YRC

YANTIC RIVER
CONSULTANTS, LLC

HYDRAULIC ANALYSIS REPORT

PREPARED FOR

REPLACEMENT OF MASONRY CULVERT STRUCTURE
MNRR NEW HAVEN MAINLINE AT MP 65.60
MILFORD, CONNECTICUT

STATE PROJECT NO. 301-175

DATE: APRIL 3, 2017
REVISED: NOVEMBER 9, 2017
REVISED: AUGUST 3, 2018

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STATE OF CONNECTICUT
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An existing 90-foot long, 2' wide rectangular stone masonry culvert structure carries stormwater runoff from the Eastern Steel Road commercial and industrial area under the Metro North Railroad (MNRR) New Haven Mainline at approximate mile post 65.60. Based on visual inspections, the inlet and outlet of the existing structure are partially collapsed, resulting in a reduction of the hydraulic capacity of the structure. The outlet structure deterioration has also resulted in sloughing of the railroad embankment. Internal dimensions and conditions of the culvert could not be evaluated due to the deteriorated end conditions and standing water.

In response to the noted deterioration, loss of hydraulic capacity, and potential for flooding of upstream properties, the Connecticut Department of Transportation (CTDOT) has identified this structure for full replacement. H.W. Lochner, Inc. (Lochner) was contracted to provide consulting engineering services for the replacement and Yantic River Consultants, LLC (YRC) was subcontracted to perform hydrologic and hydraulic analysis services.

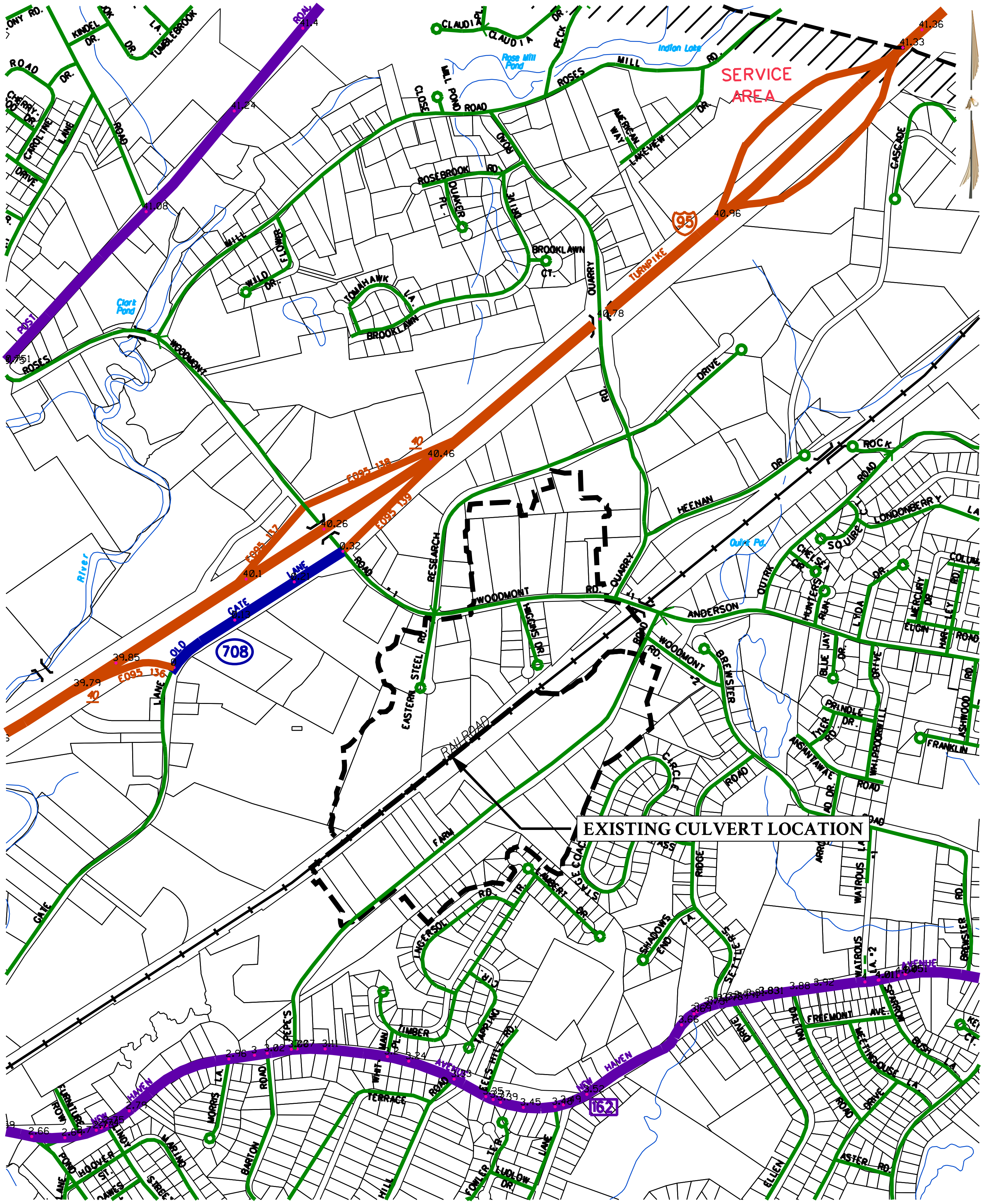
YRC performed a detailed flood routing analysis of the contributing watershed to evaluate the effect of temporary upstream ponding caused by the backwater from the existing culvert. This flood routing methodology was also used to analyze and design the replacement culverts. Twin 48-inch diameter reinforced concrete pipe culverts (RCP) are proposed to replace the existing stone masonry structure. The proposed culvert has been sized to pass the 100-year design frequency storm, provide a minimum of 1-foot of freeboard to the approximate finish floor elevation of upstream buildings, and provide a maximum headwater depth no greater than 1.5 times the pipe diameter.

