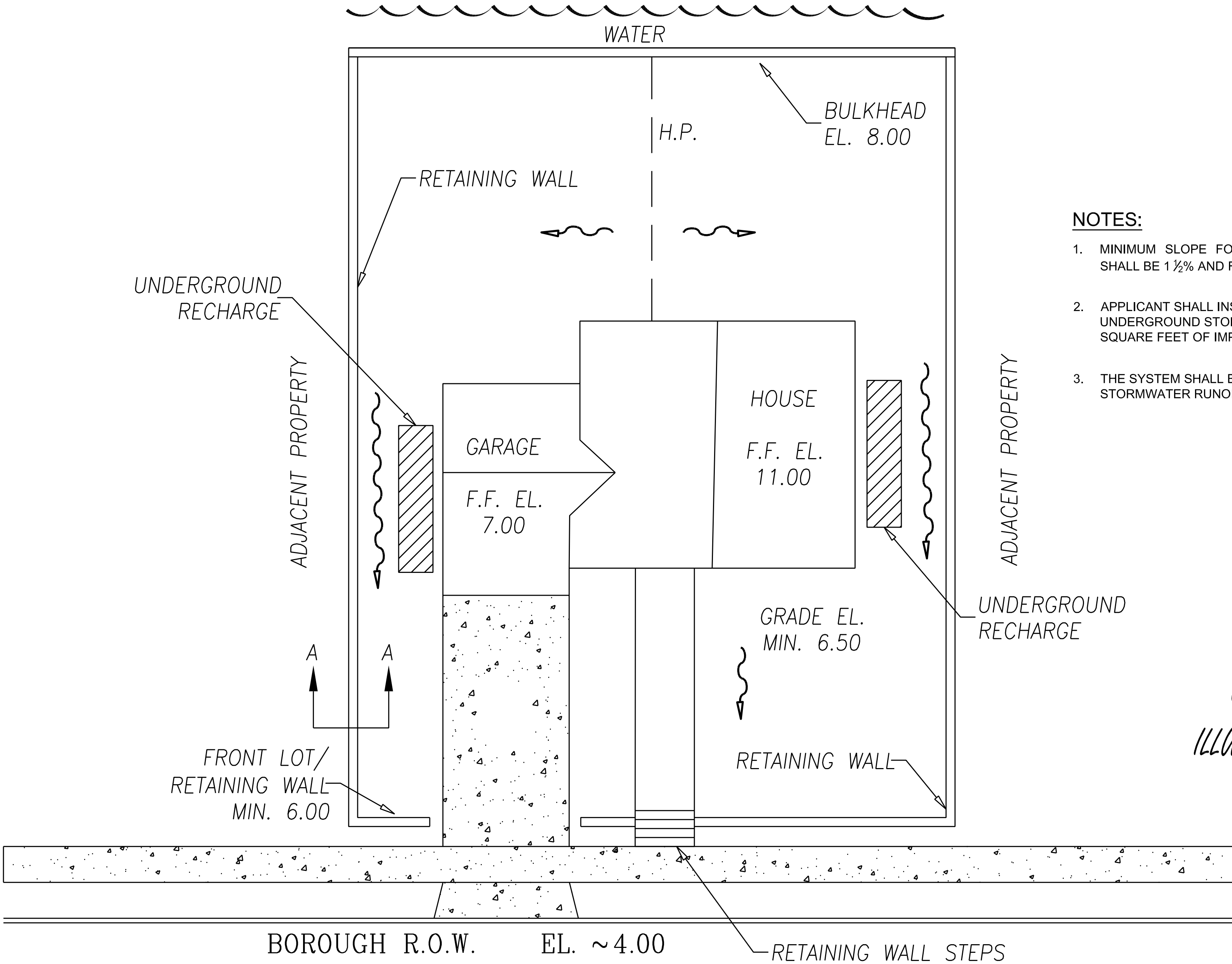
(b) The system shall be designed to collect stormwater runoff from the roof leaders or an equivalent amount of runoff through inlets or yard drains.

(c) The system will be designed to convey the excess stormwater to the street.

(6) The plan shall include center line roadway elevations at the property lines.
[Added 4-20-2021 by Ord. No. 1586]

(7) All new construction, or construction constituting substantial improvement, adjacent to roadways where the average center line elevation, measured at the property lines, is below elevation six feet (NAVD 1988) will be required to construct retaining walls consistent with § **560-50A(4)**. The retaining walls will be constructed along all of the property lines to facilitate raising the lot grade to a required minimum elevation 6.5 feet (NAVD 1988), measured at the foundation. Retaining walls will be built to elevation six feet (NAVD 1988). Garage floors shall be built to a minimum elevation of seven feet (NAVD 1988).
[Added 4-20-2021 by Ord. No. 1586]

B. Failure to adhere to the lot grading requirements or approved plans may result in additional inspections. The applicant shall be responsible to provide all additional fees associated with multiple reinspections that are necessary due to defective workmanship, lack of coordination, lack of work progression, and any aspect of work that is unacceptable to the Borough. The Borough Engineer shall advise the applicant, in writing, of said additional fee if warranted.
[Added 4 20 2021 by Ord. No. 1586]



NOTES:

1. MINIMUM SLOPE FOR LAWNS AND DISTURBED AREAS SHALL BE 1 1/2% AND FOR HARD SURFACES SHALL BE 4/10%.

2. APPLICANT SHALL INSTALL FIVE LINEAR FEET OF UNDERGROUND STORAGE (DETAIL S-2) FOR EVERY 500 SQUARE FEET OF IMPERVIOUS COVER.

3. THE SYSTEM SHALL BE DESIGNED TO COLLECT STORMWATER RUNOFF FROM ROOF LEADERS.

CONCEPTUAL AND ILLUSTRATIVE PURPOSES ONLY (DRAFT)

1/2

DEBLASIO & ASSOCIATES
CONSULTING ENGINEERS AND PLANNERS
4701 NEW JERSEY AVENUE
WILDWOOD, NJ 08260
PHONE (609) 854-3311
FAX (609) 854-4323
WWW.DEBLASIOASSOC.COM

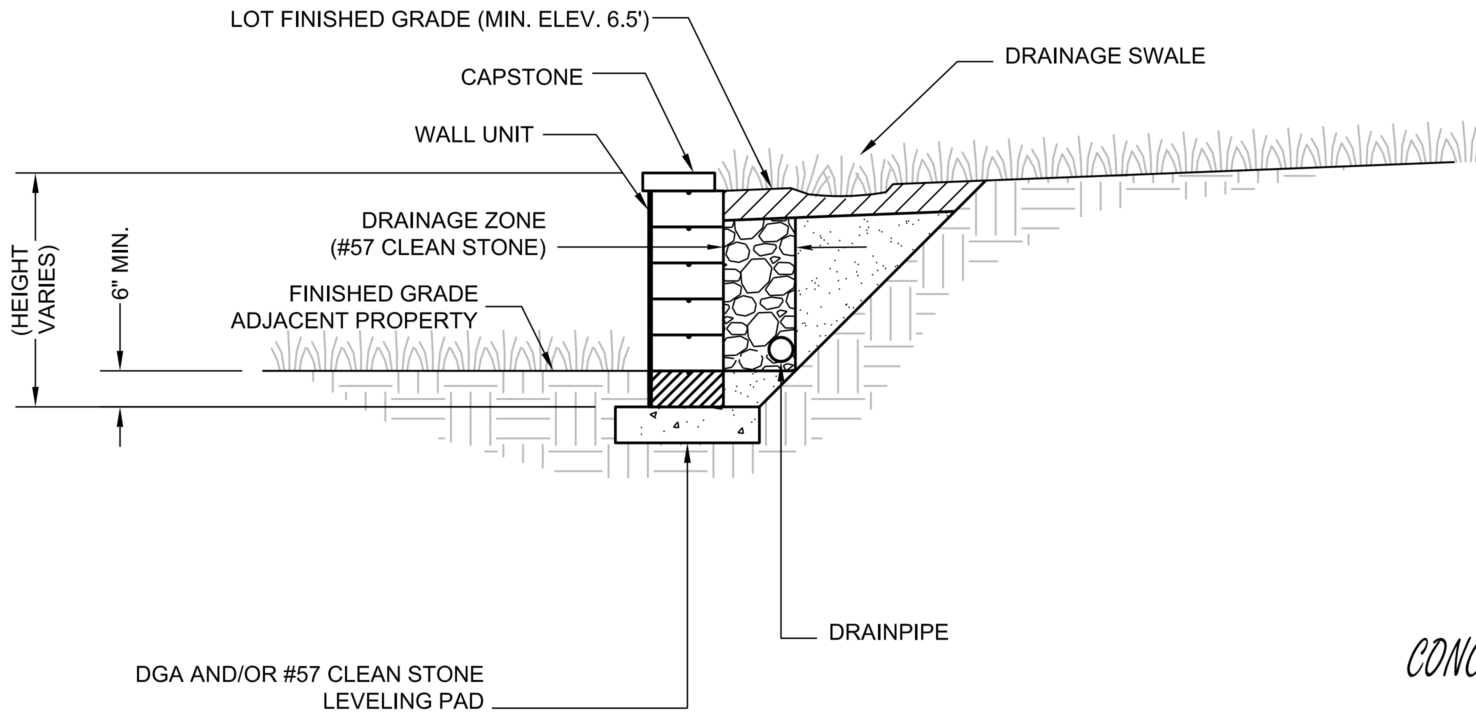
LOT GRADING ORDINANCE
CONSTRUCTION DETAILS
BOROUGH OF STONE HARBOR
CAPE MAY COUNTY, NEW JERSEY

MARC A. DEBLASIO, PE
New Jersey License No. 41599

DATE

NOTES:

1. RETAINING WALLS SHALL BE CONSTRUCTED OF REINFORCED CONCRETE OF OTHER REINFORCED MASONRY FINISHED ON ALL EXPOSED FACES.
2. RETAINING WALLS SHALL BE ADEQUATELY DESIGNED BY A NEW JERSEY LICENSED PROFESSIONAL ENGINEER AND DETAILED IN THE PLAN TO CARRY ALL EARTH PRESSURES.
3. LOTS SHALL BE GRADED TO DIRECT STORMWATER TO THE STREET.



CONCEPTUAL (DRAFT)

TYPICAL RETAINING WALL SECTION A-A

2/2

DEBLASIO & ASSOCIATES
CONSULTING ENGINEERS AND PLANNERS

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LOT GRADING ORDINANCE
SECTION A-A
BOROUGH OF STONE HARBOR
CAPE MAY COUNTY, NEW JERSEY

MARC A. DEBLASIO, PE DATE
New Jersey License No. 41599

Siren Control and Messaging System Information

FEDERAL SIGNAL

Commander® On-Premises

Siren Control and Messaging System

The Commander siren control system offers both secure activation and status monitoring of any alert and notification system. From Giant Voice to Mechanical and Intelligent siren systems, Commander is designed to control, monitor, and link your warning system.

Federal Signal Commander continues to evolve to meet the challenging demands of customers throughout the world to provide a system unmatched in its features and ease of use. Commander offers Emergency Managers and system operators complete, secure activation and status monitoring of any siren system. From siren activation to in-building alerting, this system is designed to provide your facility with complete alert and notification capability.

From controlling 1 siren to 511, the system can expand to accommodate your changing needs. Federal Commander provides an easy to use activation screen. Administrators can program 50 Hotkeys to activate all sirens, zones, or individual sirens. Each Hotkey can be programmed to include a text, email, or voice message. A single Hotkey can activate sirens and send informational messages simultaneously.

Categorize hotkeys to activate as all sirens, zones, or individual sirens.

FEATURES

- Control of municipal, county and state siren systems
- Control of Giant Voice systems
- Control of Intelligent Systems
- PC or Server based system
- Controls up to 511 sirens
- Support for analog, digital (P25/Tetra), IP, cellular, satellite and landline communications
- Modbus compatible
- App and web based control using optional CommanderOne
- Secure communications with 128 & AES 256 encryption and time-based encryption
- Custom user interface for your specific application

Commander can be integrated as a fully compliant APCO Project 25 (P25) two-way communications outdoor/indoor warning system.

Commander has integrated networking and messaging capabilities.

- Networking allows the system to operate radio systems and IP systems simultaneously.
- Messaging provides personalized alerts to devices such as cell phone, computer, pager, handheld radio, etc. Messaging provides additional information to key personnel or to citizens.

Activation of sirens based on polygons from National Weather Service is provided using the CommanderOne web based control. CommanderOne integrates automatically with your local siren activation system to provide “anywhere” activation, control and monitoring.

Siren Controllers are available for both electronic sirens, speakers, and electromechanical sirens. These controllers come equipped with over-the-air programmability via secure digital technology.

Commander® On-Premise Siren Control and Messaging System (SFCD)

SPECIFICATIONS

RTU Capacity: Up to 511 siren RTU's

Communications: Analog, Digital, P25 radio systems Cellular, satellite, IP networks, Landline communications

Security: Time based encryption,128 bit/256 bit AES encryption. User, password and role based security.

Hardware Activation: SS2000+ local activation point. Siren activations using Intelligent System Informers

RTU types: Mechanical, Ultravoice giant voice systems, and Intelligent Systems using Informer product line

Giant Voice: Live PA, Text-to-speech and WAV file broadcasts

Intelligent Systems: Informer product line Desk / Wall / Rack / Outdoor Systems Two-way Intercom and recording Custom and specialized alert and notification systems

Zoning: Unlimited zone creation

System: Alarm logging and reporting of siren activation and monitoring using customized maps

Language: English default with optional multi-language support

System Backup: Create and restore system back up files

HOW TO ORDER

Description	Part Number
Windows application software:	
for up to 10 sites	**SFCD10**
for up to 25 sites	**SFCD25**
for up to 255 sites	**SFCD255**
for up to 511 sites	**SFCD512**

OPTIONAL ACCESSORIES

Description	Part Number
Warranty, up to 10 users	**SFCD-W10**
Warranty, up to 25 users	**SFCD-W25**
Warranty, up to 255 users	**SFCD-W255**
Warranty, up to 511 users	**SFCD-W511**
Upgrade, to 25 sites	**SFCDUPI**
Upgrade, to 255 sites	**SFCDUPII**
Upgrade, to 511 sites	**SFCDUPIII**
TCP/ IP client software (5 seats)	**SFCDCLNT**
Client software extended one-year warranty	**SFCDCLNT-W**
Modem	**MODEM-MSK**
Server with Windows®, 22" flat screen monitor	**X-PCS-22**
120V Uninterruptible Power Supply	**X-UPS**
Desktop Controller	**SS2000+**

Dune Vegetation Management Plan and Beach Management Plan

BOROUGH OF STONE HARBOR
BEACH MANAGEMENT PLAN

For the Protection of Federally & State-Listed Species

IN COOPERATION WITH:

Borough of Stone Harbor

and

New Jersey Department of Environmental Protection
Division of Fish and Wildlife
Endangered and Nongame Species Program

and

United States Department of the Interior
Fish and Wildlife Service
New Jersey Field Office

March, 2008

PURPOSE

The purpose of this management plan is to provide a framework for cooperation among the Borough of Stone Harbor (Borough), the New Jersey Division of Fish and Wildlife's (NJDFW) Endangered and Nongame Species Program (ENSP), and the United States Fish and Wildlife Service's (USFWS) New Jersey Field Office (NJFO) in the stewardship of federally and State-listed endangered and threatened beach-nesting birds and flora (listed species), and other species of conservation concern occurring on the Borough's beaches. Through this plan, the parties seek to provide for the long-term protection and recovery of species populations in the Borough and the State, while balancing conflicting activities that potentially occur as the result of recreational usage and municipal management of beaches. In the plan, the parties define and describe the roles and responsibilities of the Borough, the NJDFW, and the USFWS in the protection and management of listed species within the Borough. Through this management plan, the parties endeavor to increase the nesting success of listed bird species and to foster the continued recovery of listed plant species in the Borough, chiefly by reducing detrimental human activities and decreasing predation.

This management plan is consistent with the USFWS's 1994 *Guidelines for Managing Recreational Activities in Piping Plover Breeding Habitats on the U.S. Atlantic Coast to Avoid Take Under Section 9 of the Endangered Species Act* and the 1997 *Guidelines for Managing Fireworks in the Vicinity of Piping Plovers and Seabeach Amaranth on the U.S. Atlantic Coast* (Recreational and Fireworks Guidelines), and with the New Jersey Coastal Zone Management Rules (N.J.A.C 7:7E). This plan satisfies the Conservation Measures and Terms and Conditions of the December 2005 Programmatic Biological Opinion (PBO) between the USFWS and the U.S. Army Corps of Engineers, Philadelphia District with respect to municipal management planning for the Borough. It is also intended to meet the conditions of permits issued by the New Jersey Department of Environmental Protection's (NJDEP) Division of Land Use Regulation, requiring management planning in municipalities receiving beach nourishment. Furthermore, the plan is intended to meet the requirement for a beach management plan with respect to a State-Aid Agreement between the State and the Borough for the purposes of beach replenishment. The parties to this plan acknowledge that the guidelines, rules, conservation measures, and terms and conditions contained within may be periodically revised, and agree to adjust the management of listed species as appropriate to ensure continued compliance, including revision of this plan if necessary.

SITE DESCRIPTION AND LOCATION

The Borough of Stone Harbor is located on the southern third of Seven Mile Island, 39`02'39.04"N 74`46'06.74"W, a barrier island along the Atlantic Ocean in Cape May County, New Jersey. The Borough is separated from the mainland by the Great Channel, an estuary that includes parts of the Atlantic Intracoastal Waterway, and numerous wetlands and undeveloped marsh islands. The southern end of Stone Harbor is known as the Stone Harbor Point and it currently consists of over 200 acres of a vibrant ecosystem, which supports numerous species of both common and rare wildlife.

MANAGEMENT ZONES

Two distinct management zones are identified on the Borough's beaches consisting of a Species Protection Zone and a Recreational Zone (see Map 1). The zones are primarily based on current and historical use by beach-nesting birds, as well as human uses and habitat conditions.

SPECIES PROTECTION ZONE: Stone Harbor Point (south and west of the 127th St. terminal groin)

This zone will be managed to promote the protection and recovery of listed species and other species of conservation concern, as well as the enhancement of their habitat. Recreational uses will be accommodated consistent with species protection. Management and protection of this zone is outlined in a separate comprehensive plan prepared by Terwilliger Consulting, Inc. in March 2008 (See attached *Conservation Plan for Stone Harbor Point*).

RECREATIONAL ZONE: Oceanfront beach extending from the 80th St. (Stone Harbor/Avalon Border) to the 127th St. terminal groin.

This zone is comprised of the Borough's developed recreational oceanfront beach. It will continue to be primarily managed for recreational usage. However, if listed species colonize this zone, they will be managed consistent with the 2005 PBO and in accordance with the USFWS's Recreational and Fireworks Guidelines. Furthermore, the Borough will develop and implement specific actions through consultation with the USFWS and ENSP if listed species are discovered. Consistent with the 2005 PBO, ENSP will conduct biological monitoring in this zone for the presence of beach-nesting birds during the breeding season in a manner and at intervals followed throughout the State.

ADDITIONAL BEACH MANAGEMENT PRACTICES

The following additional provisions will be implemented in the Recreational Zone to satisfy recommendation made by USFWS-NJFO to the Borough in January 2008 (see attached letter, Reference # 2008-I-0100):

BEACH MAINTENANCE: The Borough through education of its staff and, if necessary, with the placement of signs will maintain a "no-rake" zone (a 2-3 meter corridor at the toe of a dune or the landward limit of a berm) for the protection of seabeach amaranth habitat. The USFWS will provide signs to the Borough to protect seabeach amaranth should it appear. The Borough will place symbolic fence and signs around any plants that are detected in order provide at least a 3-meter buffer.

DUNE MANAGEMENT AND INVASIVE SPECIES CONTROL: The Borough recognizes that dune creation and maintenance are regulated by the New Jersey Coastal Zone Management Rules (Section 7:7E-3A.4) and that dunes should and will be managed to promote a diverse assemblage of native vegetation in accordance with those rules. Exotic invasive plant species (*e.g.*, Asiatic sand sedge [*Carex kobomugi*]) or encroaching native plant species (*e.g.*, American beach grass [*Ammophila breviligulata*]) can degrade or eliminate native habitat for listed species.

Because the Borough recognizes that invasive or encroaching plant species can compromise the integrity of native dune vegetation communities and can diminish suitability of habitat for native listed species, the Borough will work with USFWS and NJDEP to develop appropriate management strategies, as practical. The Borough will provide plans to the USFWS and ENSP for review at least 30 days before implementing any dune management or invasive and encroaching plant species control in the vicinity of listed species occurrences.

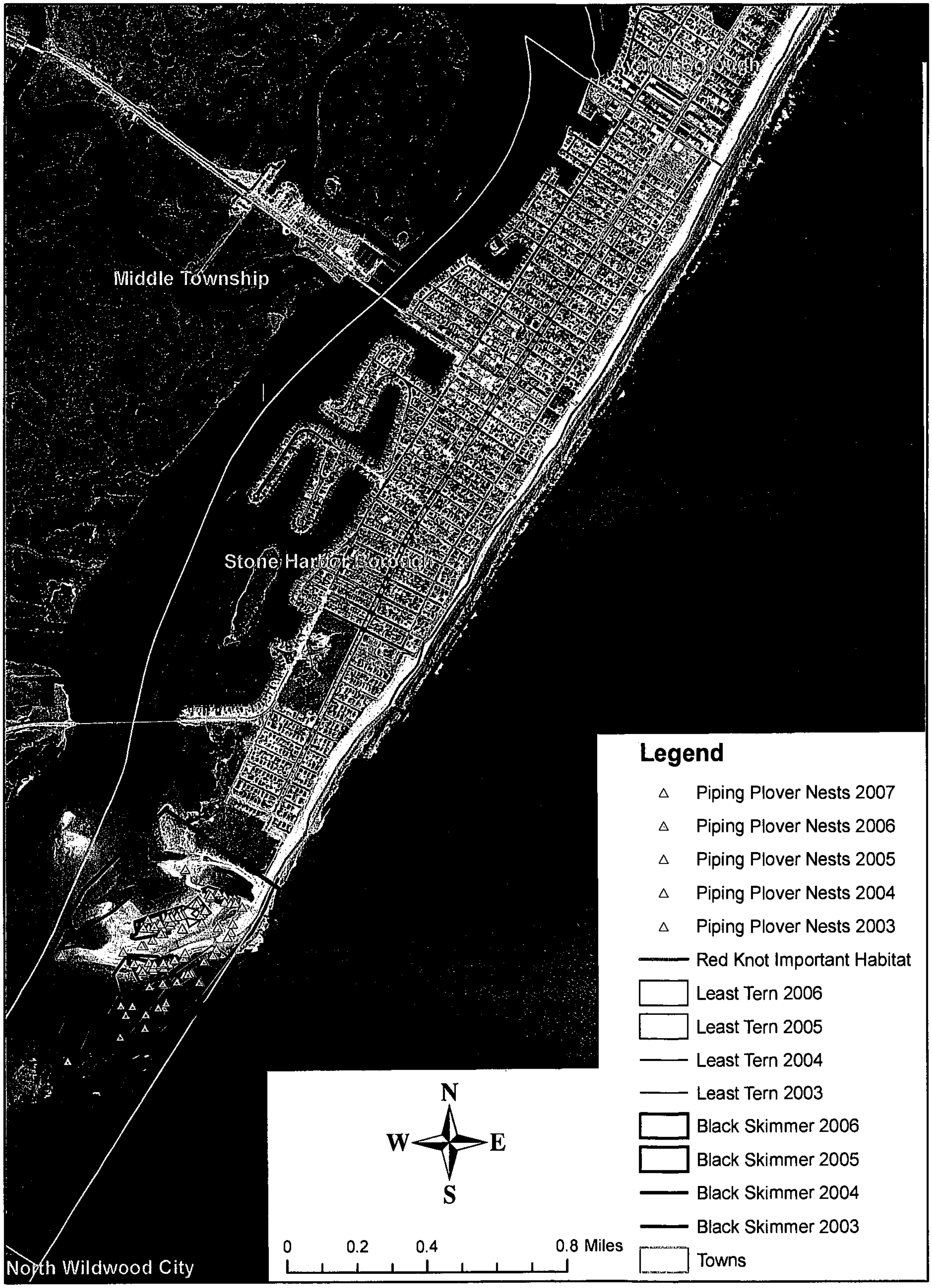
FERAL AND FREE-ROAMING CATS: The Borough of Stone Harbor currently utilizes a Trap-Neuter-Release (TNR) program for the control of feral and free-roaming cats. It continues to monitor and operate this program through the budget of the Natural Resources Committee. It also actively includes and uses a provision for the removal and/or relocation of cats in sensitive areas, which could be inclusive of the USFWS and ENSP recommended buffer from the oceanfront beaches if occupied by listed species.

The Borough's TNR Program is contained in R.G.O. 147-24 through 32. This Ordinance contains a sunset provision in R.G.O. 147-32 that will eliminate the TNR Program on December 31, 2008. If the TNR Program is eliminated, effective January 1, 2009, the Borough's Animal Control Officer (ACO) shall resume primary responsibility for the management of feral cats within the Borough, including, as necessary, the capture and transport to the County Animal Shelter for handling in accordance with the interlocal agreement between the Borough and the County applicable to handling such animals. The Borough, through its ACO, will also continue to work in partnership with the NJDFW to control cats in sensitive wildlife locations.

Since the threats posed by both feral cats and the Borough's establishment and maintenance of TNR colonies in close proximity of protected species are not completely avoided at this time, and no incidental take authorization is sought for Borough-sponsored or –approved acts, liability remains a concern. Although Borough actions included in this plan (inclusive of the *Conservation Plan for Stone Harbor Point*) regarding cats contain laudable components, the Borough would not be authorized or covered by the USFWS should take of species listed under the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) occur in the future. However, if the TNR program is eliminated via the sunset provision, effective January 1, 2009, the Borough would no longer be liable for a take that occurs as a result of a Borough sponsored TNR program.

CONCLUSION

The people of Stone Harbor are aware of its beauty and that it is a special kind of place. Protecting the beach from haphazard and unknowing diminishment or destruction is the "need" for a "Beach Management Plan". In that spirit, Stone Harbor respectfully submits this plan to all the agencies for their perusal and adoption.



Middle Township
Stone Harbor Borough
North Wildwood City
Legend
Piping Plover Nests 2007
Piping Plover Nests 2006
Piping Plover Nests 2005
Piping Plover Nests 2004
Piping Plover Nests 2003
Red Knot Important Habitat
Least Tern 2006
Least Tern 2005
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Black Skimmer 2006
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Black Skimmer 2003
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United States Department of the Interior

FISH AND WILDLIFE SERVICE

New Jersey Field Office
Ecological Services
927 North Main Street, Building D
Pleasantville, New Jersey 08232
Tel: 609/646 9310
Fax: 609/646 0352
http://www.fws.gov/northeast/njfieldoffice

U.S. FISH & WILDLIFE SERVICE

In Reply Refer to:

2008-FA-0183

APR 2 3 2008

Suzanne M. Walters, Mayor
Borough of Stone Harbor
9508 Second Avenue
Stone Harbor, New Jersey 080247

Dear Mayor Walters:

This letter is in regard to the final Conservation Plan for Stone Harbor Point (Conservation Plan) and the final Borough of Stone Harbor Beach Management Plan (Borough-wide Plan) for the Borough of Stone Harbor (Borough) to ensure protection of federally and State-listed threatened and endangered species occurring on the Borough's beaches. The Conservation Plan[1] and the Borough-wide Plan were reviewed by the U.S. Fish and Wildlife Service (Service) concurrently with the New Jersey Department of Environmental Protection (NJDEP), Endangered and Nongame Species Program (ENSP). The final Conservation Plan includes revisions based on Service review comments and beach management planning recommendations dated March 29, 2007 to Terwilliger Consulting Inc., which were coordinated with ENSP; several interagency meetings; and coordination via telephone and electronic mail among the Service, ENSP, Terwilliger Consulting Inc., and the Borough. The final Borough-wide Plan includes revisions based on Service recommendations dated January 4, 2008, which were coordinated with ENSP; and coordination via telephone and electronic mail among the Service, ENSP, and the Borough.

Enclosed is a compact disk containing an electronic copy of the final Borough-wide Plan. A copy of the final Conservation Plan will be sent to the Borough by Terwilliger Consulting Inc. We understand that the final Conservation Plan and the Borough-wide Plan were adopted by Borough resolution (No. 2008-S-78). Because the Borough has adopted the final Conservation Plan and Borough-wide Plan by resolution, it is our understanding the Borough will memorialize the plans by signing a Memorandum of Agreement (MOA) with the Service and the NJDEP. In addition, any outstanding municipal ordinances that are in need of modification to implement the plans should be completed at this time.

The Service appreciates the Borough's past and ongoing efforts to protect threatened and endangered species, and your willingness to provide a positive example of a partnering municipality that manages federally and State-listed species on its beaches. We look forward to working with the Borough and the NJDEP in signing the MOA in support of the plans, and

[1] The Conservation Plan was compiled by Terwilliger Consulting, Inc. for of the Borough of Stone Harbor in coordination with the Service and ENSP.

through Plan implementation, to continue the cooperative relationship that is protecting listed species on the Borough's beaches.

Please contact Stephanie Egger at (609) 383-3938, ext. 47, to arrange for official signing of the MOA by the Service, NJDEP, and the Borough.

Sincerely,

J. Eric Davis Jr.
Supervisor

Enclosure

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New Jersey Field Office
Ecological Services
927 North Main Street, Building D
Pleasantville, New Jersey 08232
Tel: 609/646 9310
Fax: 609/646 0352
http://www.fws.gov/northeast/njfieldoffice

In Reply Refer to:

2008-I-0100

JAN 0 4 2008

Suzanne M. Walters, Mayor
Borough of Stone Harbor
9508 Second Avenue
Stone Harbor, New Jersey 080247

Dear Mayor Walters:

As you know, the Borough of Stone Harbor (Borough), Cape May County, New Jersey, is required to develop a Borough-wide Beach Management Plan (Plan) to protect federally listed species. The U.S. Army Corps of Engineers (Corps) requires beach municipalities to develop Plans pursuant to the U.S. Fish and Wildlife Service's (Service) 2005 Programmatic Biological Opinion (PBO) on the effects of Federal beach nourishment, renourishment, stabilization, and restoration activities on the federally listed (threatened) piping plover (*Charadrius melodus*) and seabeach amaranth (*Amaranthus pumilus*).

The Service and New Jersey Department Environmental Protection (NJDEP) work with the Corps and local beach managers along New Jersey's coast to ensure protection of federally and State-listed species consistent with the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) and the New Jersey Endangered and Nongame Species Conservation Act of 1973 (N.J.S.A. 23:2A *et seq.*). Development and implementation of Service and NJDEP approved Plans are also directed by the Final Natural Resources Restoration Plan (2004) for the *Anitra* Oil Spill that occurred in May 1996. The Service's goal is to ensure the Plan provides for the Borough's beach recreational needs as well as long-term protection and recovery of federally and State-listed threatened and endangered species in conjunction with the Corps' scheduled beach renourishments and beyond.

Independent of the Corps' requirement for a Beach Management Plan, the Borough recently completed a comprehensive Conservation Plan for Stone Harbor Point. The Conservation Plan has been approved by the Service and the NJDEP's Endangered and Nongame Species Program (ENSP)[1]. As Stone Harbor Point will serve as the Borough's designated protective zone to be managed for listed species and their habitat, the Service acknowledges the Stone Harbor Point Conservation Plan as largely fulfilling the Corps' Beach Management Planning requirement. To

[1] The final draft of the Conservation Plan as compiled by Terwilliger Consulting, Inc. for of the Borough of Stone Harbor is currently with the Borough's council for final review and approval.

fully comply with the 2005 PBO, the Borough must also submit a Plan for the Borough's oceanfront beaches indicating how federally and State-listed species will be managed should they colonize any beach or dune area outside of Stone Harbor Point.

SERVICE RECOMMENDATIONS

The Service recommends that the Borough submit a Plan for the oceanfront beaches (outside of Stone Harbor Point) to the Service and the ENSP for review. The Plan should be consistent with the PBO and at a minimum address the following items.

Biological Monitoring

The Plan should state that biological monitoring of the oceanfront beaches will be ongoing during the nesting season and be conducted by ENSP consistent with the Service's 2005 PBO.

Management Zones and Provisions if Listed Species Should Occur

The Plan should indicate that Stone Harbor Point is the designated Protected Zone for the Borough and is managed to promote the protection and recovery of listed species and the enhancement of their habitat under the Conservation Plan. A copy of the Conservation Plan should be appended to the Borough's Beach Management Plan. The Plan should also indicate that the Borough's oceanfront beaches are currently managed as a Recreational Zone, but will be managed in accordance with Service's 1994 *Guidelines for Managing Recreational Activities in Piping Plover Breeding Habitats on the U.S. Atlantic Coast to Avoid Take Under Section 9 of the Endangered Species Act* and the 1997 *Guidelines for Managing Fireworks in the Vicinity of Piping Plovers and Seabeach Amaranth on the U.S. Atlantic Coast* (Guidelines) if listed species are discovered. The Plan should specify that the Borough will develop and implement specific actions in accordance with the Service's Guidelines through consultation with the Service and ENSP if listed species occur in the Recreational Zone. The Plan should also include a Borough-wide map identifying the Protected and Recreational Zones.

Beach Maintenance

<u>Beach Raking</u>

The Service recommends the Borough delineate a 2-3 meter corridor (approximately one beach-rake width) as a "no rake" zone at the toe of the dune or landward limit of the berm for seabeach amaranth habitat protection. We also recommend posting the area with signs to delineate the "no rake" zone, if necessary, to ensure compliance by the Borough's Public Works staff operating beach-rakes. If any seabeach amaranth plants occur, they should be symbolically fenced and signed with a 3-meter buffer for protection. The Service will provide signs for the Borough's use. These provisions to protect seabeach amaranth and its potential habitat should be stipulated in the Borough's Plan.

Dune Management and Invasive Plant Species Control

Dune creation and maintenance are regulated by the New Jersey Coastal Zone Management Rules (Section 7:7E-3A.4). Dunes should be managed to promote a diverse assemblage of native vegetation and in accordance with N.J.A.C. 7:7E-3A.4.

The Service recommends the Borough include provisions in their Plan to manage dunes to promote the development of a more natural dune system (without compromising storm protection), featuring an irregular face, occasional breaches, and low-lying sparsely vegetated fore-dunes. A more natural dune system can provide habitat for diverse native vegetation and wildlife. Exotic invasive plant species (*e.g.*, Asiatic sand sedge [*Carex kobomugi*]) or encroaching native plant species (*e.g.*, American beach grass [*Ammophila breviligulata*]) can degrade or eliminate native habitat for listed species.
Please provide plans to the Service and ENSP for review at least 30 days before implementing any routine dune management or invasive and encroaching plant species control in the vicinity of documented federally or State-listed species occurrences.

Trap-Neuter-Release Cat Colonies, Feral, and Free-Roaming Cats

The Borough should continue to monitor the status of any trap-neuter-release, feral, or free-roaming cats. The Plan should include a provision to allow for removal or relocation of cats within the Service and ENSP recommended buffer from the oceanfront beaches if occupied by listed species.

CONCLUSION

The Service appreciates the opportunity to provide recommendations on the Borough's Plan to fulfill Corps requirements, consistent with the Service's 2005 PBO for federal beach nourishment activities. Please contact Stephanie Egger at (609) 383-3938, extension 47, if you have any questions regarding these comments or require further assistance regarding federally listed species.

Sincerely,

J. Eric Davis Jr.
Supervisor

LITERATURE CITED

New Jersey Department of Environmental Protection, U.S. Fish and Wildlife Service, and National Oceanic and Atmospheric Administration. 2004. Final Natural Resources Restoration Plan and NEPA Environmental Assessment for the *Anitra* Oil Spill of May 1996.

DUNE VEGETATION MANAGEMENT PLAN

BOROUGH OF STONE HARBOR

CAPE MAY COUNTY, NEW JERSEY

June 2015

PREPARED FOR: **The Borough of Stone Harbor**
9508 Second Street
Stone Harbor, NJ 08247

PREPARED BY: **The Lomax Consulting Group**
PO Box 9, 1435 Route 9 North
Cape May Court House, NJ 08210

TLCG FILE No.: 12-782

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DUNE VEGETATION MANAGEMENT PLAN

SECTION 1. INTRODUCTION

The beach-dune system of the Borough of Stone Harbor is an extraordinary community asset. This dynamic coastal zone system is the major natural feature that has attracted residents and visitors to the Borough for generations. Not only is this dune ecosystem a foundation component of the tourism economy, it provides to Stone Harbor residents, businesses and their properties the following critical services.

(a) serves as a protective Atlantic Ocean buffer dissipating coastal storm energy
(b) contains a bank of sand to replenish the beach system
(c) supports a diversity of habitats for adapted coastal plants and wildlife
(d) creates the unique coastal ambiance appeal of the community to residents and visitors

The dune ecosystem, the subject of this Plan, is naturally occurring in the Borough; however, it has required management for many years to retain its integrity and to preserve its unique features for the environmental and economic benefits that it provides.

After the March 1962 storm that devastated the New Jersey coastal resorts, well-meaning protection efforts to stabilize the dune sand resulted in the introduction of species that had unintended consequences. One of these species, the Japanese black pine (*Pinus thunbergiana*), has since become a dominant vegetation feature in the back dune area and other coastal environs. Because of its invasive and dominating characteristics, it has displaced most of the native species beneath it as it has grown to heights exceeding 30 feet. While originally considered a favored,salt-tolerant conservation species, it has proven to out-compete native species. The Japanese black pine has become so well established in some of the dunes adjacent to residences that it has resulted in a monoculture. The pines produce large quantities of combustible cones and needles in this dry environment and, therefore, create a potential for wildfires in close proximity to residences. In addition, these stands have created a visual barrier impacting the value of the waterfront properties. Finally, the stands of Japanese black pine are displacing the dune-adapted, native species, thereby creating a high potential for ecological instability when they are lost. The Japanese black pine monocultures have created a risk because of their susceptibility to pests and pathogens. Dead and dying Japanese black pines are readily observable on the Seven Mile Barrier Island, as well as on the mainland. Recognizing the impending loss of these pines, it has become necessary to evaluate the extent of this issue in the Borough and to establish a strategy to reduce or eliminate the adverse impact of this species and other damaging invasive species while protecting and restoring the integrity of the Borough's dune system. Other species include bamboo and such damaging vines as Japanese honeysuckle, English ivy, Virginia creeper, poison ivy and green briar.

During the summer of 2013, The Lomax Consulting Group conducted an evaluation of the distribution of the Japanese black pine and identified principal areas of risk to the Borough. The findings and recommendations were reported to the Natural Resources Committee along with a proposed plan approach and Dune Vegetation Management Plan (DVMP or Plan) concept outline for review and direction. Subsequently, pursuant to guidance from the Committee, a presentation was made to Borough Council, officials and the public on December 3, 2013. The planning process was approved and the development of the Plan was authorized. The Plan was drafted and submitted to the Natural Resources Committee for review and comment during 2014.

SECTION 2. BACKGROUND

2.1 Statement of Values of Dunes and Dune Vegetation

The Borough of Stone Harbor dune system is a critically important and integral natural resource of the community that provides: (a) a protective buffer dissipating coastal storm energy; (b) a bank of sand to replenish the beach system during coastal storm events; (c) an extensive and diverse habitat for plants and wildlife adapted to the dune ecosystems; and (d) a unique opportunity to foster a maritime vegetation community and associated coastal ecosystems. Accordingly, the stewardship of the Stone Harbor dunes is critical to the protection of the Borough. Further, the dunes, an integral part of the beach-dune complex, are a foundation component of the tourism economy of the Borough.

2.2 Statement of Issues Relating to the Establishment of Japanese black pine and other damaging invasive species

Invasive vegetation, especially the Japanese black pine, has demonstrated its ability to spread beyond the areas where it was originally planted to portions of the back dunes and other areas adjacent to residences at such a rate that it has: (a) resulted in hazardous conditions associated with the accumulation of a combustible tinder base subject to wildfire in close proximity to residences, beach paths and the dune system; (b) evolved into monocultures resulting in degraded and unsuitable habitat for native plants and wildlife adapted to the dune system; (c) created a substantial risk to portions of the dune system to destabilization through the die back of this species; (d) created an unacceptable visual barrier impacting the value of the waterfront properties and (e) especially invasive damaging vines smother and weaken native dune trees and shrubs. Therefore, the Borough has examined the risks and established a strategy to reduce or eliminate the adverse impact of this species, while protecting and enhancing the integrity of the Borough's dune system.

SECTION 3. DUNE VEGETATION MANAGEMENT PLAN

3.1 Goals of the Plan

3.1.1 Maintain and restore a healthy, diverse dune system comprised primarily of adapted native species.

3.1.2 Establish a science-based approach to evaluating and managing/restoring dune vegetation, in a manner ensuring that the Borough receives the critical safety and ecological services that its dunes can provide.

3.2 Objectives of the Plan

3.2.1 Develop a Dune Vegetation Management Plan that addresses control of Japanese black pine and other damaging invasive plants, as appropriate, by its removal and replacement with native vegetation.

3.2.2 Provide management standards, techniques and recommended native plants that can be used for the vegetation restoration and enhancement component of the dune ecosystem.

3.3 Roles and Responsibilities

3.3.1 While the Borough maintains the overall health and integrity of the dune system; appropriate stewardship by the adjoining property owners and visitors is integral to the protection of this community asset. The Borough accomplishes this task by providing the public with an understanding of this ecosystem and its values, including educational signage that is pertinent to protection of dunes.

The Borough has established the framework for protecting its oceanfront assets by establishing and implementing Chapter 156, with special reference to Article III - Beach and Dune Protection Ordinance and the Executive Policy. **(APPENDIX A)** This Ordinance is enforced through the Regulations: unlawful activities (156-23) and Enforcement: violations and penalties (156-26). The Borough, as part of this Plan development, is obtaining a jurisdictional determination from the New Jersey Department of Environmental Protection (NJDEP) to make certain that management techniques set forth herein are in accordance with NJDEP regulations and policies. Please refer to **APPENDIX B** for a copy of the jurisdictional request and response documentation. In addition, the Borough supports dune vegetation improvement programs through its Public Works Department and through volunteer beachgrass planting initiatives, in addition to education programs.

Once the Plan is approved, the Borough Administrator will develop a Schedule of Maintenance with the Department of Public Works. The Schedule will:

a. Establish priority locations for dune vegetation management, including a schedule for the removal of dead trees and hazardous vegetation that pose a risk to the public;
b. Obtain approval for dune vegetation maintenance, including pre-maintenance documentation (i.e., area description, issue of concern, proposed action, methodology, photographic evidence);
c. Conduct maintenance activities within the areas of responsibility, including post-maintenance documentation (i.e., summary of issue, action taken, results, future consideration/monitoring, photographic evidence) and reporting progress to the Borough Administrator for inclusion in the Dune Vegetation Management Plan Base Map.

3.3.2 Property owners, especially those living in close proximity to dunes, play an important role in maintaining a healthy dune system. They have the unique opportunity to participate voluntarily in the DVMP program and engage the Borough-designated program consultant to evaluate the affected dune area in the vicinity of their property. If the site conditions are consistent with the DVMP program eligibility, the Borough-designated consultant will design a project in coordination with the property owner in order to protect and to enhance the dune system on or adjacent to their property. Further, diligent property owners may aid the Borough to monitor activities that may damage the dunes. By participating in the DVMP through the removal of Japanese black pines and the re-planting of compatible native vegetation, the stewardship of this resource becomes a shared and common purpose. Should property owners choose to participate in the DVMP program, the proposed dune enhancement project must be designed, implemented and monitored consistent with the Plan guidelines, standing land use regulation and Borough Ordinances. Responsibility for the project rests with the property owner. Accordingly, various safeguards have been incorporated into the design of the DVMP to direct landscape contractors selected by the property owner to implement an approved DVMP project. These safeguards provide an opportunity for addressing landowner interests and concerns while providing guidance and public notification through the Dune Vegetation Management planning and oversight of the implementation process.

3.3.3 Property owners and their landscape contractors, who intend to engage in and sponsor any vegetation management activities in the dune system, must coordinate with the Borough-designated program consultant and comply with the requirements of Chapter 156, Article III: Beach and Dune Protection adopted as Section 12-7 of the 1982 Revised General Ordinance prior to taking any action. During the application process the Borough's Natural Resources Committee will review and determine whether the proposed project actions are consistent with the DVMP. Then the Committee will report to the Zoning Officer of the Borough so that a zoning permit may be issued for an approved project. If the proposed action is approved, the landscape contractor will be required to provide notification to the Construction Official of their intention to carry out trimming, thinning or removal/enhancement of dune vegetation consistent with the approved project. They will also be required to coordinate with the Borough-designated program consultant in order to provide photo-documentation of the site conditions before and at the conclusion of the vegetation management process. Monitoring schedules shall be adhered to in order to ensure the success and survival of the plantings installed in the dunes. Proof of adequate training, certifications and insurance will also be a requirement for landscape contractors, as specified by the Borough, prior to the commencement of work.

3.3.4 While the Borough has assumed the role of facilitating the Dune Vegetation Management Planning process; financial responsibilities and obligations will be allocated in accordance with a Memorandum of Agreement (MOA) between private property owners and the Borough of Stone Harbor for the project design, vegetation removal and replacement and project monitoring.

3.4 Management Standards

3.4.1 The establishment of Priority Dune Vegetation Management Areas is essential to the overall success of the program. A prioritization system will allow the Borough to determine key areas where vegetation management is necessary on a priority basis to secure the integrity of the dune system and to ultimately protect the citizens of the Borough from damage associated with coastal storms or from the occurrence of injury or damage resulting from dead or dying trees on public property.

3.4.2 In areas where the implementation of the Plan includes both private and public property, an MOA will be executed by the affected parties (i.e., adjacent land owner(s) and the Borough). This MOA will lay out the proposed vegetation management and the allocation of resources. Prior to the commencement of work on private property within the dune system, approved site documents are necessary. They include, but are not limited to, an inventory of invasive vegetation to be removed, a re-planting plan, an approved and executed Memorandum of Agreement and evidence of escrowed funds, in addition to consultant/landscaper contracts.

3.4.3 Once the site boundary map on an aerial photograph has been established, the site investigations will be conducted. Site investigations must be consistent with the Dune Vegetation Management protocols to determine areas where the invasive tree management is necessary. Trees that require management will be located and identified by species, size (dbh) and condition (i.e., living or dead), in addition to whether each is a native or invasive species. This information will be plotted on a site plan. Trees that require management consistent with the Dune Vegetation Management Plan will be identified and physically marked in the field with flagging numbered to correspond to the Plan.

3.4.4 Management actions will be separated into the following three categories:

(a) The immediate removal of the aerial portion of dead trees. (Rationale: dead trees are not vegetation and must be removed in the interest of public safety – in the case that there is no imminent risk to the public, these trees or a portion of the trunk of the tree may be retained for cavity nesting birds);

(b) The removal of seedling and sapling Japanese black pine. (Rationale: pulling of seedlings or the clipping of the aerial portion of a sapling prevents the maturation and production of seedlings while preventing crowding and displacement of native vegetation);

(c) The selective removal or trimming of trees in accordance with the Dune Vegetation Management Plan. Any trees approved for removal will be cut at ground level with a hand-managed saw. Heavy (motorized) equipment will not be used in the dunes to remove such trees. (Rationale: this vegetation management will result in opening areas at ground level to provide adequate space for the planting of replacement native species during the appropriate season).

3.4.5 The invasive Japanese black pine will be replaced with native species that are:

(a) Drought tolerant;
(b) Less susceptible to disease;
(c) Less prone to wildfire; and
(d) Provide better habitat for native wildlife.

Refer to the Approved List of Dune Vegetation provided in (**APPENDIX C**), which lists native replacement vegetation according to salt spray tolerance and location within the dune landscape.

3.4.6 The management process is initiated by installing a sand fence to secure the existing sand base, if required by the National Resource Committee, along the ocean side of the area to be managed. This installation shall be performed prior to the commencement of vegetation thinning, trimming or replacement in order to protect the dunes from wind erosion. Sand fence will not be required if the dune area under restoration is not subject to failure or the installation will damage existing dune vegetation that protects the site.

3.4.7 Invasive trees less than 6 feet in height will be hand sheered at ground level and the aerial portion of the seedlings / saplings will be removed.

3.4.8 An inventory of invasive trees will be conducted to determine which trees can be thinned, trimmed or removed to provide an area for their replacement by native vegetation. Invasive trees in a stand may be thinned as part of a phased dune vegetation management project. However, thinning is limited such that the maximum distance between the remaining trees is no greater than fifteen feet. Further, the stand must be landward of the protective sand fence, if required.

3.4.9 Replacement plantings are selected, acclimated, installed and maintained consistent with Standards for Creating and Restoring Sand Dunes (**APPENDIX D**). The installation holes shall be twice the size of the plant container for shrubs and three times the size of the tree container or root ball. The soil amendments of top soil and/or organic matter are used to backfill the hole to promote survivability of the plants. They are planted in a staggered row configuration.

3.4.10 If all invasive trees are not or cannot be removed at one time (in the phased approach), then the pruning of the lower branches of the invasive trees (that have been identified for eventual removal) shall be completed such that adequate open ground area is provided for the establishment of native plants and in order to minimize the efforts to remove the invasive trees later. This process allows for the thinned and trimmed trees to remain in the dune system for the interim to maintain the integrity of the dune structure until the replacement vegetation is established.

3.4.11 If a phased approach is taken, and the native plants have been established consistent with the Plan, the remaining invasive vegetation will be removed and replaced by native species in successive years.

3.4.12 The replacement vegetation will be inspected at the end of the growing season to ensure successful establishment. Plant replacement is required for plant losses of greater than the required 85% survival rate

3.4.13 Plants that are not invasive may be maintained and may be trimmed to promote their health consistent with the approved Plan.

The property owners will be responsible for ensuring that adequate watering of the newly planted vegetation occurs through the next growing season after planting has occurred. Fixed sprinkler-type irrigation system will not be used. Temporary above-ground (e.g., Hunter High Efficiency MP Rotator head) is required between the limit of irrigation as established in the Planting Plan. The irrigation system is supplied by temporary surface tubing and will comply with the Borough Ordinance regarding time and days of watering and will be carried out three days per week unless adequate precipitation occurs. It is also recommended that temporary irrigation lines be "blown out" at the end of the season for maintenance purposes. Irrigation will be terminated and the systems removed, generally after one or two growing seasons, when it has been determined by the Borough-designated program consultant that the approved planting was successful.

3.4.14 Safeguards to assure that the overall dune system is protected, to the maximum extent practical, have been incorporated into the design of the DVMP. They include:

(a) Live native vegetation will be retained to the maximum extent practical;

(b) The entire root system of the trees to be removed will be preserved without disturbance of the soil. This root structure will help to stabilize the dune system as the replacement vegetation becomes established;

(c) Cutting and removal of the invasive trees will be accomplished by hand using trained professionals;

(d) The invasive Japanese black pine or other damaging invasive plants must be removed without the use of any vehicles in the dunes or dune path;

(e) The utmost care is required to preserve all existing native vegetation during the removal of the Japanese black pine or other damaging invasive plants;

(f) Prior to phased removal of the remaining stand of invasive trees, the replacement native plants must survive into the second growing season;

(g) The installation of a sand fence, if required, along the ocean side of any area proposed for management, when appropriate, ensures that the planted native species will be sheltered from harsh winds from the onset of the process.;

(h) The replacement native vegetation will not release weeds (non-native plants) that are not indigenous to the Stone Harbor dune system.

3.4.15 Inspections and monitoring are important elements of the DVMP by providing continued feedback concerning the successes and necessary revisions of the Program. It is proposed that a DVMP Base Map **(APPENDIX E)** be used to track priority restoration areas and facilitate monitoring success of the Dune Restoration Plan with annual updates.

3.4.16 Pre-inspections, including photo-documentation, of areas involved in dune management and restoration will be incorporated into the project proposal. Post-inspection reports of the success of replacement native plants will be submitted to the Borough for monitoring purposes. These reports will include an assessment of plant survival and coverage annually, including photo-documentation, until the plants are established, generally three (3) years.

SECTION 4. DUNE VEGETATION MANAGEMENT PLAN APPROVAL PROCESS

4.1 Review and Approval Process

The Dune Vegetation Management Plan (DVMP) promotes the use of management standards, techniques and an approved list of native replacement plants that maintain a healthy, diverse dune system.

4.1.1 The Draft Plan will be reviewed by the Borough Natural Resources Committee for comment and recommendations.

4.1.2 The Plan will be refined by The Lomax Consulting Group based on input provided by the Committee.

4.1.3 The Plan will be presented to Borough Council for its review, comments and recommendations.

4.1.4 The Plan will be submitted to NJDEP as part of the Jurisdictional Determination request.

4.1.5 The proposed changes to Borough Dune Ordinances to incorporate the DVMP program will be submitted to the Borough Natural Resource Committee for review and comment.

4.1.6 The draft changes to the Borough Dune Ordinances incorporating the DVMP program will be submitted to Borough Council for consideration and approval.

4.1.7 After review and approval by Borough Council (incorporating their changes), the Plan elements will be integrated into the Borough Beach and Dune Protection Ordinance (Chapter 156, Article III).

4.1.8 The Borough will inform the interested public and landscapers of the purpose and provisions of the DVMP through a news release and meetings, as appropriate.

SECTION 5. CONCLUSION

The benefits of a well-planned and maintained dune system that provides a protective barrier from coastal storms has become most evident since Superstorm Sandy. This Dune Vegetation Management Plan creates a framework for the community to return the dune vegetation to its natural and most resilient state. It fosters a public-private partnership where property owners within the community and the Borough implement the management standards that safeguard the integrity of the dunes, while allowing vegetation management and dune restoration. The Dune Vegetation Management Plan outlines conservation practices and safeguards to clarify roles and responsibilities and effective management of the dunes. Further, the Plan lays out the approval process to ensure that the goal of a healthy and diverse ecosystem is achieved and connected to the Borough's public policy process. Accordingly, the Dune Vegetation Management Plan is an integral part of the Community Forestry Management Plan and relevant Borough Ordinances.

In conclusion, the Dune Vegetation Management Plan recognizes that the dune system is a critical asset of the community and requires continued management to ensure that a healthy dune system is sustained to protect the Borough, its inhabitants and property, the natural ecology of the dunes and the Borough's tourism economy.

PRJ\Act\12-782/Rpts\DVMP.doc

SECTION 6. SELECTED REFERENCES

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APPENDIX A:

Borough of Stone Harbor Beach Ordinance Chapter 156
with special reference to Article III: Beach and Dune Protection
adopted as Section 12-7 of the 1982 Revised General Ordinance
and
Executive Policy
Title: Beaches and Dunes
Number: B-002

Chapter 156. BEACHES

Article III. Beach and Dune Protection

§ 156-20. Preamble.

The beach berm and dunes offer the first line of defense against the sea during a storm. Dune areas are vulnerable to erosion and damage by wind, water, indiscriminate trespass, construction, acts which damage their protective vegetation, and the absence of good husbandry. Therefore, the Borough has a vital interest in establishing and maintaining a protection program for the beach and dune areas.

§ 156-21. Policy.

A. It is the policy of this Borough to encourage the development of sand dunes, and to take whatever steps are required to maintain and protect these dunes. The specifics for such steps are set forth in Executive Policy 98-B-001, as amended from time to time.

B. All the provisions of this article are deemed necessary, material and substantial, and are therefore not subject to waiver or variance.

§ 156-22. Definitions.

As used in this article, the following terms shall have the meanings indicated:

BEACH AREA
The area between the mean low-water line of the ocean and the seaward edge of the dune as hereinafter defined.

DUNE AREA
The area between the seaward edge of the dune and the landward edge of the dune.

DUNE VEGETATION
All plant species found on beaches and dunes of northeastern US, either native or introduced, which can build and stabilize sand dunes.

LANDWARD EDGE OF THE DUNE
The intersection line of the backslope of the dune and the sea wall.

MEAN HIGH WATER (MHW)
A tidal datum that is the arithmetic mean of the high-water heights observed over a specific nineteen-year Metonic Cycle (the National Tidal Datum Epoch). For the New Jersey coast, the two high waters of each tidal day are included in the mean. This datum is available from the DEP, Bureau of Tidelands Management.

MEAN HIGH-WATER LINE (MHWL)
The intersection of the land with the water surface at elevation of mean high water. The elevation of mean high water varies along the oceanfront and the tidal bays and streams in the

coastal zone. (Note: For practical purposes, the mean high-water line is often referred to as the "ordinary" high-water line, which is typically identified as the limit of wet sand or debris line on a beach, or by a stain line on a bulkhead or piling.)

MEAN LOW WATER (MLW)

A tidal datum that is the arithmetic mean of the low water heights observed over a specific nineteen-year Metonic Cycle (the National Tidal Datum Epoch). For the New Jersey coast, the two low waters of each tidal day are included in the mean. This datum is available from the DEP, Bureau of Tidelands Management.

MEAN LOW-WATER LINE (MLWL)

The intersection of the land with the water surface at the elevation of mean low water. The elevation of mean low water varies along the oceanfront and the tidal bays and streams in the coastal zone.

MECHANICAL RELOCATION

Broadly defined to include the transport of sand by any mechanical means to or into the dune area, as well as the placement of sand obtained from off-site locations.

PATHWAY

An improved, protective accessway across the dune.

SAND FENCE

A wind-barricade-type of fence established in a line or a pattern to accumulate sand and aid in the formation of a dune, such as a picket-type consisting of light wooden slats held together by wire and affixed to wooden posts.

SEAWARD EDGE OF THE DUNE

The intersection line of the foreslope of the dune and the gradient of the beach area, or vegetation line, or the upper driftline, whichever is most easterly.

UPPER DRIFTLINE

The line produced by the winter spring tides (highest tides of the year) which contains oceanic debris (flotsam such as seaweed, etc.) and the seeds, rhizomes, or detached plants which can germinate and/or grow to produce a zone of new dune vegetation.

VEGETATION LINE

The line connecting the most seaward naturally occurring perennial plants with other such plants.

WALKWAY

A constructed means of crossing the dune area and usually consists of steps, ramps and elevated wooden walkways.

§ 156-23. Regulations; unlawful activities.

Except with the expressed approval of the Mayor and Council of the Borough of Stone Harbor, or in connection with the Borough's construction or placement of dune fencing, elevated walkways over the dunes, pathways and planting of dune vegetation, the following activities are unlawful:

A. To construct or attempt to construct any structure within the dune area.

B. To remove or cart away, by any means, any sand, sand fencing or dune vegetation from the dunes or from the area around the dunes.

C. To willfully or intentionally relocate or damage any sand fencing or any other type of dune protection device, or to hang any objects thereon.

D. To cut, burn or destroy any dune vegetation.

E. For any person, either on foot or on some form of conveyance, to:

(1) Disturb or destroy dune vegetation;

(2) Trespass within any area enclosed by sand fencing, or enclosed by sand fencing and the bulkhead along the beaches;
(3) Enter into those areas of the Public Use District and the Conservation Management District south of 122nd Street in all locations where dunes, dune grasses, or other forms of vegetation planted for the development of dunes exist;
(4) Enter into any other areas as may from time to time be specifically posted by order of the governing body.

F. To cross over the dunes by means other than using the pathways and elevated walkways constructed for that purpose.

G. To use and/or operate motor vehicles on the beach other than in accordance with Article II, Vehicles on Beaches, of this chapter.

H. To harvest beach sand or scrape beach sand or dunes without written approval by the Borough.

§ 156-24. Replenishment of sand and sand dunes.

A. Dune replenishment activity shall take place during periods prescribed by specific regulations, except in the case of emergency circumstances which constitute an immediate threat to the public health, safety and welfare as declared by appropriate Borough officials.

B. Replenished dunes shall be protected by planting appropriate vegetative cover in accordance with specifications set forth in Executive Policy 98-B-001.

C. Replenished dunes shall be immediately protected by the erection of sand fences in accordance with specifications set forth in Executive Policy 98-B-001.

D. In the event that the replenishment sand, or a portion thereof, is obtained from an off-site location, the added sand shall be of such grain size, shape, color and other characteristics as will be compatible with the existing on-site sand.

§ 156-25. Plans and records.

A. The Borough shall maintain a current plan to define the specific location and dimensions for the planting of dune vegetation, the erection of sand fencing, or the placement of temporary walkway protection in compliance with the standards set forth in Executive Policy 98-B-001.

B. The Borough shall conduct periodic inspections of beaches and prepare both written and photographic reports of findings in a format suitable for presentation as official evidence.

C. The Borough shall initiate and maintain beach profiles and engineering activities as part of a monitoring program, and maintain appropriate records.

§ 156-26. Enforcement; violations and penalties.

A. The Borough's Police Department shall enforce the various requirements defined and set forth in this article.

B. All persons or associations of persons shall, upon conviction of a violation of this article, be subject to the penalties set forth in Chapter 1, Article III, Penalty, of the Borough of Stone Harbor Code. *Editor's Note: Amended at time of adoption of Code (see Ch. 1, General Provisions, Art. I).*

§ 156-27. Exceptions.

Anything to the contrary herein notwithstanding, it shall be lawful for persons to traverse the area of the dunes upon duly designated pathways and walkways. It shall also be lawful for officials of the Borough of Stone Harbor, the State of New Jersey and the United States of America, their agents, representatives and contractors to traverse upon the dunes where necessary in connection with the erection of sand fencing, planting and fertilizing dune vegetation, erection of shore protection devices and other similar activities.

Borough of Stone Harbor, NJ
Wednesday, October 1, 2014

Chapter 156. BEACHES

[HISTORY: Adopted by the Borough Council of the Borough of Stone Harbor as indicated in article histories. Amendments noted where applicable.]

GENERAL REFERENCES

Beach supervision — See Ch. 18.
Public performances — See Ch. 121.
Alcoholic beverages — See Ch. 134.
Amusements; arcades — See Ch. 141.
Animals — See Ch. 147.
Bicycles, skateboards, roller skates and Segways — See Ch. 162.
Boating — See Ch. 170.
Bulkhead and dock construction — See Ch. 199.
Special events — See Ch. 275.
Flood damage prevention — See Ch. 300.
Loitering — See Ch. 363.
Noise — See Ch. 374.
Parks and recreation areas — See Ch. 400.
Peace and good order — See Ch. 405.

Article I. Paid Beaches

[Adopted as Sec. 12-4 of the 1982 Revised General Ordinances]

§ 156-1. Paid beaches established.

A. Paid places of resort, bathing and recreation, known as "paid beaches," are hereby established in the Borough of Stone Harbor for the public health, recreation and entertainment.

B. Such paid beaches shall include the oceanfront upon all lands in the Borough of Stone Harbor fronting on the Atlantic Ocean between 80th Street and Hereford Inlet, and upon all of the lands fronting on Hereford Inlet commonly known as "the beach."

§ 156-2. Fees and charges.

[Amended 3-7-2006 by Ord. No. 1251]

In order to provide the necessary funds and to improve, maintain and police the beaches, various fees shall be charged for such facilities and collected by the Beach Tag Sales Supervisor. The Borough Council shall have the right to change these fees from time to time by resolution of the Borough Council.

§ 156-3. Badges required; fee exemptions.

[Amended 10-18-2011 by Ord. No. 1392]

A. Persons 12 or older. No person of the age of 12 years or older shall bathe at or otherwise use the paid beaches without having first acquired and then having in his or her possession a proper and effective badge permitting him or her to use said beaches.

B. Persons in active military service. Though such persons are required to display a badge, no fees shall be charged to or collected from persons in active military service in any of the Armed Forces of the United States or to their spouse or dependent children over the age of 12 years.

C. Persons who are active members of the New Jersey National Guard. Though such persons are required to display a badge, no fees shall be charged to or collected from persons who are active members of the New Jersey National Guard who have completed initial active duty training and to their spouse or dependent children over the age of 12 years. As used in this subsection, "initial active duty training" means basic military training, for members of the New Jersey Air National Guard, and basic combat training and advanced individual training, for members of the New Jersey Army National Guard.

D. Persons who have served in any of the Armed Forces of the United States and who were discharged or released therefrom under conditions other than dishonorable and who either have served at least 90 days in active duty or have been discharged or released from active duty by reason of a service-incurred injury or disability (veterans). Though such veterans are required to display a badge, no fees shall be charged to or collected from such veterans. In order to obtain a badge with no fee, such veterans shall present to the Beach Supervisor documentation, consistent with law and the rules and regulations promulgated by The Adjutant General of the New Jersey Department of Military and Veterans Affairs, sufficient to establish entitlement to a badge with no fee.
[Added 3-4-2014 by Ord. No. 1438[1]]
[1]: *Editor's Note: Pursuant to this ordinance, former Subsection D was redesignated as Subsection E.*

E. Records and verification. As required by law, the Beach Tag Supervisor shall maintain a list of all individuals to whom beach tags are issued pursuant to Subsections **B**, **C**

and **D** above, including the names of all individuals and, as applicable hereunder, their family members who qualify for the beach fee exemption. The Beach Tag Supervisor shall also establish procedures for verifying that individuals and, as applicable hereunder, their family members qualify for the beach fee exemption by presentation by those claiming the exemption of appropriate credentials demonstrating active duty or veteran status.
[Amended 3-4-2014 by Ord. No. 1438]

§ 156-4. Hours.

The paid beaches shall be kept open during the usual bathing season, which shall be established on an annual basis by resolution of Borough Council. The beaches shall be opened during the hours from 10:00 a.m. to 5:00 p.m. prevailing time, except during inclement weather.

§ 156-5. Borough control.

The Mayor and Council are hereby authorized and empowered to:

A. Adopt by resolution, in addition to the rules and regulations herein enumerated, such other rules and regulations as may be necessary for the proper control and regulation of the beachfront and the waters adjacent thereto.

B. Designate by resolution the protected bathing beaches where boats and lifeguards are to be provided by the Borough and from which beaches persons may bathe and swim, and to change or abolish the precise location of any one or more of such protected bathing beaches from time to time, as safety and attending circumstances shall require.

C. Employ inspectors, lifeguards, and such other employees as may be necessary to carry out and enforce the provisions of this section and all rules and regulations established herein or subsequently adopted by resolution.

D. Purchase badges, checks or other insignia and such other supplies, materials and equipment as may be necessary.

E. Designate by resolution of the Borough Council from time to time, upon written application therefor, that the requirements of having a beach badge be lifted on certain beaches for the duration of certain functions found by Borough Council to be in the best interests of the Borough of Stone Harbor. Examples of such functions would be the conduct of a hobie cat race, a sailing race, a surfing tournament, a surf fishing tournament, or some other similar event. It is the intention of Borough Council that such events be kept to a reasonable number so as not to unduly interfere with the public's use of our beaches.

§ 156-6. Rules and regulations.

A. It shall be unlawful to violate any of the following rules and regulations, or those subsequently adopted by resolutions, during the bathing season or at other times if specifically provided for. No person shall:

(1) Bathe or swim from the paid beaches except from the protected bathing beaches where boats and lifeguards are provided, and at such times as the lifeguards are on duty; nor bathe or swim beyond a safe depth in the ocean as from time to time indicated or regulated by the lifeguards.

(2) Use a surfboard, boat or raft of any kind or description except at locations designated by the lifeguards.

(3) Engage in surf fishing in the bathing areas during bathing hours, except that surf fishing shall be permitted within 20 yards of either side of a jetty, subject to modification on a daily basis by the lifeguards on duty, depending upon water and wind conditions.

(4) Use the public beaches for picnicking. The word "picnicking" as used herein means the carrying of or otherwise transporting any box, basket, bag or tub or other receptacle in which there is contained food or beverage, or both, and the consumption of such food or beverages, or both.

(5) Consume alcoholic beverages on the public beaches.

(6) Change clothes, dress, undress or otherwise disrobe, except outer wraps.

(7) Sleep on the public beaches during any time between sunset and sunrise.

(8) Act in a loud, indecent, obscene or offensive manner.

(9) Revel, disport, or behave in a noisy and boisterous manner, emitting loud cries and other noises, so as to inconvenience others, or otherwise disrupt and disturb the public peace and dignity within the beach areas defined.

(10) Climb upon, stand on, tamper with or handle the lifeguard boats or other equipment used by the lifeguards.

(11) Throw, bat or catch a baseball, football, basketball, softball, metal horseshoes, beach darts, or engage in the playing of any game, which endangers the health and safety of others. This subsection shall not apply to the playing of beach tennis or playing "catch" with a soft rubber or beach ball, unless the health and safety of others is endangered.

(12)

Throw, place, deposit or leave any bottles, glass, crockery, sharp or pointed articles or things, paper, refuse or debris of any kind on the beaches.

(13) Conduct any commercial activity or business on the public beaches, unless specifically authorized to do so by Borough Council, or unless licensed to do so by the Borough of Stone Harbor. In addition, no person shall offer as a gift or free sample any article, goods, wares, merchandise, or any materials advertising any article, goods, wares or merchandise for sale, to any person on the public beaches of the Borough of Stone Harbor.

(14) Park vehicles, loiter, assemble, band or crowd together, so as to interfere, or be likely to interfere, with the ingress and egress of others at the street ends approaching the beaches.

(15) Drive or move any vehicle on the beach at anytime during the entire year without a permit issued in accordance with Article II, Vehicles on Beaches, of this chapter.

(16) Fly a kite of any size, shape or description or attempt to do so, or propel or cause the movement of any object through the air, whether manually, mechanically or electrically during the hours that the beach is made available for bathing.

(17) Start or maintain a fire on the beach at any time during the entire year without permit in writing issued by the Mayor.

(18) Permit or allow any dogs or other animals on the beachfront or the waters adjacent thereto, or upon any public walk contained on the beachfront, except as otherwise set forth in § **147-7H** of the Code of the Borough of Stone Harbor.

(19) Fail to immediately obey all orders, directions, whistles or other signals used by the lifeguards, the beach inspectors, the beach tag checkers and/or the Borough police officers.

(20) Operate a power-driven boat, jet ski, or other power-driven watercraft:

(a) Within 300 feet of any person swimming in the ocean off said beaches;

(b) Within an area circumscribed by a line drawn from the seaward end of any two of the Borough's stone revetments, the stone revetments themselves and the beach; or

(c) Within 300 feet of the seaward side of the line drawn from the seaward end of any two stone revetments.

(21) Use a surfboard, without a leash attached thereto, in the water off the beach; use a kayak, in the waters off the beach, without wearing a life jacket.

B. This section shall be applicable between the 15th day of May and the 25th day of September during the hours of 8:00 a.m. and 6:00 p.m., inclusive.

§ 156-7. Revocation of beach privileges.

The Borough reserves the right to revoke any beach privileges granted under this article for any violations of its provisions, or other rules and regulations, and to retake and impound any beach identification badge or permit which has been improperly used or obtained. Such revocation shall not preclude the imposition of any other penalties provided for such violation.

§ 156-8. Violations and penalties.

[Amended 3-7-2006 by Ord. No. 1251]
Anyone violating any provision of this article shall, upon conviction thereof, be subject to a minimum fine of $30 and the maximum penalties set forth in Chapter **1**, Article **III**, Penalty, of the Borough of Stone Harbor Code.

Article II. Vehicles on Beaches

[Adopted as Sec. 12-5 of the 1982 Revised General Ordinances]

§ 156-9. Placement or operation of vehicles regulated.

Except as hereinafter provided, it shall be unlawful to place or to operate an automobile, truck, motorcycle, minibike, or other vehicle on the beach within the Borough.

§ 156-10. Application for permit.

[Amended 8-16-2011 by Ord. No. 1385]

A. Any person desiring to operate a permitted vehicle on the beaches shall make application to the Borough Clerk of the Borough of Stone Harbor to do so between the hours of 8:30 a.m. and 4:00 p.m., Monday through Friday. The applicant shall furnish his/her name, address, valid driver's license, registration and insurance card, make, model and year of vehicle and license plate number.

B. The applicant shall sign a completed application and by signing the application agrees to have the required equipment maintained in the vehicle, tow rope, jack with board, inflated spare tire, shovel, fire extinguisher, first aid kit and flashlight. By signing the application, the applicant agrees to allow spot inspections of his/her vehicle for this equipment by the Stone Harbor Police Department while operating on the beach in

Stone Harbor. Failure to maintain the equipment while in operation on the beach in Stone Harbor will result in a fine.

§ 156-11. Permitted vehicles; insurance.

Permits shall only be issued for vehicles which have passed inspection by the Division of Motor Vehicles of the State of New Jersey for the current year or by the equivalent department or agency of the state in which the vehicle is registered. Such vehicles must also be insured for liability, etc., in an amount which is at least the amount required by the State of New Jersey.

§ 156-12. Permit fee and application.

[Amended 3-7-2006 by Ord. No. 1251; 8-16-2011 by Ord. No. 1385]
The fee for a permit shall be established by the Borough Council by resolution for the season, or any portion thereof, for which the application is made. Applications shall be accepted by the Borough Clerk between September 1 and March 15 of the following year. Payment in full shall accompany the applications.

§ 156-13. Display of permit.

Upon issuance of a permit, the permittee shall receive a descriptive decal which shall be prominently displayed upon the vehicle. The permit shall be carried on the vehicle at all times and made available for inspection to any member of the Police Department when the vehicle is on the beach, or when the vehicle is about to enter or has just exited from the beach. A copy of this article shall be carried in the vehicle during operations on the beach.

§ 156-14. Expiration date; renewal.

[Amended 8-2-2005 by Ord. No. 1240; 8-16-2011 by Ord. No. 1385]
Permits shall be issued for the season, which will run from October 1 through March 15, inclusive, for the beachfront from 122nd Street North and from the day after Labor Day to March 15 for the beach front and Point Area from 122nd Street South. Application for renewal shall be made in the same manner as an original application.

§ 156-15. Rules and regulations.

[Amended 8-2-2005 by Ord. No. 1240; 8-16-2011 by Ord. No. 1385]

A. No vehicles with sleeping or eating accommodations shall be issued a permit or operated on the beaches at any time.

B. No vehicles shall be operated on the beaches of the Borough at a speed in excess of 15 miles per hour.

C. Vehicles are prohibited from operation on the beaches between 111th and 114th Streets, inclusive.

D. Permitted vehicles may enter the beach areas only for the purposes of fishing, and when the fishing is completed, they shall promptly be removed from the beach.

E. No permit issued hereunder shall be construed to authorize the right to operate a vehicle over private property without the permission of the owner of such property.

F. Permitted vehicles shall only operate upon the hard sand and shall not be operated more than 25 feet above the mean high water line of the Atlantic Ocean, except when entering or exiting the beach. Said vehicles shall not be operated over or upon the dunes or meadowland. Permitted vehicles may only be operated by the person to whom the permit has been issued, and the hours of operation shall be as follows:

(1) On the beaches south of 122nd Street: at any time from the day after Labor Day until March 15, inclusive.

(2) Upon the beaches north of 122nd Street: during the period one hour prior to sunrise until one hour past sunset only.

G. All permitted vehicles shall only be usable for beach fishing and shall have four-wheel drive or shall otherwise be suitable for operation in the sand. The Police Department, in making the determination as to whether or not the vehicle is suitable for operation in the sand, shall consider the following factors: whether or not the vehicle has a truck-type chassis, the type of drive, i.e., front or rear, whether or not it has special tires, its power; and avoid permitting vehicles which are likely to become stuck in the sand from being operated on the beach.

H. Access to the beaches shall be limited to the following locations:

(1) The ramps at 85th Street, 96th Street, 102nd Street, 118th Street, 122nd Street, the ramp at the 123rd Street parking lot and the beach and the ramp in the southwesterly corner of the parking and turning-around area adjacent to the 127th Street groin.

I. Access to the beach from the ramp in the parking and turning area adjacent to the 127th Street groin shall be along the new access road running from the 123rd Street parking lot, west of the bulkhead. The old access road, having its entrance at 122nd Street and Second Avenue and proceeding west for approximately 150 feet before turning and heading to the beach, shall be closed to vehicular traffic with the exception of emergency vehicles and Borough vehicles on Borough business.

J. The Mayor, or in his or her absence the Acting Mayor, shall have the right to close beaches to all but emergency vehicles, when the conditions on the beach are determined by said Mayor or Acting Mayor, in his or her sole discretion, to be dangerous for motor vehicles or if the conditions are such that the motor vehicles may cause damage to the beach or the dunes or, if after consultation with state and/or federal regulators, such closure is determined by the Natural Resources Committee to be necessary for the protection of wildlife.

§ 156-16. Adoption of additional rules and regulations.

[Amended 3-7-2006 by Ord. No. 1251]
The Borough Council is authorized and empowered to adopt by resolution such other rules, regulations, and requirements as it may deem necessary for the proper control, operation, and removal of automobiles and other vehicles on the beaches, including a requirement that such vehicles shall contain equipment for the purpose as shall be specified in the resolution. Also, the power and authority to change by resolution the hours when authorized vehicles shall be permitted on the beach, and the place or places of entry to and exit from the beach. Permittees shall comply with all the rules, regulations, and requirements herein set forth and as shall subsequently be amended or adopted.

§ 156-17. Revocation of permit.

The Borough reserves the right to revoke any beach privileges granted under this article for any violations of its provisions, or of other rules and regulations, and to retake and impound any permit which has been improperly used or obtained. Such revocation shall not preclude the imposition of any other penalties provided for such violation.

§ 156-18. Exceptions.

[Amended 5-5-2009 by Ord. No. 1337]
The provisions of this article shall not apply to Borough employees who may be required to enter upon the beaches in the performance of their municipal duties or functions, nor to any governmental agency, its employees, agents, contractors and subcontractors, who may be engaged in beach restorations or protection work, nor to any Borough contractor or permitee where the terms of such contract or permit allow for the operation of vehicles.

§ 156-19. Violations and penalties; suspension or revocation of permit.

[Amended 3-7-2006 by Ord. No. 1251; 8-16-2011 by Ord. No. 1385]

Anyone violating a provision of this article shall, upon conviction thereof, be subject to a minimum fine of $250 and the maximum penalties set forth in Chapter 1, Article III, Penalty, of the Borough of Stone Harbor Code, and revocation of the permit.

Article III. Beach and Dune Protection

[Adopted as Sec. 12-7 of the 1982 Revised General Ordinances]

§ 156-20. Preamble.

The beach berm and dunes offer the first line of defense against the sea during a storm. Dune areas are vulnerable to erosion and damage by wind, water, indiscriminate trespass, construction, acts which damage their protective vegetation, and the absence of good husbandry. Therefore, the Borough has a vital interest in establishing and maintaining a protection program for the beach and dune areas.

§ 156-21. Policy.

A. It is the policy of this Borough to encourage the development of sand dunes, and to take whatever steps are required to maintain and protect these dunes. The specifics for such steps are set forth in Executive Policy 98-B-001, as amended from time to time.

B. All the provisions of this article are deemed necessary, material and substantial, and are therefore not subject to waiver or variance.

§ 156-22. Definitions.

As used in this article, the following terms shall have the meanings indicated:

BEACH AREA
The area between the mean low-water line of the ocean and the seaward edge of the dune as hereinafter defined.

DUNE AREA
The area between the seaward edge of the dune and the landward edge of the dune.

DUNE VEGETATION
All plant species found on beaches and dunes of northeastern US, either native or introduced, which can build and stabilize sand dunes.

LANDWARD EDGE OF THE DUNE
The intersection line of the backslope of the dune and the sea wall.

MEAN HIGH WATER (MHW)

A tidal datum that is the arithmetic mean of the high-water heights observed over a specific nineteen-year Metonic Cycle (the National Tidal Datum Epoch). For the New Jersey coast, the two high waters of each tidal day are included in the mean. This datum is available from the DEP, Bureau of Tidelands Management.

MEAN HIGH-WATER LINE (MHWL)

The intersection of the land with the water surface at elevation of mean high water. The elevation of mean high water varies along the oceanfront and the tidal bays and streams in the coastal zone. (Note: For practical purposes, the mean high-water line is often referred to as the "ordinary" high-water line, which is typically identified as the limit of wet sand or debris line on a beach, or by a stain line on a bulkhead or piling.)

MEAN LOW WATER (MLW)

A tidal datum that is the arithmetic mean of the low water heights observed over a specific nineteen-year Metonic Cycle (the National Tidal Datum Epoch). For the New Jersey coast, the two low waters of each tidal day are included in the mean. This datum is available from the DEP, Bureau of Tidelands Management.

MEAN LOW-WATER LINE (MLWL)

The intersection of the land with the water surface at the elevation of mean low water. The elevation of mean low water varies along the oceanfront and the tidal bays and streams in the coastal zone.

MECHANICAL RELOCATION

Broadly defined to include the transport of sand by any mechanical means to or into the dune area, as well as the placement of sand obtained from off-site locations.

PATHWAY

An improved, protective accessway across the dune.

SAND FENCE

A wind-barricade-type of fence established in a line or a pattern to accumulate sand and aid in the formation of a dune, such as a picket-type consisting of light wooden slats held together by wire and affixed to wooden posts.

SEAWARD EDGE OF THE DUNE

The intersection line of the foreslope of the dune and the gradient of the beach area, or vegetation line, or the upper driftline, whichever is most easterly.

UPPER DRIFTLINE

The line produced by the winter spring tides (highest tides of the year) which contains oceanic debris (flotsam such as seaweed, etc.) and the seeds, rhizomes, or detached plants which can germinate and/or grow to produce a zone of new dune vegetation.

VEGETATION LINE

The line connecting the most seaward naturally occurring perennial plants with other such plants.

WALKWAY

A constructed means of crossing the dune area and usually consists of steps, ramps and elevated wooden walkways.

§ 156-23. Regulations; unlawful activities.

Except with the expressed approval of the Mayor and Council of the Borough of Stone Harbor, or in connection with the Borough's construction or placement of dune fencing, elevated walkways over the dunes, pathways and planting of dune vegetation, the following activities are unlawful:

A. To construct or attempt to construct any structure within the dune area.

B. To remove or cart away, by any means, any sand, sand fencing or dune vegetation from the dunes or from the area around the dunes.

C. To willfully or intentionally relocate or damage any sand fencing or any other type of dune protection device, or to hang any objects thereon.

D. To cut, burn or destroy any dune vegetation.

E. For any person, either on foot or on some form of conveyance, to:

(1) Disturb or destroy dune vegetation;

(2) Trespass within any area enclosed by sand fencing, or enclosed by sand fencing and the bulkhead along the beaches;

(3) Enter into those areas of the Public Use District and the Conservation Management District south of 122nd Street in all locations where dunes, dune grasses, or other forms of vegetation planted for the development of dunes exist;

(4) Enter into any other areas as may from time to time be specifically posted by order of the governing body.

F. To cross over the dunes by means other than using the pathways and elevated walkways constructed for that purpose.

G.

To use and/or operate motor vehicles on the beach other than in accordance with Article II, Vehicles on Beaches, of this chapter.

H. To harvest beach sand or scrape beach sand or dunes without written approval by the Borough.

§ 156-24. Replenishment of sand and sand dunes.

A. Dune replenishment activity shall take place during periods prescribed by specific regulations, except in the case of emergency circumstances which constitute an immediate threat to the public health, safety and welfare as declared by appropriate Borough officials.

B. Replenished dunes shall be protected by planting appropriate vegetative cover in accordance with specifications set forth in Executive Policy 98-B-001.

C. Replenished dunes shall be immediately protected by the erection of sand fences in accordance with specifications set forth in Executive Policy 98-B-001.

D. In the event that the replenishment sand, or a portion thereof, is obtained from an off-site location, the added sand shall be of such grain size, shape, color and other characteristics as will be compatible with the existing on-site sand.

§ 156-25. Plans and records.

A. The Borough shall maintain a current plan to define the specific location and dimensions for the planting of dune vegetation, the erection of sand fencing, or the placement of temporary walkway protection in compliance with the standards set forth in Executive Policy 98-B-001.

B. The Borough shall conduct periodic inspections of beaches and prepare both written and photographic reports of findings in a format suitable for presentation as official evidence.

C. The Borough shall initiate and maintain beach profiles and engineering activities as part of a monitoring program, and maintain appropriate records.

§ 156-26. Enforcement; violations and penalties.

A. The Borough's Police Department shall enforce the various requirements defined and set forth in this article.

B.

All persons or associations of persons shall, upon conviction of a violation of this article, be subject to the penalties set forth in Chapter **1**, Article **III**, Penalty, of the Borough of Stone Harbor Code.[1]

[1]: *Editor's Note: Amended at time of adoption of Code (see Ch. 1, General Provisions, Art. I).*

§ 156-27. Exceptions.

Anything to the contrary herein notwithstanding, it shall be lawful for persons to traverse the area of the dunes upon duly designated pathways and walkways. It shall also be lawful for officials of the Borough of Stone Harbor, the State of New Jersey and the United States of America, their agents, representatives and contractors to traverse upon the dunes where necessary in connection with the erection of sand fencing, planting and fertilizing dune vegetation, erection of shore protection devices and other similar activities.

Article IV. Public Beachfront Recreational Area

[Adopted as Sec. 12-8 of the 1982 Revised General Ordinances]

§ 156-28. Public beachfront recreational area created.

A public beachfront recreational area is hereby created east of the oceanfront bulkhead, which presently runs from 80th to 127th Street, and also eastwardly of that line, if extended, to the southerly tip of the island, with the exception only of the parcel of beachfront between the jetties at 111th and 114th Streets in the Borough of Stone Harbor.

§ 156-29. Public beachfront nondiscriminatory.

The public beachfront recreational area shall be opened to the general public on a nondiscriminatory basis for recreational purposes, subject to appropriate fee regulation in connection with public bathing purposes and subject to other appropriate regulations by the Borough, if and when required, for the proper operation and maintenance thereof.

§ 156-30. Privately owned beachfront.

In the event the Catholic Church should cease to be the owner of Lots 1 through 8, Block 112.1, then that portion of such parcel of land east of the bulkhead shall be acquired by the Borough of Stone Harbor, and the beachfront east of the bulkhead between the jetties at 111th and 114th Street shall be included as part of the public beachfront recreational area and shall be subject to the terms of this article.

§ 156-31. Acknowledging public beachfront recreational area.

This article further acknowledges that the entire southern portion of the island south of 127th Street and a portion of the island as far north as 122nd Street is governed by an easement of record by which the Borough of Stone Harbor is to preserve and protect such property as a wildlife habitat, and a recreational educational nature area for such activities as nature walking, bird watching, and fishing as permitted and regulated. This area is subject to the Coastal Area Facility Review Act (CAFRA) Permit No. CA 75-7-125, and the Order of Dismissal from the Office of Administrative Law, Docket No. ESA 1412-80. The Permit and Order contain conditions that the area south of 127th Street is to be conserved to protect natural resources and provides that the use and parking of motor vehicles shall be regulated such that dunes, endangered and threatened wildlife habitat, critical wildlife habitat, wetlands and other natural resources are protected.

EXECUTIVE POLICY

Borough of Stone Harbor

Title: Beaches and Dunes

Number: B-002

POLICY:

It is the policy of this Borough to encourage the development of beaches and sand dunes, and to take whatever steps are required to build, maintain and protect such beaches and dunes.

In the performance of these duties, the Borough shall follow the procedures and guidelines set forth in this policy.

PROCEDURE:

DUNE PLANTING:

Planting may take place at any time based upon weather and ground conditions. Spring planting should be accomplished by frequent watering, where practical. Initial and subsequent fertilization is recommended at the rate of about 2 pounds of slow-release 10-10-10 per 1000 square feet.

For initial planting, or replanting sparse areas, Cape American beach grass (Ammophila brevillgula) should be used. The entire Dune Area behind the foreslope shall be planted. The vegetation will voluntarily grow down the foreslope.

Only fresh planting stock cut back to 16-18 inches long shall be utilized. Spacing shall be no greater than 18 inches, two stems to a hole, at least 7 inches deep. If not planted with a water flooding method, the sand shall be compacted to eliminate air pockets.

Sand placed by earth moving equipment shall be allowed to become compacted by rains before planting is commenced.

After beach grass has been established, other appropriate vegetation may be added.

Adopted by Resolution 2001-S-67 on May 1, 2001

EXECUTIVE POLICY

Borough of Stone Harbor

Title: Beaches and Dunes | Number: B-002

SAND FENCING:

Fencing shall be standard 4-foot wood sand (snow) fence in good condition, secured to wooden posts of a minimum cross-section of 4 square inches and a minimum length of 6 ½ feet, with a maximum span between posts of 12 feet. Alternate fencing, as approved by the Borough, may be used.

Where practical, there shall be at least two parallel lines of fencing the length of each section of the dune area, a minimum of 10 feet apart. At least one line of fencing should be in a zig-zag pattern with alternate posts offset by at least 5 feet.

Half-height fencing may be used on the back dune.

ELEVATED WALKWAYS:

Walkways shall be constructed at an elevation and design in accordance with Borough and other appropriate government or regulatory codes and building standards.

Whenever the dune builds to the point that any part of the surface of an existing walkway is at or below the sand surface elevation within five feet to either side, that walkway shall be raised.

PATHWAYS:

If an elevated walkway is not used to access the ocean, a clearly defined pathway may be established. Such pathway shall be protected by placing suitable material on the sand surface.

Adopted by Resolution 2001-S-67 on May 1, 2001

APPENDIX B:

NJDEP Jurisdictional Determination

State of New Jersey

DEPARTMENT OF ENVIRONMENTAL PROTECTION
Division of Land Use Regulation
Mail Code 501-02A, P. O. Box 420
Trenton, New Jersey 08625-0420
www.state.nj.us/dep/landuse

CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

BOB MARTIN
Commissioner

Stone Harbor Borough
9508 Second Ave.
Stone Harbor, NJ 08247

SEP 18 2015

Re: COASTAL JURISDICTIONAL DETERMINATION
LUR File No.: 0510-15-0006.1
Activity Number: APD150001
Applicant: STONE HARBOR BORO
Block(s) and Lot(s): [N/A, N/A]
Stone Harbor Borough, Cape May County

Dear Madam and/or Sir:

This letter is in response to your request for a jurisdictional determination for the proposed dune re-vegetation on the above referenced site within the CAFRA regulatory area in a non-qualifying municipality. Potentially applicable statutes include Waterfront Development Act (N.J.S.A. 12:5-3 et. seq.), Wetlands Act of 1970 (N.J.S.A. 13:9A-1 et. seq.) and the Coastal Area Facility Review Act, CAFRA, (N.J.S.A. 13:9-1 et. seq.).

Based on a review of the information and a review of information as maintained on the Department's Geographic Information System the following determination is made:

Based on a review of the Coastal Permit Program Rules, the following determination is made:

(x) **A Waterfront Development permit is not required**, as no portion of the proposed dune re-vegetation will be conducted at or below the elevation of Mean High Water.

Based on a review of the Coastal Permit Program Rules, the following determination is made:

(x) **A CAFRA permit is not required**, as dune re-vegetation (with native, non-invasive species) is encouraged but not regulated.

Based on a review of the Coastal Wetlands Maps, the following determination is made:

(x) **Coastal Wetlands permit is not required.** Coastal Wetlands are mapped on this site. However, no activity is proposed at or below the Upper Wetlands Boundary.

This letter does not constitute a jurisdictional determination for the Freshwater Wetlands Protection Act Rules at N.J.A.C. 7:7A and the Flood Hazard Area Control Act Rules at N.J.A.C. 7:13-1.1 et seq. For assistance with the applicability of these statutes you are advised to contact the Division's Technical Support Center at (609)777-0454.

This letter does not relieve the applicant of the responsibility of obtaining any other required State, Federal or local permits or approvals as required by law and is based on the information submitted in accordance with existing regulation. This determination shall be considered null and void if the submitted information is incorrect, site conditions or regulations change.

Please contact Jeffrey Alpert of our staff by e-mail at Jeff.Alpert@dep.nj.gov or (609) 777-0454 should you have any questions regarding this letter. Be sure to indicate the Department's file number in all communication.

Sincerely,

Wm J. Kresnosky

William J. Kresnosky, Supervisor
Division of Land Use Regulation

9/18/15
DATE:

Cc: Bureau of Coastal and Land Use Compliance and Enforcement, Toms River
Stone Harbor Borough Construction Official
Agent

APPENDIX C:
Approved List of Dune Vegetation

the LOMAX Consulting group

P. O. Box 9 (MAILING)
1435 ROUTE 9 NORTH (DELIVERY)
CAPE MAY COURT HOUSE, NJ 08210, USA

609-465-9857 (P)
609-465-2449 (F)
WWW.LOMAXCONSULTING.COM

LIST OF DUNE VEGETATION

This List of Dune Vegetation was developed for the purpose of restoring/enhancing dune ecosystems utilizing native vegetation. The List was developed from review of literature, direct dune observations in natural areas of coastal barrier island communities and preserved maritime forests, including Island Beach State Park, in addition to personal experience and communications with other qualified professionals in the field. It is acknowledged that the Dune Vegetation List presented below was prepared originally for the Borough of Avalon and approved by their Environmental Commission. This List has been tested and refined over several years.

Adapted vegetation is an integral part of the overall dune system that is vital to the protection to the Borough from coastal storms. This vegetation not only aids sand deposition and accumulation, but also serves to retain the sand in the dune system. Accordingly, the selection of plants that will survive and flourish in the harsh environment of the dune system is critical. The Borough's dune system is a diverse ecosystem exposed to wind and salt spray. The dune soils are sandy, and as such, are droughty. In recognition of these conditions, the following vegetation list has been divided into two main categories regarding exposure and soil moisture conditions: (A) Salt Spray Tolerant Vegetation; and (B) Sheltered Upland Dune Vegetation based on the species tolerance of conditions and location in the dune system. The criteria for selection of the following native plants for dune re-vegetation include: (1) adaptation to survival in the dune environment; (2) resistance to disease and pests; (3) drought hardiness after they are established; (4) ability to be pruned to control shape and height, if trimming is begun early in the tree/shrub development; and (5) availability from nurseries.

One asterisk (*) indicates that this species is used by wildlife for food (including pollinators) and cover. Two asterisks (**) indicate that the plant has high wildlife value. (E) indicates that the plant is evergreen.

A. Salt Spray Tolerant Vegetation

1. **Trees:**

Common Name	Scientific Name
Eastern red cedar *(E)	*Juniperus virginiana*
Black cherry **	*Prunus serotina*
Winged sumac **	*Rhus copallinum*
Smooth sumac **	*R. glabra*

2. **Shrubs:**

Common Name	Scientific Name
Northern bayberry **(E)	*Morella pensylvanica*

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CAPE MAY COURT HOUSE, NJ 08210, USA

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WWW.LOMAXCONSULTING.COM

A. Salt Spray Tolerant Vegetation (continued)

Wax myrtle *	*M. cerifera*
Beach plum *	*Prunus maritima*
Groundsel *	*Baccharis halimifolia*
Bearberry (E)	*Arctostaphylos uva-ursi*
Beach-heather (E)	*Hudsonia tomentosa*

3. Vines:

Common Name	Scientific Name
Virginia creeper **	*Parthenocissus quinquefolia*

4. Herbaceous:

Common Name	Scientific Name
American beachgrass	*Ammophila breviligulata*
Sea rocket	*Cakile edentula*
Seaside spurge	*Euphorbia polygonifolia*
Coastal panicgrass *	*Panicum amarum var. amarulum*
Seaside goldenrod **	*Solidago sempervirens*
Beach pea *	*Lathyrus japonicus*
Dusty miller	*Artemisia stelleriana*
Rough cocklebur	*Xanthium strumarium*
Prickly pear (cactus)*(E)	*Opuntia humifusa*

B. Sheltered Upland Dune Vegetation

1. Trees:

Common Name	Scientific Name
Pitch pine **(E)	*Pinus rigida*
Eastern red cedar *(E)	*Juniperus virginiana*
Sassafras **	*Sassafras albidum*
Hackberry **	*Celtis occidentalis*
American holly *(E)	*Ilex opaca*
Scarlet oak **	*Quercus coccinea*
Black oak **	*Q. valutina*
Blackjack oak **	*Q. marilandica*
Scrub oak **	*Q. ilicifolia*
Pignut hickory *	*Carya glabra*
Mockernut hickory *	*C. tomentosa*
Hop-hornbeam *	*Ostrya virginiana*
Winged sumac **	*Rhus copallinum*
Smooth sumac **	*R. glabra*
Persimmon **	*Diospyros virginiana*

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2. Shrubs:

Common Name	Scientific Name
Northern bayberry **(E)	*Morella pensylvanica*
Wax myrtle *	*M. cerifera*
Beach plum *	*Prunus maritime*
Groundsel *	*Baccharis halimifolia*
Inkberry holly **(E)	*Ilex glabra*
Low rose **	*Rosa carolina*
Sweet fern *	*Comptonia peregrina*

3. Vines:

Common Name	Scientific Name
Climbing bittersweet *	*Celastrus scandens*
Trumpet vine *	*Campsis radicans*

4. Herbaceous:

Common Name	Scientific Name
Bitter panicgrass *	*Panicum amarum*
Coastal panicgrass *	*Panicum amarum var. amarulum*
Saltmeadow cordgrass	*Spartina patens*
Switchgrass **	*Panicum virgatum*
Bluestem	*Schizachyrium scoparium*
Seaside goldenrod **	*Solidago sempervirens*
Beach pea *	*Lathyrus japonicus*
Partridge pea *	*Chamaecrista fasciculata*
Rough cocklebur	*Xanthium strumarium*
Dusty miller	*Artemisia stelleriana*
Prickly pear (cactus) * (E)	*Opuntia humifusa*
Spanish bayonet * (E)	*Yucca filamentosa*
Yarrow *	*Achillea millefolium*
Butterfly Milkweed **	*Asclepias tuberosa*

APPENDIX D.

Standard for Creating and Restoring Sand Dunes

STANDARD
for
CREATING and RESTORING SAND DUNES
From Massachusetts to North Carolina

Written by: Mike Fournier, Former PMC Manager

Edited by:
Christopher Miller, Regional Plant Specialist, USDA-NRCS
William Skaradek, Manager, Cape May Plant Materials Center

DEFFINITION: Effective establishment and maintenance of physical (living or inert) barriers which manage the surface movement of shifting coastal beach sands.

PURPOSE: To develop a system of coastal sand dunes to protect human lives, personal property, and community infrastructures. A secondary benefit of such developments is the creation and protection of critical habitat of threatened and endangered bird species.

WHERE APPLICABLE: Along ocean and bay shorelines; where blowing sands and storm waters may cause damage to human and wildlife resources.

METHODS and MATERIALS: Sand dunes naturally form on barrier islands, shorelines exposed directly to the ocean, and inland sand deposits. The source of this wind born sand is the ocean or its bays. These parallel ridges of sand form perpendicular to prevailing winds and grow toward its source of sand. Periodic storm events and human activity continually alter their development and original configuration. Once developed the sand dunes provide adequate protection from moderate storms and tides. The existence and maintenance of vegetation on dunes provides a network of root and foliage which holds unconsolidated sand in place. American beachgrass is the dominant, naturally occurring, vegetation of the frontal dunes of the northern Mid-Atlantic and New England coasts. From Vriginia beach southward through the Carolinas, sea oats becomes the dominant foredune plant. When beachgrass or sea oats are established with structural resources and other dune species, a formidable well-anchored storm barrier is established, capable of saving major public and private assets. Establishing curvilinear foot paths or wooden crosswalks through or over the sand dunes, bordered by sand fencing, is necessary where foot or vehicular traffic is expected.

1.VEGETATION

A. **Plant Materials**: The foliage of most sand dune species filters sand from the wind. The reduction of wind velocity near the dune's surface by vegetation allows sand to be deposited. The root mass of these plant species adapted to the sand dune environment are typically deep and extensive, anchoring the dunes to their foundation. When possible only certified cultivars, which have been tested on similar sites, should be utilized for protecting valuable coastal resources.

1).<u>Cultivar Releases</u> recommended for stabilizing sand dunes; all cultivars listed were released by the USDA- Natural Resources Conservation Service's Plant Materials Program:

a.) **'Cape'** american beachgrass (*Ammophila breviligulata*)
b.) **'Atlantic'** coastal panicgrass (*Panicum amarum var. amarulum*)
c.) **'Northpa'** bitter panicgrass (*Panicum amarum*)
d.) **'Avalon'** saltmeadow cordgrass (*Spartina patens*)
e.) **'Monarch'** seaside goldenrod (*Solidago sempervirens*)
f.) **'Wildwood'** bayberry (*Myrica pensylvanica*)
g.) **'Ocean View'** beach plum (*Prunus maritima*)
h.) **'Sandy'** rugosa rose (*Rosa rugosa*)
i.) **'Emerald Sea'** shore juniper (*Juniperus conferta*)

2.) <u>Non-Cultivar Releases</u> suitable for adding plant diversity on sand dunes:

a.) seashore little bluestem (*Schizachyrium scoparium* var. *littoralis*)
b.) sea oats (*Uniola paniculata*)
c.) switchgrass (*Panicum virgatum*)
d.) partridge pea (*Chamaecrista fasiculata*)
e.) beach pea (*Lathyrus maritimus*)
f.) eastern red cedar (*Juniperus virginiana*)
g.) groundsel tree (*Baccharis halimifolia*)

<u>**NOTE:**</u> The cultivars listed were developed specifically for sand dune stabilization and should be specified and used when available. By using cultivars developed for such a harsh environment, the risk of plant failure is reduced.

In addition, when developing a planting plan for a dune system, it is imperative to plant species in their zone of adaptation. The species best adapted to the frontal dune face are american beachgrass, bitter panicgrass, and sea oats (Delmarva Penninsula and south). As you move onto the back of the frontal dune or into the secondary dune system, the additional species listed above may be incorporated into the planting as available. By broading the plant diversity, the risk of plant failure is further minimized. See (Diagram 1) for plant zonation guidelines.

B. Plant Establishment

1.) **(Cape) american beachgrass** (*Ammophila breveligulata*)- Beachgrass is successionally classified as a pioneering type species; it is about the only species capable of surviving the harsh environmental conditions of the frontal dunes. For initially stabilizing a dune system, this species is the most reliable and commercially available option. Once established it rapidly spreads by a rhizomatous root system, developing a soil binding network of inter-woven roots.

<u>Date</u> = November 1 to April 1; under non-frozen soil conditions
<u>Planting Unit</u> = a minimum of two stems (culms) per hole
<u>Method</u> = hand placement, or use of a vegetable or tree planter
<u>Size</u> = 16 to 18 inch long stems, ≥ ¼ inch in diameter
<u>Depth</u> = culms placed approximately 8-10 inches deep
<u>Spacing</u>: severe sites = 12" X 12"
normal sites = 18" X 18"
stable sites = 24" X 24"

<u>Notes</u>:

- Plant ≥ 100 feet of horizontal distance from the mean high tide water line to ensure success
- Plant a minimum of 10 parallel rows; stagger (off-set) rows to maximize protection
- Firm soil around plants to eliminate air pockets
- If utilizing dredged fill allow salts to leach out before planting and rains to compact sands

2.) **(Northpa) bitter panicgrass** (*Panicum amarum*)– This perennial, warm-season grass with a prostrate growth habit spreads slowly from short, strong rhizomes initially forming open clumps. Over time these clumps can fuse to form a dense mat of vegetation. Since this grass produces little viable seed it must be planted vegetatively.

<u>Date</u>: potted plants = April 1 to May 1
bare root = November 1 to April 15
stem cuttings = April 1 to May 15
<u>Planting Unit</u> = single bare-root or containerized seedling or stem division; 12 - 18 inches tall
<u>Depth</u>: potted/bareroot = 2 inches deeper than the nursery depth
Stem cuttings= place on a 45 degree angle in a 8-10 inch hole or slit leaving the top 6-10" of stem exposed.
<u>Method</u>: plants = hand placed, or using a vegetable transplanter
<u>Spacing:</u> Potted/bareroot = 2 feet apart in 2-3 foot staggered rows.
Stem cuttings= minimum of three stems/hole, spaced 2 feet apart in staggered 2-3 foot rows

3.) **(Atlantic) coastal panicgrass** (*Panicum amarum var.amarulum*)- This warm season bunch-like grass is a post stabilization species thriving from the crest of the frontal dune to inland sites. It is the only dune stabilization species which has been directly seeded on to the sand dunes successfully. Potted plants and stem divisions can also be successfully established on these severe sites. The annual foliage emerges from a deep fibrous perennial root system with short lateral rhizomes. This species can be successfully planted with or over seeded into stands of American beachgrass. The closely related switchgrass is not as well adapted to sand dune conditions due to its lower seedling vigor. However, it is a good alternative, especially north of Long Island where coastal panicgrass is not native.

<u>Date</u>: Seeding: over seeding = April 1 to May 1
Dormant seeding = November 1 to April 15
Planting = April 1 to May 15
<u>Planting Unit</u> = single bare-root or containerized seedling or division; 12 - 18 inches tall
<u>Seeding rate</u> = 8 to 12 Lbs. of Pure Live Seed (PLS) per acre
<u>Depth</u>: plants = 2 inches deeper than the nursery depth
seed = drilled 1½ to 2½ inches deep
<u>Method</u>: seed = hand broadcast/incorporated, garden seeder (single row, push) or mechanically operated drill or drop seeder

plants = hand placed, or use a vegetable or tree transplanter

Spacing: plants = place 2-4 feet apart within a row with rows spaced 6-8 feet apart

seed = 3' to 10' row spacing

4.) **Sea oats** (*Uniola paniculata*)- **Adapted only south of the Delaware Bay (Delmarva Pennisula & south).** Within it's range, sea oats is the most important plant in the pioneer (frontal dune) zone. Like beachgrass, it flourishes best where sand is drifting and accumulating. However, unlike beachgrass, it persists as a perennial cover after the sand has been stilled but dies back to the ground over the winter. For initial stabilization of a sand dune, it is best to interplant both species.

Date = March 1 to April 15
Planting Unit = one bare-root or potted plant
Depth = 2 inches below the nursery grown depth
Method = hand placed, or vegetable planter
Size = ≥ 24-36 inch stem
Spacing = 18 to 36 inch row spacing with plants placed 18 inches apart within a row. May be interplanted with american beachgrass by alternating rows of each species.

5.) **(Avalon) saltmeadow cordgrass** (*Spartina patens*)- Although typically associated with tidal salt marshes, saltmeadow cordgrass also naturally occurs in the secondary and back dune areas. Predominantly inhabiting inter-dune troughs and low blow-out areas. It is dominate in these micro-sites since most other sand dune species can not tolerate wet to saturated soil conditions. The trailing rhizomes of saltmeadow cordgrass are slender, but form dense mats near the surface. It is vegetatively established on normal sites using freshly harvested stems (culms) or containerized plants on severe locations.

Date = May 1 to June 15
Planting Unit = 3 to 5 live stems placed bare-root or containerized
Depth = 2 inches below the nursery grown depth
Method = hand placed, or vegetable planter
Size = ≥ 12 inches
Spacing = 18 to 36 inches depending on the severity of the planting site
Notes: Utilize this species in low elevation sites of sand dunes which are frequently moist or inundated.

6.) **Switchgrass** (*Panicum virgatum*)– This warm-season, bunchgrass commonly grows in back dune swales and upper margins of tidal marshes. Seedling vigor is lower than in the closely related coastal panicgrass and therefore is not as well adapted for seeding on actively shifting sand dunes. However, switchgrass is a good alternative to coastal panicgrass north of Long Island, which is beyond the native range of coastal panicgrass.

Date: Seeding: over seeding = April 1 to May 1
dormant seeding = November 1 to April 15
planting = April 1 to May 15
Planting Unit = single bare-root or containerized seedling or division; 12 - 18 inches tall
Seeding rate = 8 to 12 Lbs. of Pure Live Seed (PLS) per acre
Depth: plants = 2 inches deeper than the nursery depth
seed = drilled 1½ to 2½ inches deep
Method: seed = hand broadcast/incorporated, single row garden seeder, or mechanically operated drill or drop seeder
plants = hand placed, or use a vegetable or tree planter
Spacing: plants = 4' X 4'
seed = 3' to 10' row spacing

7.) **Seacoast bluestem** (*Schizachyrium littorale*)– This native, warm-season grass is a coastal variation of the inland little bluestem. It differs visually with a more prostrate growth habit. Found in scattered open clumps in the back dunes, it rarely forms a solid stand, but is found mixed with other species such as beach heather, seaside goldenrod, beachgrass, bayberry, beach plum.

Date = March 1 to April 15
Planting Unit = one bare-root or potted plant
Depth = 2 inches below the nursery grown depth
Method = hand placed or vegetable planter
Size = ≥ 12-24 inch stem
Spacing = 24 to 36 inch row spacing with plants placed 24 inches apart within a row. Plant in the backdunes where sand is stable. May be interplanted with switchgrass, coastal panicgrass, saltmeadow cordgrass, seaside goldenrod, and beach or partridge pea.

8.) **(Monarch germplasm) seaside goldenrod** (*Solidago sempervirens*) – This perennial forb adds color and variety to a dune planting. It is a major food source on the fall migration of the Monarch butterfly. From it's inconspicuous green basal leaves in winter into early summer arises a brilliant yellow flower cluster in early fall. Although often blamed for causing allergies, it is actually an insect pollinated plant. (Ragweed is the real culprit).

<u>Date</u> = March 1 to May 15
<u>Planting Unit</u> = one bare-root or potted plant
<u>Depth</u> = 2 inches below the nursery grown depth
<u>Method</u> = hand placed or vegetable planter
<u>Size</u> = ≥ 12-18 inch stem
<u>Spacing</u> = 24 to 36 inch row spacing with plants placed 24 inches apart within a row. Plant in the backdunes where sand is stable. May be interplanted with switchgrass, coastal panicgrass, saltmeadow cordgrass, and beach or partridge pea.

9.) **Beach pea and partridge pea** (*Lathyrus maritimus/Chamaecrista fasciculata*) Beach pea is adapted from New Jersey- north and partridge pea, an annual reseeding legume, from Massachusetts to the Carolinas. These native legumes have good wildlife value as edible seed for both upland game and shore birds.

Partridge pea (seed only)
<u>Date</u>: Seeding: over seeding = April 1 to May 15
dormant seeding = November 1 to April 15

<u>Seeding rate</u> = 2-4 pounds of Pure Live Seed (PLS) per acre.

<u>Depth</u>: = seed drilled 1½ to 2½ inches deep in stilled sand

<u>Method:</u> seed = hand broadcast/incorporated, single row garden seeder, or mechanically operated drill or drop seeder

Beach pea (plants only)

Planting Unit = single bare-root or containerized seedling or division; 12 - 18 inches tall

planting = April 1 to May 15

Depth: plants = 2 inches deeper than the nursery depth

Method: plants = hand placed, or use a vegetable or tree planter

Spacing: plants = 4' X 4'

seed = 3' to 10' row spacing

10.) Shrubs and Trees (bayberry, beachplum, rugosa rose, groundsel)- Medium sized shrubs and small trees naturally dominate the back dune zone of New Jersey's barrier islands. The shrubs begin to co-inhabit the mid secondary dunes. Once extensive stands of bayberry, beach plum, pitch pine and other woody species covered these islands where houses now stand. The shrub species which are well adapted to the dune ecosystem are capable of either layering or root suckering. The trees and shrubs of the sand dunes have deep tap root systems for supplying adequate moisture and nutrients. Each species utilized for back dune stabilization has its own unique attributes Beach plum has a colorful bloom in spring which yields a tasty succulent cherry like fruit. Bayberry roots have nodules which enable it to fix atmospheric nitrogen similar to legumes; it also produces aromatic fruit and leaves. The thorny stems of rugosa rose are useful in directing pedestrian traffic along established access trails. This rose species also blooms from late spring to early fall, then gives rise to a bright red fruit. The pines and junipers which are adapted to sand dunes provide the visual appeal of evergreens in the back dunes. The major function of tree and shrub vegetation on sand dunes is still the permanent solid structural stabilization. All of trees and shrubs of the sand dunes produce viable seed, but intentional establishment occurs using bare-rooted or potted seedlings.

Date = March 15 to April 15; unless soil is frozen

Planting Unit = 1/0 or 2/0 bare-root seedlings or containerized transplants

Depth = 2 inches below the nursery grown depth

Method = hand placement or using a tree planter

Size = ≥ 12 inches tall

Spacing = 4 to 6 feet apart; off-set (stagger) rows for maximum protection

Notes: to ensure establishment (first 2 years) all competing vegetation must be removed from within 2 feet of each plant; it is important not fertilize the surrounding vegetation which will potentially out-compete the tree or shrub

C. **Maintenance**

1) Fertilizer

Date = May through July; no sooner than 30 days after planting

Rate = $\leq$ 50 lbs. of nitrogen (N) per acre, $\leq$ 25 lbs. of phosphorus (P) and potassium (K) per acre

Frequency :

- Apply N for the first two years after planting, then as needed to maintain stem density and plant health.
- Single or split applications are acceptable if not applied before May 1 or after July 30. Split applications must be at least 30 days apart.
- It is only necessary to apply P and K bi-annually

Recommended Formulations:

- 10-10-10, 20-10-10, 15-10-10, etc. are acceptable as long as the maximum rates per nutrient are not exceeded
- Time release fertilizers are encouraged that will provide the target amounts of the primary nutrients per acre.

Notes:

- Only apply fertilizer to within the drip line of shrubs and trees. Not following this rule will result in excessive herbaceous growth, which will out compete newly established trees and shrubs.
- Apply using broadcasting machinery

2.) Replant:

- Like a chain, a dune system is no stronger than its weakest link. Uniform, unbroken dune lines are essential to the protection a system can provide.
- Uncontrollable events (i.e. storms, construction, etc.) may damage sand dunes. If such damage occurs between October and April replant within a month. If the damage is experienced from May to September, utilize the outlined sand fencing or excavation procedures listed below, then plant during the recommended establishment period .

2. **SAND FENCING**: A quick and effective way to build temporary sand dunes is with the use of sand fencing (standard snow fence). Utilizing lines of

fencing and wooden posts, orientated parallel to the beach. A source of sand is necessary for this technique to be effective, but it is not limited by time of establishment.

A. **Materials**

1) Fencing:
   - Standard 4 ft. slatted wood snow fencing; wood must be decay free
   - Four wire ties ($\geq$ 12 ga.) must be used to secure fencing to each post.

2) Posts:
   - Wooden posts must be $\geq$ 6½ ft. long, with a minimum diameter of 3 inches; typical length ranges from 7 to 8 ft.
   - The posts should be made from black locust, eastern red cedar, Atlantic white cedar, or other species of similar durability and strength.
   - Space posts 10 ft. apart, and set them $\geq$ 3 feet deep

B. **Technique**

1) Position - orientate fence lines parallel to waterline of the beach, at least 140 feet from mean high tide (see figure 2)
2) Height - with adequate sand sources, dune elevations can be increased annually by at least four foot increments. (approximately the maximum height of the fencing, this can be increased with vegetation); The maximum dune height which is attainable will range from 12 to 15 feet, but is greatly influenced by prevailing wind velocities and sand grain size
3) Installation - weave fencing in front of and behind alternating posts to attain maximum strength
4) Number of Rows - 2 parallel rows spaced 30 to 40 feet apart, are ideal; but single rows with 30 ft. perpendicular spurs, spaced 40 ft. apart are also acceptable if space is a major limiting factor
5) Replacement - sand will typically fill fencing to ¾ of its total height at a maximum; upon reaching maximum fence capacity, additional lines of fence can be added until maximum planned dune height is reached; replace damaged fencing and posts within one month of storm damage to maintain a contiguous dune line

C. **Comments**

- This method is more expensive per linear foot than building dunes with vegetation alone, but less expensive than using earth moving machinery to construct dunes.
- Although dune height can be increased faster, it is limited by the fence height and ability to continually add more lines of fencing.
- Planting parallel rows of vegetation on either side of fences is usually more effective than either vegetation or fencing techniques alone.
- When complementing fencing with vegetation, do not plant closer than ten feet and no further than 15 feet from the fence lines. Vegetative strips should be about 20 ft. wide

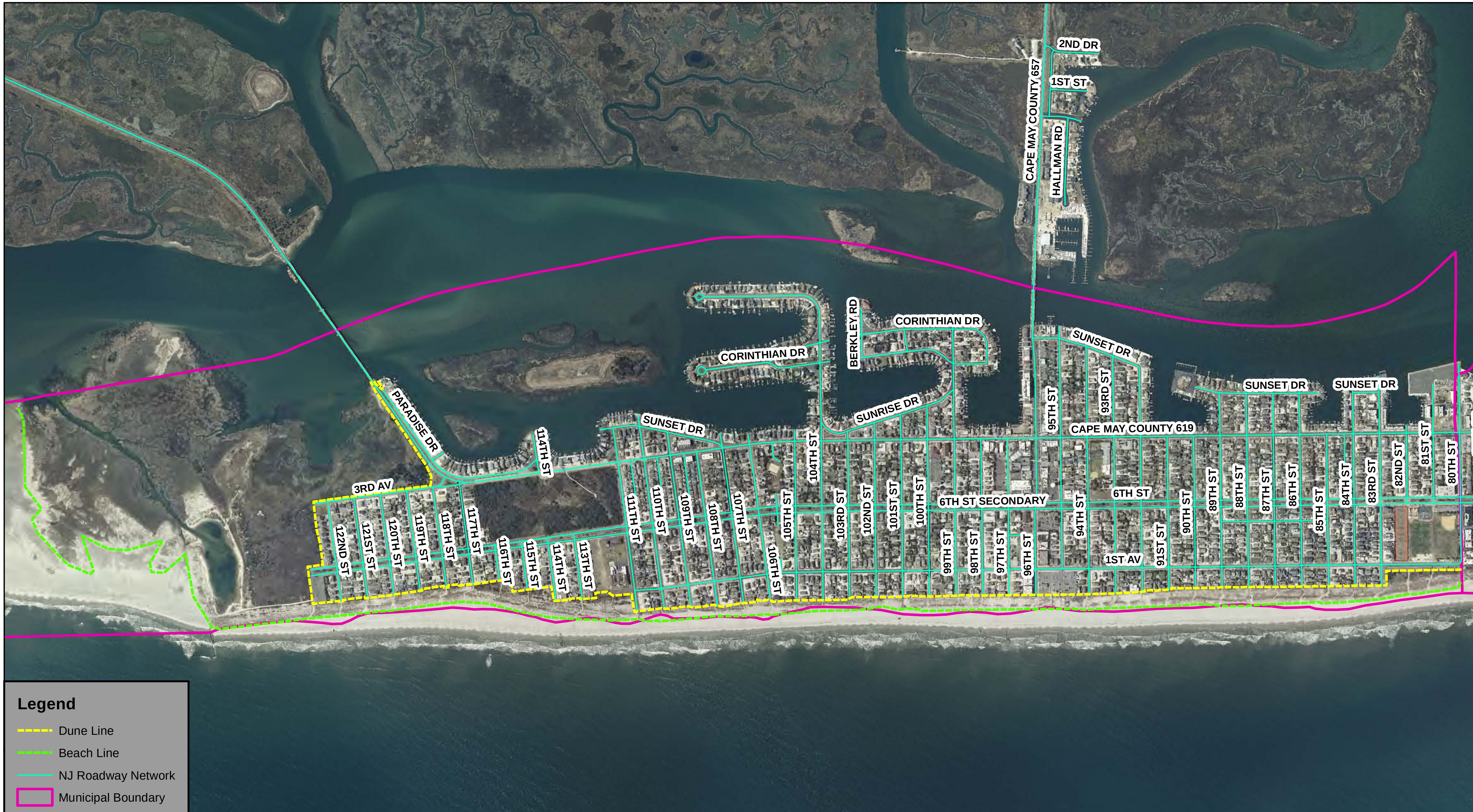
3. **MECHANICAL EXCAVATION**

- With the use of various earth moving machines temporary, excavated sand dunes are quickly created.
- Since time is required for settling and cohesion to occur, such dunes are often short lived and only provide minimal protection to the public and private resources behind them.
- This method is often useful in the repair of storm damaged sand dunes during the fall and winter months. Any blow-out areas can be quickly filled.
- Front-end loaders of all sizes can be used. Various grading machines are also useful.
- Pumped sand from off shore dredging can be shaped and positioned with machinery

APPENDIX E

Dune Vegetation Management Plan Base Map

Prepared by The Lomax Consulting Group, dated December 4, 2014



APPENDIX E: DUNE VEGETATION MANAGEMENT PLAN BASE MAP
FIGURE 1 2012 AERIAL OVERVIEW OF BOROUGH OF STONE HARBOR

SOURCE: GIS DATA PROVIDED BY THE NJDEP AT http://njgin.nj.gov/ & THE CAPE MAY COUNTY PLANNING DEPARTMENT

DATE: 12-4-14

DRAWN BY: ACB

1 inch = 1,000 feet

the LOMAX Consulting group

P. O. Box 9 (Mailing)
1435 Route 9 North (Delivery)
Cape May Court House, NJ 08210, USA

the Lomax Consulting group

609-465-9857 (P)
609-465-2449 (F)
www.lomaxconsulting.com

Aaron C. Baker, Environmental Consultant
(609) 465-9857 ext. 14
abaker@lomaxconsulting.com

LETTER OF TRANSMITTAL

October 6, 2017
Via USPS & Email

Borough of Stone Harbor
9508 Second Avenue
Stone Harbor, NJ 08247
Attn: Jill Gougher, Borough Administrator

RE: Dune Management Prioritization 2017
Borough of Stone Harbor, Cape May County, NJ
TLCG File No.: 16-782.1

ENCLOSED PLEASE FIND THE FOLLOWING:

QUANTITY	DESCRIPTION
1	Distribution of Japanese Black Pine for Dune Management Prioritization, September 2017

Dear Ms. Gougher:

Enclosed please find the above-referenced report which provides a review of the distribution of Japanese black pine in the Borough of Stone Harbor dunes and subject public areas, pursuant to tasks within the Dune Vegetation Management Plan (DVMP). This document is meant to aid the Borough by identifying areas containing the most numerous stands of Japanese black pine for potential future DVMP projects and allocation of resources.

Please let me know if you have any comments and if you would like Joe or myself to present this report to the Natural Resource Committee. Should you need anything else, please do not hesitate to call.

Sincerely,
THE LOMAX CONSULTING GROUP, LLC

Aaron Baker

Aaron C. Baker
Environmental Consultant

Enclosures
CC: K. Stevenson (w/enclosure)

DISTRIBUTION OF JAPANESE BLACK PINE
FOR
DUNE MANAGEMENT PRIORITIZATION

BOROUGH OF STONE HARBOR
CAPE MAY COUNTY, NEW JERSEY

SEPTEMBER 2017

PREPARED FOR: The Borough of Stone Harbor
9508 Second Street
Stone Harbor, NJ 08247

PREPARED BY: The Lomax Consulting Group
PO Box 9, 1435 Route 9 North
Cape May Court House, NJ 08210

DUNE PRIORITY MAPPING

The dune system is a critical feature to protect the Borough of Stone Harbor from coastal storms in addition to sustaining the beaches and its tourism economy. As such, the Borough has established the Dune Vegetation Management Plan to address control of Japanese black pine (JBP) and other damaging invasive plants, as appropriate, by their removal and replacement with native vegetation. The JBP removal and replacement is important to protect the integrity of the dune system. The establishment of Priority Dune Vegetation Management Areas is essential to the overall success of the program. A prioritization system allows the Borough to determine key areas where vegetation management is necessary, on a priority basis, to secure the vegetative diversity of the dune system and to ultimately protect the citizens of the Borough from coastal storms in addition to the occurrence of injury or damage resulting from dead or failing trees on public property.

To aid in dune vegetation management in the Borough, a survey of the dunes and public lands along the Atlantic Ocean and Stone Harbor Point was conducted by The Lomax Consulting Group in August 2017 to assess the distribution of JBP. The survey involved the visual inspection of the subject dunes and public areas for the presence of mature JBP. Mature JBP were considered individual trees estimated to be at least 6 feet in height or with 1 inch or greater diameter at breast height. These trees are generally capable of reproducing and spreading the JBP into natural areas of the Borough, most notably the dunes. Seedlings and small saplings were not used as a criterion to establish priority areas in the survey.

Mapping depicting the distribution of JBP was created based on the survey of the subject dunes and public areas **(Figures 1 and 2)**. The distribution of JBP is presented on a block by block basis to assist with determining priority areas at a manageable scale. Each area was categorized based on the number of mature JBP present as either High, Medium, Low, None, or DVMP Project. High distribution means that the area contains more than 10 mature JBP. These areas represent mature stands of JBP with heights that can reach 20 feet or more. Medium area indicates that there are between 5 and 10 mature JBP present, with heights that can reach up to 20 feet. Low areas contain less than 5 mature JBP, typically 10 feet or less, and represent the establishment of new stands of JBP. Areas labeled as None did not contain any visible mature JBP, but seedlings or young saplings could be present. Areas that have been previously included in a Dune Vegetation Management Project are labeled as DVMP Project. JBP have been previously removed from the DVMP Project areas and native vegetation has been re-established.

The dune management prioritization aids the Borough natural resource managers to assist with the focus of resources on areas containing most numerous stands of damaging and invasive JBP to prevent their spread. The replacement of JBP with well-adapted native dune plants that not subject to endemic pests, disease and fire will improve the overall health and integrity of the dunes system in the Borough.

ATTACHMENT 1

Mature Japanese Black Pine Distribution in the Dunes as of August 2017

Figure 1: Dune Vegetation Management - North
Figure 2: Dune Vegetation Management - South

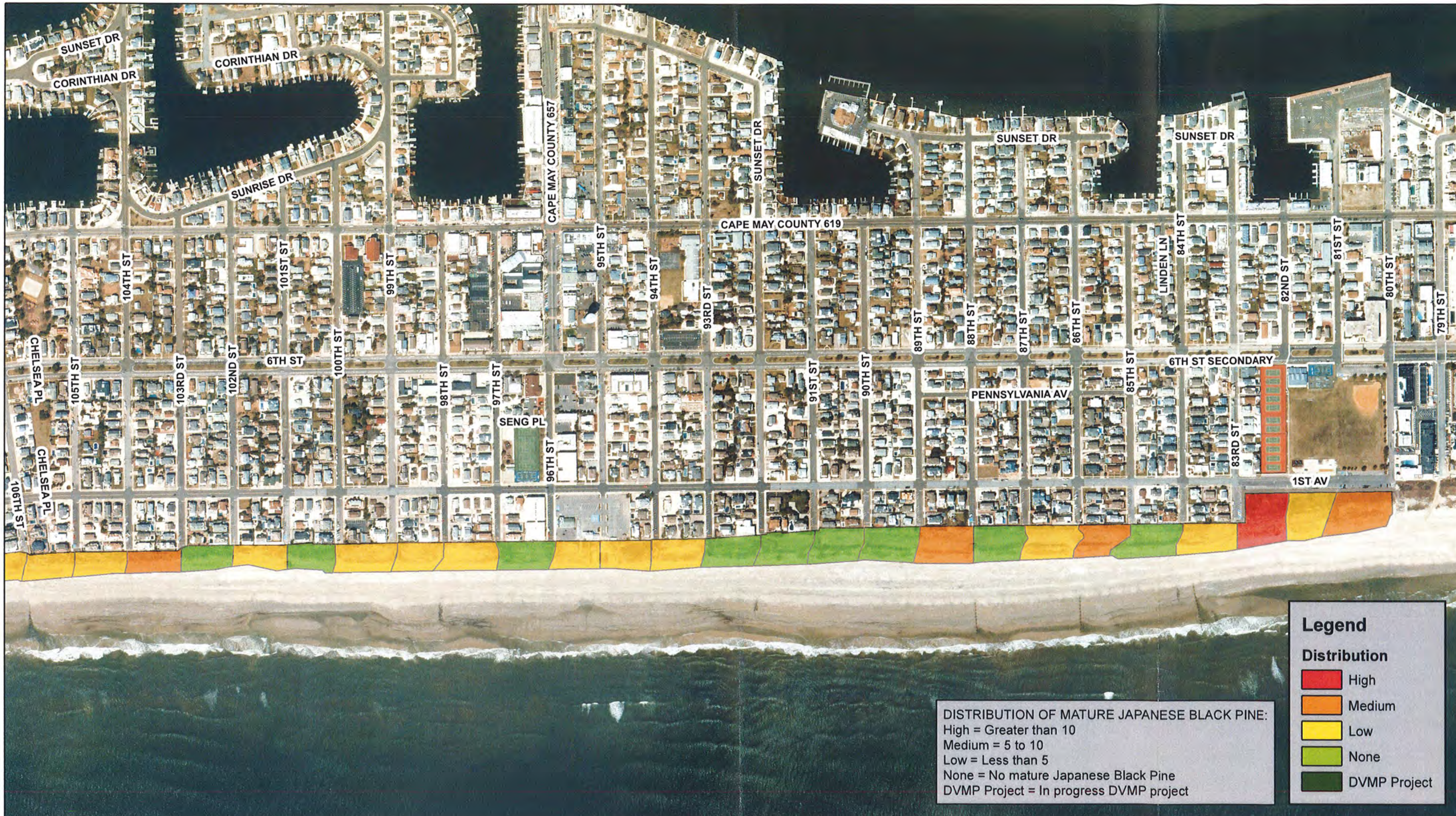


FIGURE 1: MATURE JAPANESE BLACK PINE DISTRIBUTION IN THE DUNES AS OF AUGUST 2017
SHOWN ON 2015 AERIAL PHOTOGRAPH OF BOROUGH OF STONE HARBOR
DUNE VEGETATION MANAGEMENT - NORTH
SOURCE: GIS DATA PROVIDED BY THE NJDEP AT http://njgin.nj.gov/ &
THE CAPE MAY COUNTY PLANNING DEPARTMENT

DATE: 9-22-17

DRAWN BY: ACB

1 inch = 500 feet

the LOMAX Consulting group

FIGURE 2: MATURE JAPANESE BLACK PINE DISTRIBUTION IN THE DUNES AS OF AUGUST 2017
SHOWN ON 2015 AERIAL PHOTOGRAPH OF BOROUGH OF STONE HARBOR
DUNE VEGETATION MANAGEMENT - SOUTH

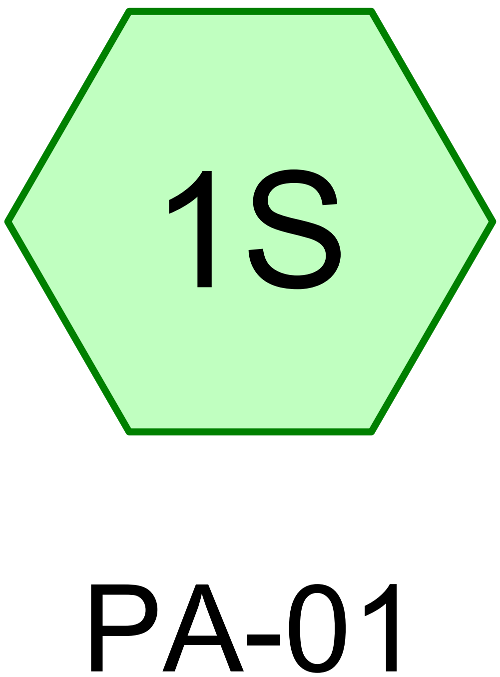
SOURCE: GIS DATA PROVIDED BY THE NJDEP AT http://njgin.nj.gov/ &
THE CAPE MAY COUNTY PLANNING DEPARTMENT

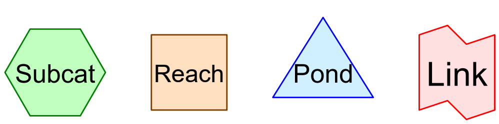
DATE:	DRAWN BY:
9-22-17	ACB

1 inch = 500 feet

the LOMAX Consulting group

Proposed Pump Station Drainage Calculation and Pump Specifications





Routing Diagram for Proposed
Prepared by DeBlasio & Associates, Printed 11/19/2020
HydroCAD® 10.00-25 s/n 11007 © 2019 HydroCAD Software Solutions LLC

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
22.930	61	>75% Grass cover, Good, HSG B (1S)
53.510	98	Impervious (1S)
76.440	**87**	**TOTAL AREA**

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: PA-01 Runoff Area=76.440 ac 70.00% Impervious Runoff Depth>2.08"
Flow Length=2,500' Slope=0.0030 '/' Tc=37.5 min CN=61/98 Runoff=61.58 cfs 13.238 af

Total Runoff Area = 76.440 ac Runoff Volume = 13.238 af Average Runoff Depth = 2.08"
30.00% Pervious = 22.930 ac 70.00% Impervious = 53.510 ac

Summary for Subcatchment 1S: PA-01

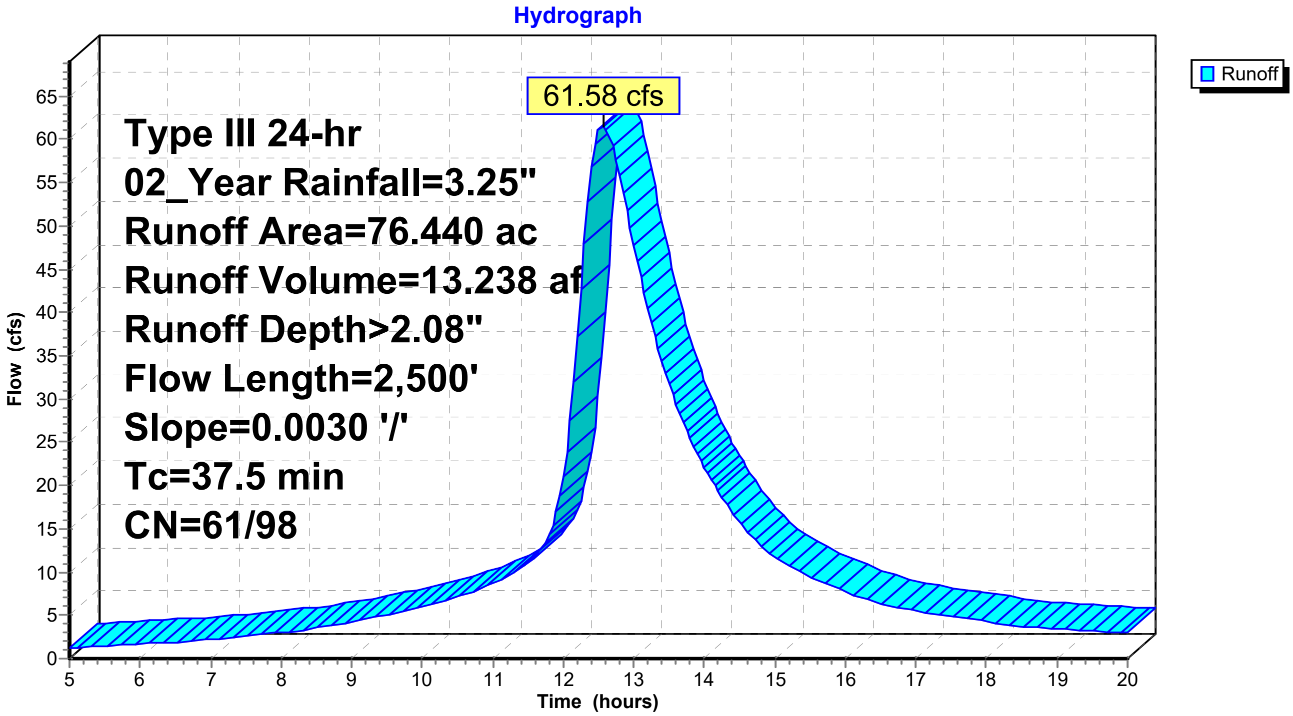
Runoff = 61.58 cfs @ 12.56 hrs, Volume= 13.238 af, Depth> 2.08"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 02_Year Rainfall=3.25"

	Area (ac)	CN	Description
*	53.510	98	Impervious
	22.930	61	>75% Grass cover, Good, HSG B
	76.440	87	Weighted Average
	22.930	61	30.00% Pervious Area
	53.510	98	70.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
37.5	2,500	0.0030	1.11		**Shallow Concentrated Flow, TC1** Paved Kv= 20.3 fps

Subcatchment 1S: PA-01



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: PA-01 Runoff Area=76.440 ac 70.00% Impervious Runoff Depth>2.82"
Flow Length=2,500' Slope=0.0030 '/' Tc=37.5 min CN=61/98 Runoff=83.72 cfs 17.981 af

Total Runoff Area = 76.440 ac Runoff Volume = 17.981 af Average Runoff Depth = 2.82"
30.00% Pervious = 22.930 ac 70.00% Impervious = 53.510 ac

Summary for Subcatchment 1S: PA-01

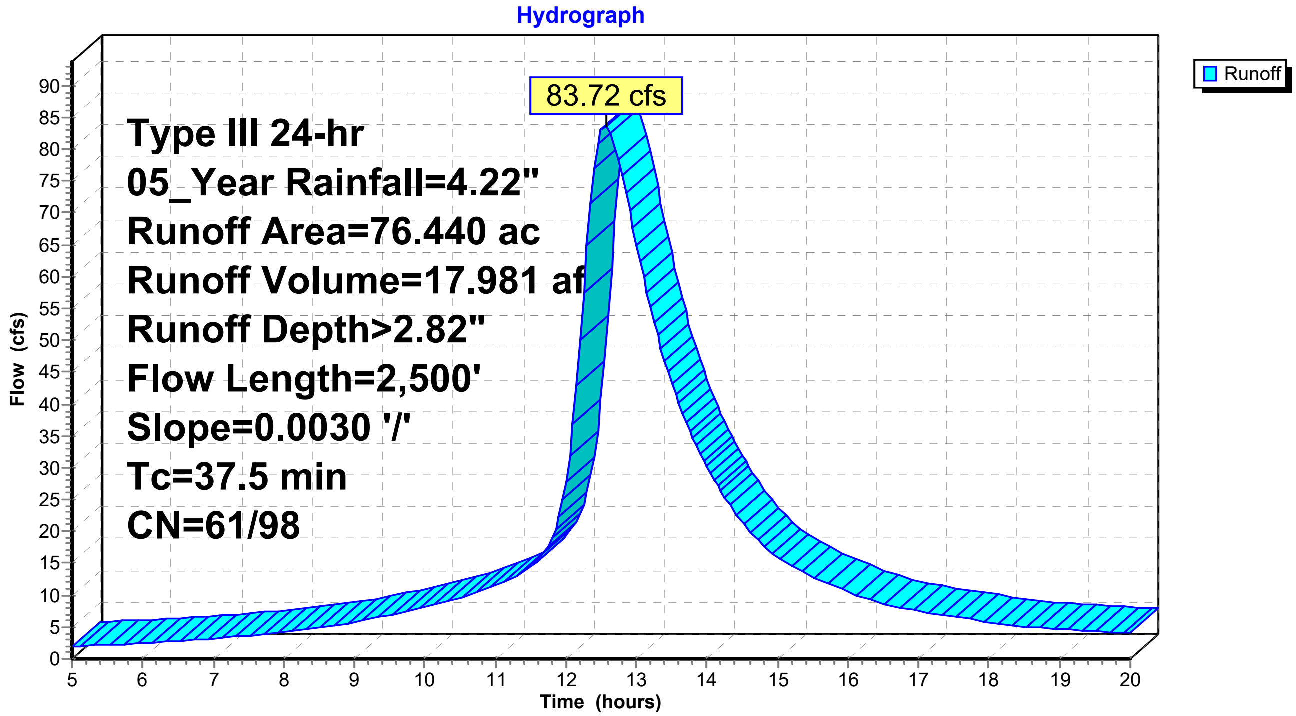
Runoff = 83.72 cfs @ 12.56 hrs, Volume= 17.981 af, Depth> 2.82"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 05_Year Rainfall=4.22"

	Area (ac)	CN	Description
*	53.510	98	Impervious
	22.930	61	>75% Grass cover, Good, HSG B
	76.440	87	Weighted Average
	22.930	61	30.00% Pervious Area
	53.510	98	70.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
37.5	2,500	0.0030	1.11		**Shallow Concentrated Flow, TC1** Paved Kv= 20.3 fps

Subcatchment 1S: PA-01



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: PA-01 Runoff Area=76.440 ac 70.00% Impervious Runoff Depth>3.50"
Flow Length=2,500' Slope=0.0030 '/' Tc=37.5 min CN=61/98 Runoff=104.03 cfs 22.275 af

Total Runoff Area = 76.440 ac Runoff Volume = 22.275 af Average Runoff Depth = 3.50"
30.00% Pervious = 22.930 ac 70.00% Impervious = 53.510 ac

Summary for Subcatchment 1S: PA-01

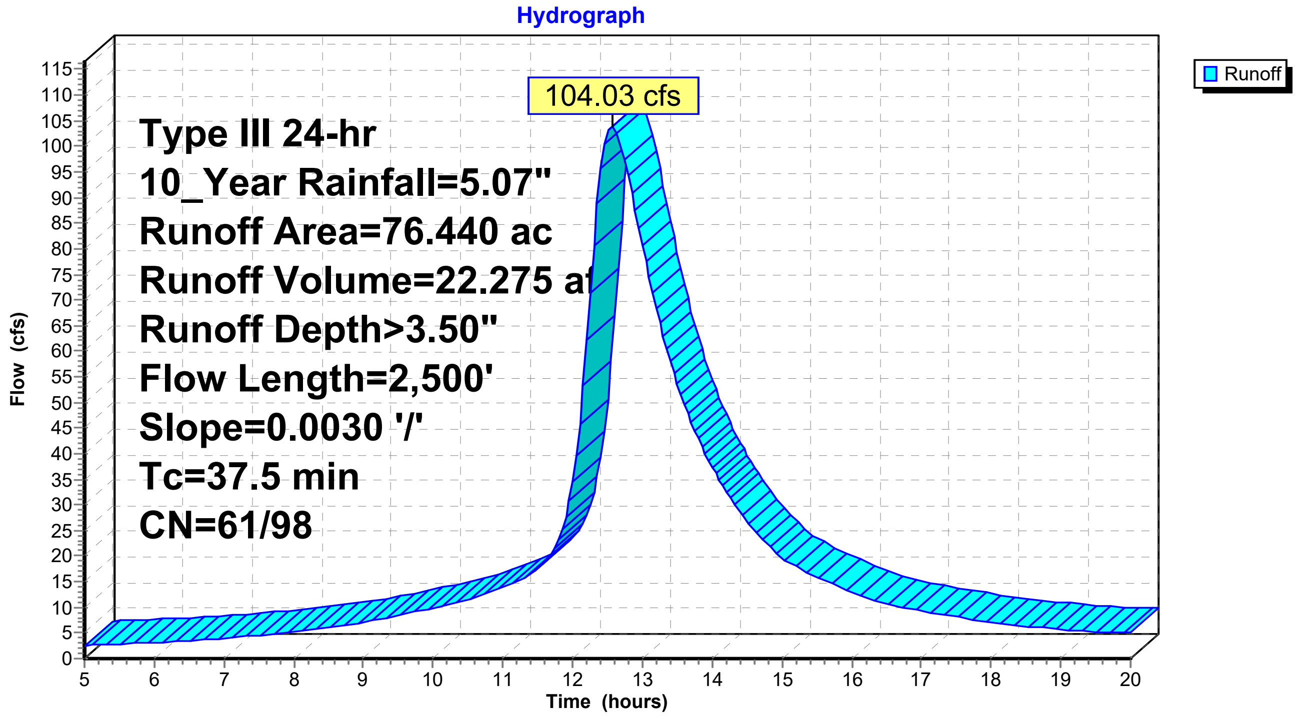
Runoff = 104.03 cfs @ 12.56 hrs, Volume= 22.275 af, Depth> 3.50"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10_Year Rainfall=5.07"

	Area (ac)	CN	Description
*	53.510	98	Impervious
	22.930	61	>75% Grass cover, Good, HSG B
	76.440	87	Weighted Average
	22.930	61	30.00% Pervious Area
	53.510	98	70.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
37.5	2,500	0.0030	1.11		**Shallow Concentrated Flow, TC1** Paved Kv= 20.3 fps

Subcatchment 1S: PA-01



MPC-T59131-030519.pdf

Lineshaft Pumps

Axial Flow Pumps

Pump Features:

- Flanged Drive Coupling
- Removable Stuffing Box & Bearing Housing
- Removable Bearing Retainer
- Stainless Steel Line Shaft
- Stainless Steel High-Efficiency Propeller
- Durable Nitrile Rubber Marine Bearings
- Close Tolerance Parallel Machined Flanges
- Stainless Steel Bowl Wear Ring
- Optional Ceramic Coating

MORRISON
PUMP COMPANY

Tel. +1 (954) 922-5880 Fax +1 (954) 922-7729
www.morrisonpump.com

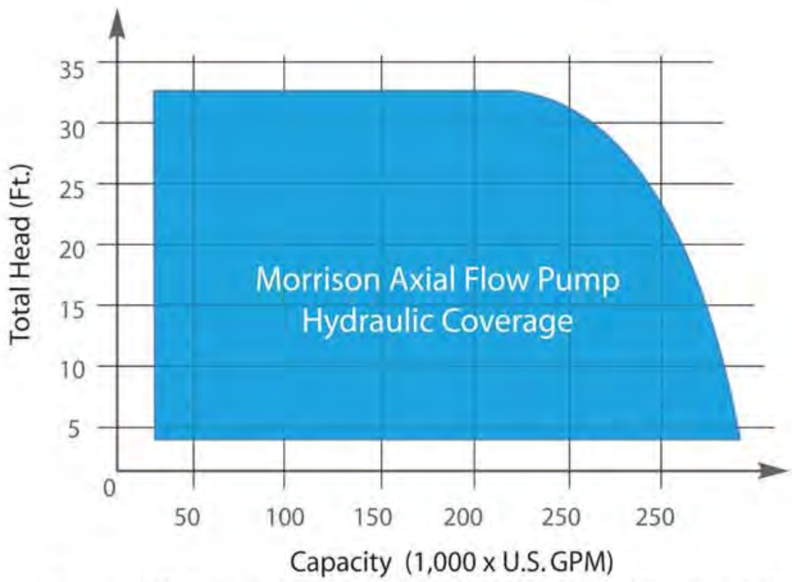
...delivering solutions

Lineshaft Pumps- Axial Flow

The High Efficiency Morrison Pump Axial Flow Lineshaft Pump has been engineered and manufactured for severe duty applications and continuous operation.

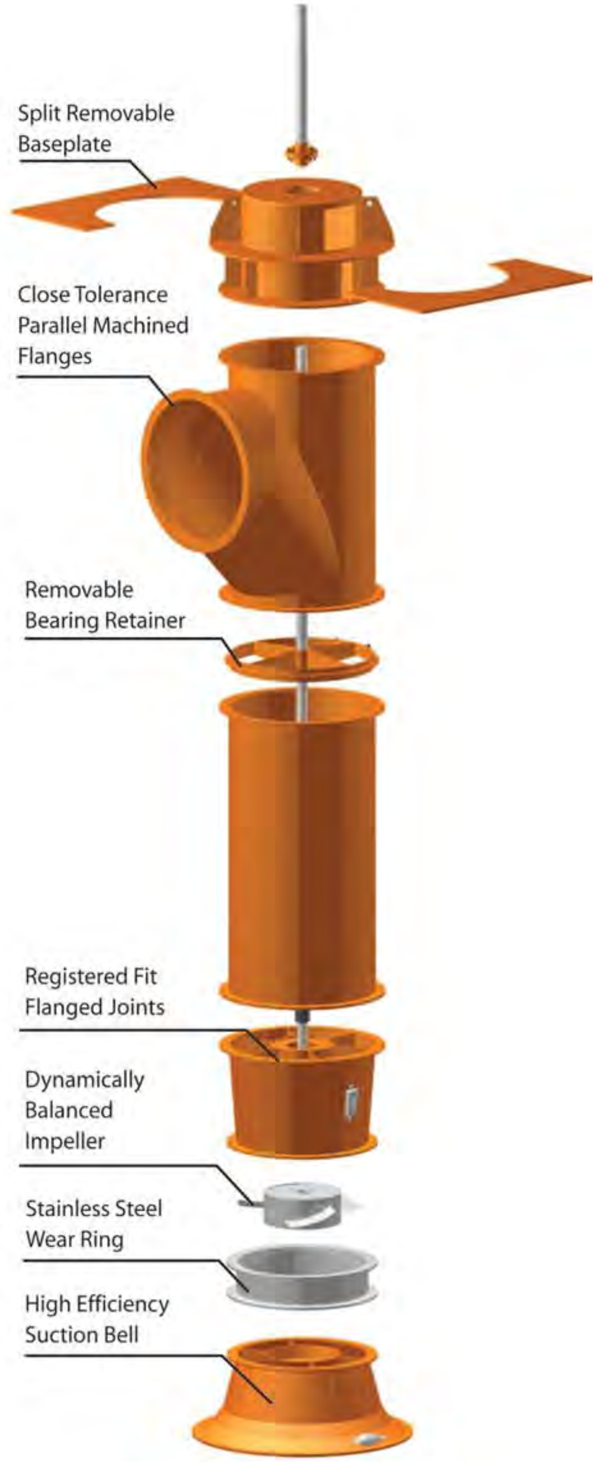
Some of the standard features that distinguish Morrison Lineshaft Pumps include our jointed (segmented) pump construction, dynamic balancing of impellers, stainless steel rotating elements and wear rings, flanged drive couplings, electrical isolation of dissimilar metals, removable bearing retainers, and standard marine nitrile rubber radial bearings. Furthermore, all Axial Flow Pumps are provided with certified pump performance curves.

Morrison High-Efficiency Axial Flow Lineshaft Pumps can be in vertical, horizontal, or slant (angle) configurations, and may be oil, water, or product lubricated (no seals, no oil). Various material options include marine steel, austenitic stainless steel (AISI 316L), duplex stainless steels, and titanium.



Please consult Morrison Pump Company for larger pump sizes. Morrison Mixed Flow also available.

PUMP PART	PART DESCRIPTION
Pump Body	Segmented, A36 Carbon Steel
Propeller	Stainless Steel 304L / 316L
Wear Ring	Flanged, Isolated, Stainless Steel 304L / 316L
Lineshaft	Stainless Steel 304L / 316L
Bearings - Product Lube	Marine Nitrile Rubber
Bearings - Oil Lube	Bronze SAE 64
Bearing Retainers	Removable, A36 Carbon Steel
Support Baseplate	Split & Removable, A36 Carbon Steel
Mounting Hardware	Stainless Steel 304 / 316



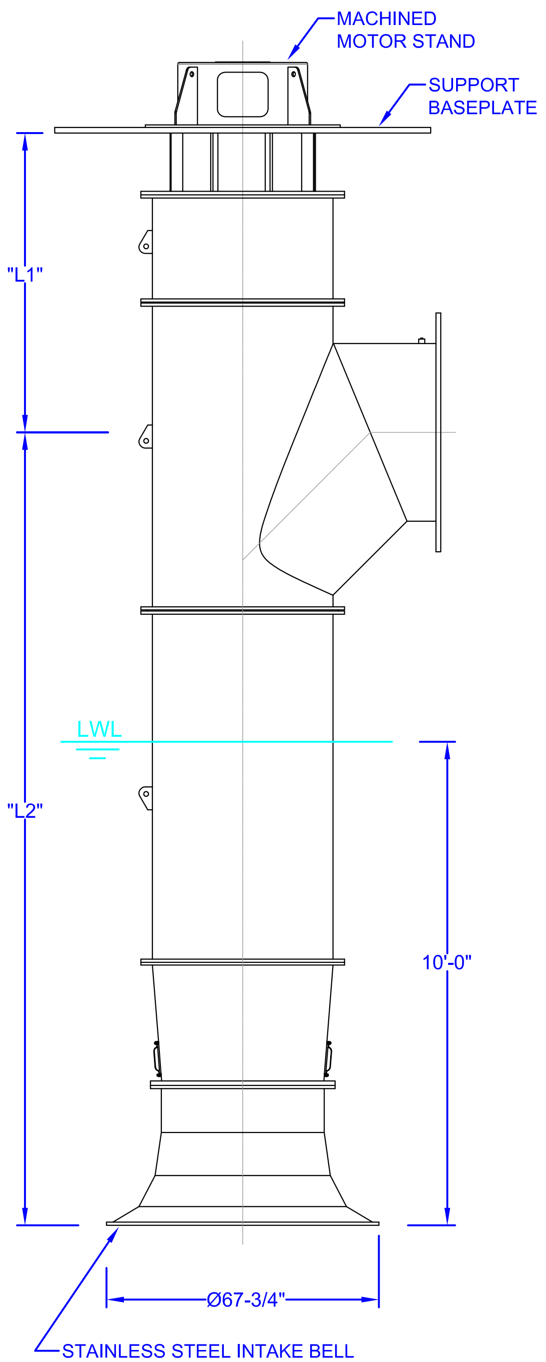
MORRISON
PUMP COMPANY

Tel. +1 (954) 922-5880 Fax +1 (954) 922-7729
www.morrisonpump.com

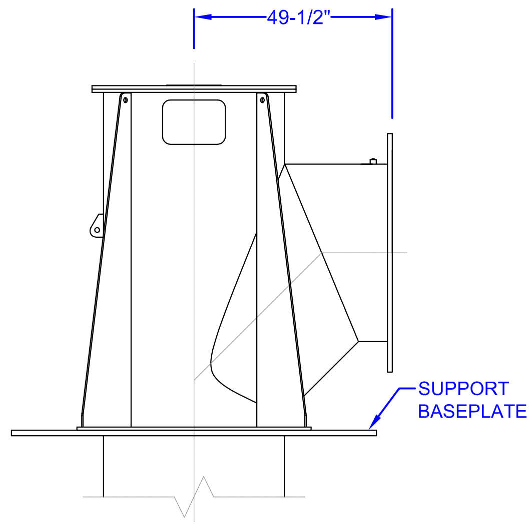
...delivering solutions

MORRISON MODEL VPS-44-40
GENERAL DIMENSIONS

BELOW GRADE DISCHARGE



ABOVE GRADE DISCHARGE



PUMP PERFORMANCE:

MORRISON PUMP MODEL	:	VPS-44-40
BOWL MODEL	:	MP-40-03-LH
DESIGN CAPACITY	:	54,000 GPM
DESIGN HEAD	:	15.0 FT. TDH
DESIGN SPEED	:	450 RPM
BOWL EFFICIENCY	:	87.2% @ RATED CONDITION
NPSHR	:	29.8 FT. @ RATED CONDITION
POWER	:	235 BHP @ RATED CONDITION

PUMP CONSTRUCTION:

PUMP TYPE	:	AXIAL FLOW IMPELLER LINESHAFT
CONFIGURATION	:	VERTICAL LINESHAFT PUMP
DISCHARGE	:	Ø44 OR Ø48 INCHES
LUBRICATION	:	PRODUCT LUBRICATION
IMPELLER	:	FORGED 304L STAINLESS STEEL, DYNAMICALLY BALANCED
SHAFT	:	DUPLEX STAINLESS STEEL, S31803
RADIAL BEARINGS	:	NITRILE RUBBER OR THORDON SXL
BOWL	:	STAINLESS STEEL & CARBON STEEL
COLUMN & ELBOW	:	A36 CARBON STEEL
FLANGES	:	MACHINED WITH REGISTERS
COATING	:	12 MILS 2-PART EPOXY
MISC.	:	REMOVABLE SPIDERS, NO SUCTION BELL BEARING, NO OIL/NO GREASE

NOTES:

1. DRAWING IS FOR GENERAL REFERENCE ONLY.
2. VERTICAL ELECTRIC MOTOR NOT SHOWN.
3. LWL = LOW WATER LEVEL INDICATING MINIMUM SUBMERGENCE PER ANSI/HI 9.8-2018 INTAKE DESIGN STANDARDS

MORRISON PUMP COMPANY
A BUSINESS UNIT OF PATTERSON

DWG. TITLE: MORRISON PUMP MODEL VPS-44-40 GENERAL DIMENSIONS

PROJECT: MPC 59131A - REINER PUMP / STORMWATER PUMP STATION

DATE: 05-MARCH-2019

FILE: DWG-59131-VPS-44

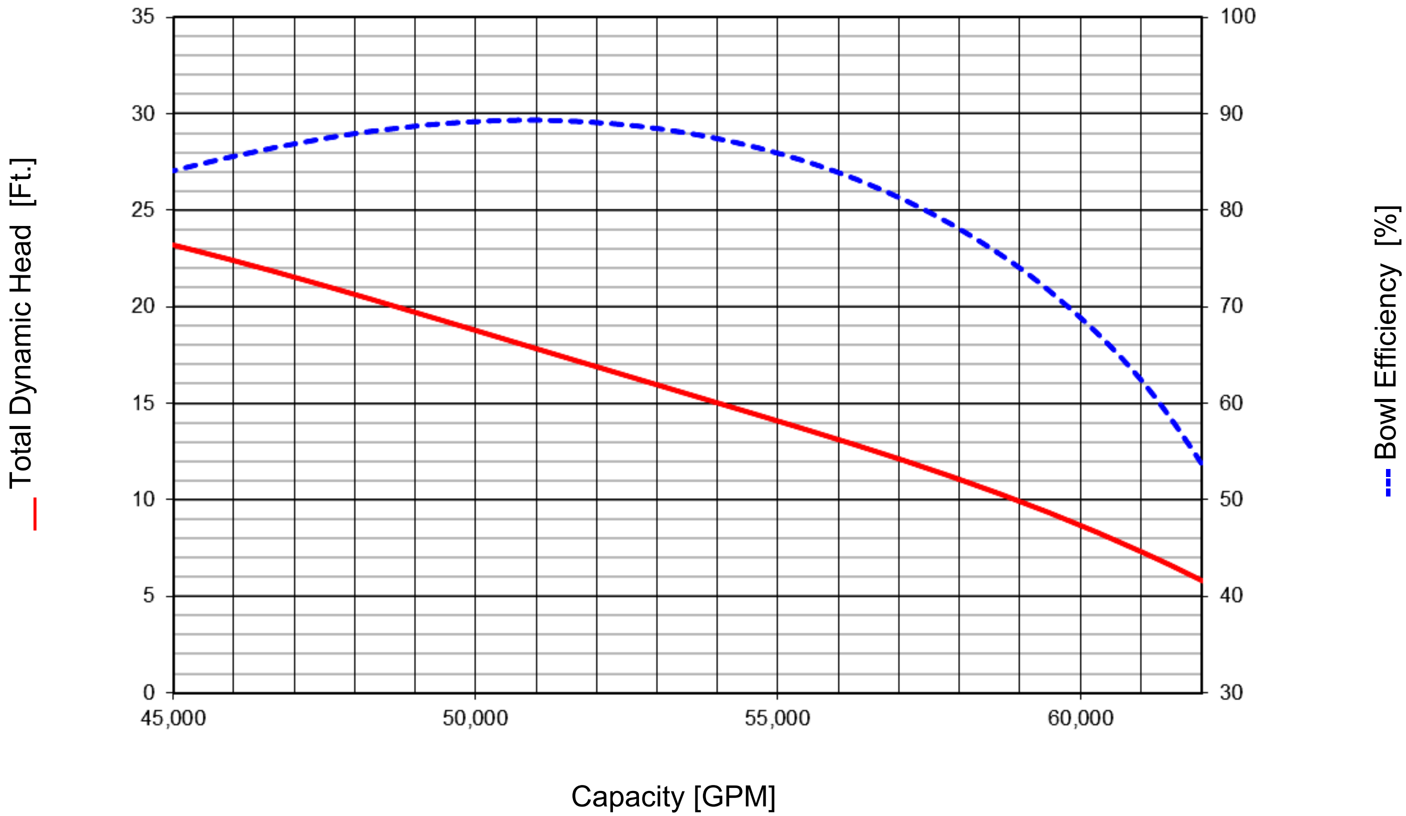
Pump Performance

Axial Flow Impeller, One-Stage, High-Efficiency

Project No.:	MPC 59131A
Project Name:	Reiner Pump – DeBlasio & Associates, Stormwater Pump Station
Date:	05-March-2019

MORRISON PUMP MODEL VPS-44-40

Design Condition = 54,000 GPM @ 15.0 Ft. TDH



Morrison Pump Bowl No.:	MP-40-03-LH
Impeller Diameter:	39.4 inches
Shaft Speed:	450 RPM

MORRISON PUMP COMPANY

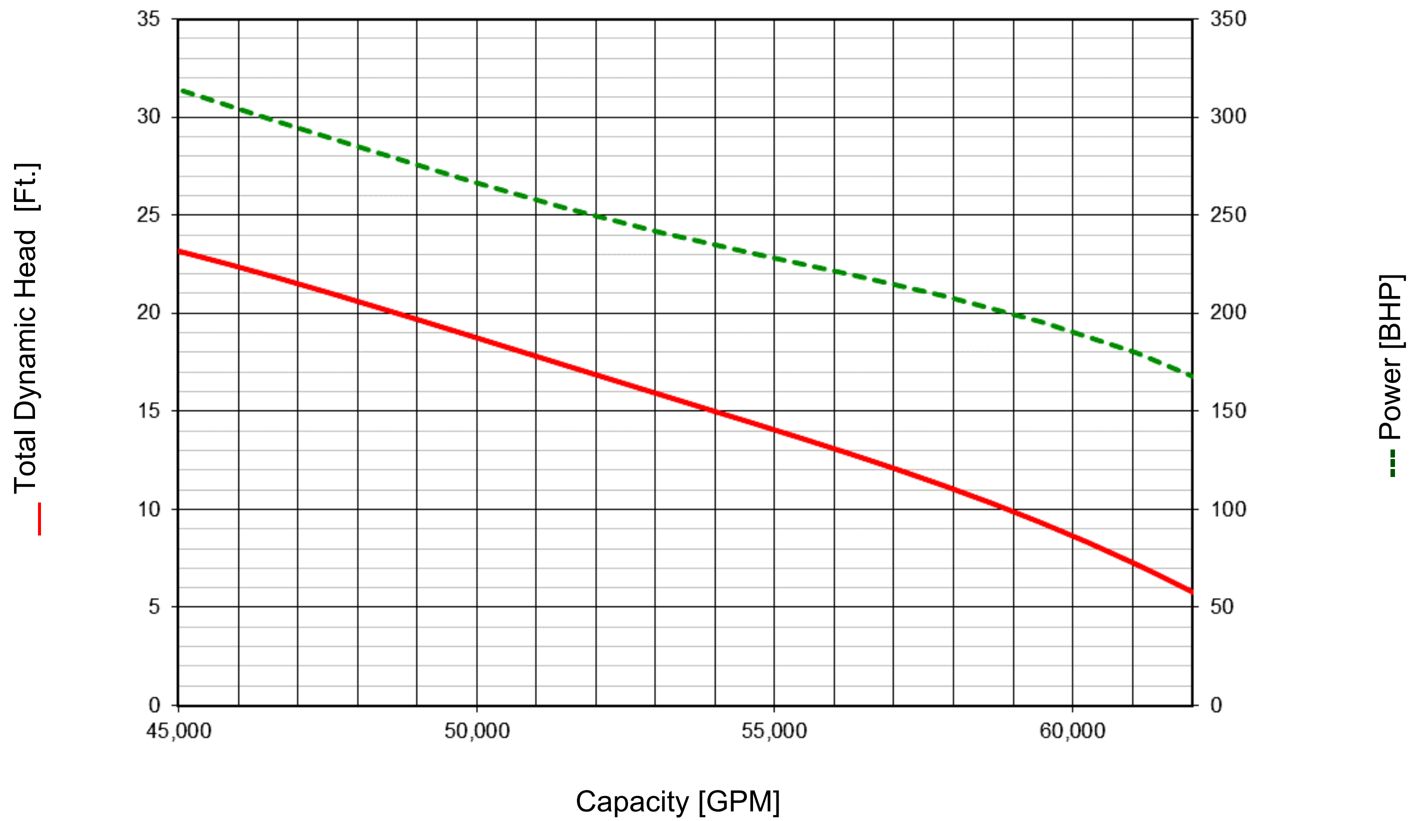
A BUSINESS UNIT OF PATTERSON

Pump Performance

Axial Flow Impeller, One-Stage, High-Efficiency

Project No.: MPC 59131A
Project Name: Reiner Pump – DeBlasio & Associates, Stormwater Pump Station
Date: 05-March-2019

MORRISON PUMP MODEL VPS-44-40
Design Condition = 54,000 GPM @ 15.0 Ft. TDH

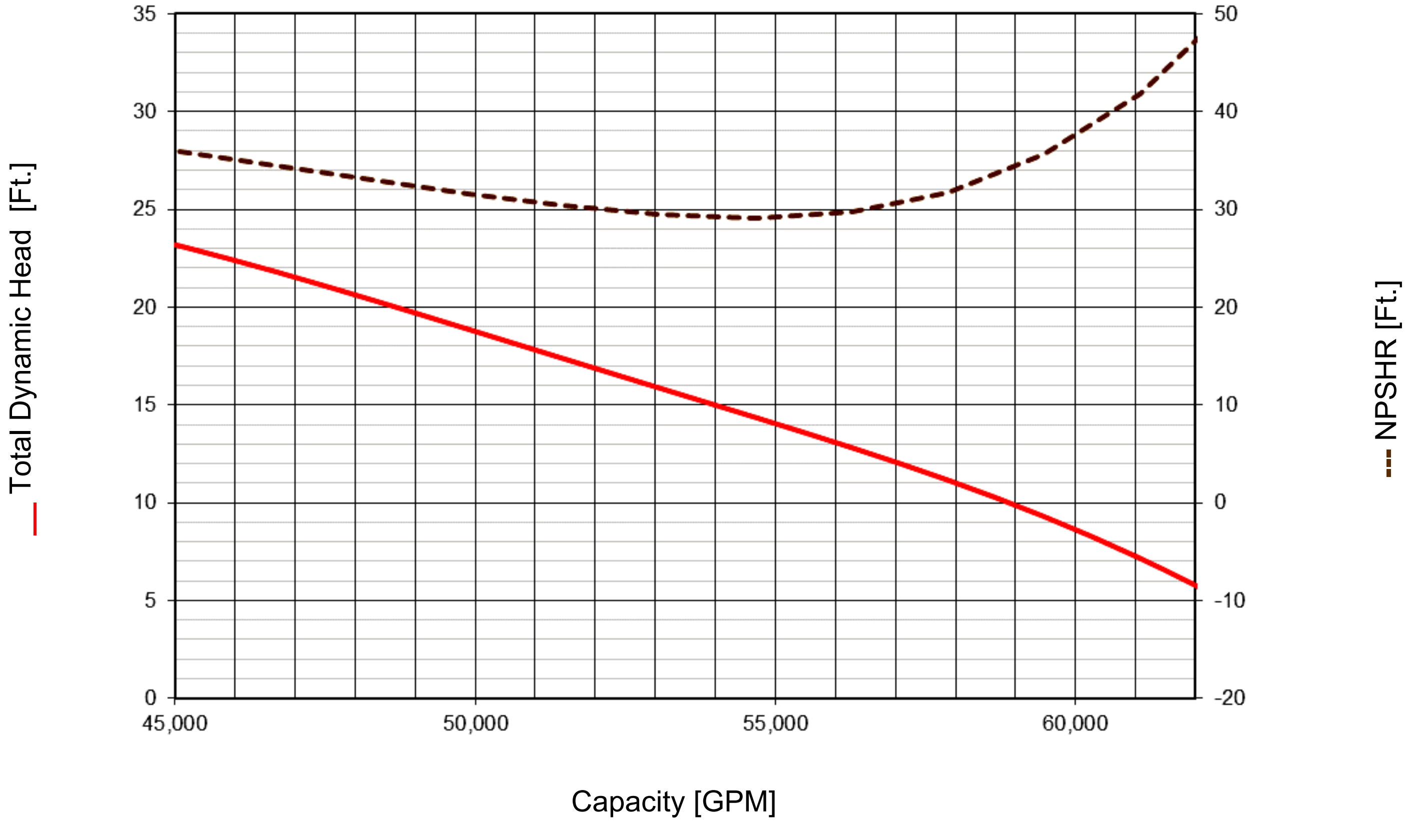


Morrison Pump Bowl No.: MP-40-03-LH
Impeller Diameter: 39.4 inches
Shaft Speed: 450 RPM

MORRISON PUMP COMPANY
A BUSINESS UNIT OF PATTERSON

Pump Performance Axial Flow Impeller, One-Stage, High-Efficiency	Project No.: MPC 59131A Project Name: Reiner Pump – DeBlasio & Associates, Stormwater Pump Station Date: 05-March-2019

MORRISON PUMP MODEL VPS-44-40
Design Condition = 54,000 GPM @ 15.0 Ft. TDH

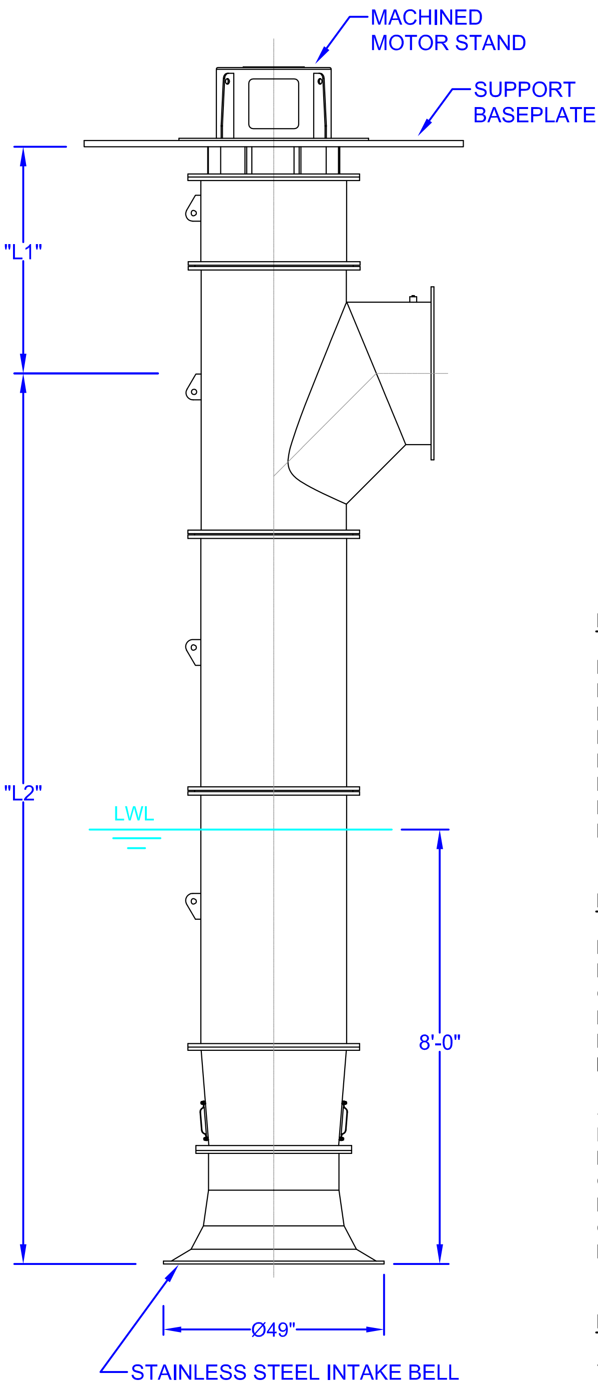


Morrison Pump Bowl No.:	MP-40-03-LH
Impeller Diameter:	39.4 inches
Shaft Speed:	450 RPM

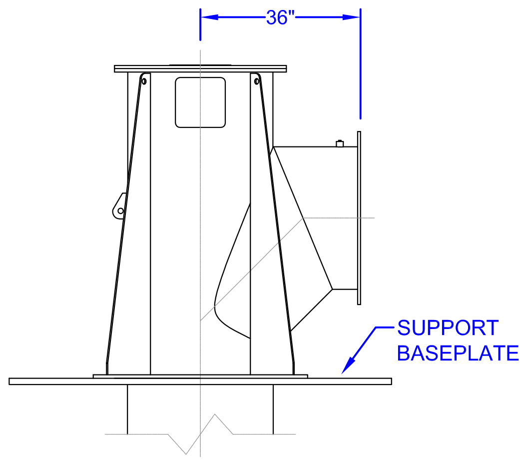
MORRISON PUMP COMPANY
A BUSINESS UNIT OF PATTERSON

MORRISON MODEL VPS-32-28
GENERAL DIMENSIONS

BELOW GRADE DISCHARGE



ABOVE GRADE DISCHARGE



PUMP PERFORMANCE:

MORRISON PUMP MODEL	:	VPS-32-28
BOWL MODEL	:	MP-28-03-MH
DESIGN CAPACITY	:	27,000 GPM
DESIGN HEAD	:	15.0 FT. TDH
DESIGN SPEED	:	450 RPM
BOWL EFFICIENCY	:	88.4% @ RATED CONDITION
NPSHR	:	28.8 FT. @ RATED CONDITION
POWER	:	116 BHP @ RATED CONDITION

PUMP CONSTRUCTION:

PUMP TYPE	:	AXIAL FLOW IMPELLER
LINESHAFT CONFIGURATION	:	VERTICAL LINESHAFT PUMP
DISCHARGE	:	Ø32 OR Ø36 INCHES
LUBRICATION	:	PRODUCT LUBRICATION
IMPELLER	:	FORGED 304L STAINLESS STEEL, DYNAMICALLY BALANCED
SHAFT	:	DUPLEX STAINLESS STEEL, S31803
RADIAL BEARINGS	:	NITRILE RUBBER OR THORDON SXL
BOWL	:	STAINLESS STEEL & CARBON STEEL
COLUMN & ELBOW	:	A36 CARBON STEEL
FLANGES	:	MACHINED WITH REGISTERS
COATING	:	12 MILS 2-PART EPOXY
MISC.	:	REMOVABLE SPIDERS, NO SUCTION BELL BEARING, NO OIL/NO GREASE

NOTES:

1. DRAWING IS FOR GENERAL REFERENCE ONLY.
2. VERTICAL ELECTRIC MOTOR NOT SHOWN.
3. LWL = LOW WATER LEVEL INDICATING MINIMUM SUBMERGENCE PER ANSI/HI 9.8-2018 INTAKE DESIGN STANDARDS

MORRISON
PUMP COMPANY
A BUSINESS UNIT OF PATTERSON

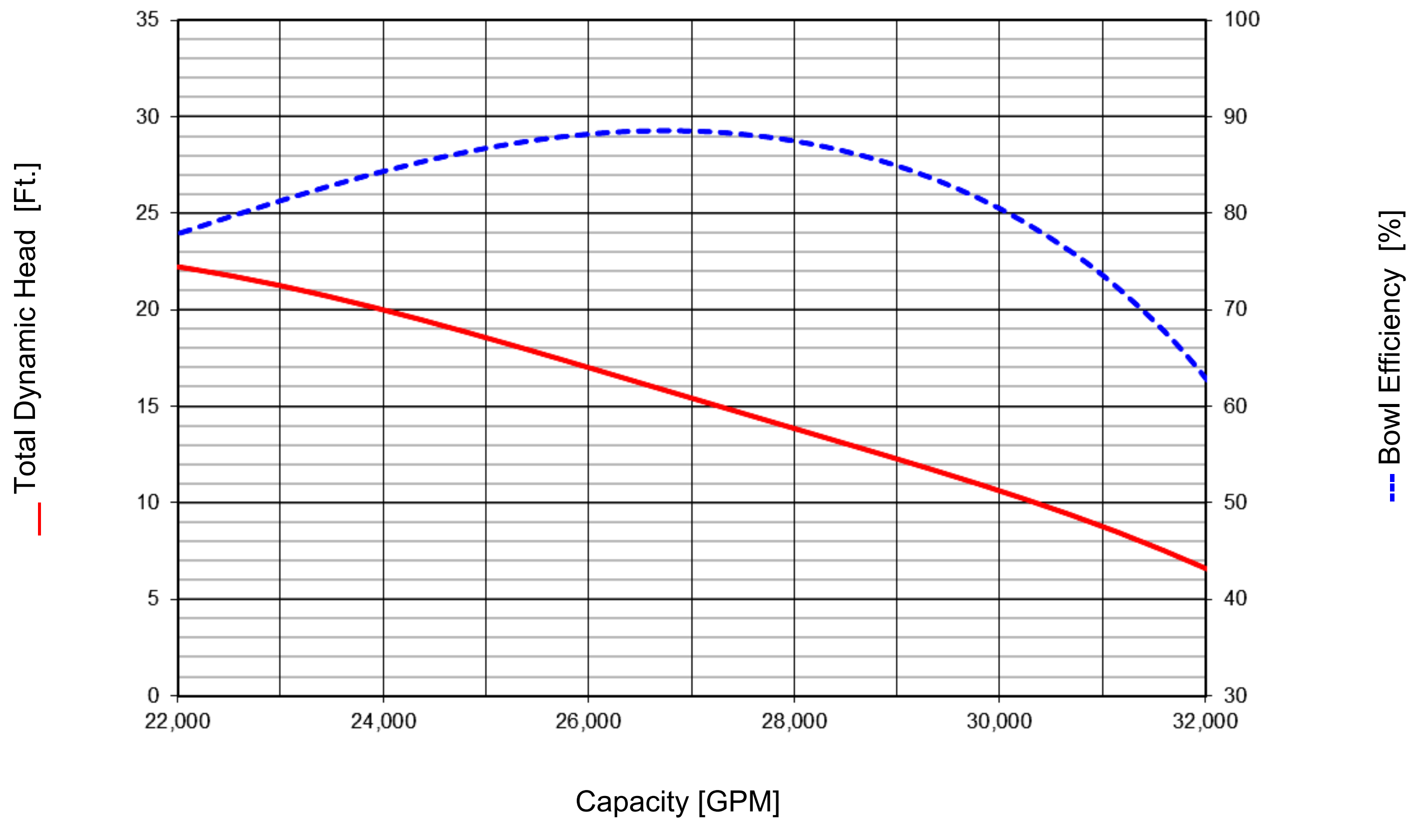
DWG. TITLE: MORRISON PUMP MODEL VPS-32-28 GENERAL DIMENSIONS	DATE: 05-MARCH-2019
PROJECT: MPC 59131B - REINER PUMP / STORMWATER PUMP STATION	FILE: DWG-59131-VPS-32

Pump Performance

Axial Flow Impeller, One-Stage, High-Efficiency

Project No.: MPC 59131B
Project Name: Reiner Pump – DeBlasio & Associates, Stormwater Pump Station
Date: 05-March-2019

MORRISON PUMP MODEL VPS-32-28
Design Condition = 27,000 GPM @ 15.0 Ft. TDH



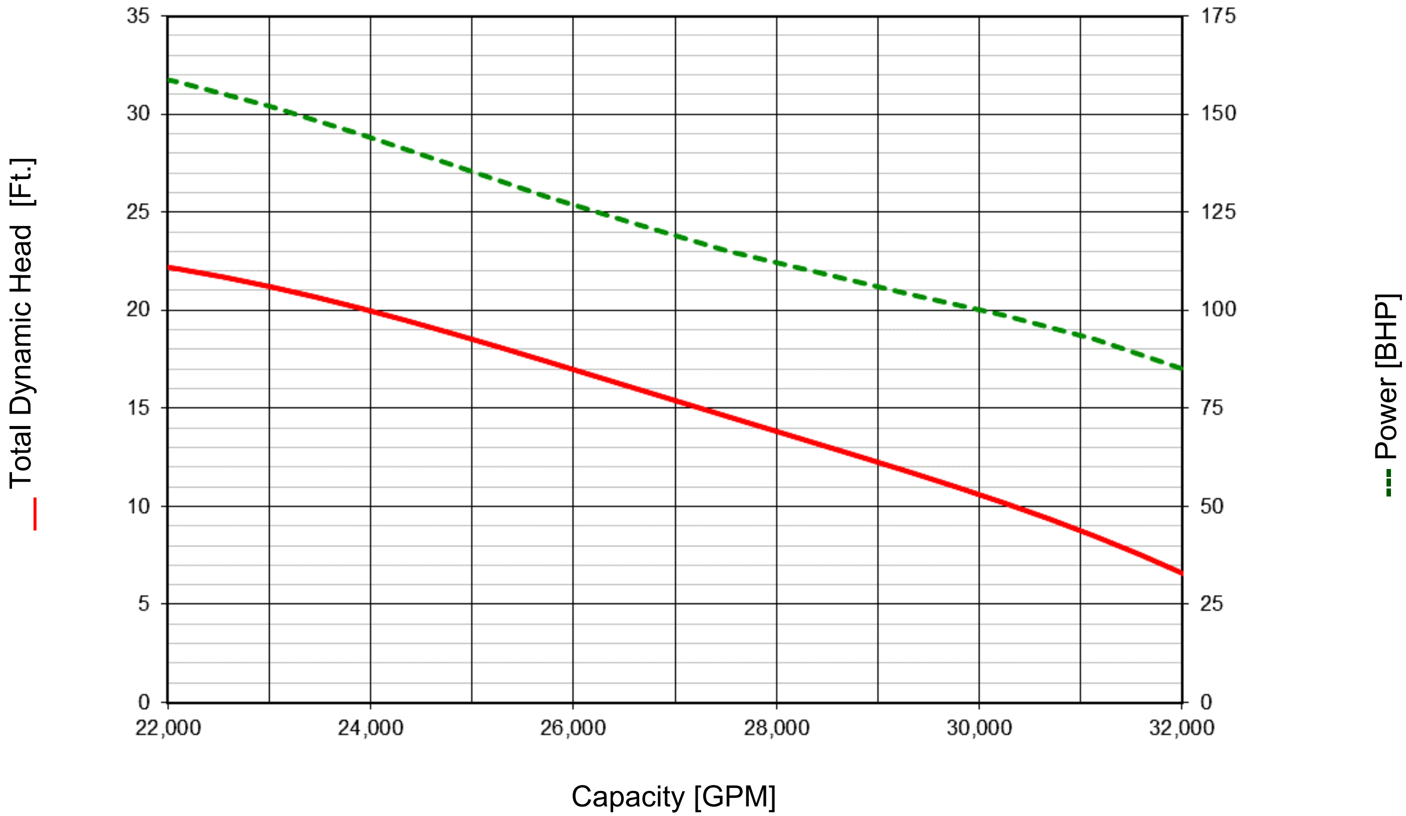
Morrison Pump Bowl No.: MP-28-03-MH
Impeller Diameter: 28.0 inches
Shaft Speed: 595 RPM

MORRISON PUMP COMPANY
A BUSINESS UNIT OF PATTERSON

Pump Performance
Axial Flow Impeller, One-Stage, High-Efficiency

Project No.: MPC 59131B
Project Name: Reiner Pump – DeBlasio & Associates, Stormwater Pump Station
Date: 05-March-2019

MORRISON PUMP MODEL VPS-32-28
Design Condition = 27,000 GPM @ 15.0 Ft. TDH



Morrison Pump Bowl No.: MP-28-03-MH
Impeller Diameter: 28.0 inches
Shaft Speed: 595 RPM

MORRISON
PUMP COMPANY
A BUSINESS UNIT OF PATTERSON

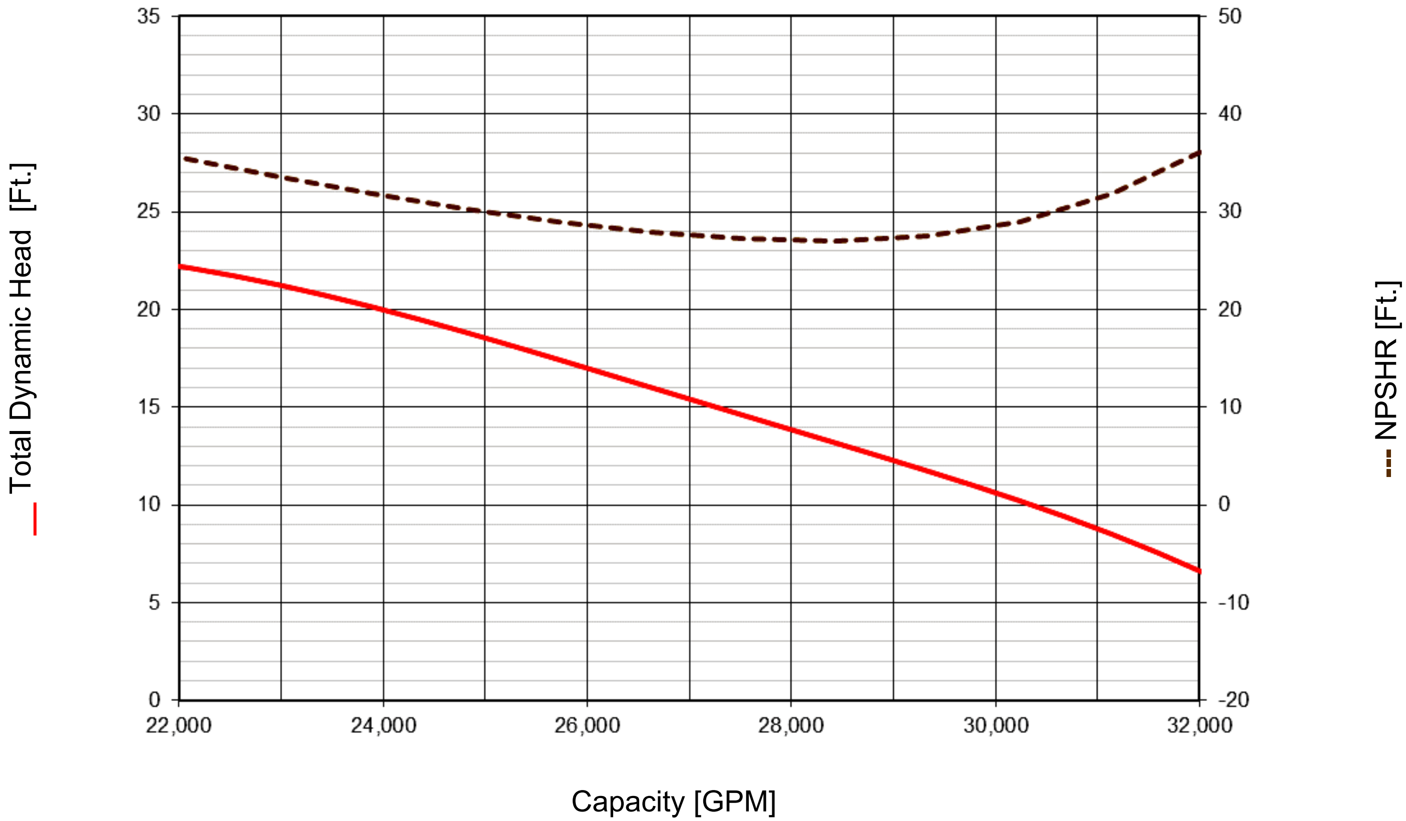
The curve provided is proprietary and for general reference use only. Pump performance is based on open sump testing on clean water with a specific gravity 1.00 at 76°F.