The increased hydraulic opening of the replacement structure has the potential to increase flooding on downstream properties and two (2) existing culvert crossings carrying Pepes Farm Road. To mitigate any potential increase in flooding downstream, CTDOT has required that the hydraulic opening of the proposed culvert be restricted to generally match original culvert conditions. Therefore, to satisfy this requirement, interim structure modifications will be implemented, including installation of full blocking of the upstream end of the southern RCP cell and installation of a slide gate to partially block the upstream end of the northern RCP cell. These interim measures will provide a hydraulic opening comparable to the original 2' x 2' stone masonry structure and will remain until downstream structures are upgraded.

Until the flow restriction measures are removed, the replacement structure will be hydraulically inadequate. This report contains the information in accordance with Section 9.3.9 of the CTDOT Drainage Manual for request of a Design Exception.

The analysis was performed in accordance with the CTDOT Drainage Manual and to satisfy the requirements of Section 13a-94 and Sections 25-68b through 25-68h of the Connecticut General Statutes, as revised.

All elevations within this report are 1988 North American Vertical Datum (NAVD88).



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DATE: 3/24/17

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YRC YANTIC RIVER CONSULTANTS, LLC

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CULVERT REPLACEMENT

CONNECTICUT DEPARTMENT OF TRANSPORTATION

SITE LOCATION MAP

NEW HAVEN MAINLINE — MILFORD, CT

INTRODUCTION

An existing 2' masonry culvert structure carries stormwater runoff from the Eastern Steel Road commercial and industrial area under the MNRR New Haven Mainline at approximate mile post 65.60. Based on visual inspections, the inlet and outlet of the existing structure are partially collapsed, resulting in a reduction of the hydraulic capacity of the structure. The outlet structure deterioration has also resulted in sloughing of the railroad embankment.

The 2' masonry culvert discharges to a wetland system that is situated between the MNRR railroad corridor to the north and Pepes Farm Road to the south. Commercial and industrial buildings and land uses are adjacent to the wetland areas. Stormwater runoff is conveyed under Pepes Farm Road through an existing twin 42" diameter RCP culvert.

PROPOSED REPLACEMENT

Twin 48-inch diameter reinforced concrete pipe (RCP) culverts are proposed to replace the existing stone masonry culvert structure. The RCP culvert will be set to maintain existing flow lines of the watercourse at the upstream and downstream face of the railroad embankment. To mitigate any potential increase in flooding downstream, interim structure modifications will be implemented, including installation of full blocking of the upstream end of the southern RCP cell and installation of a slide gate to partially block the upstream end of the northern RCP cell. These interim measures will provide a hydraulic opening comparable to the original 2' x 2' stone masonry structure and will remain until downstream structures are upgraded.

The pipes will be jacked through the existing railroad embankment to minimize impact to the railroad service above. This replacement alternative was selected based on constructability and improved hydraulic capacity. The interim structure modifications were selected to meet the CTDOT requirement to generally match original culvert flow conditions and also allow for routine access, inspection, and maintenance by CTDOT and MNRR personnel.

HYDRAULIC DESIGN CRITERIA

The existing culvert structure has a drainage area of less than 1.0 square mile with an established watercourse and is classified as a "Small" culvert structure per Section 8.3.11 of the CTDOT Drainage Manual. Minimum design criteria is a 50-year design frequency, a 100-year check frequency and a minimum of 1.0' of freeboard to the upstream design control.

Based on CTDOT requirements for this specific rail project, the culvert will be designed to accommodate a 100-year frequency storm event. The upstream design control was selected as the approximate finish floor elevation (±35.0 NAVD) of the existing building(s) located to the northwest of the culvert with headwater depths not to exceed HW/D < 1.5.

The increased hydraulic opening of the replacement structure has the potential to increase flooding on downstream properties and two (2) existing culvert crossings carrying Pepes Farm Road. As stated above, CTDOT has required that the hydraulic opening of the proposed culvert be restricted to generally match original culvert conditions until downstream structures are upgraded. Until the flow restriction measures are removed, the replacement structure will be hydraulically inadequate and a design exception is required in accordance with Section 9.3.9 of the CTDOT Drainage Manual.

FLOOD INSURANCE STUDY

The culvert site is not located within a designated Special Flood Hazard Area based on FEMA Flood Insurance Rate Map (FIRM) No. 09009C0532J for New Haven County, Connecticut.

HISTORIC FLOODING

Based on information provided by CTDOT staff, the low-lying developed areas immediately upstream of the subject culvert have a history of flooding. Due to the partial collapse of the outlet, the frequency of flooding has increased.

In a phone conversation between Richard Bray, PE of Lochner and James Connors of Connors Properties, LLC, owner of the parcels upstream of the subject culvert, Mr. Connors confirmed that the area has a long history of flooding, a condition that has worsened since the partial collapse of the outlet.

HYDROLOGY

The design flows used in the hydraulic analysis were presented in the *Hydrology Report Prepared for Replacement of Masonry Culvert Structure, MNRR New Haven Mainline at MP 65.60, Milford, Conn., State Project No. 301-0175*, dated November 2015 as revised March 2016, prepared by Yantic River Consultants, LLC. The Hydrology Report was approved by CTDOT in a letter to Mr. Jayantha Mather, Transportation Principal Engineer, from Mr. Michael E. Maysayda, Transportation Principal Engineer, dated May 18, 2016. The approved design flows are summarized in the table below.

AVG. RECURRENCE INTERVAL (STORM)	PEAK FLOW RATE (CFS)
	TR-55 METHOD
Avg. Day	0.2
Avg. Spring	0.4
1-year	86
2-year	111
5-year	153
10-year	188
25-year	235
50-year	271
100-year	**307**
500-year	427

TABLE 1: PEAK FLOW RATES

ROUTING ANALYSIS

YRC performed a detailed flood routing analysis of the contributing watershed to evaluate the effect of temporary upstream ponding caused by the backwater from the existing culvert and design the replacement culverts. Using Bentley Systems CivilStorm v8i, unit hydrographs and peak flows were generated for the watershed for the 1, 2, 10, 25, 50, 100, and 500-year frequency events and run through the existing and proposed conditions.

The routing analysis consisted of two (2) catchment areas delineated based on a combination of topographic information obtained from CTDOT survey and NOAA LiDAR.

- CM-1 is located to the north of the MNRR corridor and delineates the watershed draining to the culvert under the railroad. This subarea contains storage area PO-1, which includes areas within the natural bank and wetland limits and surrounding low-lying developed areas that may be subjected to flooding.
- CM-2 is located to the south of the MNRR corridor and delineates the watershed draining to the culvert under Pepes Farm Road. This subarea contains storage area PO-2, which consists of the area within the natural bank limits of the channel and surrounding wetland area.

Curve numbers (CN) were assigned for each catchment area based on the Hydrologic Soil Group (HSG) and land use. Soils within CM-1 have a HSG Rating of D and within CM-2 a Rating of B or D. Land use within CM-1 consists of impervious surfaces, open space (apparent landscaped areas), woods and the railroad corridor as determined from the 2016 NOAA Aerial Imagery. The composite CN for CM-1 is 91.0, which is consistent for an industrial developed area. Land use within CM-2 generally consists of a mix of industrial, residential ¼ acre and woods along the railroad corridor. The composite CN for CM-2 is 83.

Time of concentration (Tc) for CM-1 was determined using the SCS TR-55 Method where the flow path is divided into three categories: sheet or overland, shallow concentrated and channel flow. Given the similarities in basin development and topography, CM-2 was assigned a Tc value of 30 minutes which is comparable to the calculated Tc for CM-1.

24-hour precipitation rates from NOAA Atlas 14 Volume 10: Precipitation-Frequency Atlas of the United States, Northeastern States were used in the analysis from the nearest published station, Bridgeport Sikorsky Memorial Airport, Station ID 06-0806.

PROPOSED STRUCTURE DESCRIPTION

The existing stone culvert will be replaced with twin 48” RCP Culvert Pipes, each with a total length of 101’, and upstream invert of 28.10 and a downstream invert of 27.60 to match existing grades within the channel. The culverts will be installed via pipe jacking to minimize disturbance of the active rail above and maintain the top of rail elevation of ±43.1. Cast-in-place or precast concrete headwalls will be constructed at each culvert end.

INTERIM STRUCTURE MODIFICATION

To mitigate any potential increase in flooding downstream, CTDOT has required that the hydraulic opening of the proposed culvert be restricted to generally match original culvert conditions. To satisfy this requirement, the southern RCP cell will be fully blocked and the northern RCP cell will be partially blocked with a slide gate, which will provide a hydraulic opening comparable to the original 2’ x 2’ stone structure.

These interim modifications will remain in place until downstream structures are upgraded. The slide gate position will be set in the field, documented, and recorded for future inspection and reference. In addition, the gate mechanism will be locked to prohibit unauthorized modification and/or operation.

COMPARISON

A comparison of computed water surface elevations and velocities for existing, proposed, and interim conditions are provided in the table below.

STORM EVENT	W.S. ELEVATIONS[1] (NAVD) UPSTREAM OF MNRR			W.S. ELEVATIONS[1] (NAVD) DOWNSTREAM OF MNRR		
	EXISTING	PROPOSED	INTERIM	EXISTING	PROPOSED	INTERIM
1-year	33.33	30.05	32.72	30.22	29.78	30.33
2-year	33.96	30.13	33.26	30.42	29.86	30.49
5-year	35.03	30.78	34.39	30.77	30.02	30.78
10-year	35.56	31.05	34.95	30.94	30.11	30.94
25-year	36.24	31.15	35.63	31.16	30.21	31.14
50-year	36.72	31.48	36.08	31.31	30.38	31.26
100-year	**37.18**	**31.66**	**36.50**	**31.46**	**30.40**	**31.38**
500-year	38.00[2]	32.76	38.00[2]	-	30.74	-
STORM EVENT	**VELOCITY[3] (FT/S) UPSTREAM OF MNRR**			**VELOCITY[3] (FT/S) DOWNSTREAM OF MNRR**		
	EXISTING	PROPOSED	INTERIM	EXISTING	PROPOSED	INTERIM
1-year	8.57	6.75	9.54	8.57	5.87	13.92
2-year	9.15	8.18	10.70	9.15	7.16	14.70
5-year	10.05	8.47	12.45	10.05	9.55	15.53
10-year	10.46	9.22	13.06	10.46	11.00	15.51
25-year	10.98	11.24	13.78	10.98	13.29	15.46
50-year	11.32	11.79	14.23	11.32	14.33	15.41
100-year	**11.65**	**12.70**	**14.64**	**11.65**	**15.95**	**15.36**
500-year	-[4]	15.70	-[4]	-[4]	18.66	-[4]