Pump Performance

Axial Flow Impeller, One-Stage, High-Efficiency

Project No.: MPC 59131B
Project Name: Reiner Pump – DeBlasio & Associates, Stormwater Pump Station
Date: 05-March-2019

MORRISON PUMP MODEL VPS-32-28
Design Condition = 27,000 GPM @ 15.0 Ft. TDH



Morrison Pump Bowl No.: MP-28-03-MH
Impeller Diameter: 28.0 inches
Shaft Speed: 595 RPM

MORRISON PUMP COMPANY
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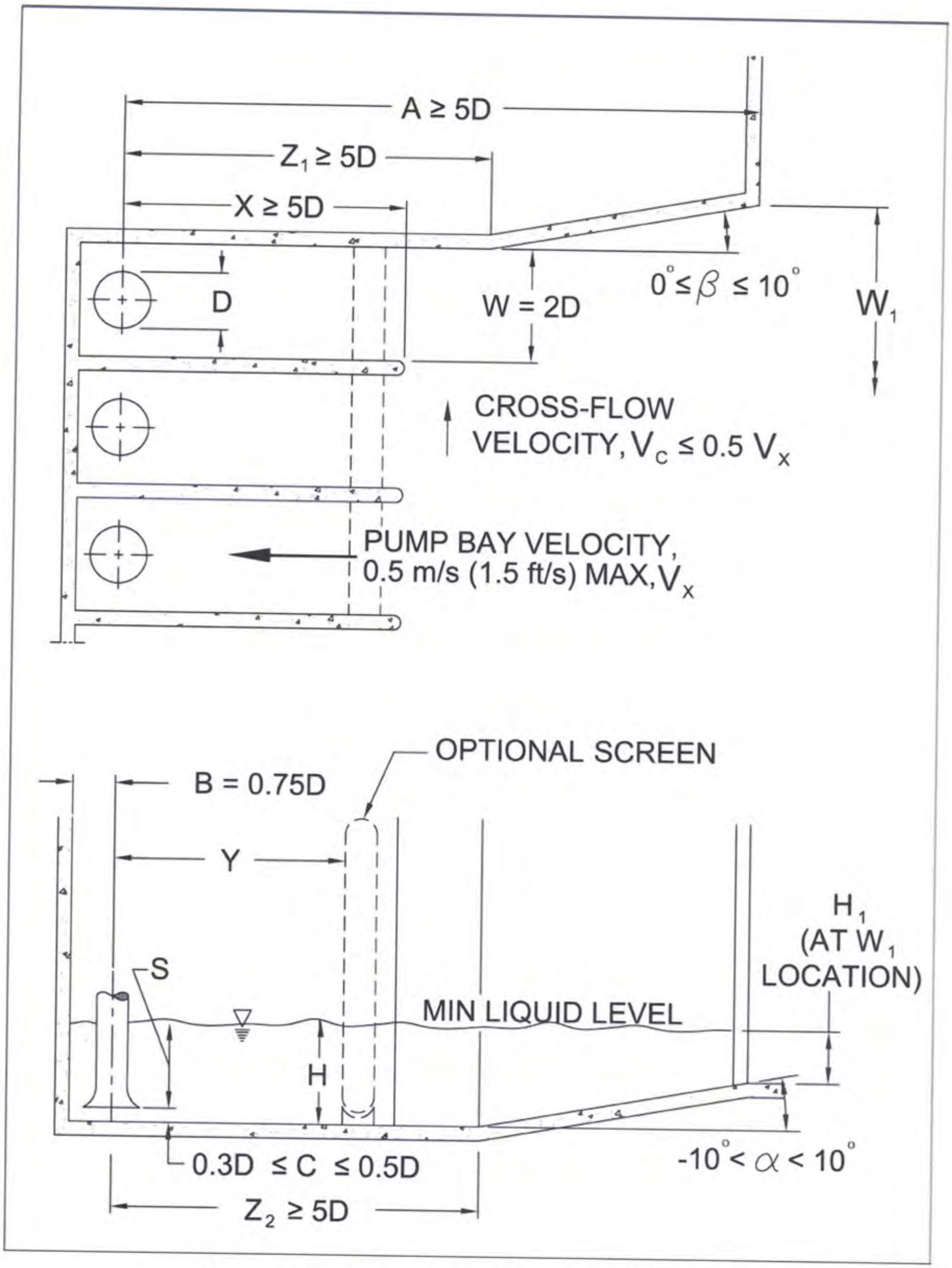


Figure 9.8.3.1.4a Rectangular intake structure layout

Table 9.8.3.1.4b provides a sequence of steps to follow in determining the general layout and internal geometry of a rectangular intake structure.

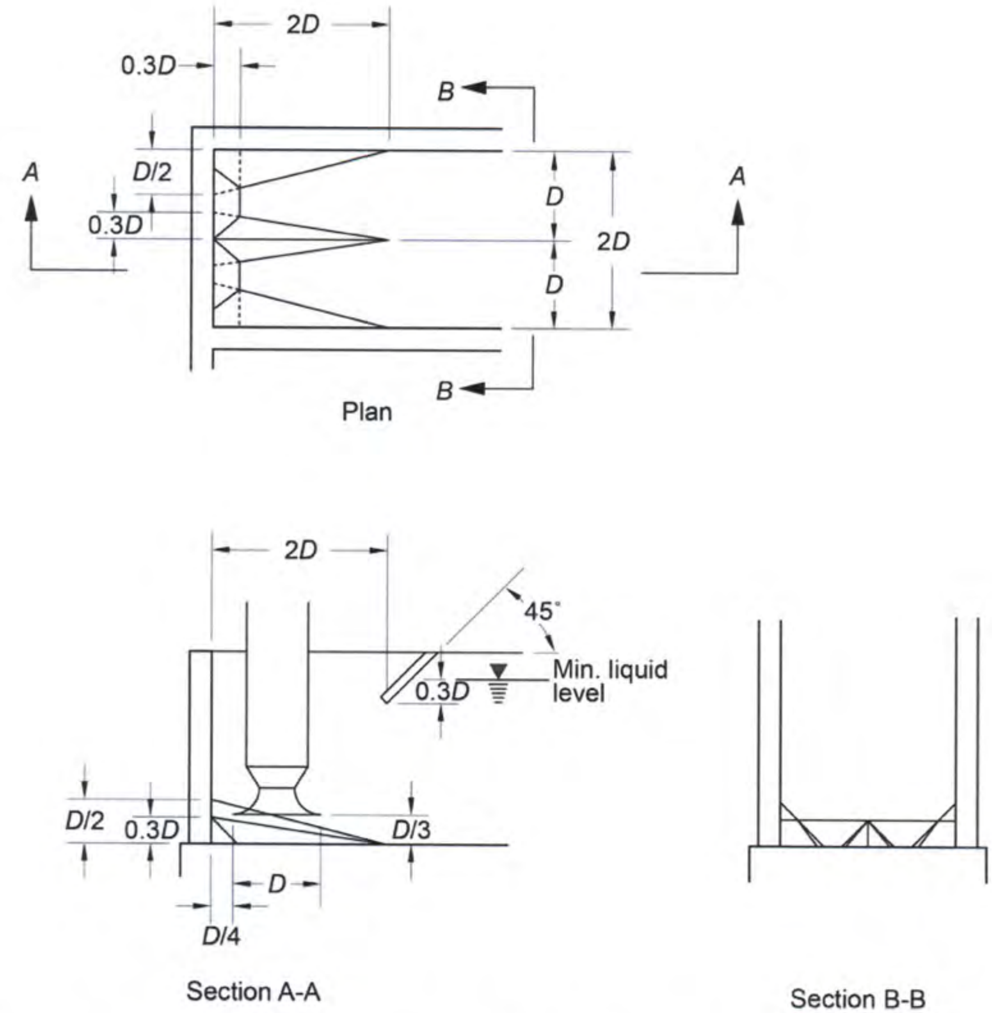
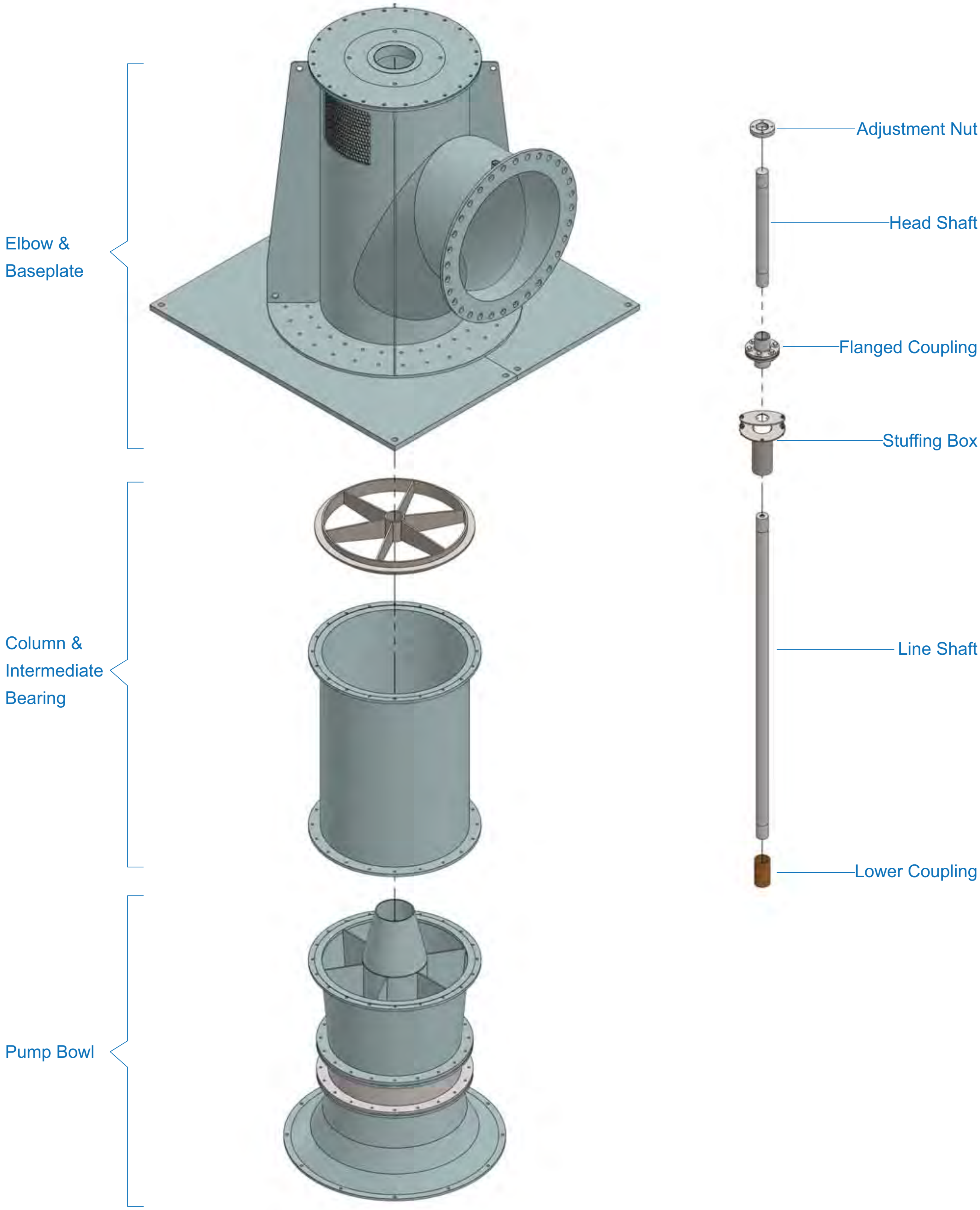


Figure J.2 Pump bay details near the pump bells for rectangular intakes with a shallow liquid source

MORRISON PUMP STANDARD PUMP DETAIL



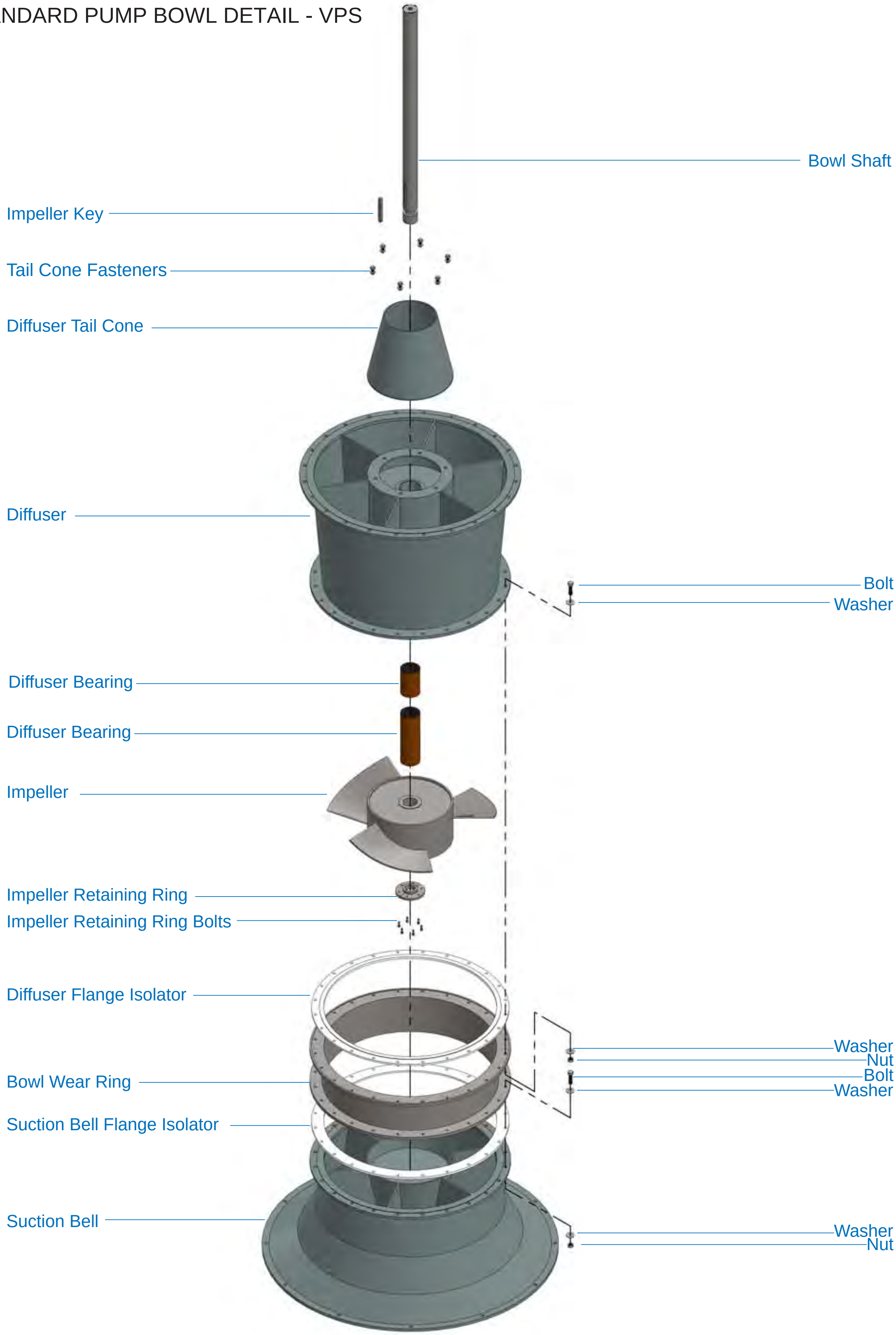
See Sub-Assembly Drawings for Detail.

Standard Pump Components & Detail - Morrison Pump VPS - Model

File: PartsDetail-Overview-VPS Above Ground Discharge

MORRISON PUMP COMPANY

STANDARD PUMP BOWL DETAIL - VPS

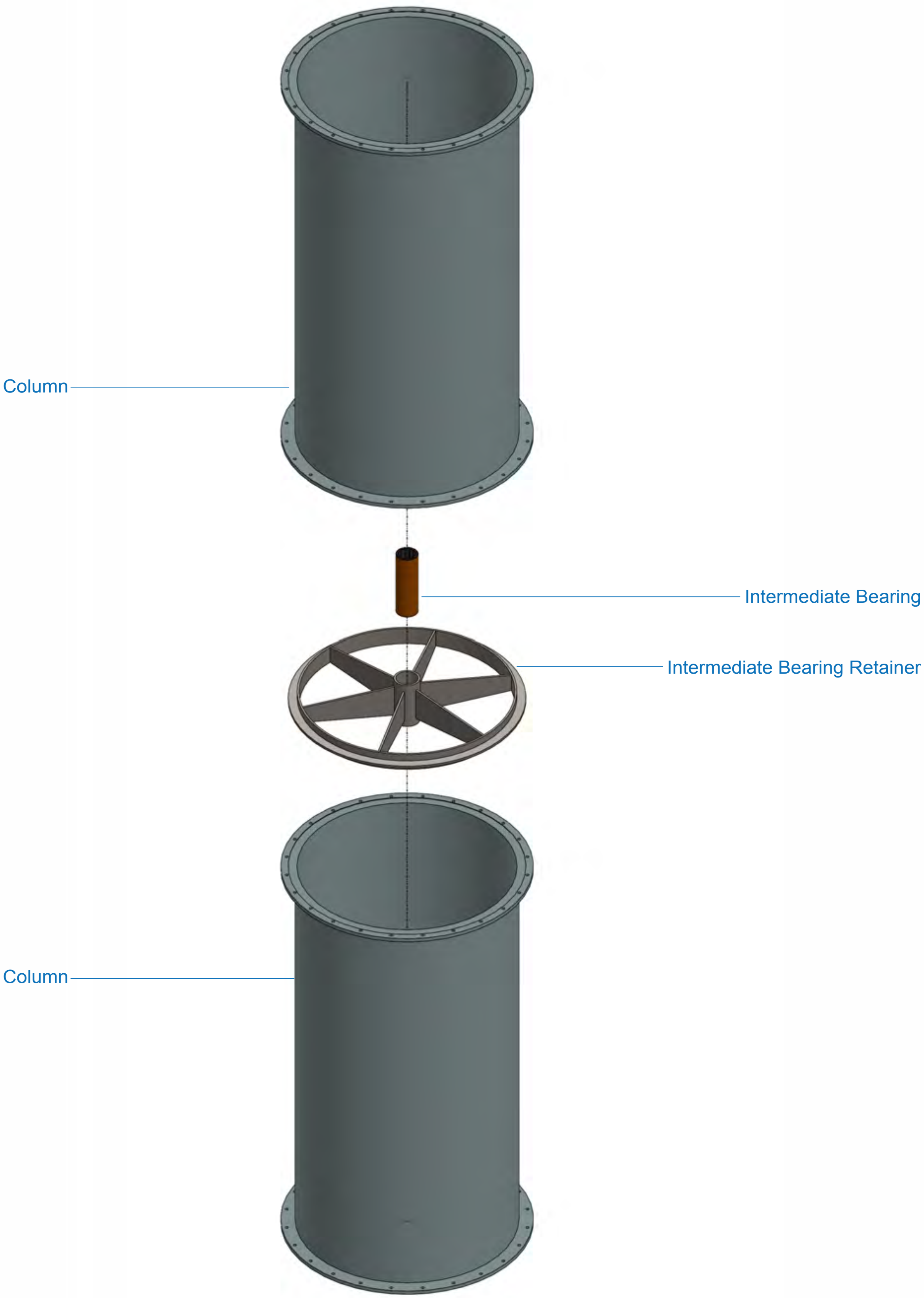


Standard Pump Bowl Detail - Morrison Pump Model VPS

File: PartsDetail-PumpBowl-VPS

MORRISON PUMP COMPANY

STANDARD PUMP COLUMN DETAIL

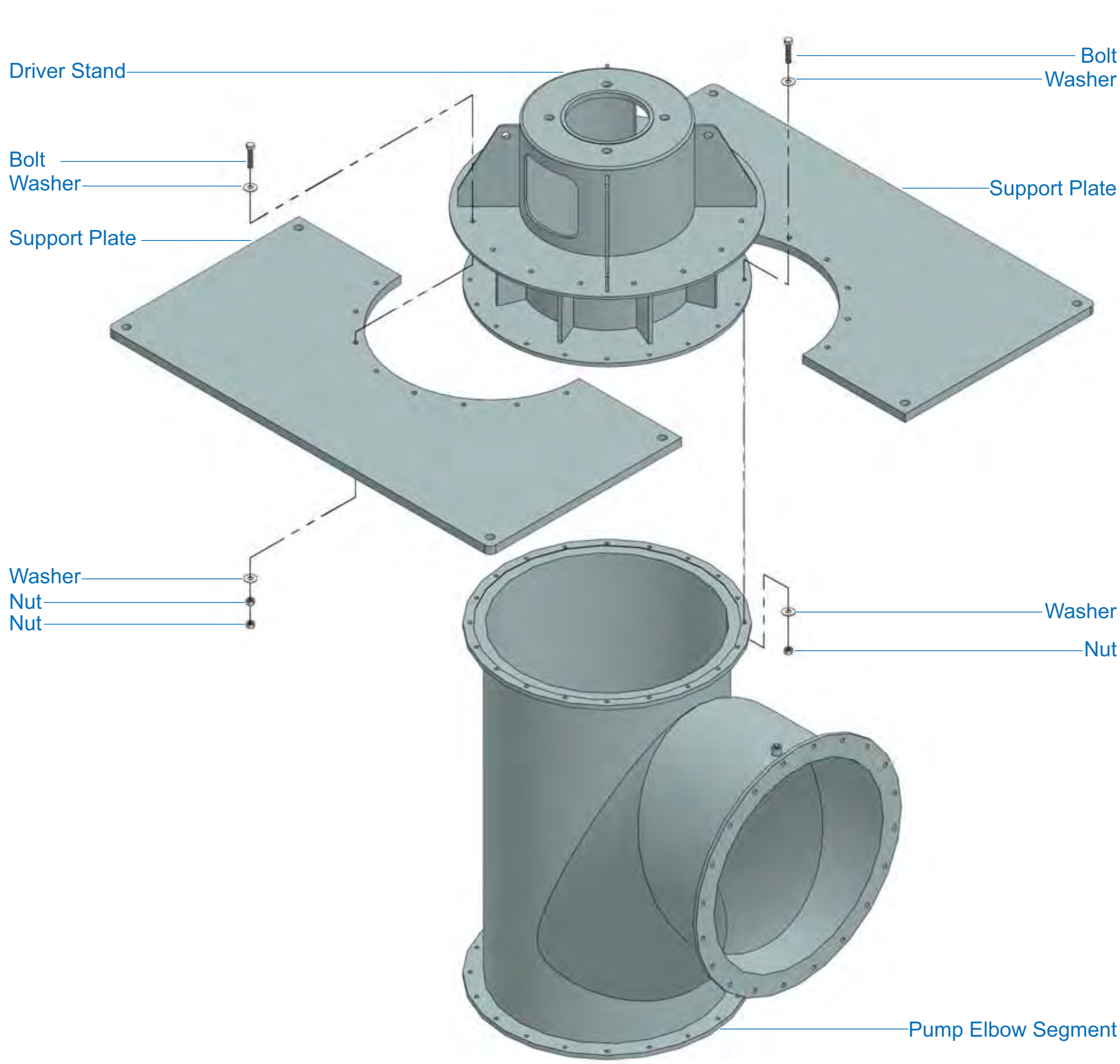


Center Column & Intermediate Bearing Retainer

File: PartsDetail-ColumnBearing

MORRISON PUMP COMPANY
A BUSINESS UNIT OF PATTERSON

STANDARD PUMP ELBOW & BASEPLATE DETAIL

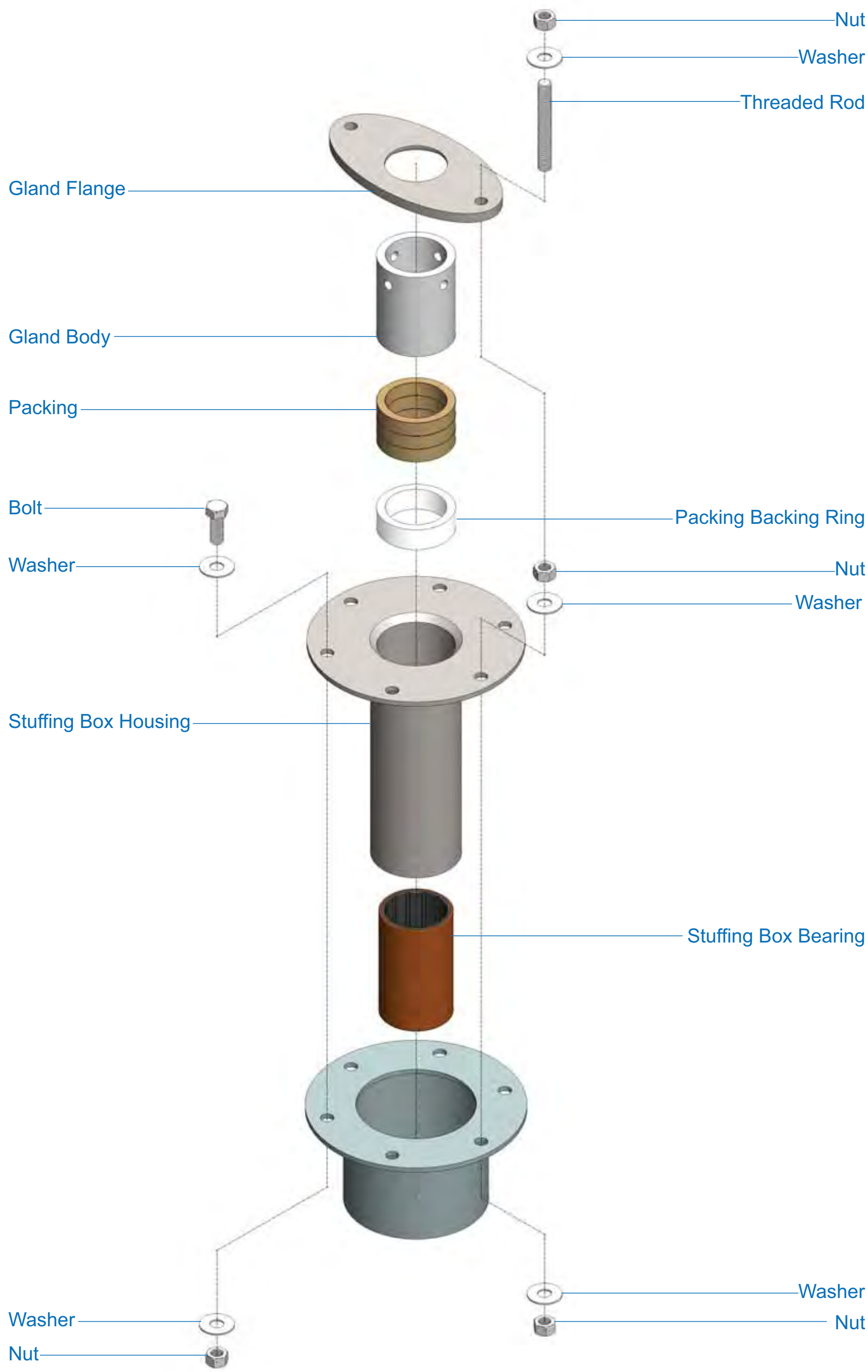


Standard Split Baseplate Detail

File: Parts Detail - Split Baseplate Discharge Elbow

MORRISON PUMP COMPANY

STANDARD STUFFING BOX DETAIL

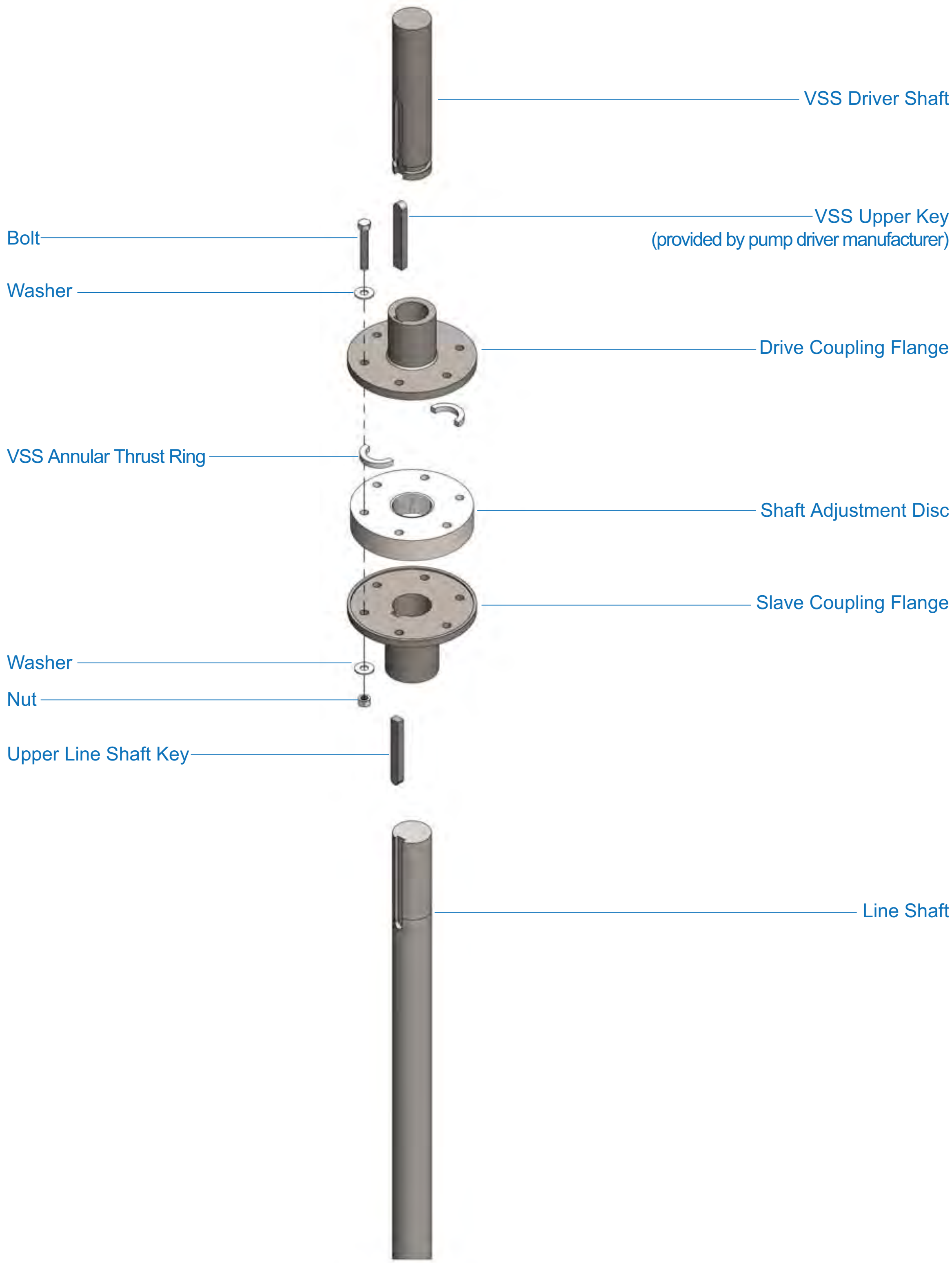


Standard Pump Detail - Stuffing Box - Morrison Pump Models VPS

File: PartsDetail-Stuffing Box

MORRISON PUMP COMPANY

HEAD SHAFT AND UPPER COUPLING DETAIL
THREADED & FLANGED COUPLING - VSS



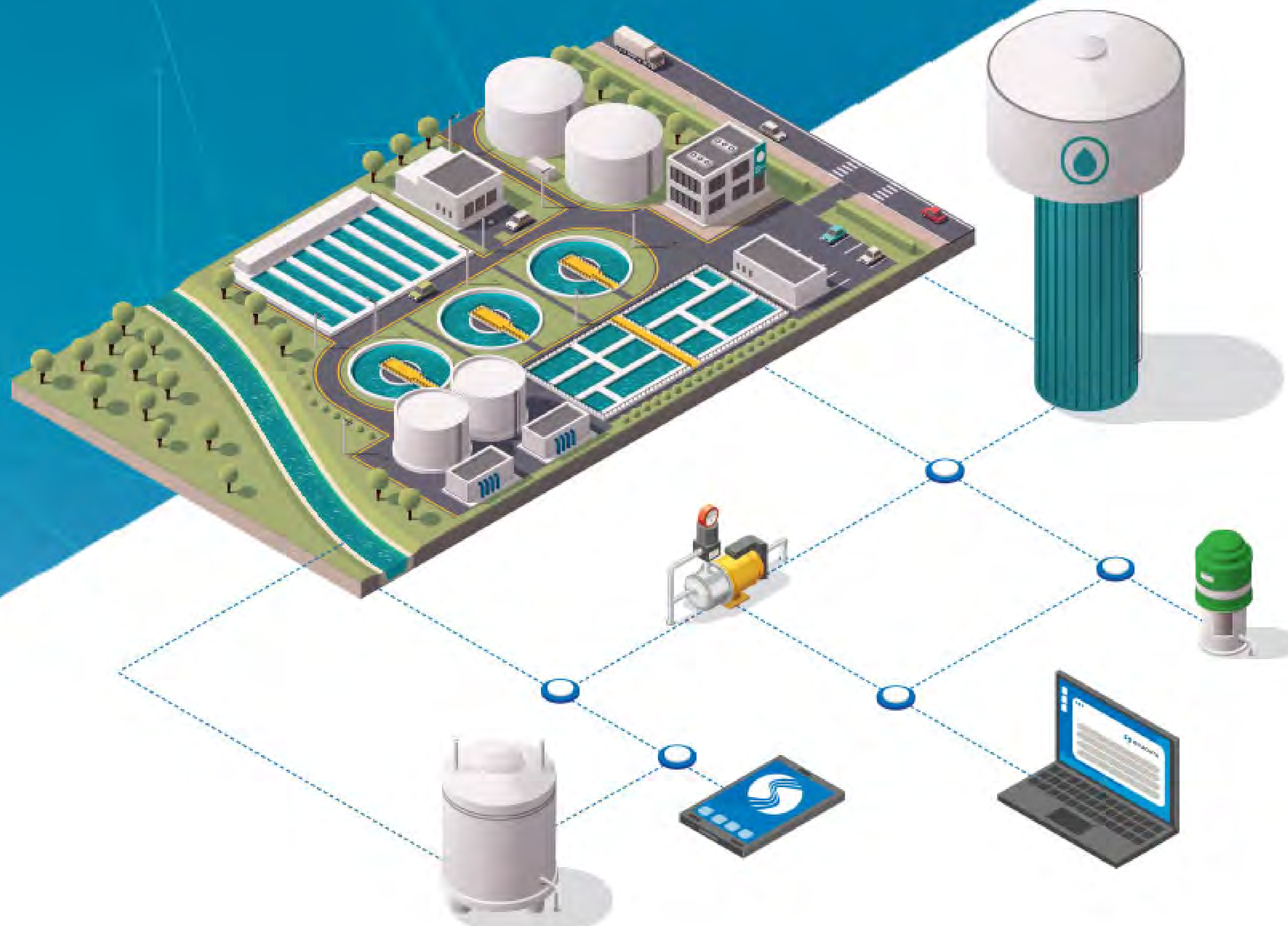
Head Shaft & Threaded Flanged Coupling VSS
File: PartsDetail-HeadShaft-ThreadedFlangedCoupling VSS

MORRISON PUMP COMPANY

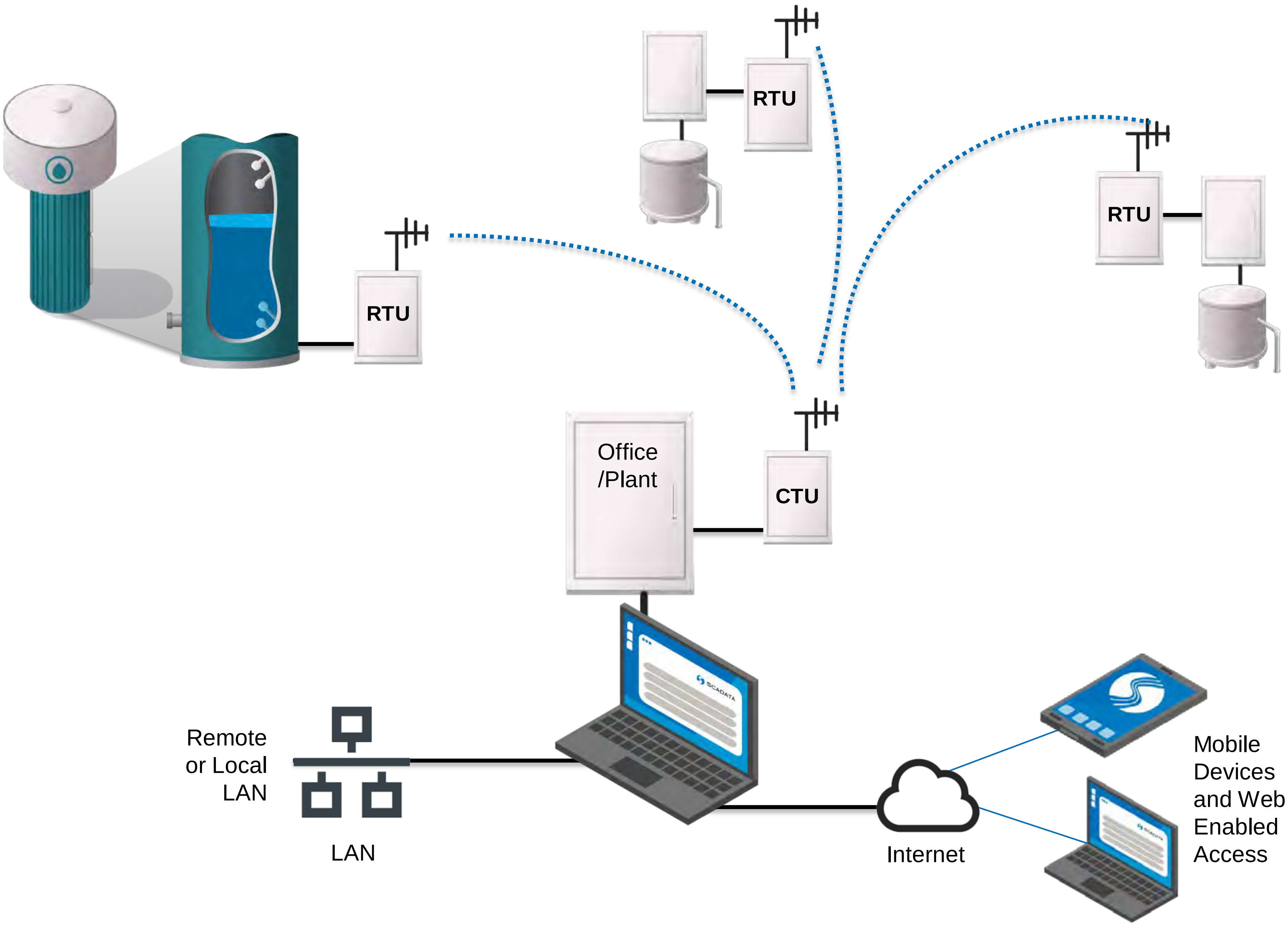
SCADA Operating System Information

SCADATA

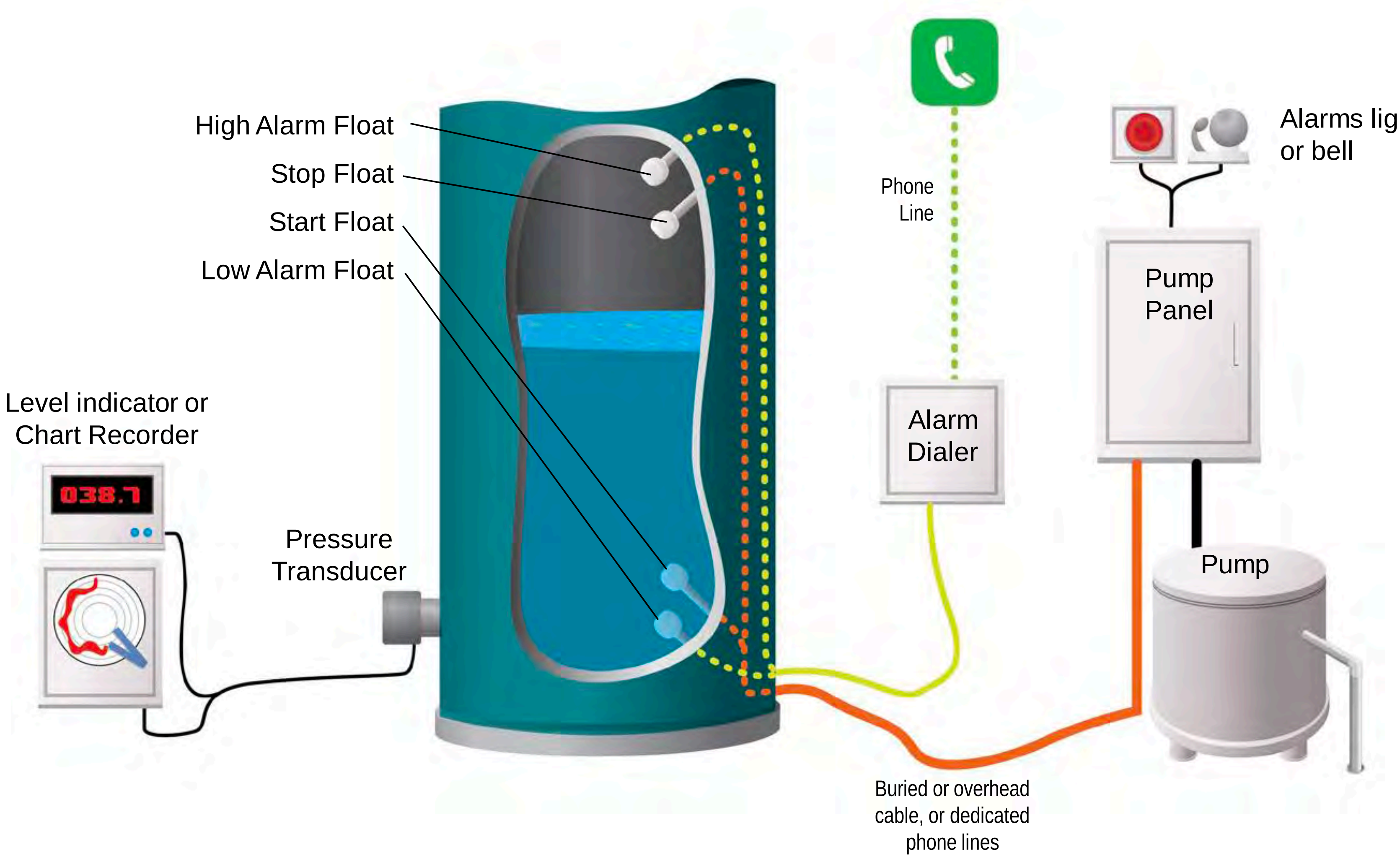
SIMPLY SENSIBLE SCADA



What is a SCADATA System?

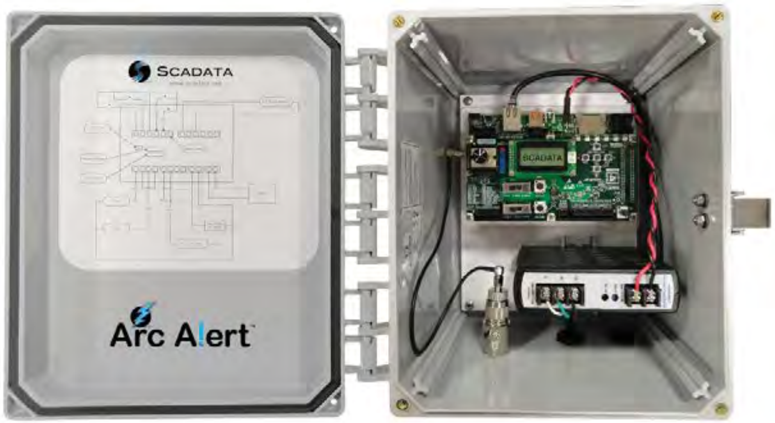


Remote Site



SCADATA

SCADATA Hardware



SCADATA

RT4422 Point-to-Multipoint RTU

Features

- Integrates with SCADATA Software Suite
- Onboard run-time logging and pulse counting capable
- Radio, Cellular and Ethernet interface
- Communicates wirelessly and remotely
- Real-time monitoring
- Expandable interface

Benefits

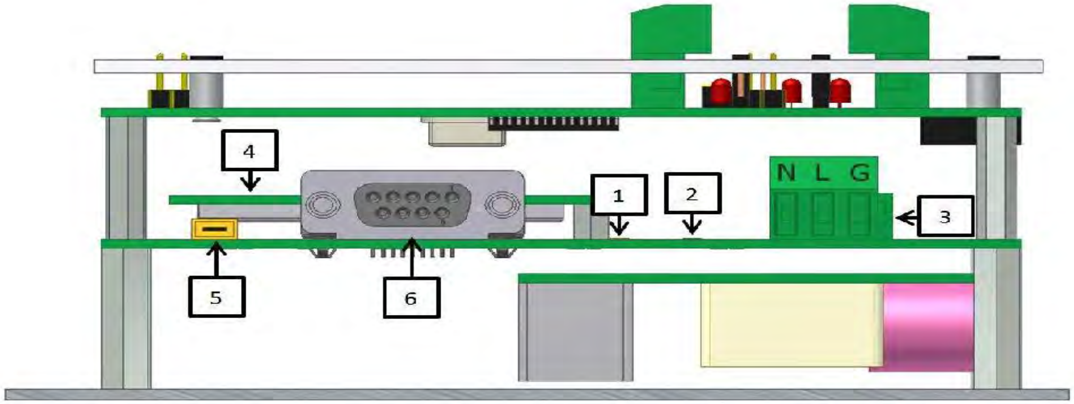
- Comprehensive I/O capabilities - Monitor & Control Capable
- Allows for reporting, trending and totalizing
- Flexible communication method
- Seamless integration with industry devices

Specifications for RT4422

- 4 digital inputs
  - pulse inputs on 1-3
- 4 analog inputs
  - (Can be converted to digital)
- 2 digital outputs
- 2 analog outputs
- Built-In
  - Power Fail
  - Low Battery
  - Communications Failure

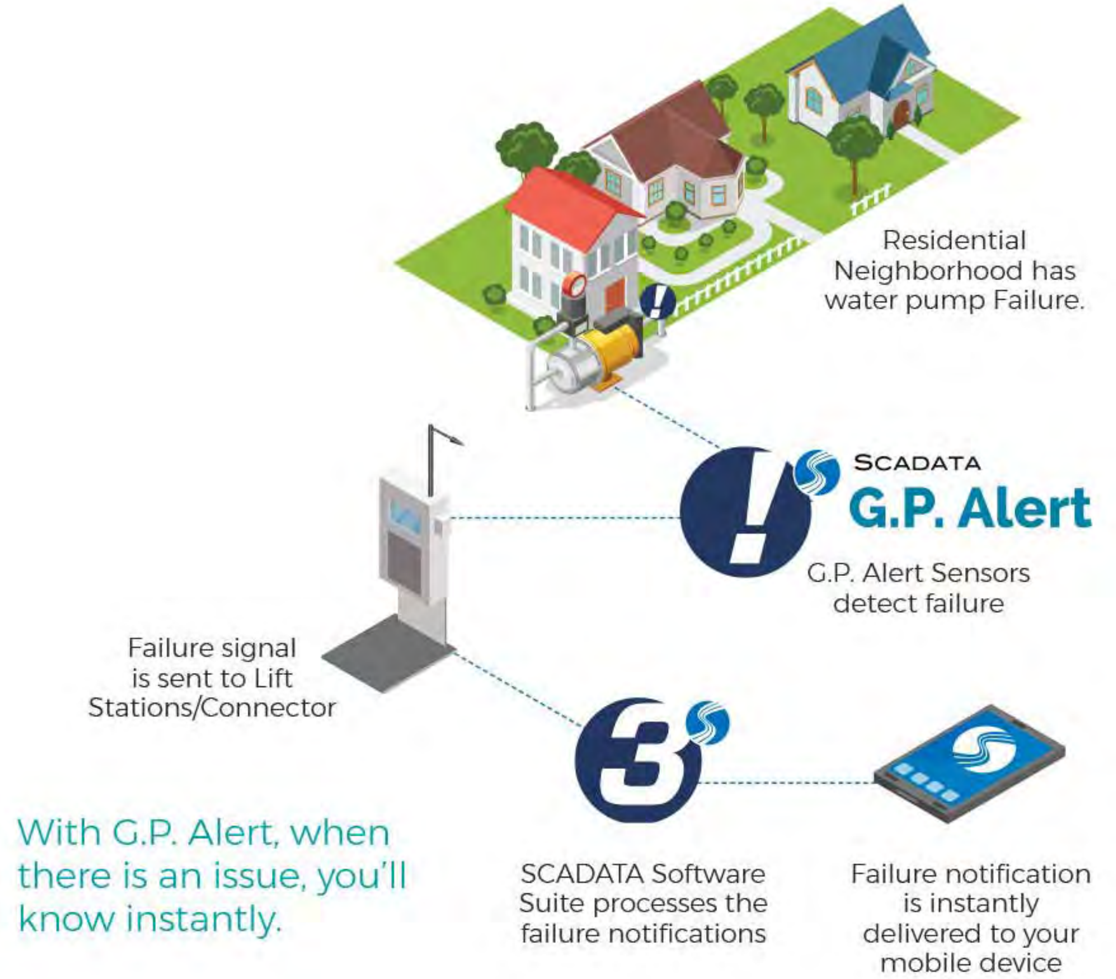
RTU with 900 MHz Radio

- RT4422-MM2T
  - 1. Output Indicator (D6): Yellow LED indicates 12 VDC is flowing from the I/O board.
  - 2. Input Indicator (D2): Green LED indicates the transceiver is plugged in to power source and110 VAC is flowing into the I/O board.
  - 3. AC receiving port
  - 4. Radio module
  - 5. Diagnostic port
  - 6. Serial port



GP Alert

G.P. Alert
SCADATA



Residential Neighborhood has water pump Failure.
SCADATA
G.P. Alert
G.P. Alert Sensors detect failure
Failure signal is sent to Lift Stations/Connector
With G.P. Alert, when there is an issue, you'll know instantly.
SCADATA Software Suite processes the failure notifications
Failure notification is instantly delivered to your mobile device

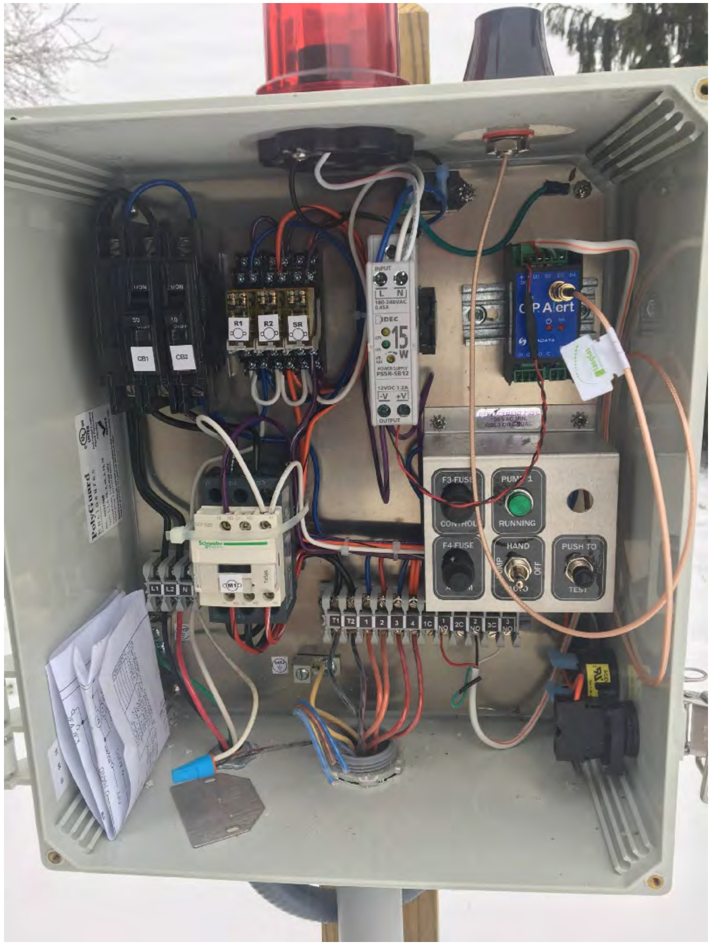
GP Alert

Features

- Uniquely designed for small systems
- Cost-effective
- Real-time monitoring
- Alerts and notifications via text and email
- Communicates wirelessly and remotely

Benefits

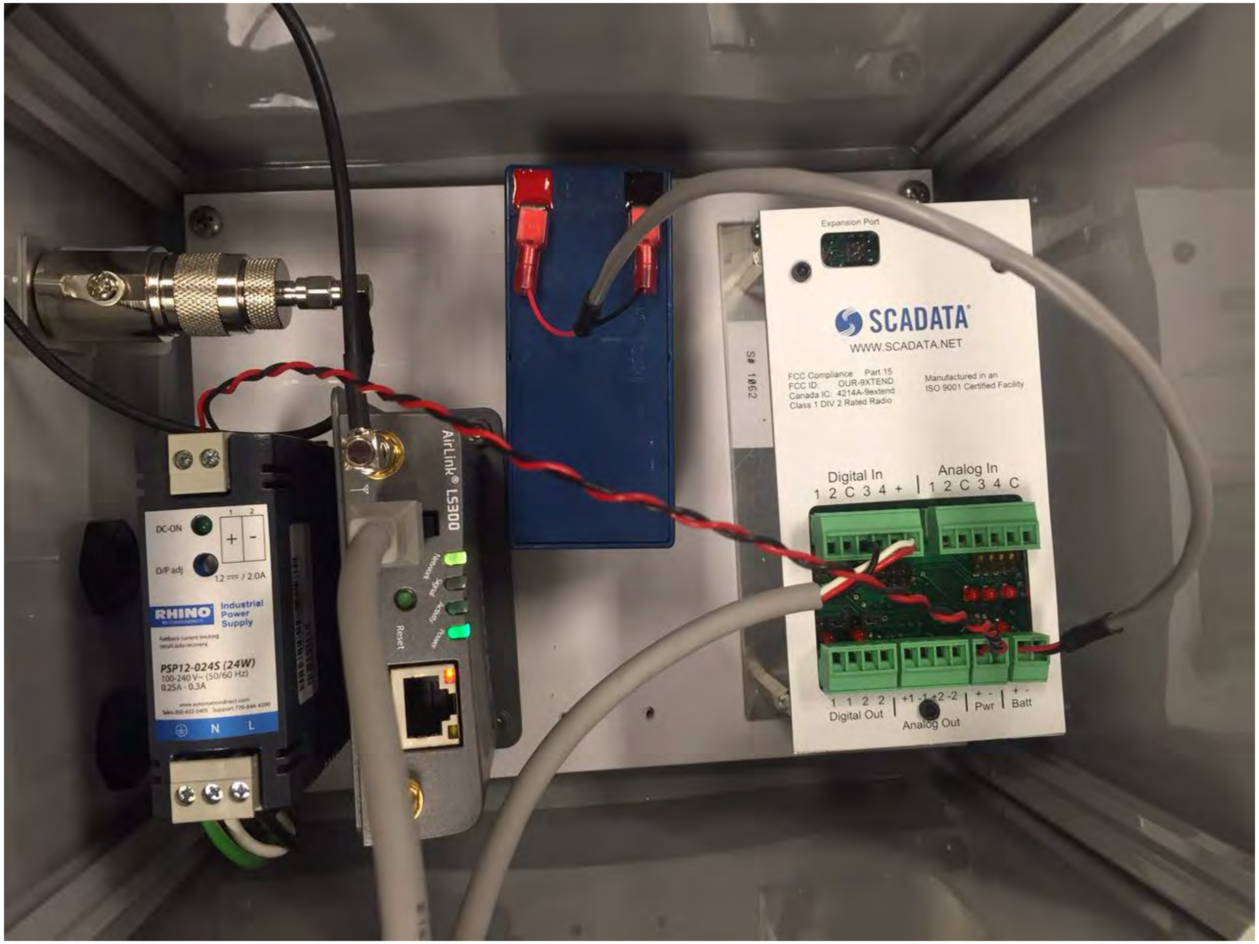
- Continuously monitors remote locations
- Reduces costs and manpower
- Improves ability to offer high-quality service to your customers efficiently
- Seamless integration
- Quick deployment system



Our Communication Options

- We provides free radio path analysis using latitude and longitude coordinates
- 900 MHz unlicensed radios – most common
- Cellular modems
- VHF: 150-170 MHz (Licensed)
- UHF: 450-470 MHz (Licensed)
- Ethernet/Fiber
- Wi-Fi

SCADATA RT4422 w/ Cell Modem



SCADATA RT4422 w/ VHF Radio

What Communication method is right for your system?

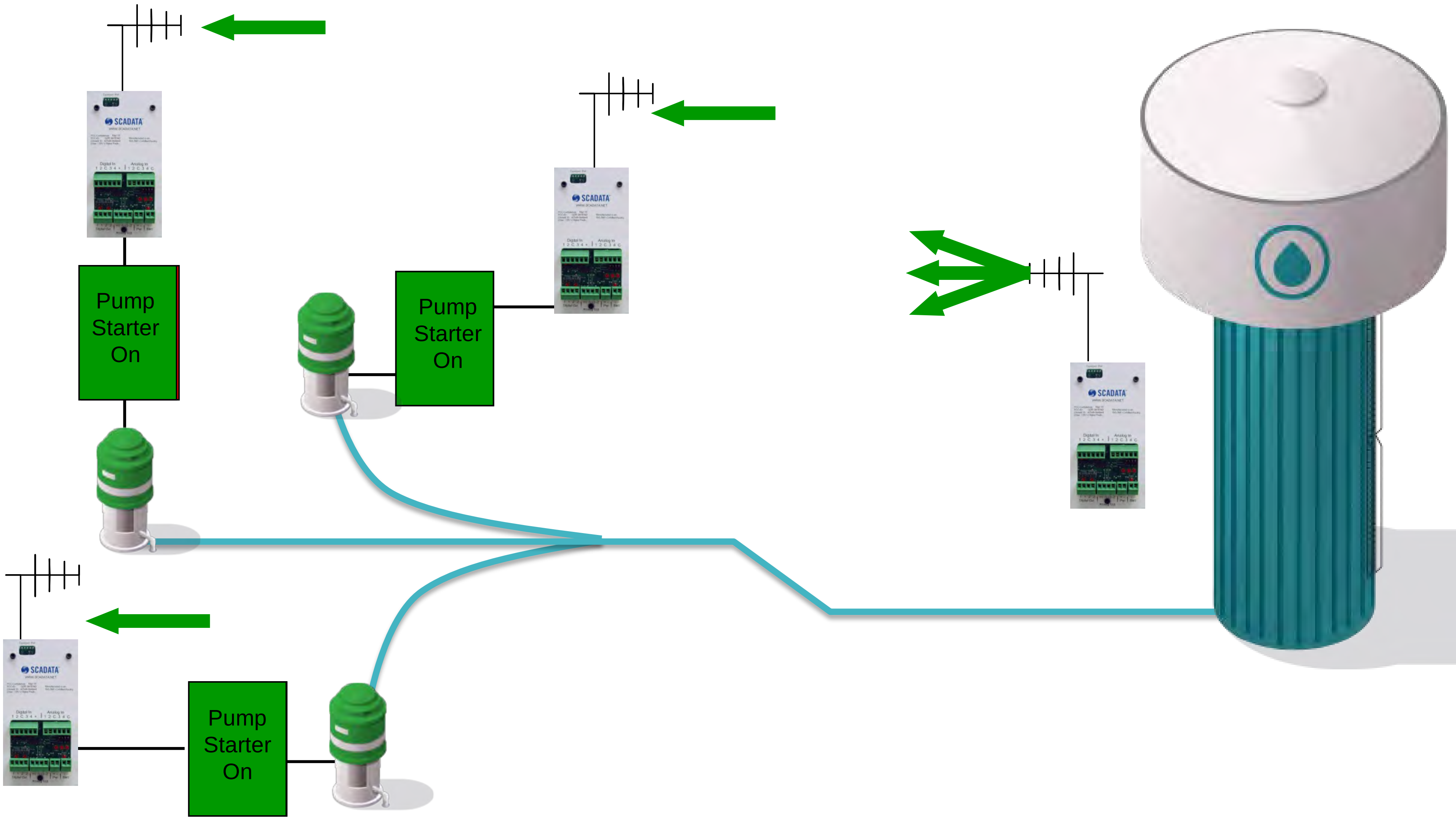
- When looking at a new system all communication options are on the table.
- At each site we look to find the best option while keeping cost down for the customer long term.
- Radio commonly being the best long term savings and Cellular being the most versatile.
- Before every project we conduct digital path studies and guarantee communication.

We strive to make the most out of our customers radio systems.

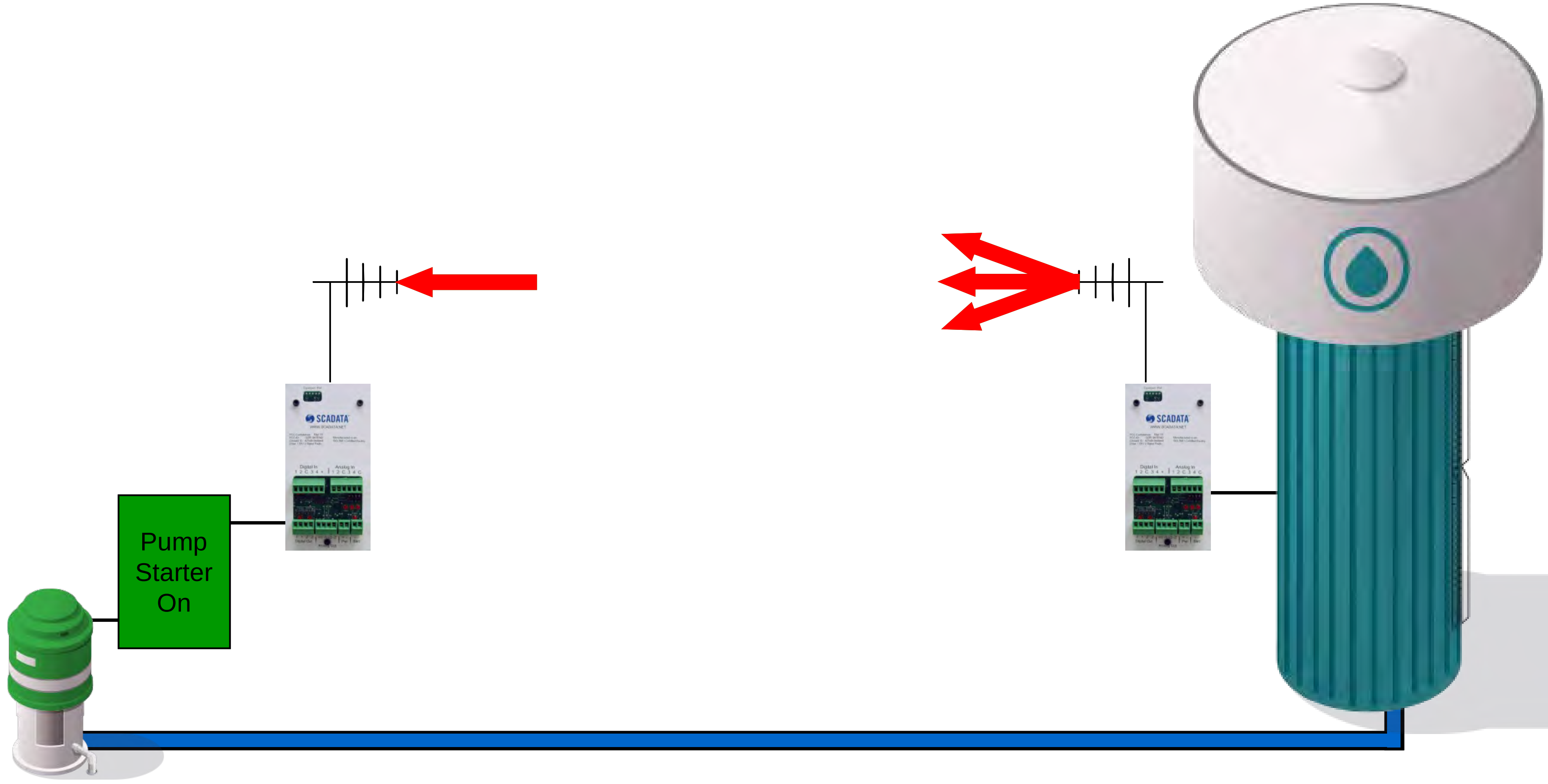
- In-depth radio path studies
- Repeater site capability
- Radio signal boosting and diagnostics
- Spectrum analysis

All to ensure strong connections keep long term cost down.

Multiple RTUs using Radios



SCADATA Wireless Wires



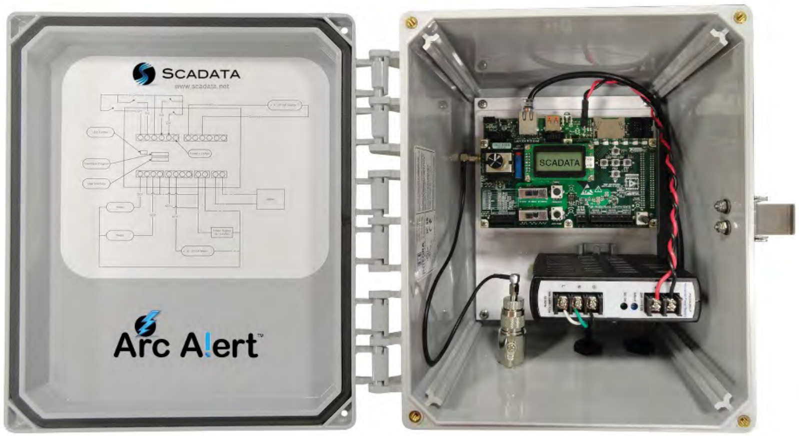
Constant Speed Application

ARC Monitoring Solution

Real- time continuous detection of corona, tracking, arc, and partial discharge conditions

- Uses ultrasound technology to detect potentially harmful arc conditions
- Alarms notify you before dangerous situations occur
- Real-time and historical data monitoring
- Increased facility safety and efficiency
- Reduced labor costs

ARC Monitoring System



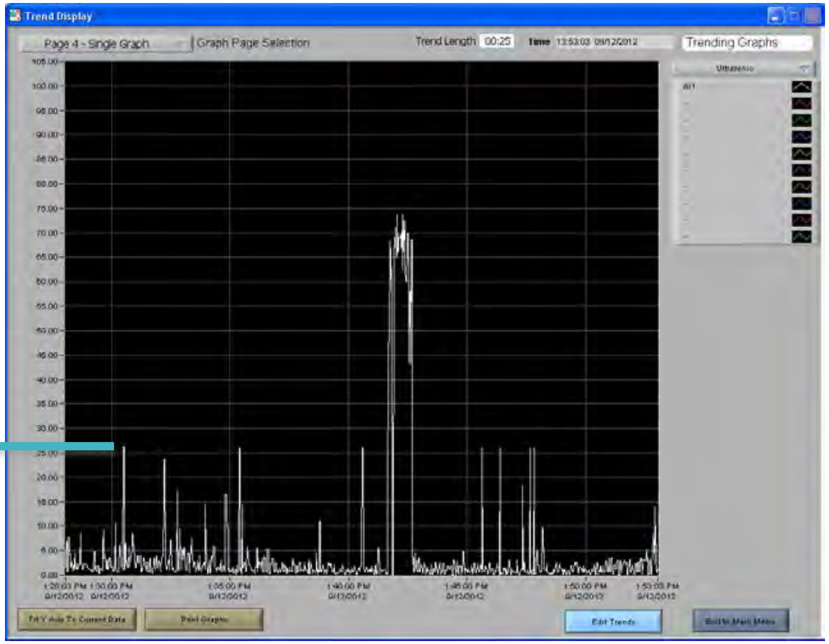
Sensing Device

Interface Wireless
or Ethernet

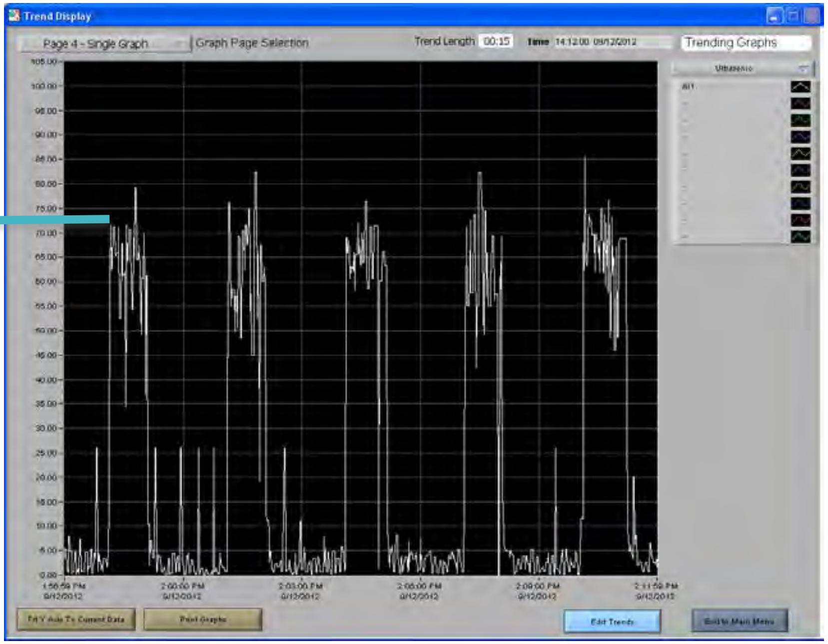
Real-Time
Notification

SCADATA – ARC Testing

Partial Discharge

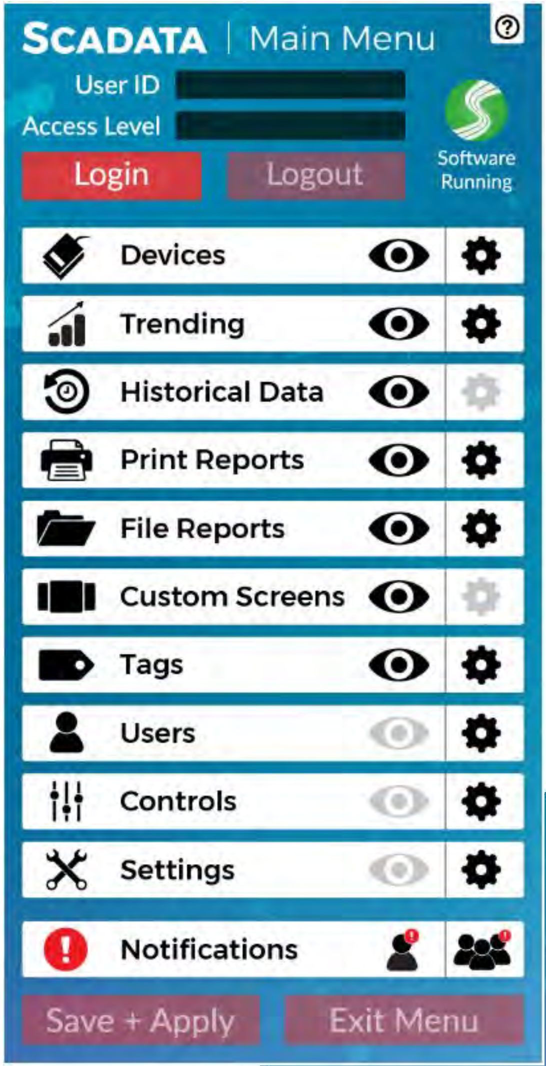


ARC Event



SCADATA

SCADATA
Software Suite



DAQ & Management Software

SCADATA

Software Suite

- Our data acquisition and management software is written using LabView Software
- Interfaces with all industry devices
- User-friendly navigation and setup
- Simple reporting options

LabVIEW TOOLS NETWORK

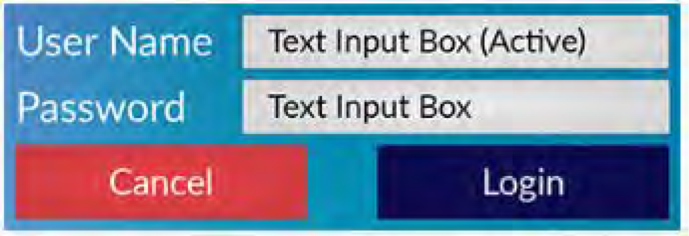
SCADATA Software Suite

Hosted and Non-hosted

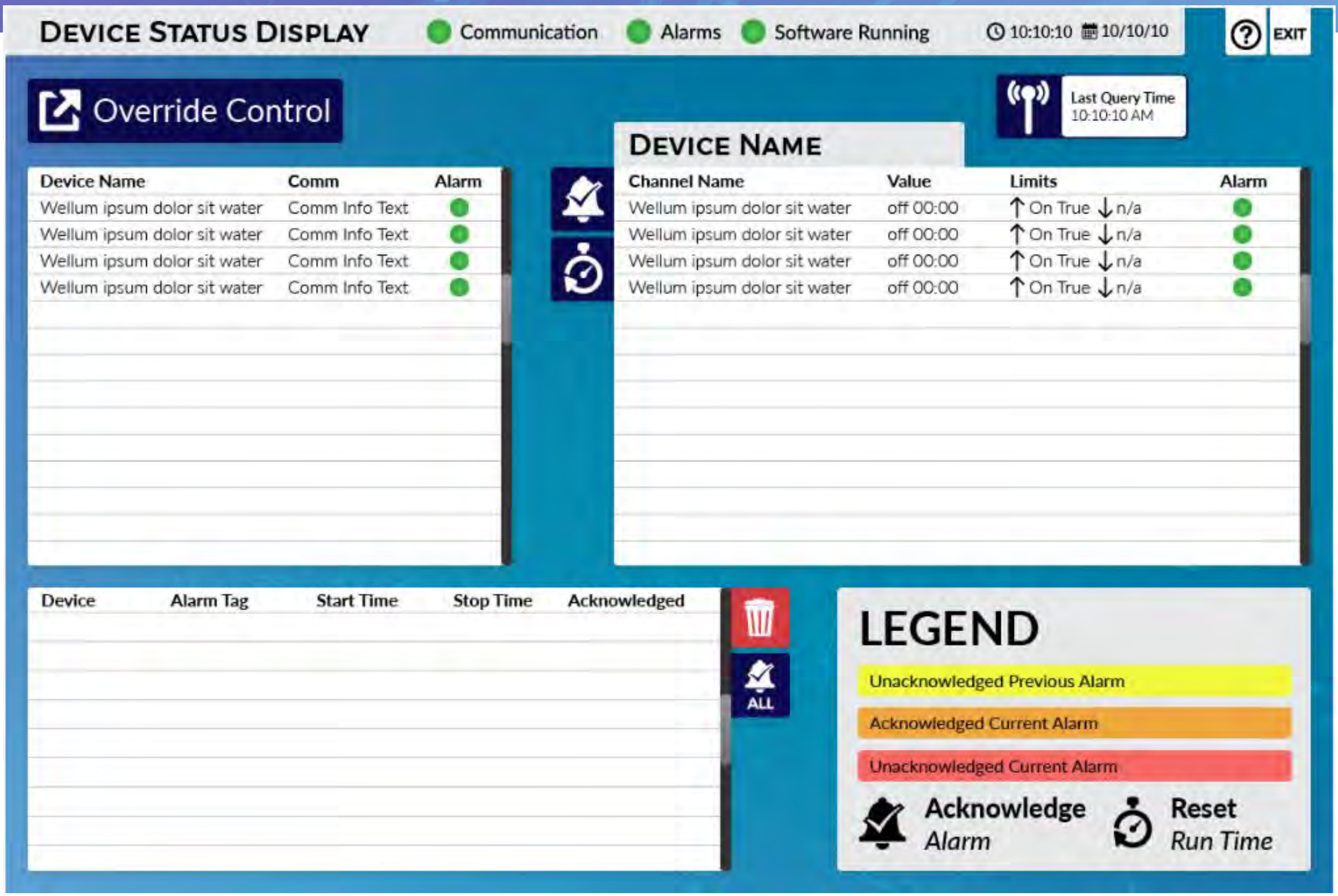
- Scadata can offer direct software licenses or hosted server.
- Direct software License would reside on a customer computer.
- Hosted server option is accessed through internet remote access from any computer.
- Scadata also offers a phone application for both software offerings.

Secure Software

- Account Management
  - User access management
- Activity Log
  - Activity description
  - Time stamp activity



- Data Integrity Validation
  - Electronic records with data storage
  - RSA encryption

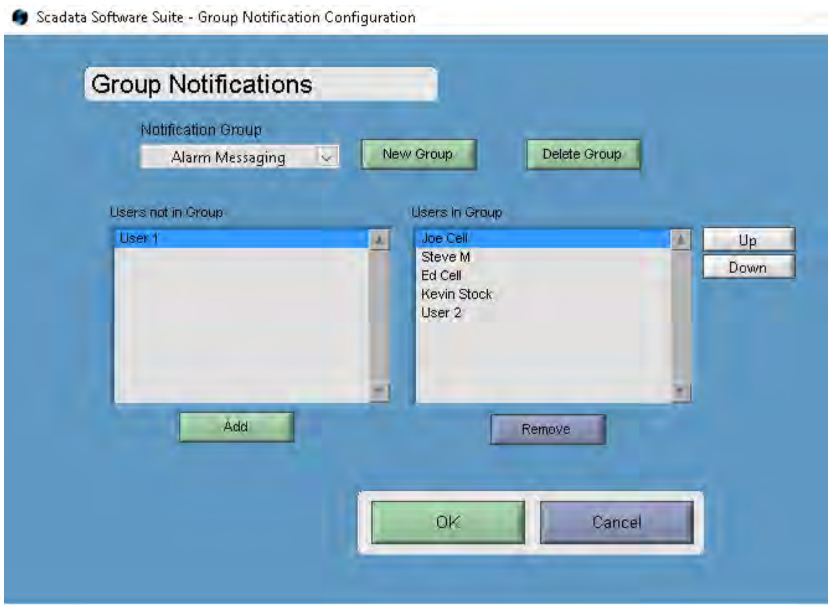


- View all RTUs and I/O status on single screen
- Manage alarms
- Reset run times
- Communications status

Real Time Trend Graphs

Alarms User Notifications

Email

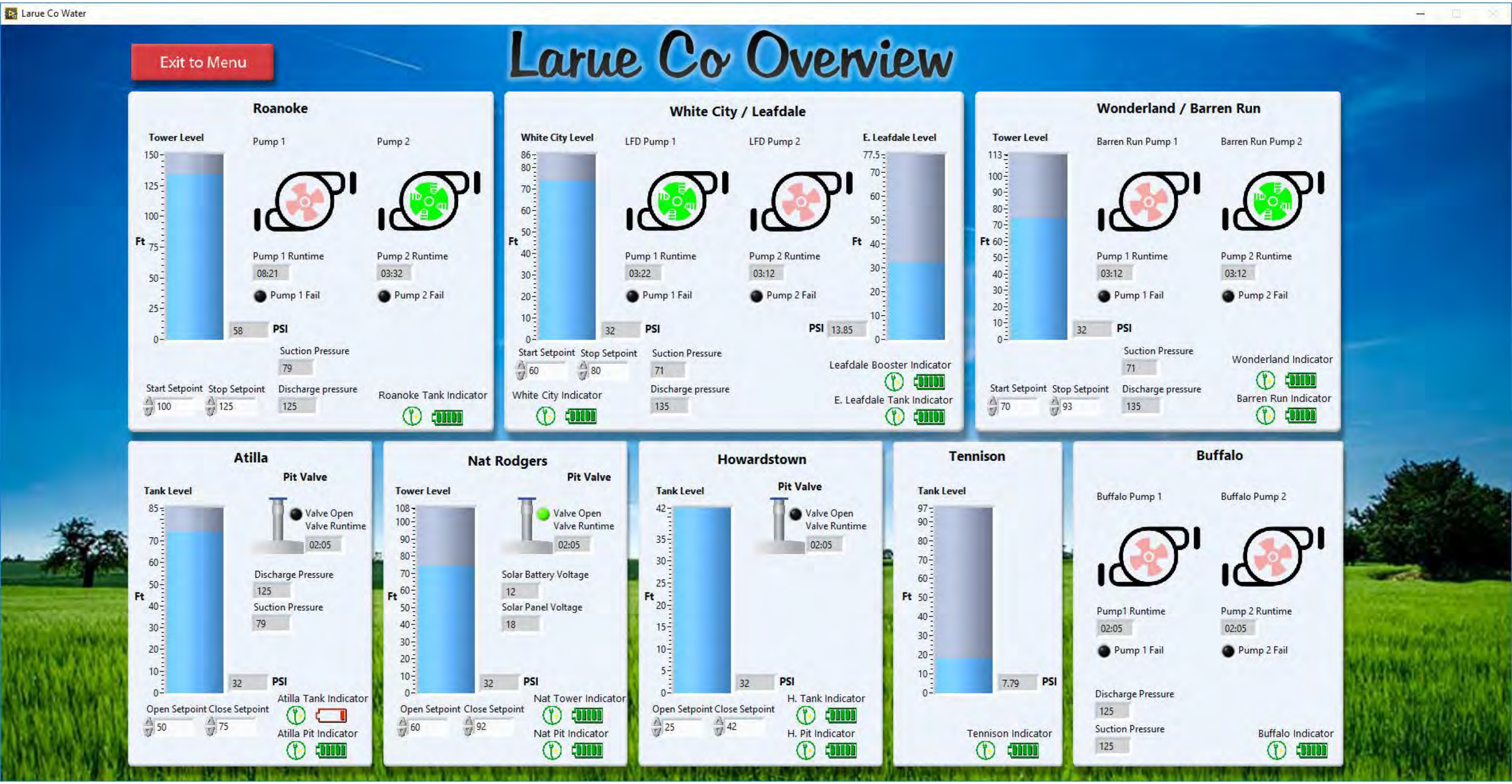


Text

Custom Screen Example

Custom Screen Example

Custom Screen Example



SCADATA

New Jersey Stormwater Best Management Practices Manual: Groundwater Recharge

C H A P T E R 6

Groundwater Recharge

This chapter presents the standards, data, and procedures necessary to meet the groundwater recharge requirements of the NJDEP Stormwater Management Rules at N.J.A.C. 7:8. According to these Rules, a "major development" project, which is one that disturbs at least 1 acre of land or creates at least 0.25 acres of new or additional impervious surface, must include nonstructural and/or structural stormwater management measures that prevent the loss of groundwater recharge at the project site. This requirement is included in the Rules because the loss of groundwater recharge can adversely impact the health of streams and wetlands and the yield of water supply wells. Urban redevelopment and certain linear development projects are exempt from the groundwater recharge requirements, while waivers may obtained under certain conditions for public roadway, railroad, and pedestrian walkway enlargements. Complete details can be found in Subchapter 5 of the Stormwater Management Rules.

Specifically, the Stormwater Management Rules require that a proposed major land development comply with one of the following two groundwater recharge requirements:

Requirement 1: That 100 percent of the site's average annual pre-developed groundwater recharge volume be maintained after development; or

Requirement 2: That 100 percent of the difference between the site's pre- and post-development 2-Year runoff volumes be infiltrated.

The Stormwater Management Rules allow the site designer to select which requirement to follow. The Rules also state that compliance with either of the above alternative requirements must be demonstrated through hydrologic and hydraulic analysis. Regardless of which alternative requirement is selected, such an analysis will generally begin with a computation of the existing (or pre-developed) hydrologic conditions at the proposed development site. In the case of Requirement 1, these conditions will focus on the annual amount of groundwater recharge that occurs at the site under pre-developed conditions while, for Requirement 2, the focus will instead be on the pre-developed volume of 2-Year site runoff.

These computations will then be followed by similar ones for the proposed (or post-developed) conditions at the site. A comparison of the results of either of these pre- and post-development computations will then yield the annual volume of groundwater that must be recharged (Requirement 1) or 2-Year storm runoff volume that must be infiltrated (Requirement 2) through one or more structural recharge or infiltration BMPs. Ideally, the planning and design of the proposed site will have incorporated nonstructural measures to such an extent that the need for structural facilities is reduced to a practical minimum.

Finally, once the analysis of pre- and post-development conditions has established the need for structural recharge (Requirement 1) or infiltration (Requirement 2) BMPs, the hydrologic and hydraulic analysis would next focus on the actual design of such facilities. This process would include answering such questions such as:

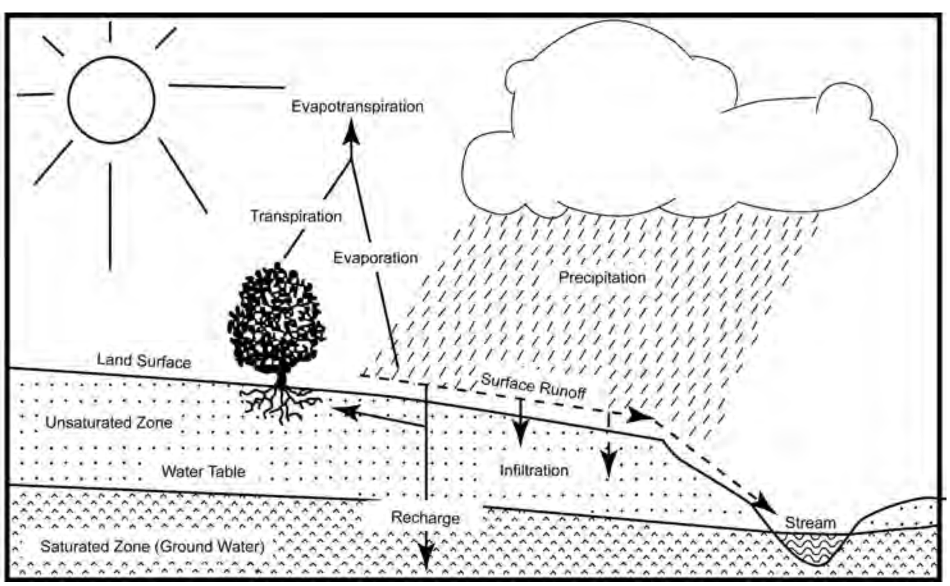
- Should the required recharge or infiltration be achieved at a single facility or several located throughout the development site?
- Should the facilities be located above or below ground?
- Which portions of the development site should be utilized to generate runoff to the facilities?
- What facility dimensions are required?
- Where should the facilities be located on the site relative to buildings, septic systems, property lines, and other sensitive areas?

This chapter presents the groundwater recharge information necessary to perform the hydrologic and hydraulic analysis required for Requirement 1 (maintaining pre-developed annual recharge volumes). Information necessary for the analysis required for Requirement 2 (infiltrating the increased 2-Year runoff volume) is presented in *Chapter 5: Computing Stormwater Runoff Rates and Volumes*. Design information regarding structural recharge and infiltration BMPs can be found in this chapter and *Chapter 9: Structural Stormwater Management Measures*.

Fundamentals

In both the NJDEP Stormwater Management Rules and this manual, groundwater recharge is defined as precipitation that infiltrates into the soil and is not evapotranspired. Instead, the infiltrated precipitation moves downward to a depth below the root zone of the surface vegetation, where it cannot be removed by that vegetation through uptake and evapotranspiration. At such a depth, it is considered available to enter the soil's saturated zone and become groundwater. The role of groundwater recharge in the overall hydrologic cycle is illustrated in Figure 6-1 below.

Figure 6-1: Groundwater Recharge in the Hydrologic Cycle



Source: New Jersey Geological Survey Report GSR-32.

According to the New Jersey Geological Survey (NJGS):

> *The potential for natural groundwater recharge begins with precipitation (rain, snow, hail, sleet). Some of the precipitation never seeps into the soil, but instead leaves the system as surface runoff. The water that seeps into the soil is infiltration. Part of the water that does infiltrate is returned to the atmosphere through evapotranspiration. Evapotranspiration refers to water that is returned to the atmosphere from vegetated areas by evaporation from the soil and plant surfaces and soil water that is taken up by plant roots and transpired through plant leaves or needles. Infiltrated water that is not returned to the atmosphere by evapotranspiration moves vertically downward and, upon reaching the saturated zone, becomes ground water. This ground water could be in a geologic material that is either an aquifer or nonaquifer, depending on whether it can yield satisfactory quantities to wells.* (NJGS GSR-32)

In addition to supplying water to wells, groundwater can also provide base flow to streams, wetlands, and other water bodies, directly affecting the ecology and geomorphology of these resources.

The potentially adverse impacts of land development on groundwater recharge have long been recognized. From the description presented above, it can be seen that land development activities that either cover permeable soils with impervious surfaces or reduce the soils' permeability through disturbance and compaction will reduce the rate of groundwater recharge that occurs under pre-developed site conditions. As noted above, such reductions in groundwater recharge can adversely impact streams, wetlands, and other water bodies by reducing the volume and rate of base flow to them. Reductions in groundwater recharge to aquifers can also adversely impact the yield of water supply wells. As a result, the New Jersey Stormwater Management Rules require that pre-developed groundwater recharge rates be maintained at land development sites under post-development conditions.

Computing Groundwater Recharge

Overview

As described above, the groundwater recharge requirements of the NJDEP Stormwater Management Rules can be met by demonstrating that the average volume of precipitation that is annually recharged to the groundwater at a major land development site under pre-developed conditions will be maintained following site development. As described in detail below, this can be achieved through a combination of natural recharge over the developed site's pervious surfaces and artificial recharge through groundwater recharge BMPs constructed at the site. The BMP volume is based on an average annual distribution of runoff-producing precipitation events at the site, the impervious drainage area to the BMP, and the losses that may occur to the infiltrated runoff before it can travel below the root zone of surrounding vegetation and become groundwater.

The data and analytic procedures necessary to meet these requirements have been developed by the New Jersey Department of Environmental Protection (NJDEP) with assistance from the New Jersey Geologic Survey (NJGS), the U.S. Geologic Survey (USGS), and professional consultants, and have been compiled into the New Jersey Groundwater Recharge Spreadsheet (NJGRS), a Microsoft Excel-based computer spreadsheet program. The NJGRS is intended for use by site planners, designers, engineers, and reviewers to determine average annual groundwater recharge amounts under both pre- and post-development site conditions and to design the groundwater recharge BMPs necessary to maintain 100 percent of the pre-developed site's annual groundwater recharge rate. Information regarding the NJGRS, including a detailed User's Guide, an example problem, and instructions on how to download the NJGRS from the NJDEP stormwater management website, is presented below. Details of the program's theoretical basis, equations, and supporting databases are also summarized.

In general, the analytic procedures utilized by the NJGRS to achieve compliance with the groundwater recharge requirements of the Stormwater Management Rules (described as Requirement 1 above) can be summarized by the following computational steps:

1. Compute the average amount of annual groundwater recharge occurring over the land development site under pre-developed site conditions.
2. Compute the average amount of annual groundwater recharge occurring over the land development site under post-developed conditions. Such site conditions should reflect the use, to the maximum extent practicable, of nonstructural stormwater management measures at the post-developed site in accordance with the Stormwater Management Rules. Details of such nonstructural measures are presented in *Chapter 2: Low Impact Development Techniques*.
3. Compute any resulting annual groundwater recharge deficit by subtracting the post-developed annual recharge amount in Step 2 from the pre-developed annual amount in Step 1. This deficit represents the average annual amount of groundwater recharge that must be achieved at the development site through structural groundwater recharge BMPs.
4. Determine the storage volume and related dimensions of the structural groundwater recharge BMP that will be required to satisfy the average annual groundwater recharge deficit computed in Step 3 above. In doing so, the BMP volume must be based on the average annual distribution of runoff-producing precipitation events at the development site, the size of the drainage area over which these events will occur (and from which runoff will be collected or captured for recharge), and the infiltration, evapotranspiration, and other losses that may occur to the recharged runoff in the BMP before it can actually enter the groundwater.