[1] WS elevation obtained from hydraulic grades at MNRR Conduit Report In & Out
[2] The culvert is at full capacity and fills the storage area; elevation defaults to 38.00 & model terminates
[3] Velocity obtained from MNRR Conduit Report In & Out
[4] No velocity reported due to model limitations & varying times to maximum flow vs. hydraulic grade under full capacity

TABLE 2: ROUTING RESULTS

STORM EVENT	UPSTREAM OF MNRR				DOWNSTREAM OF MNRR			
	PR vs EX		INT vs EX		PR vs EX		INT vs EX	
	WS ELEV.	VEL.	WS ELEV.	VEL.	WS ELEV.	VEL.	WS ELEV.	VEL.
1-year	-3.28	-1.82	-0.61	0.97	-0.44	-2.70	0.11	5.35
2-year	-3.83	-0.97	-0.70	1.55	-0.56	-1.99	0.07	5.55
5-year	-4.25	-1.58	-0.64	2.40	-0.75	-0.50	0.01	5.48
10-year	-4.51	-1.24	-0.61	2.60	-0.83	0.54	0.00	5.05
25-year	-5.09	0.26	-0.61	2.80	-0.95	2.31	-0.02	4.48
50-year	-5.24	0.47	-0.64	2.91	-0.93	3.01	-0.05	4.09
100-year	**-5.52**	**1.05**	**-0.68**	**2.99**	**-1.06**	**4.30**	**-0.08**	**3.71**
500-year	-5.24	-	0.00	-	-	-	-	-

TABLE 3: ROUTING COMPARISON

STORM EVENT	W.S. ELEVATIONS[1] (NAVD)			COMPARISON	
	UPSTREAM OF PEPES FARM RD.				
	EXISTING	PROPOSED	INTERIM	PR VS. EX	INT VS. EX
1-year	26.49	26.92	26.70	0.43	0.21
2-year	26.69	27.22	26.93	0.53	0.24
5-year	27.10	27.72	27.33	0.62	0.23
10-year	27.32	28.00	27.54	0.68	0.22
25-year	27.59	28.42	27.81	0.83	0.22
50-year	27.77	28.72	27.99	0.95	0.22
100-year	**27.94**	**29.02**	**28.16**	**1.08**	**0.22**
500-year	28.47	29.82	28.10	1.35	-0.37
[1] WS elevation obtained from hydraulic grades at PO-2					

TABLE 4: WATER SURFACE ELEVATIONS AT PEPES FARM ROAD

WATER SURFACE ELEVATIONS:

For the 100-year design storm, the proposed replacement culvert reduces water surfaces elevations upstream and downstream. The twin 48” RCP culvert is a hydraulically adequate structure with over 1’ of freeboard to the upstream buildings (±35.0) and meets the 1.5 Hw/D ratio. However, due to an existing downstream restriction at Pepes Farm Road, the proposed structure results in an increase in water surface elevations in the wetland and natural overbanks above Pepes Farm Road.

Under the 500-year storm event the culvert is at full capacity. At full capacity, elevations are well below the top of rail elevation of ±43.1 and will continue to provide adequate freeboard to the upstream buildings. An increase in water surface elevations above Pepes Farm Road also occurs.

For both storm events, the increase downstream is contained within the wetlands and natural overbanks depicted on the Storage (Pond) Volume Map. To mitigate any potential increase in flooding downstream, CTDOT has required the hydraulic opening for the proposed replacement structure be reduced until the Pepes Farm Road crossing can be upgraded.

The interim structure modifications, which reduce the hydraulic opening to meet CTDOT requirements, result in water surface elevations comparable to existing conditions under both the 100-year and 500-year events with minor increases and decreases. These variations are attributed to improved roughness coefficients. These interim structure modifications maintain a hydraulically inadequate structure.

Culvert profiles are provided in Figure 2.

VELOCITIES:

Improved roughness coefficients, increased hydraulic capacity, and reduction of backwater conditions at MNRR under larger storm events result in an increase in velocities under larger storm events for proposed conditions. The interim structure modifications result in increased velocities under all storm events as the structure remains hydraulically inadequate with improved roughness coefficients.

Although no velocity is reported for the 500-year storm under Existing and the Interim Structure Modifications due to the limitations of the model, it is anticipated an increase in velocity, consistent with the 100-year storm will occur.

Installation of revetment at the inlet and outlet is recommended to provide scour protection. See Appendix F: Channel Design for further discussion.

WATER HANDLING

The 48" pipes will be jacked through the existing railroad embankment to minimize impact to the railroad service above. Existing flow will be diverted through the existing culvert using bypass pipes and cofferdams. Design Plans, provided under separate cover, detail the method of construction to accomplish the work, provide protection of the work during construction and minimize impacts to the natural resources.

For a complete discussion, see Appendix E: Temporary Facilities & Flood Contingency.

All construction activities will be performed in accordance with CTDOT Form 817, supplemented as needed with project specific special provisions. Proper erosion and sedimentation controls will be installed and maintained throughout the duration of the project so as not to increase turbidity levels.

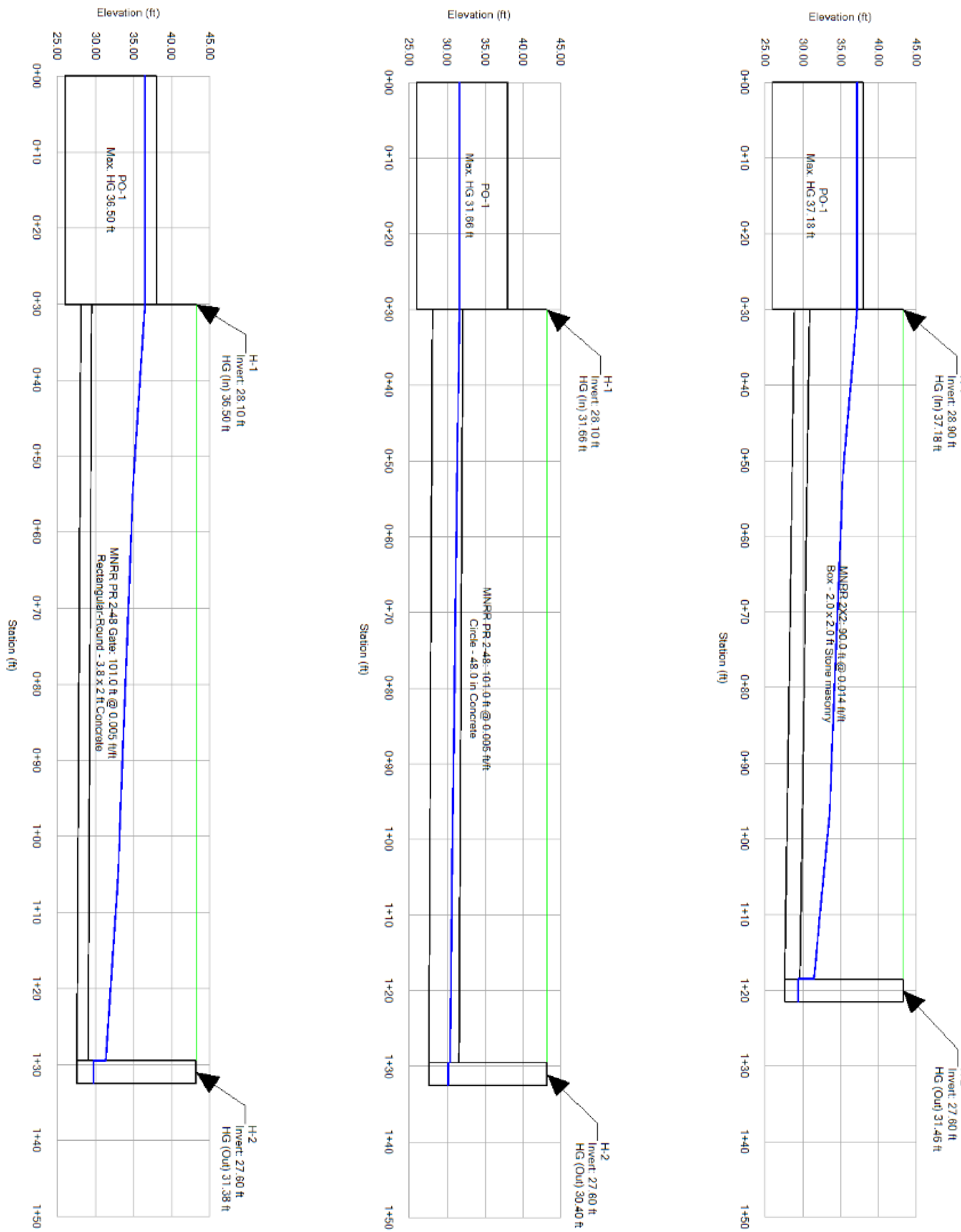

FIGURE 2: MNRR Culvert Profiles

CONCLUSION

Twin 48" RCP culverts are recommended for replacement to provide over 1' of freeboard to the upstream buildings (±35.0) and meet the 1.5 Hw/D ratio. The RCP culvert will be set to maintain existing flow lines of the watercourse. To mitigate any potential increase in flooding downstream, interim structure modifications will be installed to restrict the hydraulic opening of the proposed culvert cells and generally match original culvert conditions until downstream structures are upgraded.

The restriction results in a minor increase in water surface elevation upstream of Pepes Farm Road; however, the increase is contained within the general limits of channel, wetlands and natural overbanks areas and will not increase the potential for flooding or adversely impact public safety and downstream properties.

The Twin 48" RCP culverts with interim structure modifications will maintain current hydraulic capacity, provide a hydraulically adequate structure at a future date, and meet constructability and water handling needs.