Theoretical Basis of Computations

Computation of the average annual groundwater recharge at a land development site under either pre- or post-developed conditions (as described above in Steps 1 and 2) can be performed with the New Jersey Groundwater Recharge Spreadsheet (NJGRS). This Microsoft Excel-based spreadsheet is based on the data and computational procedures contained in the 1993 *Geological Survey Report GSR-32: A Method for Evaluating Ground Water Recharge Areas in New Jersey* developed by the NJGS. As described in the report, GSR-32 utilizes precipitation, soil, land cover, and climate data, and rainfall-runoff and mass balance computations to estimate average annual groundwater recharge amounts at sites within any New Jersey municipality under a variety of surface and development conditions. All pertinent GSR-32 databases and computational algorithms have been incorporated into the NJGRS. As such, use of the NJGRS is governed, in part, by the assumptions and limitations of GSR-32.

Design of the required recharge BMP (as described in Step 4 above) to compensate for the developed site's groundwater recharge deficit (as described in Step 3 above) can also be performed with the NJGRS. The design computations in the NJGRS are based on a number of analytic techniques and databases. Conceptually, a groundwater recharge BMP will recharge the runoff it receives from its drainage area for all storms up to a particular precipitation depth, which can be referred to as the BMP's groundwater recharge design storm. While the recharge BMP will also receive runoff from larger storms, it will only recharge that portion of the runoff that equals the Recharge Design Storm runoff. The remaining runoff from these larger storms will overflow or otherwise bypass the BMP. It is important to note that the range of precipitation depths typically involved in the design of a groundwater recharge BMP are relatively small when compared to depths associated with runoff quality or quantity control. As a result, the NJGRS requires that the entire drainage area to a recharge BMP be impervious, since pervious surfaces would typically not be able to produce a sufficient amount of rechargeable runoff from such small precipitation depths.

Assuming that all of the precipitation falling in a recharge BMP's impervious drainage area can be collected and recharged (i.e., no runoff, infiltration, or recharge losses), computation of the BMP's Recharge Design Storm depth can be conceptually illustrated with the following conversion equation:

$$\begin{array}{c}\text{Total Average}\\ \text{Annual Recharge}\\ \text{Deficit}\end{array} = \begin{array}{c}\text{Annual Sum of}\\ \text{Recharge Design and}\\ \text{Smaller Storm}\\ \text{Depths}\end{array} + \left[\begin{array}{c}\text{Recharge Design}\\ \text{Storm Depth}\end{array} \times \begin{array}{c}\text{Number of}\\ \text{Larger}\\ \text{Storms}\end{array}\right]$$

The above equation shows that, with appropriate precipitation data and ignoring all losses, the total annual recharge deficit at a land development site can be converted to the sum of two precipitation amounts, both of which are based on a single groundwater recharge design storm. The first amount is the sum of all storm depths up to and including the Recharge Design Storm that would occur at the site in an average year. The second amount is the product of the Recharge Design Storm depth times the number of larger storms that would also occur at the site in that same average year.

Unfortunately, most of the ease and simplicity of the conversion equation shown above is gained through its two assumptions: that appropriate precipitation data is available, and that all of the precipitation falling on the BMP's impervious drainage area can be recharged without loss. In reality, compiling such precipitation data for a specific land development site requires considerable effort and resources and must be repeated for each new development site. In addition, precipitation losses will occur and must be taken into consideration in the design of a recharge BMP. As noted above, these losses, which will vary with the total precipitation depth, include those occurring in the conversion of precipitation to runoff, including surface storage, evaporation, and infiltration through cracks, joints, and seams in the drainage area's impervious surface. Further losses will occur once the runoff is delivered to the recharge BMP, primarily in the form of evapotranspiration by the vegetation above, beneath, and/or adjacent to the BMP. Further complications arise when one attempts to estimate these variable losses. While equations exist to predict such losses for individual storm events, there are none readily available that can do so for an annual precipitation depth.

The NJGRS addresses these problems in several ways. Regarding the need for appropriate precipitation data for all possible development site locations in New Jersey, the NJGRS developers compiled and analyzed 52 years of daily precipitation data collected at 92 precipitation stations throughout New Jersey between 1948 and 1999. To ensure a proper database, only precipitation depths greater than 0.04 inches were considered, since this depth was considered the minimum amount necessary to produce runoff from impervious surfaces. All daily values at each station were sorted for each year and then averaged over the 52 year period of record. Next, all values with the same rank were averaged across all 92 stations to produce an average annual series of 79 precipitation events for the state. Finally, this series was normalized by dividing each event value by 46.32 inches, which was the average annual precipitation for the 92 stations. This produced an average annual series of 79 precipitation events, expressed as a percentage of total annual precipitation, that are analyzed individually by the NJGRS to compute the runoff, infiltration, and recharge losses and the resulting annual groundwater recharge achieved by a recharge BMP at a land development site in any New Jersey municipality.

This average annual series of precipitation events for New Jersey is shown below in Figures 6-2 and 6-3. Figure 6-2 depicts the precipitation depth, expressed as a percentage of total average annual rainfall, of each event in the series in ascending order, while Figure 6-3 depicts, also in ascending order, the events' cumulative percentage of the average annual rainfall. More detailed information about each specific event in the average annual series is contained in the NJGRS' databases. The average annual precipitation series shown in Figure 6-2 is used by NJGRS to produce a site-specific, year-long series of design storms by multiplying each event value in the series by the average annual precipitation in the municipality where the recharge BMP is located. Since the NJGRS also contains average annual precipitation values for each New Jersey municipality, the NJGRS user can generate this site-specific average annual design series simply by specifying the municipality and county in which the development site is located.

Figure 6-2: Average Annual Precipitation Series in NJGRS

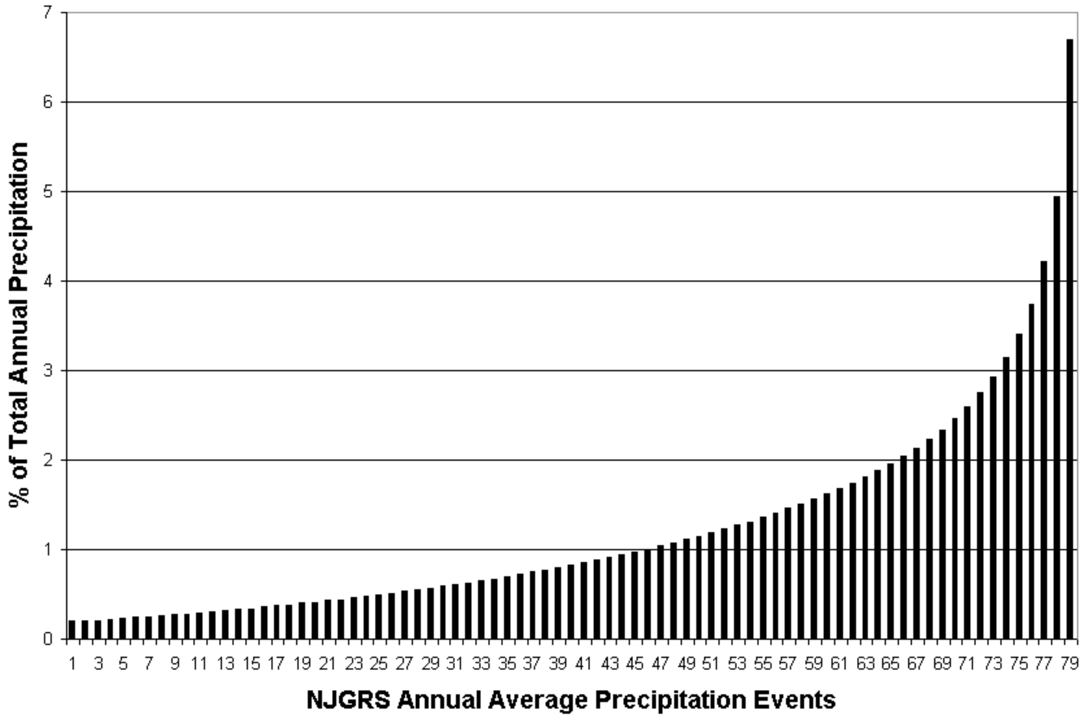
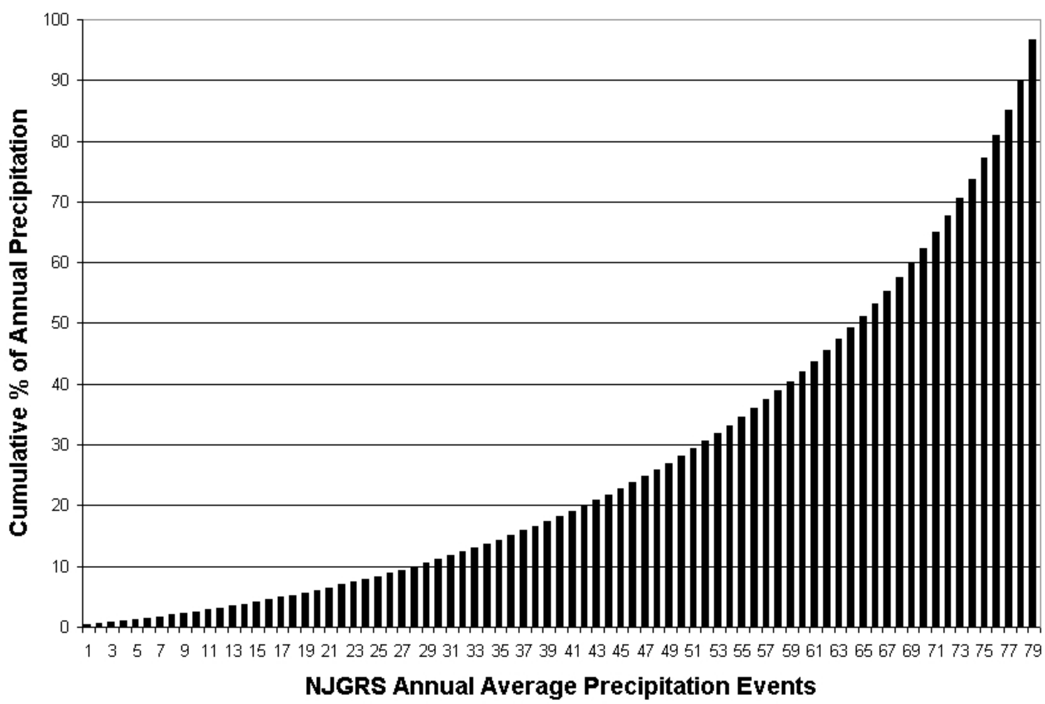


Figure 6-3: Cumulative Total of Average Annual Precipitation Series in NJGRS



Once an average annual design series is computed for the specific recharge BMP site, the NJGRS next addresses the problem of precipitation losses. As noted above, all of the possible losses that will occur, from the time the precipitation falls on the BMP's impervious drainage area to when the recharged water moves below the root zone of the vegetation in or adjacent to the BMP, must be accounted for in order to accurately compute the actual volume that will be recharged. Such losses can include infiltration and surface storage losses on the drainage area surface as the precipitation is converted into runoff, as well as evapotranspiration and infiltration losses as the runoff is converted to recharge within the BMP itself. To compute runoff losses, the NJGRS uses one of three equations depending upon the total depth of the event. These equations are applied to each event in the average annual design series to compute the resultant runoff for each one. This resultant runoff is then used in additional equations that estimate the losses that will occur for each design event once the runoff enters the recharge BMP.

When computing runoff losses for design event depths less than 0.0408 inches, the NJGRS assumes that the entire precipitation depth is consumed by surface storage, infiltration, and other losses and no runoff is produced.

For design event depths between 0.04 and 1.25 inches, the NJGRS uses the following equation to compute runoff:

$$Q = 0.95\ (P - 0.0408)\ 0.90$$

where:

Q = Runoff Depth in Inches

P = Precipitation Depth in Inches

For design event depths greater than 1.25 inches, the NJGRS uses the NRCS Runoff Equation with a Runoff Curve Number (CN) of 98:

$$Q = \frac{(P - 0.04)^2}{(P + 0.16)}$$

where:

Q = Runoff Depth in Inches

P = Precipitation Depth in Inches

As noted above, the resultant runoff depth for each design event is then applied to specialized equations developed specifically for the NJGRS to estimate the losses that will occur to the runoff after it is stored in the recharge BMP. These losses will depend upon a number of factors, including the climate at the development site, the specific vegetation and soil conditions at the recharge BMP location, and the depth of the BMP relative to the vegetation's root zone. A complete description of the loss equations used in the NJGRS is presented in the program's User's Guide. By subtracting these losses from the stored runoff, the amount of runoff that is actually recharged for each design event is computed. The NJGRS then adds up the recharge amounts from each design event to obtain a total annual recharge amount, which is then compared with the average annual recharge deficit created by the development to determine whether the recharge BMP's performance is adequate. Similar to the computation of the average annual design series described above, the NJGRS' loss computations are performed automatically each time the user provides new development site or recharge BMP data and then requests a BMP design update. The NJGRS will then either evaluate the performance of the proposed recharge BMP or, if requested, compute the effective BMP storage depth or surface area necessary to offset the development's annual recharge deficit.

New Jersey Groundwater Recharge Spreadsheet (NJGRS)

General Instructions

As described above, the New Jersey Groundwater Recharge Spreadsheet (NJGRS) is a Microsoft Excel-based computer spreadsheet program. It is typically used in a two step procedure, utilizing first the Annual Recharge worksheet and then the BMP Calculations worksheet in the program. During the first step, the average annual groundwater recharge amounts at the site under pre- and post-developed conditions are estimated based upon site data provided by the user. From these estimates, the program computes the average annual groundwater recharge deficit caused by the site development that must be offset by a groundwater recharge BMP. During the second step, this recharge BMP is sized based upon user-specified information regarding both the BMP and its location at the development site. General information regarding each step is provided below. Specific information about the program's use and computation methods are provided in the NJGRS User's Guide, which is presented at the end of this chapter.

It should be noted that, as a spreadsheet, certain cells of the program are reserved for user input while others provide intermediate and final results. All user input cells are shaded with a tan color while spreadsheet output cells are shaded with gray. Only the tan, user-input cells should be changed. In addition, the spreadsheet contains several combinations of commands known as macros. While these macros are essential to the spreadsheet's operations, they are unsigned and, as such, their presence may conflict with the Excel program's security settings in the user's computer. These conflicts would be identified to the user through an error or warning message immediately after opening the NJGRS. If such conflicts are encountered, they can usually be addressed by setting the Excel macro security level to Medium. *The user should determine whether this level of security is acceptable for their own system.* The user would then be prompted to enable the NJGRS macros each time the spreadsheet is opened.

Finally, upon completing use of the NJGRS for a specific project, the user will be asked whether the changes made during use should be saved. While such decisions are at the discretion of each user, it may be helpful for training purposes to retain the spreadsheet original settings, which match those in the NJGRS User's Guide. In this case, a copy of the revised NJGRS with project specific data entered can be saved with a project-specific name using the *Save As* command under *File* on the Excel command line.

Annual Recharge Worksheet

Annual groundwater recharge at a land development site under both pre- and post-developed (or existing and proposed) site conditions can be estimated using the Annual Recharge worksheet in the NJGRS. As discussed above, these estimates are based on the methodology contained in *Geological Survey Report GSR-32: A Method for Evaluating Ground Water Recharge Areas in New Jersey* (GSR-32) developed by the New Jersey Geological Survey. In general, use of this worksheet requires the following user input:

1. Name of municipality and county in which the project site is located (Cell C3). Upon input of this data through use of a drop-down list, the NJGRS will immediately display the average annual precipitation and climate factor for the site's municipality from the GSR-32 databases in the NJGRS. The user can also specify a project name, description, and date in the lines provided (Cells K1, K2, and K3).
2. Land use and land cover (LULC) data for the site under both pre- and post-developed conditions. This data will consist of the area (in acres), LULC characteristics, and soil series name for up to 15 land segments of the pre- and post-developed site. The NJGRS will issue a warning message if the total area specified under pre-developed conditions is different than post-developed. The LULC data and soil series names are listed in a drop-down list next to the respective input cells. It is

important to note that the LULC categories in the drop-down list are based on those contained in Table 2-2 of the NRCS *Technical Release 55 – Urban Hydrology for Small Watersheds*. For a correlation between these LULC categories and those in GSR-32, upon which the NJGRS is based, see Table 6-1 below.

Table 6-1: NJGRS/TR-55 and GSR-32 LULC Descriptions

NJGRS/TR-55 LULC Descriptions	GSR-32 LULC Descriptions
Brush	Brush
Gravel, Dirt	Unvegetated
Impervious Areas	Unlandscaped Developed
Meadow, Pasture, Grassland or Range	Agricultural – Pasture
Open Space	Landscape Open Space
Residential 1 to 2 Acre	1 - 2 Acre Lots
Residential 1/2 to 1 Acre	1/2 - 1 Acre Lots
Residential 1/3 to 1/4 Acre	1/8 - 1/2 Acre Lots
Residential 1/8 Acre or Less	1/8 Acre Lots
Row Crop	Agricultural – General
Small Grain or Legumes	Agricultural – Cropland, Legume
Urban Districts	Landscaped Developed
Woods	Woods
Woods – Grass Combination	Wooded – General

As noted in the NJGRS User's Guide, it is important to specify a site's LULC characteristics as accurately as possible. Therefore, while a 1/4 acre residential site could be specified in the NJGRS by the "Residential 1/3 to 1/4 Acre" LULC description in Table 6-1, it is generally more accurate to divide the site into impervious and pervious areas and specify each as a separate land segment in the NJGRS. For example, at a 1/4 acre residential site with a total area of 10 acres consisting of 40 percent connected impervious and 60 percent grassed surfaces and a single soil series, it would be more appropriate to specify the site's LULC characteristics in the program as a separate 4 acre impervious area land segment and a 6 acre open space land segment. This separation of connected impervious and pervious areas is similar to the technique for computing runoff volume using the NRCS methodology in Chapter 5. It should be noted that the total impervious area for post-developed conditions displayed in Cell M23 of the Annual Recharge worksheet will be based only on those post-developed land segments specified as impervious.

When using the above technique, it should be noted that if any impervious areas at a development site are unconnected (see Chapters 2 and 5 for complete details and requirements), the area used in the impervious surface designations described above for these unconnected areas should be one half of the actual area. For example, if a site has 3 acres of directly connected impervious surface, but 2 acres of unconnected impervious area, the total impervious area specified in the NJGRS can be 3 + (0.5)(2) or 4 acres. This 50 percent reduction in the size of unconnected impervious areas accounts for the runoff re-infiltration that can occur downstream of such areas and is consistent with the runoff computations for such areas contained in TR-55. To keep the total site area correct, the user should remember to specify the "remainder" of the unconnected impervious area as a pervious one with the appropriate soil series and LULC based upon the actual pervious area downstream of the unconnected impervious area.

It should also be noted that if a proposed recharge BMP will have a specific location within a land development site with similarly specific LULC and soil characteristics, that portion of the site should be specified as a separate land segment on the Annual Recharge worksheet. This is true even if that segment will be covered with an impervious surface. Doing this will allow the NJGRS to more accurately compute the losses and resultant recharge at the BMP. More details are presented below in the NJGRS User's Guide, including the need to specify this segment on the BMP Calculation worksheet.

From the above, it can be seen that the more generalized Residential and Urban District LULC descriptions in Table 6-1 above should be used only for general planning studies of groundwater recharge requirements, particularly at sites with multiple lots of similar size and impervious coverage where each lot will have a separate groundwater recharge BMP. Since the soil series in which each BMP will be located may vary from lot to lot, the general LULC descriptions can be used to compute typical or general groundwater recharge requirements and BMP dimensions for the entire site. These general values can then be refined on a lot by lot basis during later, more detailed project phases with specific lot and BMP information.

Finally, in accordance with NJGS Report GSR-32, which is the basis of the NJGRS, zero recharge volume will be computed for any land segment specified for either pre- or post-development conditions that contain soils that are hydric. See Report GSR-32 for more details.

BMP Calculations Worksheet

The dimensions of a groundwater recharge BMP can be either determined or tested using the BMP Calculations worksheet in the NJGRS. This worksheet can be used to calculate the effective depth required at a recharge BMP if the impervious drainage area and BMP area are specified. Conversely, the worksheet can also be used to calculate the required area of the BMP if the drainage area and effective BMP depth are specified. Finally, the BMP Calculations worksheet can be used to analyze a specific recharge BMP with a certain area and effective depth to see what amount of annual groundwater recharge it can provide.

As explained in the NJGRS User's Guide, it is critical that the surface area of a recharge BMP (variable ABMP) be specified in the program as accurately as possible. This is because the program uses the ratio of the BMP's drainage area and surface area to determine the resultant depth of runoff in the BMP for each storm event analyzed. In addition, a recharge BMP's effective depth (variable dBMP) represents the maximum equivalent water depth that can be achieved in the BMP before overflow begins. Therefore, if the proposed recharge BMP will consist, for example, of a subsurface, vertical-walled chamber, dBMP will simply be the maximum achievable depth before the chamber is full and overflow occurs. However, if the proposed BMP will be filled with broken stone or other suitable material, dBMP will be the product of the BMP's actual or physical depth and the void ratio of the fill material.

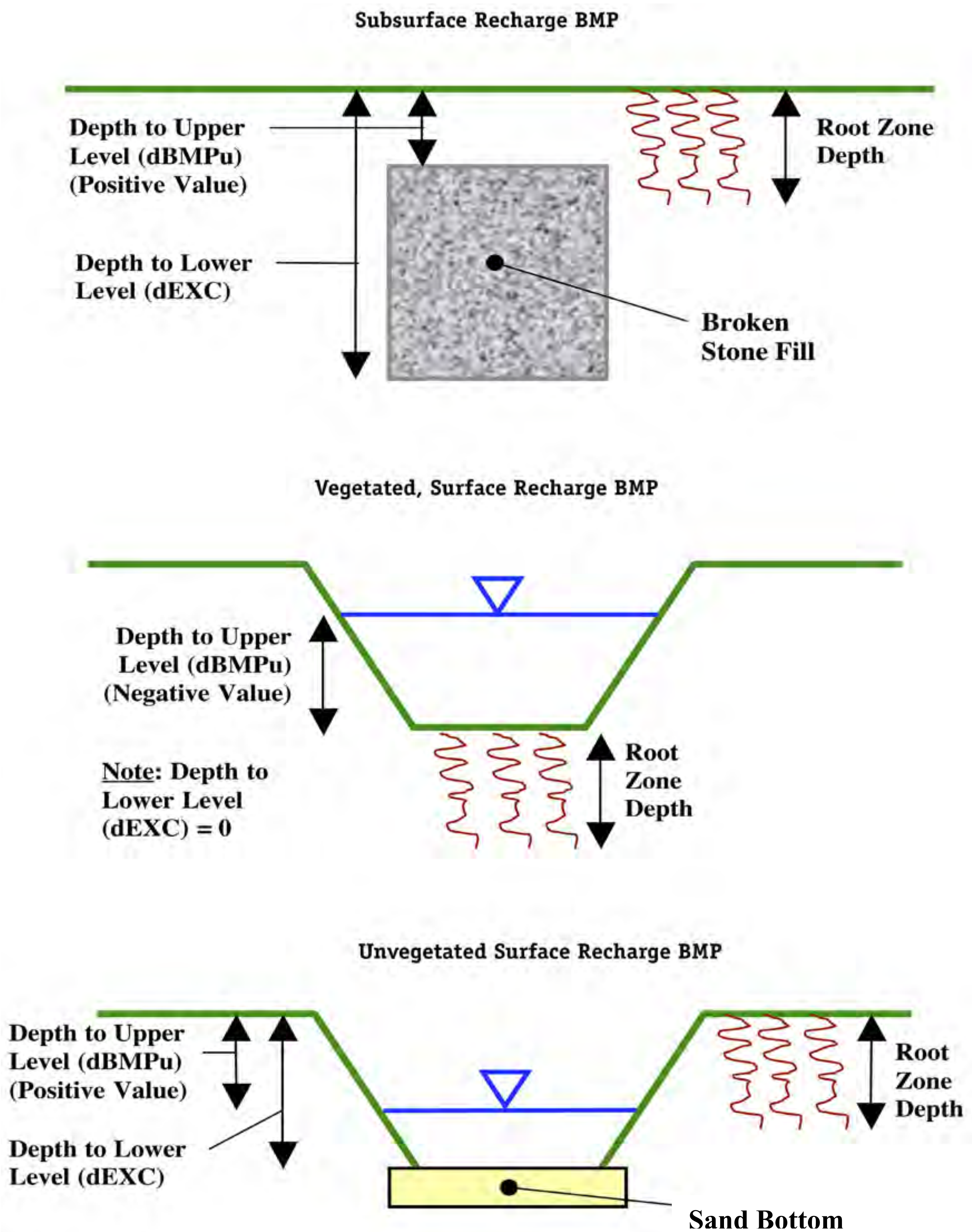
For recharge BMPs that consist of a combination of filled and open areas (e.g., a perforated pipe within a stone filled trench) or for irregular-shaped BMPs with nonvertical sides, dBMP can be computed by dividing the BMP's total storage volume by its surface area (ABMP). For BMPs with varying surface areas (e.g., a trapezoidal infiltration basin with sloping sides or a perforated elliptical pipe), the user should exercise discretion in selecting the correct surface area to use. In most cases, the average surface area would be appropriate. In all cases, the user should always verify that the product of the specified surface area (ABMP) and effective depth (dBMP) equals the BMP's total storage volume (variable VBMP in Cell G12). More information and recommendations can be found in the NJGRS User's Guide.

In addition to the above, it is important to note that the BMP Calculations Worksheet assumes that all runoff stored in the recharge BMP at depths at or below dBMP (i.e., the maximum storage depth in the BMP) will be infiltrated into the soils below the BMP and that any greater runoff amounts will overflow the BMP. As such, the BMP Calculations Worksheet cannot directly model a recharge BMP that will infiltrate some of its runoff while it is simultaneously discharging some through an overflow or other outlet. Examples of such a recharge BMP would include an extended detention basin where stored runoff is simultaneously infiltrated through the basin bottom and out its outlet structure. For such BMPs, alternative BMP calculation techniques will be required.

With regards to BMP location, if a recharge BMP will be located within a particular post-developed land segment specified on the Annual Recharge worksheet, it should be specified in Cell C9 (variable C9) of the BMP Calculations worksheet. As described earlier, doing so will allow the NJGRS to more accurately compute the losses and resultant recharge at the BMP. If this land segment is not specified on the BMP Calculations worksheet, the NJGRS will, by default, use average soil and loss factors based on all of the post-developed land segments specified on the Annual Groundwater Recharge worksheet.

The BMP Calculations worksheet can analyze a recharge BMP located either on grade or constructed below grade through excavation. An excavated BMP can be either a surface or subsurface BMP. The specific type of BMP is described in the BMP Calculations worksheet through its effective depth (dBMP) and two additional vertical distances. The first is the vertical distance from the vegetated ground surface to the maximum water surface level in the BMP (variable dBMPu in Cell C7). This value is positive if the maximum level is below the vegetated ground surface and negative if above the vegetated ground surface. The second is the vertical distance from the vegetated ground surface to the bottom of the BMP (variable dEXC in Cell C8). For example, if the top of a 36-inch deep stone-filled infiltration trench is located 24 inches below ground level, dBMPu would be 24 inches and dEXC would be 60 inches (i.e., dBMPu plus the 36-inch actual depth of the trench). It should be noted, however, that since the trench is filled with gravel with a certain void ratio, the BMP's effective depth (dBMP) would be 36 inches times that void ratio. Using the dBMPu and dEXC variables, virtually all types of recharge BMPs can be specified, including "above the surface," "semi-buried," and "completely buried" BMPs. See Figure 6-4 below and the NJGRS User's Guide for more information.

Figure 6-4: Examples of Depths to Upper (dBMPu) and Lower (dEXC) Levels of Recharge BMP



In using the BMP Calculations worksheet, it is important to note that, by default, the NJGRS takes the values from the Annual Recharge worksheet for the Post-Development Recharge Deficit Volume (Cell K24) and the Total Impervious Area (Cell M23) and specifies them as initial values on the BMP Calculations worksheet for the Post-Development Deficit Recharge (variable Vdef in Cell C14) and Post-Development Impervious Area (variable Aimp in Cell C15). This allows solution of the site's total recharge deficit by a single groundwater recharge BMP that will receive runoff from a developed site's entire impervious area (if specified as impervious land segments). However, in many instances, the single groundwater recharge BMP will receive runoff from only a portion of the site's impervious area (e.g., only roof runoff). In such cases, the user must specify the exact size of Aimp (impervious area to the BMP) in Cell C15. Failure to do this for such BMPs will result in an overestimation of the amount of runoff captured by the BMP and erroneous BMP dimensions and/or recharge amounts.

At other sites, it may be necessary or desirable to utilize more than one groundwater recharge BMP to meet the site's recharge requirements. In such cases, each BMP will not only receive runoff from a portion of the site's impervious surface, but each will also seek to provide only a portion of the site's total recharge deficit. In such cases, the user must specify both the exact Aimp and Vdef (Post-Development Deficit) for each BMP in Cells C14 and 15 of the BMP Calculations worksheet. *In such cases, the user must also use a separate NJGRS spreadsheet for each BMP. Using multiple copies of the BMP Calculations worksheet within a single spreadsheet can yield erroneous results.*

In addition, computational problems can occur if, in designing a recharge BMP, the user selects either an initial BMP surface area (ABMP) or effective depth (dBMP) that is drastically different than the actual value needed to meet the required recharge deficit. If this occurs, the NJGRS may not be able to compute the correct value and will, instead, display excessive large answers or divide by zero messages. If this occurs, the user should adjust the initial value to one that more closely approximates the final answer and rerun the worksheet.

The BMP Calculations worksheet will also present various characteristics of the recharge BMP, including its effectiveness in converting runoff to infiltrated water and then recharged groundwater. See the NJGRS User's Guide presented at the end of this chapter for more information.

BMP Calculation Messages

The BMP Calculations worksheet provides three important messages to check the validity of the computed results. The Volume Balance message (Cell J11) is a check of the Annual BMP Recharge Volume in Cell G14 against the Post-Development Deficit Recharge (variable Vdef in Cell C14). If these values are equal, the problem is solved successfully and the message in this section will read "OK." However, if the BMP's annual recharge volume does not equal Vdef, the message instructs the user to continue to solve the problem. This may also occur if the user changes any of the BMP design parameters and forgets to solve the problem by clicking on any of the two solve buttons.

The dBMP Check message (Cell J12) checks the validity of the value inputted for the dBMP, the BMP's effective depth in Cell C6. If this value is greater than the difference between the depths to the BMP's upper and lower surfaces (variables dBMPu and dEXC in Cells C7 and C8, a warning message is issued telling the user to adjust dBMP. dEXC Check (Cell J13) is the third message. It checks the validity of dEXC to ensure it is larger than dBMPu. If it is not, a message will appear instructing the user to make dEXC larger than dBMPu.

Below these messages is a report on the location of the BMP as specified by the user in Cell C9 (variable segBMP). If the user has entered a valid segment number for segBMP, the message will read "OK." If the user enters a zero for segBMP, the message will read "Location is selected as distributed or undetermined." However, if the user enters a land segment number that was not previously defined in the Annual Recharge worksheet under Post-Developed Conditions, the message will say: "Land Segment Number Selected for BMP is not Defined." The user should then make appropriate corrections to segBMP.

See the NJGRS User's Guide for more information regarding calculation check messages and warnings.

Additional Information

In addition to the above, the following important features and characteristics of the NJGRS should be noted:

1. The NJGRS gives the user the opportunity to specify what percentage of a development site's annual groundwater recharge deficit must be retained (Cell K23 of the Annual Recharge worksheet). However, it should be noted that the program's default value is 100 percent which, as noted above, is the amount required by the NJDEP Stormwater Management Rules.
2. The pre- and post-development average annual recharge at a development site is a function, in part, of the municipality in which the site is located. Therefore, changing the name of the municipality in Cell C3 of the Annual Recharge worksheet will change both the pre- and post-development recharge volumes. Similarly, if the user wishes to analyze a site in a different municipality, the new municipality's name must be entered through the drop-down list in Cell C3 in order to accurately compute pre-and post-development recharge amounts.
3. In Cell K6 of the BMP Calculations worksheet, the NJGRS will display the "Inches of Rainfall to Capture." This value is also displayed graphically in Chart 1 of the NJGRS along with other pertinent BMP performance information. This value specifies the minimum depth of rainfall over the BMP's impervious drainage area that must be collected to meet the development site's average annual recharge deficit. It is also the maximum event rainfall that the BMP can store without overflowing and, as such, it is equal to the BMP's Recharge Design Storm depth described previously in "Theoretical Basis of Calculations." This design storm depth is important, as it can be used to estimate the resultant groundwater recharge design storm runoff from a development site with groundwater recharge BMPs. See Examples 4, 5 and 6 in Chapter 5 for more details on this procedure.
4. At the time of the NJGRS' development, all soil series mapped in New Jersey were included in its databases. Nevertheless, instances may arise where a soil series identified at a land development site has not been included. In such instances, the user should select a similar soil series from the program's database. In doing so, the following criteria should be utilized, generally in the order presented:
    - Select a NJGRS soil series within the same Hydrologic Soil Group (HSG) as the site soil.
    - Within the same HSG, select an NJGRS soil series with similar textural characteristics and classification as the soil.
    - If the site soil includes a fragipan, bedrock, or other restrictive layer below its surface, select an NJGRS soil series with a similar restrictive depth.
    - If more than one choice of NJGRS soil series appears reasonable, the user may then analyze and compare the annual groundwater recharge amounts for each using the NJGRS program to help make a final selection.

Recharge BMP Design Guidelines

In general, the design of a groundwater recharge BMP to offset a development site's groundwater recharge deficit should follow the standards and guidelines for dry wells, infiltration basins, and pervious paving systems with storage beds presented in Chapter 9. This includes utilizing soil permeability data obtained from tests such as those contained in Standards for Individual Subsurface Sewage Disposal Systems at N.J.A.C. 7:9A at the site of the proposed recharge BMP. In addition, the recharge BMP design must be based on the following guidelines:

1. Computation of the pre- and post-development annual groundwater recharge rate and the annual recharge deficit should be based upon the New Jersey Geological Survey Report GSR-32 A Method For Evaluating Ground-Water-Recharge Areas in New Jersey, which is incorporated into the NJGRS.
2. Only the directly connected impervious portions of a recharge BMP's drainage area can be used to compute runoff to the BMP. In the NJGRS, the input parameter Aimp, which is the size of the recharge BMP's drainage area, must represent only directly connected impervious surfaces. This is particularly relevant for infiltration basins and pervious paving systems used for groundwater recharge that may also have pervious and unconnected impervious areas draining to them.
3. Runoff collected from roofs and other above-grade surfaces can be directly conveyed to a recharge BMP. However, roof gutter guards and/or sumps or traps equipped with clean-outs should be included upstream of the recharge BMP wherever possible to minimize the amount of sediment or other solids that can enter the BMP.
4. Runoff collected from parking lots, driveway, roads, and other on-grade impervious surfaces and conveyed to a subsurface recharge BMP must be pretreated to remove 80 percent of TSS in order to prevent the loss of storage volume and/or recharge capacity due to sedimentation and clogging. Exceptions may be possible for patios, tennis courts, and similar on-grade impervious surfaces with minimal TSS loadings on case-by-case basis. Such treatment can also be used to meet the site's overall TSS removal requirements. In addition, all on-grade drainage areas to a subsurface recharge BMP should consist only of impervious surfaces. Exceptions to this requirement may include roadway right-of-ways, vegetated parking lot medians, planting and landscape beds, and other pervious surfaces provided that they comprise only a small percentage of the total drainage area and will not generate an excessive amount of TSS or other material that might adversely impact the subsurface recharge BMP. As noted above, if such areas are part of the actual drainage area, they must not be included in the drainage area size (variable Aimp) used in the NJGRS' BMP Calculations worksheet to design the recharge BMP.

   In addition, it should be noted that, since the BMP Calculations Worksheet assumes that all runoff from a recharge BMP's impervious drainage area will be delivered to the BMP, it cannot directly account for runoff losses incurred at a pretreatment measure located between the drainage area and the recharge BMP. If such losses will occur due to the selected pretreatment measure, appropriate compensating adjustments may be attempted in the BMP Calculations Worksheet input data or alternative BMP calculation techniques utilized.
5. In general, County Soil Surveys prepared by the U.S. Department of Agriculture and the State Soil Conservation Committee can be used to obtain the soil series data required for the determination of annual land development site recharge rates and deficits and the dimensions of recharge BMPs using the NJGRS program. However, site soil tests will be required at the actual location of a proposed recharge BMP in order to confirm the BMP's ability to function properly without failure. Such tests should include a determination of the textural classification and permeability of the soil

at the bottom of the proposed recharge BMP. As noted above, permeability testing can be conducted in accordance with Standards for Individual Subsurface Sewage Disposal Systems at N.J.A.C. 7:9A.

Depending upon the type, location, use, and maximum design storm of the selected recharge BMP, minimum design soil permeability rates will vary from 0.2 to 0.5 inches per hour and that a factor of safety of 2 must be applied when converting a tested permeability rate to a design rate. In addition, the soil permeability rate must allow the recharge BMP to fully drain its maximum design storm runoff volume within 72 hours. Recharge BMP locations that fail to meet these two requirements should be rejected and alternative onsite locations selected. A groundwater recharge waiver may be sought from the applicable reviewing agencies if suitable permeability rates cannot be found at any recharge BMP locations on the development site.

See Chapter 9 for details on structural best management practices that can be used as recharge BMPs, including minimum design permeability rates. Such BMPs include dry wells (Chapter 9.3), infiltration basins (Chapter 9.5), and certain types of pervious paving systems (Chapter 9.7).

6. The results of the BMP site soil testing should be compared with the County Soil Survey data used in the NJGRS' annual recharge and BMP design computations to ensure reasonable data consistency. If significant differences exist between the BMP site soil test results and the County Soil Survey data, additional development site soil tests are recommended to determine and evaluate the extent of the data inconsistency and the need for revised annual recharge and BMP design computations based upon the site soil test results. All significant inconsistencies should be discussed with the local Soil Conservation District prior to proceeding with such redesign to help ensure that the site soil data is accurate. It should also be noted that significant inconsistencies between development site soil tests and the County Soil Survey may warrant revisions to the site's stormwater quality and quantity storm computations.
7. The development site areas that extensive site soil testing determine to have permeability rates less than 0.2 inches per hour may be considered to belong to Hydrologic Soil Group D in the NJGRS program. For such areas, the user may use any HSG D soil in the NJGRS soil series database to define such site areas in the NJGRS' Annual Recharge worksheet. In accordance with the assumptions of both the NJGRS program and N.J. Geological Survey's Geological Survey Report GSR-32: A Method for Evaluating Ground Water Recharge Areas in New Jersey, such areas will not produce any groundwater recharge. Once again, the assignment of HSG D to any development site areas should be discussed with the local Soil Conservation District prior to proceeding to help ensure that the site soil data is accurate.

The New Jersey Groundwater Recharge Spreadsheet (NJGRS)

User's Guide

Version 2.0 – November 2003

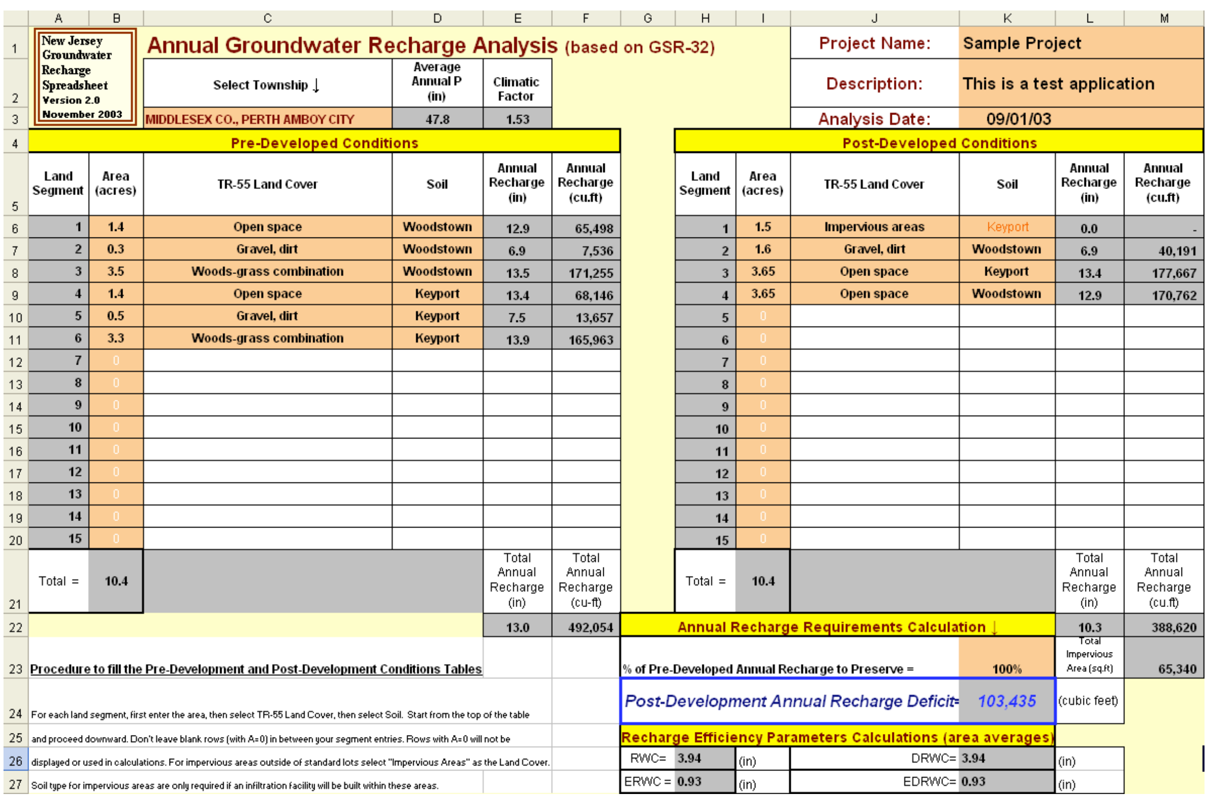
There are two computational worksheets in the NJGRS spreadsheet:

- **Annual Recharge:** This worksheet, which resides on the first page of the spreadsheet, is used to estimate the annual groundwater recharge volumes that occur naturally under the Pre-Developed and Post-Developed Conditions. Based on the value of *"percent of Pre-Developed Annual Recharge to Preserve"* that the user provides (NJDEP currently requires 100 percent for this parameter), the worksheet calculates the *"Post-Development Annual Recharge Deficit"* in cubic feet. This is the annual recharge volume that must be provided by one or more groundwater recharge BMPs.
- **BMP Calculations:** This worksheet, which resides on the second page of the spreadsheet, is used to design the required size and configuration of one or more groundwater recharge BMPs to satisfy the *"Post-Development Annual Recharge Deficit"* calculated in the Annual Recharge worksheet.

NOTE: Only the above worksheets in the NJ Groundwater Recharge Spreadsheet are for user input. Charts 1 through 3 can be viewed for visual inspection of the results. Other worksheets in the spreadsheet are either for internal calculations or contain the databases used by calculations. The user should refrain from changing anything in these worksheets.

Part 1: Using the Annual Recharge Worksheet

Figure 1: Screen Capture Showing the Annual Recharge Worksheet



New Jersey Groundwater Recharge Spreadsheet Version 2.0 November 2003

Annual Groundwater Recharge Analysis (based on GSR-32)

Select Township ↓	Average Annual P (in)	Climatic Factor
MIDDLESEX CO., PERTH AMBOY CITY	47.8	1.53

Project Name:	Sample Project
Description:	This is a test application
Analysis Date:	09/01/03

Pre-Developed Conditions

Land Segment	Area (acres)	TR-55 Land Cover	Soil	Annual Recharge (in)	Annual Recharge (cu.ft)
1	1.4	Open space	Woodstown	12.9	65,498
2	0.3	Gravel, dirt	Woodstown	6.9	7,536
3	3.5	Woods-grass combination	Woodstown	13.5	171,255
4	1.4	Open space	Keyport	13.4	68,146
5	0.5	Gravel, dirt	Keyport	7.5	13,657
6	3.3	Woods-grass combination	Keyport	13.9	165,963
7	0				
8	0				
9	0				
10	0				
11	0				
12	0				
13	0				
14	0				
15	0				
Total =	10.4			Total Annual Recharge (in)	Total Annual Recharge (cu-ft)
				13.0	492,054

Post-Developed Conditions

Land Segment	Area (acres)	TR-55 Land Cover	Soil	Annual Recharge (in)	Annual Recharge (cu.ft)
1	1.5	Impervious areas	Keyport	0.0	-
2	1.6	Gravel, dirt	Woodstown	6.9	40,191
3	3.65	Open space	Keyport	13.4	177,667
4	3.65	Open space	Woodstown	12.9	170,762
5	0				
6	0				
7	0				
8	0				
9	0				
10	0				
11	0				
12	0				
13	0				
14	0				
15	0				
Total =	10.4			Total Annual Recharge (in)	Total Annual Recharge (cu.ft)
				10.3	388,620

Annual Recharge Requirements Calculation ↓

% of Pre-Developed Annual Recharge to Preserve =	100%	Total Impervious Area (sq.ft)	65,340
Post-Development Annual Recharge Deficit=	103,435	(cubic feet)	

Recharge Efficiency Parameters Calculations (area averages)

RWC=	3.94	(in)	DRWC=	3.94	(in)
ERWC =	0.93	(in)	EDRWC=	0.93	(in)

Procedure to fill the Pre-Development and Post-Development Conditions Tables

For each land segment, first enter the area, then select TR-55 Land Cover, then select Soil. Start from the top of the table and proceed downward. Don't leave blank rows (with A=0) in between your segment entries. Rows with A=0 will not be displayed or used in calculations. For impervious areas outside of standard lots select "Impervious Areas" as the Land Cover. Soil type for impervious areas are only required if an infiltration facility will be built within these areas.

- Figure 1 is a screen capture from an example application of the Annual Recharge Worksheet. All user-input cells are tan colored. All gray colored cells are used to show calculation results or internal validity checks and must *not* be changed by the user. The three cells at the upper right corner of the sheet are where the user can input project information. These inputs are optional, but they can help in identifying the project and the alternative being analyzed.
- As the first step, the user must select the project's municipality. Click once on the municipality cell (Cell C3) and select the project's county and municipality from the drop-down list of all New Jersey municipalities, which is arranged by county in alphabetical order. Once the user has selected a municipality, the values of average annual precipitation and the climate factor are set for that municipality in the two cells to the immediate right of the municipality's name (Cells D3 and E3).
- The next step is to provide information about pre-developed site conditions. The first column is the land segment number (Cells A6 to A20). Up to 15 different land segments can be inputted in this table.

  NOTE: If you have more than 15 different land segments, try to combine similar segments together or subdivide your area into smaller areas not consisting of more than 15 land segments.

- For each land segment, first enter the area in acres. Then select an appropriate TR-55 land cover description from the drop-down list of standard NRCS land cover descriptions. Finally, select the segments soil series from the drop-down list. Note that, as soon as the area for a segment is entered, the entries for other columns become visible and selectable. Start from the top of table and proceed downward. Do not leave blank rows (with zero area) between land segment entries; rows with zero areas will not be displayed or used in calculations.

  NOTE: Once you click on any of these cells a pop-up help message will appear to briefly tell you about the required input for that cell.

- As can be seen from the list of available TR-55 land cover descriptions in the drop-down list, there may be more than one way to describe the pre-developed land cover at a project site, particularly when that cover is a mixture of pervious and impervious surfaces such as a single family residential development. For assistance, see the guidelines in the New Jersey Groundwater Recharge Spreadsheet (NJGRS) section of Chapter 6 for selecting segment limits and land cover descriptions. Finally, it should be noted that, under the Pre-Developed Conditions section, it is not necessary to specify the soil series for site segments with impervious land cover, since the natural recharge in these segments is set at zero.

  NOTE: If the soil you select for a land segment is hydric, recharge will be set to zero for that segment.

- Once the user has completed inputting all land covers in the table for the Pre-Developed Conditions, check the total area in acres (Cell B21) to ensure that the total project area is correct. The last two columns of this table show the naturally occurring average annual recharge amount as a depth (in inches over the segment area) and a volume (in cubic feet) for each land segment. At the bottom of these columns (Cells E22 and F22), the average recharge depth (in inches) and the total annual recharge volume (in cubic feet) over the total area under Pre-Developed Conditions is given. This number is later used in the calculation of any post-development recharge deficit.
- The above procedure can also be used to enter the required data for the post-developed site conditions. In doing so, please note the following additional requirements:
  1. To correctly compute the performance and/or required size of a proposed groundwater recharge BMP, the area in which the BMP will be located must be entered as a separate site

segment with its associated soil series. The number of this segment must also be specified on the BMP Calculations spreadsheet (see below).

2. As noted above, it is normally not necessary to specify the soil series within an impervious site segment. However, the soil series of the impervious segment must be specified if a proposed groundwater recharge BMP will be located within or below it (e.g., a stone-filled infiltration trench below a parking lot). As noted in 1 above, the soil series is necessary in order to accurately compute the performance and/or required size of the proposed BMP.

- Finally, as noted above, see the guidelines in the New Jersey Groundwater Recharge Spreadsheet (NJGRS) section of Chapter 6 for further assistance in selecting appropriate segment limits and TR-55 land cover descriptions for post-developed site conditions.

NOTE: Soil series selected for the impervious areas in the Post-Developed Conditions table are automatically displayed in orange, signifying that they have no effect on the site's natural annual recharge calculation (i.e., recharge set to zero for all land segments classified as "Impervious areas" regardless of the soil type), but that they can affect the artificial annual recharge volume of any groundwater recharge BMP set below them.

- Once the user has completed inputting all land segment information in the table for the Post-Developed Conditions, once again check the total project area (Cell I21) to ensure that the total post-development project area is correct.

NOTE: If the total area in the Post-Developed Conditions is different from the total area in the Pre-Developed Conditions, a warning message will appear to the right of the total Post-Developed project area (Cell J21).

- As an additional check, the total impervious area (in square feet) under Post-Developed conditions will be shown at the bottom right of this table (Cell M23). Please note that this value reflects only those impervious areas specified as separate project segments and does not include any impervious areas within those segments specified by the standard TR-55 residential or urban land descriptions. The last two columns of this table show the naturally occurring average annual recharge depth (in inches) and volume (in cubic feet) for each land segment. At the bottom of these columns (Cells L22 and M22), the average recharge depth (in inches) and the total annual recharge volume (in cubic feet) over the total area under Post-Developed Conditions is given. This number is also used later in the calculation of any Post-Development recharge deficit.
- Immediately below the Post-Developed Conditions table is the Annual Recharge Requirements Calculation section. The user needs to input the "percent of Pre-Developed Annual Recharge to Preserve" (Cell K23) to set the percentage of the recharge under Pre-Developed Conditions that must be maintained under the Post-Developed Conditions. The NJDEP Stormwater Management Rules at N.J.A.C. 7:8 currently requires this value to be 100 percent, which is the spreadsheet's default value. The spreadsheet then computes the difference between the total annual recharge volumes for Pre- and Post-Developed Conditions and multiplies it by the "percent of Pre-Developed Annual Recharge to Preserve." The resulting value is shown as the "Post-Development Annual Recharge Deficit" in the worksheet (Cell K24). This amount is 103,435 cubic feet in the case of the example in Figure 1. This is the volume of groundwater recharge that must be artificially recharged under Post-Developed Conditions annually through groundwater recharge BMPs.
- The "Recharge Efficiency Parameter Calculations" table shown below the "Post-Development Annual Recharge Deficit" show the parameters calculated by this worksheet that are later used in the BMP Calculations worksheet.

NOTE: The Appendix to this guide provides the basic equations and defines the variables used in Recharge Efficiency Parameter Calculations.

Part 2: Using the BMP Calculations Worksheet

This worksheet allows the proper sizing of groundwater recharge BMPs to provide the desired or required volume of annual groundwater recharge. Alternatively, it can be used to evaluate the performance of a user-specified recharge BMP. As described in Chapter 2, groundwater recharge BMPs can also be referred to as Low Impact Development BMPs (or LID-BMPs), depending on their size and location in the project site.

Figure 2: Screen Capture from the BMP Calculations Worksheet

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**Project Name**		**Description**			**Analysis Date**		**BMP or LID Type**						
2	**Sample Project**		**This is a test application**			**09/01/03**								
3	Infiltration BMP Input Parameters				Root Zone Water capacity Calculated Parameters				Recharge Design Parameters					
4	Parameter	Symbol	Value	Unit	Parameter	Symbol	Value	Unit	Parameter	Symbol	Value	Unit		
5	BMP Area	ABMP	6656.0	sq.ft	Empty Portion of RWC under Post-D Natural Recharge	ERWC	0.93	in	Inches of Runoff to capture	Qdesign	0.54	in		
6	BMP Effective Depth, this is the design variable	dBMP	5.2	in	ERWC Modified to consider dEXC	EDRWC	0.93	in	Inches of Rainfall to capture	Pdesign	0.67	in		
7	Upper level of the BMP surface (negative if above ground)	dBMPu	-5.2	in	Empty Portion of RWC under Infilt. BMP	RERWC	0.74	in	Recharge Provided Avg. over Imp. Area		19.0	in		
8	Depth of lower surface of BMP, must be>=dBMPu	dEXC	0.0	in					Runoff Captured Avg. over imp. Area		24.8	in		
9	Post-development Land Segment Location of BMP , Input Zero if Location is distributed or undetermined	SegBMP	0	unitless										
10	Solve for ABMP to provide Vdef	Solve for dBMP to provide Vdef	Default Vdef & Aimp		BMP Calculated Size Parameters				CALCULATION CHECK MESSAGES					
11					ABMP/Aimp	Aratio	0.10	unitless	Volume Balance->	OK				
12					BMP Volume	VBMP	2,873	cu.ft	dBMP Check--->	OK				
13	Parameters from Annual Recharge Worksheet				System Performance Calculated Parameters				dEXC Check--->	OK				
14	Post-D Deficit Recharge (or desired recharge volume)	Vdef	103,435	cu.ft	Annual BMP Recharge Volume		103,435	cu.ft	BMP Location--->	Location is selected as distributed or undetermined				
15	Post-D Impervious Area (or target Impervious Area)	Aimp	65,340	sq.ft	Avg BMP Recharge Efficiency		76.7%	Represents % Infiltration Recharged	OTHER NOTES					
16	Root Zone Water Capacity	RWC	3.94	in	%Rainfall became Runoff		78.3%	%	Pdesign is accurate only after BMP dimensions are updated to make rech volume= deficit volume. The portion					
17	RWC Modified to consider dEXC	DRWC	3.94	in	%Runoff Infiltrated		66.2%	%	of BMP infiltration prior to filling and the area occupied by BMP are ignored in these calculations. Results are					
18	Climatic Factor	C-factor	1.53	no units	%Runoff Recharged		50.8%	%	sensetive to dBMP, make sure dBMP selected is small enough for BMP to empty in less than 3 days. For land					
19	Average Annual P	Pavg	47.8	in	%Rainfall Recharged		39.7%	%	Segment Location of BMP if you select "impervious areas" RWC will be minimal but not zero as determined by					
20	Recharge Requirement over Imp. Area	dr	19.0	in					the soil type and a shallow root zone for this Land Cover allowing consideration of lateral flow and other losses.					
21	**How to solve for different recharge volumes:** By default the spreadsheet assigns the values of total deficit recharge volume "Vdef" and total proposed impervious area "Aimp" from the "Annual Recharge" sheet to "Vdef" and "Aimp" on this page. This allows solution for a single BMP to handle the entire recharge requirement assuming the runoff from entire impervious area is available to the BMP. To solve for a smaller BMP or a LID-IMP to recharge only part of the recharge requirement, set Vdef to your target value and Aimp to impervious area directly connected to your infiltration facility and then solve for ABMP or dBMP. To go back to the default configuration clik the "Default Vdef & Aimp" button.													

- Figure 2 is a screen capture from a portion of the BMP Calculations worksheet. While most of the calculations in this worksheet are performed in a separate worksheet, the portion shown in Figure 2 can be studied to understand the worksheet usage. There are several sections and solve buttons in this part of the worksheet, as explained below.

  NOTE: The three entries for Project Name, Description and Analysis Date are automatically copied from the Annual Recharge Sheet to the top of this sheet. The user can optionally input information regarding Groundwater Recharge BMP type.

Recharge BMP Input Parameters

- The user may start by inputting an initial value for the BMP surface area in square feet (variable ABMP) in Cell C5. In the NJGRS program, the variable ABMP is used in conjunction with the size of the recharge BMP's drainage area to determine the depth of stored runoff in the BMP resulting from a specific rain event. If a specific recharge BMP is being analyzed, ABMP will be based on the actual area of the BMP. If the spreadsheet is being used to determine the required recharge BMP dimensions, this value should be an initial estimate of the required surface area to satisfy the Post-Developed Recharge Deficit volume. This deficit volume (variable Vdef) is shown in Cell C14 and is either user-specified or, by default, taken from the Post-Development Annual Recharge Defici computed on the Annual Recharge worksheet (Cell K24).

- Next, a value for the recharge BMP's effective storage depth (variable dBMP) must be specified in inches in Cell C6. In the NJGRS program, dBMP represents the maximum equivalent water depth that can be achieved in the BMP before overflow begins. Therefore, if the proposed recharge BMP will, for example, be a subsurface, vertical-walled chamber, dBMP will simply be the maximum achievable depth before the chamber is full and overflow occurs. However, if the proposed BMP will be filled with broken stone or other suitable material, dBMP will be the product of the BMP's actual or physical depth and the void ratio of the fill. For recharge BMPs that consist of a combination of filled and open areas (e.g., a perforated pipe within a stone filled trench) or for irregular, nonrectangular BMP shapes (e.g., a perforated elliptical pipe or an infiltration basin with sloping sides), dBMP can be computed by dividing the BMP's total storage volume by its surface area.
- Just like the BMP surface area variable ABMP, the dBMP value entered for effective storage depth can be either a given value for a specific recharge BMP or an initial guess for a BMP to be sized by the spreadsheet. If this second option is selected, the user should remember that the resultant dBMP computed by the program may or may not be its actual or physical depth, depending on whether the BMP uses broken stone or other media in which to store runoff.
- In addition to dBMP, the user must also provide two additional recharge BMP depths. In Cell C7, the variable dBMPu is the vertical distance from the vegetated ground surface to the maximum water level of the BMP. This value should be positive if the maximum level is below the ground surface and negative if above the vegetated ground surface. In Cell C8, the variable dEXC is the vertical distance from the vegetated ground surface to the bottom of the BMP. For example, if the top of a 36-inch deep stone-filled infiltration trench (void ratio = 0.33) is located 24 inches below ground level, dBMPu would be 24 inches and dEXC would be 60 inches (i.e., dBMPu plus the 36-inch actual or physical depth of the trench). Remember, however, that since the trench is filled with gravel, the effective BMP depth (dBMP) would be 12 inches (i.e., 36 inches times 0.33). Using the dBMPu and dEXC variables, virtually all types of recharge BMPs can be specified, including "above the surface," "semi-buried," and "completely buried" BMPs. See Figure 6-4 for additional examples of dBMPu and dEXC.
- The next input cell on the BMP Calculations worksheet is the variable segBMP (Cell C9). This variable represents the post-developed site segment (as specified on the Annual Recharge worksheet) in which the proposed recharge BMP will be located. For example, if the recharge BMP is proposed to be built in Land Segment 3 in the Post-Developed Conditions table shown in Figure 1, then enter 3 for segBMP on the BMP Calculations worksheet.

  NOTE: Input zero for segBMP if the location of the BMP is still undetermined or a series of identical BMPs will be distributed over multiple site segments.
- The last input cell on the BMP Calculations worksheet is the variable Aimp (Cell C15). Similar to the variable Vdef in Cell C14, Aimp is either user-specified or, by default, taken from the Total Impervious Area computed on the Annual Recharge worksheet (Cell M23).

- Once values and/or initial guesses are entered in the input cells, either of two solve buttons can be used to solve the design problem. These buttons are described below.

NOTE: Click this button to automatically evaluate the value of ABMP that provides Vdef given all other input values.

NOTE: Click this button to automatically evaluate the value of dBMP that provides Vdef given all other input values.

If the initial guess values you enter for ABMP or dBMP are drastically off from what is needed to satisfy Vdef (i.e., too small or too big, too shallow or too deep), the program may not be able to find the right answer. You can tell the answers are not acceptable because negative values or division by zero signs will show up. If this happens just change your ABMP and/or dBMP values to more realistic numbers and solve the problem again.

- It is important to remember that, by default, the spreadsheet takes the values computed on the Annual Recharge worksheet for the Post-Development Recharge Deficit Volume (Cell K24) and the Total Impervious Area (Cell M23) and specifies them as initial values on the BMP Calculations worksheet for the Post-Development Deficit Recharge (variable Vdef in Cell C14) and Post-Development Impervious Area (variable Aimp in Cell C15). This allows solution of the site's total recharge deficit by a single groundwater recharge BMP that will receive runoff from the site's entire impervious area. However, in many instances, the single groundwater recharge BMP will receive runoff from only a portion of the site's impervious area (e.g., only roof runoff). In such cases, the user must specify the exact size of Aimp (impervious area to the BMP) in Cell C15. Failure to do this for such BMPs will result in an overestimation of the amount of runoff captured by the BMP and erroneous BMP dimensions and/or recharge amounts.
- At other sites, it may be necessary or desirable to utilize more than one groundwater recharge BMP to meet the site's recharge requirements. In such cases, each BMP will not only receive runoff from a portion of the site's impervious surface, but each will also seek to provide only a portion of the site's total recharge deficit. In such cases, the user must specify both the exact Aimp and Vdef (Post-Development Deficit) for each BMP in Cells C14 and 15 of the BMP Calculations worksheet. *IMPORTANT: In such cases, the user* must *also use a separate NJGRS spreadsheet for each BMP. Using multiple copies of the BMP Calculations worksheet within a single spreadsheet can yield erroneous results.*

NOTE: These procedures area also summarized in a note at the bottom of the BMP Calculations worksheet.

NOTE: Click this button to retrieve the initial, default values of Vdef and Aimp from the Annual Recharge worksheet.

- Similar to the Annual Recharge worksheet, the user-input cells in the BMP Calculations worksheet are tan colored. This includes the cells for Vdef and Aimp so that they can be altered from their default values by the user. As described above, these cells are initially assigned default values from the Annual Recharge worksheet so the user does not have to input values for certain sites and BMPs. All gray colored cells are used to show calculation results or internal validity checks and must *not* be changed by the user.

NOTE: Remember that the default configuration assumes that the runoff from the site's entire impervious area (set by specifying one or more land segments to "Impervious Areas" on the Annual Recharge worksheet) will drain to the BMP. If only a portion of this impervious area will do so, the correct impervious area must be specified for Aimp (Cell C15) on the BMP Recharge worksheet.

- The values shown in Figure 2 above are the final results obtained by solving for ABMP (with a constant dBMP of 5.2 inches) to satisfy the entire annual recharge deficit of 103,435 cubic feet (which is the default Vdef value from the Annual Recharge worksheet). The user can tell the results are correct by comparing the calculated Annual BMP Recharge Volume amount in Cell G14 (under the "System Performance Calculated Parameters" heading) with the Vdef amount in Cell C14. In addition, the user can see that the volume balance is shown to be "OK" (Cell J11) in the "Calculation Check Messages" section.

Parameters from Annual Recharge Worksheet

- This section of the BMP Calculations worksheet contains various parameters initially computed in and then transferred from the Annual Recharge worksheet. As noted above, the initial values for Vdef (Cell C14) and Aimp (Cell C15) are taken from the Post-Development Recharge Deficit Volume (Cell K24) and the Total Impervious Area (Cell M23) on the Annual Recharge worksheet. A complete description of when the user must specify other values for these parameters is presented above. The values for Root Zone Water Capacity (variable RWM in Cell C16) and RWC Modified to Consider dEXC (variable DRWC in Cell C17) are automatically adjusted to reflect the user's choice for the excavation depth (variable dEXC) of the BMP. The values for Climatic Factor (variable C-Factor in Cell C18) and Average Annual P (variable Pavg in Cell C19) are constant values for the municipality selected in Cell C3 of the Annual Recharge worksheet. It is important to note that if the user wishes to analyze a site in a different municipality, the user must go back to the Annual Recharge worksheet and change the municipality's name in order to obtain the correct C-Factor and Pavg values on the BMP Calculations worksheet.

WARNING: By changing the municipality, you also change the site's annual recharge deficit.

- The final value shown in this section of the BMP Calculations worksheet is the Recharge Requirement over Impervious Area (variable dr in Cell C20). This value is the average depth of annual recharge in inches over the impervious area (Aimp) specified (either by default or the user) in Cell C15. The value of dr is calculated by dividing Vdef by Aimp.

Root Zone Water Capacity Calculated Parameters

- This section of the BMP Calculations worksheet contains the calculated results for three root zone water capacity parameters. These values are needed for estimating the recharge efficiency of the groundwater recharge BMP under consideration. These parameters enable the NJGRS spreadsheet to estimate what portion of the infiltrated water from the BMP will travel downward below the root zone of the surrounding vegetation. As described above, this degree of water movement is the technical definition of groundwater recharge. The values of these three root zone water capacity parameters are automatically adjusted for the municipality and LULC segment in which the BMP is to be located. If the variable segBMP (Cell C9) is set to zero, weighted averages of these three parameters are utilized based on all the land segments specified on the Annual Recharge worksheet.

NOTE: See the Appendix to this guide for more information about these three root zone water capacity parameters.

BMP Calculated Size Parameters

- This section of the BMP Calculations worksheet contains values for two recharge BMP design parameters. The parameter Aratio (Cell G11) is computed by dividing the area (ABMP) of the BMP by the impervious area (Aimp) draining to it. The parameter VBMP (Cell G12) is the maximum storage volume in the BMP. It is computed by multiplying the BMP area (ABMP) by its effective depth (dBMP). These values can be checked by the user to help ensure that the ABMP, Aimp, and dBMP values have been inputted and used correctly by the NJGRS spreadsheet.

System Performance Calculated Parameters

- This section of the BMP Calculations worksheet contains various calculated BMP performance values. Of these, the Annual BMP Recharge Volume value (Cell G14) is the most important, since it must match the Post-Development Deficit Recharge value (variable Vdef in Cell C14) for the BMP to completely satisfy the site's annual recharge deficit or target recharge volume (as described above).
- The next parameter, Average BMP Recharge Efficiency (Cell G15), specifies the percentage of infiltrated water that is recharged (i.e., travels below the root zone) over an average year. This efficiency depends on many factors, including the project location, land cover, soil types, BMP dimensions, and depth of BMP. For the example shown in Figure 2 above, the recharge efficiency of the selected BMP is 76.7 percent.
- The remaining performance values in this section (Cells G16 to G19) are self-explanatory.

Recharge Design Parameters

- Inches of Runoff to Capture (variable Qdesign in Cell K5) is the first value in this section of the BMP Calculations worksheet. This value is the minimum depth of runoff over the BMP's tributary impervious area that must be captured and directed to the BMP to allow it to meet the site's groundwater recharge deficit. Similarly, Inches of Rainfall to Capture (variable Pdesign in Cell K6) specifies the minimum depth of rainfall over the BMP's impervious area that must be similarly controlled by the BMP to meet the site's recharge deficit. This value is also the maximum event rainfall the BMP can store without overflowing and, therefore, is the design rainfall for the BMP as described above.
- The next parameter in this section, Recharge Provided Average over Impervious Area (Cell K7) is the total annual depth of groundwater recharge provided by the BMP. For a site's recharge deficit to be met, this value must equal the Recharge Requirement over Impervious Area (variable dr in Cell C20). Runoff Captured Average over Impervious Area (Cell K8) is the last parameter in this section. It is the total annual depth of runoff over the impervious area tributary to the BMP that infiltrates into the ground. As such, it does not contain that part of the impervious area runoff to the BMP that overflows from the BMP during rainfall events greater than the BMP's design rainfall (Pdesign).

Calculation Check Messages

- This section the BMP Calculations worksheet provides three important messages to check the validity of the computed results. The Volume Balance message (Cell J11) is a check of the Annual BMP Recharge Volume in Cell G14 against the Post-Development Deficit Recharge (variable Vdef in Cell C14). If these values are equal, the problem is solved successfully and the message in this section should read "OK." However, if the BMP's annual recharge volume does not equal Vdef, the message instructs the user to continue to solve the problem. This may also occur if the user changes any of the BMP design parameters and forgets to solve the problem by clicking on any of the two solve buttons described above.
- The dBMP Check message (Cell J12) checks the validity of the value inputted for the dBMP, the BMP's effective depth in Cell C6. If this value is greater than the difference between the depths to the BMP's upper and lower surfaces (variables dBMPu and dEXC in Cells C7 and C8, a warning message is issued telling the user to adjust dBMP. dEXC Check (Cell J13) is the third message. It checks the validity of dEXC to make sure it is larger than dBMPu. If it is not, a message will appear instructing the user to make dEXC larger than dBMPu.
- Below these messages is a report on the location of the BMP as specified by the user in Cell C9 (variable segBMP). If the user has entered a valid segment number for segBMP, the message will read "OK." If the user enters a zero for segBMP, the message will read "Location is selected as distributed or undetermined." However, if the user enters a land segment number that was not previously defined in the Annual Recharge worksheet under Post-Developed Conditions, the message will say "Land Segment Number Selected for BMP is not Defined." The user should then make appropriate corrections to segBMP.

Other Notes

- This section of the BMP Calculations worksheet contains notes regarding the assumptions and limitations of the calculations in this worksheet. In the current version of the spreadsheet, these notes refer to the following aspects of spreadsheet use:
  1. The variable Pdesign (Cell K6) is accurate only after the BMP's annual recharge volume (Cell G14) is equal to the site's recharge deficit (variable Vdef in Cell C14). In addition, Pdesign is computed from the results of the BMP's performance. It is not used to compute that performance.
  2. A recharge BMP results are sensitive to its effective depth (dBMP in Cell C6). The user must ensure that the selected dBMP is small enough for the BMP to empty in less than 72 hours.
  3. If a BMP is located within an impervious Post-Development land segment, the Root Zone Water Capacity (variable RWC in Cell C16) at the BMP will be minimal, but not zero. This allows consideration for lateral flow and other losses at the BMP.

A P P E N D I X

Basic Equations and Variables Used in Recharge Efficiency Parameters Calculations

Basic Equations for Soil Water Capacity

A. Equation from GSR-32:

RWC = Root Depth x AWC (1)

RWC: Root Zone Water Capacity, (inch)

AWC: Available Water Capacity, (inch/ft)

B. New Equation:

ERWC = (1-0.5 x C-Factor) x RWC (2)

ERWC: Empty Root Zone Water Capacity under natural recharge, (inch)

C-Factor: Climate Factor = Ratio of precipitation to potential ET, (unitless)

Range of Values in NJ: RWC: (0.3, 14.35), C-Factor: (1.18-1.83)

ERWC: (0.02, 5.88)

Infiltration and Artificial Recharge under BMP or LID-IMP

$$\text{Average Annual Total Infiltration Depth} = \sum_{i=1}^{n} \text{Minimum (Qi/Aratio, dBMP)} \qquad (3)$$

n = total number of runoff producing precipitation events in an average year

Aratio = Ratio of surface area of BMP (ABMP) to the impervious surface area served by the BMP (Aimp), unitless.

Find Average Empty RWC under Infiltration Facility

A. Modification to account for the buried depth of the facility

We know that dBMPb = dEXC- Max(0,dBMPu);

We can define the following relationship:

DRWC = Max {0, Root Depth- 0.5 dBMPb - (dEXC- dBMPb)} AWC

which can be simplified to:

DRWC = Max (0, Root Depth- dEXC+ 0.5 dBMPb) AWC (4)

DRWC = Root zone water capacity under BMP modified for the buried portion of the BMP and calculated over all land segments, (inch)

B. Define the empty portion of EDRWC

EDRWC = (1- 0.5 x C-Factor) x DRWC (5)

EDRWC = Empty Portion of DRWC, (inch)

C. Account for the effect of moisture supplied by infiltration facility in reduction of empty portion of root zone

$$REavg = (1/n) \sum_{i=1}^{n} \text{Maximum}\ (EDRWC - inf_i) \qquad (6)$$

REavg = DRWC modified to account for infiltration under BMP, (inch)

infi = Infiltration depth in BMP during "i"th event (inch)

$$RERWC = (n/365) \times REavg + [(365-n)/n] \times EDRWC \qquad (7)$$

RERWC = Average empty root zone water capacity under BMP operation calculated for the average RWC of all land segments (inch)

$$RBMP = \sum_{i=1}^{n} \text{Maximum}\ (inf_i - RERWC,\ 0) \qquad (8)$$

RBMP = Total infiltration depth under BMP during an average year, (inch)

$$\text{BMP Recharge Efficiency} = \frac{RBMP}{\sum_{i=1}^{n} inf_i} \qquad (9)$$

In equations (8) and (9), results are very sensitive to C-Factor. As C-Factor increases, natural recharge increases and recharge deficit due to development increases. The NJGRS equations imply that if a development is constructed in an area of high natural recharge, the recharge efficiency of a BMP at the site would also be high. Therefore, the size of required recharge BMP should not be unduly large in areas with a large C-Factor.

The above parameters are calculated in the spreadsheet for each land segment as well as for the entire area (area weighted average) under Post-Developed Conditions. If the user specifies the location of the recharge BMP, the relevant parameters of the same land segment will be used. If the user does not specify the location, the average soil and loss factors based on all of the post-developed land segments specified on the Annual Groundwater recharge worksheet will be used.

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FEMA: Building Community Resilience with Natural Based Solutions

BUILDING COMMUNITY RESILIENCE WITH NATURE-BASED SOLUTIONS

A GUIDE FOR LOCAL COMMUNITIES

FEMA

RiskMAP
Increasing Resilience Together

TABLE OF CONTENTS

FEMA would like to express appreciation to the National Oceanic and Atmospheric Administration (NOAA) nature-based solutions and coastal community resilience subject matter experts who provided their valuable and constructive suggestions during the development of this resource. Their willingness to devote their time and expertise so generously to enhance the impact of this resource for communities is greatly appreciated.

COVER PHOTO: *Buffalo Bayou Park in Houston, TX. The park serves as both critical flood infrastructure and an important recreational and cultural asset for the downtown area. The popular park stretches 2.3 miles along the floodprone Buffalo Bayou and includes trails, public art installations, gardens, two festival lawns, a skate park, and a restaurant. In the park's first year, a survey counted nearly 150,000 trail users in a single month.*

INTRODUCTION

Natural hazards such as flooding, high wind, drought, and landslides pose major threats to communities across the United States. Reducing the threats they pose to lives, properties, and the economy is a top priority for many communities. The National Mitigation Investment Strategy identifies nature-based solutions as a cost-effective approach to keep natural hazards from becoming costly disasters. The promise of nature-based solutions comes from the many benefits they offer and the many partners they can draw to the table.

Nature-based solutions weave natural features and processes into a community's landscape through planning, design, and engineering practices. These practices can be applied to a community's built environment (for example, a stormwater park) or its natural areas (for example, land conservation). While nature-based solutions have many hazard mitigation benefits, they can also help a community meet its social, environmental, and economic goals. Communities across the country are finding nature-based solutions to be a highly effective way to provide public services that were traditionally met with structural or "gray" infrastructure. Local officials and their partners are using nature-based solutions to improve water quality in Lenexa, Kansas; to reduce flood risks in Milwaukee, Wisconsin; to limit erosion in coastal North Carolina; and to provide neighborhood amenities in Houston, Texas.

FEMA and its federal partners produced the National Mitigation Investment Strategy to increase our nation's resilience to natural hazards. Its purpose is to coordinate the use of federal, state, local, and private resources to help communities survive and thrive in the face of natural disasters. This guide builds on the three key goals of the Investment Strategy.

1. To motivate communities to invest in mitigation (for example, by showing how to measure its value);
2. To shrink barriers to investing in mitigation (for example, by improving access to risk information and funding); and
3. To make investing in mitigation standard practice (for example, by considering mitigation in all investment decisions for public infrastructure).

Hatteras, NC. The Durant's Point living shoreline project protects the shoreline from storm surge while providing habitat for many species. Since its construction, the project has weathered hurricanes, a summer of drought, and tropical storms. Photo: N.C. Coastal Federation

GOAL OF THE GUIDE

The key goal of this guide is to help communities identify and engage the staff and resources that can play a role in building resilience with nature-based solutions. Planning and building cost-effective nature-based solutions will require collaboration. Many departments may need to be involved in planning and carrying out the strategies in this guide. Consider including the following local government partners:

- Parks and Recreation
- Public Works
- Planning and Economic Development
- Environmental Protection
- Utilities
- Transportation
- Floodplain Administration
- Emergency Management

In addition, non-governmental community partners like civic associations, watershed groups, and non-profit organizations should be involved in the planning process. They may have the capacity to customize and implement nature-based solutions.

The focus of this guide is local communities, but many of the ideas and advice may also apply to state, territorial, and tribal governments.

STRUCTURE OF THE GUIDE

Some local communities may use this guide to learn about nature-based solutions and weigh their value for the community. Others may be ready to move from planning to action. The guide includes six sections, and users can jump in at any point, depending on their current knowledge base and interests. The six sections are described below.

WHAT ARE NATURE-BASED SOLUTIONS?
Describes three broad categories of nature-based solutions.
Identifies types of nature-based solutions in each category.

THE BUSINESS CASE
Outlines the many hazards that can be mitigated with nature-based solutions.
Discusses the multiple benefits of nature-based solutions, in addition to hazard mitigation.

PLANNING AND POLICY-MAKING PHASE
Identifies planning processes and programs that can help users invest in nature-based solutions.
Discusses how plans and policies can be updated to allow and encourage nature-based solutions.

IMPLEMENTATION PHASE
Reviews how local resources can be mobilized to preserve, restore, and build nature-based solutions.
Discusses innovative ways of promoting private investment.

FEDERAL FUNDING OPPORTUNITIES
Outlines federal funding sources for nature-based solutions.
Emphasizes FEMA’s Hazard Mitigation Assistance (HMA) grant programs.

KEY TAKEAWAYS AND RESOURCES
Summarizes key points for communities.
Provides additional resources.

WHAT ARE NATURE-BASED SOLUTIONS?

This guide defines nature-based solutions as sustainable planning, design, environmental management, and engineering practices that weave natural features or processes into the built environment to build more resilient communities. While this guide uses the term nature-based solutions, other organizations use related terms, such as green infrastructure, natural infrastructure, or Engineering with Nature®, a program of the U.S. Army Corps of Engineers. As a best practice, use the term(s) that best resonates with your target audience.

Green Infrastructure and Low Impact Development

Some organizations use the term green infrastructure to capture the value and functions of natural lands. For example, the Conservation Fund defines green infrastructure as "a strategically planned and managed network of natural lands, working landscapes, and other open spaces that conserves ecosystem values and functions and provides associated benefits to human populations."

Other organizations use the term green infrastructure for nature-based solutions to urban stormwater pollution. These organizations emphasize solutions that protect water quality and aquatic habitat. The other outcomes, such as mitigating natural hazards, are seen as co-benefits. Low impact development is another term that is often used to describe nature-based solutions for urban stormwater. In the field of stormwater management, "green infrastructure" and "low impact development" are sometimes used interchangeably.

Natural Infrastructure

The term "natural infrastructure" is often used to describe natural or naturalized landscapes that are actively managed to provide multiple benefits to communities. The International Institute for Sustainable Development, a think tank, notes that active management is what sets natural infrastructure apart from nature. For example, a managed wetland is a type of natural infrastructure. Manipulating water levels and cleaning out plant growth can enhance a managed wetland's water quality, habitat, and flood storage benefits.

Engineering with Nature

Organizations that design and operate water infrastructure projects may also refer to Engineering with Nature®, a term that comes from the U.S. Army Corps of Engineers' (USACE) Engineering with Nature Initiative. This term refers to water resources projects that use collaborative approaches to project design and operation to create multi-functional infrastructure. Engineering with Nature® can result in projects that deliver a broader range of economic, environmental, and social benefits.

Tying It All Together

The common thread among these terms is that nature-based solutions provide more value than single-purpose gray infrastructure. Gray infrastructure refers to public works structures that are engineered to provide a specific level of service under specific scenarios. In the context of drinking water and wastewater, gray infrastructure includes water and wastewater treatment plants, pipes, catch basins, and stormwater basins. In the context of coastal communities, gray infrastructure includes sea walls, groins, and breakwaters. While gray infrastructure provides only the service for which it was designed, nature-based solutions yield additional community and ecosystem benefits.

CATEGORIES OF NATURE-BASED SOLUTIONS

This guide categorizes nature-based solutions practices based on scale and location:

- **WATERSHED OR LANDSCAPE SCALE:** Interconnected systems of natural areas and open space. These are large-scale practices that require long-term planning and coordination.
- **NEIGHBORHOOD OR SITE SCALE:** Distributed stormwater management practices that manage rainwater where it falls. These practices can often be built into a site, corridor, or neighborhood without requiring additional space.
- **COASTAL AREAS:** Nature-based solutions that stabilize the shoreline, reducing erosion and buffering the coast from storm impacts. While many watershed and neighborhood-scale solutions work in coastal areas, these systems are designed to support coastal resilience.

The illustrations on the following pages are examples of nature-based solutions and do not cover all options.

Rain Garden — City Hall in Bay Village, OH

WATERSHED SCALE

LAND CONSERVATION

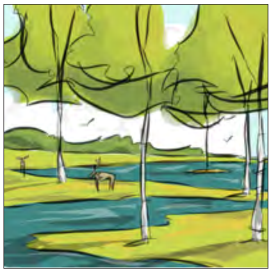
Land conservation is one way of preserving interconnected systems of open space that sustain healthy communities.

Land conservation projects begin by prioritizing areas of land for acquisition. Land or conservation easements can be bought or acquired through donation.

GREENWAYS

Greenways are corridors of protected open space managed for both conservation and recreation.

Greenways often follow rivers or other natural features. They link habitats and provide networks of open space for people to explore and enjoy.



WETLAND RESTORATION AND PROTECTION

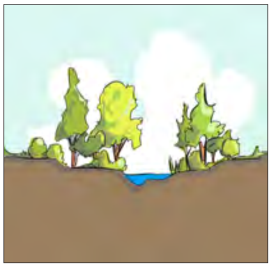
Restoring and protecting wetlands can improve water quality and reduce flooding. Healthy wetlands filter, absorb, and slow runoff.

Wetlands also sustain healthy ecosystems by recharging groundwater and providing habitat for fish and wildlife.

STORMWATER PARKS

Stormwater parks are recreational spaces that are designed to flood during extreme events and to withstand flooding.

By storing and treating floodwaters, stormwater parks can reduce flooding elsewhere and improve water quality.



FLOODPLAIN RESTORATION

Undisturbed floodplains help keep waterways healthy by storing floodwaters, reducing erosion, filtering water pollution, and providing habitat.

Floodplain restoration rebuilds some of these natural functions by reconnecting the floodplain to its waterway.

High-resolution versions of these graphics are available in the FEMA Media Library.

NEIGHBORHOOD OR SITE SCALE

RAIN GARDENS

A rain garden is a shallow, vegetated basin that collects and absorbs runoff from rooftops, sidewalks, and streets.

Rain gardens can be added around homes and businesses to reduce and treat stormwater runoff.

VEGETATED SWALES

A vegetated swale is a channel holding plants or mulch that treats and absorbs stormwater as it flows down a slope.

Vegetated swales can be placed along streets and in parking lots to soak up and treat their runoff, improving water quality.

GREEN ROOFS

A green roof is fitted with a planting medium and vegetation. A green roof reduces runoff by soaking up rainfall. It can also reduce energy costs for cooling the building.

Intensive green roofs, which have deeper soil, are more common on commercial buildings. Extensive green roofs, which have shallower soil, are more common on residential buildings.

RAINWATER HARVESTING

Rainwater harvesting systems collect and store rainfall for later use. They slow runoff and can reduce the demand for potable water.

Rainwater systems include rain barrels that store tens of gallons and rainwater cisterns that store hundreds or thousands of gallons.

PERMEABLE PAVEMENT

Permeable pavements allow more rainfall to soak into the ground. Common types include pervious concrete, porous asphalt, and interlocking pavers.

Permeable pavements are most commonly used for parking lots and roadway shoulders.

TREE CANOPY

Tree canopy can reduce stormwater runoff by catching rainfall on branches and leaves and increasing evapotranspiration. By keeping neighborhoods cooler in the summer, tree canopy can also reduce the "urban heat island effect."

Because of trees' many benefits, many cities have set urban tree canopy goals.

TREE TRENCHES

A stormwater tree trench is a row of trees planted in an underground infiltration structure made to store and filter stormwater.

Tree trenches can be added to streets and parking lots with limited space to manage stormwater.

GREEN STREETS

Green streets use a suite of green infrastructure practices to manage stormwater runoff and improve water quality.

Adding green infrastructure features to a street corridor can also contribute to a safer and more attractive environment for walking and biking.

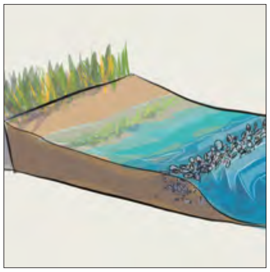
High-resolution versions of these graphics are available in the FEMA Media Library.

COASTAL AREAS

COASTAL WETLANDS

Coastal wetlands are found along ocean, estuary, or freshwater coastlines.

They are often referred to as "sponges" because of their ability to absorb wave energy during storms or normal tide cycles.



OYSTER REEFS

Oysters are often referred to as "ecosystem engineers" because of their tendency to attach to hard surfaces and create large reefs made of thousands of individuals.

In addition to offering shelter and food to coastal species, oyster reefs buffer coasts from waves and filter surrounding waters.

DUNES

Dunes are coastal features made of blown sand. Healthy dunes often have dune grasses or other vegetation to keep their shape.

Dunes can serve as a barrier between the water's edge and inland areas, buffering waves as a first line of defense.

WATERFRONT PARKS

Waterfront parks in coastal areas can be intentionally designed to flood during extreme events, reducing flooding elsewhere.

Waterfront parks can also absorb the impact from tidal or storm flooding and improve water quality.

LIVING SHORELINES

Living shorelines stabilize a shore by combining living components, such as plants, with structural elements, such as seawalls.

Living shorelines can slow waves, reduce erosion, and protect coastal property.

High-resolution versions of these graphics are available in the FEMA Media Library.

THE BUSINESS CASE

Many communities are looking for ways to build resilience that yield the most benefit for the least cost. This section builds the business case for nature-based solutions by summarizing their non-monetary benefits and potential cost savings. Thoughtfully planned nature-based solutions can contribute to a community's triple bottom line, providing social, environmental, and financial value.

HAZARD MITIGATION BENEFITS

Nature-based solutions can help reduce the loss of life and property resulting from some of our nation's most common natural hazards. These include flooding, storm surge, drought, and landslides. As future conditions amplify these hazards, nature-based solutions can help communities adapt and thrive.

Riverine Flooding

Communities can mitigate riverine flooding by investing in watershed-scale practices. Land conservation, floodplain restoration, and waterfront parks can keep development out of harm's way. They also store and slow floodwaters.

The GreenSeams program in greater Milwaukee, Wisconsin permanently keeps floodprone lands in high-growth areas from being developed. Since 2001, the GreenSeams program has preserved more than 3,000 acres of land that can store 1.3 billion gallons of water.

Urban Drainage Flooding

When the amount of stormwater flowing into a community's storm sewer system exceeds the system's capacity, water can back up and flood streets, basements, and homes. This type of flooding is most common where new development and changing rainfall patterns produce more runoff than the system was designed to handle. While urban drainage flooding is often less damaging than riverine flooding, it also tends to be more frequent. Over time, repeated minor floods can cost a community more than the extreme floods. They can also decrease real estate values and drive businesses away. Communities can mitigate this type of flooding by encouraging or requiring neighborhood- and site-scale nature-based solutions like bioretention systems. Bioretention systems include practices such as rain gardens, rainwater harvesting, green roofs, and more. These practices soak up runoff from hard surfaces and reduce the amount of stormwater flowing into the storm sewer system.

In Huntington, West Virginia, many neighborhoods experience flooding after heavy rainfalls. The city's comprehensive plan recommends using nature-based solutions that manage stormwater onsite to reduce the burden to the storm sewer system and reduce flooding.

Coastal Flooding and Storm Surge

Coastal flooding can be caused by unusually high tides, strong winds, or storm surge. As future conditions lead to more intense storms and rising sea levels, coastal flooding is becoming more frequent and storm surges are becoming more severe. Communities can mitigate coastal flooding by investing in nature-based shoreline stabilization. Living shorelines, reefs, and dunes can slow waves, reduce wave height, and reduce erosion. At the same time, these practices benefit the ecosystem by filtering and cleaning water and providing habitat.

According to a 2014 journal article in Ocean & Coastal Management, North Carolina properties with natural shoreline protection measures withstood wind and storm surge during Hurricane Irene (2011) better than properties with seawalls or bulkheads. The storm damaged 76 percent of bulkheads surveyed, while there was no detected damage to other shoreline types.

Drought

Droughts are also expected to be amplified by future conditions. As precipitation patterns become more unpredictable, communities can increase their resilience. Two options are conservation and rainwater harvesting. Conservation is a watershed-scale approach. It preserves or restores rainwater infiltration to increase groundwater. At the site scale, rainwater harvesting can help. It offsets some of the demand for non-potable water. This demand can be further reduced by xeriscaping, or drought-tolerant landscaping.

In Tucson, Arizona, almost 45 percent of the city's water is used for outdoor (non-potable) purposes. The City of Tucson's Commercial Rainwater Harvesting Ordinance aims to reduce this demand. It requires commercial property developers to harvest rainwater for at least 50 percent of their landscaping needs.

Landslides

Landslide hazards tend to be highest in steeply sloped areas. They are particularly high when soils are saturated and vegetation has decreased, or as a result of fires and droughts. At the watershed scale, communities can reduce landslide threats through conservation aimed at steeply sloped land. At the neighborhood and site scale, communities can invest in green stormwater infrastructure and bioretention systems. This includes trees, rain gardens, bioswales, infiltration basins, and pervious pavement. These stabilize slopes by keeping them drier and adding vegetation and root structures.

The Minnesota Department of Natural Resources lists stabilizing slopes using native vegetation and drainage improvements as one way to mitigate landslide hazards.

Mud slide with rock, boulders, and debris

COMMUNITY CO-BENEFITS

The biggest selling points for nature-based solutions are its many benefits beyond mitigating the effects of natural hazards. Nature-based solutions can provide short- and long-term environmental, economic, and social advantages that improve a community's quality of life and make it more attractive to new residents and businesses. Unlike gray infrastructure, a single nature-based project can yield a variety of community benefits that fulfill many departments' goals. Local leaders can highlight these co-benefits to encourage collaboration and make nature-based solutions standard practice. The bottom line is that collaboration on nature-based solutions can help communities survive in the long-term and thrive day-to-day.

Environmental Benefits

- **Improved water quality:** NBS can be used to filter pollutants from stormwater runoff and to reduce the volume of polluted water flowing into rivers, lakes, and coastal waters. In older cities with combined sewer systems, NBS can also reduce the untreated sewage going into community waterways. Combined sewer systems send all stormwater and sewage to a wastewater treatment plant before releasing the treated wastewater into waterways. When it rains, these systems sometimes carry more water than the treatment plant can handle. As a result, some of the mixed stormwater and sewage will be released untreated into waterways. These events are called combined sewer overflows (CSOs). By lowering the volume of rainwater flowing into a combined sewer system, NBS can reduce CSOs and improve water quality.

> The City of Lenexa, Kansas focuses on nature-based solutions to prevent stormwater pollution and reduce stormwater runoff.

- **Cleaner water supplies:** Nature-based solutions that protect the land around drinking water reservoirs can keep polluted runoff away from a community's water supply. New York City has high-quality tap water because the city invested in nature-based solutions around its 19 reservoirs. The city's $600 million investment to conserve and restore the land keeps the water draining into the reservoirs clean. It provided the same level of service as the $6 billion water filtration plant that the city would have needed otherwise.

- **Improved air quality:** Trees, parks, and other plant-based, nature-based solutions can absorb and filter pollutants and reduce air temperatures. Doing so reduces smog and improves air quality.

- **Healthier wildlife habitats:** Watershed and shoreline nature-based solutions preserve open space and natural environments. If thoughtfully designed, they can also connect habitats to give plants and animals more space to move across the landscape. Both types of nature-based solutions protect aquatic and wildlife habitats by improving water quality.

Economic Benefits

- **Increased property values:** If a property is near a park or has more landscaping, it generally has a higher value. A study of 193 public parks in Portland, Oregon found that parks had a significant, positive impact on nearby property values. A park within 1,500 feet of a home increased its sale price by $1,290 to $3,455 (adjusted to 2020 dollars). As parks increased in size, their impact on property value grew.

- **Improved property tax base:** Nature-based solutions can improve the tax base in both high-growth and low-growth communities. In high-growth areas, nature-based features translate into a higher property tax base. In low-growth communities, nature-based solutions can stabilize property values in areas with high vacancies.