APPENDIX A

HYDROLOGY REPORT

Approval Memo
Report Narrative, March 2016

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION

M E M O R A N D U M

subject: Project No. 301-0175
Revised Hydrologic Report Review
MNRR New Haven Mainline
Culvert Replacement (MP 65.6)
Milford

date: May 18, 2016

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to: Mr. Jayantha Mather
Trans. Principal Engineer
Office of Rail
Design and Construction
Bureau of Public Transportation

from: Michael E. Masayda
Trans. Principal Engineer
Hydraulics and Drainage
Bureau of Engineering
and Construction

The Hydraulics and Drainage Section has reviewed the Hydrology Report (revised March 2016) for the subject project, and has no further comments.

Neal Cianciolo:
cc: Theodore H. Nezames-Michael E. Masayda-Chong Lung Chow
Andrew H. Davis
Haresh Dholakia-Jay Young-Abraham Monger

YANTIC RIVER
CONSULTANTS, LLC

HYDROLOGY REPORT

PREPARED FOR

REPLACEMENT OF MASONRY CULVERT STRUCTURE
MNRR NEW HAVEN MAINLINE AT MP 65.60
MILFORD, CONNECTICUT

STATE PROJECT NO. 301-175

DATE: NOVEMBER, 2015
REVISED: MARCH, 2016

PREPARED BY: ______________________
Brandon Handfield, PE

CHECKED BY: ______________________
David Miroslaw, PE

APPROVED BY: ______________________
Brandon Handfield, PE

STATE OF CONNECTICUT
BRANDON J. HANDFIELD
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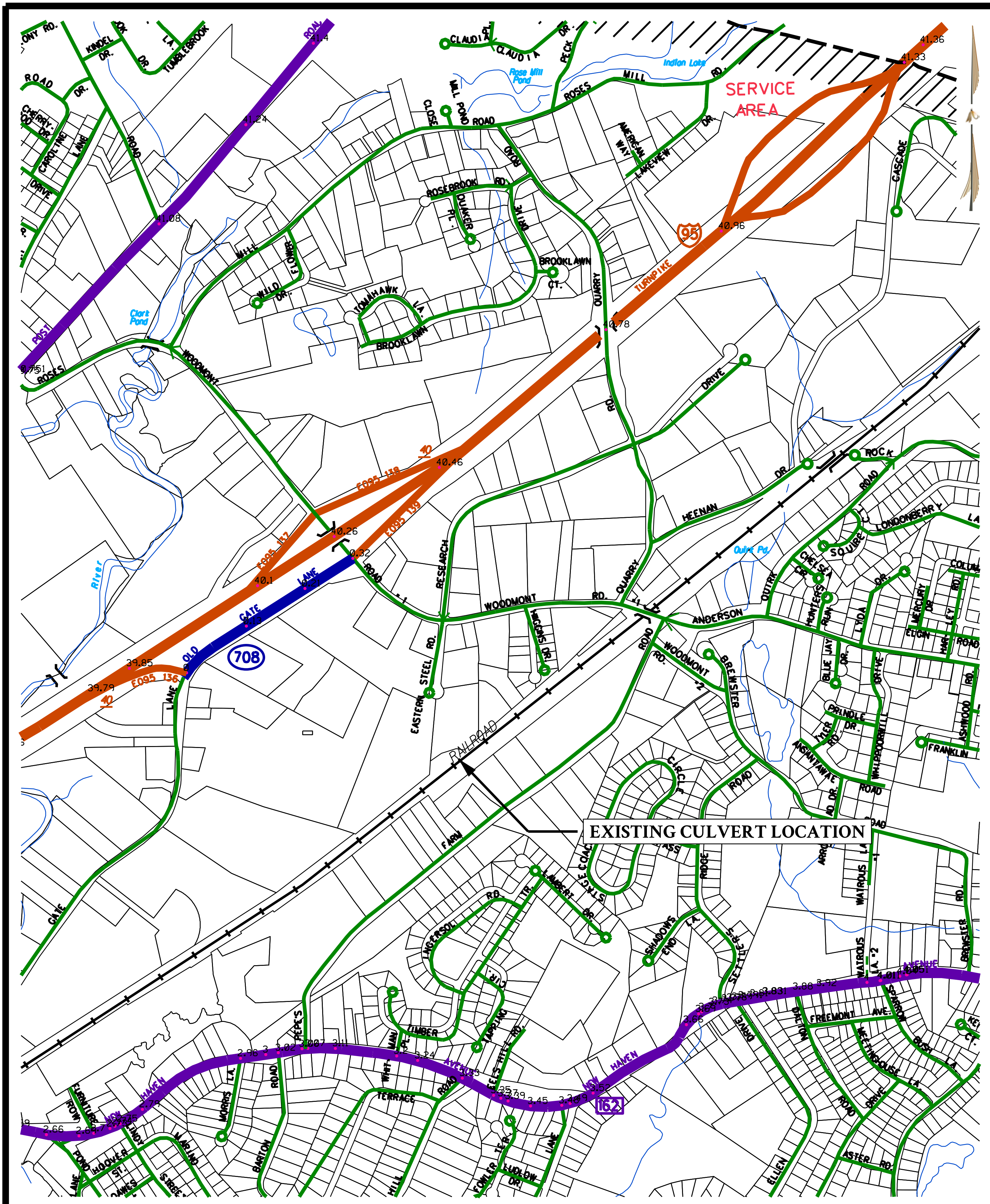
An existing 90-foot long, 2' wide rectangular stone masonry culvert structure carries stormwater runoff from the Eastern Steel Road commercial and industrial area under the Metro North Railroad (MNRR) New Haven Mainline at approximate mile post 65.60. Based on visual inspections, the inlet and outlet of the existing structure are partially collapsed, resulting in a reduction of the hydraulic capacity of the structure. The outlet structure deterioration has also resulted in sloughing of the railroad embankment. Internal dimensions and conditions of the culvert could not be evaluated due to the deteriorated end conditions and standing water.

In response to the noted deterioration, loss of hydraulic capacity, and potential for flooding of upstream properties, the Connecticut Department of Transportation (CTDOT) has identified this structure for full replacement. H.W. Lochner, Inc. (Lochner) was contracted to provide consulting engineering services for the replacement and Yantic River Consultants, LLC (YRC) was subcontracted to perform hydrologic and hydraulic analysis services.

YRC performed a hydrologic analysis for the watershed draining to the existing culvert to determine peak flow rates in accordance with the procedures outline in the CTDOT Drainage Manual. Peak flow rates were calculated using both the Rational Method and the NRCS TR-55 methodology with consideration of existing soils, land uses, topography and rainfall data published for Bridgeport Sikorsky Memorial Airport by NOAA Atlas 14 Volume 10. Each method produced comparable flow rates with the TR-55 method producing slightly more conservative values.

Based on hydrologic calculations, field observations, historical flooding and Milford map research, YRC recommends that the peak flow rates calculated utilizing the TR-55 be used for hydraulic analysis of existing and proposed conditions to allow for evaluation of available storage within the upstream basin. The calculated peak flow rates for the TR-55 Method are provided in the table below, with the recommended 100-year design flow in bold.

AVG. RECURRENCE INTERVAL (STORM)	PEAK FLOW RATE (CFS)
	TR-55 METHOD
Avg. Day	0.2
Avg. Spring	0.4
1-year	86
2-year	111
5-year	153
10-year	188
25-year	235
50-year	271
100-year	**307**
500-year	427



SCALE: 1"= 400' 400 0 400 800		CONTACT INFORMATION	CULVERT REPLACEMENT - MP 65.60
DATE 11/11/15	PAGE 2	YANTIC RIVER CONSULTANTS, LLC 191 NORWICH AVENUE LEBANON, CONN 06249 Phone: (860) 367-7264 Web: www.yanticriverconsultants.com	CONNECTICUT DEPARTMENT OF TRANSPORTATION SITE LOCATION MAP NEW HAVEN MAINLINE MILFORD, CT

YRC
YANTIC RIVER CONSULTANTS, LLC

INTRODUCTION

An existing 90-foot long, 2' wide rectangular stone masonry culvert structure carries stormwater runoff from the Eastern Steel Road commercial and industrial area under the MNRR New Haven Mainline at approximate mile post 65.60. Based on visual inspections, the inlet and outlet of the existing structure are partially collapsed, resulting in a reduction of the hydraulic capacity of the structure. The outlet structure deterioration has also resulted in sloughing of the railroad embankment. Internal dimensions and conditions of the culvert could not be evaluated due to the deteriorated end conditions and standing water.

YRC performed a hydrologic analysis for the watershed draining to the existing culvert to determine peak flow rates in accordance with the procedures outline in the CTDOT Drainage Manual.

HYDROLOGY

WATERSHED PROPERTIES

The existing culvert has a total drainage area of 67.14 acres (0.10 mi^2) measured using a compilation of the following mapping, as confirmed through field observation.

1. CTDOT Survey Data (SV_D3_300_175_Milford_Metro_North_Culvert_GRN.dgn)
2. 2011 FEMA Lidar: Quinnipiac River Watershed (CT) contour data obtained from NOAA Office for Coastal Management Digital Coast Data Access Viewer
3. 2010 Coastal CT ADS40 4 Band aerial imagery obtained from NOAA Office for Coastal Management Digital Coast Data Access Viewer
4. Stormwater System mapping obtained from Milford Engineering Department

The watershed, which lies in the Indian River subregional drainage basin 5306, is part of the South Central Coast major drainage basin number 5. Located in the southeastern portion of Milford, the watershed can be characterized as dense commercial and industrial development with sparse areas of vegetation and woods.

The area consists of moderate sloping terrain directing runoff through a series of stormwater collection systems to the south towards the MNRR corridor and the subject culvert. The stormwater networks ultimately flow to a wooded wetland area that forms a natural stormwater detention basin prior to discharging to the culvert. Based upon a report prepared by Connecticut Ecosystems LLC, dated November 12, 2015, groundwater discharges were evident within the defined channel and wetland area in the vicinity of the culvert, even during drier times of the year, signifying a perennial or mostly perennial flow.

Other than the natural stormwater detention basin described above, there are no significant waterbodies or major flood retention structures within the watershed. Based on Town of Milford mapping, there appear to be underground detention and/or infiltration structures serving a few properties and/or developments. As a conservative measure, these mapped underground storage structures were disregarded in the hydrologic analyses.

Drainage area maps and watershed data provided in Appendix B.

PREVIOUS STUDIES

The site is not located within a FEMA Special Flood Hazard Area with no published hydrologic studies of the watershed draining to the subject culvert.

HISTORIC FLOODING

Based on information provided by CTDOT staff, the low-lying developed areas immediately upstream of the subject culvert have a history of flooding. Due to the partial collapse of the outlet, the frequency of flooding has increased.