> In Philadelphia, Pennsylvania, vacant lots were found to deflate neighborhood property values by as much as 20 percent. The Pennsylvania Horticultural Society initiated a program to green and maintain vacant lots. This program now maintains about 7,000 parcels totaling 8 million square feet. A 2012 study of the program found that homes within a quarter mile of a greened lot increased in value by 2 to 5 percent annually – generating $100 million in additional annual property taxes.

- **Green jobs:** Green stormwater infrastructure creates new job opportunities in sectors like landscape design, paving, and construction. It also opens new job opportunities in emerging industries.

Los Angeles, California saw an increase of more than 2,000 jobs from its $166 million investment in nature-based solutions from 2012-2014. The best part about this job growth is that many of these jobs are local, providing an extra boost to the local economy.

- **Improved triple bottom line:** The triple bottom line is an accounting framework that measures the value of social and environmental benefits, as well as financial benefits. Nature-based solutions provide more triple bottom line benefits than traditional, gray infrastructure. As a result, they increase a community's return on investment.

Social Benefits

- **Added recreational space:** Nature-based solutions that preserve and enhance open space provide more areas for recreation. In addition, nature-based solutions such as greenways and green streets can increase opportunities for active transportation, such as biking and walking. These spaces can also provide aesthetic benefits that contribute to improved mental health and physical well-being.

Hunter's Point South Park in Queens, New York City gives residents a new space to play and relax outdoors, while also mitigating flood risk along the East River. Nature-based features include bioswales and street-side stormwater planters to slowly absorb and release stormwater, and 1.5 acres of new wetlands to shield upland areas from storm surge.

- **Cooler summer temperatures:** Built-up areas tend to be hotter than nearby rural areas, particularly on summer nights. The "urban heat island effect" can lead to higher rates of heat-related illness. Adding trees and vegetation can help reduce these effects by providing shade and cooling through evapotranspiration.
- **Improved public health:** Many of the environmental and social benefits of nature-based solutions also benefit public health, including mental health. Improved air and water quality reduce exposure to harmful pollutants. Cooler summer temperatures reduce the risk of heat-related illness. Additional recreation spaces increase opportunities for physical activity and social engagement.

Hunter's Point South Park, a part of Gantry Plaza State Park, NY

COMMUNITY COST SAVINGS

The final piece of the business case for nature-based solutions is the potential for cost savings. Savings may come when nature-based solutions cost less than alternative investments, avoid the need for certain infrastructure altogether, or reduce the cost of rebuilding and repairs after a disaster. It is important to emphasize that it is often, *but not* always, possible to identify nature-based approaches that are cheaper than gray infrastructure alternatives.

Reduced Stormwater Management Costs

Using nature-based infrastructure can reduce the cost of stormwater management for new development because material costs are lower. Nature-based solutions can reduce the need for expensive below-ground infrastructure. They can also reduce the number of curbs, catch basins, and outlet control structures required. Nature-based solutions can save money on site preparation because they require less land disturbance.

In older cities with combined sewer systems, using both green and gray infrastructure can reduce combined sewer overflows (CSOs) at a lower cost. The traditional, gray infrastructure approach is to install below-ground tanks and tunnels and expand existing facilities. This process has extremely high capital costs. It also delays water quality improvements until the end of a decades-long design and construction process. Many nature-based solutions practices have lower capital costs and begin to provide benefits in a few years. New York City developed a plan to reduce CSOs using both green and gray infrastructure. The nature-based solutions component will eventually capture runoff from 10 percent of the impervious areas of the combined sewer watersheds. While the gray infrastructure option would cost about $3.9 billion in public funds, the nature-based alternative will cost about $1.5 billion.

Reduced Drinking Water Treatment Costs

Watershed-scale conservation practices can keep drinking water clean. They are often more cost-effective than building filtration plants to treat polluted water.

The Quabbin and Wachusett Reservoirs serve 2.5 million people in central Massachusetts and the Boston area. Over 20 years, the Massachusetts Water Resources Authority spent $130 million on nature-based solutions. The nature-based solutions protect 22,000 acres of the watershed that drains into these reservoirs. A water filtration plant would have cost $250 million to build and $4 million annually to operate and maintain.

Avoided Flood Losses

Nature-based solutions can also help communities save money by reducing losses from future floods and other natural disasters. The U.S. Environmental Protection Agency (EPA) studied this issue in a landmark 2015 study. The study estimated the flood losses that would be avoided nationwide by adding requirements to manage stormwater onsite. It found that, over time, using nature-based solutions in new development and redevelopment could save hundreds of millions of dollars in flood losses.

PLANNING AND POLICY-MAKING PHASE

The goal of this guide is to help communities identify and engage the staff who can play a role in building resilience with nature-based solutions. Planning and carrying out nature-based solutions requires an integrated approach that works across agencies and departments. This section provides tips for adding nature-based solutions to traditional community planning processes and programs. For each program area, this section recommends which officials to engage (ENGAGE); which types of nature-based solutions to consider (ASSESS); and how to update plans, policies, and ordinances to drive those solutions (UPDATE).

LAND USE PLANNING

The Land Use Element of a community's Comprehensive Plan (sometimes called a Master or General Plan) typically guides land use planning. It sets goals for where and how land will be developed and preserved over the next 20 to 30 years. It also identifies strategies to support these goals. The Land Use Element provides the basis for the community's land use regulations, including zoning ordinances and subdivision and land development ordinances (SALDOs).

ENGAGE: Planning staff typically develop the Comprehensive Plan in coordination with other government and public stakeholders. For coordinated investments in nature-based solutions, planning staff should invite other departments to help develop the Land Use Element. Include staff with roles in parks and recreation planning, public works, environmental protection, utilities planning, transportation planning, floodplain management, and emergency management.

ASSESS: The land use planning process can help drive investments in nearly every type of nature-based solution. To prioritize nature-based solutions, consider the community's most pressing issues, including development or hazards and risks. For communities approaching build-out, for example, preserving parks and greenways before all remaining land is developed may be most important.

UPDATE: The land use planning process should begin with the goals and principles in the Land Use Element. This will provide the rationale and stimulus for ordinance improvements, policy and procedure changes, and training. Once the Land Use Element is updated, make more detailed updates to zoning ordinances and subdivision and land development ordinances. Depending on the type of nature-based solutions prioritized by the community, update ordinances and procedures to:

- Establish riparian buffers and protect stream corridors;
- Direct development to previously developed areas and areas with existing infrastructure;
- Promote compact (e.g., mixed-use and transit-oriented) development;
- Reduce impervious cover; and
- Modify landscape requirements, including tree protection requirements.

HAZARD MITIGATION PLANNING

Hazard mitigation activities are typically guided by a Hazard Mitigation Plan (HMP), which is updated on a five-year cycle. The HMP identifies specific risk reduction projects as mitigation actions. Each action is linked to a plan that describes how and when the project will be completed.

ENGAGE: A Steering Committee typically leads the development of the HMP. The committee often includes planners, emergency managers, and other local officials. To enable joint investments in nature-based solutions, invite other departments to help define the HMP's goals and mitigation actions. Include staff with roles in parks and recreation, public works, planning, environmental protection, utilities management, and transportation planning. They can participate in both the five-year plan update process and the annual reviews and updates.

ASSESS: Hazard mitigation planning can drive investments in nearly every type of nature-based solution. To prioritize nature-based solutions, consider the community's most pressing hazards. For example, addressing droughts may be most important for communities in arid environments with high water demand. FEMA's Local Mitigation Planning Handbook specifically identifies protecting natural systems as important mitigation activities. These actions minimize losses and preserve or restore the functions of natural systems.

UPDATE: Nature-based solutions can be integrated into HMPs through both long-term goals and specific mitigation actions. Mitigation actions may include nature-based projects, but they should also promote nature-based solutions more broadly. Consider policies and regulations, education and outreach, and incentive-based programs. Develop these projects, policies, and incentives with relevant departmental staff so that they can also integrate nature-based solutions into their programs and planning processes.

The Capital Region Council of Governments in Connecticut established the following goal in its 2019-2024 HMP. Increase the use of natural, "green," or "soft" hazard mitigation measures such as open space preservation and green infrastructure. Specific mitigation actions encouraged adopting regulations to promote low impact development and nature-based techniques. They also supported education initiatives to help municipal staff and elected officials understand nature-based solutions practices.

STORMWATER MANAGEMENT

Stormwater management programs typically aim to reduce water pollution, preserve aquatic ecosystems, and protect the public from stormwater flooding. Many must also comply with federal and state stormwater management regulations. These regulations are designed to reduce pollutant discharges from Municipal Separate Storm Sewer Systems (MS4s) and CSOs. Communities with MS4s typically base their program on a Stormwater Management Program Plan (SMPP). Those with CSOs typically use a local Long-Term Control Plan (LTCP). These plans are carried out by various local programs, ordinances, and development procedures.

ENGAGE: Stormwater or public works departments typically develop the SMPP or LTCP. To coordinate investments in nature-based solutions, invite others to help develop the plan and put it into action. Include staff with roles in parks and recreation planning, environmental protection, utilities planning, transportation planning, floodplain management, and emergency management.

ASSESS: Stormwater management programs are best suited to drive investments in neighborhood- or site-scale nature-based solutions that retains and treats stormwater onsite. To choose which nature-based solutions to emphasize, consider the community's most pressing stormwater issues and priorities. Communities with a lot of existing development and limited new development might emphasize tree trenches, green roofs, and rainwater harvesting. These nature-based practices have smaller footprints and are easily integrated into tighter spaces. If that community also had limited water supplies, it might prioritize rainwater harvesting; if it did not have enough tree cover, it might prioritize tree trenches.

UPDATE: Updating a community's stormwater management program should begin with its SMPP or LTCP. To encourage the use of nature-based solutions, many communities are adding stormwater retention standards to their post-construction stormwater programs. According to an EPA summary, 28 states and two territories have post-construction retention standards. This type of standard requires some runoff volume to be managed onsite. This reduces both pollutant loads and erosive peak flows. Communities can also develop a hierarchy of acceptable nature-based solutions. For example, the Philadelphia Water Department divides these practices into three preference levels: Highest, Medium, and Low.

Once the SMPP or LTCP is updated, make more detailed updates to stormwater management ordinances and procedures. Depending on the type of nature-based solutions prioritized by the community, update ordinances and procedures to:

- Include nature-based solutions in proposed capital projects for stormwater management (for public projects);
- Make nature-based solutions legal and preferred for managing stormwater runoff (for private projects);
- Have stormwater management plan reviews take place early in the development review process (for private projects);
- Provide other ways for developers to meet stormwater requirements when onsite alternatives are not feasible, such as "payment-in-lieu of" programs (for private projects);
- Emphasize collaboration between the stormwater management department, streets department, and private developers to build green streets;
- Ensure that local building and plumbing codes allow harvested rainwater for exterior and non-potable uses; and
- Include effective monitoring, tracking, and maintenance requirements for stormwater management.

Rain Garden — Greenbriar Middle School in Parma, OH

TRANSPORTATION PLANNING

The Transportation Element of the local Comprehensive Plan, the regional Long-Range Transportation Plan, and the Transportation Improvement Program typically guide transportation planning. These plans set goals for a community's transportation system over the next 20 to 30 years. They also identify strategies and projects to support these goals. The plans provide the basis for local codes related to transportation and for local investments in transportation infrastructure.

ENGAGE: Planning staff typically develop the Comprehensive Plan, with input from local staff and the public. To coordinate investments in nature-based solutions, planning staff should invite other departments to help develop the Transportation Element. Include those with roles in parks and recreation planning, public works, environmental protection, utilities planning, floodplain management, and emergency management.

ASSESS: Transportation and land use planning are closely linked and often interdependent. As with the land use planning process, the transportation planning process can help drive investments in nearly every type of nature-based solution. To prioritize nature-based solutions, consider the community's most pressing issues. For communities with limited options for pedestrians, retrofitting streetscapes to increase walkability may be most important.

For an excellent model of how to systematically incorporate nature-based solutions into the transportation planning process, communities should review the "Eco-Logical" Approach promoted by the Federal Highway Administration.

UPDATE: Updating the transportation planning process should begin with the goals and principles in the Transportation Element. These provide the rationale and stimulus for ordinance improvements, policy and procedure changes, and training. Once the Transportation Element is updated, make more detailed updates to the policies, procedures, and ordinances on street and parking design. Communities can update their street design standards to provide clear direction on the appropriate installation of nature-based solutions. They can adopt a complete streets policy that encourages designs including nature-based solutions. And they can create a green streets manual that provides guidance on designing nature-based solutions.

Local ordinances and procedures related to street design and parking can also be updated. Use this process to minimize impervious cover and promote nature-based solutions. Depending on the type of nature-based solutions prioritized by the community, update ordinances and procedures to encourage or require:

- Adding nature-based solutions to proposed transportation projects in the Transportation Improvement Plan and capital improvement plan;
- Making street trees a part of public capital improvement projects;
- Making streets no wider than is necessary to move traffic effectively;
- Using pervious materials for lower-traffic paving areas, including alleys, streets, sidewalks, driveways, and parking lots;
- Providing alternative parking requirements (e.g., shared or offsite parking), and varying requirements by zone to reflect places where more trips are by foot or transit;
- Using alternative measures to reduce required parking, such as transportation demand management; and
- Using nature-based solutions to strengthen the resilience of transportation infrastructure to natural hazards.

OPEN SPACE PLANNING

The Open Space and Recreation Element of a community's Comprehensive Plan typically guides open space planning. This element establishes a policy framework and action program. These are used for maintaining, improving, and expanding the community's open space and recreational facilities.

ENGAGE: Planning staff typically develop the Comprehensive Plan with government and public stakeholders. To coordinate investments in nature-based solutions, invite other departments to help develop this element. Include staff with roles in hazard mitigation, public works, environmental protection, utilities planning, floodplain management, and emergency management.

ASSESS: The open space planning process can help drive investments in nearly every type of nature-based solution. At the watershed scale, it can support interconnected systems of greenways and parks. These mitigate natural hazards and provide co-benefits to the community. At the neighborhood scale, open space planning can incorporate nature-based solutions into local parks and recreational facilities. This helps reduce and treat neighborhood stormwater runoff. In coastal areas, open space planning can drive investments in living shorelines, waterfront parks, and other coastal nature-based practices.

UPDATE: Updating the open space planning process should begin with the Open Space and Recreation Element of the Comprehensive Plan. Once the plan is updated, consider more detailed updates to facilities management programs, park planning and design, and local ordinances.

Facilities management programs can add neighborhood-scale nature-based solutions to existing parks and playgrounds. As local governments retrofit existing facilities, they can incorporate nature-based solutions to reduce impervious cover, enhance tree cover, and treat and soak up stormwater runoff. Park planning and design are also opportunities. Communities can apply nature-based practices and principles as they expand their network of parks and trails and design each park site. Using nature-based solutions for retrofitting existing parks or acquiring and designing new parks can mobilize new partners and funding sources. Finally, updating local ordinances can help to preserve watershed-scale nature-based solutions. Based on the needs of the community, ordinances can be updated to:

- Protect natural resource areas and critical habitat;
- Establish no-development buffer zones and other protections around wetlands, riparian area, and floodplains; and
- Limit development and land disturbance in source water protection areas.

Folly Beach, SC

FEMA's Community Rating System (CRS) allows participating communities to earn lower flood insurance rates for property owners, renters, and businesses. They get credit for actions that reduce risk under the National Flood Insurance Program. FEMA recently elevated the potential CRS credit values for nature-based solutions. Credit is given for actions such as preserving open space, restoring wetlands, and developing a living shoreline. The number of points awarded for preserving open space is now among the highest given in the program. Credits are awarded according to the percentage of preserved open space in a community's floodplain. The larger the percentage, the more credit is awarded, accompanied by potentially higher insurance discounts. Folly Beach, South Carolina incorporated nature-based solutions into their CRS program and received a 30-percent reduction in premiums.

IMPLEMENTATION PHASE

To build a network of nature-based solutions, communities should encourage both public and private investments. This section provides tips for boosting public investment and incentivizing private investment. Many of these tips rely on the diverse benefits of nature-based solutions. Recognizing these diverse benefits can help pool resources from public and private partners to mobilize more funding for nature-based solutions. This section is aligned with the third goal of the National Mitigation Investment Strategy — to make mitigation investments standard practice.

BOOSTING PUBLIC INVESTMENT

Diversifying Local Resources

Traditional local funding sources for public infrastructure include general funds, bond proceeds, taxes, and fees. Support for nature-based solutions investments could come from taxes levied on property, special or business improvement districts, or tax increment financing (TIF) districts. Local fees could include development impact fees, fee-in-lieu payments, or utility fees (including stormwater utilities). Pooling resources is also a way to integrate NBS practices into planned or ongoing capital improvement projects. Consider NBS when creating or improving roads, streetscapes, stormwater management projects, parks, and parking areas. Incorporating NBS into public improvements is an opportunity to lead by example and to educate other departments, private developers, and the public.

GENERAL FUNDS	BOND PROCEEDS	TAX AND FEE REVENUES
PROS • Financial flexibility **CONS** • Funds can be reassigned • Influenced by changes incommunity, including political climate	**PROS** • Dedicated and consistent source of funding **CONS** • Could increase local taxes and fee rates • Influenced by credit rating • Repayment often includes interest	**PROS** • Dedicated and consistent source of funding **CONS** • Lack of financial flexibility • Could increase local taxes and fee rates

While each funding source has pros and cons, communities should use more than one internal resource. Pooling resources is a more cost-effective and fiscally responsible funding choice. Pooling resources is also a way to integrate nature-based solutions practices into planned or ongoing capital improvement projects. Consider nature-based solutions when creating or improving roads, streetscapes, stormwater management projects, parks, and parking areas. Incorporating nature-based solutions into public improvements is an opportunity to lead by example and to educate other departments, private developers, and the public.

Attracting Grant Funding

To maximize public investment in nature-based solutions, communities should creatively combine local and external resources as often as possible. Since nature-based solutions provide many different co-benefits, a single project may be eligible for a variety of private, state, and federal grant programs. The key to leveraging these resources is to think outside the box when applying for funding, and to apply to diverse programs. For example, a coastal community may seek grant funding for a flood risk reduction project that uses nature-based approaches. In addition to applying for hazard mitigation grants, this community could apply for habitat conservation grants, water quality grants, and coastal resilience grants. The final section of this guide lists some of the most common federal grant funding opportunities for nature-based solutions. Communities should also identify and leverage the financial assistance available through state-specific programs. Other potential sources are non-profit organizations, special districts, and private foundations.

As a growing suburb of Kansas City, Lenexa, Kansas is managing the effects of increased impervious cover through nature-based solutions. To integrate nature-based solutions into major capital projects, such as rebuilding roads and parks, Lenexa is using funds from several internal and external sources:

1. sales tax revenues;
2. stormwater utility fees;
3. new development fees; and
4. state and federal grants.

Building Nature-Based Solutions into the Capital Improvement Plan

The Capital Improvement Plan (CIP) process is another tool for increasing investments in nature-based solutions. Many communities use a CIP to plan the timing and financing of public improvements over the medium term (approximately five years). Agencies submit projects to be evaluated and included in the CIP, and the CIP team analyzes and ranks submitted projects. Ultimately, highly ranked projects are funded first. Rankings often consider how the project advances mandated activities and community priorities. They are also based on whether the project is fiscally responsible. Including a nature-based component can help increase a project's ranking, as nature-based solutions may contribute toward federal Clean Water Act requirements, hazard mitigation, and other community priorities. It is important to emphasize the multi-functional nature of these solutions and how they can provide more bang for the public's buck.

Funding Nature-Based Solutions with Stormwater Utility Fees

Stormwater utility fee programs are designed to pay for the cost of managing stormwater runoff. Typically, stormwater fees are collected in a fund dedicated to the stormwater management program and stormwater-related projects. This can be a good, steady source of funding that does not compete with other community priorities.

Many stormwater utilities are structured to charge users based on their property's stormwater runoff volume. For example, communities can charge a fee based on a property's impervious area, rather than its total area. For this type of fee structure, communities need to have a good understanding of their impervious cover. Stormwater utilities are also able to collect fees from all property owners, including those otherwise exempt from property taxes.

The 2017 Western Kentucky University Stormwater Utility Survey identified 1,639 stormwater utility programs in 40 states. The smallest program served a population of 88.

Financing Nature-Based Solutions with the Clean Water State Revolving Fund

The Clean Water State Revolving Fund (CWSRF) is a financial assistance program established through the Clean Water Act. It provides low-interest loans for water infrastructure projects (including nature-based solutions) that address water quality.

The EPA provides funding to all 50 states and Puerto Rico to operate CWSRF programs. States provide a 20-percent match for all federal funds. Since the CWSRF was established, it has supplied more than $43 billion to state programs. With that support, states have given $133 billion in loans to communities.

For most projects, public, private, and non-profit entities get an average interest rate of 1.4 percent. The loan period must not exceed 30 years. A key benefit of the program's low interest rate is that communities may be able to cover debt service payments without raising the rates for local taxes or fees. By further reducing operation and maintenance costs for infrastructure, nature-based solutions help communities meet their loan repayment terms.

The Camden County Municipal Utility Authority was awarded a $5.4 million loan from the New Jersey Infrastructure Bank, the state's CWSRF, to fund a city-wide nature-based solutions project. The project has an estimated cost savings of $3.1 million over the 30-year loan. It involves building nature-based solutions throughout the City of Camden, including rain gardens and porous concrete sidewalks. The project also has a green jobs component. In the past 3 years, Camden trained about 240 youths in nature-based solutions maintenance.

Managed dune on Long Beach Island, NJ. Dune restoration is an example of nature-based solutions that can be funded by many federal funding sources.

INCENTIVIZING PRIVATE INVESTMENT

While public investment in nature-based solutions is critical and continues to evolve, communities should also investigate ways to incentivize nature-based solutions on private property. One option is to make these investments more appealing to homeowners, businesses, and developers. Incentives typically use public funds to seed additional investments by private parties. Innovative incentive-based programs can create unique ways to fund and build nature-based projects. Some examples are public-private partnerships, rebates and financing programs, grants, and cost-share arrangements. Banking or credit trading programs, development or redevelopment incentives, local fee or tax discounts, and community awards and recognition programs have also been useful. Such voluntary programs can increase the use of nature-based solutions on private land, where most traditional development takes place. They can balance regulations and may relieve some of the administrative burden that communities carry when adopting and managing their own nature-based policies or projects.

Public-Private Partnerships

Through partnerships, local governments and private-sector parties can invest together in public asset or service projects. These long-term partnerships are most successful when they have shared goals and benefits. Private partners may have more flexibility than a public agency. Linking any partnership with performance-based payments can encourage efficiencies in time and cost.

Local officials can work with private partners to develop and finance nature-based solutions in many ways. One key step is to demonstrate the benefits of nature-based solutions – to make the business case locally. Another is to offer continued technical assistance and coordination for nature-based projects. This may include policy support, training, or other ways to build capacity. Finally, seek long-term agreements with any private stakeholders that would provide these services traditionally delivered by the public sector. Above all, communities should create partnerships with private parties for specific projects.

In Prince George's County, Maryland, a new water resources plan proposed extensive stormwater-related restoration. Also, 20 percent of the county's impervious surfaces needed to be replaced. Recognizing its challenges in volume and timing, the county built a public-private partnership. A private party was contracted to restore 2,000 acres, with the potential for extending the contract to an additional 2,000 acres if it met performance metrics. This partnership met its project costs and deadlines. It was also recognized for meeting social goals such as hiring and training minority-owned businesses and focusing on projects in lower-income areas.

Rebates and Financing Programs

Rebates, tax credits, or low-interest loans can encourage nature-based solutions and practices. For example, Tucson Water sponsors a Rainwater Harvesting rebate program. It provides rebates of up to $2,000 to single-family residential or small commercial customers who install a rainwater harvesting system. Eligible options include passive rainwater harvesting, which directs and retains water in the landscape, and active rainwater harvesting, such as tanks that store water for later use. Often, participants in this kind of program need capital at the beginning of a project. Since residents may not want or be able to fund improvements on their own, many communities target their rebates and loans at businesses. Philadelphia, for example, offers low interest (1 percent) loans for nature-based solutions retrofits on non-residential property.

Another finance option for promoting nature-based solutions is the Department of Energy's Property Assessed Clean Energy (PACE). Communities can use PACE to help property owners finance nature-based solutions. It also applies to installing renewable energy or energy-efficient assets on private properties. Depending on state laws, communities can create PACE programs by issuing a revenue bond to the property owner. PACE borrowers can benefit immediately from new nature-based solutions and repay their debt by increasing property taxes. For example, increases are at a set rate for an agreed-upon term, typically 5–25 years. The PACE assessment is attached as a tax on the property, not the property owner. Because PACE is funded through private loans or municipal bonds, it creates no liability to local government funds.

Grants and Cost-Share Agreements

Communities can also encourage nature-based solutions by directly funding property owners or groups. Onondaga County, New York has a Green Improvement Fund that funds nature-based solutions on private commercial and non-profit properties. Applicants in the target sewer districts can choose their own nature-based solutions techniques, but grants are determined by the amount of stormwater the project captures. The Green Improvement Fund has awarded 88 grants since 2010, for a total of nearly $11 million. Nature-based solutions projects have included the installation of porous pavement, added green space, rain gardens, green roofs, and infiltration projects. Together, the completed projects can capture more than 38 million gallons of stormwater runoff per year. Philadelphia manages a similar voluntary retrofit grant program. It covers the upfront costs of typical nature-based solutions on private property if the owner agrees to maintain it.

Banking or Credit Trading

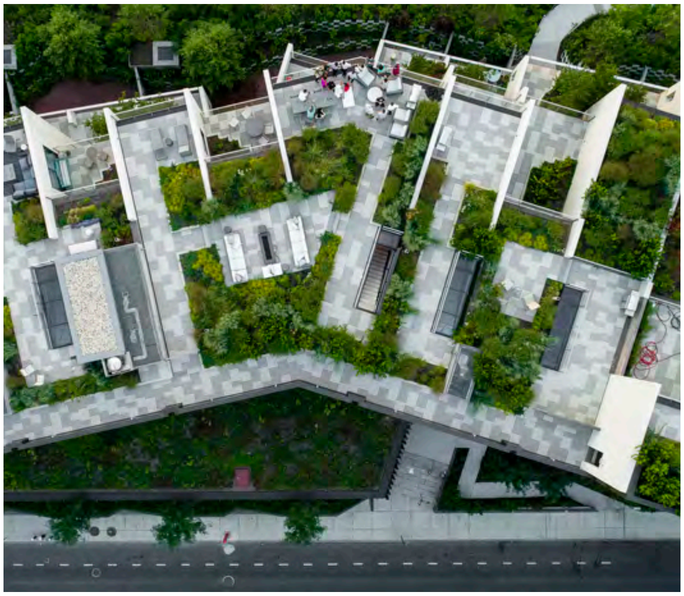
Banking or credit trading programs can help developers meet onsite stormwater retention requirements when nature-based solutions are not feasible onsite. They create a mechanism for developers to pay the community to build nature-based solutions off site. This concept is like that of wetland mitigation banking.

Washington, DC has begun a Stormwater Retention Credit (SRC) Trading Program. It allows large-scale development and redevelopment projects to meet stormwater management requirements by buying credits from properties with voluntary nature-based solutions improvements. The credit trading program encourages developers to choose cost-effective, nature-based solutions. It also creates an incentive for other property owners to integrate green stormwater practices. Through this program, properties that use nature-based solutions or reduce impervious cover can earn and sell credits to the Department of Energy and Environment or in an open market.

Environmental Impact Bonds

Several traditional debt financing tools are available to communities. However, environmental impact bonds (EIBs) are a recent innovation. EIBs can help communities obtain upfront capital for hard-to-finance environmental projects. These bonds link project performance incentives to desired environmental outcomes. In practice, most EIBs function like traditional bonds, with a fixed interest rate and term. Unlike normal bonds, they offer investors a "performance payment" if projects perform better than expected. The primary benefit of this model is that it shifts the project performance risk to a private party and ties borrowing costs to the effectiveness of a project. If a project underperforms, investors must reimburse the borrowing entity; if it overperforms, the entity pays the investors. This model has potential applications for multiple areas of environmental restoration and resilience, including nature-based solutions.

Environmental Impact Bonds have already been issued in several cities, including Washington, DC and Atlanta, Georgia, where they are funding a range of nature-based solutions projects to reduce stormwater runoff and address critical flooding issues.



Modern rooftops, Brooklyn Heights, New York City

Development or Redevelopment Incentives

Communities can update their land use, zoning, or other local regulations to provide incentives for using nature-based solutions. Zoning incentives can allow a greater height, density, or intensity of development if a developer uses nature-based approaches. One common zoning incentive is an increased floor-to-area ratio (FAR), which regulates the density of development on a site. The City of Portland, Oregon offers increased FAR as an incentive for installing green roofs. Communities can also exempt green roofs or pervious pavements from any regulations that apply to impervious cover.

More incentives for adopting nature-based solutions approaches can be used in the development application and review period. These include discounted application fees and discounted or waived maintenance bonding requirements. The City of Chicago, Illinois waives permit fees for developments that meet specific nature-based solutions thresholds. For redevelopment, communities can also give a one-time tax credit for using nature-based approaches that benefit the public.

More communities are moving from strict standards to more flexible instruments that include incentives. They are encouraging developers to use nature-based solutions through unified development ordinances. They are providing options for flexibility and creativity during the site plan review process.

The City of Norfolk, Virginia recently created a "resilient quotient system." Developers earn points for adopting measures that reduce flood risk, manage stormwater, and increase energy resilience. Under this system, new developments must meet different resilience point values. The points are based on the size and type of development (residential, non-residential, mixed-use). Developers get points for installing green roofs, rain gardens, or other stormwater infiltration systems; using pervious paving systems; providing a community garden space; preserving natural, native vegetation; planting trees; and preserving large, non-exotic trees.

Stormwater Utility Incentives

Communities can use a local stormwater utility fee program to establish a dedicated funding stream for nature-based solutions. This type of program can offer incentives for property owners to incorporate nature-based solutions. For example, a program that charges users based on their property's impervious area could offer discounts when property owners "disconnect" some of their impervious area from the storm sewer system by adding nature-based solutions. Other incentives may be offered for creating more buildings with green roofs and other retention or infiltration systems, or for rainwater harvesting.

In Nashville, Tennessee, properties in a combined sewer overflow area may receive a discount on their sewer fees if nature-based solutions are incorporated. Similar incentives are part of stormwater utility programs in Philadelphia and Washington, DC. In Lancaster, Pennsylvania, stormwater credits available to all property owners can reduce fees by up to 50 percent a year. To qualify, owners must use nature-based solutions on the property.

Father and toddler examining plants in a park in Norfolk, VA

FEDERAL FUNDING OPPORTUNITIES

As governments have become more aware of the many benefits and financial value of nature-based solutions, federal agencies have provided more funding opportunities. Each year, the federal government provides millions of dollars in grants for nature-based infrastructure projects. These projects lead to safer, more resilient communities. Other levels of government and private organizations also fund and invest in nature-based solutions.

Some common nationally available federal grant funding opportunities for nature-based solutions are summarized below. This is a starting point, not a complete list. Additional funding may be available from other federal programs, state agencies, non-profit organizations, conservation districts, universities, and private foundations.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)	
COMMUNITY-BASED RESTORATION PROGRAM	
DESCRIPTION	**PROJECTS**
NOAA's Community-Based Restoration Program provides funding for coastal and marine habitat restoration projects. The program supports projects that use a habitat-based approach to rebuild productive and sustainable fisheries, contribute to the recovery and conservation of protected resources, promote healthy ecosystems, and yield community and economic benefits.	Typical habitat restoration projects include hydrologic reconnection of wetlands, coral reef restoration, and bivalve shellfish habitat restoration that includes some form of protection from harvesting. Feasibility, design, and implementation projects are all eligible.
NATIONAL COASTAL RESILIENCE FUND	
DESCRIPTION	**PROJECTS**
The National Coastal Resilience Fund, a public-private partnership between the National Fish and Wildlife Foundation, NOAA, Shell, and TransRe, provides grants to support natural infrastructure. Established in 2018, the Fund invests in projects that protect coastal communities from extreme storm and flood events while enhancing natural habitat.	Community capacity-building and planning, engineering, design, and construction projects such as living shoreline, floodplain-habitat restoration design, marsh and wetland habitat restoration, and natural channel design.

U.S. DEPARTMENT OF HOMELAND SECURITY (DHS) – FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

HAZARD MITIGATION ASSISTANCE

DESCRIPTION	PROJECTS
FEMA's Hazard Mitigation Assistance (HMA) includes three funding programs for risk reduction activities. They are the Hazard Mitigation Grant Program, Flood Mitigation Assistance Program, and Pre-Disaster Mitigation Program. States, territories, tribes, and local communities may apply for HMA funding if they have a FEMA-approved HMP. **Note:** The Pre-Disaster Mitigation Program is sunsetting in 2020 and will be replaced by the Building Resilient Infrastructure and Communities (BRIC) Program.	Primarily drought and flood risk reduction projects, such as aquifer storage and recovery, floodplain and stream restoration, and flood diversion and storage. Reforestation projects in wildfire-affected areas may also be eligible.
Public Assistance (PA) is FEMA's largest grant program, providing funds to assist communities responding to and recovering from declared disasters. The program provides funding for permanently restoring community infrastructure, and for hazard mitigation measures to minimize future loss to damaged facilities through **PA 406 Hazard Mitigation**.	Primarily erosion control projects, such as bank or slope stabilization. There are many opportunities to expand the use of nature-based solutions with PA mitigation projects provided they meet the eligibility requirements.

The City of Cuyahoga Falls, Ohio used Hazard Mitigation Grant Program funding to buy and remove four homes that had flooded repeatedly. The resulting open space was used to create The Rain Garden Reserve, a beautifully landscaped public space. The Reserve also serves as a stormwater retention area, reducing flood risk for neighboring homes.

Rain garden in Euclid Creek Watershed, OH. Photo: Cuyahoga Soil & Water Conservation District

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (HUD)

COMMUNITY DEVELOPMENT BLOCK GRANT

DESCRIPTION	PROJECTS
The Community Development Block Grant (CDBG) Program provides funding to ensure decent affordable housing, provide services to the most vulnerable in our communities, and create jobs through expanding and retaining businesses. Since 2001, the CDBG-Disaster Recovery Program has provided additional assistance to areas affected by Presidentially declared disasters. This program supports disaster recovery activities such as housing redevelopment and rebuilding, infrastructure repair, and economic revitalization. In August 2019, HUD announced its first allocation of CDBG-Mitigation funds. Nearly $7 billion was made available to 14 grantees affected by recent Presidentially declared disasters, solely for the purposes of mitigating future disasters.	CDBG-Disaster Recovery: Infrastructure, housing, and economic development projects may incorporate nature-based solutions, usually at the neighborhood or site scale. CDBG-Mitigation: In addition to infrastructure, housing, and economic development projects, planning and administration projects can reduce regulatory barriers to nature-based solutions and help make mitigation investments standard practice.

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

SECTION 319 NONPOINT SOURCE MANAGEMENT PROGRAM

DESCRIPTION	PROJECTS
The Section 319 Nonpoint Source Management Program (Section 319) was established under the Clean Water Act. It helps focus efforts to address nonpoint source (NPS) pollution caused by land runoff from rainfall and snowmelt. Section 319 funds can be used for technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and regulatory programs. Contact your state-designated NPS Program Coordinator for more information.	Nature-based solutions demonstration projects related to water quality improvements may also provide hazard-reduction co-benefits; these may include stream restoration, riparian buffer creation, wetland creation, rain gardens, and other bio-retention projects.

KEY TAKEAWAYS FOR LOCAL COMMUNITIES

Communities that invest in nature-based approaches to reducing disaster risk can save money, lives, and property in the long-term AND improve quality of life in the short term. The key takeaways from this guide are:

1. Building the business case for nature-based solutions can generate widespread interest among diverse organizations. Nature-based solutions can reduce the loss of life and property from some of our Nation's most common natural hazards, such as flooding, storm surge, drought, and landslides. The biggest selling point for nature-based solutions, though, is the many ways it can improve a community's quality of life and make it more attractive to new residents and businesses. Unlike gray infrastructure, nature-based solutions projects serve multiple functions and goals.
2. To build resilience with nature-based solutions, diverse partners must collaborate. Planning and carrying out nature-based solutions requires many departments and processes to work together. Departments will need to cooperate to reduce the barriers to nature-based solutions and make using nature-based solutions a standard practice.
3. Scaling up nature-based solutions will require communities to align public and private investments. Communities can get more bang for their buck by using a range of strategies to enable public investment in nature-based solutions and incentivize private investment.
4. Many types of grant programs can be leveraged to fund nature-based solutions. Since nature-based solutions provide a variety of co-benefits, a single project may be eligible for many different private, state, and federal grant programs. The key to leveraging these resources is to think outside the box when applying for funding, and to apply to diverse programs.

Volunteers planting sea grass on a beach in Florida.

RESOURCES

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Rutgers University: Green Infrastructure Guidance

RUTGERS COOPERATIVE EXTENSION WATER RESOURCES PROGRAM

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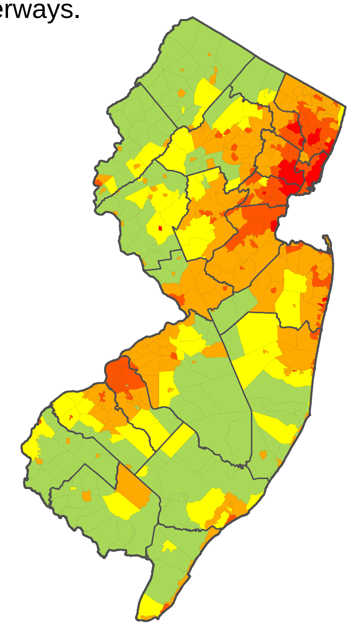
This document has been prepared by the Rutgers Cooperative Extension Water Resources Program with funding provided by Surdna Foundation, the National Fish and Wildlife Foundation, and the New Jersey Agricultural Experiment Station. This work is intended to provide guidance for the design and implementation of green infrastructure practices throughout New Jersey.

GREEN INFRASTRUCTURE GUIDANCE

FOR REDUCING THE IMPACTS OF IMPERVIOUS COVER ON WATER QUALITY

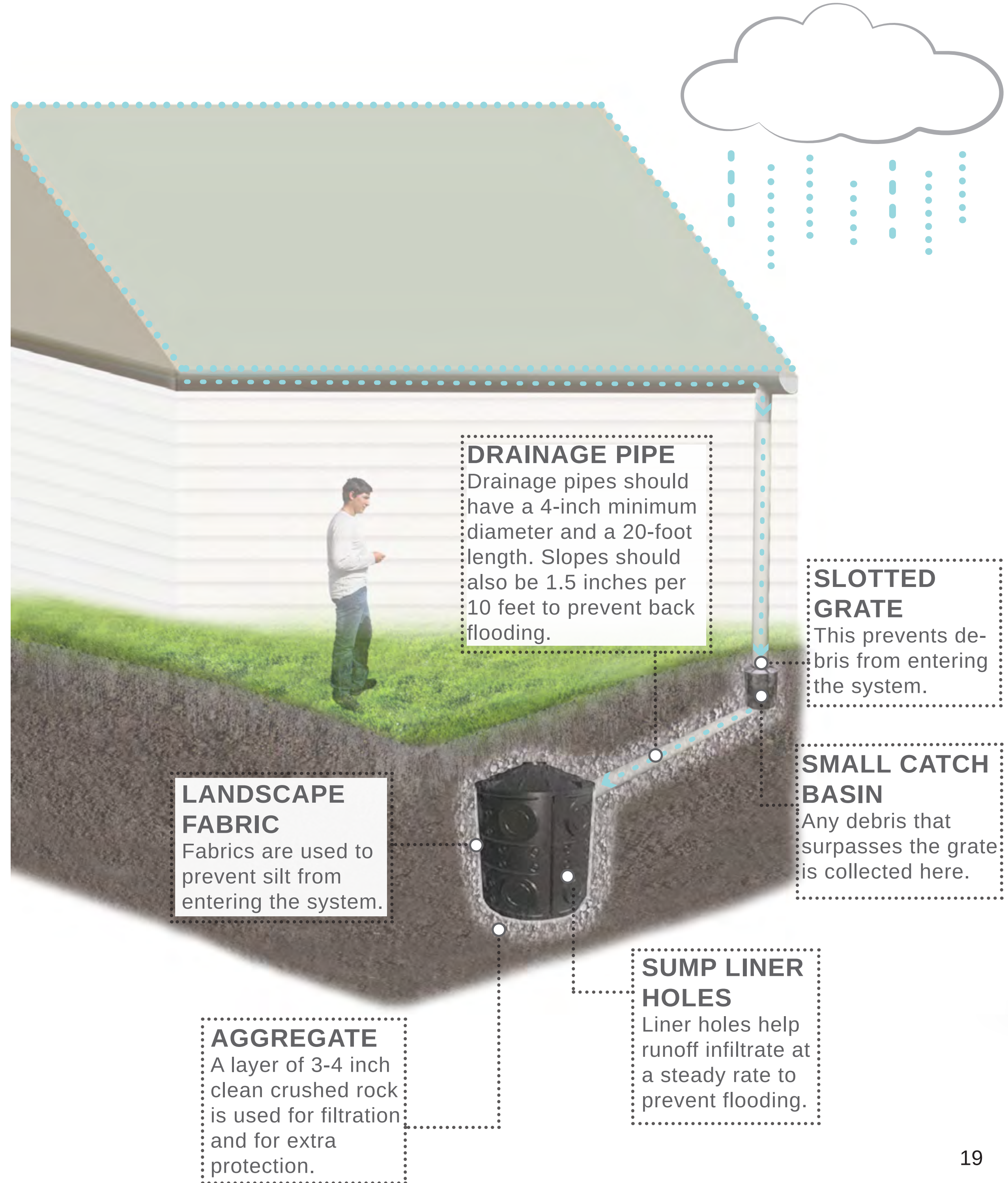
GREEN INFRASTRUCTURE FOR NEW JERSEY

As the amount of impervious surfaces like roadways, parking lots, and rooftops increase, stormwater runoff increases. Scientific research has linked these increases in impervious surfaces to degraded waterways. Because of this, many municipalities have limits on impervious cover for individual building lots. Green infrastructure can be designed to mitigate these increases in impervious cover by reducing their impact on local waterways.



New Jersey has
675,200
acres of impervious cover

This brochure is intended to serve as a quick reference guide for green infrastructure. Many of these practices can easily be installed on sites to offset increases in impervious surfaces.



DRY WELL SYSTEMS
STORAGE AND INFILTRATION

A dry well is an underground structure built to manage surface runoff that cannot directly infiltrate into the ground. The system accepts stormwater runoff through a pipe and captures it in a large container. The system receives water from an entry pipe or channel and discharges the water through small openings distributed along the sides and bottom of the container. The system is designed to accept a large quantity of stormwater during a rainfall event. Subsequent to the storm, the dry well allows the stormwater to slowly infiltrate back into the ground.

Dry wells can be designed in a number of ways. Simple dry wells are a pit filled with gravel, riprap, and rubble. Other dry wells are designed as a large perforated concrete container. These dry wells are usually buried completely and provide storage for a larger stormwater capacity.

LOCATION: Holmdel, NJ. This residential dry well was installed in Monmouth County. It is a underground system that uses an empty container to store large quantities of stormwater during rainfall events.

photo credit: http://www.jemoweryandson-inc.com/drywells.html

Green infrastructure is an approach to stormwater management that is cost-effective, sustainable, and environmentally friendly. Green infrastructure practices capture, filter, absorb, and/or reuse stormwater to help restore the natural water cycle. When used as components of a stormwater management system, green infrastructure practices such as bioretention, green roofs, pervious pavement, rain gardens, and vegetated swales can produce a variety of environmental benefits. In addition to effectively retaining and infiltrating runoff, these practices can help filter air pollutants, reduce energy demands, mitigate urban heat islands, and sequester carbon while also providing communities with aesthetic and natural resource benefits.

When managing stormwater with green infrastructure practices, the overall goal is to disconnect impervious surfaces that are connected (i.e., drain directly to sewer systems or local waterways). Green infrastructure practices can be designed to capture and infiltrate stormwater. These practices tend to filter water using soil, as in the case of bioretention, or using stone, as in the case of porous asphalt. In areas where infiltration is not possible, these green infrastructure practices can be used as a detention system to store runoff and slowly release it after the storm event. Some green infrastructure practices are used to harvest stormwater runoff for non-potable water usage such as watering gardens. Other green infrastructure practices, like bioswales, are designed to move water from one location to another while filtering pollutants.

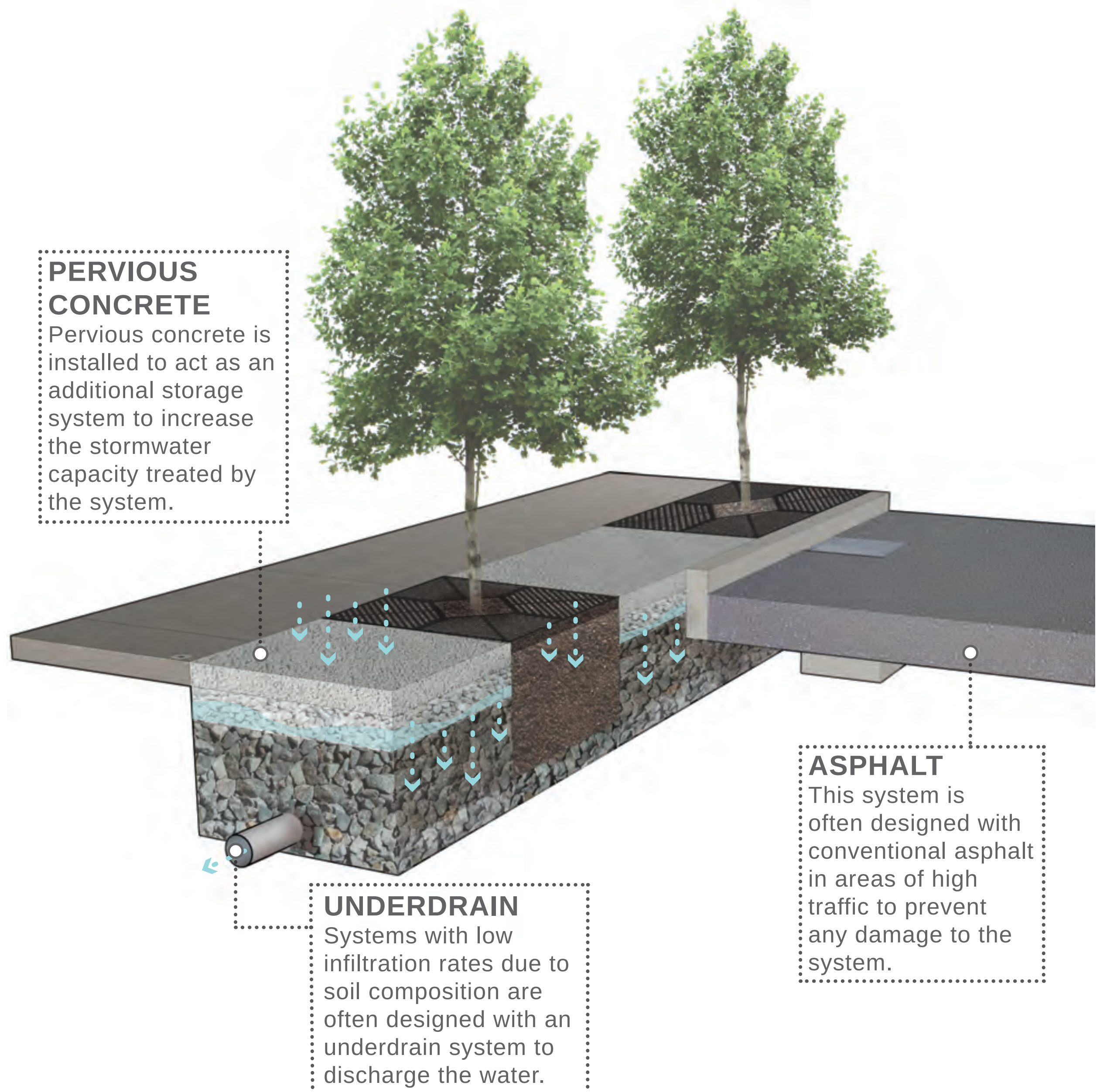
The following pages describe some green infrastructure practices that have been proven to be successful in New Jersey. These practices include: bioretention/rain gardens, bioswales, downspout planters, stormwater planters, cisterns and rain barrels, permeable pavements, tree filter boxes, and dry well systems.

BIORETENTION/RAIN GARDEN SYSTEMS
INFILTRATION AND STORAGE

A rain garden, or bioretention system, is a landscaped, shallow depression that captures, filters, and infiltrates stormwater runoff. The rain garden removes nonpoint source pollutants from stormwater runoff while recharging groundwater. A rain garden serves as a functional system to capture, filter, and infiltrate stormwater runoff at the source while being aesthetically pleasing. Rain gardens are an important tool for communities and neighborhoods to create diverse, attractive landscapes while protecting the health of the natural environment. Rain gardens can also be installed in areas that do not infiltrate by incorporating an underdrain system.

Rain gardens can be implemented throughout communities to begin the process of re-establishing the natural function of the land. Rain gardens offer one of the quickest and easiest methods to reduce runoff and help protect our water resources. Beyond the aesthetic and ecological benefits, rain gardens encourage environmental stewardship and community pride.

LOCATION: Hamilton, NJ
This residential rain garden is 150 square feet and six (6) inches deep. It was designed to capture the rainwater from the roof of this home.



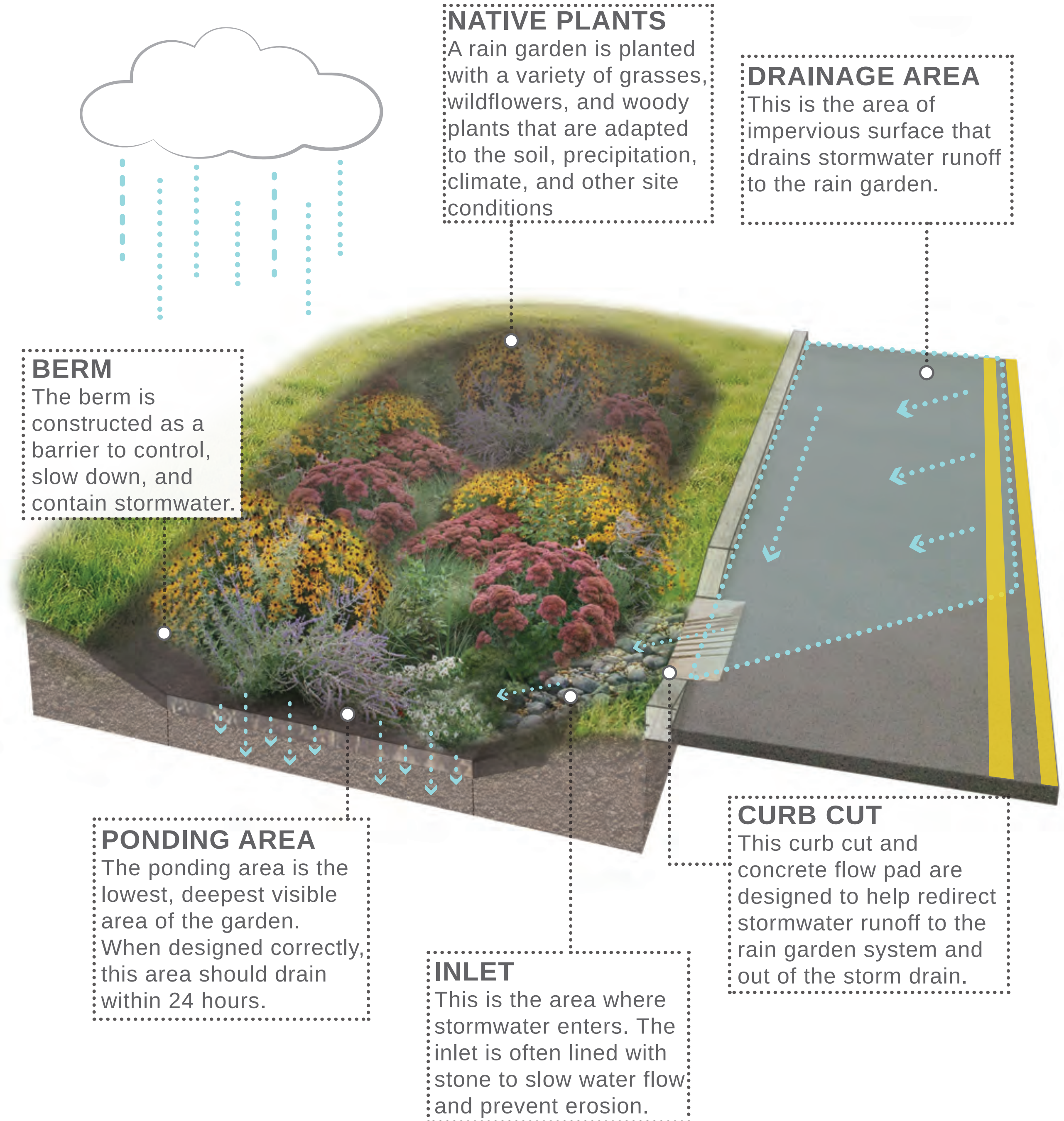
TREE FILTER BOXES

STORAGE AND INFILTRATION

Tree filter boxes can be pre-manufactured concrete boxes or enhanced tree pits that contain a special soil mix and are planted with a tree or shrub. They filter stormwater runoff but provide little storage capacity. They are typically designed to quickly filter stormwater and then discharge it to the local storm sewer system.

LOCATION: Parsippany, NJ
This enhanced tree pit is located at the Parsippany-Troy Hills Municipal Court parking lot. The tree pit collects and filters water from the existing parking lot.

Often tree filter boxes are incorporated into streetscape systems that include an underlying stormwater system which connects several boxes (as shown on the next page). This is also coupled with pervious concrete to increase the storage capacity for rainwater in the system.

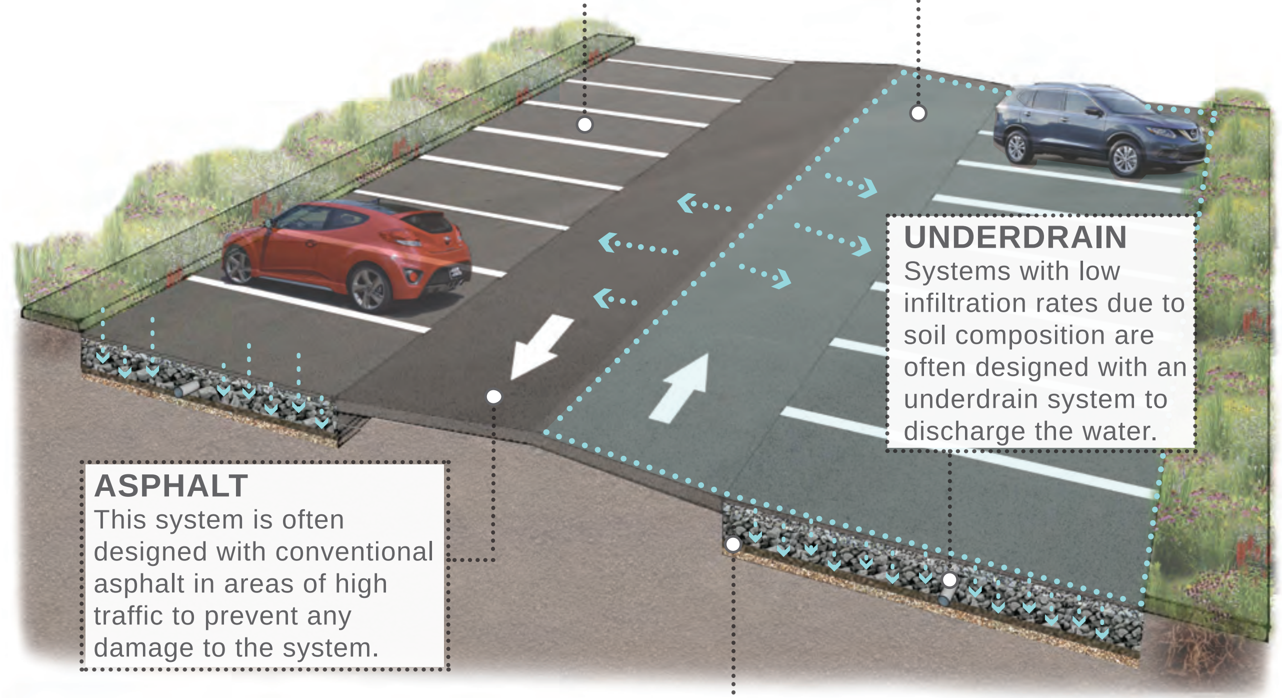


BIOSWALES
CONVEYANCE AND INFILTRATION

Bioswales are landscape features that convey stormwater from one location to another while removing pollutants and allowing water to infiltrate. Bioswales are often designed for larger scale sites where water needs time to move and slowly infiltrate into the groundwater.

Much like rain garden systems, bioswales can also be designed with an underdrain pipe that allows excess water to discharge to the nearest catch basin or existing stormwater system.

LOCATION: Parsippany, NJ
This bioswale was installed at St. Gregory's Church. The bioswale was designed to capture water from the parking lot and move it toward the forest area on the south end of the site.



POROUS ASPHALT
It is common to design porous asphalt in the parking stalls of a parking lot. This saves money and reduces wear.

DRAINAGE AREA
The drainage area of the porous asphalt system is the conventional asphalt cartway and the porous asphalt in the parking spaces. Runoff from the conventional asphalt flows into the porous asphalt parking spaces.

UNDERDRAIN
Systems with low infiltration rates due to soil composition are often designed with an underdrain system to discharge the water.

ASPHALT
This system is often designed with conventional asphalt in areas of high traffic to prevent any damage to the system.

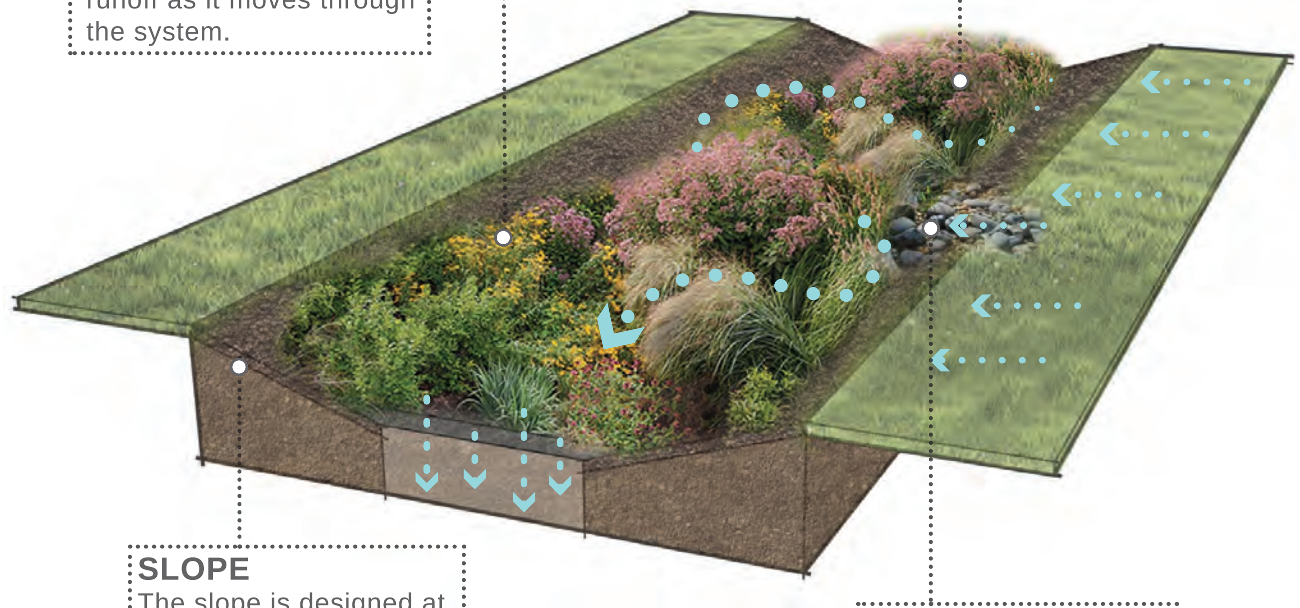
SUBGRADE
Porous pavements are unique because of their subgrade structure. This structure includes a layer of choker course, filter course, and soil.

PERMEABLE PAVEMENTS
STORAGE AND INFILTRATION

These surfaces include pervious concrete, porous asphalt, interlocking concrete pavers, and grid pavers. Pervious concrete and porous asphalt are the most common of the permeable surfaces. They are similar to regular concrete and asphalt but without the fine materials. This allows water to quickly pass through the material into an underlying layered system of stone that holds the water, allowing it to infiltrate into the underlying uncompacted soil. They have an underlying stone layer to store stormwater runoff and allow it to slowly seep into the ground.

By installing an underdrain system, these systems can be used in areas where infiltration is limited. The permeable pavement system will still filter pollutants and provide storage but will not infiltrate the runoff.

TYPICAL POROUS ASPHALT SUBGRADE: *CROSS-SECTION*

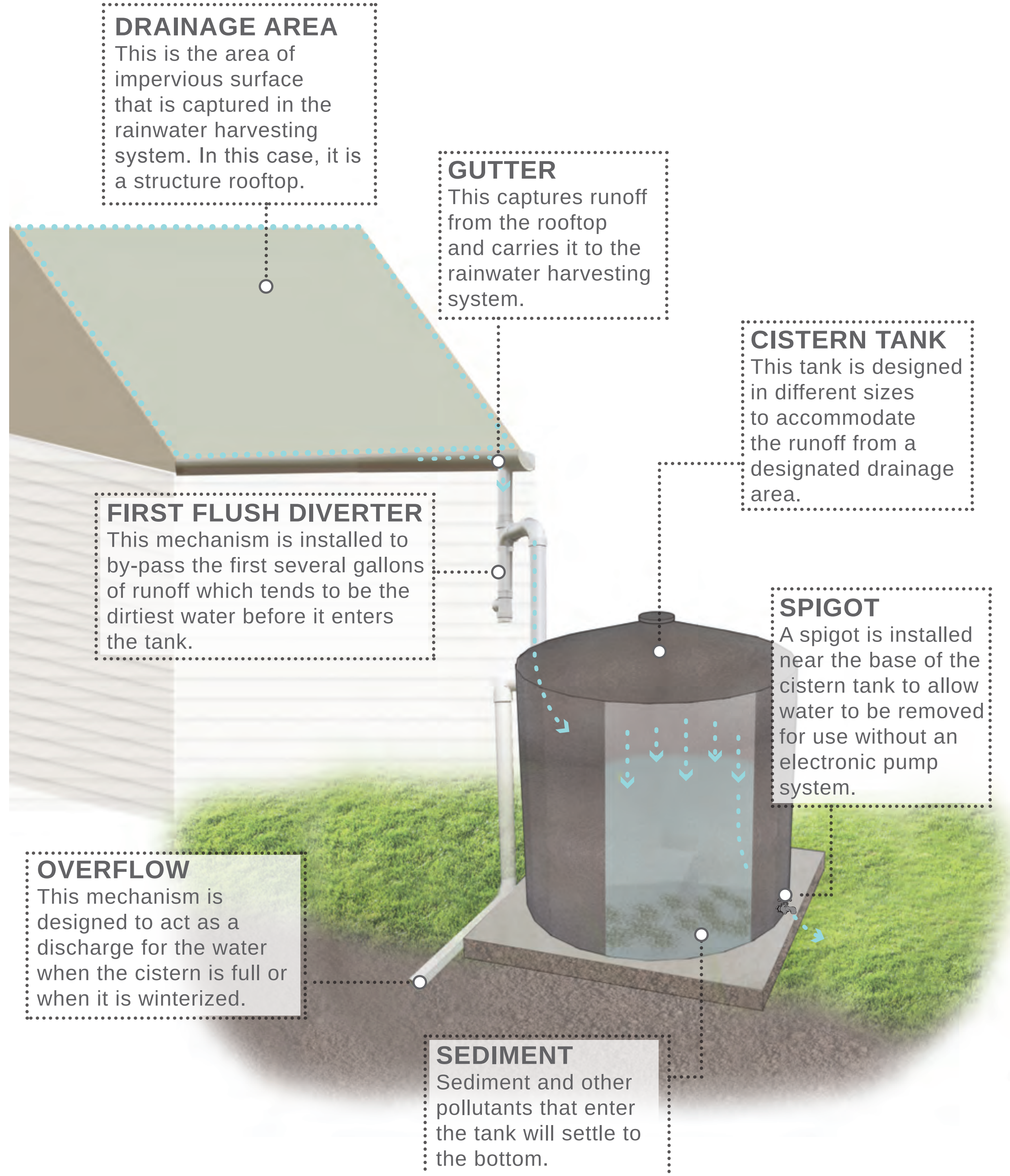


DOWNSPOUT PLANTERS
STORAGE

Downspout planter boxes are wooden or concrete boxes with plants installed at the base of the downspout that provide an opportunity to beneficially reuse rooftop runoff. Although small, these systems have some capacity to store rooftop runoff during rainfall events and release it slowly back into the storm sewer system through an overflow.

Most often, downspout planter boxes are a reliable green infrastructure practice used to provide some rainfall storage and aesthetic value for property.

LOCATION: Camden, NJ
Downspout planters are installed at the end of a downspout to capture, store, and slowly discharge stormwater back to the nearest storm sewer system.

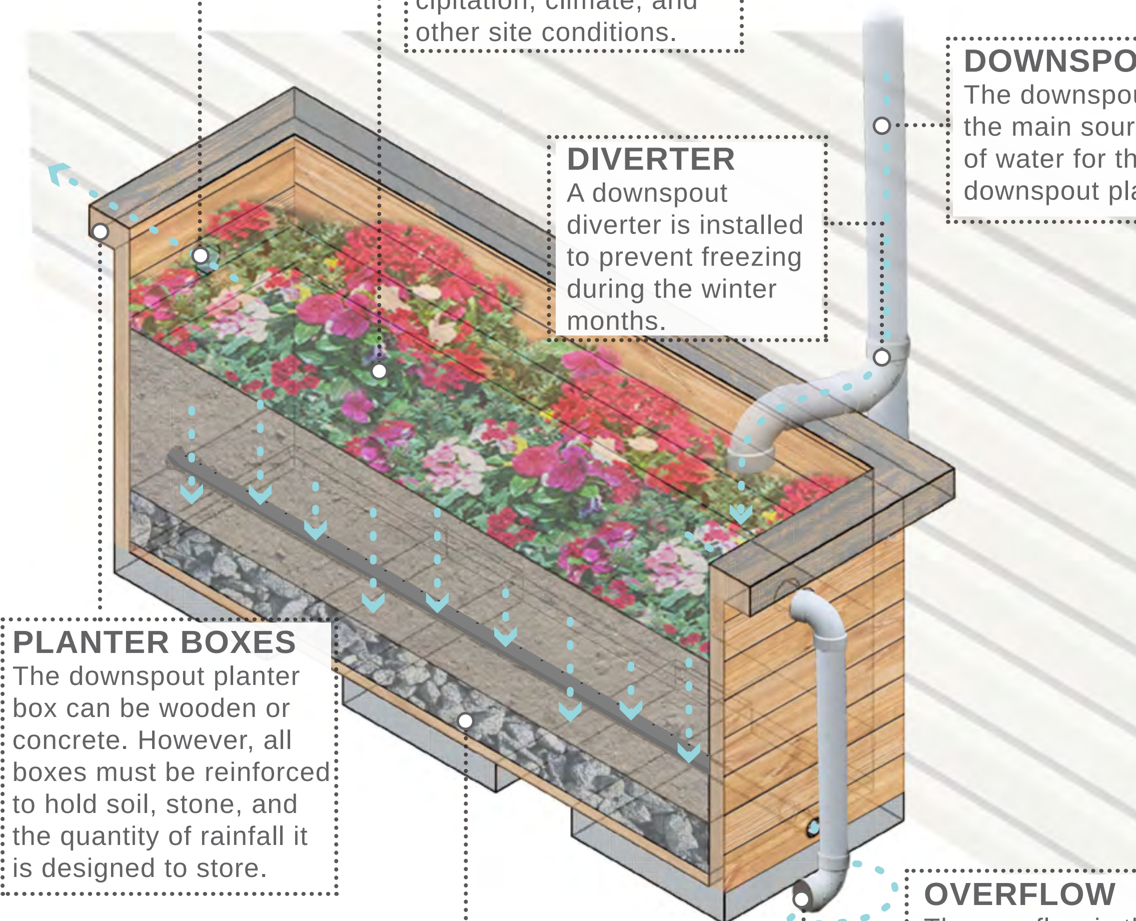


CISTERNS & RAIN BARRELS
RAINWATER HARVESTING

These systems capture rainwater, mainly from rooftops, in cisterns or rain barrels. The water can then be used for watering gardens, washing vehicles, or for other non-potable uses.

Rainwater harvesting systems come in all shapes and sizes. These systems are good for harvesting rainwater in the spring, summer, and fall but must be winterized during the colder months. Cisterns are winterized, and then their water source is redirected from the cistern back to the original discharge area.

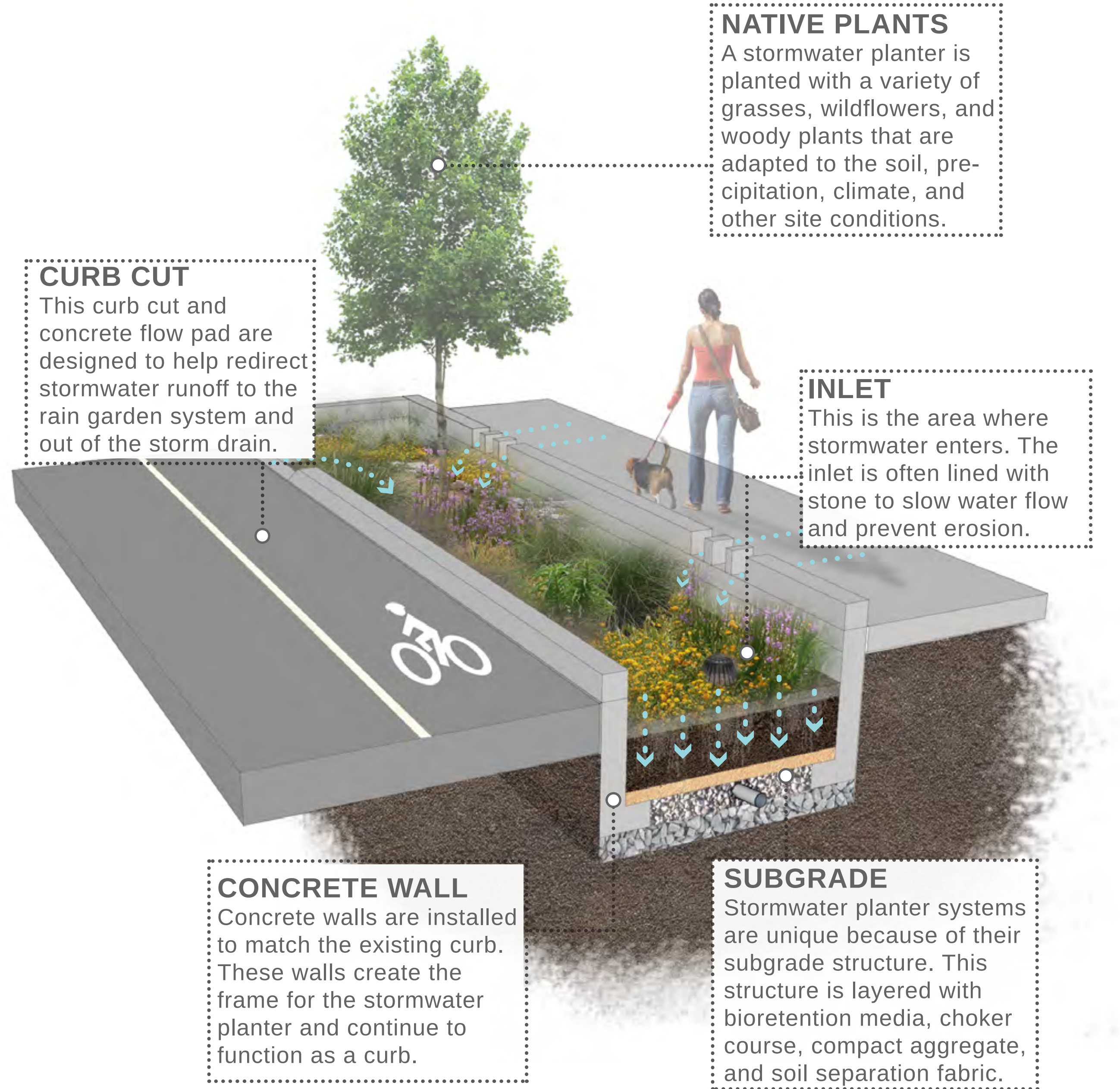
LOCATION: Clark, NJ
This cistern was installed at a public works department. The rainwater is harvested from the rooftop of the building and used as part of a "green car wash" system that uses rainwater.



STORMWATER PLANTERS
STORAGE AND INFILTRATION

Stormwater planters are vegetated structures that are built into the sidewalk to intercept stormwater runoff from the roadway or sidewalk. Stormwater planters, like rain gardens, are a type of bioretention system. This means many of these planters are designed to allow the water to infiltrate into the ground. However, some are designed simply to filter the water and convey it back into the storm sewer system via an underdrain system.

LOCATION: Camden, NJ
This stormwater planter was designed to capture stormwater runoff from the street in front of the Brimm School in Camden, New Jersey.



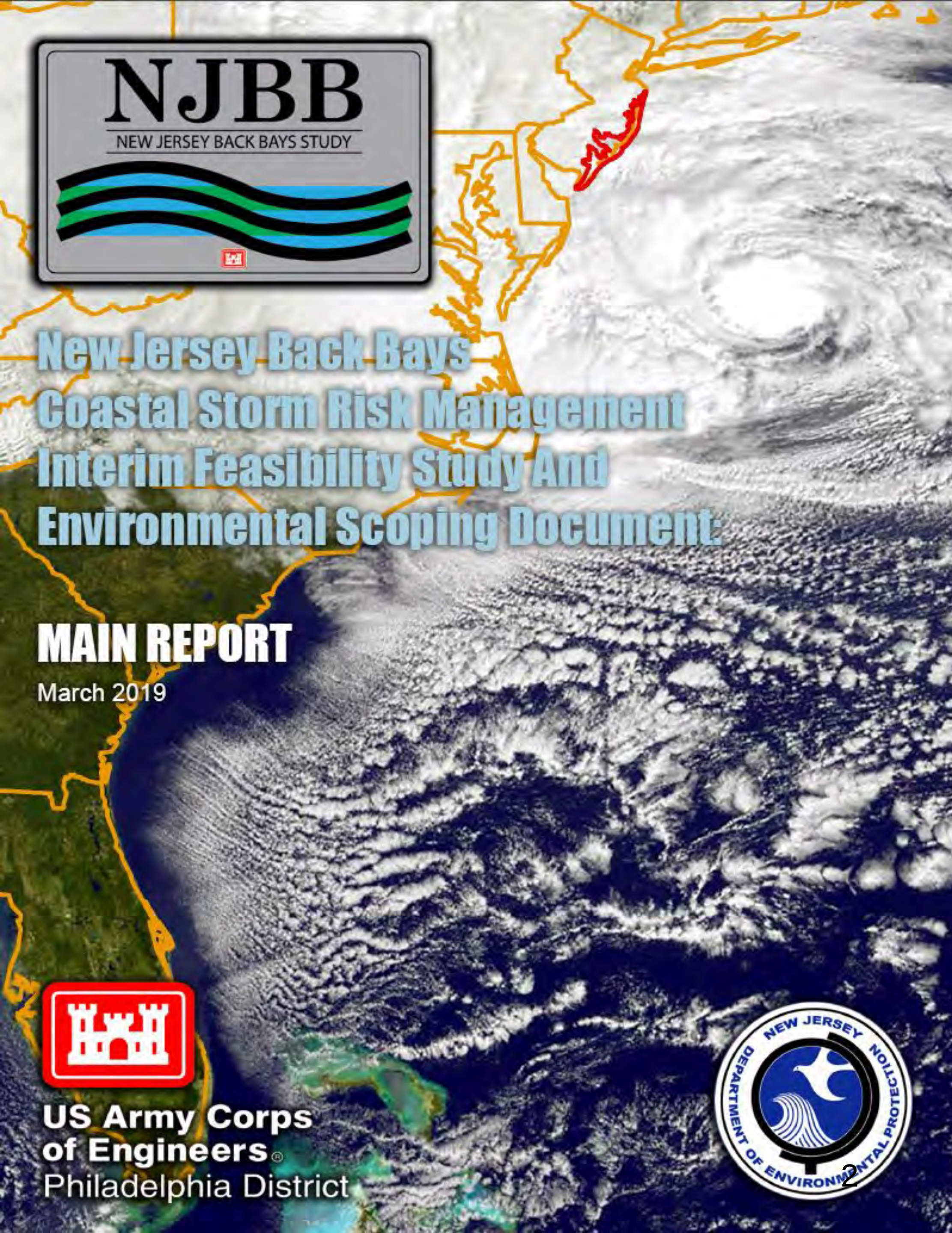
US Army Corps of Engineers: New Jersey Back Bays Presentation

New Jersey Back Bays
Coastal Storm Risk Management
Interim Report and
Environmental Scoping Document

Virtual Meeting

14 March 2019

US Army Corps of Engineers Philadelphia District



Agenda

- Report Highlights
- Focused Array Overview
- Process Overview
- Questions & Answers
- Closing Comments

New Jersey Back Bays Coastal Storm Risk Management Study

Interim Report

The U.S. Army Corps of Engineers and the New Jersey Department of Environmental Protection announced the release of an Interim Report for the New Jersey Back Bays Coastal Storm Risk Management Study, and a virtual meeting on March 14, 2019 from 9 a.m. to 10 a.m. The Interim Report presents a focused array of alternative plans that manage risk and reduce damages from coastal storms as well as the engineering, economic, social, and environmental analyses that have been conducted to develop the focused array of alternatives outlined in the report. The Army Corps and NJDEP invite the public to comment on the report by April 1, 2019. Comments can be submitted by email or in writing to: U.S. Army Corps of Engineer Planning Division, 100 Penn Square E. Philadelphia PA 19107.

- News Release (with webinar details)
- Executive Summary
- Main Report
- Appendix A - Plan Formulation
- Appendix B - Engineering
- Appendix C - Economics
- Appendix D - Nonstructural Analyses
- Appendix E - Correspondence and Communication
- Appendix F - Environmental and Cultural

Public Meetings

The U.S. Army Corps of Engineers and the New Jersey Department of Environmental Protection hosted public meetings regarding the New Jersey Back Bays Flood Risk Management study on Sept. 12, 2018 in Ventnor City, N.J. and on Sept 13 in Toms River Township, N.J. Some of the measures that were discussed at the public meetings included structural solutions such as storm surge barriers, tide gates, levees, and floodwalls; non-structural solutions such as elevating homes; and nature-based features such as marsh restoration and the creation of living shorelines.

- Presentation for Public Meeting in Toms River, NJ (Sept. 13, 2018)
- Presentation for Public Meeting in Ventnor City, NJ (Sept. 12, 2018)
- New Jersey Back Bays Fact Card (Sept 2018)
- Public Comment Form (Sept 2018)
- Meeting Welcome Form (Sept 2018)

Contact

Philadelphia District
Planning Division
100 Penn Square E.
Philadelphia, PA 19107
215-656-6579
Email

Links

- Study Area Map
- Public Mtg Presentation (Sept 13, 2018)
- Public Mtg Presentation (Sept 12, 2018)
- Public Comment Form (Sept. 2018)
- Meeting Welcome Form (Sept. 2018)
- Public Outreach Summary
- Study Fact Card
- Study Overview Factsheet

Study Documents

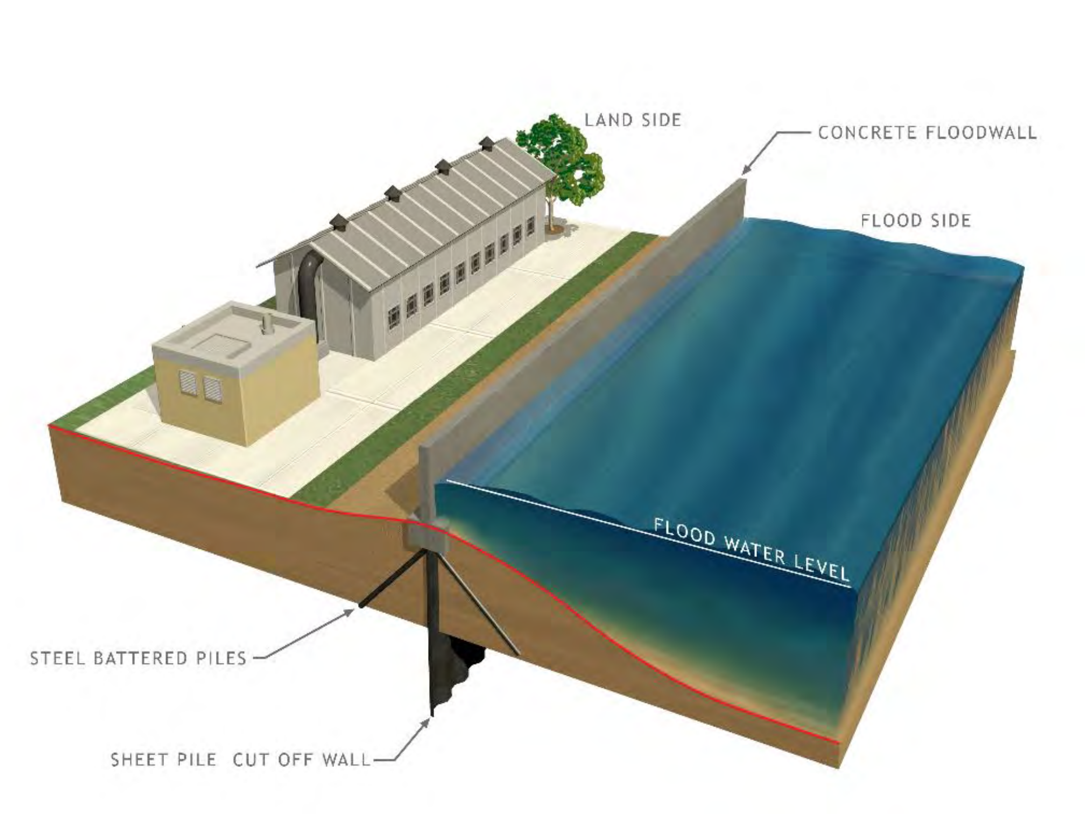
- ⊞ Study Documents
- ⊞ Presentations
- ⊞ Sept 2018 Public Meeting Posters

Interim Report Outline

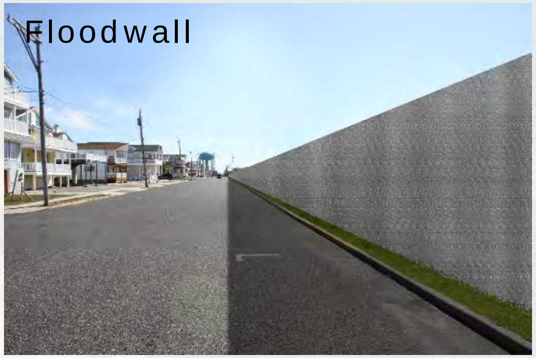
- Executive Summary
- Main Report
- Appendix A - Plan Formulation
- Appendix B - Engineering
- Appendix C - Economics
- Appendix D - Nonstructural Analyses
- Appendix E - Correspondence and Communication
- Appendix F - Environmental and Cultural

Structural Measure – Floodwalls & Levees

- **Main Report (Ch 9.4, p. 130)**

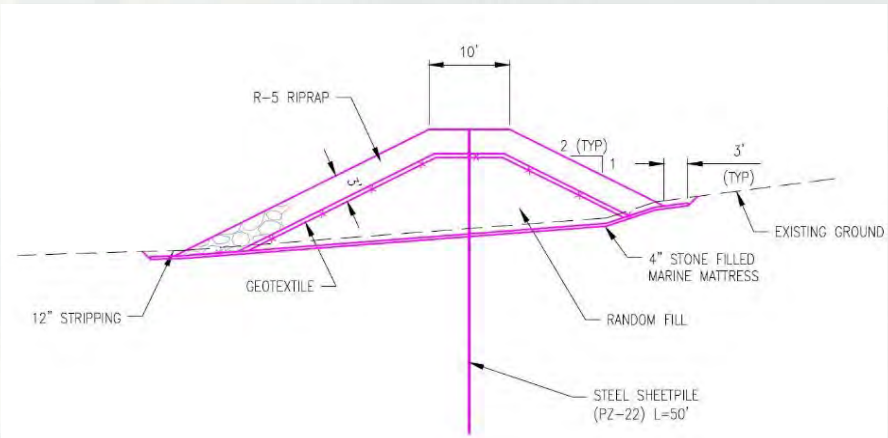


Visual Impacts

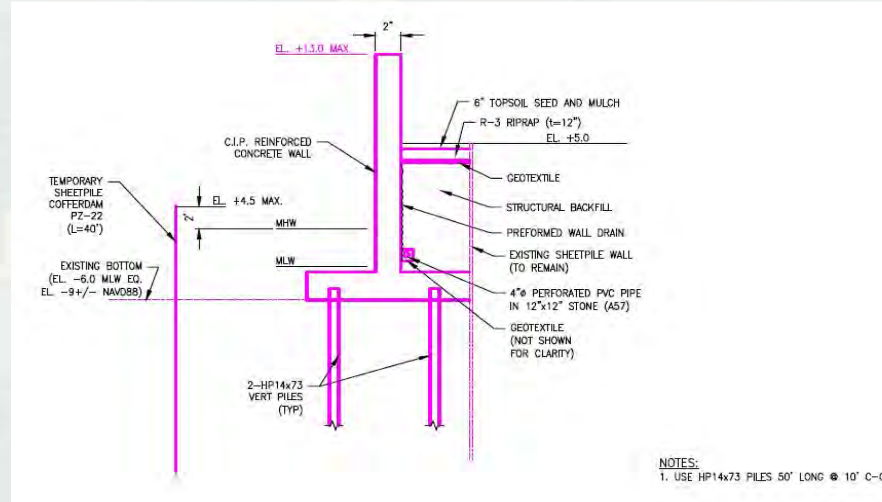


Floodwall/Levee Screening Results

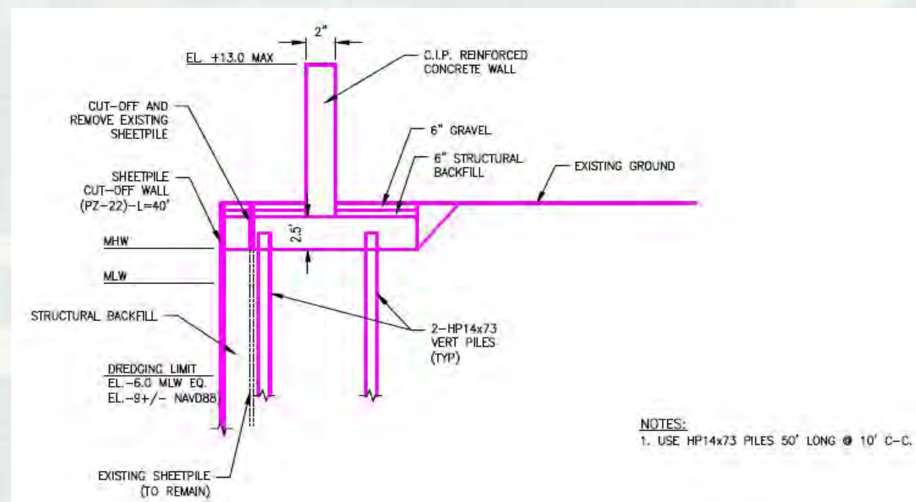
Floodwall/Levee Typical Sections



Levee



Floodwall – water construction

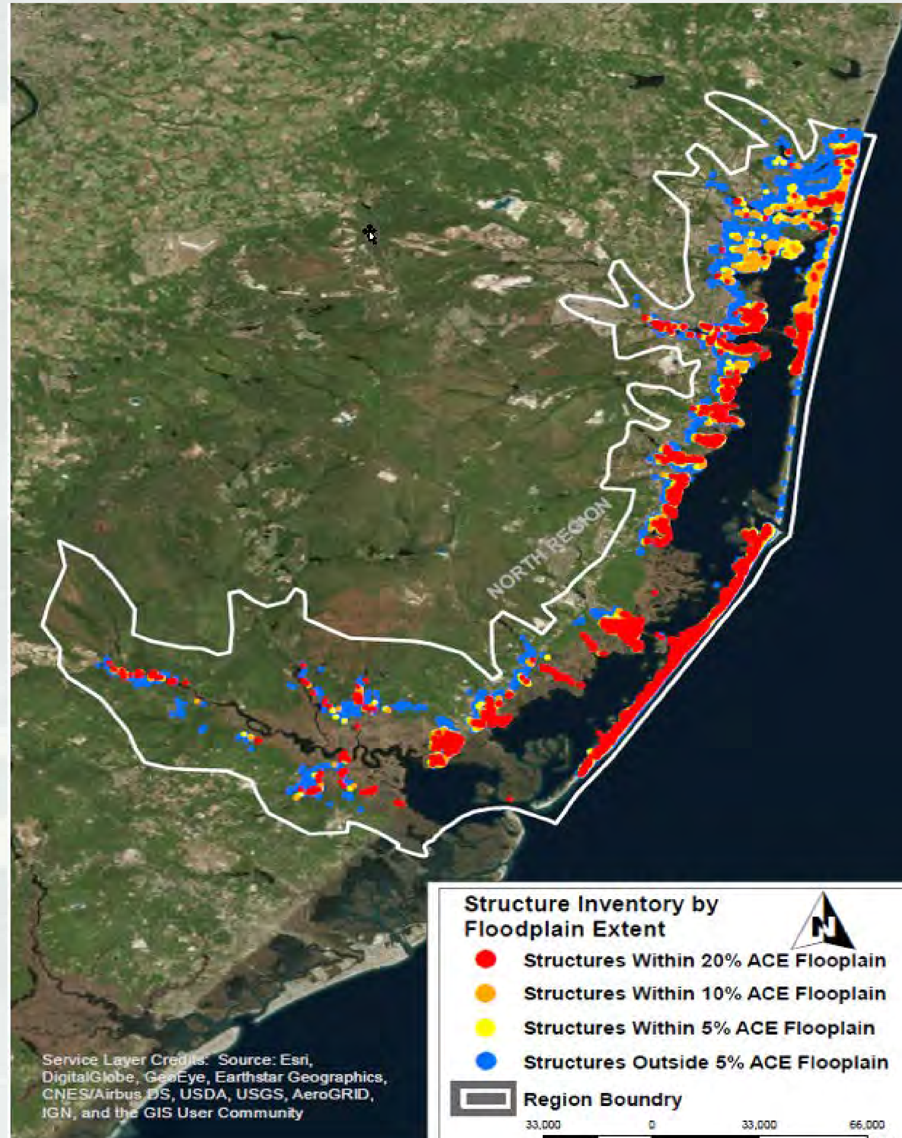


Floodwall – land construction

Nonstructural Measures – Building Elevation

- ## Main Report (Ch 9.4, p. 137)

- **Primary Nonstructural measures**
  - **Building elevation**
  - **Acquisition and relocation later**
- **Recommended in combination with structural measures to formulate economically justified hybrid plans**
- **The process**
  - **Develop structure inventory**
  - **Identify Design Flood Elevation (DFE) = FEMA BFE + 3 feet**
  - **Approximately 30,000 structures in the 20-year floodplain**
  - **Additional floodplains beyond 5-, 10-, and 20-year floodplains**

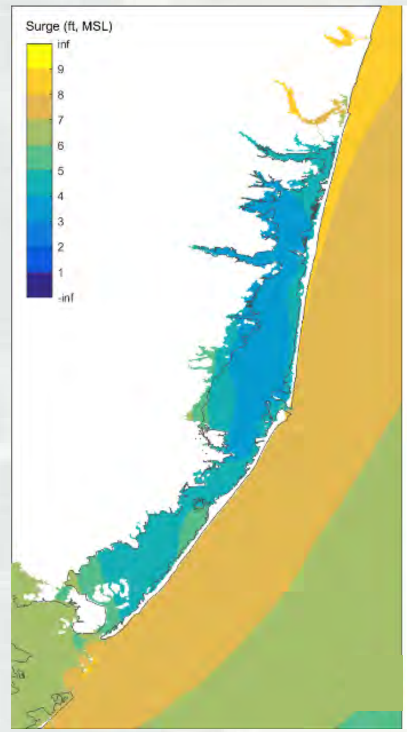


Structural Measure - Storm Surge Barriers

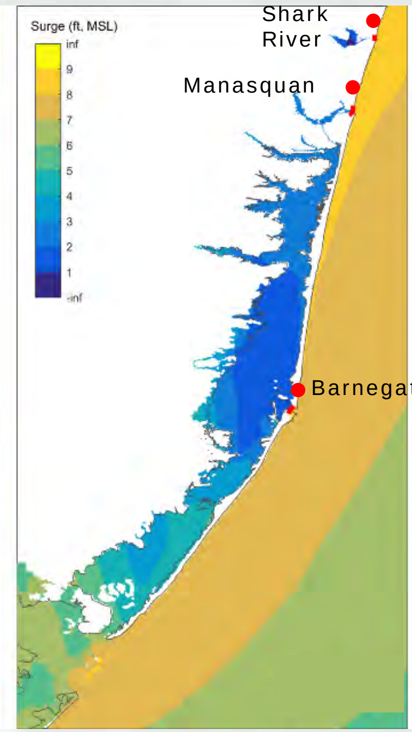
- **Main Report Ch 8, 9**

Seabrook - New Orleans, LA

Example at Barnegat Inlet, NJ



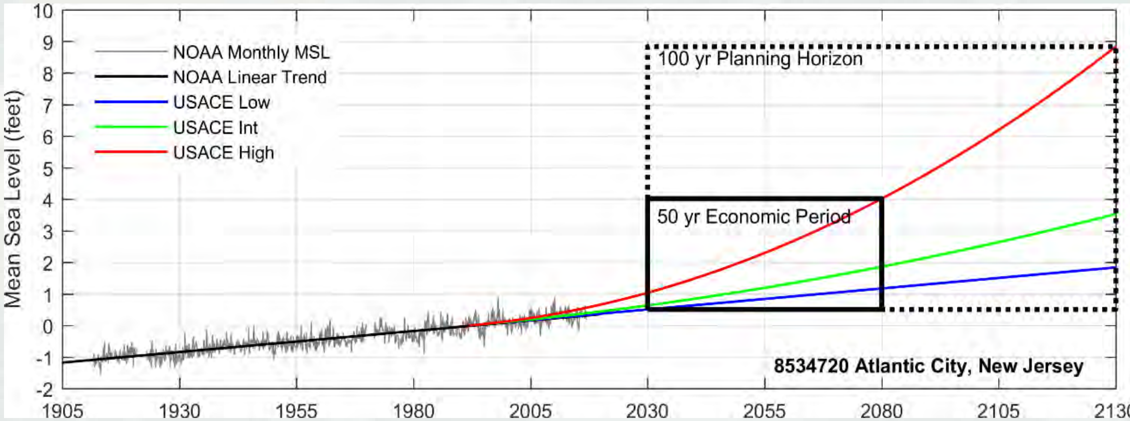
Existing Conditions



Barrier Alternative

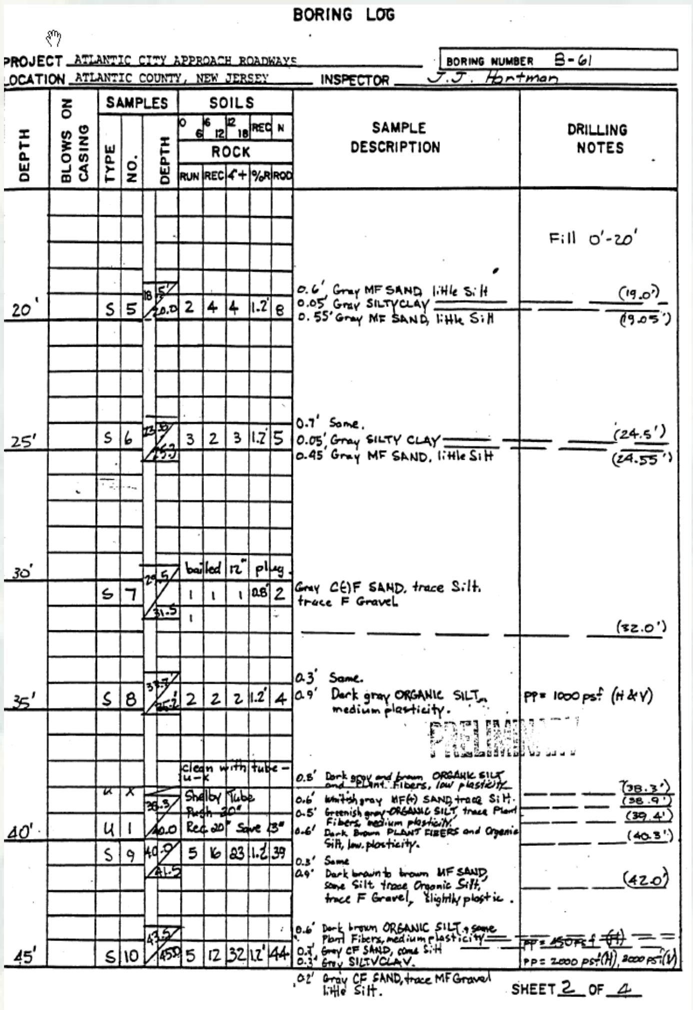
Interim Report Engineering Highlights

- ## Appendix B - Engineering



Relative sea level changes for the study area

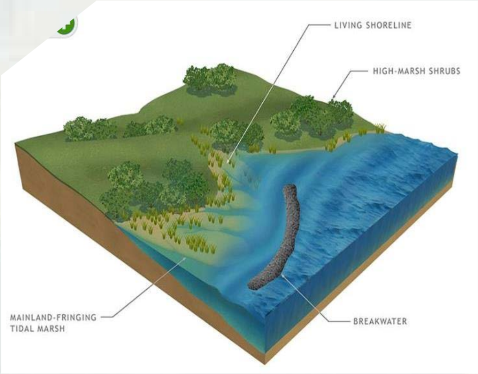
NWS stage floodplains



Geotechnical boring log

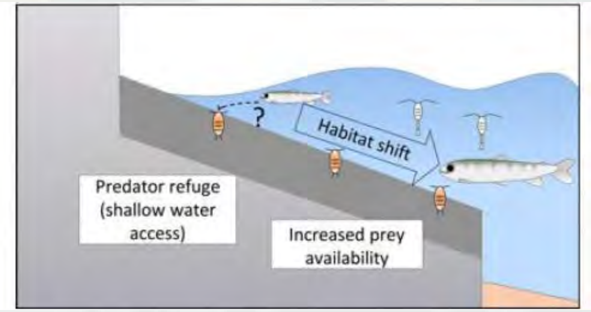
Natural and Nature Based Features (NNBF)

• Main Report Ch 9.2 and 10.2



- **Primary NNBF measure under consideration is living shorelines. Current criteria for this measure include:**
  - **Unarmored shorelines adjacent to infrastructure**
  - **Complementary to structural measures such as floodwalls and levees**
- **NJBB study is also considering modifications that can be made to structural measures that can increase their habitat value:**
  - **Habitat benches to restore more natural slope along shorelines**
  - **Textured concrete to support colonization of algae and invertebrates**

Construction of living shoreline in Camp Pecometh, MD



Conceptual diagram of habitat bench

Textured concrete

Alternative Screening, Evaluation, and Comparison using System of Accounts

- **Main Report Ch 9; Appendix A – Plan Formulation**

National Economic Development Screening (NED)

If Average Annual Net Benefits were < 0, the alternative failed the NED criteria and was screened out.

Environmental Quality (EQ) Screening

Alternatives were assessed for their impact on a range of different environmental categories on an ordinal scale from 0-6. Any score of 0 resulted in an alternative failing the EQ criteria. The EQ scores for each environmental category were averaged to create an EQ ranking.

OSE and RED Evaluation

Criteria to assess OSE included feedback from Public Meetings, Social Vulnerability Risk and Exposure indices from the NACCS, and mapped infrastructure and evacuation routes.

RED evaluation is still under development

Remaining alternatives are evaluated as part of the focused array

Environmental Considerations of the Focused Array of Alternatives

- **Main Report Ch 6, 11; Appendix F**

STRUCTURAL MEASURES

Perimeter Plans: Floodwalls/Levees →

Temporary Impacts:
- Water Quality/Turbidity
- Habitat disturbance
- Air Quality/Noise
- Community

→ **Permanent/Cumulative Impacts:**
- High Direct Habitat Losses
- High Mitigation Costs
- Community/Visual Aesthetics

Storm Surge Barriers: Inlet/Bay Closures →

Temporary Impacts:
- Water Quality/Turbidity
- Habitat disturbance
- Air Quality/Noise
- Community

→ **Permanent/Cumulative Impacts:**
- Lower Direct Habitat Losses
- Potential High Indirect Impacts
- Potential High Mitigation Costs
- Potential T & E species impacts at some locations
- Localized Community/Visual Aesthetics

NON-STRUCTURAL MEASURES

Building Raising →

Temporary Impacts:
- Water Quality/Turbidity
- Low or no Habitat disturbance
- Minor Air Quality/Noise
- Community

→ **Permanent/Cumulative Impacts:**
- Low or no Direct Habitat Losses
- Potential High Cultural Resources Impacts
- Community

Acquisition →

Temporary Impacts:
- Community
- Water Quality/Turbidity if earth disturbance from building razing

→ **Permanent/Cumulative Impacts:**
- Community
- Potential High Cultural Resources Impacts
- Potential Beneficial Environmental Effect If Building Razing Removes Impervious Surface

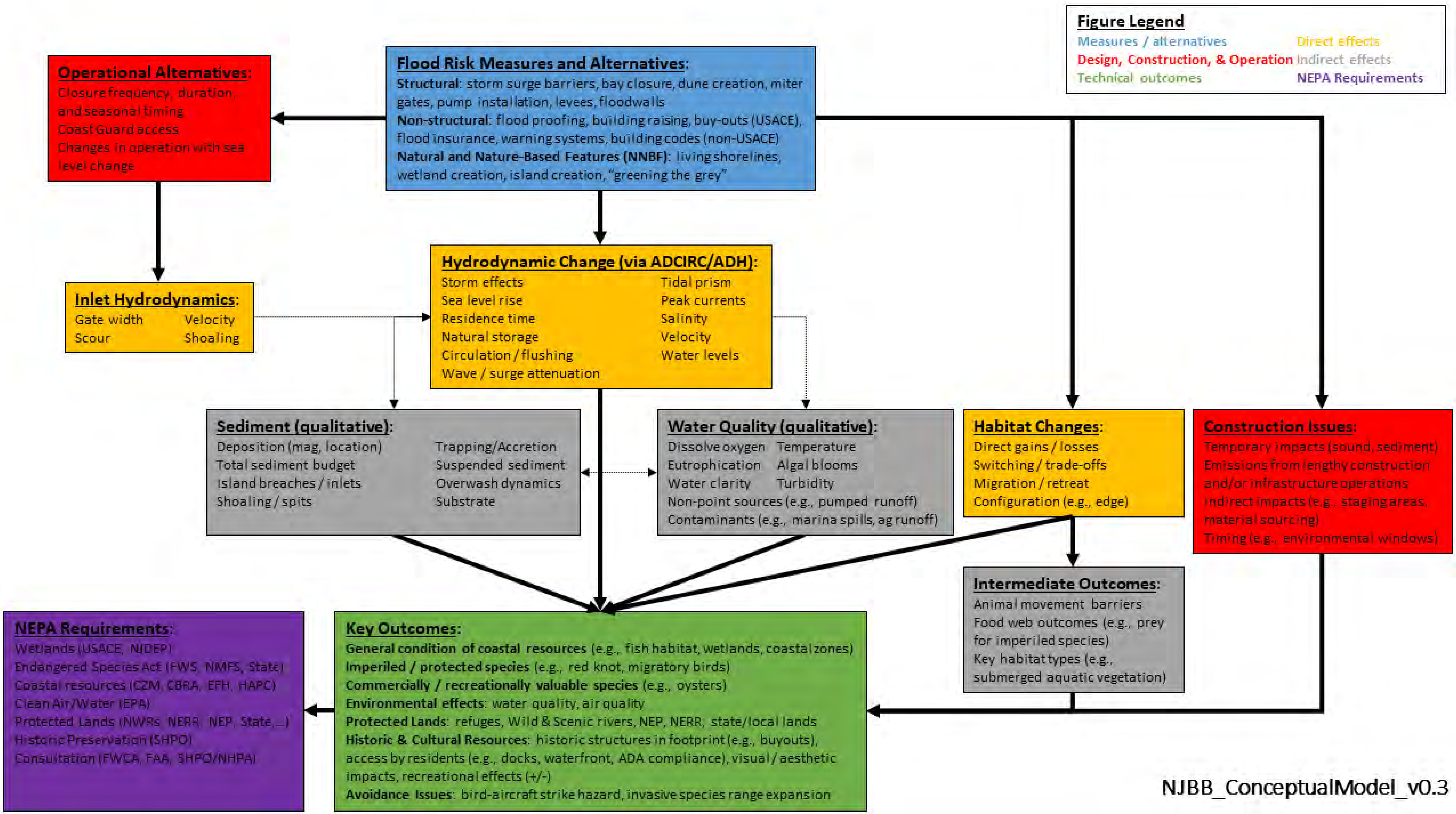
Natural and Nature Based Features (NNBF)

Wetlands/SAVs/ Living Shorelines →

Temporary Impacts:
- Water Quality/Turbidity
- Habitat disturbance
- Air Quality/Noise
- Community

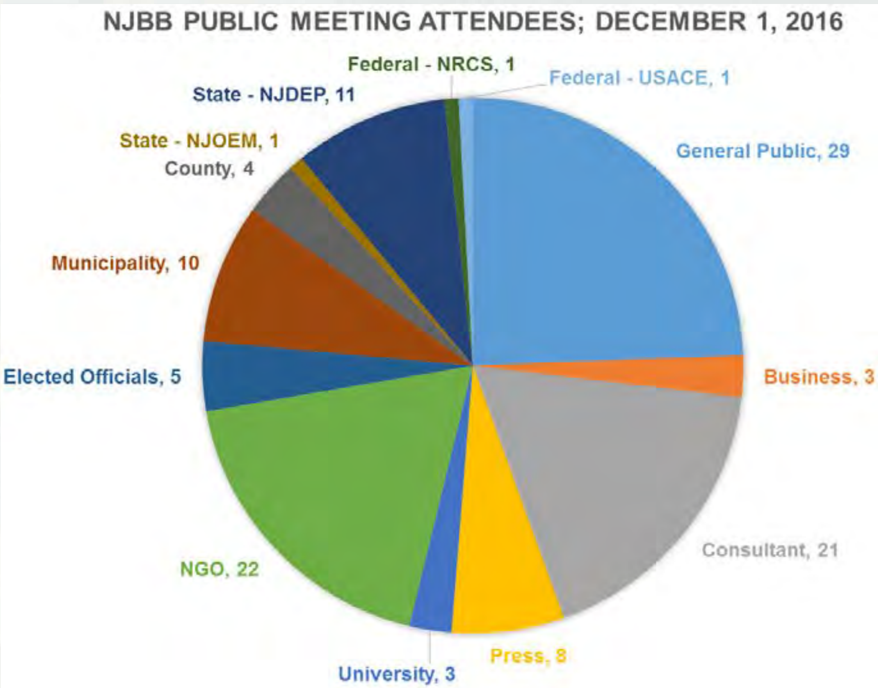
→ **Permanent/Cumulative Impacts:**
- Beneficial Ecological Uplift
- Increase in Environmental Services

Preliminary Impact Assessment Conceptual Model



Interim Report Highlights

- **Appendix E - Correspondence and Communication**



Detailed summaries

U.S. Army Corps of Engineers
New Jersey Back Bays
Flood Risk Management Planning Workshop

Coastal Risk Management Strategy Profile

CONTACT INFORMATION (Name, Affiliation, Email, Phone):

LOCATION (Describe the precise location of the problem; provide a map if possible):

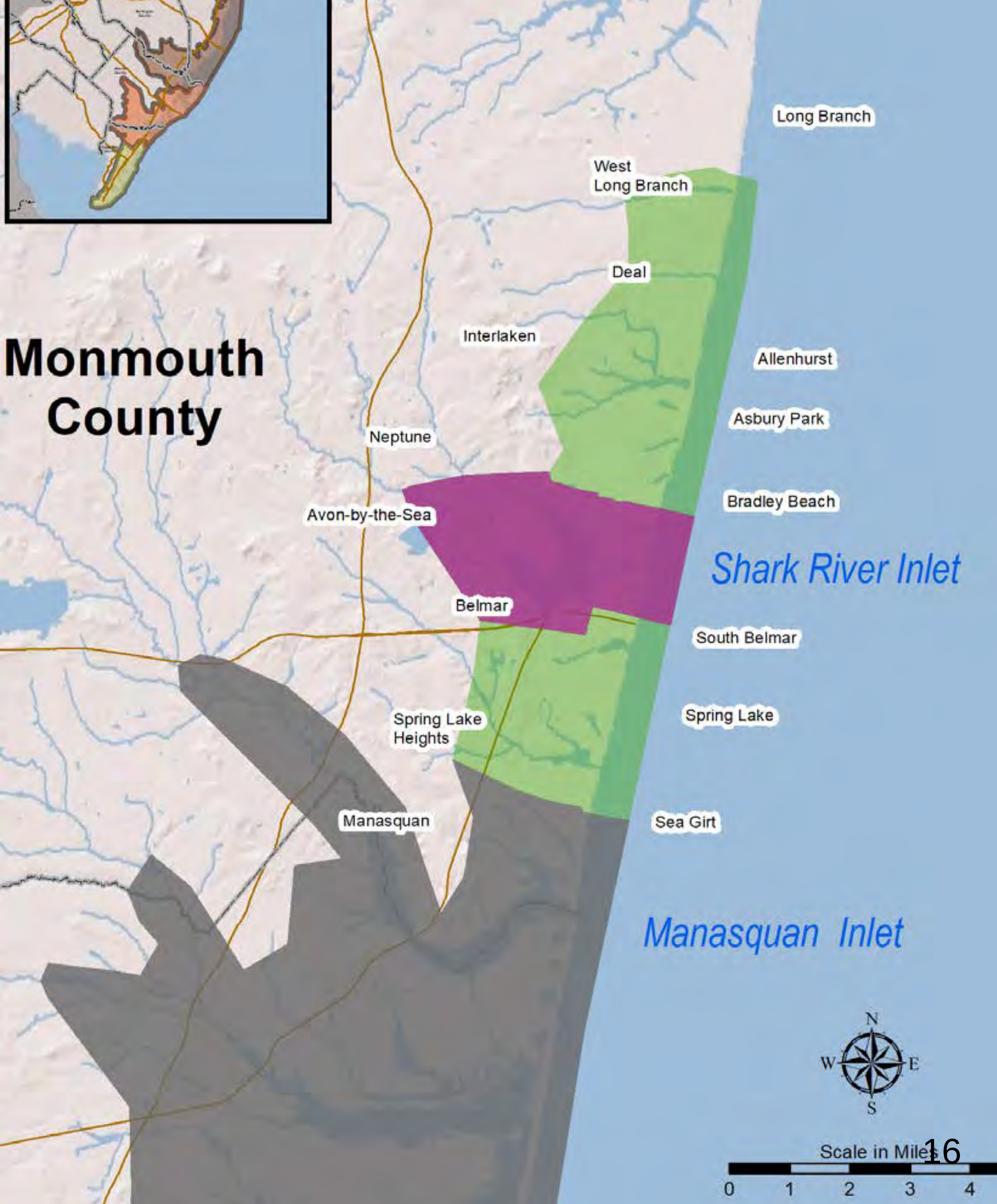
PROBLEM (Define the problem and its general location)

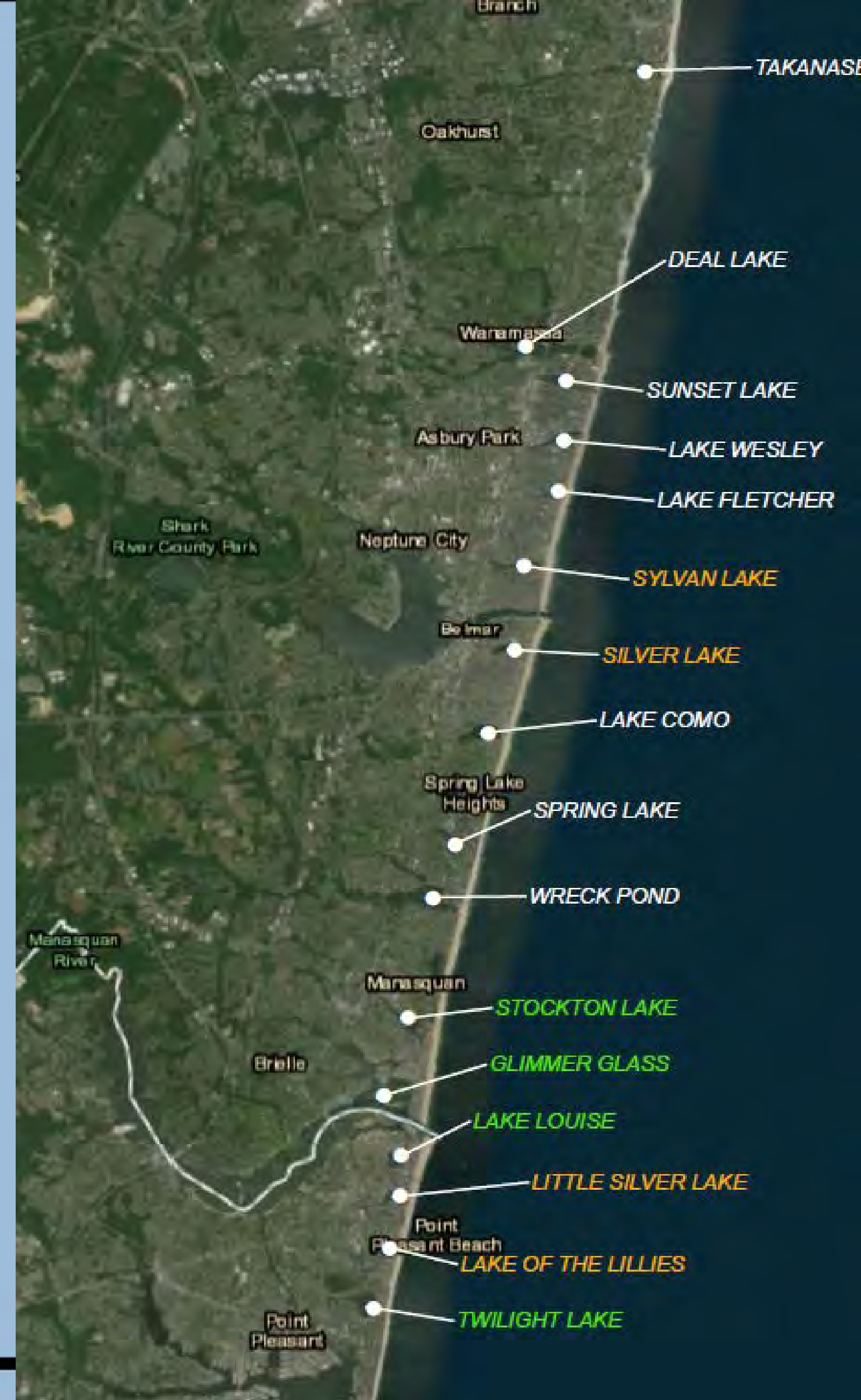
- Discuss if any work has been done on analysis, repairs, advocacy for this problem:

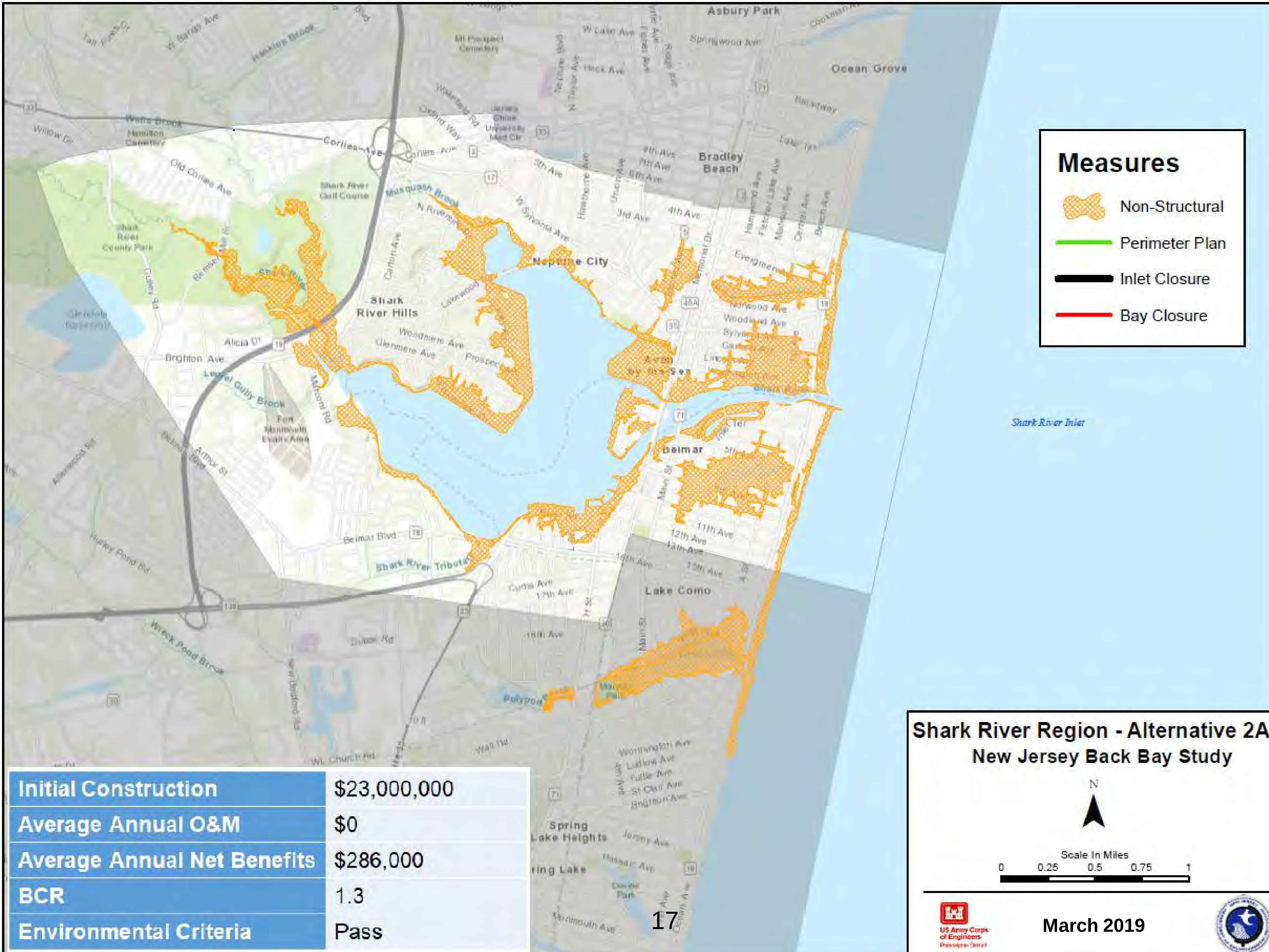
- Provide any specific elevation information of existing management measures:

Local flooding profile

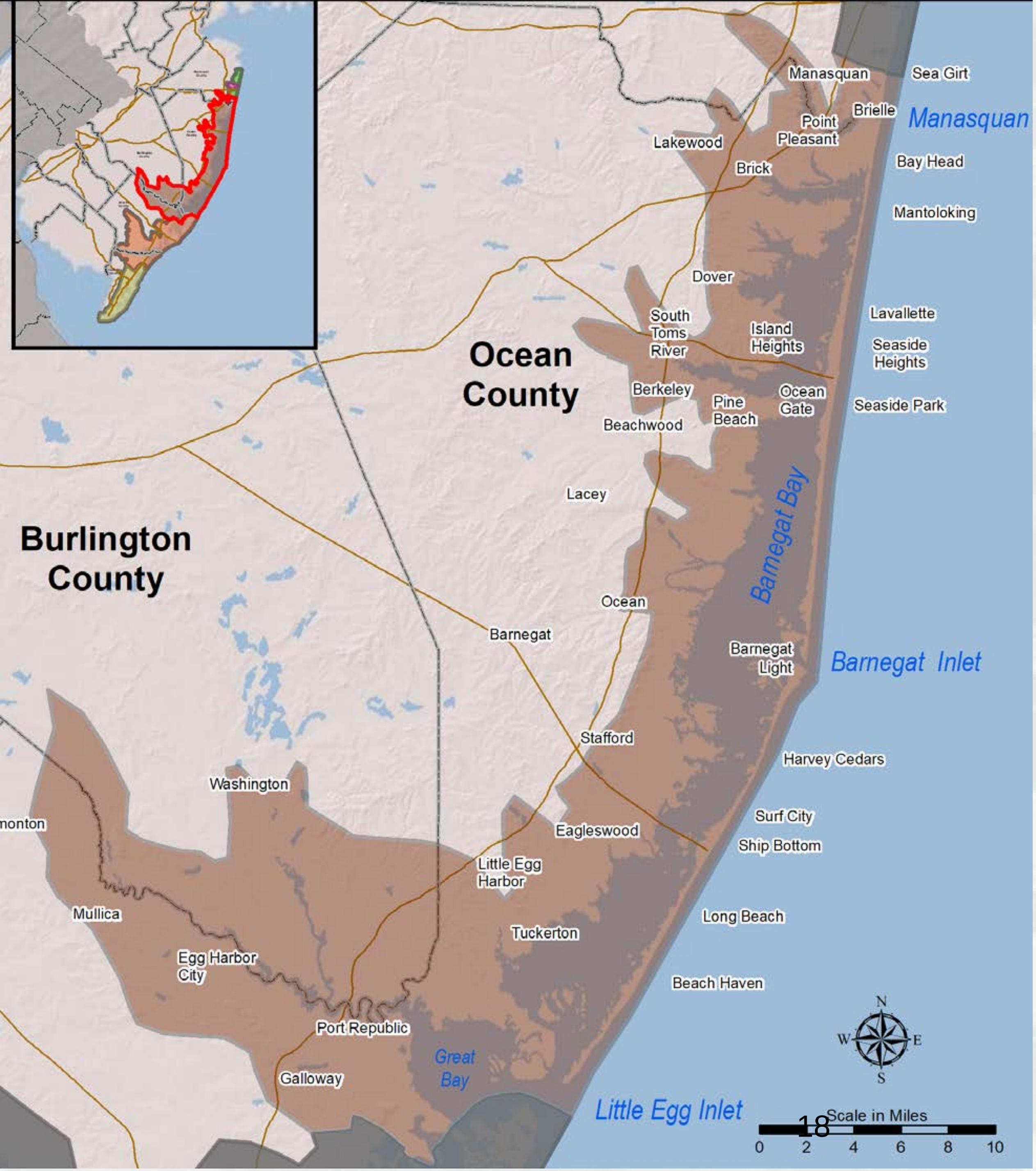
Coastal Lakes and Shark River Regions





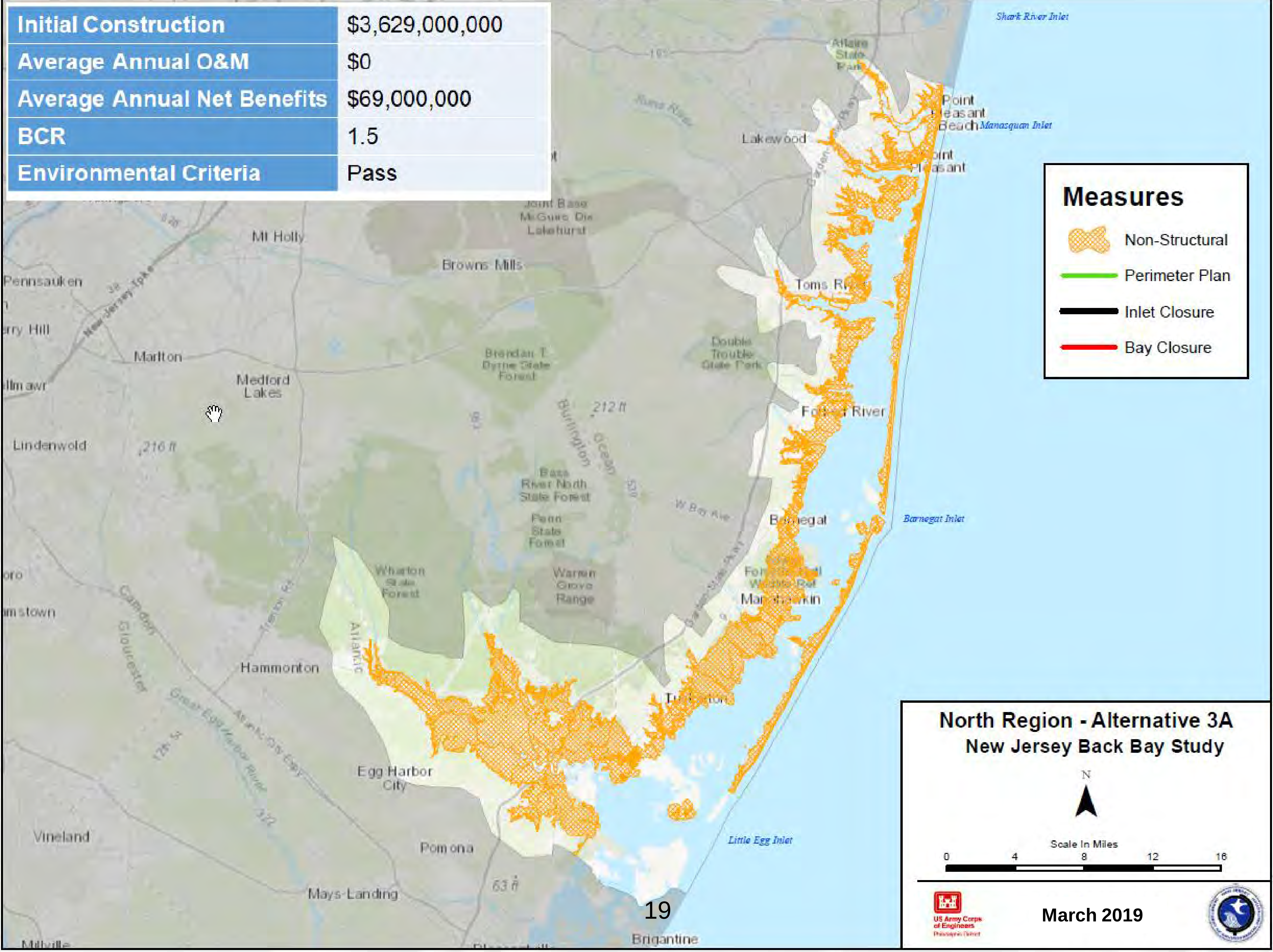


Initial Construction	$23,000,000
Average Annual O&M	$0
Average Annual Net Benefits	$286,000
BCR	1.3
Environmental Criteria	Pass

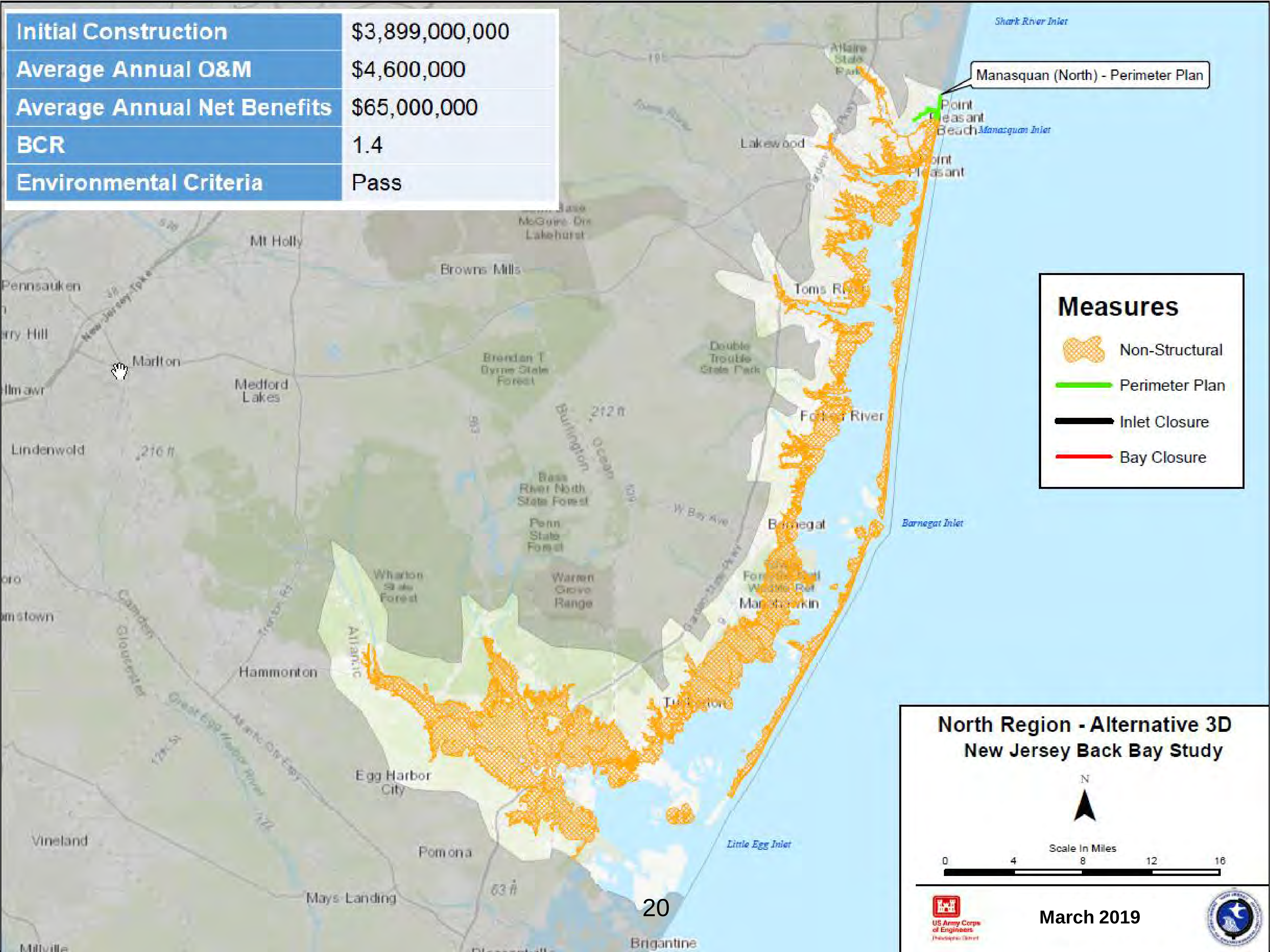


North Region

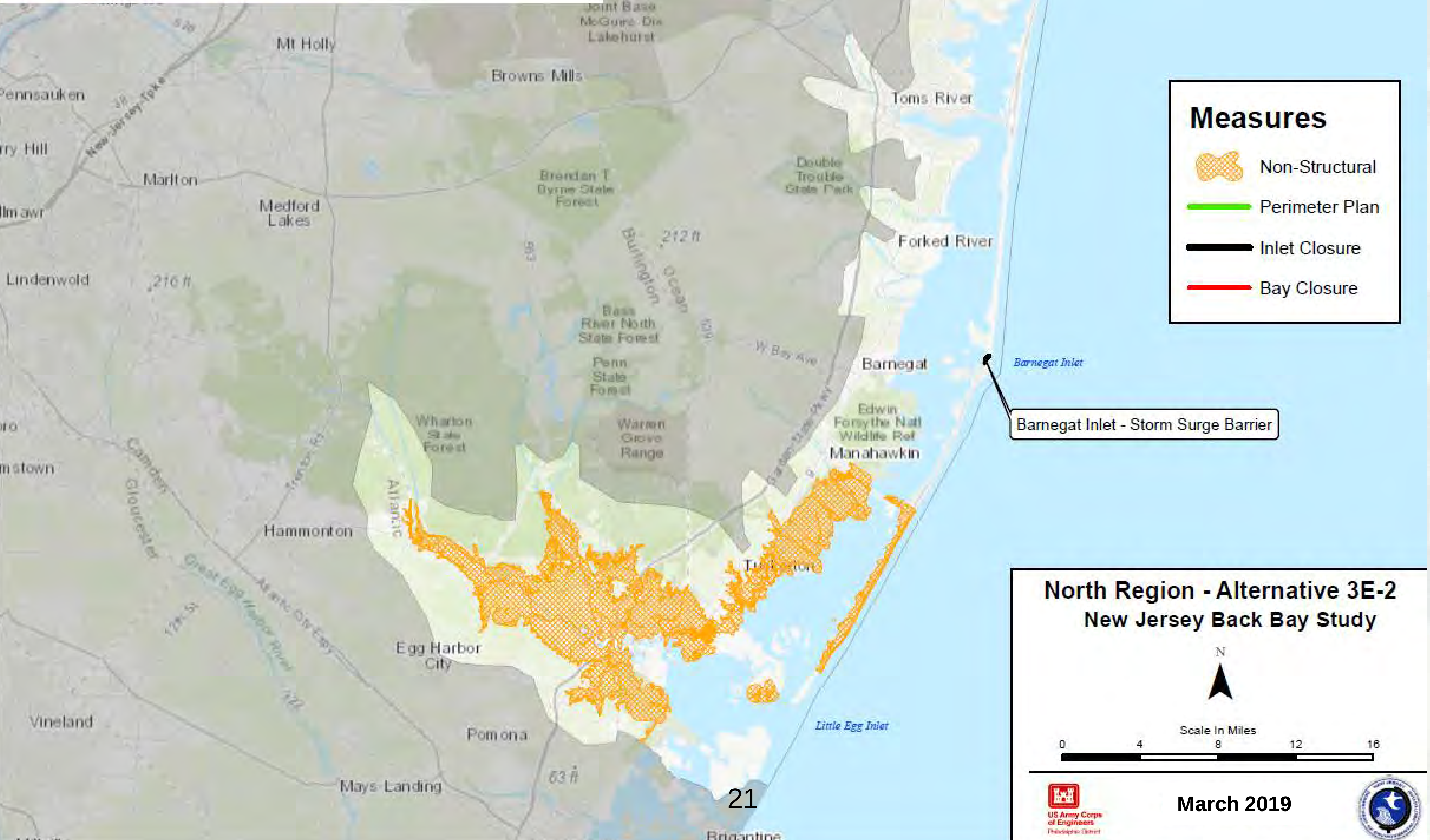
Initial Construction	$3,629,000,000
Average Annual O&M	$0
Average Annual Net Benefits	$69,000,000
BCR	1.5
Environmental Criteria	Pass



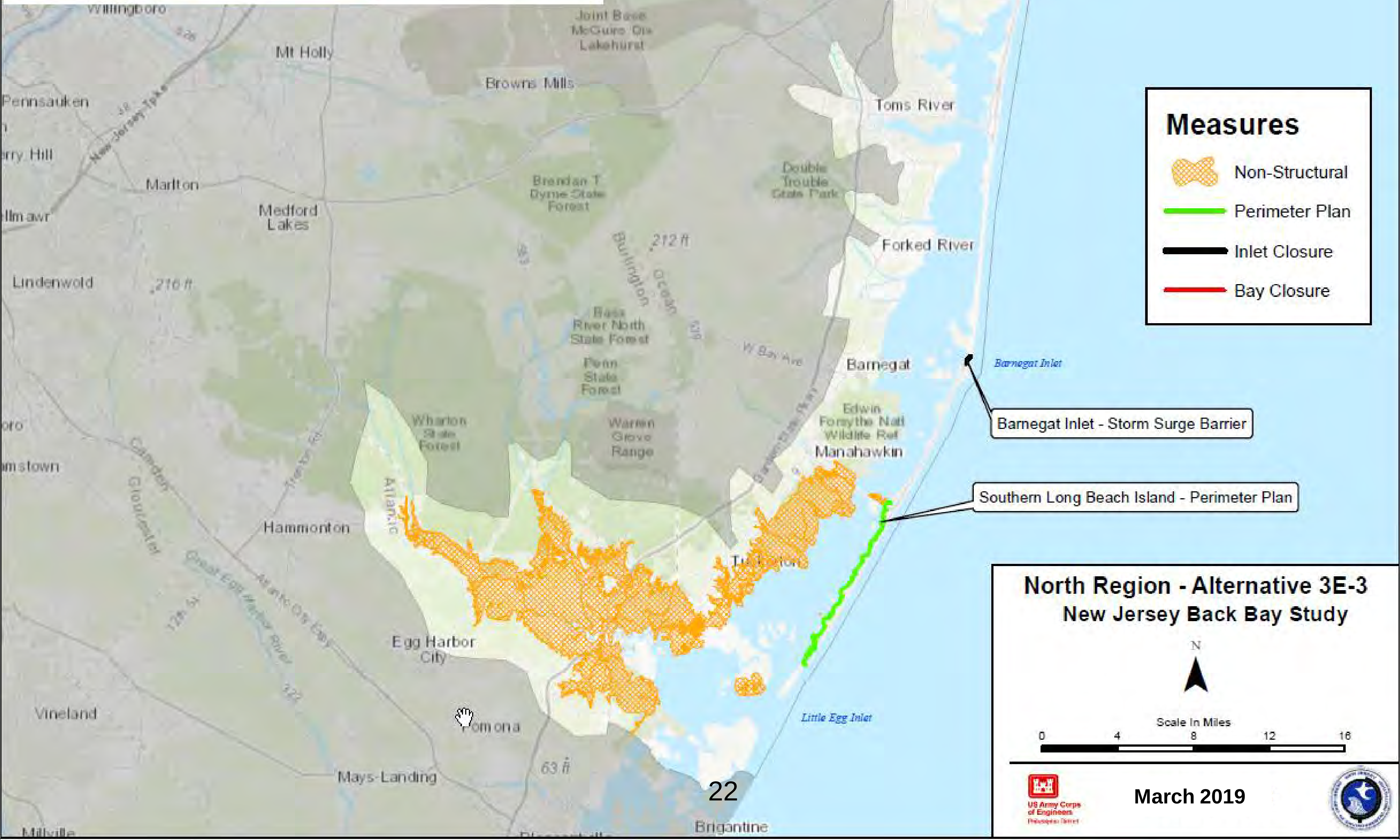
Initial Construction	$3,899,000,000
Average Annual O&M	$4,600,000
Average Annual Net Benefits	$65,000,000
BCR	1.4
Environmental Criteria	Pass

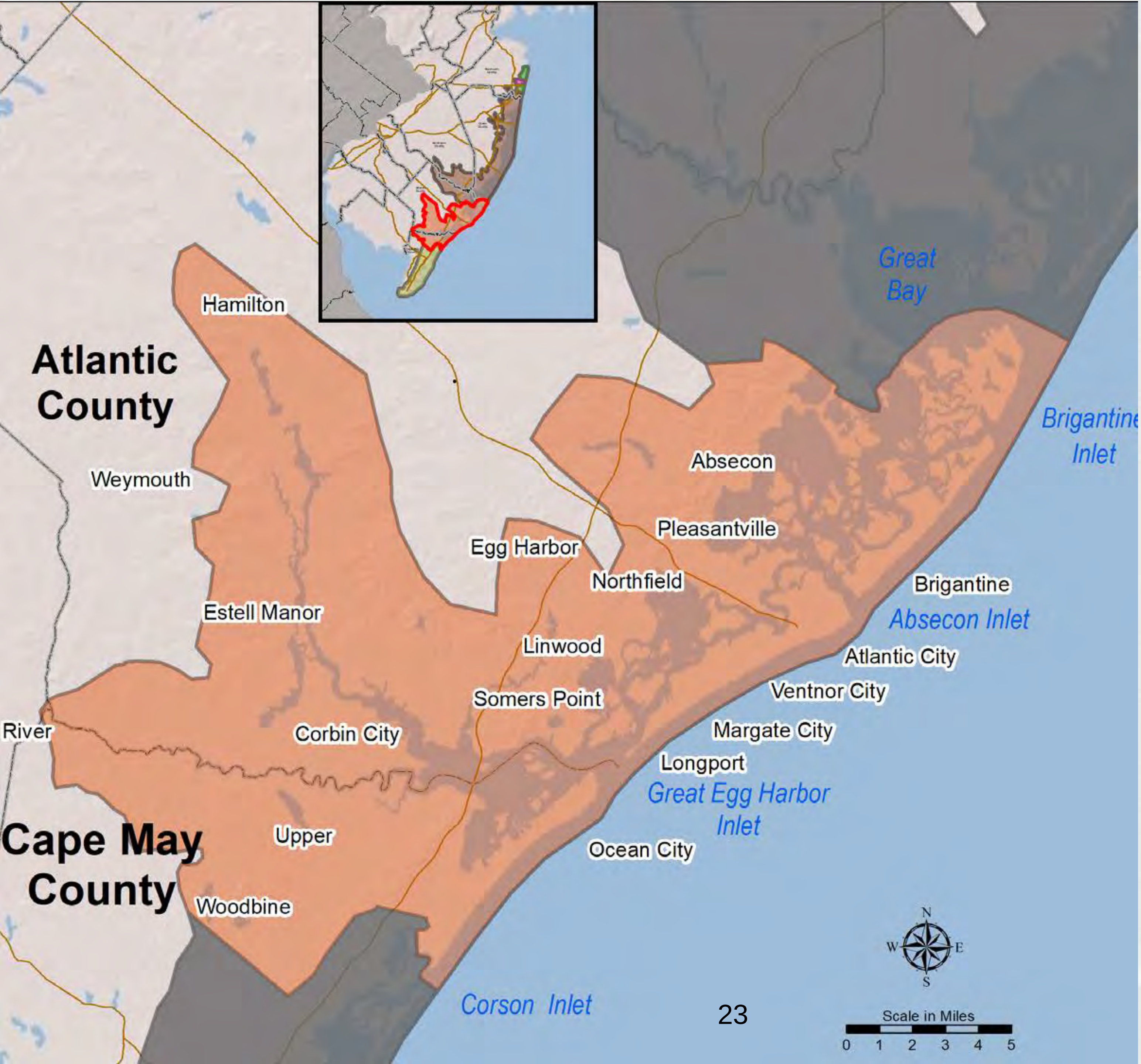


Initial Construction	$3,838,000,000
Average Annual O&M	$39,000,000
Average Annual Net Benefits	$160,000,000
BCR	1.8
Environmental Criteria	Pass

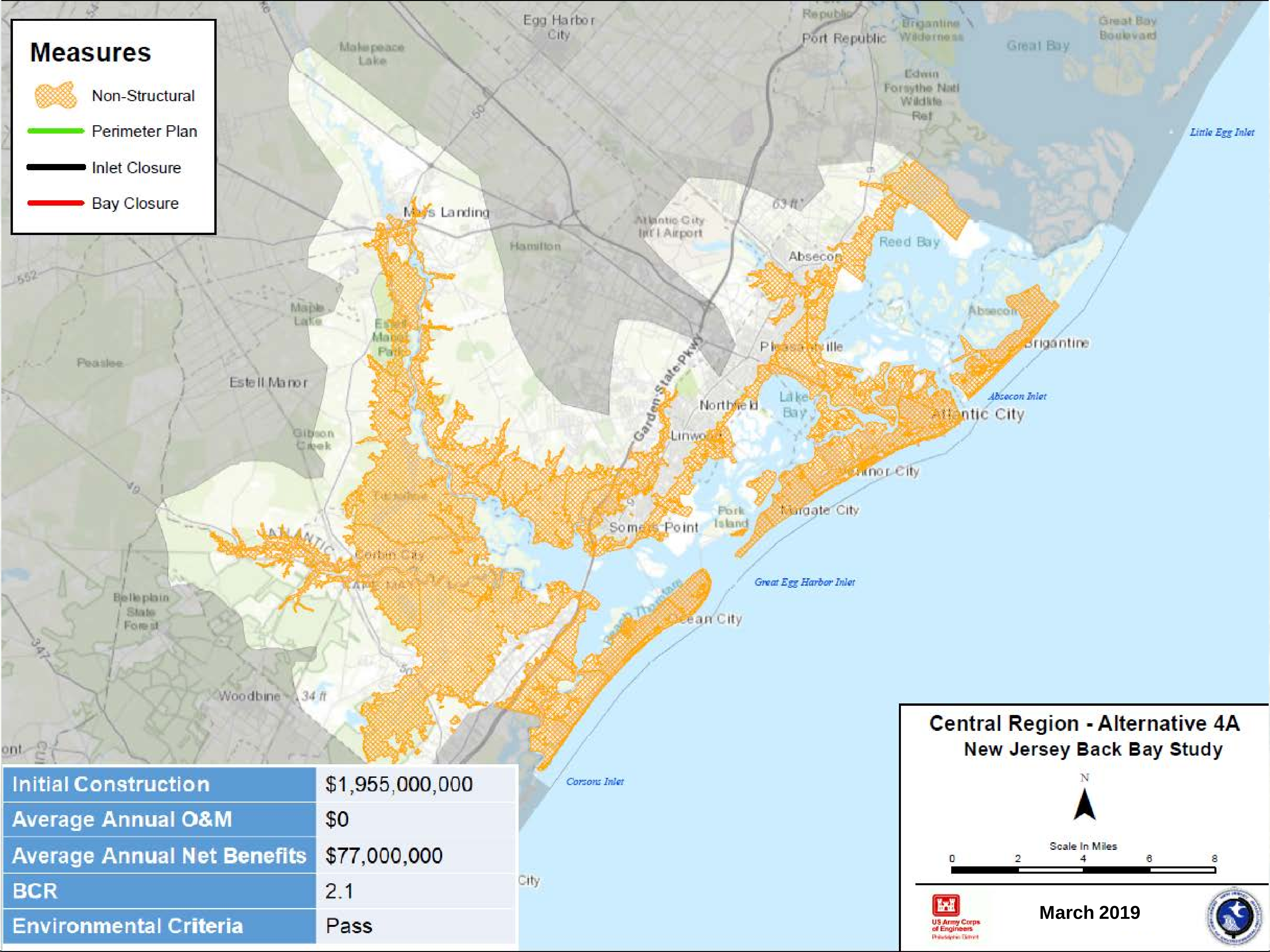


Initial Construction	$4,838,000,000
Average Annual O&M	$54,000,000
Average Annual Net Benefits	$132,000,000
BCR	1.5
Environmental Criteria	Pass





Central Region



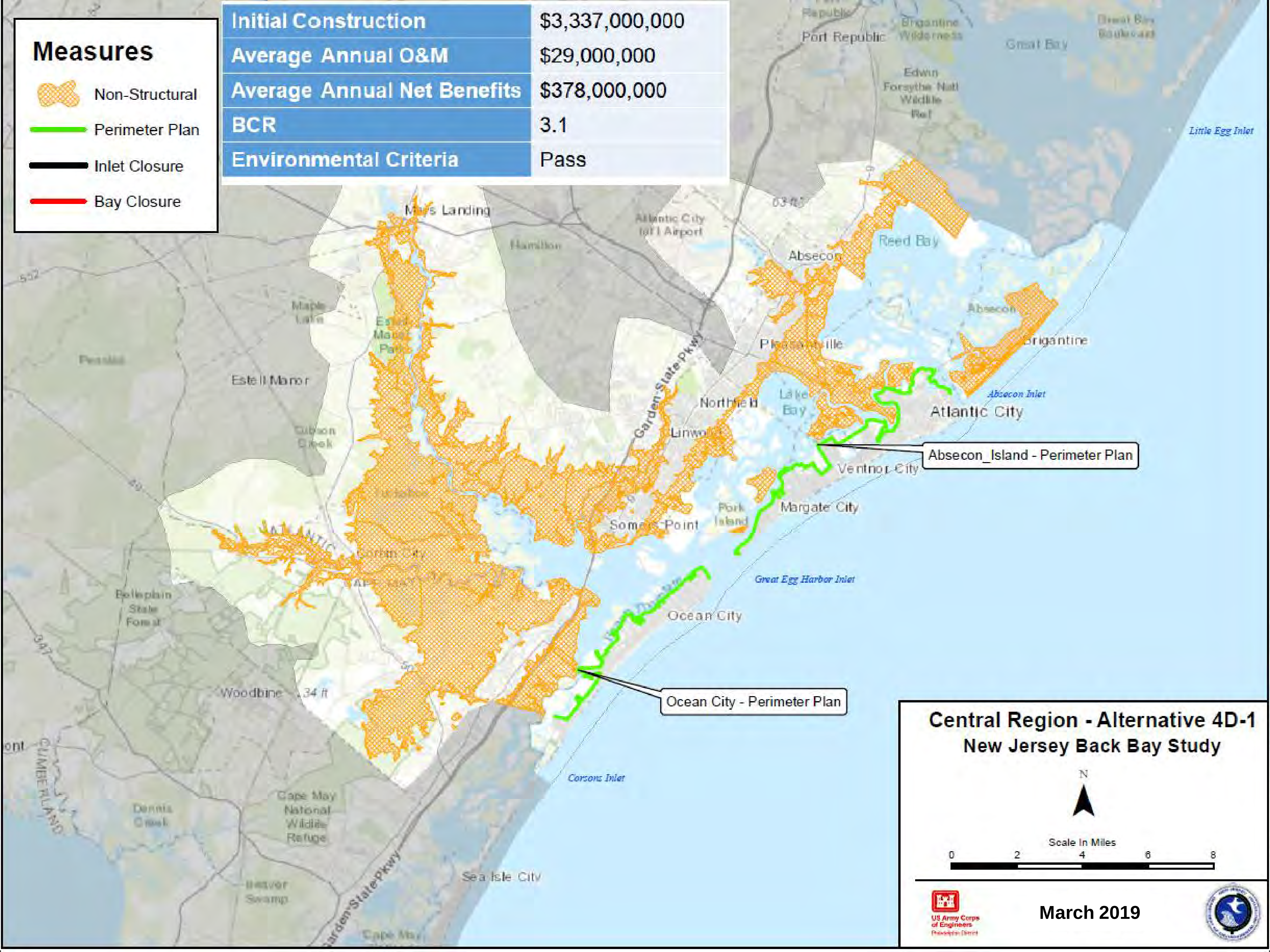
Initial Construction	$1,955,000,000
Average Annual O&M	$0
Average Annual Net Benefits	$77,000,000
BCR	2.1
Environmental Criteria	Pass

Central Region - Alternative 4A

New Jersey Back Bay Study

March 2019

Initial Construction	$3,337,000,000
Average Annual O&M	$29,000,000
Average Annual Net Benefits	$378,000,000
BCR	3.1
Environmental Criteria	Pass

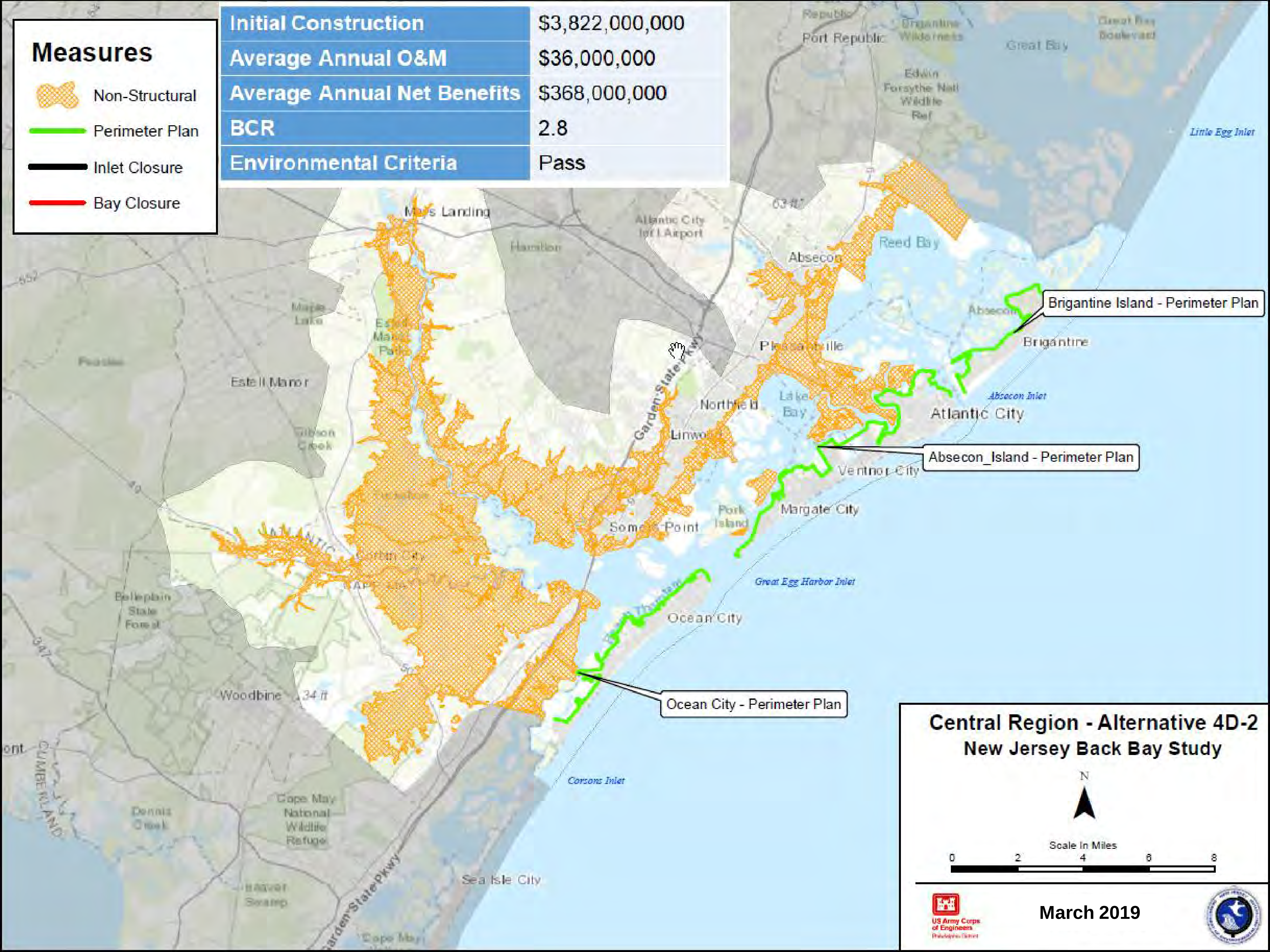


Central Region - Alternative 4D-1

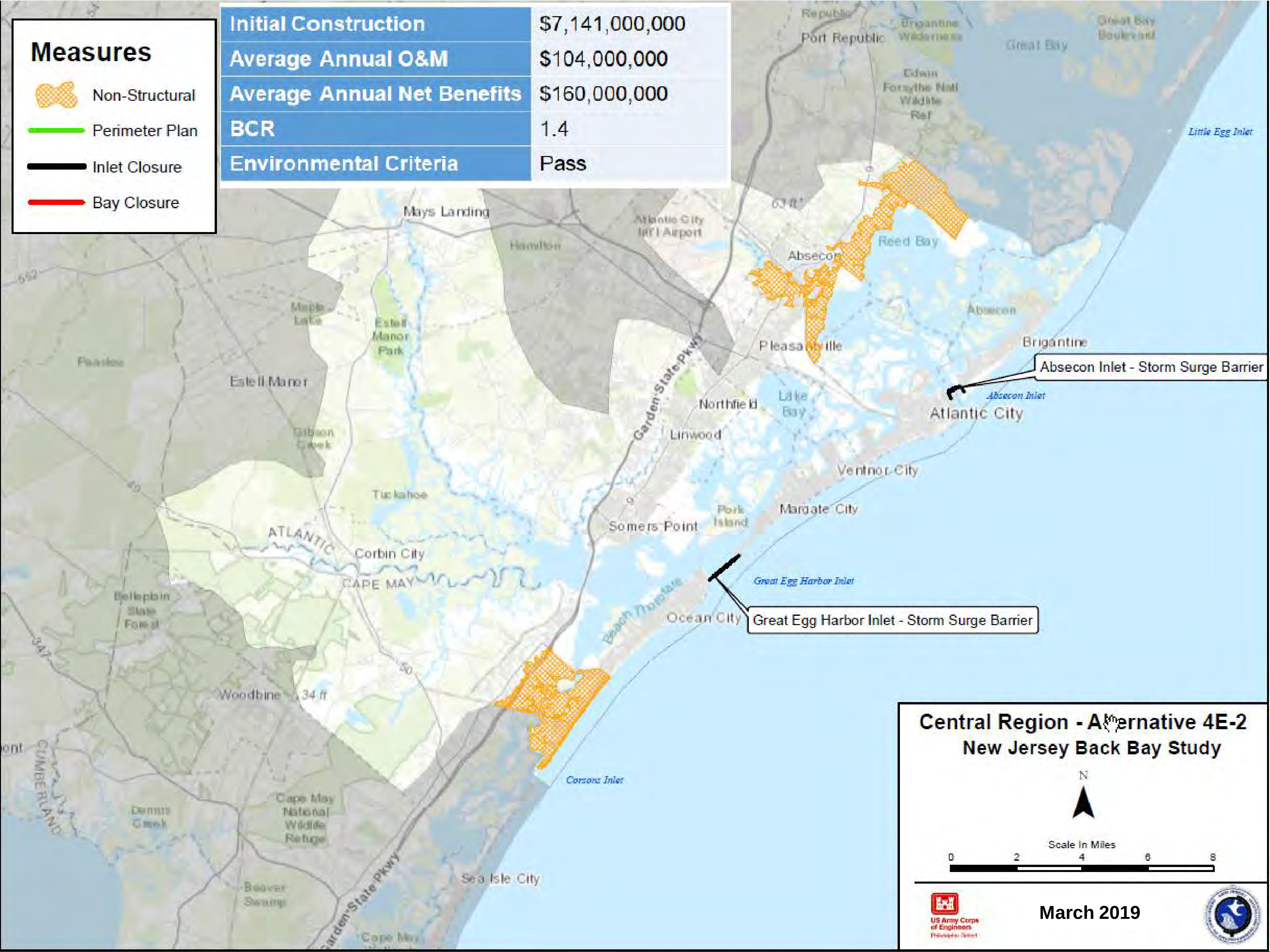
New Jersey Back Bay Study

March 2019

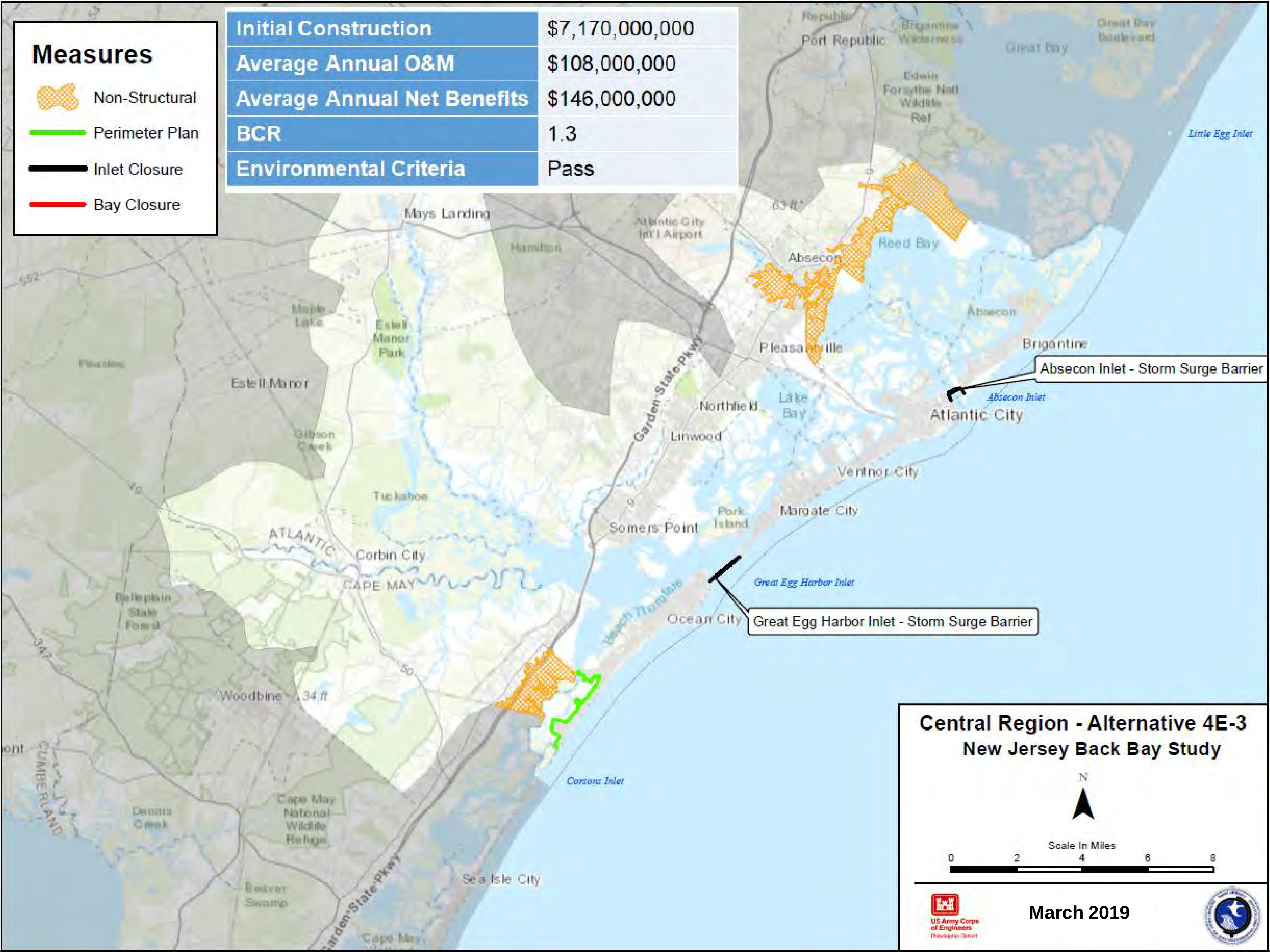
Initial Construction	$3,822,000,000
Average Annual O&M	$36,000,000
Average Annual Net Benefits	$368,000,000
BCR	2.8
Environmental Criteria	Pass



Initial Construction	$7,141,000,000
Average Annual O&M	$104,000,000
Average Annual Net Benefits	$160,000,000
BCR	1.4
Environmental Criteria	Pass

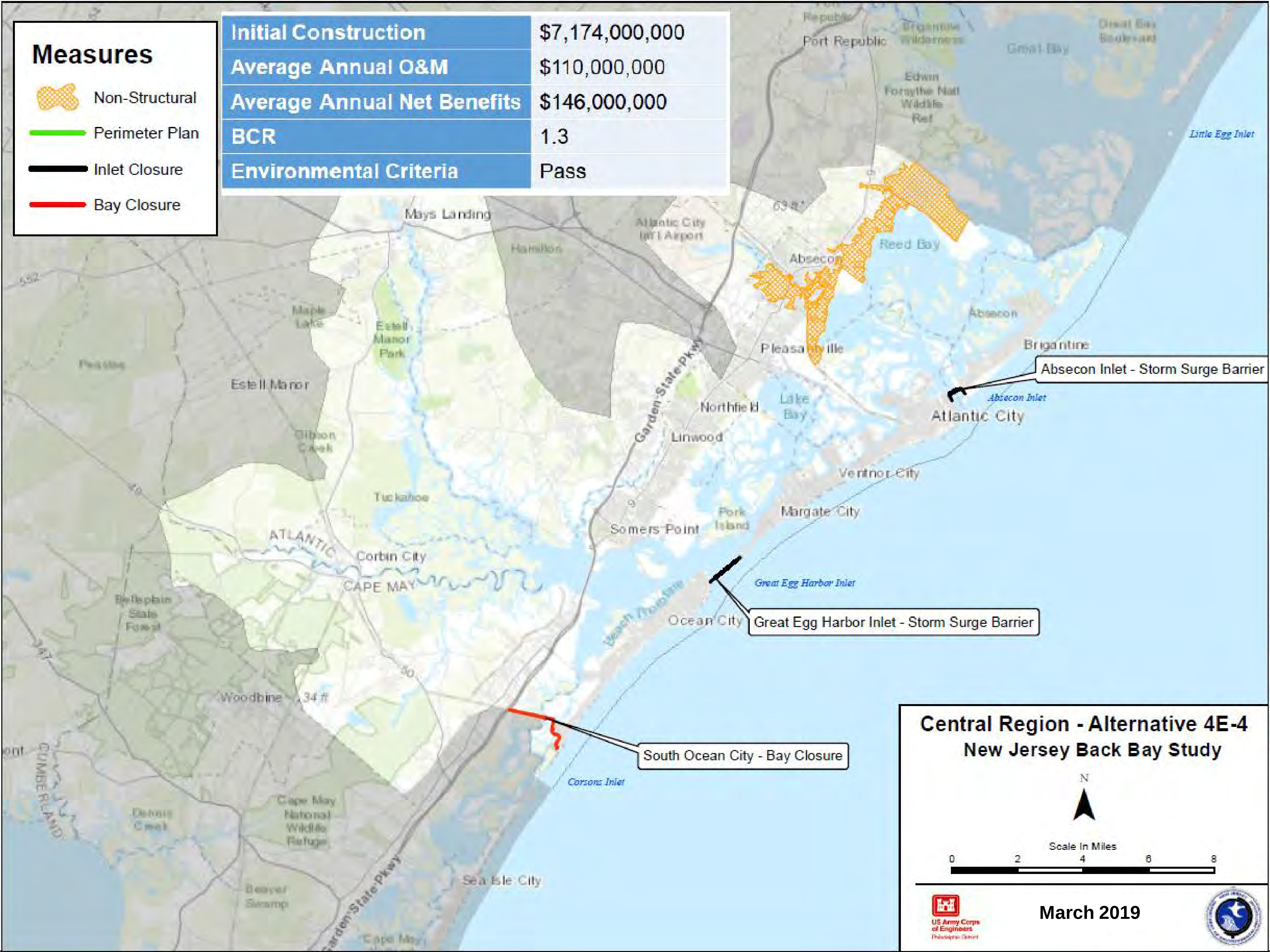


Initial Construction	$7,170,000,000
Average Annual O&M	$108,000,000
Average Annual Net Benefits	$146,000,000
BCR	1.3
Environmental Criteria	Pass



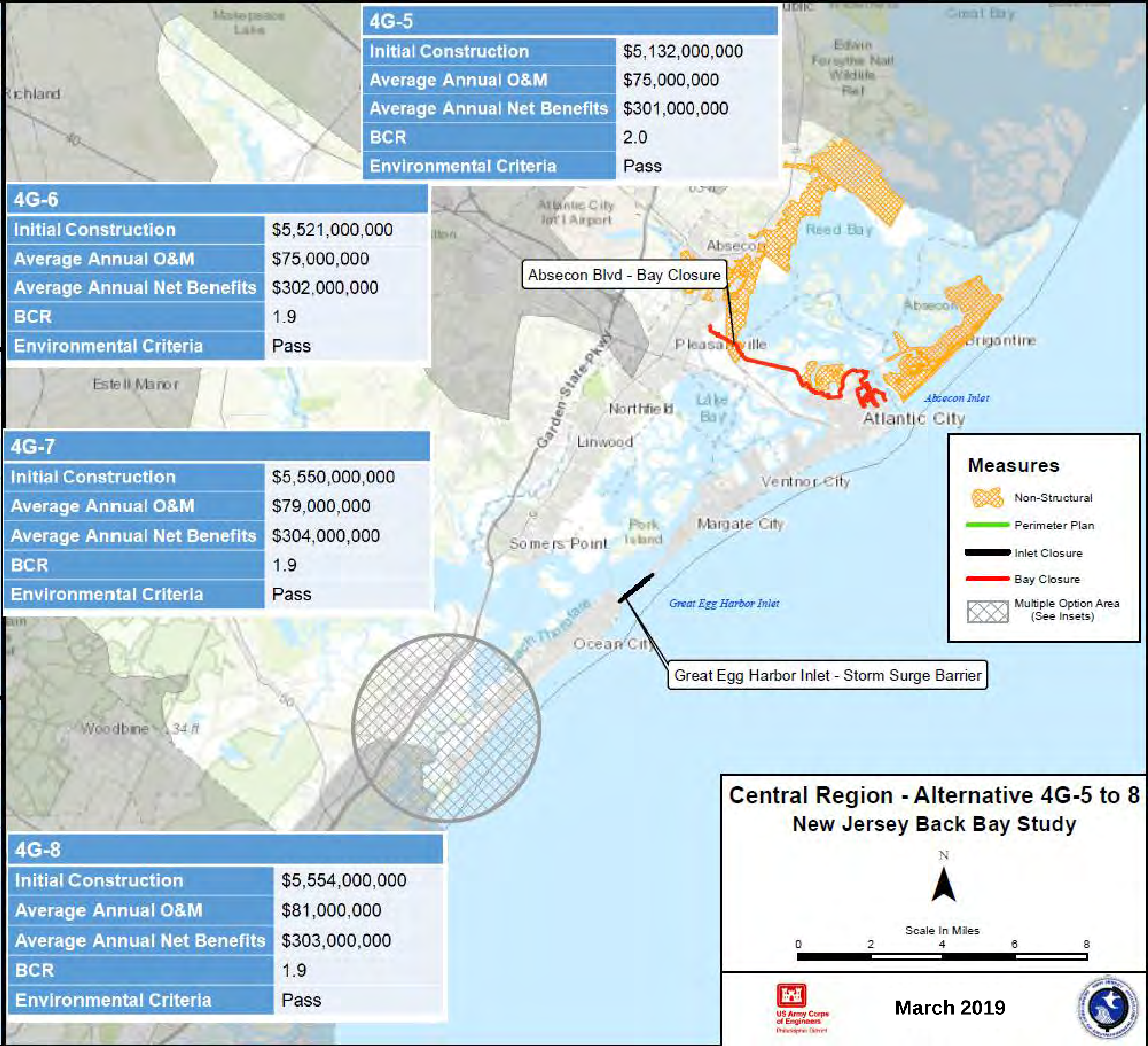
Central Region - Alternative 4E-3
New Jersey Back Bay Study

March 2019



Initial Construction	$7,174,000,000
Average Annual O&M	$110,000,000
Average Annual Net Benefits	$146,000,000
BCR	1.3
Environmental Criteria	Pass

Central Region - Alternative 4G-5 to 8
New Jersey Back Bay Study



4G-5	
Initial Construction	$5,132,000,000
Average Annual O&M	$75,000,000
Average Annual Net Benefits	$301,000,000
BCR	2.0
Environmental Criteria	Pass

4G-6	
Initial Construction	$5,521,000,000
Average Annual O&M	$75,000,000
Average Annual Net Benefits	$302,000,000
BCR	1.9
Environmental Criteria	Pass

4G-7	
Initial Construction	$5,550,000,000
Average Annual O&M	$79,000,000
Average Annual Net Benefits	$304,000,000
BCR	1.9
Environmental Criteria	Pass

4G-8	
Initial Construction	$5,554,000,000
Average Annual O&M	$81,000,000
Average Annual Net Benefits	$303,000,000
BCR	1.9
Environmental Criteria	Pass

Central Region - Alternative 4G-9 to 12

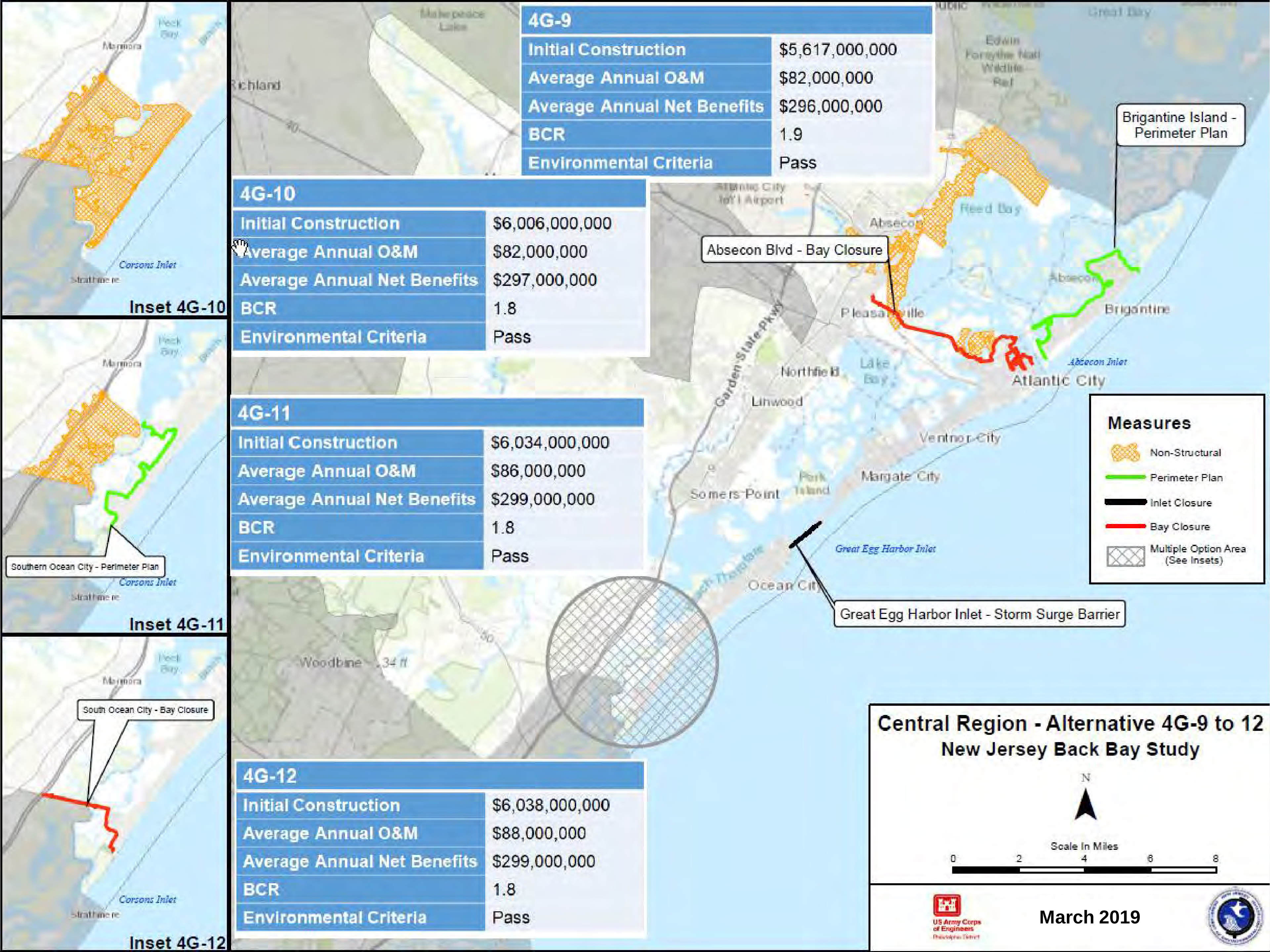
New Jersey Back Bay Study

4G-9	
Initial Construction	$5,617,000,000
Average Annual O&M	$82,000,000
Average Annual Net Benefits	$296,000,000
BCR	1.9
Environmental Criteria	Pass

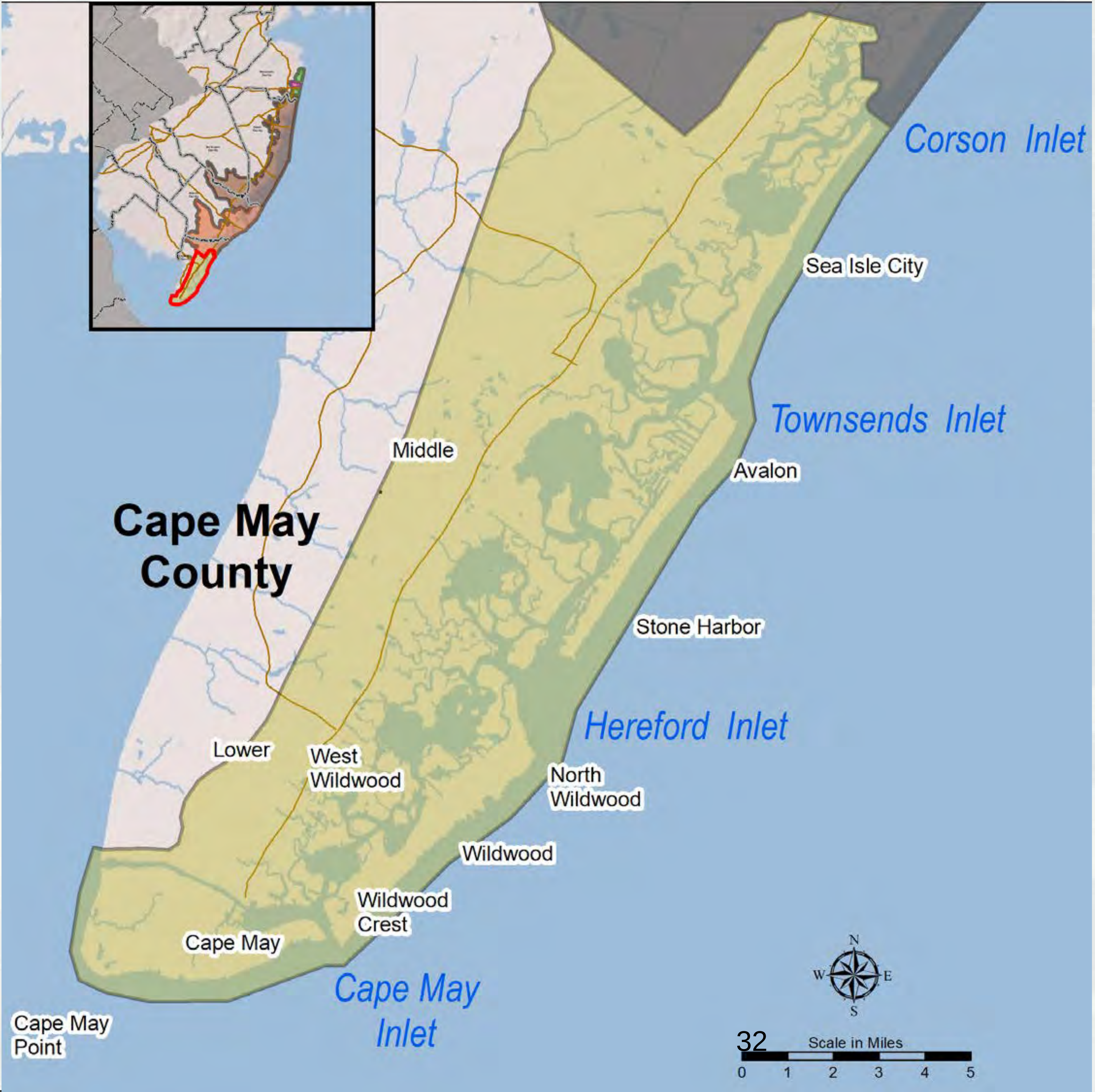
4G-10	
Initial Construction	$6,006,000,000
Average Annual O&M	$82,000,000
Average Annual Net Benefits	$297,000,000
BCR	1.8
Environmental Criteria	Pass

4G-11	
Initial Construction	$6,034,000,000
Average Annual O&M	$86,000,000
Average Annual Net Benefits	$299,000,000
BCR	1.8
Environmental Criteria	Pass

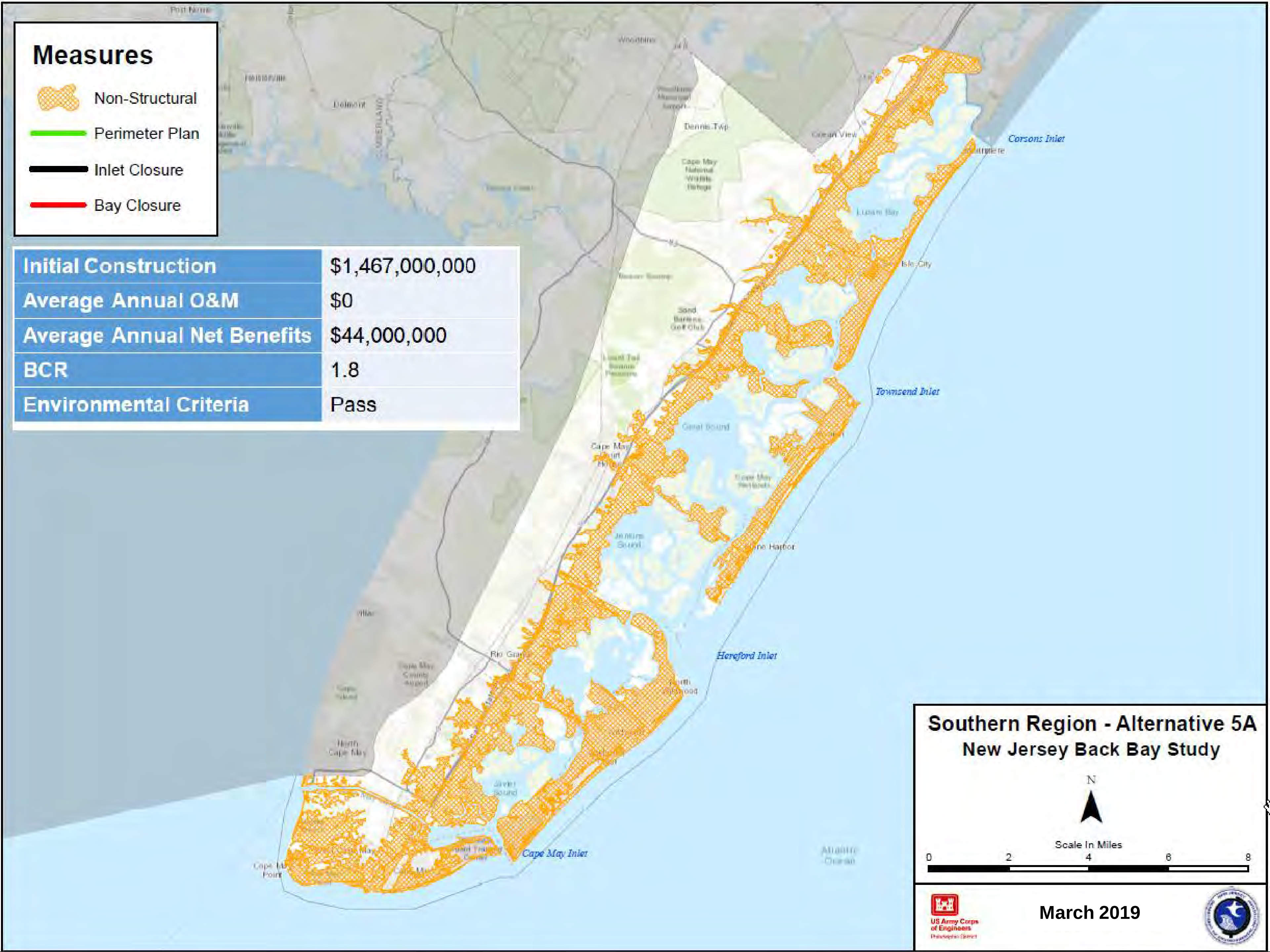
4G-12	
Initial Construction	$6,038,000,000
Average Annual O&M	$88,000,000
Average Annual Net Benefits	$299,000,000
BCR	1.8
Environmental Criteria	Pass



March 2019



South Region

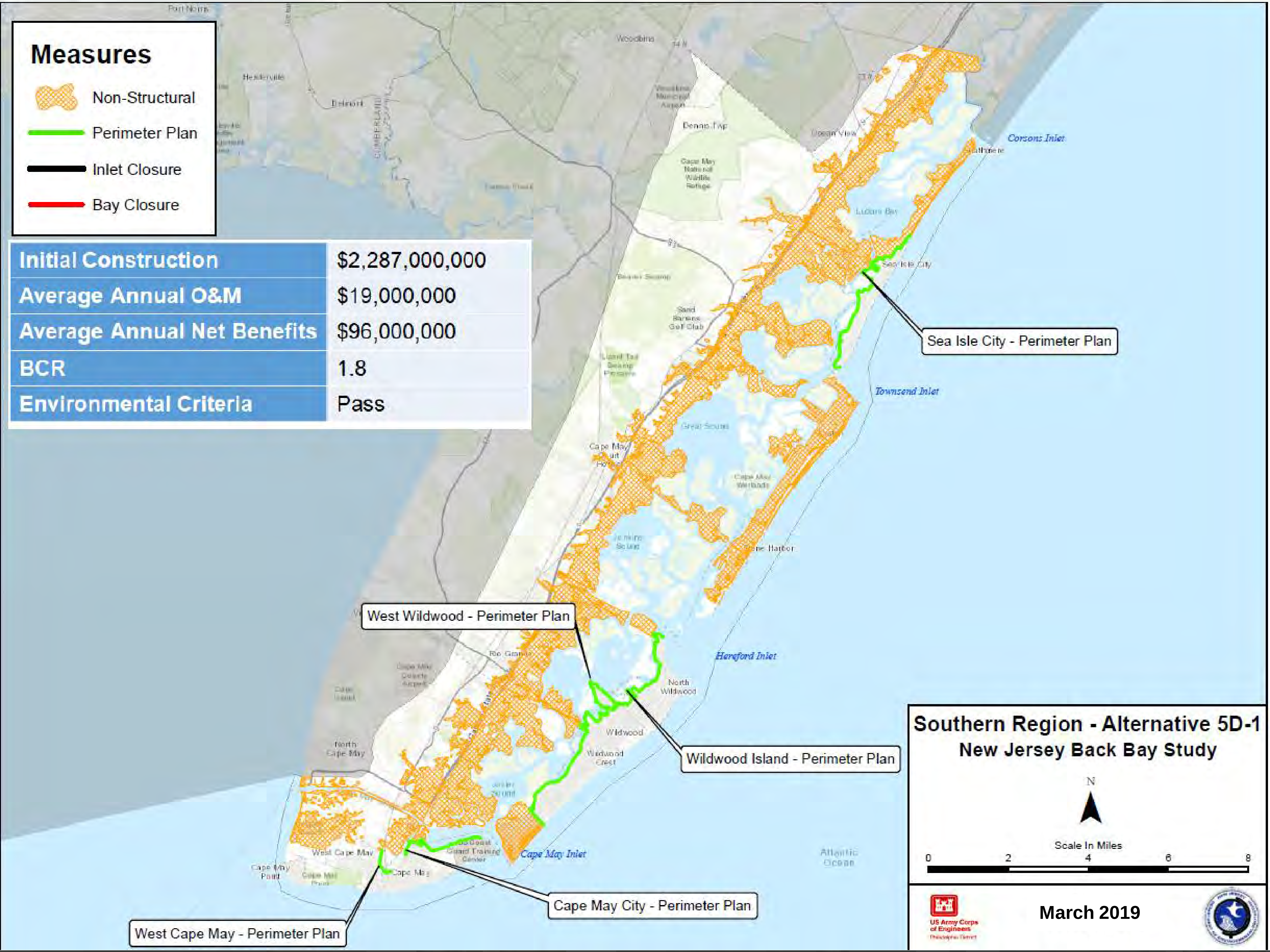


Initial Construction	$1,467,000,000
Average Annual O&M	$0
Average Annual Net Benefits	$44,000,000
BCR	1.8
Environmental Criteria	Pass

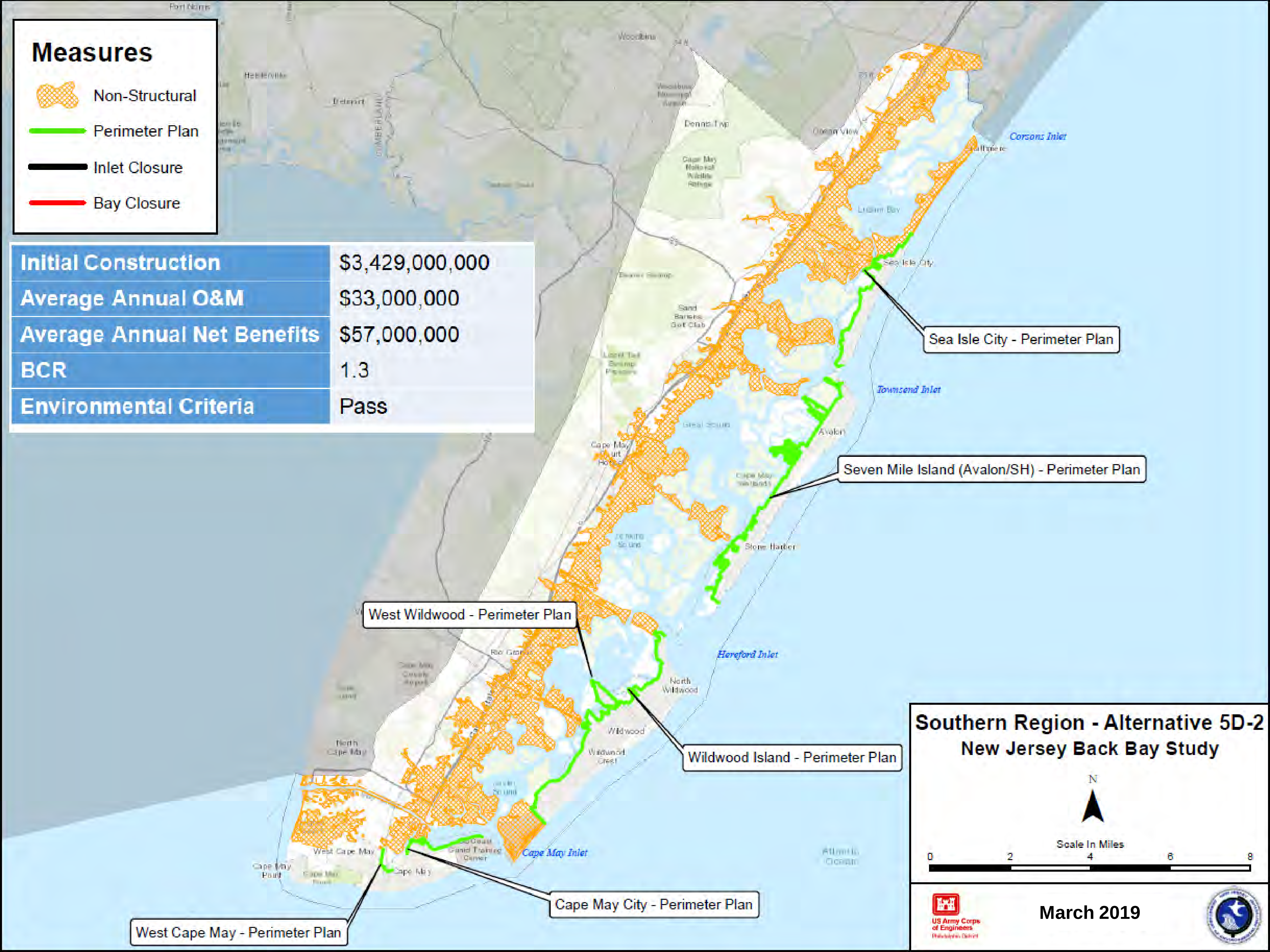
Southern Region - Alternative 5A

New Jersey Back Bay Study

March 2019



Initial Construction	$2,287,000,000
Average Annual O&M	$19,000,000
Average Annual Net Benefits	$96,000,000
BCR	1.8
Environmental Criteria	Pass



Initial Construction	$3,429,000,000
Average Annual O&M	$33,000,000
Average Annual Net Benefits	$57,000,000
BCR	1.3
Environmental Criteria	Pass

Feasibility Study Process

SCOPING & Initial Analyses → **ALTERNATIVE FORMULATION & ANALYSIS** → **FEASIBILITY-LEVEL ANALYSIS** → **CHIEF'S REPORT**

1

APRIL 2016
Study Start

DECEMBER 2016
Alternatives Milestone

2

MARCH 2019
Release Draft Interim Report and Environmental Scoping Document

3

JANUARY 2020
Tentatively Selected Plan Milestone

Draft Feasibility Report and Draft Environmental Impact Statement

4

NOVEMBER 2021
Final Feasibility Report and Environmental Impact Statement

5

APRIL 2022
Feasibility Phase Completed

Design & Construction Process

POST CHIEF'S REPORT

6 — **2022** Authorization & Congressional Approval

7 — **2022** Construction Funds Appropriation

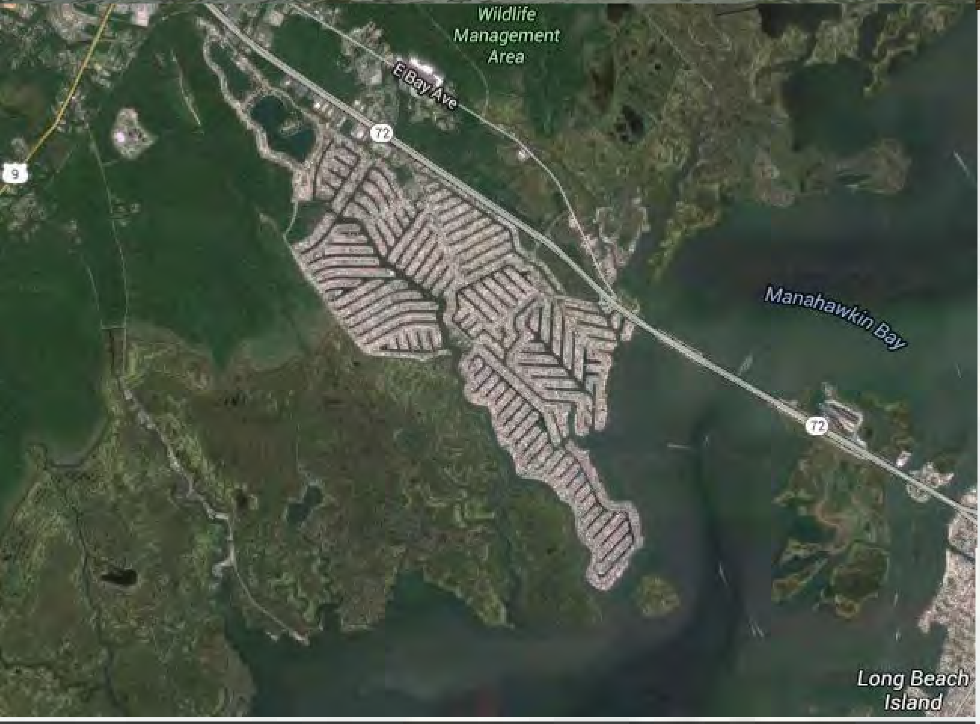
8 — **2023** Preconstruction Engineering & Design Initiation

9 — **2026** Incremental Construction Commencement

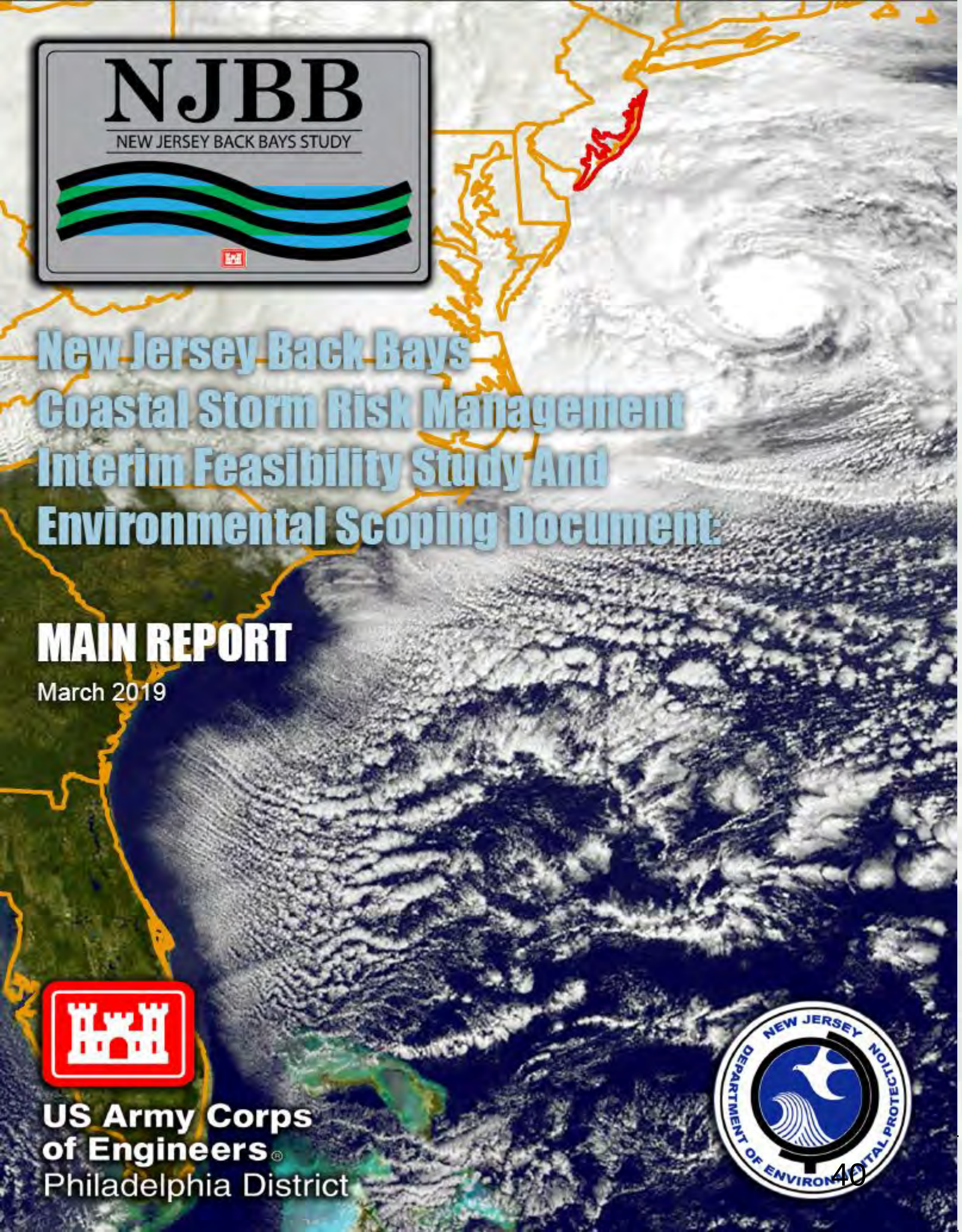
10 — **2027** Monitor & Adapt

* Dates tentative pending funding

Questions & Answers



Closing Comments



The

New Jersey Back Bays Coastal Storm Risk Management

Virtual Meeting has concluded.

Thank you for your interest!

Cape May County Hazard Mitigation Plan:
Borough of Stone Harbor

9.11 BOROUGH OF STONE HARBOR

This section presents the jurisdictional annex for the Borough of Stone Harbor. The annex includes a general overview of the Borough of Stone Harbor; an assessment of the Borough of Stone Harbor's risk, vulnerability, and mitigation capabilities; and a prioritized action plan to implement prior to a disaster to reduce future losses and achieve greater resilience to natural hazards.

9.11.1 Hazard Mitigation Planning Team

The following individuals are the Borough of Stone Harbor's identified HMP update primary and alternate points of contact and NFIP Floodplain Administrator.

Table 9.11-1. Hazard Mitigation Planning Team

Primary Point of Contact	Alternate Point of Contact
Name / Title: Robert Smith, Borough Administrator Address: 9508 Second Avenue Stone Harbor, New Jersey 08247 Phone number: (609) 368-5102 Email: smithr@shnj.org	Name / Title: Jonathan Lakose, OEM Coordinator Address: 9508 Second Avenue Stone Harbor, New Jersey 08247 Phone number: (610) 842-6526 Email: lakosej@shnj.org
NFIP Floodplain Administrator	
Name / Title: Ray Poudrier. Construction Official/CFM Address: 9508 Second Avenue Stone Harbor, New Jersey 08247 Phone number: (609) 368-6814 Email: poudrierr@shnj.org	

9.11.2 Jurisdiction Profile

Stone Harbor is a barrier island resort and residential community located on the southern portion of Seven Mile Island in Cape May County, New Jersey. Stone Harbor consists of 1,256 acres of land and is lined by more than 3.5 miles of pristine beachfront and miles of back bay shoreline, including marsh and private waterfront. The Borough was incorporated in 1914 and has grown through the years to be both a residential year-round community as well as a seasonal resort community.

According to the U.S. Census, the 2010 population for the Borough of Stone Harbor was 866. The estimated 2018 population was 955, a 10.2 percent increase from the 2010 Census. Data from the 2018 U.S. Census American Community Survey indicate that 0.2 percent of the population is 5 years of age or younger and 42.5 percent is 65 years of age or older. Communities must deploy a support system that enables all populations to safely reach shelters or to quickly evacuate a hazard area.

9.11.3 Growth/Development Trends

Understanding how past, current, and projected development patterns have or are likely to increase or decrease risk in hazard areas is a key component to understanding a jurisdiction's overall risk to its hazards of concern. Table 9.11-2 summarizes recent and expected future development trends, including major residential/commercial development and major infrastructure development. Figure 9.11-1 at the end of this annex illustrates the geographically-delineated hazard areas and the location of potential new development.

Table 9.11-2. Recent and Expected Future Development

Type of Development	2015		2016		2017		2018		2019	
Number of Building Permits for New Construction Issued Since the Previous HMP										
	Total	**Within SFHA**	**Total**	**Within SFHA**	**Total**	**Within SFHA**	**Total**	**Within SFHA**	**Total**	**Within SFHA**
Single and Two-Family Units	26	24	37	34	43	42	39	35	39	36
Multi-Family	0	0	2	0	0	0	2	0	2	0
Other (commercial, mixed-use, etc.)	0	0	0	0	0	0	0	0	0	0

Property or Development Name	Type of Development	# of Units / Structures	Location (address and/or block and lot)	Known Hazard Zone(s)*	Description / Status of Development
Recent Major Development and Infrastructure from 2015 to Present					
The Reeds II	Mixed Use Hotel	22	9622-28 Third Ave	AE9	Received certificate of occupancy
100th Street LLC	Day Spa	N/A	96.03/111; 9622-28 Third Ave	AE9	Completed
Known or Anticipated Major Development and Infrastructure in the Next Five (5) Years					
Villa Maria	Retreat Center /13SF Subdivision	13 Single Fam/1 Retreat Center	11101 First Ave 111.01/1-20 112.01/1 & 112.02/22-60	AE8	In Engineering
93rd St Stormwater Pump Station	Stormwater Pump Station	1	93rd & Third Ave		In Design

** Only location-specific hazard zones or vulnerabilities identified.*

9.11.4 Capability Assessment

The Borough of Stone Harbor performed an inventory and analysis of existing capabilities, plans, programs, and policies that enhance its ability to implement mitigation strategies. Section 6 (Capability Assessment) describes the components included in the capability assessment and their significance for hazard mitigation planning. This section summarizes the following findings of the assessment:

- An assessment of planning, legal and regulatory capabilities.
- Development and permitting capabilities.
- An assessment of administrative and technical capabilities.
- An assessment of fiscal capabilities.
- An assessment of education and outreach capabilities.
- Classification under various community mitigation programs.
- The community's adaptive capacity.
- Information on National Flood Insurance Program (NFIP) compliance.

For a community to succeed in reducing long-term risk, hazard mitigation must be integrated into the day-to-day local government operations. As part of this planning effort, planning/policy documents were reviewed, and each jurisdiction was surveyed to obtain a better understanding of their progress in plan integration. Areas with current mitigation integration are summarized in Capability Assessment (Section 9.11.4). The Borough of Stone Harbor identified specific integration activities that will be incorporated into municipal procedures are included in the updated mitigation strategy.

Planning, Legal and Regulatory Capability

The table below summarizes the legal and regulatory tools that are available to the Borough of Stone Harbor and where hazard mitigation has been integrated.

Table 9.11-3. Planning, Legal and Regulatory Capability

	Do you have this? (Yes/No)	Authority that enforces (Federal, State, Regional, County, Local)	Is this State Mandated?	Have aspects of this been integrated into your mitigation plan? If yes- how? Describe in comments	If no - can it be a mitigation action? If yes, add Mitigation Action #.
Codes, Ordinances, & Requirements					
Building Code	Yes	State & Local	Yes	Yes	-
Comment: • *State mandated on local level under NJAC 5:23-3.14. International Building Code – New Jersey Edition, 2018, NJAC 5:24-3.14 Adopted 9/3/2019 (with NJ edits dated March 14, 2020 coming soon)* • *Construction Codes, Uniform, Chapter 230, adopted by Borough Council in 1982 and amended through 2019. There is hereby established in the Borough of Stone Harbor a state uniform construction code enforcing agency, to be known as the "Department of Construction Inspection," consisting of a construction official, building subcode official, plumbing subcode official, electrical subcode official, fire protection subcode official. The Construction Official and the Subcode Officials shall be determined from time to time by resolution of Borough Council.* • *The Ordinance contains no specific mitigation actions other than those required in the Uniform Construction Code.*					
Zoning Code	Yes	State & Local	Yes – if municipality has a	Yes	-

	Do you have this? (Yes/No)	Authority that enforces (Federal, State, Regional, County, Local)	Is this State Mandated?	Have aspects of this been integrated into your mitigation plan? If yes- how? Describe in comments	If no - can it be a mitigation action? If yes, add Mitigation Action #.
			Planning Board		
Comment: • *State permissive on local level. Per State of NJ Municipal Land Use Law (MLUL) L. 1975, s. 2, eff Aug 1, 1976, 40-55D-62: 49. Power to zone, requires all jurisdictions to have current zoning and other land development ordinances after the planning board has adopted the land use element and master plan.* • *Zoning, Chapter 560, adopted by Borough Council on 12-06-11 and amended through 2019. Pursuant to the Municipal Land Use Law, N.J.S.A. 40:55D-1 et seq., and for the purposes set forth therein, the Borough of Stone Harbor, New Jersey, hereby establishes the Zoning Ordinance of Stone Harbor, New Jersey.* • *This Chapter addresses flooding in basic terms by making exceptions to normal standards for height and setbacks to allow for building elevations.* • *Regarding Stormwater, All new construction and substantial improvements as defined in Chapter 300 will be required to furnish and install an underground stormwater recharge system to limit the amount of runoff generated by the construction. The system shall be designed to collect stormwater runoff from the roof leaders or an equivalent amount of runoff through inlets or yard drains. There is a separate Chapter that addresses Stormwater Management in more detail.*					
Subdivisions	Yes	County & Local	Yes – if municipality has a Planning Board	Yes	-
Comment: • *P.L.1975, c.291 (C.40:55D-47): 40:55D-37. Grant of power; referral of proposed ordinance; county planning board approval a. The governing body may by ordinance require approval of subdivision plats by resolution of the planning board as a condition for the filing of such plats with the county recording officer and approval of site plans by resolution of the planning board as a condition for the issuance of a permit for any development, except that subdivision or individual lot applications for detached one or two dwelling-unit buildings shall be exempt from such site plan review and approval; provided that the resolution of the board of adjustment shall substitute for that of the planning board whenever the board of adjustment has jurisdiction over a subdivision or site plan pursuant to subsection 63b. of this act . Dictated by the Municipal Land Use Law. NJ Statute 40:27-6.2 - the board of freeholders of any county having a county planning board shall provide for the review of all subdivisions of land within the county by said county planning board and for the approval of those subdivisions affecting county road or drainage facilities as set forth and limited hereinafter in this section.* • *Land Development Procedures, Chapter 345, adopted by Borough Council in 1982, amended through 2019. The purpose of this chapter shall be to establish the functions of the Planning Board and Zoning Board of Adjustment and to provide rules, regulations and standards to guide land subdivision and site development in the Borough of Stone Harbor. It is further the purpose to promote the purposes of the New Jersey Municipal Land Use Law, as amended (N.J.S.A. 40:55D-2), including but not limited to public health, safety, convenience and general welfare of the municipality. It shall be administered to ensure orderly growth and development or redevelopment, the conservation, protection and proper use of land and adequate provision for circulation, utilities and services.* • *The Planning Board shall have the power to administer the provisions of the Land Subdivision Ordinance and Site Plan Review Ordinance of the Borough in accordance with the provisions of these ordinances, and the Municipal Land Use Law, Chapter 291, P.L. 1975, N.J.S.A. 40:55D-1 et seq. The Zoning Board shall have the same powers when such applications are within its jurisdiction. There shall be no division of any lot, tract or parcel of land in this Borough into two or more lots, tracts or parcels of land for sale or development without first obtaining subdivision approval from the Planning or Zoning Board.* • *This Chapter makes general provisions for flood protection and stormwater controls.*					
Stormwater Management	Yes	State & Local	Yes	Yes	-
Comment: • *See Title 7 of the NJ Administrative Code, N.J.A.C. 7:8* • *Storm Sewer System, Chapter 468, adopted by Borough Council on 06-01-10. This article requires dumpsters and other refuse containers that are outdoors or exposed to stormwater to be covered at all times and prohibits the spilling, dumping, leaking, or otherwise discharging of liquids, semi-liquids or solids from the containers to the municipal separate storm sewer system(s); and the retrofitting of existing storm drain inlets which are in direct contact with repaving, repairing, reconstruction, or resurfacing or alterations of facilities on private property to prevent the discharge of solids and floatables (such as plastic bottles, cans, food wrappers and other litter) to the municipal separate storm sewer system(s) operated by the Borough of Stone Harbor.* • *Chapter 470 of the Borough's code regulates stormwater management.*					
Post-Disaster Recovery	No	-	No	-	-
Comment:					

	Do you have this? (Yes/No)	Authority that enforces (Federal, State, Regional, County, Local)	Is this State Mandated?	Have aspects of this been integrated into your mitigation plan? If yes- how? Describe in comments	Have aspects of this been integrated into your mitigation plan? If no - can it be a mitigation action? If yes, add Mitigation Action #.
Real Estate Disclosure	Yes	State, Division of Consumer Affairs	Yes	Yes	-
Comment: *N.J.A.C. 13:45A-29.1 - Before signing a contract of sale, all purchasers must receive a New Jersey Public Offering Statement (POS) approved by the New Jersey Real Estate Commission. The POS provides information such as estimated completion dates for improvements, fees for services and amenities, the type of title and ownership interest being offered, its proximity to hospitals, schools, fire and police, as well as any hazards, risks or nuisances in or around the subdivision.* • *It should be noted that Section 300-3 of the Borough's Flood Damage Prevention Ordinance 'Statement of Purpose' has a provision to ensure that potential buyers are notified that property is in an area of special flood hazard.*					
Growth Management	No	-	Yes – if municipality has a Planning Board	-	-
Comment: • *State Mandated on a municipal level. See Zoning Ordinance; Also - Plan Endorsement Process via the State Development & Redevelopment Plan provides for the delineation of Growth Areas and Environs; Use of the endorsed plans in the implementation of state environmental regulations makes the Plan Endorsement process a growth management strategy.*					
Site Plan Review	Yes	County & Local	Yes – if municipality has a Planning Board	Yes	-
Comment: • *Dictated by the Municipal Land Use Law which sets forth minimum requirements for plans, etc., timeframes for development review. NJ Statute 40:27-6.2: The board of freeholders of any county having a county planning board shall provide for the review of all subdivisions of land within the county by said county planning board and for the approval of those subdivisions affecting county road or drainage facilities as set forth and limited hereinafter in this section. 40:27-6.10 In order that county planning boards shall have a complete file of the planning and zoning ordinances of all municipalities in the county, each municipal clerk shall file with the county planning board a copy of the planning and zoning ordinances of the municipality in effect on the effective date of this act and shall notify the county planning board of the introduction of any revision or amendment of such an ordinance which affects lands adjoining county roads or other county lands, or lands lying within 200 feet of a municipal boundary, or proposed facilities or public lands shown on the county master plan or official county map. Such notice shall be given to the county planning board at least 10 days prior to the public hearing thereon by personal delivery or by certified mail of a copy of the official notice of the public hearing together with a copy of the proposed ordinance.* • *Land Development Procedures, Chapter 345, adopted by Borough Council in 1982, amended through 2019. The purpose of this chapter shall be to establish the functions of the Planning Board and Zoning Board of Adjustment and to provide rules, regulations and standards to guide land subdivision and site development in the Borough of Stone Harbor. It is further the purpose to promote the purposes of the New Jersey Municipal Land Use Law, as amended (N.J.S.A. 40:55D-2), including but not limited to public health, safety, convenience and general welfare of the municipality. It shall be administered to ensure orderly growth and development or redevelopment, the conservation, protection and proper use of land and adequate provision for circulation, utilities and services.* • *The Planning Board shall have the power to administer the provisions of the Land Subdivision Ordinance and Site Plan Review Ordinance of the Borough in accordance with the provisions of these ordinances, and the Municipal Land Use Law, Chapter 291, P.L. 1975, N.J.S.A. 40:55D-1 et seq. The Zoning Board shall have the same powers when such applications are within its jurisdiction. There shall be no division of any lot, tract or parcel of land in this Borough into two or more lots, tracts or parcels of land for sale or development without first obtaining subdivision approval from the Planning or Zoning Board.* • *This Chapter makes general provisions for flood protection and stormwater controls.*					
Environmental Protection	Yes	Local	No	Yes	-
Comment: • *Parks, Recreation Areas and Bird Sanctuary, Chapter 400, adopted by Borough Council in 1982, amended 05-05-09 to add Article IV. Bird Sanctuary. Although not a comprehensive Environment Protection regulation, the Bird Sanctuary provides for the protection of Borough property between 111th and 117th Streets and between 2nd and 3rd Avenues, referred to as Stone Harbor Bird Sanctuary or Bird Sanctuary, is approximately 21+ acres of wetlands and maritime forest dedicated to being a bird sanctuary.* • *Chapter 560-24 Conservation District* • *Chapter 466-19 – Single Use Plastics Ban*					

	Do you have this? (Yes/No)	Authority that enforces (Federal, State, Regional, County, Local)	Is this State Mandated?	Have aspects of this been integrated into your mitigation plan? If yes- how? Describe in comments	If no - can it be a mitigation action? If yes, add Mitigation Action #.
Flood Damage Prevention	Yes	State & Local	Yes	Yes	-
Comment: • *The NJ State Law Flood Area Control Act (N.J.S.A. 58:16A-52) and the National Flood Control Act of 1968 (NFIP) are state and federal acts to support minimization of flood losses. They do not require local adoption but as enforced by the NJDEP, the floodplain ordinances of each municipality must be reviewed for compliance with these regulations. In addition, participation in the NFIP requires a floodplain ordinance. Regulations for the Flood Control Hazards Act were adopted in 2007 and amended effective June 20, 2016.* • *Flood Damage Prevention, Chapter 300, adopted by Borough Council on 09-19-17 and amended 04-17-18. It is the purpose of this chapter to promote the public health, safety, and general welfare, and to minimize public and private losses due to flood conditions in specific areas by provisions designed to: Protect human life and health; Minimize expenditure of public money for costly flood control projects; Minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public; Minimize prolonged business interruptions; Minimize damage to public facilities and utilities such as water and gas mains, electric, telephone and sewer lines, streets, and bridges located in areas of special flood hazard; Help maintain a stable tax base by providing for the sound use and development of areas of special flood hazard so as to minimize future flood blight areas; Ensure that potential buyers are notified that property is in an area of special flood hazard; and Ensure that those who occupy the areas of special flood hazard assume responsibility for their actions.* • *In order to accomplish its purposes, this chapter includes methods and provisions for: Restricting or prohibiting uses which are dangerous to health, safety, and property due to water or erosion hazards, or which result in damaging increases in erosion or in flood heights or velocities; Requiring that uses vulnerable to floods, including facilities which serve such uses, be protected against flood damage at the time of initial construction; Controlling the alteration of natural floodplains, stream channels, and natural protective barriers, which help accommodate or channel floodwaters; Controlling filling, grading, dredging, and other development which may increase flood damage; and Preventing or regulating the construction of flood barriers which will unnaturally divert floodwaters or which may increase flood hazards in other areas.* • *The Floodplain Manager is hereby appointed to administer and implement this chapter by granting or denying development permit applications in accordance with its provisions.* • *It appears this Chapter requires regulated residential and nonresidential structures in a SFHA be elevated to or above the BFE and that manufactured homes in a SFHA be elevated to a minimum of three feet above the BFE.*					
Wellhead Protection	No	-	No	-	-
Comment:					
Emergency Management	No	-	No	-	-
Comment:					
Climate Change	No	-	No	-	-
Comment:					
Disaster Recovery Ordinance	No	-	No	-	-
Comment:					
Disaster Reconstruction Ordinance	No	-	No	-	-
Comment:					
Other	Yes	Federal, State & Local	No	No	-
Comment: • *Beaches, Chapter 156, adopted by Borough Council in 1982 and last amended 12-12-15. The beach berm and dunes offer the first line of defense against the sea during a storm. Dune areas are vulnerable to erosion and damage by wind, water, indiscriminate trespass, construction, acts which damage their protective vegetation, and the absence of good husbandry. Therefore, the Borough has a vital interest in establishing and maintaining a protection program for the beach and dune areas. It is the policy of this Borough to encourage the development of sand dunes, and to take whatever steps are required to maintain and protect these dunes. The specifics for such steps are set forth in Executive Policy 98-B-001, as amended from time to time.* • *The Borough of Stone Harbor has adopted a Dune Vegetation Management Plan, as approved by the New Jersey Department of Environmental Protection. The Dune Vegetation Management Plan includes a Dune Maintenance Program whereby interested private property owners can partner with the Borough to, among other things, help eliminate certain nonindigenous and/or invasive species of vegetation from dune areas. The Borough undertakes dune maintenance and protection measures.*					
Planning Documents					

<table>
<tr><th rowspan="2"></th><th rowspan="2">Do you have this? (Yes/No)</th><th rowspan="2">Authority that enforces (Federal, State, Regional, County, Local)</th><th rowspan="2">Is this State Mandated?</th><th colspan="2">Have aspects of this been integrated into your mitigation plan?</th></tr>
<tr><th>If yes- how? Describe in comments</th><th>If no - can it be a mitigation action? If yes, add Mitigation Action #.</th></tr>
<tr><td>Comprehensive / Master Plan</td><td>Yes</td><td>State & Local</td><td>Yes</td><td>Yes</td><td>-</td></tr>
<tr><td colspan="6">Comment:
2018 Revised NJ Statute 40:27-2; the county planning board shall make and adopt a master plan for the physical development of the county. The master plan of a county, with the accompanying maps, plats, charts, and descriptive and explanatory matter, shall show the county planning board's recommendations for the development of the territory covered by the plan, and may include, among other things, the general location, character, and extent of streets or roads, viaducts, bridges, waterway and waterfront developments, parkways, playgrounds, forests, reservations, parks, airports, and other public ways, grounds, places and spaces; the general location and extent of forests, agricultural areas, and open-development areas for purposes of conservation, food and water supply, sanitary and drainage facilities, or the protection of urban development, and such other features as may be important to the development of the county. The county planning board shall encourage the co-operation of the local municipalities within the county in any matters whatsoever which may concern the integrity of the county master plan and to advise the board of chosen freeholders with respect to the formulation of development programs and budgets for capital expenditures. Per State of NJ Municipal Land Use Law (MLUL) L. 1975, s. 2, eff Aug 1, 1976 40:55D-28 provides the required components of a municipal Master Plan and requires that each municipality prepare a master plan and update it every 6 years. Further, all zoning ordinances must be consistent with the Master Plan or will not be benefitted from a presumption of validity.
Master Plan, Land Use Plan Element, adopted by the Planning Board on June 22, 2009. The Plan recognizes that the continued impact of hurricanes, storms and other natural consequences has eroded beaches, damaged dunes and infrastructure and destroyed natural habitats. The beaches are important for protecting the dunes and habitats, because they deflect the impact of the force of the water and minimize the size and strength of waves before they reach the dunes and lands further ashore. Beach replenishment returns the sands to the beaches so that they can continue to serve these functions. The Land Use Element also includes a Stone Harbor Action Plan that identifies tasks involving Ordinances, Master Plans and Specialty Plans & Public and Private Initiatives. Some of these tasks have been completed while others may be considered for actions in the HMP.
Master Plan Re-Examination Report, dated June 2019. The Plan makes general mention of flood hazard issues but does point to the fact that Storm water development in the Borough is looking to the future to control nuisance flooding as well as catastrophic failures during major storm and tidal flooding events. The current plan breaks down the island into thirteen drainage areas where storm water runoff would be moved to the lowest point and dispersed through underground recharge systems or conveyed by pumps either downstream or into the bay. While the ultimate goal is to reduce impermeable surface runoff through recharge, rain gardens, pervious surfaces, and underground storage; in some areas the runoff and elevation exceeds the limitations of those methods. Part of the storm water planning process also brought about changes to the bulkhead requirements that have already been implemented.</td></tr>
<tr><td>Capital Improvement Plan</td><td>Yes</td><td>Local</td><td>No</td><td>Yes</td><td>-</td></tr>
<tr><td colspan="6">Comment: The Borough of Stone Harbor has a five (5) year Capital Improvement Plan: Infrastructure Upgrades</td></tr>
<tr><td>Disaster Debris Management Plan</td><td>No</td><td>-</td><td>No</td><td>-</td><td>2021-StoneHarbor-014</td></tr>
<tr><td colspan="6">Comment:</td></tr>
<tr><td>Floodplain or Watershed Plan</td><td>Yes</td><td>State & Local</td><td>No</td><td>Yes</td><td>-</td></tr>
<tr><td colspan="6">Comment:
The Stone Harbor Watershed Plan was completed in November 2019 by the Stockton University Coastal Research Center.
The goals of the Stormwater Management Plan are to:
Evaluate future conditions and long-duration storms
Evaluate the impact of sea level rise and climate change
Identify wetlands and natural areas
Address the protection of natural channels
Provide a dedicated funding source for implementing the plan</td></tr>
<tr><td>Stormwater Management Plan</td><td>Yes</td><td>State & Local</td><td>Yes</td><td>Yes</td><td>-</td></tr>
<tr><td colspan="6">Comment:
The Stormwater Management rules (N.J.A.C. 7:8) rules were published in the February 2, 2004 NJ Register. These rules set forth the required components of regional and municipal stormwater management plans and establish the stormwater management design and performance standards for new (proposed) development. The design and performance standards for new development include groundwater recharge, runoff quantity controls, and runoff quality controls. The rules emphasize, as a primary consideration, the use of nonstructural stormwater management techniques including minimizing disturbance, minimizing impervious surfaces, minimizing the use of stormwater pipes, preserving natural drainage features, etc. The rules also set forth requirements for groundwater recharge, stormwater runoff quantity control, stormwater runoff quality control, and the prohibition of major development to be located within or to discharge runoff from the</td></tr>
</table>

	Do you have this? (Yes/No)	Authority that enforces (Federal, State, Regional, County, Local)	Is this State Mandated?	Have aspects of this been integrated into your mitigation plan? If yes- how? Describe in comments	Have aspects of this been integrated into your mitigation plan? If no - can it be a mitigation action? If yes, add Mitigation Action #.
major development into a 300-foot riparian zone without prior authorization from the Department under the Flood Hazard Area Control Act Rules, N.J.A.C. 7:13. • *Stormwater Plan, no date. The Borough's Stormwater Master Plan addresses the two major causes of Borough-wide flooding and presents a comprehensive plan of stormwater management and flood hazard mitigation techniques to mitigate the repetitive losses to properties throughout the Borough. The main causes of flooding include: Above Normal Tide Levels; and Inadequacy of the existing stormwater conveyance system.* • *The Master Plan establishes a ten (10) year plan aimed at mitigation of Borough-wide flooding.* • *The Master Plan recommended monitoring impervious coverage limits to ensure that they can maintain the balance of light and air along with historically desirable densities. This problem persists but has not been exacerbated.* • *93rd Street Stormwater Pump Station – to be completed 2022 – Reduce Nuisance Flooding in the business district.* • *Marina Improvements – improved bulkhead, raising of parking lot **See Master Plan Update 2019* • *Continued Infrastructure Improvements – 5 year Capital Improvement Plan*					
Stormwater Pollution Prevention Plan	Yes	State & Local	Yes	Yes	-
Comment: • *The Phase II New Jersey Pollutant Discharge Elimination System Stormwater Regulation Program (NJPDES) rules (N.J.A.C. 7:14A) were published in the February 2, 2004, NJ Register. These NJPDES rules are intended to address and reduce pollutants associated with existing stormwater runoff. The NJPDES rules establish a regulatory program for existing stormwater discharges as required under the Federal Clean Water Act. These NJPDES rules govern the issuance of permits to entities that own or operate small municipal separate storm sewer systems, known as MS4s. Under this program, permits must be secured by municipalities, certain public complexes such as universities and hospitals, and State, interstate and federal agencies that operate or maintain highways. The permit program establishes the Statewide Basic Requirements that must be implemented to reduce nonpoint source pollutant loads from these sources. The Statewide Basic Requirements include measures such as: the adoption of ordinances (litter control, pet waste, wildlife feeding, proper waste disposal, etc.); the development of a municipal stormwater management plan and implementing ordinance(s); requiring certain maintenance activities (such as street sweeping and catch basin cleaning); implementing solids and floatables control; locating discharge points and stenciling catch basins; and a public education component.* • *Stormwater Pollution Prevention Plan (SPPP), dated May 25, 2011 & revised December 26, 2019. The Plan addressed the Borough's ongoing compliance efforts with the MS4 regulations in the areas of Storm Drain Inlet Labeling; Outfall Mapping; Illicit Connections; Yard Waste Collection; Street Sweeping; Stormwater Facility Maintenance; Outfall Pipe Remediation; De-icing material storage; and Employee Training Requirements.*					
Urban Water Management Plan	No	-	No	-	-
Comment:					
Habitat Conservation Plan	Yes	State & Local	No	Yes	-

Comment:
• *Dune Vegetation Management Plan, dated June 2015. Goals of the Plan include;*
  ○ *Establish a science-based approach to evaluating and managing/restoring dune vegetation, in a manner ensuring that the Borough receives the critical safety and ecological services that its dunes can provide.*
  ○ *Develop a Dune Vegetation Management Plan that addresses control of Japanese black pine and other damaging invasive plants, as appropriate, by its removal and replacement with native vegetation*
  ○ *Provide management standards, techniques and recommended native plants that can be used for the vegetation restoration and enhancement component of the dune ecosystem*
• *In addition to the Dune Protection Ordinance, the Borough supports dune vegetation improvement programs through its Public Works Department and through volunteer beachgrass planting initiatives, in addition to education programs.*
• *Chapter 560-24 Conservation Management District*
• *Borough of Stone Harbor Beach Management Plan – For the protection of State & Federal listed species*					

Economic Development Plan	No	-	No	-	-
Comment:					
Shoreline Management Plan	Yes	Construction Office	Yes – if located in a coastal zone	Yes	-
Comment: • *NJ Coastal Area Facility Review Act (N.J.S.A. 13:19) or CAFRA regulates almost all development along the coast for activities including construction, relocation, and enlargement of buildings or structures, and excavation, grading, shore protection structures, and site preparation. This law is implemented through NJ's Coastal Zone management Rules N.J.A.C. 7:7E-1 et seq.*					

	Do you have this? (Yes/No)	Authority that enforces (Federal, State, Regional, County, Local)	Is this State Mandated?	Have aspects of this been integrated into your mitigation plan?	
				If yes- how? Describe in comments	If no - can it be a mitigation action? If yes, add Mitigation Action #.
Community Wildfire Protection Plan	No	-	No	-	-
Comment:					
Community Forest Management Plan	Yes	State & Local	No	Yes	-
Comment: • *Community Forestry Management Plan, submitted to the State in 2016 for 2016 – 2020. This Community Forestry Management Plan (CFMP or Plan) for the Borough of Stone Harbor was prepared to establish programs that recognize the unique nature of its tree resources and to plan future programs that will continue to protect and enhance these resources. The Borough established goals and objectives compatible with its forestry planning process vision to provide forest and tree streetscapes for the benefit of its residents and visitors in addition to the wildlife that rely on tree resources. The mission of the Borough's CFMP is to protect, enhance and sustain productive community shade tree and forest resources that will improve the quality of life for the residents, visitors and wildlife that inhabit and/or visit this unique resort community.*					
Transportation Plan	Yes	Local	No	No	-
Comment:					
Agriculture Plan	No	-	No	-	-
Comment:					
Climate Action Plan	No	-	No	-	-
Comment:					
Tourism Plan	No	-	No	-	-
Comment:					
Business Development Plan	No	-	No	-	-
Comment:					
Other	Yes	-	No	-	-

Comment:
• *Green Purchasing Policy, adopted by Borough Council on November 7, 2017. It is the policy & practice of the Borough of Stone Harbor to:*
  ○ *Institute practices that reduce waste by increasing product efficiency and effectiveness, and*
  ○ *Purchase products that minimize environmental impacts, toxics, pollution, and hazards to worker and community safety to the greatest extent practicable, and*
  ○ *Purchase products that include recycled content, are durable and long-lasting, conserve energy and water, use agricultural fibers and residues, reduce greenhouse gas emissions, use unbleached or chlorine free manufacturing processes, are lead-free and mercury-free, and use wood from sustainably harvested forests (FSC) when & where possible.*
• *The Borough instituted a Single Use Plastic ban within our Business District Chapter 466-19*					

Response/Recovery Planning					
Comprehensive Emergency Management Plan (CEMP) / Emergency Operations Plan (EOP)	Yes	Local OEM & State Police	Yes	Yes	-
Comment: • *Each county and municipality in the State shall prepare a written Emergency Operations Plan with all appropriate annexes necessary to implement the plan. Each Emergency Operations Plan shall be adopted no later than one year after the State Emergency Planning Guidelines have been adopted by the State Office of Emergency Management and shall be evaluated at such subsequent scheduled review of the State Emergency Operations Plan. L.1989, c.222, s.19.* • *The Municipal Emergency Manager, with support for County OEM and New Jersey OEM, is continuing to develop, enhance, and implement existing emergency plans.*					
Threat & Hazard Identification & Risk Assessment (THIRA)	No	-	No	-	-
Comment:					
Post-Disaster Recovery Plan	No	-	No	-	-

	Do you have this? (Yes/No)	Authority that enforces (Federal, State, Regional, County, Local)	Is this State Mandated?	Have aspects of this been integrated into your mitigation plan? If yes- how? Describe in comments	Have aspects of this been integrated into your mitigation plan? If no - can it be a mitigation action? If yes, add Mitigation Action #.
Comment:					
Continuity of Operations Plan	Yes	OEM Director	No	Yes	-
Comment:					
Public Health Plan	No	-	No	-	-
Comment:					
Other	No	-	No	-	-
Comment:					

Table 9.11-4. Development and Permitting Capability

Criterion	Response
Does your jurisdiction issue development permits? - If no, who does? If yes, which department?	Yes – Zoning Board Construction Office
Does your jurisdiction have the ability to track permits by hazard area?	Yes
Does your jurisdiction have a buildable lands inventory? -If yes, please describe briefly. -If no, please quantitatively describe the level of buildout in the jurisdiction.	No- the Borough is built-out and all new development is redevelopment.

Administrative and Technical Capability

The table below summarizes potential staff and personnel resources available to the Borough of Stone Harbor.

Table 9.11-5. Administrative and Technical Capabilities

Staff/Personnel Resource	Available?	Department/Agency/Position
Administrative Capability		
Planning Board	Yes	Zoning Officer
Mitigation Planning Committee	Yes	Flood Mitigation Committee
Environmental Board / Commission	No	-
Open Space Board / Committee	Yes	County
Economic Development Commission / Committee	Yes	Council
Warning Systems / Services (reverse 911, outdoor warning signals)	Yes	Fire Department & OEM. The Borough is maintaining flood siren warning systems throughout the Borough to alert residents in the event of an emergency.
Maintenance program to reduce risk	Yes	Public Works. There is a continued maintenance of the 12 outfall pipes along the beachfront of the Borough by regularly cleaning and adding replacement sands to the area for Emergency Access.
Mutual aid agreements	Yes	Police/Fire/Public Works. The Borough is creating, enhancing, and maintaining mutual aid agreements with neighboring communities.
Technical/Staffing Capability		

Staff/Personnel Resource	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Planning Board, Kates Schneider Engineering, LLC – Planner & DeBlasio & Associates, - Engineer
Engineers or professionals trained in building or infrastructure construction practices	Yes	Construction Official and Borough Engineer
Planners or engineers with an understanding of natural hazards	Yes	Kates Schneider Engineering, LLC – Planner & DeBlasio & Associates, - Engineer
Staff with training in benefit/cost analysis	Yes	CFO, Borough Engineer
Staff with training in green infrastructure	Yes	Borough Engineer, Public Works
Staff with education/knowledge/training in low impact development	No	-
Surveyor	Yes	DeBlasio & Associates
Stormwater engineer	Yes	DeBlasio & Associates
Personnel skilled or trained in GIS applications	Yes	Deblasio & Associates
Local or state water quality professional	Yes	Craig Loper, Licenses Operator
Scientist familiar with natural hazards in local area	Yes	Dr. Stewart Farrell, Coast Research Center
Emergency manager	Yes	Jonathan Lakose, OEM Director, Roger Stanford, Deputy
Watershed planner	Yes	Dr. Stewart Farrell, Stockton Coastal Research
Environmental specialist	Yes	Dr Lenore Tedesco, The Wetlands Institute
Grant writers	Yes	DeBlasio & Associates
Resilience Officer	No	-
Other	No	-

Fiscal Capability

The table below summarizes financial resources available to the Borough of Stone Harbor.

Table 9.11-6. Fiscal Capabilities

Financial Resource	Accessible or Eligible to Use?
Community Development Block Grants (CDBG, CDBG-DR)	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	No
Incur Debt through Private Activity Bonds	No
Withhold Public Expenditures in Hazard-Prone Areas	No
State-Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	No
Clean Water Act 319 Grants (Nonpoint Source Pollution)	No
Other	No

Education and Outreach Capability

The table below summarizes the education and outreach resources available to the Borough of Stone Harbor.

Table 9.11-7. Education and Outreach Capabilities

Criterion	Response
Do you have a public information officer or communications office?	Yes- Jenny Olson, Tourism Director/PIO
Do you have personnel skilled or trained in website development?	Yes- Joyce Media/Jenny Olson, Tourism Director
Do you have hazard mitigation information available on your website? -If yes, briefly describe.	Yes- Flood Information Tab that provides all aspects within CRS
Do you use social media for hazard mitigation education and outreach? -If yes, briefly describe.	Yes- Storm Notification, Hurricane Awareness and Preparedness, Links to FEMA Funding
Do you have any citizen boards or commissions that address issues related to hazard mitigation? -If yes, briefly describe.	Yes- Flood Mitigation Committee - Council, Environmental Specialists, Engineers, Public Works, Construction, OEM and Private Citizens
Do you have any other programs already in place that could be used to communicate hazard-related information? If yes, briefly describe.	Yes- Stone Harbor Emergency Website – CODE RED Notification

Community Classifications

The table below summarizes the classifications for community programs available to the Borough of Stone Harbor.

Table 9.11-8. Community Classifications

Program	Participating?	Classification	Date Classified
Community Rating System	Yes	5	May 1, 2014
Building Code Effectiveness Grading Schedule (BCEGS)	Yes	3	July 5, 2012
Public Protection (Fire ISO Protection Class)	Yes	3	2019
Storm Ready Certification	No	-	-
Firewise Community Classification	No	-	-
Sustainable Jersey	Yes	Silver	12/13/2017

Adaptive Capacity

Adaptive capacity is defined as "the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or respond to consequences" (IPCC 2014). In other words, it describes a jurisdiction's current ability to adjust to, protect from, or withstand a hazard event. This term is often discussed in reference to climate change; however, adaptive capacity also includes an understanding of local capacity for adapting to current and future risks and changing conditions. The table below summarizes the adaptive capacity for each hazard and the jurisdiction's rating.

Table 9.11-9. Adaptive Capacity

Hazard	Adaptive Capacity (Capabilities) – Strong/Moderate/Weak
Climate Change and SLR	Moderate
Coastal Erosion	Moderate
Disease Outbreak	Moderate
Drought	Moderate
Flood	Moderate
Hurricane	Moderate
Nor'Easter	Moderate
Severe Weather	Moderate
Severe Winter Weather	Strong
Tsunami	Moderate
Wildfire	Moderate

Notes:
Strong = Capacity exists and is in use; Moderate = Capacity may exist, but is not used or could use some improvement;
Weak = Capacity does not exist or could use substantial improvement; Unsure = Not enough information is known to assign a rating.

The Borough has access to resources to determine the possible impacts of climate change upon the municipality. For example, the Borough has tide gauges that monitor sea level rise and 16 sensors that measure stormwater. The Borough administration is supportive of integrating climate change in policies or actions and has already implemented a flood mitigation/stormwater master plan.

National Flood Insurance Program

This section provides specific information on the management and regulation of the regulatory floodplain.

Table 9.11-10. National Flood Insurance Program Compliance

Criterion	Response
What local department is responsible for floodplain management?	Construction Office
Who is your floodplain administrator? (name, department/position)	Ray Poudrier, Construction Official
Are any certified floodplain managers on staff in your jurisdiction?	Ray Poudrier, Construction Official & Marc DeBlasio, DeBlasio & Associates, Borough Engineer
What is the date that your flood damage prevention ordinance was last amended?	9/19/2017
Does your floodplain management program meet or exceed minimum requirements? -If exceeds, in what ways?	Exceeds – Substantial Improvements @ 40%. Greater of or Higher of +2 or 11 feet NAVD88
When was the most recent Community Assistance Visit or Community Assistance Contact?	January 2020 – Douglass Reedy ISO
Does your jurisdiction have any outstanding NFIP compliance violations that need to be addressed? -If so, state what they are.	No. The Borough is continuing to work with property owners to bring all applicable properties within the Borough up to code within the NFIP.
Are any RiskMAP projects currently underway in your jurisdiction? If so, state what they are.	Yes. The Borough participated in a FEMA Roadmap Workshop and worked on Risk Map Overlay
Do your flood hazard maps adequately address the flood risk within your jurisdiction? -If no, state why.	Yes
Does your floodplain management staff need any assistance or training to support its floodplain management program? - If so, what type of assistance/training is needed?	Yes – Always need updates for changing criteria. CRS Updates.
Does your jurisdiction participate in the Community Rating System (CRS)? -If yes, is your jurisdiction interested in improving its CRS Classification? -If no, is your jurisdiction interested in joining the CRS program?	The Borough participates and is interested in improving its ranking.
How many flood insurance policies are in force in your jurisdiction?* -What is the insurance in force? -What is the premium in force?	1,959 policies
How many total loss claims have been filed in your jurisdiction?* -How many claims are still open or were closed without payment? -What were the total payments for losses?	1,334 total claims $388,798 total payments for losses
Do you maintain a list of properties that have been damaged by flooding?	Yes – Repetitive Loss and Substantial Damage List.
Do you maintain a list of property owners interested in flood mitigation?	Yes - Listing reported within our CRS Certification

**According to FEMA statistics as of October 2020*

Additional Areas of Existing Integration

- The Borough, working with NJDEP and USACE, is working to maintain relationship with Army Corps and NJDEP for dune maintenance along the oceanfront via planting dune grass and installing sand fencing.
- There is a continuation of annual review of ordinances and appropriate laws with regard to planning, zoning and code enforcement within the Borough.
- Stone Harbor participates in Sustainable Jersey and has undertaken a number of actions to advance sustainability and resiliency. The Borough has completed the Climate Adaptation: Flood Risk action by comprehensively examining its existing and future flood risk. The Borough also received credit for emergency communications planning and its robust public outreach system. Stone Harbor received credit for a water conservation ordinance that mitigates the drought hazard.

9.11.5 Hazard Event History Specific to the Jurisdiction

Cape May County has a history of hazard events, as detailed in Section 5 (Risk Assessment) of this plan. A summary of historical events is provided in each of the hazard profiles in Section 5.4 (Hazard Profiles) and includes a chronology of events that affected Cape May County and its jurisdictions. The Borough of Stone Harbor's history of federally-declared (as presented by FEMA) and significant hazard events (as presented in NOAA-NCEI) is consistent with that of Cape May County. Table 9.11-11 provides details regarding municipal-specific loss and damages the Borough experienced during hazard events. Information provided in the table below is based on reference material or local sources.

Table 9.11-11. Hazard Event History

Date(s) of Event	Event Type (disaster declaration if applicable)	Cape May County Designated?	Summary of Event	Summary of Local Damages and Losses
January 23, 2016	Winter Storm Jonas (Nor'easter)	No. State Designated, yes	Severe winter storm which borough historic flooding to the Borough	Multiple businesses and homes in low-lying areas sustained moderate flood damage
October 27, 2018	Nor'easter	No	Nor'easter brought severe flooding to Borough.	Several businesses sustained moderate flood damage
August 4, 2020	Hurricane/Tropical Storm Isaias	Yes	Tropical Storm conditions, including high winds and heavy rains	Multiple buildings sustained minor wind damage. Widespread trees and wires down.

Source: FEMA; Borough of Stone Harbor

9.11.6 Jurisdiction-Specific Vulnerabilities and Hazard Ranking

The hazard profiles in Section 5 (Risk Assessment) provide detailed information regarding each plan participant's vulnerability to the identified hazards. A gradient of certainty was developed to summarize the confidence level regarding the input used to populate the hazard ranking. Refer to Section 5.1 (Methodology) and Section 5.3 (Hazard Ranking) for a detailed summary for the Borough of Stone Harbor risk assessment results and data used to determine the hazard ranking.

Repetitive Flood Losses

The table below summarizes the repetitive and severe repetitive flood losses in the Borough of Stone Harbor.

- Number of repetitive loss (RL) properties: 137
- Number of severe repetitive loss (SRL) properties: 38
- Number of RL/SRL properties that have been mitigated: 44

Source: NFIP FEMA Region 2, 2020
Note: The number of SRL properties excludes RL properties.

Critical Facilities

The table below identifies critical facilities in the community located in the 1-percent and 0.2-percent floodplain.

Table 9.11-12. Potential Flood Losses to Critical Facilities and Lifelines

Name	Type	Exposure 1% Event	Exposure 0.2% Event
104th. Street Bridge	Bridge	X	X
No Name	Communications Facility	X	X
No Name	Communications Facility	X	X
Borough Hall Communications Tower	Communications Facility	X	X
Stone Harbor Branch Library	County Facilities	X	X
STONE HARBOR ELEMENTARY	Education	X	X
Stone Harbor Branch Library	Library	X	X
Stone Harbor Public Marina	Marinas	X	X
Stone Harbor	Municipal Facilities	X	X
80th Street Well	Potable Water Facilities	X	X
92nd Street Well	Potable Water Facilities	X	X
95th Street Well	Potable Water Facilities	X	X
81St St Pump Station	Wastewater Treatment Facilities	X	X
93rd Street Lift Station	Wastewater Treatment Facilities	X	X
114th Street Lift Station	Wastewater Treatment Facilities	X	X
94th Street Lift Station	Wastewater Treatment Facilities	X	X
STONE HARBOR VOLUNTEER FIRE DEPARTMENT	Fire Stations		X
101st Street Well	Potable Water Facilities		X
Water Plant	Potable Water Facilities		X
Stone Harbor Police Department	Police Stations		X
STONE HARBOR FIRE HOUSE	Polling Places		X
STONE HARBOR RESCUE SQUAD	EMS		X
BORO OF STONE HARBOR Municipal Hall	Municipal Facilities		X

Source: FEMA DFIRM 2014/2017; Cape May County 2020

Identified Issues

The jurisdiction has identified the following vulnerabilities within their community:

- The Borough has low bulkhead heights along the bayfront. Bulkheads will be required to be eight feet high by 2050 and 6.2 feet high by 2026.
- Stone Harbor experiences nuisance flooding Third Avenue 93rd Street to 99th Street.

Hazard Area Extent and Location

Hazard area extent and location maps were generated for the Borough of Stone Harbor that illustrate the probable areas impacted within the municipality. These maps are based on the best available data at the time of the preparation of this plan and are adequate for planning purposes. Maps have been generated only for those hazards that can be clearly identified using mapping techniques and technologies and for which the Borough of Stone Harbor has significant exposure. A map of the Borough of Stone Harbor hazard area extent and location is provided on the following page. This map indicates the location of the regulatory floodplain, as well as identified critical facilities within the municipality.

HAZARD RANKING

This section includes the community specific identification of the primary hazard concerns based on identified problems, impacts and the results of the risk assessment as presented in Section 5 (Risk Assessment). The ranking process involves an assessment of the likelihood of occurrence for each hazard; its potential impacts on people, property, and the economy; community capability and changing future climate conditions. This input supports the mitigation action development to target those hazards with highest level of concern.

As discussed in Section 5.3 (Hazard Ranking), each plan participant may have differing degrees of risk exposure and vulnerability compared to Cape May County as a whole. Therefore, each jurisdiction ranked the degree of risk to each hazard as it pertains to their community factoring in their capabilities to withstand impacts and rebound after the event. The table below summarizes the hazard rankings of potential natural hazards for the Borough of Stone Harbor. The Borough of Stone Harbor has reviewed the Cape May County hazard ranking table and has provided input to its individual results to reflect the relative risk of the hazards of concern to the community.

During the review of the hazard ranking, the Borough assented to the proposed hazard ranking.

Table 9.11-13. Borough of Stone Harbor Hazard Ranking Input

Climate Change and SLR	Coastal Erosion	Disease Outbreak	Drought	Flood	Hurricane
High	Medium	Medium	Medium	High	High

Nor'Easter	Severe Weather	Severe Winter Weather	Tsunami	Wildfire
High	High	High	Medium	Medium

9.11.7 Mitigation Strategy and Prioritization

This section discusses past mitigations actions and status, describes proposed hazard mitigation initiatives, and provides action prioritization.

PAST MITIGATION INITIATIVE STATUS

The following table summarizes the jurisdiction's progress on their mitigation strategy identified in the 2015 HMP. Actions that are carried forward as part of this plan update are included in the following subsection in its own table with prioritization. Previous actions that are now on-going programs and capabilities are indicated as such in the following table and can also be found under 'Capability Assessment' presented previously in this annex.

Table 9.11-14. Status of Previous HMP Mitigation Actions

2015 Action Number	Action Description	Responsible Party	Status (In Progress, No Progress, Ongoing Capability, or Completed)	Include in the 2021 HMP Update? Check if Yes	Enter 2021 HMP Action #
SH-1a (former SH-1a)	Property Mitigation Support – Retrofit	Borough (likely through NFIP Floodplain Administrator)	In Progress	X	2021-StoneHarbor-005
SH-1b (former SH-1b)	Property Mitigation Support – Acquisition/Relocation	Borough (likely through NFIP Floodplain Administrator)	No Progress, not interested in acquisition		
SH-1c	Retrofit or relocate critical facilities in the 100-year floodplain	Borough (likely through NFIP Floodplain Administrator); working with facility manager/operator	In Progress	X	2021-StoneHarbor-006
SH-2 (former SH-2, -4)	Strive to maintain compliance with, and good-standing in the National Flood Insurance program, including continued active participation in incentive-based program.	Borough (primarily through NFIP Floodplain Administrator) & CRS Coordinator	Ongoing Capability		
SH-3 (former SH-3)	Continue to support the implementation, monitoring, maintenance, and updating of this Plan, as defined in Section 7.0	Borough (through mitigation planning point of contacts)	Ongoing Capability		
SH-4	Train staff or acquire contract support for benefit-cost analysis	Borough (primarily through NFIP Floodplain Administrator and Engineering)	In Progress	X	2021-StoneHarbor-007
SH-5 (former SH-5)	Continue to develop, enhance, and implement existing emergency plans.	Municipal Emergency Manager with support from County OEM and NJ OEM	Ongoing Capability		
SH-6 (former SH-6)	Create/enhance/ maintain mutual aid agreements with neighboring communities.	Borough	Ongoing Capability		
SH-7 (former SH-7)	Support County-wide initiatives identified in Section 9.1 of the County Annex.	Local departments (as applicable for specific initiative)	Ongoing Capability		
SH-8 (former SH-8 and SH-22)	Continue to support beach replenishment activities from 98th to 111th Streets. This is an ongoing yearly initiative	NJDEP with Borough support	In Progress	X	2021-StoneHarbor-008
SH-9 (former SH-9)	Continue stormwater drainage improvements throughout the Borough to increase capacity.	Borough	In Progress	X	2021-StoneHarbor-009
SH-10 (former SH-10a (CMC-26, BA-8)	Upgrade stormwater system on CR-619 through Stone Harbor and Avalon. Seven stormwater pump stations were installed along CR-619 from Avalon Boulevard to 19th Street (Avalon business district) to address flooding in this area.	County Engineering with municipalities	In Progress	X	2021-StoneHarbor-010
SH-11 (former SH-11)	Support installation of back-up generator at SH School. Assist in obtaining grants when available.	School Board; with Borough support as appropriate	No Progress	X	2021-StoneHarbor-011

2015 Action Number	Action Description	Responsible Party	Status (In Progress, No Progress, Ongoing Capability, or Completed)	Include in the 2021 HMP Update? Check if Yes	Enter 2021 HMP Action #
SH-12 (former SH-12)	Remote tide-gages with cameras, using tide gauges at CMC Bridge Comm. and 80th Street Marina.	Borough	In Progress	X	2021-StoneHarbor-012
SH-13 (former SH-14)	Support private property owner with elevation of The Market (commercial property).	Borough	No Progress		
SH-14 (CMC-14)	Elevate Stone Harbor Boulevard (CR-657) from the Parkway into Stone Harbor proper	County Engineering, with local support	No Progress	X	2021-StoneHarbor-013
SH-15	Maintain relationship with Army Corps and NJDEP for dune maintenance along the oceanfront via planting dune grass and installing sand fencing.	Borough; working with NJDEP and USACE	Ongoing Capability		
SH-16	Continue annual review of ordinances and appropriate laws with regard to planning, zoning and code enforcement within the Borough.	Medium - High	Ongoing Capability		
SH-17	Maintain the 12 outfall pipes along the beachfront of the Borough by regularly cleaning and adding replacement sands to the area for Emergency Access.	High	Ongoing Capability		
SH-18	Continue to work with property owners to bring all applicable properties within the Borough up to code within the NFIP.	Medium - High	Ongoing Capability		
SH-19	Maintain flood siren warning systems throughout the Borough to alert residents in the event of an emergency.	Medium - High	Ongoing Capability		

In addition to the above progress, the Borough of Stone Harbor identified the following mitigation projects/activities that were completed but not identified in the 2015 HMP mitigation strategy:

- The Borough undertook stormwater improvements to 111th Street to prevent the collection of rainwater at the 111th & Second Street intersection.
- The Borough raised 88th Street adjacent to the bulkhead.
- Stone Harbor Point has been subject to sand replenishment in support of ecological enhancements.
- At 92nd Street as it curves onto Sunset Drive, two storm basins were added in addition to a pipe that ran to 93rd Street to collect and redirect the flow to the 93rd Street bay end outlet and onto the bay.
- During the 95th Street road project between First Avenue to Sunset Drive, storm water basins were added to help collect runoff and move it to the other side of the street. In addition, any old existing basins were removed and replaced. A pipe was added to cross Second Avenue from east to west to change the flow that once flowed to 94th Street, ensuring all ran down 95th Street to end at back bay outlet.

Proposed Hazard Mitigation Initiatives for the Plan Update

The Borough of Stone Harbor participated in a risk assessment workshop in June 2020 in which detailed information was provided about assets exposed and vulnerable to the identified hazards of concern. The Borough of Stone

Harbor participated in a mitigation action workshop in July 2020 and was provided a Mitigation Toolbox that included a mitigation catalog developed specifically for Cape May County and its hazards of concerns; challenges and opportunities identified during the capability and risk assessments; and the following FEMA publications to use as a resource as part of their comprehensive review of all possible activities and mitigation measures to address their hazards: FEMA 551 *Selecting Appropriate Mitigation Measures for Floodprone Structures* (March 2007) and FEMA *Mitigation Ideas – A Resource for Reducing Risk to Natural Hazards* (January 2013). Section 6 (Mitigation Strategy) and Appendix F (Mitigation Strategy Supplement) provide a more complete description of the Mitigation Toolbox and its resources.

Table 9.11-15 summarizes the comprehensive-range of specific mitigation initiatives the Borough of Stone Harbor would like to pursue in the future to reduce the effects of hazards. Some of these initiatives might be previous actions carried forward for this HMP update. Initiatives are dependent upon available funding (grants and local match availability) and can be modified or omitted at any time based on the occurrence of new hazard events and changes in municipal priorities. Both the 4 FEMA mitigation action categories and the 6 CRS mitigation action categories are listed in the table below to further demonstrate the wide-range of activities and mitigation measures selected.

As discussed in Section 6 (Mitigation Strategy), 14 evaluation/prioritization criteria are used to complete the prioritization of mitigation initiatives. For each new mitigation action, a numeric rank is assigned (-1, 0, or 1) for each of the 14 evaluation criteria to assist with prioritizing actions as *High*, *Medium*, or *Low*. The table below summarizes the evaluation of each mitigation initiative, listed by action number.

Table 9.11-16 provides a summary of the prioritization of all proposed mitigation initiatives for this HMP update.

Table 9.11-15. Proposed Hazard Mitigation Initiatives

Initiative Number	Mitigation Initiative Name	Description of the Problem and Solution	New or Existing Assets?	Hazard(s) to be Mitigated	Goals Met	Lead and Support Agencies	Potential Funding Sources	Estimated Benefits	Estimated Cost	Timeline	Priority	Mitigation Category	CRS Category
2021-StoneHarbor-001	Stone Harbor Hazard Mitigation Initiatives for Land Development	**Problem**: In 2020, Borough representatives joined the NJ Office of Planning Advocacy, NJ Department of Environmental Protection, and FEMA Region II in the development of land use strategies to mitigate natural hazards in the Borough. The initiative examined the Borough's land development regulations and collaboratively developed recommendations to mitigate flood risk. While Stone Harbor's flood development regulations exceed NFIP requirements, further improvements were acknowledged as critical for fostering resiliency. **Solution:** The Borough proposes to implement three land use practices: overlay zoning, critical infrastructure protection, and modifying required development application submittals to consider hazards.	New	Flood; Hurricane/Tropical Storm; Nor'easter; Coastal Erosion; Climate Change and Sea Level Rise	1, 3, 4, 6	Stone Harbor Administration; NJDEP; NJOPA; FEMA Region II	Borough funds; existing staff capabilities	Enhanced resilience to natural hazards	None	Short-term	High	LPR	PR
2021-StoneHarbor-002	Bayside Stormwater Pump Station	**Problem**: The bayfront areas of Stone Harbor the Borough's lowest lying developed areas. Flooding is evident in these areas with water levels as little as one foot above typical high tide. During rain events in conjunction with high tides, runoff cannot discharge through back bay outfalls. **Solution:** The Borough proposes to construct a bayside stormwater pump station to pump runoff out of flooded streets. Outfalls will also be re-routed to facilitate drainage.	New	Flood; Hurricane/Tropical Storm; Nor'easter; Climate Change and Sea Level Rise; Severe Weather	1, 3	Borough Engineer/Borough Certified Floodplain Manager/Director of Public Works	HMGP; BRIC; Local match	Alleviate flooding in roadways, homes and allow for access to businesses	$8 million	Less than five years	High	SIP	SP
2021-StoneHarbor-003	Boat Ramp Marina Raising	**Problem**: The Borough's Boat Ramp at 81st Street is located at elevation 4.0 NAVD88 datum. Floodwaters enter through boat ramp resulting in flooding of marina parking lot and surrounding area. **Solution:** The Borough proposes to remove and elevate boat ramp to 6.0 feet and add	Existing	Flood; Hurricane/Tropical Storm; Nor'easter; Climate Change and Sea Level Rise	1, 3	Borough Engineer/Borough Floodplain Manager/Director of	HMGP; BRIC; Local match	Alleviate flooding - roadways, surrou	$500,000	Less than two	High	SIP	SP

Initiative Number	Mitigation Initiative Name	Description of the Problem and Solution	New or Existing Assets?	Hazard(s) to be Mitigated	Goals Met	Lead and Support Agencies	Potential Funding Sources	Estimated Benefits	Estimated Cost	Timeline	Priority	Mitigation Category	CRS Category
		a flood gate to allow functional use of the ramp and enabling closures during surge events.				Public Works		nding properties		years			
2021-StoneHarbor-004	Bayside Outfall Tide Closure Valves	**Problem**: Tidal water floods roadways by entering bayside outfalls. Tidal water then backs up through stormwater pipes and inlets and onto streets, causing nuisance flooding. Duck bill valves are currently in place on outfalls to prevent backflow, but do not close during storm events. **Solution:** Install automated (mechanical) tide valves that close during high tides.	Existing	Flood; Hurricane/Tropical Storm; Nor'easter; Climate Change and Sea Level Rise	1, 3	Borough Engineer/Borough Certified Floodplain Manager/Director of Public Works	HMGP, BRIC, Borough budget	Alleviate flooding in roadways, homes and allow for access to businesses	$2 million	Less than two years	High	SIP	SP
2021-StoneHarbor-005 (Former SH-1a)	Property Mitigation Support – Retrofit	**Problem**: Stone Harbor has a number of repetitive loss, severe repetitive loss, and substantially damaged properties. Many of these structures were built without flood design standards. These properties require mitigation to prevent future losses and prevent loss of life and property damage. Progress has been made on elevating buildings and reconstructing new buildings that are more resistant to flooding. **Solution:** Where appropriate, support retrofitting (e.g. elevation) of structures located in hazard-prone areas to protect structures from future damage, with substantial damages, repetitive loss and severe repetitive loss properties as priority. Identify facilities that are viable candidates for retrofitting based on cost-effectiveness versus relocation. Where retrofitting is determined to be a viable option, consider implementation of that action based on available funding.	Existing	Flood; Hurricane/Tropical Storm; Nor'easter; Climate Change and Sea Level Rise; Severe Weather	1, 3, 4	Floodplain Administrator, Homeowners	FMA; HMGP; Owner funds	High	High	Long Term DOF	High	SIP	PP
2021-StoneHarbor-006	Critical Facilities Retrofit	**Problem**: Numerous critical facilities and lifelines in Stone Harbor are located in the Special Flood Hazard Area. The facilities	Existing	Flood; Hurricane/Tropical Storm;	1, 3, 4	Borough (likely through	FMA; HMGP; Owner	High	High	Long Te	High	SIP	PP

Initiative Number	Mitigation Initiative Name	Description of the Problem and Solution	New or Existing Assets?	Hazard(s) to be Mitigated	Goals Met	Lead and Support Agencies	Potential Funding Sources	Estimated Benefits	Estimated Cost	Timeline	Priority	Mitigation Category	CRS Category
(Former SH-1c)		provide crucial services to Stone Harbor and require elevation and floodproofing to continue providing service during future flooding events. **Solution:** Design and construct improvements to critical facilities or construct new critical facilities that are floodproofed to the 500 year base flood elevation and higher.		Nor'easter; Climate Change and Sea Level Rise; Severe Weather		NFIP Floodplain Administrator); working with facility manager/operator	funds; Local match			rm DOF			
2021-StoneHarbor-007 (Former SH-4)	Benefit Cost Analysis Training	**Problem**: Benefit cost analyses help identify and prioritize projects that protect people and property. With climate change and sea level rise posing increasing risks to the Borough, benefit cost analysis training has been identified as a need to assist Borough officials with determining what kinds of infrastructure projects should be pursued. **Solution:** Train staff or acquire contract support for benefit-cost analysis.	N/A	All Hazards	1, 2, 3, 4, 5, 6	Borough (primarily through NFIP Floodplain Administrator and Engineering); FEMA	Local Budget	Medium	Low	Short term	High	EAP	PI
2021-StoneHarbor-008 (Former SH-8)	Beach Replenishment Innovations	**Problem:** The Borough has US Army Corps of Engineers-replenished beaches and receives periodic maintenance refurbishments funded by the Borough and NJDEP. Given existing inefficiencies and the maintenance need, alternatives and innovations to existing replenishment projects are desired to help the Borough retain sand for its beaches and dunes. **Solution:** Continue to support beach replenishment activities from 98th to 111th Streets and explore innovative options for replenishment.	Existing	Hurricane, Nor'Easter, Coastal Erosion, Flooding, Severe Weather	1, 3, 5	NJDEP with Borough support	NJDEP – 75%; Borough – 25%; US Army Corps	High	High	Long term	High	NSP	NR
2021-StoneHarbor-009 (Former SH-9)	Stormwater Management Enhancements	**Problem:** Stone Harbor is low-lying and continually experiences nuisance flooding aggravated by stormwater conditions. Drainage improvements have been undertaken throughout the Borough though new and proposed improvements continue to be identified per the Watershed Management Plan and capital improvement plan.	Existing	Flood; Hurricane/Tropical Storm; Nor'easter; Climate Change and Sea Level Rise; Severe Weather	1, 3, 4, 5	Borough Engineer	Borough funds; BRIC	High	High	Long term	High	SIP	PP

Initiative Number	Mitigation Initiative Name	Description of the Problem and Solution	New or Existing Assets?	Hazard(s) to be Mitigated	Goals Met	Lead and Support Agencies	Potential Funding Sources	Estimated Benefits	Estimated Cost	Timeline	Priority	Mitigation Category	CRS Category
		Solution: Continue stormwater drainage improvements throughout the Borough to increase capacity.											
2021-StoneHarbor-010 (Former SH-10)	Seven Mile Island CR-619 Stormwater Improvements (See 2021-CapeMayCounty-018)	**Problem**: Ocean Drive/Third Avenue in Avalon and Stone Harbor is a major thoroughfare connecting the communities and is the longest and busiest roadway in Avalon and Stone Harbor that is most vulnerable to flooding. Flooding impacts begin with a flood event bringing water levels just one foot above high tide. The removal of outfalls is currently in the design phase. The Borough is currently at 60% Design of new Stormwater Pump Station at 93rd & Third Ave. **Solution:** Upgrade stormwater system on CR-619 through Stone Harbor and Avalon. Seven stormwater pump stations were installed along CR-619 from Avalon Boulevard to 19th Street (Avalon business district) to address flooding in this area.	Existing	Flood; Hurricane/Tropical Storm; Nor'easter; Climate Change and Sea Level Rise	1, 3, 4, 6	County Engineering with municipalities	FEMA HMA grant programs, local match	High	High	Long Term DOF	Medium	SIP	PP
2021-StoneHarbor-011 (Former SH-11)	SHES Generator	**Problem**: The Stone Harbor Elementary School lacks a back-up generator. The School is a designated critical facility. **Solution:** Support installation of back-up generator at SH School.	Existing	Flood; Hurricane/Tropical Storm; Nor'easter; Severe Winter Weather; Severe Weather	1, 3, 4	School Board; with Borough support as appropriate	FEMA BRIC; School Board/Borough funds	High-continued functioning of school facility during outages	Medium	Long Term DOF	M-H (DOF)	SIP	PP
2021-StoneHarbor-012 (Former SH-12)	Flood Cameras	**Problem**: The Borough carefully tracks flooding owing to its vulnerability. Several problem areas in the Borough are bellwethers for flooding in the Borough and region as a whole. The ability to remotely sense and view flooding would support life safety and emergency management efforts. **Solution:** The Borough seeks to install flood cameras at the 96th Street bridge and at the 81st Street boat ramp.	New	Flood; Hurricane/Tropical Storm; Nor'easter; Climate Change and Sea Level Rise	1, 3, 4	Borough Administration	Local, Coastal Coalition	Medium	Medium	Short term	High	EAP	PI
2021-StoneHa		**Problem**: Stone Harbor Boulevard (CR-657) is the principal access point into the	Existing	Flood; Hurricane/Trop	1, 3, 4	County Engineering	County funds;	Continued	High	Long		SIP	PP

Initiative Number	Mitigation Initiative Name	Description of the Problem and Solution	New or Existing Assets?	Hazard(s) to be Mitigated	Goals Met	Lead and Support Agencies	Potential Funding Sources	Estimated Benefits	Estimated Cost	Timeline	Priority	Mitigation Category	CRS Category
rbor-013 (Former SH-13)	Stone Harbor Boulevard Elevation	Borough and stretches from Exit 10 into Stone Harbor proper. The roadway is vulnerable to tidal flooding at levels that exceed two feet above typical high tide. The roadway sees between 5,000 and 6,000 vehicles on average each day and is an evacuation route. **Solution:** Elevate Stone Harbor Boulevard (CR-657) from the Parkway into Stone Harbor up to the base flood elevation.		ical Storm; Nor'easter; Climate Change and Sea Level Rise; Severe Weather		, with local support	Local match; BRIC; NJDOT	use of evacuation route and access to Stone Harbor		Term DOF	Medium		
2021-StoneHarbor-014	Disaster Debris Management Plan	**Problem:** The Borough lacks a debris management plan. **Solution:** The Borough will develop and adopt a Disaster Debris Management Plan.	N/A	All Hazards	4, 6	Administration	Municipal budget	Plan in place for debris management	Staff time	1 year	High	LPR	ES

Notes:

Acronyms and Abbreviations:

CAV	*Community Assistance Visit*
CRS	*Community Rating System*
DPW	*Department of Public Works*
FEMA	*Federal Emergency Management Agency*
FPA	*Floodplain Administrator*
HMA	*Hazard Mitigation Assistance*
N/A	*Not applicable*
NFIP	*National Flood Insurance Program*
OEM	*Office of Emergency Management*

Potential FEMA HMA Funding Sources:

FMA	*Flood Mitigation Assistance Grant Program*
HMGP	*Hazard Mitigation Grant Program*
BRIC	*Building Resilient Infrastructure and Communities Program*

Timeline:
The time required for completion of the project upon implementation

Cost:
The estimated cost for implementation.

Benefits:
A description of the estimated benefits, either quantitative and/or qualitative.

Mitigation Category:

- *Local Plans and Regulations (LPR) – These actions include government authorities, policies or codes that influence the way land and buildings are being developed and built.*
- *Structure and Infrastructure Project (SIP) - These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could apply to public or private structures as well as critical facilities and infrastructure. This type of action also involves projects to construct manmade structures to reduce the impact of hazards.*
- *Natural Systems Protection (NSP) – These are actions that minimize damage and losses and preserve or restore the functions of natural systems.*
- *Education and Awareness Programs (EAP) – These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. These actions may also include participation in national programs, such as StormReady and Firewise Communities.*

CRS Category:

- *Preventative Measures (PR) - Government, administrative or regulatory actions, or processes that influence the way land and buildings are developed and built. Examples include planning and zoning, floodplain local laws, capital improvement programs, open space preservation, and storm water management regulations.*
- *Property Protection (PP) - These actions include public activities to reduce hazard losses or actions that involve (1) modification of existing buildings or structures to protect them from a hazard or (2) removal of the structures from the hazard area. Examples include acquisition, elevation, relocation, structural retrofits, storm shutters, and shatter-resistant glass.*

- *Public Information (PI) - Actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. Actions include outreach projects, real estate disclosure, hazard information centers, and educational programs for school-age children and adults.*
- *Natural Resource Protection (NR) - Actions that minimize hazard loss and preserve or restore the functions of natural systems. Actions include sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.*
- *Structural Flood Control Projects (SP) - Actions that involve the construction of structures to reduce the impact of a hazard. Structures include dams, setback levees, floodwalls, retaining walls, and safe rooms.*
- *Emergency Services (ES) - Actions that protect people and property during and immediately following a disaster or hazard event. Services include warning systems, emergency response services, and the protection of essential facilities.*

Table 9.11-16. Summary of Prioritization of Actions

Initiative Number	Mitigation Initiative Name	Life Safety	Property Protection	Cost Effectiveness	Technical	Political	Legal	Fiscal	Environmental	Social	Administrative	Multi-Hazard	Timeline	Agency Champion	Other Community Objectives	Total	High / Medium / Low
2021-StoneHarbor-001	Stone Harbor Hazard Mitigation Initiatives for Land Development	1	1	1	1	1	1	1	1	0	0	1	1	1	1	12	High
2021-StoneHarbor-002	Bayside Stormwater Pump Station	1	1	1	1	1	1	0	1	0	0	1	0	1	1	10	High
2021-StoneHarbor-003	Boat Ramp Marina Raising	1	1	1	1	1	1	-1	1	0	0	1	1	1	1	11	High
2021-StoneHarbor-004	Bayside Outfall Tide Closure Valves	1	1	1	1	1	1	0	1	1	0	1	1	1	1	12	High
2021-StoneHarbor-005 (Former SH-1a)	Property Mitigation Support – Retrofit	1	1	1	1	1	0	0	0	1	1	1	0	1	0	9	High
2021-StoneHarbor-006 (Former SH-1c)	Critical Facilities Retrofit	1	1	1	1	1	1	0	0	1	1	1	0	1	0	10	High
2021-StoneHarbor-007 (Former SH-4)	Benefit Cost Analysis Training	1	1	1	1	1	1	1	0	1	1	1	1	0	0	11	High
2021-StoneHarbor-008 (Former SH-8)	Beach Replenishment Innovations	1	1	1	1	0	1	0	0	1	1	1	0	1	1	9	High
2021-StoneHarbor-009 (Former SH-9)	Stormwater Management Enhancements	0	1	1	1	1	1	0	1	1	1	1	0	1	1	11	High
2021-StoneHarbor-010 (Former SH-10)	Seven Mile Island CR-619 Stormwater Improvements (See 2021-CapeMayCounty-018)	1	1	1	1	1	0	0	1	0	0	1	0	1	0	9	Medium
2021-StoneHarbor-011 (Former SH-11)	SHES Generator	1	1	1	1	1	0	0	1	1	1	1	0	1	1	11	High

Initiative Number	Mitigation Initiative Name	Life Safety	Property Protection	Cost Effectiveness	Technical	Political	Legal	Fiscal	Environmental	Social	Administrative	Multi-Hazard	Timeline	Agency Champion	Other Community Objectives	Total	High / Medium / Low
2021-StoneHarbor-012 (Former SH-12)	Flood Cameras	1	1	1	1	1	1	1	1	1	1	1	1	1	1	14	High
2021-StoneHarbor-013 (Former SH-13)	Stone Harbor Boulevard Elevation	1	0	0	1	1	0	1	1	1	0	1	0	1	0	8	Medium
2021-StoneHarbor-014	Disaster Debris Management Plan	0	1	1	1	1	1	1	1	1	1	1	1	1	1	13	High

Notes: *Section 6 (Mitigation Strategy) conveys guidance on prioritizing mitigation actions.*
Low (0-4), Medium (5-8), High (9-14).

Table 9.11-17. Analysis of Mitigation Actions by Hazard and Category

Hazard	Prevention	Property Protection	Public Education and Awareness	Natural Resource Protection	Emergency Services	Structural Projects	Climate Resilient	Community Capacity Building
Climate Change and Sea Leve Rise	X	X	X		X	X	X	X
Coastal Erosion	X		X	X	X			X
Disease Outbreak			X		X			X
Drought			X		X			X
Flood	X	X	X	X	X	X		X
Hurricane	X	X	X	X	X	X		X
Nor'easter	X	X	X	X	X	X		X
Severe Weather		X	X	X	X	X		X
Severe Winter Weather			X		X			X
Tsunami			X		X			X
Wildfire			X		X			X

Note: Section 6 (Mitigation Strategy) provides for an explanation of the mitigation categories.
RED high ranked hazard
ORANGE medium ranked hazard
YELLOW low ranked hazard

9.11.8 Staff and Local Stakeholder Involvement in Annex Development

The Borough of Stone Harbor followed the planning process described in Section 3 (Planning Process). This annex was developed over the course of several months with input from many jurisdiction representatives. All departments were asked to contribute to the annex development through reviewing and contributing to the capability assessment, reporting on the status of previously identified actions, and participating in action identification and prioritization. The following table summarizes who participated and in what capacity. Additional documentation on the municipality's planning process through Planning Partnership meetings is included in Section 3 (Planning Process) and Appendix C (Meeting Documentation).

Table 9.11-18. Contributors to the Annex

Name	Title	Method of Participation
Kim Stevenson	CRS Coordinator	Annex Development and Review, Project Development, Meeting Attendance
Marc Deblasio	Borough Engineer	Project Development, Meeting Attendance
Ray Poudrier	Construction Official/CFM	Annex Review, Meeting Attendance
Robert Smith	Borough Administrator	Annex Review, Meeting Attendance
Jonathan Lakose	OEM Coordinator	Annex Review, Meeting Attendance

Figure 9.11-1. Borough of Stone Harbor Hazard Area Extent and Location Map 1

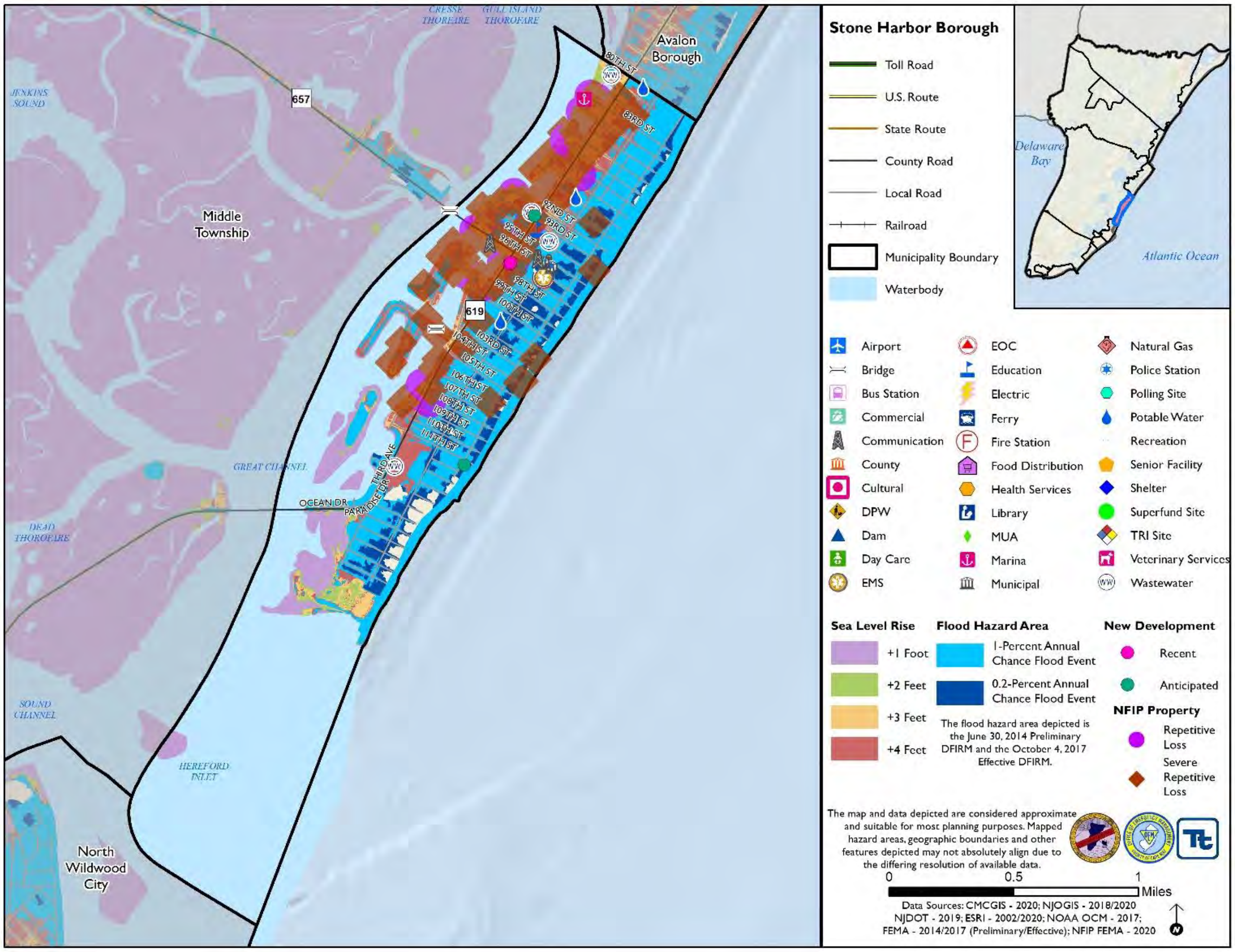


Figure 9.11-2. Borough of Stone Harbor Hazard Area Extent and Location Map 2

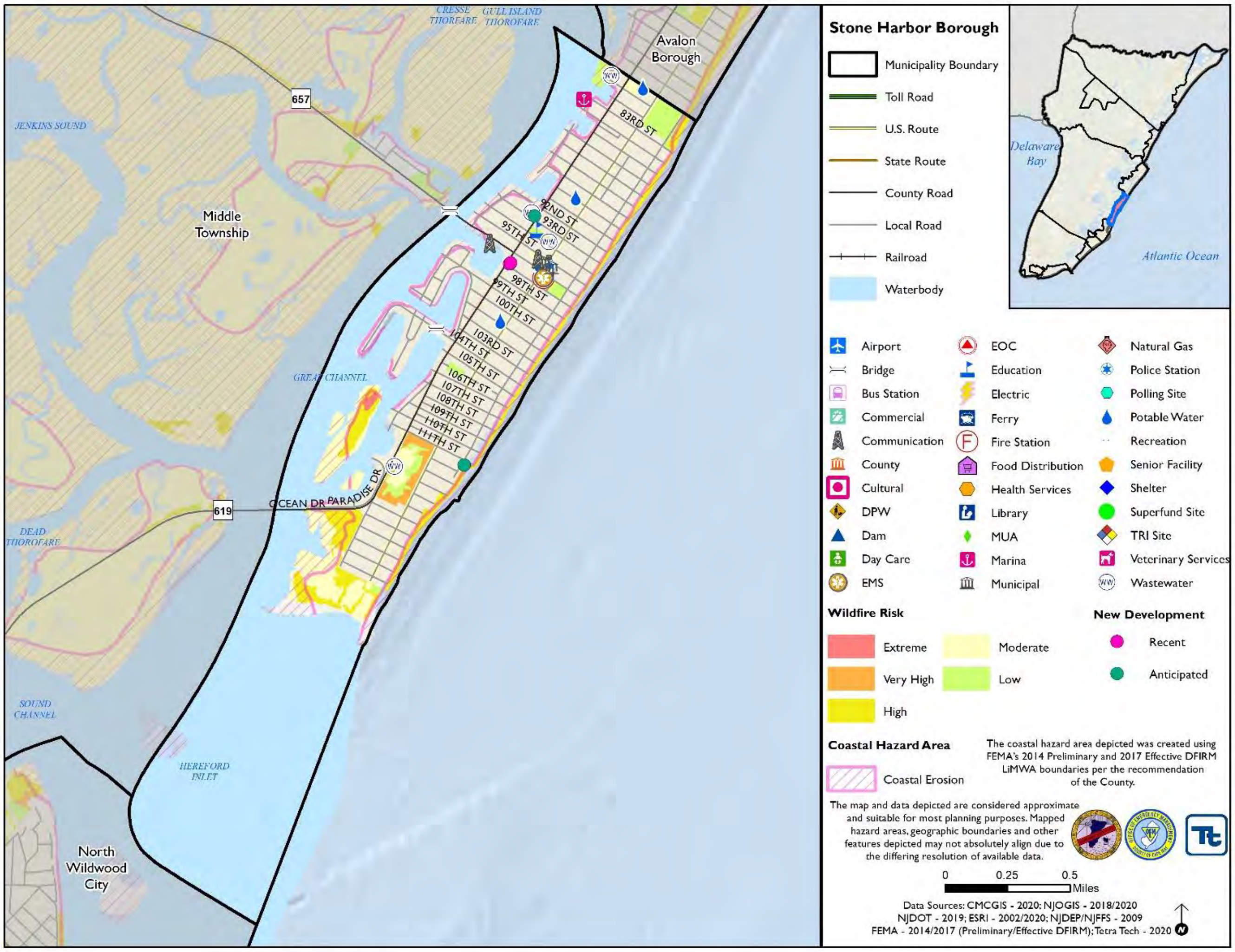
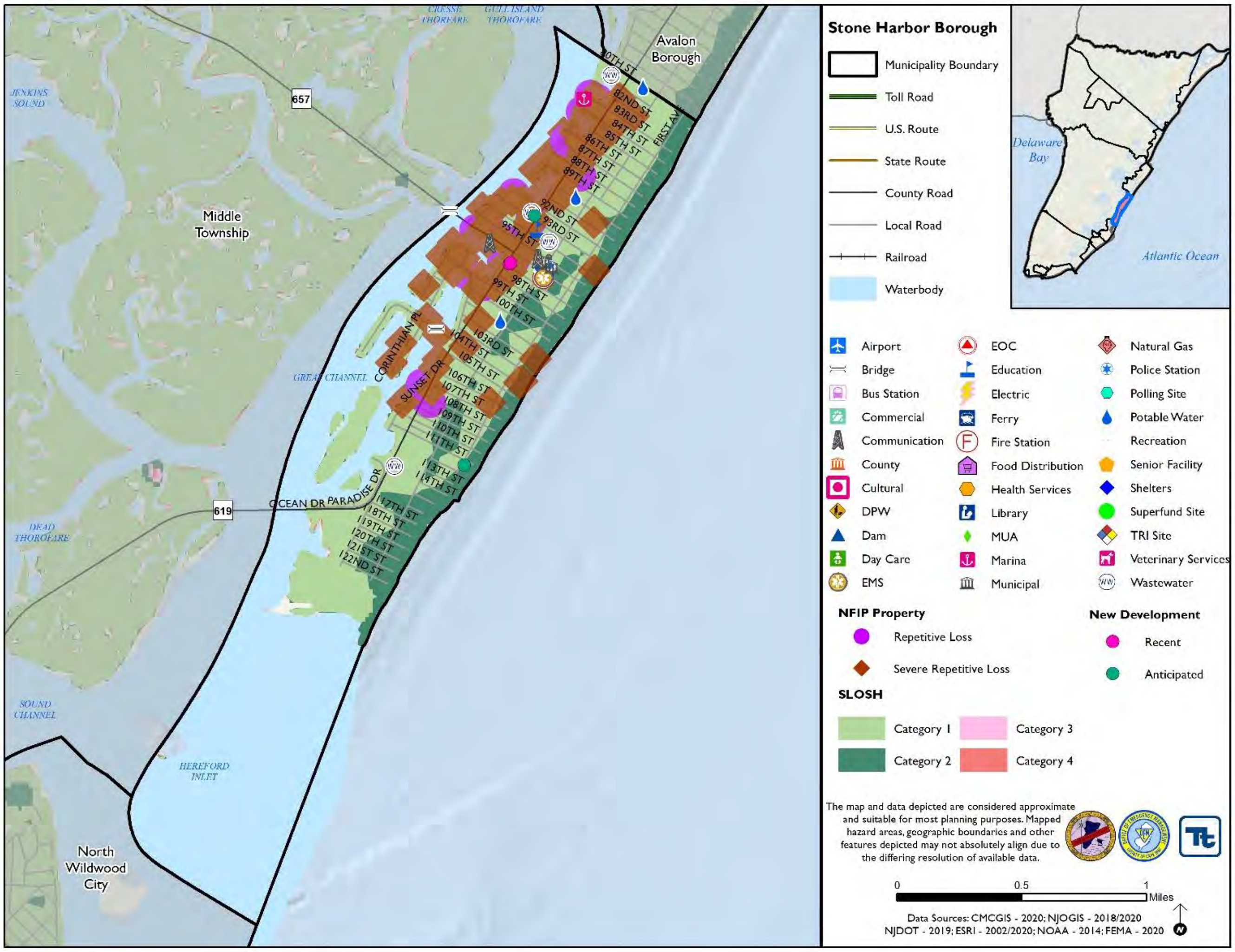


Figure 9.11-3. Borough of Stone Harbor Hazard Area Extent and Location Map 3



Action Worksheet			
Project Name:	Bayside Stormwater Pump Station		
Project Number:	2021-StoneHarbor-002		
Risk / Vulnerability			
Hazard(s) of Concern:	Flood; Hurricane/Tropical Storm; Nor'easter; Climate Change and Sea Level Rise; Severe Weather		
Description of the Problem:	The bayfront areas of Stone Harbor the Borough's lowest lying developed areas. Flooding is evident in these areas with water levels as little as one foot above typical high tide. During rain events in conjunction with high tides, runoff cannot discharge through back bay outfalls.		
Action or Project Intended for Implementation			
Description of the Solution:	The Borough proposes to construct a bayside stormwater pump station to pump runoff out of flooded streets. Outfalls will also be re-routed to facilitate drainage.		
Is this project related to a Critical Facility or Lifeline?	Yes ☐	No ☒	
Level of Protection:	Base Flood Elevation	**Estimated Benefits (losses avoided):**	Alleviate flooding in roadways, homes and allow for access to businesses
Useful Life:	30 years	**Goals Met:**	1, 3
Estimated Cost:	$8 million	**Mitigation Action Type:**	Structure and Infrastructure Project
Plan for Implementation			
Prioritization:	High	**Desired Timeframe for Implementation:**	Within five years
Estimated Time Required for Project Implementation:	2 Years	**Potential Funding Sources:**	HMGP; BRIC; Local match
Responsible Organization:	Borough Engineer/Borough Certified Floodplain Manager/Director of Public Works	**Local Planning Mechanisms to be Used in Implementation if any:**	Watershed Management Plan
Three Alternatives Considered (including No Action)			
Alternatives:	**Action**	**Estimated Cost**	**Evaluation**
	No Action	--	Continued flooding
	Remove outfalls and replace with larger outfalls	High	Pumping needed
	Installing actuated tidal valves	High	Pumping needed
Progress Report (for plan maintenance)			
Date of Status Report:			
Report of Progress:			
Update Evaluation of the Problem and/or Solution:			

Action Worksheet		
Project Name:	Bayside Stormwater Pump Station	
Project Number:	2021-StoneHarbor-002	
Criteria	**Numeric Rank (-1, 0, 1)**	**Provide brief rationale for numeric rank when appropriate**
Life Safety	1	
Property Protection	1	
Cost-Effectiveness	1	
Technical	1	
Political	1	
Legal	1	The Borough has the legal authority to complete the project
Fiscal	0	Project requires funding support
Environmental	1	
Social	0	
Administrative	0	
Multi-Hazard	1	Flood; Hurricane/Tropical Storm; Nor'easter; Climate Change and Sea Level Rise; Severe Weather
Timeline	1	
Agency Champion	1	Borough Engineer/Borough Certified Floodplain Manager/Director of Public Works
Other Community Objectives	1	
Total	11	
Priority (High/Med/Low)	High	

Action Worksheet			
Project Name:	Boat Ramp Marina Raising		
Project Number:	2021-StoneHarbor-003		
Risk / Vulnerability			
Hazard(s) of Concern:	Flood; Hurricane/Tropical Storm; Nor'easter; Climate Change and Sea Level Rise; Severe Weather		
Description of the Problem:	The Borough's Boat Ramp at 81st Street is located at elevation 4.0 NAVD88 datum. Floodwaters enter through boat ramp resulting in flooding of marina parking lot and surrounding area.		
Action or Project Intended for Implementation			
Description of the Solution:	The Borough proposes to remove and elevate boat ramp to 6.0 feet and add a flood gate to allow functional use of the ramp and enabling closures during surge events.		
Is this project related to a Critical Facility or Lifeline?	Yes ☐	No ☒	
Level of Protection:	100 year	**Estimated Benefits (losses avoided):**	Alleviate flooding - roadways, surrounding properties
Useful Life:	50 years	**Goals Met:**	1, 3
Estimated Cost:	$500,000	**Mitigation Action Type:**	Structure and Infrastructure Project
Plan for Implementation			
Prioritization:	High	**Desired Timeframe for Implementation:**	Within 2 years
Estimated Time Required for Project Implementation:	1 Year	**Potential Funding Sources:**	HMGP; BRIC; Local match
Responsible Organization:	Borough Engineer/Borough Floodplain Manager/Director of Public Works	**Local Planning Mechanisms to be Used in Implementation if any:**	Watershed Master Plan
Three Alternatives Considered (including No Action)			
Alternatives:	**Action**	**Estimated Cost**	**Evaluation**
	No Action	N/A	Flooding Continues
	Eliminate Boat Ramp	Low	Loss of access
	Add Flood Gate	Medium	Requires deployment, requires monitoring of flooding conditions
Progress Report (for plan maintenance)			
Date of Status Report:			
Report of Progress:			
Update Evaluation of the Problem and/or Solution:			

Action Worksheet		
Project Name:	Boat Ramp Marina Raising	
Project Number:	2021-StoneHarbor-003	
Criteria	**Numeric Rank (-1, 0, 1)**	**Provide brief rationale for numeric rank when appropriate**
Life Safety	1	
Property Protection	1	
Cost-Effectiveness	1	Saves on flood insurance claims
Technical	1	Design is underway
Political	1	
Legal	1	Borough owns land
Fiscal	-1	Borough engineer created design- there was an opportunity for open space funding but County was not in favor of boat ramp specifically
Environmental	1	
Social	0	
Administrative	0	
Multi-Hazard	1	Flood; Hurricane/Tropical Storm; Nor'easter; Climate Change and Sea Level Rise; Severe Weather
Timeline	1	Project imminent
Agency Champion	1	
Other Community Objectives	1	Master Plan- Recreation goals
Total	11	
Priority (High/Med/Low)	High	

Action Worksheet			
Project Name:	Bayside Outfall Tide Closure Valves		
Project Number:	2021-StoneHarbor-004		
Risk / Vulnerability			
Hazard(s) of Concern:	Flood; Hurricane/Tropical Storm; Nor'easter; Climate Change and Sea Level Rise		
Description of the Problem:	Tidal water floods roadways by entering bayside outfalls. Tidal water then backs up through stormwater pipes and inlets and onto streets, causing nuisance flooding. Duck bill valves are currently in place on outfalls to prevent backflow, but do not close during storm events.		
Action or Project Intended for Implementation			
Description of the Solution:	Install automated (mechanical) tide valves that close during high tides.		
Is this project related to a Critical Facility or Lifeline?	Yes ☐	No ☒	
Level of Protection:	100 year	**Estimated Benefits (losses avoided):**	Alleviate flooding in roadways, homes and allow for access to businesses
Useful Life:	5 years	**Goals Met:**	1, 3
Estimated Cost:	2 Million	**Mitigation Action Type:**	Structure and Infrastructure Project
Plan for Implementation			
Prioritization:	High	**Desired Timeframe for Implementation:**	Less than two years
Estimated Time Required for Project Implementation:	1.5 Years	**Potential Funding Sources:**	HMGP, BRIC, Borough budget
Responsible Organization:	Borough Engineer/Borough Certified Floodplain Manager/Director of Public Works	**Local Planning Mechanisms to be Used in Implementation if any:**	Watershed Master Plan
Three Alternatives Considered (including No Action)			
Alternatives:	**Action**	**Estimated Cost**	**Evaluation**
	No Action	N/A	Problem Continues
	Consolidate Outfalls	High	May not be feasible
	Add Pump Station	High	Costly
Progress Report (for plan maintenance)			
Date of Status Report:			
Report of Progress:			
Update Evaluation of the Problem and/or Solution:			

Action Worksheet		
Project Name:	Bayside Outfall Tide Closure Valves	
Project Number:	2021-StoneHarbor-004	
Criteria	**Numeric Rank (-1, 0, 1)**	**Provide brief rationale for numeric rank when appropriate**
Life Safety	1	
Property Protection	1	
Cost-Effectiveness	1	
Technical	1	
Political	1	
Legal	1	Borough owns all outfalls except for some County-owned
Fiscal	0	The project requires funding support.
Environmental	1	
Social	1	Fewer nuisance flooding events
Administrative	0	
Multi-Hazard	1	Flood; Hurricane/Tropical Storm; Nor'easter; Climate Change and Sea Level Rise
Timeline	1	Within next year
Agency Champion	1	
Other Community Objectives	1	Stormwater Plan
Total	12	
Priority (High/Med/Low)	High	

	Action Worksheet		
Project Name:	Property Mitigation Support – Retrofit		
Project Number:	2021-StoneHarbor-005 (Former SH-1a)		
	Risk / Vulnerability		
Hazard(s) of Concern:	Hurricane, Nor'Easter, Flood, Severe Weather		
Description of the Problem:	Stone Harbor has a number of repetitive loss, severe repetitive loss, and substantially damaged properties. Many of these structures were built without flood design standards. These properties require mitigation to prevent future losses and prevent loss of life and property damage. Progress has been made on elevating buildings and reconstructing new buildings that are more resistant to flooding.		
	Action or Project Intended for Implementation		
Description of the Solution:	Where appropriate, support retrofitting (e.g. elevation) of structures located in hazard-prone areas to protect structures from future damage, with repetitive loss and severe repetitive loss properties as priority. Identify facilities that are viable candidates for retrofitting based on cost-effectiveness versus relocation. Where retrofitting is determined to be a viable option, consider implementation of that action based on available funding.		
Is this project related to a Critical Facility or Lifeline?		Yes ☐	No ☒
Level of Protection:	Base Flood Elevation	**Estimated Benefits (losses avoided):**	High
Useful Life:	30 years	**Goals Met:**	1, 3, 4
Estimated Cost:	High	**Mitigation Action Type:**	Structure and Infrastructure Project
	Plan for Implementation		
Prioritization:	High	**Desired Timeframe for Implementation:**	Long term
Estimated Time Required for Project Implementation:	Long Term DOF	**Potential Funding Sources:**	FEMA Mitigation Grant Programs (primarily HMGP and FMA); local property owner for match as supported by ICC and other non-Federal match sources as available.
Responsible Organization:	Borough (likely through NFIP Floodplain Administrator)	**Local Planning Mechanisms to be Used in Implementation if any:**	Building Code, Zoning Code
	Three Alternatives Considered (including No Action)		
Alternatives:	**Action**	**Estimated Cost**	**Evaluation**
	No Action	$0	Current problem continues
	Elevate roads	$500,000+	Elevated roadways would not protect the homes from flood damages
	Install floodwalls around neighborhoods that flood	$500,000+	Costly; not feasible in all areas that experience flood damage; some homes could still experience damage
	Progress Report (for plan maintenance)		

Action Worksheet		
Project Name:	Property Mitigation Support – Retrofit	
Project Number:	2021-StoneHarbor-005 (Former SH-1a)	
Criteria	**Numeric Rank (-1, 0, 1)**	**Provide brief rationale for numeric rank when appropriate**
Life Safety	1	
Property Protection	1	Properties protected from flooding
Cost-Effectiveness	1	
Technical	1	
Political	1	
Legal	0	
Fiscal	0	The project requires funding support
Environmental	0	
Social	1	
Administrative	1	
Multi-Hazard	1	Hurricane, Nor'Easter, Flood, Severe Weather
Timeline	0	Long term
Agency Champion	1	Borough (likely through NFIP Floodplain Administrator)
Other Community Objectives	0	
Total	9	
Priority (High/Med/Low)	High	

<table>
<tr><th colspan="5">Action Worksheet</th></tr>
<tr><td>Project Name:</td><td colspan="4">Critical Facility Retrofit/floodproofing</td></tr>
<tr><td>Project Number:</td><td colspan="4">2021-StoneHarbor-006 (Former SH-1c)</td></tr>
<tr><th colspan="5">Risk / Vulnerability</th></tr>
<tr><td>Hazard(s) of Concern:</td><td colspan="4">Flood; Hurricane/Tropical Storm; Nor'easter; Climate Change and Sea Level Rise; Severe Weather</td></tr>
<tr><td>Description of the Problem:</td><td colspan="4">Numerous critical facilities and lifelines in Stone Harbor are located in the Special Flood Hazard Area. The facilities provide crucial services to Stone Harbor and require elevation and floodproofing to continue providing service during future flooding events.</td></tr>
<tr><th colspan="5">Action or Project Intended for Implementation</th></tr>
<tr><td>Description of the Solution:</td><td colspan="4">Design and construct improvements to critical facilities or construct new critical facilities that are floodproofed to the 500 year base flood elevation and higher.</td></tr>
<tr><td colspan="2">Is this project related to a Critical Facility or Lifeline?</td><td>Yes ☒</td><td colspan="2">No ☐</td></tr>
<tr><td>Level of Protection:</td><td>500-year flood elevation plus two feet</td><td>Estimated Benefits (losses avoided):</td><td colspan="2">High</td></tr>
<tr><td>Useful Life:</td><td>Variable</td><td>Goals Met:</td><td colspan="2">1, 3, 4</td></tr>
<tr><td>Estimated Cost:</td><td>High</td><td>Mitigation Action Type:</td><td colspan="2">Structure and Infrastructure Project</td></tr>
<tr><th colspan="5">Plan for Implementation</th></tr>
<tr><td>Prioritization:</td><td>High</td><td>Desired Timeframe for Implementation:</td><td colspan="2">Five years</td></tr>
<tr><td>Estimated Time Required for Project Implementation:</td><td>Long Term DOF</td><td>Potential Funding Sources:</td><td colspan="2">FEMA Mitigation Grant Programs (primarily HMGP and FMA); local property owner for match as supported by ICC and other non-Federal match sources as available.</td></tr>
<tr><td>Responsible Organization:</td><td>Borough (likely through NFIP Floodplain Administrator); working with facility manager/operator</td><td>Local Planning Mechanisms to be Used in Implementation if any:</td><td colspan="2">Capital improvement plan; watershed master plan</td></tr>
<tr><th colspan="5">Three Alternatives Considered (including No Action)</th></tr>
<tr><td rowspan="4">Alternatives:</td><td>Action</td><td>Estimated Cost</td><td colspan="2">Evaluation</td></tr>
<tr><td>No Action</td><td>$0</td><td colspan="2">Current problem continues</td></tr>
<tr><td>Relocate CFs</td><td>High</td><td colspan="2">Not feasible due to lack of locations</td></tr>
<tr><td>Floodproof CFs</td><td>High</td><td colspan="2">Feasible</td></tr>
<tr><th colspan="5">Progress Report (for plan maintenance)</th></tr>
<tr><td>Date of Status Report:</td><td colspan="4"></td></tr>
<tr><td>Report of Progress:</td><td colspan="4"></td></tr>
<tr><td>Update Evaluation of the Problem and/or Solution:</td><td colspan="4"></td></tr>
</table>

Action Worksheet		
Project Name:	Critical Facility Retrofit/floodproofing	
Project Number:	2021-StoneHarbor-006 (Former SH-1c)	
Criteria	**Numeric Rank (-1, 0, 1)**	**Provide brief rationale for numeric rank when appropriate**
Life Safety	1	Protect critical services
Property Protection	1	Protect critical facilities from damage
Cost-Effectiveness	1	
Technical	1	
Political	1	
Legal	1	The Borough has the legal authority to complete the project
Fiscal	0	Project requires funding support
Environmental	0	
Social	1	
Administrative	1	
Multi-Hazard	1	Flood; Hurricane/Tropical Storm; Nor'easter; Climate Change and Sea Level Rise; Severe Weather
Timeline	0	5 years
Agency Champion	1	Borough (likely through NFIP Floodplain Administrator); working with facility manager/operator
Other Community Objectives	0	
Total	10	
Priority (High/Med/Low)	High	

Action Worksheet			
Project Name:	Stormwater Management Enhancements		
Project Number:	2021-StoneHarbor-009 (Former SH-9)		
Risk / Vulnerability			
Hazard(s) of Concern:	Hurricane, Nor'Easter, Flood, Severe Weather		
Description of the Problem:	Stone Harbor is low-lying and continually experiences nuisance flooding aggravated by stormwater conditions. Drainage improvements have been undertaken throughout the Borough though new and proposed improvements continue to be identified per the Watershed Management Plan and capital improvement plan.		
Action or Project Intended for Implementation			
Description of the Solution:	Continue stormwater drainage improvements throughout the Borough to increase capacity.		
Is this project related to a Critical Facility or Lifeline?	Yes ☒	No ☐	
Level of Protection:	N/A	**Estimated Benefits (losses avoided):**	High
Useful Life:	50 years	**Goals Met:**	1, 3, 4, 5
Estimated Cost:	High	**Mitigation Action Type:**	Structure and Infrastructure Project
Plan for Implementation			
Prioritization:	High	**Desired Timeframe for Implementation:**	Long Term
Estimated Time Required for Project Implementation:	This is a yearly initiative through our annual infrastructure upgrades, included in our yearly and long range capital plan.	**Potential Funding Sources:**	This is a yearly initiative through our annual infrastructure upgrades, included in our yearly and long range capital plan.
Responsible Organization:	Borough Engineer	**Local Planning Mechanisms to be Used in Implementation if any:**	Capital Improvement Plan; Watershed Management Plan
Three Alternatives Considered (including No Action)			
Alternatives:	**Action**	**Estimated Cost**	**Evaluation**
	No Action	$0	Current problem continues
	Road elevations	High	Does not mitigate flooding completely
	Drainage Improvements	TBD	Alleviates drainage
Progress Report (for plan maintenance)			
Date of Status Report:			
Report of Progress:			
Update Evaluation of the Problem and/or Solution:			

Action Worksheet		
Project Name:	Stormwater Management Enhancements	
Project Number:	2021-StoneHarbor-009 (Former SH-9)	
Criteria	**Numeric Rank (-1, 0, 1)**	**Provide brief rationale for numeric rank when appropriate**
Life Safety	0	
Property Protection	1	
Cost-Effectiveness	1	
Technical	1	
Political	1	
Legal	1	The Borough has the legal authority to complete the project
Fiscal	0	The project requires funding support
Environmental	1	
Social	1	
Administrative	1	
Multi-Hazard	1	Hurricane, Nor'Easter, Flood, Severe Weather
Timeline	0	Long term
Agency Champion	1	Borough Engineer
Other Community Objectives	1	
Total	11	
Priority (High/Med/Low)	High	

Action Worksheet			
Project Name:	Seven Mile Island CR-619 Stormwater Improvements		
Project Number:	2021-StoneHarbor-010		
Risk / Vulnerability			
Hazard(s) of Concern:	Flood; Hurricane/Tropical Storm; Nor'easter; Climate Change and Sea Level Rise		
Description of the Problem:	Ocean Drive/Third Avenue in Avalon and Stone Harbor is a major thoroughfare connecting the communities and is the longest and busiest roadway in Avalon and Stone Harbor that is most vulnerable to flooding. Flooding impacts begin with a flood event bringing water levels just one foot above high tide. The removal of outfalls is currently in the design phase.		
Action or Project Intended for Implementation			
Description of the Solution:	The County will upgrade the stormwater system on CR-619 through Stone Harbor and Avalon.		
Is this project related to a Critical Facility or Lifeline?	Yes ☐	No ☒	
Level of Protection:	TBD by design	**Estimated Benefits (losses avoided):**	High
Useful Life:	30 years	**Goals Met:**	1, 3, 4, 6
Estimated Cost:	High	**Mitigation Action Type:**	Structure and Infrastructure
Plan for Implementation			
Prioritization:	Medium	**Desired Timeframe for Implementation:**	Within five years
Estimated Time Required for Project Implementation:	Long Term DOF	**Potential Funding Sources:**	FEMA HMA grant programs, local match
Responsible Organization:	County Engineering with municipalities	**Local Planning Mechanisms to be Used in Implementation if any:**	CIP; Local floodplain management plans
Three Alternatives Considered (including No Action)			
Alternatives:	**Action**	**Estimated Cost**	**Evaluation**
	No Action	$0	Current problem continues
	Road elevation	High	Not currently feasible
	Drainage Upgrades	High	Less disruptive than elevation
Progress Report (for plan maintenance)			
Date of Status Report:			
Report of Progress:			
Update Evaluation of the Problem and/or Solution:			

Action Worksheet		
Project Name:	Seven Mile Island CR-619 Stormwater Improvements	
Project Number:	2021-StoneHarbor-010	
Criteria	**2021-StoneHarbor-010**	**Provide brief rationale for numeric rank when appropriate**
Life Safety	1	
Property Protection	1	Project will protect roadway from flooding
Cost-Effectiveness	1	
Technical	1	
Political	1	
Legal	0	The project is under the county's jurisdiction
Fiscal	0	The project requires funding support
Environmental	1	
Social	1	
Administrative	0	
Multi-Hazard	1	Flood; Hurricane/Tropical Storm; Nor'easter; Climate Change and Sea Level Rise
Timeline	0	Within five years
Agency Champion	1	County Engineering with municipalities
Other Community Objectives	0	
Total	9	
Priority (High/Med/Low)	High	

Action Worksheet			
Project Name:	SHES Generator		
Project Number:	2021-StoneHarbor-011 (Former SH-11)		
Risk / Vulnerability			
Hazard(s) of Concern:	All Hazards, except Wildfire and Coastal Erosion		
Description of the Problem:	The Stone Harbor Elementary School lacks a back-up generator. The School is a designated critical facility.		
Action or Project Intended for Implementation			
Description of the Solution:	Support installation of back-up generator at SH School. Assist in obtaining grants when available.		
Is this project related to a Critical Facility or Lifeline?	Yes ☒	No ☐	
Level of Protection:	500 Year Flood Level	**Estimated Benefits (losses avoided):**	High- continued functioning of school facility during outages
Useful Life:	30 years	**Goals Met:**	1, 3, 4
Estimated Cost:	Medium	**Mitigation Action Type:**	Structure and Infrastructure Project
Plan for Implementation			
Prioritization:	High	**Desired Timeframe for Implementation:**	Within five years
Estimated Time Required for Project Implementation:	Long Term DOF	**Potential Funding Sources:**	FEMA BRIC; School Board/Borough funds
Responsible Organization:	School Board; with Borough support as appropriate	**Local Planning Mechanisms to be Used in Implementation if any:**	Capital Improvements Plan
Three Alternatives Considered (including No Action)			
Alternatives:	**Action**	**Estimated Cost**	**Evaluation**
	No Action	$0	Current problem continues
	Microgrid	High	Cost prohibitive
	Solar panels	High	Weather dependent
Progress Report (for plan maintenance)			
Date of Status Report:			
Report of Progress:			
Update Evaluation of the Problem and/or Solution:			

Action Worksheet		
Project Name:	SHES Generator	
Project Number:	2021-StoneHarbor-011 (Former SH-11)	
Criteria	**Numeric Rank (-1, 0, 1)**	**Provide brief rationale for numeric rank when appropriate**
Life Safety	1	Project will protect critical services of the school
Property Protection	1	Project will protect school from power outages
Cost-Effectiveness	1	
Technical	1	
Political	1	
Legal	0	The project is under the school's jurisdiction
Fiscal	0	The project requires funding support
Environmental	1	
Social	1	
Administrative	1	
Multi-Hazard	1	All Hazards, except Wildfire and Coastal Erosion
Timeline	0	Within 5 years
Agency Champion	1	
Other Community Objectives	1	
Total	11	
Priority (High/Med/Low)	High	

<table>
<tr><th colspan="4">Action Worksheet</th></tr>
<tr><td>Project Name:</td><td colspan="3">Stone Harbor Boulevard Elevation</td></tr>
<tr><td>Project Number:</td><td colspan="3">2021-StoneHarbor-013 (Former SH-13)</td></tr>
<tr><th colspan="4">Risk / Vulnerability</th></tr>
<tr><td>Hazard(s) of Concern:</td><td colspan="3">Flood; Hurricane/Tropical Storm; Nor'easter; Climate Change and Sea Level Rise; Severe Weather</td></tr>
<tr><td>Description of the Problem:</td><td colspan="3">Stone Harbor Boulevard (CR-657) is the principal access point into the Borough and stretches from Exit 10 into Stone Harbor proper. The roadway is vulnerable to tidal flooding at levels that exceed two feet above typical high tide. The roadway sees between 5,000 and 6,000 vehicles on average each day and is an evacuation route.</td></tr>
<tr><th colspan="4">Action or Project Intended for Implementation</th></tr>
<tr><td>Description of the Solution:</td><td colspan="3">The County will elevate Stone Harbor Boulevard (CR-657) from the Parkway into Stone Harbor up to the base flood elevation.</td></tr>
<tr><td colspan="2">Is this project related to a Critical Facility or Lifeline?</td><td>Yes ☐</td><td>No ☒</td></tr>
<tr><td>Level of Protection:</td><td>Base Flood Elevation</td><td>Estimated Benefits (losses avoided):</td><td>Continued use of evacuation route and access to Stone Harbor</td></tr>
<tr><td>Useful Life:</td><td>50 years</td><td>Goals Met:</td><td>1, 3, 4</td></tr>
<tr><td>Estimated Cost:</td><td>High</td><td>Mitigation Action Type:</td><td>Structure and Infrastructure Project</td></tr>
<tr><th colspan="4">Plan for Implementation</th></tr>
<tr><td>Prioritization:</td><td>Medium</td><td>Desired Timeframe for Implementation:</td><td>Within 5 years</td></tr>
<tr><td>Estimated Time Required for Project Implementation:</td><td>Long Term DOF</td><td>Potential Funding Sources:</td><td>County funds; Local match; BRIC; NJDOT</td></tr>
<tr><td>Responsible Organization:</td><td>County Engineering, with local support</td><td>Local Planning Mechanisms to be Used in Implementation if any:</td><td>Capital Improvement Plan</td></tr>
<tr><th colspan="4">Three Alternatives Considered (including No Action)</th></tr>
<tr><td rowspan="4">Alternatives:</td><td>Action</td><td>Estimated Cost</td><td>Evaluation</td></tr>
<tr><td>No Action</td><td>$0</td><td>Current problem continues</td></tr>
<tr><td>Road abandonment</td><td>Low</td><td>Loss of access</td></tr>
<tr><td>Road elevation</td><td>High</td><td>Continued access during high water events</td></tr>
<tr><th colspan="4">Progress Report (for plan maintenance)</th></tr>
<tr><td>Date of Status Report:</td><td colspan="3"></td></tr>
<tr><td>Report of Progress:</td><td colspan="3"></td></tr>
<tr><td>Update Evaluation of the Problem and/or Solution:</td><td colspan="3"></td></tr>
</table>

Action Worksheet		
Project Name:	Stone Harbor Boulevard Elevation	
Project Number:	2021-StoneHarbor-013 (Former SH-14)	
Criteria	**Numeric Rank (-1, 0, 1)**	**Provide brief rationale for numeric rank when appropriate**
Life Safety	1	Project maintains emergency access to Stone Harbor Boulevard
Property Protection	0	
Cost-Effectiveness	0	
Technical	1	
Political	1	
Legal	0	The project is under the county's jurisdiction
Fiscal	1	The project has funding support
Environmental	1	
Social	1	
Administrative	0	
Multi-Hazard	1	Flood; Hurricane/Tropical Storm; Nor'easter; Climate Change and Sea Level Rise; Severe Weather
Timeline	0	Within 5 years
Agency Champion	1	County Engineering, with local support
Other Community Objectives	0	
Total	8	
Priority (High/Med/Low)	Medium	

Stormwater Management Ordinance
(*DRAFT*)

(2)

BOROUGH OF STONE HARBOR
CAPE MAY COUNTY
ORDINANCE NO. 1584

Storm Water Regulations – Replaces current Chapter 470

Chapter #470 – Stormwater Management

Section I. Scope and Purpose:

A. Policy Statement

Flood control, groundwater recharge, and pollutant reduction shall be achieved through the use of stormwater management measures, including green infrastructure Best Management Practices (GI BMPs) and nonstructural stormwater management strategies. GI BMPs and low impact development (LID) should be utilized to meet the goal of maintaining natural hydrology to reduce stormwater runoff volume, reduce erosion, encourage infiltration and groundwater recharge, and reduce pollution. GI BMPs and LID should be developed based upon physical site conditions and the origin, nature and the anticipated quantity, or amount, of potential pollutants. Multiple stormwater management BMPs may be necessary to achieve the established performance standards for water quality, quantity, and groundwater recharge.

B. Purpose

The purpose of this ordinance is to establish minimum stormwater management requirements and controls for "major development," as defined below in Section II.

C. Applicability

1. This ordinance shall be applicable to the following major developments:
   a. Non-residential major developments; and
   b. Aspects of residential major developments that are not pre-empted by the Residential Site Improvement Standards at N.J.A.C. 5:21.
2. This ordinance shall also be applicable to all major developments undertaken by the Borough of Stone Harbor.

D. Compatibility with Other Permit and Ordinance Requirements

Development approvals issued pursuant to this ordinance are to be considered an integral part of development approvals and do not relieve the applicant of the responsibility to secure required permits or approvals for activities regulated by any other applicable code, rule, act, or ordinance. In their interpretation and application, the provisions of this ordinance shall be held to be the minimum requirements for the promotion of the public health, safety, and general welfare.

This ordinance is not intended to interfere with, abrogate, or annul any other ordinances, rule or regulation, statute, or other provision of law except that, where any provision of this ordinance imposes restrictions different from those imposed by any other ordinance, rule or regulation, or other provision of law, the more restrictive provisions or higher standards shall control.

Section II. Definitions:

For the purpose of this ordinance, the following terms, phrases, words and their derivations shall have the meanings stated herein unless their use in the text of this Chapter clearly demonstrates a different meaning. When not inconsistent with the context, words used in the present tense include the future, words used in the plural number include the singular number, and words used in the singular number include the plural number. The word "shall" is always mandatory and not merely directory. The definitions below are the same as or based on the corresponding definitions in the Stormwater Management Rules at N.J.A.C. 7:8-1.2.

"CAFRA Centers, Cores or Nodes" means those areas with boundaries incorporated by reference or revised by the Department in accordance with N.J.A.C. 7:7-13.16.

"CAFRA Planning Map" means the map used by the Department to identify the location of Coastal Planning Areas, CAFRA centers, CAFRA cores, and CAFRA nodes. The CAFRA Planning Map is available on the Department's Geographic Information System (GIS).

"Community basin" means an infiltration system, sand filter designed to infiltrate, standard constructed wetland, or wet pond, established in accordance with N.J.A.C. 7:8-4.2(c)14, that is designed and constructed in accordance with the New Jersey Stormwater Best Management Practices Manual, or an alternate design, approved in accordance with N.J.A.C. 7:8-5.2(g), for an infiltration system, sand filter designed to infiltrate, standard constructed wetland, or wet pond and that complies with the requirements of this chapter.

"Compaction" means the increase in soil bulk density.

"Contributory drainage area" means the area from which stormwater runoff drains to a stormwater management measure, not including the area of the stormwater management measure itself.

"Core" means a pedestrian-oriented area of commercial and civic uses serving the surrounding municipality, generally including housing and access to public transportation.

"County review agency" means an agency designated by the County Commissioners to review municipal stormwater management plans and implementing ordinance(s). The county review agency may either be:

1. A county planning agency or

2. A county water resource association created under N.J.S.A 58:16A-55.5, if the ordinance or resolution delegates authority to approve, conditionally approve, or disapprove municipal stormwater management plans and implementing ordinances.

"Department" means the Department of Environmental Protection.

"Designated Center" means a State Development and Redevelopment Plan Center as designated by the State Planning Commission such as urban, regional, town, village, or hamlet.

"Design engineer" means a person professionally qualified and duly licensed in New Jersey to perform engineering services that may include, but not necessarily be limited to, development of project requirements, creation and development of project design and preparation of drawings and specifications.

"Development" means the division of a parcel of land into two or more parcels, the construction, reconstruction, conversion, structural alteration, relocation or enlarge-enlargement of any building or structure, any mining excavation or landfill, and any use or change in the use of any building or other structure, or land or extension of use of land, for which permission is required under the Municipal Land Use Law, N.J.S.A. 40:55D-1 *et seq.*

In the case of development of agricultural land, development means: any activity that requires a State permit, any activity reviewed by the County

Agricultural Board (CAB) and the State Agricultural Development Committee (SADC), and municipal review of any activity not exempted by the Right to Farm Act , N.J.S.A 4:1C-1 et seq.

"Disturbance" means the placement or reconstruction of impervious surface or motor vehicle surface, or exposure and/or movement of soil or bedrock or clearing, cutting, or removing of vegetation. Milling and repaving is not considered disturbance for the purposes of this definition.

"Drainage area" means a geographic area within which stormwater, sediments, or dissolved materials drain to a particular receiving waterbody or to a particular point along a receiving waterbody.

"Environmentally constrained area" means the following areas where the physical alteration of the land is in some way restricted, either through regulation, easement, deed restriction or ownership such as: wetlands, floodplains, threatened and endangered species sites or designated habitats, and parks and preserves. Habitats of endangered or threatened species are identified using the Department's Landscape Project as approved by the Department's Endangered and Nongame Species Program.

"Environmentally critical area" means an area or feature which is of significant environmental value, including but not limited to: stream corridors, natural heritage priority sites, habitats of endangered or threatened species, large areas of contiguous open space or upland forest, steep slopes, and well head protection and groundwater recharge areas. Habitats of endangered or threatened species are identified using the Department's Landscape Project as approved by the Department's Endangered and Nongame Species Program.

"Empowerment Neighborhoods" means neighborhoods designated by the Urban Coordinating Council "in consultation and conjunction with" the New Jersey Redevelopment Authority pursuant to N.J.S.A 55:19-69.

"Erosion" means the detachment and movement of soil or rock fragments by water, wind, ice, or gravity.

"Green infrastructure" means a stormwater management measure that manages stormwater close to its source by:

1. Treating stormwater runoff through infiltration into subsoil;
2. Treating stormwater runoff through filtration by vegetation or soil; or
3. Storing stormwater runoff for reuse.

"HUC 14" or "hydrologic unit code 14" means an area within which water drains to a particular receiving surface water body, also known as a subwatershed, which is identified by a 14-digit hydrologic unit boundary designation, delineated within New Jersey by the United States Geological Survey.

"Impervious surface" means a surface that has been covered with a layer of material so that it is highly resistant to infiltration by water.

"Infiltration" is the process by which water seeps into the soil from precipitation.

"Lead planning agency" means one or more public entities having stormwater management planning authority designated by the regional stormwater management planning committee pursuant to N.J.A.C. 7:8-3.2, that serves as the primary representative of the committee.

"Major development" means an individual "development," as well as multiple developments that individually or collectively result in:

1. The disturbance of one or more acres of land since February 2, 2004;

2. The creation of one-quarter acre or more of "regulated impervious surface" since February 2, 2004;
3. The creation of one-quarter acre or more of "regulated motor vehicle surface" since March 2, 2021 {*or the effective date of this ordinance, whichever is earlier*}; or
4. A combination of 2 and 3 above that totals an area of one-quarter acre or more. The same surface shall not be counted twice when determining if the combination area equals one-quarter acre or more.

Major development includes all developments that are part of a common plan of development or sale (for example, phased residential development) that collectively or individually meet any one or more of paragraphs 1, 2, 3, or 4 above. Projects undertaken by any government agency that otherwise meet the definition of "major development" but which do not require approval under the Municipal Land Use Law, N.J.S.A. 40:55D-1 et seq., are also considered "major development."

NOTE: The definition of major development above aligns with the definition at N.J.A.C. 7:8-1.2 and is recommended for consistency. Alternatively, a municipality may adopt the following definition, which is the minimum standard required. Municipalities that have already adopted the definition at N.J.A.C. 7:8-1.2 or another definition that goes beyond the minimum requirement should not reduce the stringency of their definition by adopting the minimum standard.

> *"Major development" means an individual "development," as well as multiple developments that individually or collectively result in the disturbance of one or more acres of land since February 2, 2004.*
>
> *Major development includes all developments that are part of a common plan of development or sale (for example, phased residential development) that collectively or individually result in the disturbance of one or more acres of land since February 2, 2004. Projects undertaken by any government agency that otherwise meet the definition of "major development" but which do not require approval under the Municipal Land Use Law, N.J.S.A. 40:55D-1 et seq., are also considered "major development."*

Additionally, individual municipalities may define major development with a smaller area of disturbance, a smaller area of regulated impervious or motor vehicle surface, or both.

"Motor vehicle" means land vehicles propelled other than by muscular power, such as automobiles, motorcycles, autocycles, and low speed vehicles. For the purposes of this definition, motor vehicle does not include farm equipment, snowmobiles, all-terrain vehicles, motorized wheelchairs, go-carts, gas buggies, golf carts, ski-slope grooming machines, or vehicles that run only on rails or tracks.

"Motor vehicle surface" means any pervious or impervious surface that is intended to be used by "motor vehicles" and/or aircraft, and is directly exposed to precipitation including, but not limited to, driveways, parking areas, parking garages, roads, racetracks, and runways.

"Municipality" means any city, borough, town, township, or village.

"New Jersey Stormwater Best Management Practices (BMP) Manual" or "BMP Manual" means the manual maintained by the Department providing, in part, design specifications, removal rates, calculation methods, and soil testing procedures approved by the Department as being capable of contributing to the achievement of the stormwater management standards specified in this chapter. The BMP Manual is periodically amended by the Department as necessary to provide design specifications on additional best management practices and new information on already included practices reflecting the best available current information regarding the particular practice and the Department's determination as to the ability of that best management practice to contribute to compliance with the standards contained in this chapter. Alternative stormwater management measures, removal rates, or calculation methods may be utilized, subject to any limitations specified in this chapter, provided the design engineer demonstrates to the municipality, in accordance with Section IV.F. of this ordinance and N.J.A.C. 7:8-5.2(g), that the proposed measure and its design will contribute to achievement of the design and performance standards established by this chapter.

"Node" means an area designated by the State Planning Commission concentrating facilities and activities which are not organized in a compact form.

"Nutrient" means a chemical element or compound, such as nitrogen or phosphorus, which is essential to and promotes the development of organisms.

"Person" means any individual, corporation, company, partnership, firm, association, political subdivision of this State and any state, interstate or Federal agency.

"Pollutant" means any dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, refuse, oil, grease, sewage sludge, munitions, chemical wastes, biological materials, medical wastes, radioactive substance (except those regulated under the Atomic Energy Act of 1954, as amended (42 U.S.C. §§ 2011 *et seq.*)), thermal waste, wrecked or discarded equipment, rock, sand, cellar dirt, industrial, municipal, agricultural, and construction waste or runoff, or other residue discharged directly or indirectly to the land, ground waters or surface waters of the State, or to a domestic treatment works. "Pollutant" includes both hazardous and nonhazardous pollutants.

"Recharge" means the amount of water from precipitation that infiltrates into the ground and is not evapotranspired.

"Regulated impervious surface" means any of the following, alone or in combination:

1. A net increase of impervious surface;
2. The total area of impervious surface collected by a new stormwater conveyance system (for the purpose of this definition, a "new stormwater conveyance system" is a stormwater conveyance system that is constructed where one did not exist immediately prior to its construction or an existing system for which a new discharge location is created);
3. The total area of impervious surface proposed to be newly collected by an existing stormwater conveyance system; and/or
4. The total area of impervious surface collected by an existing stormwater conveyance system where the capacity of that conveyance system is increased.

"Regulated motor vehicle surface" means any of the following, alone or in combination:

1. The total area of motor vehicle surface that is currently receiving water;
2. A net increase in motor vehicle surface; and/or
quality treatment either by vegetation or soil, by an existing stormwater management measure, or by treatment at a wastewater treatment plant, where the water quality treatment will be modified or removed.

"Sediment" means solid material, mineral or organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water or gravity as a product of erosion.

"Site" means the lot or lots upon which a major development is to occur or has occurred.

"Soil" means all unconsolidated mineral and organic material of any origin.
"State Development and Redevelopment Plan Metropolitan Planning Area (PA1)" means an area delineated on the State Plan Policy Map and adopted by the State Planning Commission that is intended to be the focus for much of the State's future redevelopment and revitalization efforts.

"State Plan Policy Map" is defined as the geographic application of the State Development and Redevelopment Plan's goals and statewide policies, and the official map of these goals and policies.

"Stormwater" means water resulting from precipitation (including rain and snow) that runs off the land's surface, is transmitted to the subsurface, or is captured by separate storm sewers or other sewage or drainage facilities, or conveyed by snow removal equipment.

"Stormwater management BMP" means an excavation or embankment and related areas designed to retain stormwater runoff. A stormwater management BMP may either be normally dry (that is, a detention basin or infiltration system), retain water in a permanent pool (a retention basin), or be planted mainly with wetland vegetation (most constructed stormwater wetlands).

"Stormwater management measure" means any practice, technology, process, program, or other method intended to control or reduce stormwater runoff and associated pollutants, or to induce or control the infiltration or groundwater recharge of stormwater or to eliminate illicit or illegal non-stormwater discharges into stormwater conveyances.

"Stormwater runoff" means water flow on the surface of the ground or in storm sewers, resulting from precipitation.

"Stormwater management planning agency" means a public body authorized by legislation to prepare stormwater management plans.

"Stormwater management planning area" means the geographic area for which a stormwater management planning agency is authorized to prepare stormwater management plans, or a specific portion of that area identified in a stormwater management plan prepared by that agency.

"Tidal Flood Hazard Area" means a flood hazard area in which the flood elevation resulting from the two-, 10-, or 100-year storm, as applicable, is governed by tidal flooding from the Atlantic Ocean. Flooding in a tidal flood hazard area may be contributed to, or influenced by, stormwater runoff from inland areas, but the depth of flooding generated by the tidal rise and fall of the Atlantic Ocean is greater than flooding from any fluvial sources. In some situations, depending upon the extent of the storm surge from a particular storm event, a flood hazard area may be tidal in the 100-year storm, but fluvial in more frequent storm events.

"Urban Coordinating Council Empowerment Neighborhood" means a neighborhood given priority access to State resources through the New Jersey Redevelopment Authority.

"Urban Enterprise Zones" means a zone designated by the New Jersey Enterprise Zone Authority pursuant to the New Jersey Urban Enterprise Zones Act, N.J.S.A. 52:27H-60 et. seq.

"Urban Redevelopment Area" is defined as previously developed portions of areas:

1. Delineated on the State Plan Policy Map (SPPM) as the Metropolitan Planning Area (PA1), Designated Centers, Cores or Nodes;
2. Designated as CAFRA Centers, Cores or Nodes;
3. Designated as Urban Enterprise Zones; and

4. Designated as Urban Coordinating Council Empowerment Neighborhoods.

"Water control structure" means a structure within, or adjacent to, a water, which intentionally or coincidentally alters the hydraulic capacity, the flood elevation resulting from the two-, 10-, or 100-year storm, flood hazard area limit, and/or floodway limit of the water. Examples of a water control structure may include a bridge, culvert, dam, embankment, ford (if above grade), retaining wall, and weir.

"Waters of the State" means the ocean and its estuaries, all springs, streams, wetlands, and bodies of surface or groundwater, whether natural or artificial, within the boundaries of the State of New Jersey or subject to its jurisdiction.

"Wetlands" or "wetland" means an area that is inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as hydrophytic vegetation.

Section III. Design and Performance Standards for Stormwater Management Measures

A. Stormwater management measures for major development shall be designed to provide erosion control, groundwater recharge, stormwater runoff quantity control, and stormwater runoff quality treatment as follows:

1. The minimum standards for erosion control are those established under the Soil and Sediment Control Act, N.J.S.A. 4:24-39 et seq., and implementing rules at N.J.A.C. 2:90.
2. The minimum standards for groundwater recharge, stormwater quality, and stormwater runoff quantity shall be met by incorporating green infrastructure.

B. The standards in this ordinance apply only to new major development and are intended to minimize the impact of stormwater runoff on water quality and water quantity in receiving water bodies and maintain groundwater recharge. The standards do not apply to new major development to the extent that alternative design and performance standards are applicable under a regional stormwater management plan or Water Quality Management Plan adopted in accordance with Department rules.

Note: Alternative standards shall provide at least as much protection from stormwater-related loss of groundwater recharge, stormwater quantity and water quality impacts of major development projects as would be provided under the standards in N.J.A.C. 7:8-5.

Section IV. Stormwater Management Requirements for Major Development

A. The development shall incorporate a maintenance plan for the stormwater management measures incorporated into the design of a major development in accordance with Section X.

B. Stormwater management measures shall avoid adverse impacts of concentrated flow on habitat for threatened and endangered species as documented in the Department's Landscape Project or Natural Heritage Database established under N.J.S.A. 13:1B-15.147 through 15.150, particularly *Helonias bullata* (swamp pink) and/or *Clemmys muhlnebergi* (bog turtle).

C. The following linear development projects are exempt from the groundwater recharge, stormwater runoff quality, and stormwater runoff quantity requirements of Section IV.P, Q and R:

1. The construction of an underground utility line provided that the disturbed areas are revegetated upon completion;
2. The construction of an aboveground utility line provided that the existing conditions are maintained to the maximum extent practicable; and
3. The construction of a public pedestrian access, such as a sidewalk or trail with a maximum width of 14 feet, provided that the access is made of permeable material.

D. A waiver from strict compliance from the green infrastructure, groundwater recharge, stormwater runoff quality, and stormwater runoff quantity requirements of Section IV.O, P, Q and R may be obtained for the enlargement of an existing public roadway or railroad; or the construction or enlargement of a public pedestrian access, provided that the following conditions are met:

1. The applicant demonstrates that there is a public need for the project that cannot be accomplished by any other means;
2. The applicant demonstrates through an alternatives analysis, that through the use of stormwater management measures, the option selected complies with the requirements of Section IV.O, P, Q and R to the maximum extent practicable;
3. The applicant demonstrates that, in order to meet the requirements of Section IV.O, P, Q and R, existing structures currently in use, such as homes and buildings, would need to be condemned; and
4. The applicant demonstrates that it does not own or have other rights to areas, including the potential to obtain through condemnation lands not falling under IV.D.3 above within the upstream drainage area of the receiving stream, that would provide additional opportunities to mitigate the requirements of Section IV.O, P, Q and R that were not achievable onsite.

E. Tables 1 through 3 below summarize the ability of stormwater best management practices identified and described in the New Jersey Stormwater Best Management Practices Manual to satisfy the green infrastructure, groundwater recharge, stormwater runoff quality and stormwater runoff quantity standards specified in Section IV.O, P, Q and R. When designed in accordance with the most current version of the New Jersey Stormwater Best Management Practices Manual, the stormwater management measures found at N.J.A.C. 7:8-5.2 (f) Tables 5-1, 5-2 and 5-3 and listed below in Tables 1, 2 and 3 are presumed to be capable of providing stormwater controls for the design and performance standards as outlined in the tables below. Upon amendments of the New Jersey Stormwater Best Management Practices to reflect additions or deletions of BMPs meeting these standards, or changes in the presumed performance of BMPs designed in accordance with the New Jersey Stormwater BMP Manual, the Department shall publish in the New Jersey Registers a notice of administrative change revising the applicable table. The most current version of the BMP Manual can be found on the Department's website at:

https://njstormwater.org/bmp_manual2.htm.

F. Where the BMP tables in the NJ Stormwater Management Rule are different due to updates or amendments with the tables in this ordinance the BMP Tables in the Stormwater Management rule at N.J.A.C. 7:8-5.2(f) shall take precedence.

Table 1
Green Infrastructure BMPs for Groundwater Recharge, Stormwater Runoff Quality, and/or Stormwater Runoff Quantity

Best Management Practice	Stormwater Runoff Quality TSS Removal Rate (percent)	Stormwater Runoff Quantity	Groundwater Recharge	Minimum Separation from Seasonal High Water Table (feet)
Cistern	0	Yes	No	--
Dry Well[(a)]	0	No	Yes	2
Grass Swale	50 or less	No	No	2[(e)] 1[(f)]
Green Roof	0	Yes	No	--
Manufactured Treatment Device[(a)] [(g)]	50 or 80	No	No	Dependent upon the device
Pervious Paving System[(a)]	80	Yes	Yes[(b)] No[(c)]	2[(b)] 1[(c)]
Small-Scale Bioretention Basin[(a)]	80 or 90	Yes	Yes[(b)] No[(c)]	2[(b)] 1[(c)]
Small-Scale Infiltration Basin[(a)]	80	Yes	Yes	2
Small-Scale Sand Filter	80	Yes	Yes	2
Vegetative Filter Strip	60-80	No	No	--

Table 2
Green Infrastructure BMPs for Stormwater Runoff Quantity
(or for Groundwater Recharge and/or Stormwater Runoff Quality with a Waiver or Variance from N.J.A.C. 7:8-5.3)

Best Management Practice	Stormwater Runoff Quality TSS Removal Rate (percent)	Stormwater Runoff Quantity	Groundwater Recharge	Minimum Separation from Seasonal High Water Table (feet)
Bioretention System	80 or 90	Yes	Yes[(b)] No[(c)]	2[(b)] 1[(c)]
Infiltration Basin	80	Yes	Yes	2
Sand Filter[(b)]	80	Yes	Yes	2
Standard Constructed Wetland	90	Yes	No	N/A
Wet Pond[(d)]	50-90	Yes	No	N/A

Table 3 **BMPs for Groundwater Recharge, Stormwater Runoff Quality, and/or Stormwater Runoff Quantity only with a Waiver or Variance from N.J.A.C. 7:8-5.3**				
Best Management Practice	**Stormwater Runoff Quality TSS Removal Rate (percent)**	**Stormwater Runoff Quantity**	**Groundwater Recharge**	**Minimum Separation from Seasonal High Water Table (feet)**
Blue Roof	0	Yes	No	N/A
Extended Detention Basin	40-60	Yes	No	1
Manufactured Treatment Device(h)	50 or 80	No	No	Dependent upon the device
Sand Filter(c)	80	Yes	No	1
Subsurface Gravel Wetland	90	No	No	1
Wet Pond	50-90	Yes	No	N/A

Notes to Tables 1, 2, and 3:

(a) subject to the applicable contributory drainage area limitation specified at Section IV.O.2;

(b) designed to infiltrate into the subsoil;

(c) designed with underdrains;

(d) designed to maintain at least a 10-foot wide area of native vegetation along at least 50 percent of the shoreline and to include a stormwater runoff retention component designed to capture stormwater runoff for beneficial reuse, such as irrigation;

(e) designed with a slope of less than two percent;

(f) designed with a slope of equal to or greater than two percent;

(g) manufactured treatment devices that meet the definition of green infrastructure at Section II;

(h) manufactured treatment devices that do not meet the definition of green infrastructure at Section II.

G. An alternative stormwater management measure, alternative removal rate, and/or alternative method to calculate the removal rate may be used if the design engineer demonstrates the capability of the proposed alternative stormwater management measure and/or the validity of the alternative rate or method to the municipality. A copy of any approved alternative stormwater management measure, alternative removal rate, and/or alternative method to calculate the removal rate shall be provided to the Department in accordance with Section VI.B. Alternative stormwater management measures may be used to satisfy the requirements at Section IV.O only if the measures meet the definition of green infrastructure at Section II. Alternative stormwater management measures that function in a similar manner to a BMP listed at Section O.2 are subject to the contributory drainage area limitation specified at Section O.2 for that similarly functioning BMP. Alternative stormwater management measures approved in accordance with this subsection that do not function in a similar manner to any BMP listed at Section O.2 shall have a contributory drainage area less than or equal to 2.5 acres, except for alternative stormwater management measures that function similarly to cisterns, grass swales, green roofs, standard constructed wetlands, vegetative filter strips, and wet ponds, which are not subject to a contributory drainage area limitation. Alternative measures that function similarly to standard constructed wetlands or wet ponds shall not be used for compliance with the stormwater runoff quality standard unless a variance in accordance with N.J.A.C. 7:8-4.6 or a waiver from strict compliance in accordance with Section IV.D is granted from Section IV.O.

H. Whenever the stormwater management design includes one or more BMPs that will infiltrate stormwater into subsoil, the design engineer shall assess the hydraulic impact on the groundwater table and design the site, so as to avoid adverse hydraulic impacts. Potential adverse hydraulic impacts include, but are not limited to, exacerbating a naturally or seasonally high water table, so as to cause surficial ponding, flooding of basements, or interference with the proper operation of subsurface sewage disposal systems or other subsurface structures within the zone of influence of the groundwater mound, or interference with the proper functioning of the stormwater management measure itself.

I. Design standards for stormwater management measures are as follows:

1. Stormwater management measures shall be designed to take into account the existing site conditions, including, but not limited to, environmentally critical areas; wetlands; flood-prone areas; slopes; depth to seasonal high water table; soil type, permeability, and texture; drainage area and drainage patterns; and the presence of solution-prone carbonate rocks (limestone);
2. Stormwater management measures shall be designed to minimize maintenance, facilitate maintenance and repairs, and ensure proper functioning. Trash racks shall be installed at the intake to the outlet structure, as appropriate, and shall have parallel bars with one-inch spacing between the bars to the elevation of the water quality design storm. For elevations higher than the water quality design storm, the parallel bars at the outlet structure shall be spaced no greater than one-third the width of the diameter of the orifice or one-third the width of the weir, with a minimum spacing between bars of one inch and a maximum spacing between bars of six inches. In addition, the design of trash racks must comply with the requirements of Section VIII.C;
3. Stormwater management measures shall be designed, constructed, and installed to be strong, durable, and corrosion resistant. Measures that are consistent with the relevant portions of the Residential Site Improvement Standards at N.J.A.C. 5:21-7.3, 7.4, and 7.5 shall be deemed to meet this requirement;
4. Stormwater management BMPs shall be designed to meet the minimum safety standards for stormwater management BMPs at Section VIII; and

5. The size of the orifice at the intake to the outlet from the stormwater management BMP shall be a minimum of two and one-half inches in diameter.

J. Manufactured treatment devices may be used to meet the requirements of this subchapter, provided the pollutant removal rates are verified by the New Jersey Corporation for Advanced Technology and certified by the Department. Manufactured treatment devices that do not meet the definition of green infrastructure at Section II may be used only under the circumstances described at Section IV.O.4.

K. Any application for a new agricultural development that meets the definition of major development at Section II shall be submitted to the Soil Conservation District for review and approval in accordance with the requirements at Sections IV.O, P, Q and R and any applicable Soil Conservation District guidelines for stormwater runoff quantity and erosion control. For purposes of this subsection, "agricultural development" means land uses normally associated with the production of food, fiber, and livestock for sale. Such uses do not include the development of land for the processing or sale of food and the manufacture of agriculturally related products.

L. If there is more than one drainage area, the groundwater recharge, stormwater runoff quality, and stormwater runoff quantity standards at Section IV.P, Q and R shall be met in each drainage area, unless the runoff from the drainage areas converge onsite and no adverse environmental impact would occur as a result of compliance with any one or more of the individual standards being determined utilizing a weighted average of the results achieved for that individual standard across the affected drainage areas.

M. Any stormwater management measure authorized under the municipal stormwater management plan or ordinance shall be reflected in a deed notice recorded in the {*insert Office of the County Clerk or the registrar of deeds and mortgages of the county in which the development, project, project site, or mitigation area containing the stormwater management measure is located, as appropriate, to the municipality*}. A form of deed notice shall be submitted to the municipality for approval prior to filing. The deed notice shall contain a description of the stormwater management measure(s) used to meet the green infrastructure, groundwater recharge, stormwater runoff quality, and stormwater runoff quantity standards at Section IV.O, P, Q and R and shall identify the location of the stormwater management measure(s) in NAD 1983 State Plane New Jersey FIPS 2900 US Feet or Latitude and Longitude in decimal degrees. The deed notice shall also reference the maintenance plan required to be recorded upon the deed pursuant to Section X.B.5. Prior to the commencement of construction, proof that the above required deed notice has been filed shall be submitted to the municipality. Proof that the required information has been recorded on the deed shall be in the form of either a copy of the complete recorded document or a receipt from the clerk or other proof of recordation provided by the recording office. However, if the initial proof provided to the municipality is not a copy of the complete recorded document, a copy of the complete recorded document shall be provided to the municipality within 180 calendar days of the authorization granted by the municipality.

N. A stormwater management measure approved under the municipal stormwater management plan or ordinance may be altered or replaced with the approval of the municipality, if the municipality determines that the proposed alteration or replacement meets the design and performance standards pursuant to Section IV of this ordinance and provides the same level of stormwater management as the previously approved stormwater management measure that is being altered or replaced. If an alteration or replacement is approved, a revised deed notice shall be submitted to the municipality for approval and subsequently recorded with the {*insert appropriate Office of the County Clerk or the registrar of deeds and mortgages, as applies*} and shall contain a description and location of the stormwater management measure, as well as reference to the maintenance plan, in accordance with M above. Prior to the commencement of construction, proof that the above required deed notice has been filed shall be submitted to the municipality in accordance with M above.

O. Green Infrastructure Standards

1. This subsection specifies the types of green infrastructure BMPs that may be used to satisfy the groundwater recharge, stormwater runoff quality, and stormwater runoff quantity standards.

2. To satisfy the groundwater recharge and stormwater runoff quality standards at Section IV.P and Q, the design engineer shall utilize green infrastructure BMPs identified in Table 1 at Section IV.F. and/or an alternative stormwater management measure approved in accordance with Section IV.G. The following green infrastructure BMPs are subject to the following maximum contributory drainage area limitations:

Best Management Practice	**Maximum Contributory Drainage Area**
Dry Well	1 acre
Manufactured Treatment Device	2.5 acres
Pervious Pavement Systems	Area of additional inflow cannot exceed three times the area occupied by the BMP
Small-scale Bioretention Systems	2.5 acres
Small-scale Infiltration Basin	2.5 acres
Small-scale Sand Filter	2.5 acres

3. To satisfy the stormwater runoff quantity standards at Section IV.R, the design engineer shall utilize BMPs from Table 1 or from Table 2 and/or an alternative stormwater management measure approved in accordance with Section IV.G.

4. If a variance in accordance with N.J.A.C. 7:8-4.6 or a waiver from strict compliance in accordance with Section IV.D is granted from the requirements of this subsection, then BMPs from Table 1, 2, or 3, and/or an alternative stormwater management measure approved in accordance with Section IV.G may be used to meet the groundwater recharge, stormwater runoff quality, and stormwater runoff quantity standards at Section IV.P, Q and R.

5. For separate or combined storm sewer improvement projects, such as sewer separation, undertaken by a government agency or public utility (for example, a sewerage company), the requirements of this subsection shall only apply to areas owned in fee simple by the government agency or utility, and areas within a right-of-way or easement held or controlled by the government agency or utility; the entity shall not be required to obtain additional property or property rights to fully satisfy the requirements of this subsection. Regardless of the amount of area of a separate or combined storm sewer improvement project subject to the green infrastructure requirements of this subsection, each project shall fully comply with the applicable groundwater recharge, stormwater runoff quality control, and stormwater runoff quantity standards at Section IV.P, Q and R, unless the

project is granted a waiver from strict compliance in accordance with Section IV.D.

P. Groundwater Recharge Standards

1. This subsection contains the minimum design and performance standards for groundwater recharge as follows:
2. The design engineer shall, using the assumptions and factors for stormwater runoff and groundwater recharge calculations at Section V, either:

i. Demonstrate through hydrologic and hydraulic analysis that the site and its stormwater management measures maintain 100 percent of the average annual pre-construction groundwater recharge volume for the site; or
ii. Demonstrate through hydrologic and hydraulic analysis that the increase of stormwater runoff volume from pre-construction to post-construction for the 2-year storm is infiltrated.

3. This groundwater recharge requirement does not apply to projects within the "urban redevelopment area," or to projects subject to 4 below.
4. The following types of stormwater shall not be recharged:

i. Stormwater from areas of high pollutant loading. High pollutant loading areas are areas in industrial and commercial developments where solvents and/or petroleum products are loaded/unloaded, stored, or applied, areas where pesticides are loaded/unloaded or stored; areas where hazardous materials are expected to be present in greater than "reportable quantities" as defined by the United States Environmental Protection Agency (EPA) at 40 CFR 302.4; areas where recharge would be inconsistent with Department approved remedial action work plan or landfill closure plan and areas with high risks for spills of toxic materials, such as gas stations and vehicle maintenance facilities; and
ii. Industrial stormwater exposed to "source material." "Source material" means any material(s) or machinery, located at an industrial facility, that is directly or indirectly related to process, manufacturing or other industrial activities, which could be a source of pollutants in any industrial stormwater discharge to groundwater. Source materials include, but are not limited to, raw materials; intermediate products; final products; waste materials; by-products; industrial machinery and fuels, and lubricants, solvents, and detergents that are related to process, manufacturing, or other industrial activities that are exposed to stormwater.

Q. Stormwater Runoff Quality Standards

1. This subsection contains the minimum design and performance standards to control stormwater runoff quality impacts of major development. Stormwater runoff quality standards are applicable when the major development results in an increase of one-quarter acre or more of regulated motor vehicle surface.
2. Stormwater management measures shall be designed to reduce the post-construction load of total suspended solids (TSS) in stormwater runoff generated from the water quality design storm as follows:

i. Eighty percent TSS removal of the anticipated load, expressed as an annual average shall be achieved for the stormwater runoff from the net increase of motor vehicle surface.

ii. If the surface is considered regulated motor vehicle surface because the water quality treatment for an area of motor vehicle surface that is currently receiving water quality treatment either by vegetation or soil, by an existing stormwater management measure, or by treatment at a wastewater treatment plant is to be modified or removed, the project shall maintain or increase the existing TSS removal of the anticipated load expressed as an annual average.

3. The requirement to reduce TSS does not apply to any stormwater runoff in a discharge regulated under a numeric effluent limitation for TSS imposed under the New Jersey Pollutant Discharge Elimination System (NJPDES) rules, N.J.A.C. 7:14A, or in a discharge specifically exempt under a NJPDES permit from this requirement. Every major development, including any that discharge into a combined sewer system, shall comply with 2 above, unless the major development is itself subject to a NJPDES permit with a numeric effluent limitation for TSS or the NJPDES permit to which the major development is subject exempts the development from a numeric effluent limitation for TSS.

4. The water quality design storm is 1.25 inches of rainfall in two hours. Water quality calculations shall take into account the distribution of rain from the water quality design storm, as reflected in Table 4, below. The calculation of the volume of runoff may take into account the implementation of stormwater management measures.

Table 4 - Water Quality Design Storm Distribution

Time (Minutes)	Cumulative Rainfall (Inches)	Time (Minutes)	Cumulative Rainfall (Inches)	Time (Minutes)	Cumulative Rainfall (Inches)
1	0.00166	41	0.1728	81	1.0906
2	0.00332	42	0.1796	82	1.0972
3	0.00498	43	0.1864	83	1.1038
4	0.00664	44	0.1932	84	1.1104
5	0.00830	45	0.2000	85	1.1170
6	0.00996	46	0.2117	86	1.1236
7	0.01162	47	0.2233	87	1.1302
8	0.01328	48	0.2350	88	1.1368
9	0.01494	49	0.2466	89	1.1434
10	0.01660	50	0.2583	90	1.1500
11	0.01828	51	0.2783	91	1.1550
12	0.01996	52	0.2983	92	1.1600
13	0.02164	53	0.3183	93	1.1650
14	0.02332	54	0.3383	94	1.1700
15	0.02500	55	0.3583	95	1.1750
16	0.03000	56	0.4116	96	1.1800
17	0.03500	57	0.4650	97	1.1850
18	0.04000	58	0.5183	98	1.1900
19	0.04500	59	0.5717	99	1.1950
20	0.05000	60	0.6250	100	1.2000
21	0.05500	61	0.6783	101	1.2050
22	0.06000	62	0.7317	102	1.2100
23	0.06500	63	0.7850	103	1.2150
24	0.07000	64	0.8384	104	1.2200
25	0.07500	65	0.8917	105	1.2250
26	0.08000	66	0.9117	106	1.2267
27	0.08500	67	0.9317	107	1.2284
28	0.09000	68	0.9517	108	1.2300
29	0.09500	69	0.9717	109	1.2317
30	0.10000	70	0.9917	110	1.2334
31	0.10660	71	1.0034	111	1.2351
32	0.11320	72	1.0150	112	1.2367
33	0.11980	73	1.0267	113	1.2384
34	0.12640	74	1.0383	114	1.2400
35	0.13300	75	1.0500	115	1.2417
36	0.13960	76	1.0568	116	1.2434
37	0.14620	77	1.0636	117	1.2450
38	0.15280	78	1.0704	118	1.2467
39	0.15940	79	1.0772	119	1.2483
40	0.16600	80	1.0840	120	1.2500

5. If more than one BMP in series is necessary to achieve the required 80 percent TSS reduction for a site, the applicant shall utilize the following formula to calculate TSS reduction:

$R = A + B - (A \, x \, B) / 100$,
Where

R = total TSS Percent Load Removal from application of both BMPs, and
A = the TSS Percent Removal Rate applicable to the first BMP
B = the TSS Percent Removal Rate applicable to the second BMP.

6. Stormwater management measures shall also be designed to reduce, to themaximum extent feasible, the post-construction nutrient load of the anticipated load from the developed site in stormwater runoff generated from the water quality design storm. In achieving reduction of nutrients to the maximum extent feasible, the design of the site shall include green infrastructure BMPs that optimize nutrient removal while still achieving the performance standards in Section IV.P, Q and R.
7. In accordance with the definition of FW1 at N.J.A.C. 7:9B-1.4, stormwater management measures shall be designed to prevent any increase in stormwater runoff to waters classified as FW1.
8. The Flood Hazard Area Control Act Rules at N.J.A.C. 7:13-4.1(c)1 establish 300-foot riparian zones along Category One waters, as designated in the Surface Water Quality Standards at N.J.A.C. 7:9B, and certain upstream tributaries to Category One waters. A person shall not undertake a major development that is located within or discharges into a 300-foot riparian zone without prior authorization from the Department under N.J.A.C. 7:13.
9. Pursuant to the Flood Hazard Area Control Act Rules at N.J.A.C. 7:13-11.2(j)3.i, runoff from the water quality design storm that is discharged within a 300-foot riparian zone shall be treated in accordance with this subsection to reduce the post-construction load of total suspended solids by 95 percent of the anticipated load from the developed site, expressed as an annual average.
10. This stormwater runoff quality standards do not apply to the construction of one individual single-family dwelling, provided that it is not part of a larger development or subdivision that has received preliminary or final site plan approval prior to December 3, 2018, and that the motor vehicle surfaces are made of permeable material(s) such as gravel, dirt, and/or shells.

R. Stormwater Runoff Quantity Standards

1. This subsection contains the minimum design and performance standards to control stormwater runoff quantity impacts of major development.
2. In order to control stormwater runoff quantity impacts, the design engineer shall, using the assumptions and factors for stormwater runoff calculations at Section V, complete one of the following:

   i. Demonstrate through hydrologic and hydraulic analysis that for stormwater leaving the site, post-construction runoff hydrographs for the 2-, 10-, and 100-year storm events do not exceed, at any point in time, the pre-construction runoff hydrographs for the same storm events;
   ii. Demonstrate through hydrologic and hydraulic analysis that there is no increase, as compared to the pre-construction condition, in the peak runoff rates of stormwater leaving the site for the 2-, 10- and 100-year storm events and that the increased volume or change in timing of stormwater runoff will not increase flood damage at or downstream of the site. This analysis shall include the analysis of impacts of existing land uses and projected land uses assuming full development under existing zoning and land use ordinances in the drainage area;

iii. Design stormwater management measures so that the post-construction peak runoff rates for the 2-, 10- and 100-year storm events are 50, 75 and 80 percent, respectively, of the pre-construction peak runoff rates. The percentages apply only to the post-construction stormwater runoff that is attributable to the portion of the site on which the proposed development or project is to be constructed; or

iv. In tidal flood hazard areas, stormwater runoff quantity analysis in accordance with 2.i, ii and iii above is required unless the design engineer demonstrates through hydrologic and hydraulic analysis that the increased volume, change in timing, or increased rate of the stormwater runoff, or any combination of the three will not result in additional flood damage below the point of discharge of the major development. No analysis is required if the stormwater is discharged directly into any ocean, bay, inlet, or the reach of any watercourse between its confluence with an ocean, bay, or inlet and downstream of the first water control structure.

3. The stormwater runoff quantity standards shall be applied at the site's boundary to each abutting lot, roadway, watercourse, or receiving storm sewer system.

Section V. Calculation of Stormwater Runoff and Groundwater Recharge:

A. Stormwater runoff shall be calculated in accordance with the following:

1. The design engineer shall calculate runoff using one of the following methods:

i. The USDA Natural Resources Conservation Service (NRCS) methodology, including the NRCS Runoff Equation and Dimensionless Unit Hydrograph, as described in Chapters 7, 9, 10, 15 and 16 Part 630, Hydrology National Engineering Handbook, incorporated herein by reference as amended and supplemented. This methodology is additionally described in *Technical Release 55 - Urban Hydrology for Small Watersheds* (TR-55), dated June 1986, incorporated herein by reference as amended and supplemented. Information regarding the methodology is available from the Natural Resources Conservation Service website at:

https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044171.pdf

or at United States Department of Agriculture Natural Resources Conservation Service, 220 Davison Avenue, Somerset, New Jersey 08873; or

ii. The Rational Method for peak flow and the Modified Rational Method for hydrograph computations. The rational and modified rational methods are described in "Appendix A-9 Modified Rational Method" in the Standards for Soil Erosion and Sediment Control in New Jersey, January 2014. This document is available from the State Soil Conservation Committee or any of the Soil Conservation Districts listed at N.J.A.C. 2:90-1.3(a)3. The location, address, and telephone number for each Soil Conservation District is available from the State Soil Conservation Committee, PO Box 330, Trenton, New Jersey 08625. The document is also available at:

http://www.nj.gov/agriculture/divisions/anr/pdf/2014NJSoilErosionControlStandardsComplete.pdf.

2. For the purpose of calculating runoff coefficients and groundwater recharge, there is a presumption that the pre-construction condition of a site or portion thereof is a wooded land use with good hydrologic condition. The term "runoff coefficient" applies to both the NRCS methodology above at Section V.A.1.i and the Rational and Modified Rational Methods at Section V.A.1.ii. A runoff coefficient or a groundwater recharge land cover for an existing condition may be used on all or a portion of the site if the design engineer verifies that the hydrologic condition has existed on the site or portion of the site for at least five years without interruption prior to the time of application. If more than one land cover have existed on the site during the five years immediately prior to the time of application, the land cover with the lowest runoff potential shall be used for the computations. In addition, there is the presumption that the site is in good hydrologic condition (if the land use type is pasture, lawn, or park), with good cover (if the land use type is woods), or with good hydrologic condition and conservation treatment (if the land use type is cultivation).

3. In computing pre-construction stormwater runoff, the design engineer shall account for all significant land features and structures, such as ponds, wetlands, depressions, hedgerows, or culverts, that may reduce pre-construction stormwater runoff rates and volumes.

4. In computing stormwater runoff from all design storms, the design engineer shall consider the relative stormwater runoff rates and/or volumes of pervious and impervious surfaces separately to accurately compute the rates and volume of stormwater runoff from the site. To calculate runoff from unconnected impervious cover, urban impervious area modifications as described in the NRCS *Technical Release 55 – Urban Hydrology for Small Watersheds* or other methods may be employed.

5. If the invert of the outlet structure of a stormwater management measure is below the flood hazard design flood elevation as defined at N.J.A.C. 7:13, the design engineer shall take into account the effects of tailwater in the design of structural stormwater management measures.

B. Groundwater recharge may be calculated in accordance with the following:

The New Jersey Geological Survey Report GSR-32, A Method for Evaluating Groundwater-Recharge Areas in New Jersey, incorporated herein by reference as amended and supplemented. Information regarding the methodology is available from the New Jersey Stormwater Best Management Practices Manual; at the New Jersey Geological Survey website at:

https://www.nj.gov/dep/njgs/pricelst/gsreport/gsr32.pdf

or at New Jersey Geological and Water Survey, 29 Arctic Parkway, PO Box 420 Mail Code 29-01, Trenton, New Jersey 08625-0420.

Section VI. Sources for Technical Guidance:

A. Technical guidance for stormwater management measures can be found in the documents listed below, which are available to download from the Department's website at:

http://www.nj.gov/dep/stormwater/bmp_manual2.htm.

1. Guidelines for stormwater management measures are contained in the New Jersey Stormwater Best Management Practices Manual, as

amended and supplemented. Information is provided on stormwater management measures such as, but not limited to, those listed in Tables 1, 2, and 3.

2. Additional maintenance guidance is available on the Department's website at:

   https://www.njstormwater.org/maintenance_guidance.htm.

B. Submissions required for review by the Department should be mailed to:

   The Division of Water Quality, New Jersey Department of Environmental Protection, Mail Code 401-02B, PO Box 420, Trenton, New Jersey 08625-0420.

Section VII. Solids and Floatable Materials Control Standards:

A. Site design features identified under Section IV.F above, or alternative designs in accordance with Section IV.G above, to prevent discharge of trash and debris from drainage systems shall comply with the following standard to control passage of solid and floatable materials through storm drain inlets. For purposes of this paragraph, "solid and floatable materials" means sediment, debris, trash, and other floating, suspended, or settleable solids. For exemptions to this standard see Section VII.A.2 below.

1. Design engineers shall use one of the following grates whenever they use a grate in pavement or another ground surface to collect stormwater from that surface into a storm drain or surface water body under that grate:

   i. The New Jersey Department of Transportation (NJDOT) bicycle safe grate, which is described in Chapter 2.4 of the NJDOT Bicycle Compatible Roadways and Bikeways Planning and Design Guidelines; or

   ii. A different grate, if each individual clear space in that grate has an area of no more than seven (7.0) square inches, or is no greater than 0.5 inches across the smallest dimension.

      Examples of grates subject to this standard include grates in grate inlets, the grate portion (non-curb-opening portion) of combination inlets, grates on storm sewer manholes, ditch grates, trench grates, and grates of spacer bars in slotted drains. Examples of ground surfaces include surfaces of roads (including bridges), driveways, parking areas, bikeways, plazas, sidewalks, lawns, fields, open channels, and stormwater system floors used to collect stormwater from the surface into a storm drain or surface water body.

   iii. For curb-opening inlets, including curb-opening inlets in combination inlets, the clear space in that curb opening, or each individual clear space if the curb opening has two or more clear spaces, shall have an area of no more than seven (7.0) square inches, or be no greater than two (2.0) inches across the smallest dimension.

2. The standard in A.1. above does not apply:

   i. Where each individual clear space in the curb opening in existing curb-opening inlet does not have an area of more than nine (9.0) square inches;

ii. Where the municipality agrees that the standards would cause inadequate hydraulic performance that could not practicably be overcome by using additional or larger storm drain inlets;

iii. Where flows from the water quality design storm as specified in N.J.A.C. 7:8 are conveyed through any device (e.g., end of pipe netting facility, manufactured treatment device, or a catch basin hood) that is designed, at a minimum, to prevent delivery of all solid and floatable materials that could not pass through one of the following:

a. A rectangular space four and five-eighths (4.625) inches long and one and one-half (1.5) inches wide (this option does not apply for outfall netting facilities); or

b. A bar screen having a bar spacing of 0.5 inches.

Note that these exemptions do not authorize any infringement of requirements in the Residential Site Improvement Standards for bicycle safe grates in new residential development (N.J.A.C. 5:21-4.18(b)2 and 7.4(b)1).

iv. Where flows are conveyed through a trash rack that has parallel bars with one-inch (1 inch) spacing between the bars, to the elevation of the Water Quality Design Storm as specified in N.J.A.C. 7:8; or

v. Where the New Jersey Department of Environmental Protection determines, pursuant to the New Jersey Register of Historic Places Rules at N.J.A.C. 7:4-7.2(c), that action to meet this standard is an undertaking that constitutes an encroachment or will damage or destroy the New Jersey Register listed historic property.

Section VIII. Safety Standards for Stormwater Management Basins:

A. This section sets forth requirements to protect public safety through the proper design and operation of stormwater management BMPs. This section applies to any new stormwater management BMP.

B The provisions of this section are not intended to preempt more stringent municipal or county safety requirements for new or existing stormwater management BMPs. Municipal and county stormwater management plans and ordinances may, pursuant to their authority, require existing stormwater management BMPs to be retrofitted to meet one or more of the safety standards in Section VIII.C.1, VIII.C.2, and VIII.C.3 for trash racks, overflow grates, and escape provisions at outlet structures.

C. Requirements for Trash Racks, Overflow Grates and Escape Provisions

1. A trash rack is a device designed to catch trash and debris and prevent the clogging of outlet structures. Trash racks shall be installed at the intake to the outlet from the Stormwater management BMP to ensure proper functioning of the BMP outlets in accordance with the following:

i. The trash rack shall have parallel bars, with no greater than six-inch spacing between the bars;

ii. The trash rack shall be designed so as not to adversely affect the hydraulic performance of the outlet pipe or structure;

iii. The average velocity of flow through a clean trash rack is not to exceed 2.5 feet per second under the full range of stage and discharge. Velocity is to be computed on the basis of the net area of opening through the rack; and
iv. The trash rack shall be constructed of rigid, durable, and corrosion resistant material and designed to withstand a perpendicular live loading of 300 pounds per square foot.

2. An overflow grate is designed to prevent obstruction of the overflow structure. If an outlet structure has an overflow grate, such grate shall meet the following requirements:

   i. The overflow grate shall be secured to the outlet structure but removable for emergencies and maintenance.
   ii. The overflow grate spacing shall be no less than two inches across the smallest dimension
   iii. The overflow grate shall be constructed and installed to be rigid, durable, and corrosion resistant, and shall be designed to withstand a perpendicular live loading of 300 pounds per square foot.

3. Stormwater management BMPs shall include escape provisions as follows:

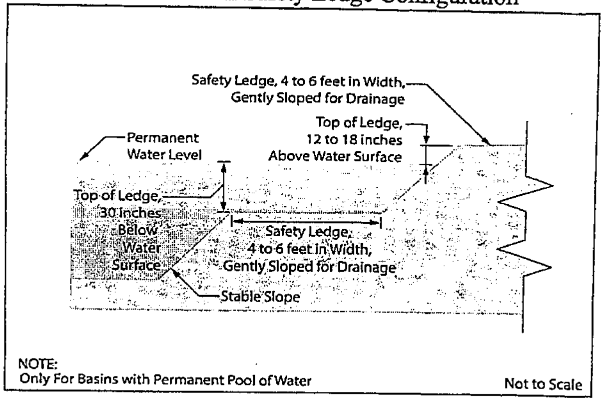
   i. If a stormwater management BMP has an outlet structure, escape provisions shall be incorporated in or on the structure. Escape provisions include the installation of permanent ladders, steps, rungs, or other features that provide easily accessible means of egress from stormwater management BMPs. With the prior approval of the municipality pursuant to VIII.C, a free-standing outlet structure may be exempted from this requirement;
   ii. Safety ledges shall be constructed on the slopes of all new stormwater management BMPs having a permanent pool of water deeper than two and one-half feet. Safety ledges shall be comprised of two steps. Each step shall be four to six feet in width. One step shall be located approximately two and one-half feet below the permanent water surface, and the second step shall be located one to one and one-half feet above the permanent water surface. See VIII.E for an illustration of safety ledges in a stormwater management BMP; and
   iii. In new stormwater management BMPs, the maximum interior slope for an earthen dam, embankment, or berm shall not be steeper than three horizontal to one vertical.

D. Variance or Exemption from Safety Standard

A variance or exemption from the safety standards for stormwater management BMPs may be granted only upon a written finding by the municipality that the variance or exemption will not constitute a threat to public safety.

E. Safety Ledge Illustration

Elevation View –Basin Safety Ledge Configuration



Section IX. Requirements for a Site Development Stormwater Plan:

A. Submission of Site Development Stormwater Plan

1. Whenever an applicant seeks municipal approval of a development subject to this ordinance, the applicant shall submit all of the required components of the Checklist for the Site Development Stormwater Plan at Section IX.C below as part of the submission of the application for approval.

2. The applicant shall demonstrate that the project meets the standards set forth in this ordinance.

3. The applicant shall submit [*specify number*] copies of the materials listed in the checklist for site development stormwater plans in accordance with Section IX.C of this ordinance.

B. Site Development Stormwater Plan Approval

The applicant's Site Development project shall be reviewed as a part of the review process by the municipal board or official from which municipal approval is sought. That municipal board or official shall consult the municipality's review engineer to determine if all of the checklist requirements have been satisfied and to determine if the project meets the standards set forth in this ordinance.

C. Submission of Site Development Stormwater Plan

The following information shall be required:

1. Topographic Base Map

The reviewing engineer may require upstream tributary drainage system information as necessary. It is recommended that the topographic base map of the site be submitted which extends a minimum of 200 feet beyond the limits of the proposed development, at a scale of 1"=200' or greater, showing 2-foot contour intervals. The map as appropriate may indicate the following: existing surface water drainage, shorelines, steep slopes, soils, erodible soils, perennial or intermittent streams that drain into or upstream of the Category One waters, wetlands and flood plains along with their appropriate buffer strips, marshlands and other wetlands, pervious or vegetative surfaces, existing man-made structures, roads, bearing and distances of property lines, and significant natural and manmade features not otherwise shown.

2. Environmental Site Analysis

   A written and graphic description of the natural and man-made features of the site and its surroundings should be submitted. This description should include a discussion of soil conditions, slopes, wetlands, waterways and vegetation on the site. Particular attention should be given to unique, unusual, or environmentally sensitive features and to those that provide particular opportunities or constraints for development.

3. Project Description and Site Plans

   A map (or maps) at the scale of the topographical basè map indicating the location of existing and proposed buildings roads, parking areas, utilities, structural facilities for stormwater management and sediment control, and other permanent structures. The map(s) shall also clearly show areas where alterations will occur in the natural terrain and cover, including lawns and other landscaping, and seasonal high groundwater elevations. A written description of the site plan and justification for proposed changes in natural conditions shall also be provided.

4. Land Use Planning and Source Control Plan

   This plan shall provide a demonstration of how the goals and standards of Sections III through V are being met. The focus of this plan shall be to describe how the site is being developed to meet the objective of controlling groundwater recharge, stormwater quality and stormwater quantity problems at the source by land management and source controls whenever possible.

5. Stormwater Management Facilities Map

   The following information, illustrated on a map of the same scale as the topographic base map, shall be included:

   i. Total area to be disturbed, paved or built upon, proposed surface contours, land area to be occupied by the stormwater management facilities and the type of vegetation thereon, and details of the proposed plan to control and dispose of stormwater.
   ii. Details of all stormwater management facility designs, during and after construction, including discharge provisions, discharge capacity for each outlet at different levels of detention and emergency spillway provisions with maximum discharge capacity of each spillway.

6. Calculations

   i. Comprehensive hydrologic and hydraulic design calculations for the pre-development and post-development conditions for the design storms specified in Section IV of this ordinance.
   ii. When the proposed stormwater management control measures depend on the hydrologic properties of soils or require certain separation from the seasonal high water table, then a soils report shall be submitted. The soils report shall be based on onsite boring logs or soil pit profiles. The number and location of required soil borings or soil pits shall be determined based on what is needed to determine the suitability and distribution of soils present at the location of the control measure.

7. Maintenance and Repair Plan

   The design and planning of the stormwater management facility shall meet the maintenance requirements of Section X.

8. Waiver from Submission Requirements

   The municipal official or board reviewing an application under this ordinance may, in consultation with the municipality's review engineer, waive submission of any of the requirements in Section IX.C.1 through IX.C.6 of this ordinance when it can be demonstrated that the information requested is impossible to obtain or it would create a hardship on the applicant to obtain and its absence will not materially affect the review process.

Section X. Maintenance and Repair:

A. Applicability

   Projects subject to review as in Section I.C of this ordinance shall comply with the
   requirements of Section X.B and X.C.

B. General Maintenance

   1. The design engineer shall prepare a maintenance plan for the stormwater management measures incorporated into the design of a major development.

   2. The maintenance plan shall contain specific preventative maintenance tasks and schedules; cost estimates, including estimated cost of sediment, debris, or trash removal; and the name, address, and telephone number of the person or persons responsible for preventative and corrective maintenance (including replacement). The plan shall contain information on BMP location, design, ownership, maintenance tasks and frequencies, and other details as specified in Chapter 8 of the NJ BMP Manual, as well as the tasks specific to the type of BMP, as described in the applicable chapter containing design specifics.

   3. If the maintenance plan identifies a person other than the property owner (for example, a developer, a public agency or homeowners' association) as having the responsibility for maintenance, the plan shall include documentation of such person's or entity's agreement to assume this responsibility, or of the owner's obligation to dedicate a stormwater management facility to such person under an applicable ordinance or regulation.

   4. Responsibility for maintenance shall not be assigned or transferred to the owner or tenant of an individual property in a residential development or project, unless such owner or tenant owns or leases the entire residential development or project. The individual property owner may be assigned incidental tasks, such as weeding of a green infrastructure BMP, provided the individual agrees to assume these tasks; however, the individual cannot be legally responsible for all of the maintenance required.

   5. If the party responsible for maintenance identified under Section X.B.3 above is not a public agency, the maintenance plan and any future revisions based on Section X.B.7 below shall be recorded upon

the deed of record for each property on which the maintenance described in the maintenance plan must be undertaken.

6. Preventative and corrective maintenance shall be performed to maintain the functional parameters (storage volume, infiltration rates, inflow/outflow capacity, etc.).of the stormwater management measure, including, but not limited to, repairs or replacement to the structure; removal of sediment, debris, or trash; restoration of eroded areas; snow and ice removal; fence repair or replacement; restoration of vegetation; and repair or replacement of non-vegetated linings.

7. The party responsible for maintenance identified under Section X.B.3 above shall perform all of the following requirements:

   i. maintain a detailed log of all preventative and corrective maintenance for the structural stormwater management measures incorporated into the design of the development, including a record of all inspections and copies of all maintenance-related work orders;
   ii. evaluate the effectiveness of the maintenance plan at least once per year and adjust the plan and the deed as needed; and
   iii. retain and make available, upon request by any public entity with administrative, health, environmental, or safety authority over the site, the maintenance plan and the documentation required by Section X.B.6 and B.7 above.

8. The requirements of Section X.B.3 and B.4 do not apply to stormwater management facilities that are dedicated to and accepted by the municipality or another governmental agency, subject to all applicable municipal stormwater general permit conditions, as issued by the Department.

   Note: It may be appropriate to delete requirements in the maintenance and repair plan that are not applicable if the ordinance requires the facility to be dedicated to the municipality. If the municipality does not want to take this responsibility, the ordinance should require the posting of a two year maintenance guarantee in accordance with N.J.S.A. 40:55D-53. Maintenance and inspection guidance can be found on the Department's website at:

   https://www.njstormwater.org/maintenance_guidance.htm.

9. In the event that the stormwater management facility becomes a danger to public safety or public health, or if it is in need of maintenance or repair, the municipality shall so notify the responsible person in writing. Upon receipt of that notice, the responsible person shall have fourteen (14) days to effect maintenance and repair of the facility in a manner that is approved by the municipal engineer or his designee. The municipality, in its discretion, may extend the time allowed for effecting maintenance and repair for good cause. If the responsible person fails or refuses to perform such maintenance and repair, the municipality or County may immediately proceed to do so and shall bill the cost thereof to the responsible person. Nonpayment of such bill may result in a lien on the property.

C. Nothing in this subsection shall preclude the municipality in which the major development is located from requiring the posting of a performance or maintenance guarantee in accordance with N.J.S.A. 40:55D-53

Section XI. Penalties:

Any person(s) who erects, constructs, alters, repairs, converts, maintains, or uses any building, structure or land in violation of this ordinance shall be subject to the following penalties:

{*Municipality to specify*}

Section XII. Severability:

Each section, subsection, sentence, clause and phrase of this Ordinance is declared to be an independent section, subsection, sentence, clause and phrase, and the finding or holding of any such portion of this Ordinance to be unconstitutional, void, or ineffective for any cause, or reason, shall not affect any other portion of this Ordinance.

Section XIII. Effective Date:

This Ordinance shall be in full force and effect from and after its adoption and any publication as required by law.

APPROVED:

Judith M. Davies-Dunhour, Mayor

ATTEST:

Suzanne C. Stanford, Borough Clerk