In a phone conversation between Richard Bray, PE of Lochner and James Connors of Connors Properties, LLC, owner of the parcels upstream of the subject culvert, Mr. Connors confirmed that the area has a long history of flooding, a condition that has worsened since the partial collapse of the outlet.

PEAK FLOW METHODS

Peak flow rates for the contributing watershed were calculated using the Rational Method and Technical Release TR-55 as described below.

RATIONAL METHOD: In accordance with Section 6.9 of the CTDOT Drainage Manual, the Rational Method was used to calculated peak runoff rates for watersheds up to 200 acres in size using the following parameters.

- **RUNOFF COEFFICIENT:** A composite runoff coefficient (C) was calculated for the watershed based on land uses, as determined from the 2011 NOAA Aerial Imagery, and runoff values for various landuses and surface materials provided in Table 6-4 and 6-5 in the CTDOT Drainage Manual. The composite C for the watershed is 0.69.
- **TIME OF CONCENTRATION:** Time of concentration (Tc) was determined using the SCS method, with a combination of sheet flow and shallow concentrated flow from the hydraulically most distant point of the watershed to the approximate limits of backwater inundation resulting from the existing culvert. The calculated Tc for the watershed is 0.457 hours or 27.4 minutes.
- **RAINFALL INTENSITY:** As required in the CTDOT Engineering Bulletin EB-2015-2, dated November 3, 2015, precipitation frequency estimates (rainfall data) were obtained from NOAA Atlas 14 Volume 10: Precipitation-Frequency Atlas of the United States, Northeastern States. The nearest published station is Bridgeport Sikorsky Memorial Airport, Station ID 06-0806. Rainfall intensity rates were interpolated from the published data based on a calculated Tc of 27.1 minutes.

Storm	1-Year	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Intensity (in/hr)	1.74	2.09	2.68	3.17	3.84	4.35	4.87

- **INFREQUENT STORMS:** In order to account for a reduction in the impact of infiltration and other losses for less frequent, higher intensity storms greater than the 10-year, Frequency Factors (Cf) were applied to the rational formula as follows:

Storm	1-Year	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Cf	1.0	1.0	1.0	1.0	1.1	1.2	1.25

TR-55 METHOD: Technical Release 55 (TR-55), developed by the USDA Natural Resources Conservation Service (NRCS) for urban and urbanizing watersheds, is a procedure for estimating storm runoff volume and peak discharge rates in small watersheds utilizing 24-hour rainfall data, runoff curve numbers (CN), and time of concentration (Tc). Bentley PondPack v8i was used to generate peak flows from the watershed with the following parameters:

- **RAINFALL:** Similar to the Rational Method, NOAA Atlas 14 Volume 10 rainfall data was used for the nearest published station in Bridgeport Sikorsky Memorial Airport, Station ID 06-0806. 24-hour rainfall depths are provided in the table below.

Storm	1-Year	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Depth (in.)	2.81	3.44	4.46	5.31	6.48	7.38	8.29

- **CURVE NUMBER:** Curve numbers (CN) were assigned based on the hydrologic soil group and land use. Based on USDA NRCS Web Soil Survey, soils within the subject watershed consist of Urban Land, Map Unit 307, with a Hydrologic Soil Group Rating of D. Landuse within the watershed consists of impervious (roads, sidewalks, driveways, parking areas, loading areas and buildings), open space (apparent landscaped areas), woods and the railroad corridor as determined from the 2011 NOAA Aerial Imagery. The composite CN for the watershed is 91.0.

- **TIME OF CONCENTRATION:** A time of concentration (Tc) of 0.457 hours or 27.4 minutes was used to match the approach used in the Rational Method.

PEAK FLOW COMPARISON

As shown in the table below, the Rational and TR-55 Methods produced similar peak flow rates, with the TR-55 Method producing slightly higher, more conservative rates for all storms.

AVG. RECURRENCE INTERVAL (STORM)	PEAK FLOW RATE (CFS)	
	TR-55	RATIONAL METHOD
Avg. Day	0.2	0.2
Avg. Spring	0.4	0.4
1-year	86	80
2-year	111	97
5-year	153	124
10-year	188	147
25-year	235	195
50-year	271	241
100-year	307	282
500-year	427	369

RECOMMENDED FLOWS

Per the CTDOT Drainage Manual, a culvert conveying an established watercourse with a drainage area less than 1.0 square mile is considered a "Small" structure, with a recommended 50-year storm design flow and a 100-year check flow. However, per the CTDOT Office of Rail Drainage Facility Practices, culverts carrying railroad lines with regularly scheduled passenger services shall be designed to accommodate a 100-year storm regardless of watershed size. In recognition of the Office of Rail requirements, a 100-year design storm is recommended.

As described in the Peak Flow Comparison section above, the calculated flows for the TR-55 and Rational Methods were comparable, with the TR-55 flows ranging from 8% to 30% higher than the Rational Method depending on the storm event. For the 100-year design storm, the calculated flows for each method are within 10% and therefore, either method appears to provide a reasonable flow for analysis and design purposes for the subject culvert.

Beyond the calculated peak flow rates, consideration was also given to the complexity of the watershed and the nature of documented flooding problems in the vicinity of the subject culvert. The flooding appears to be the result of increased development within the watershed and a deterioration of the existing culvert structure. As a result, runoff exceeds the capacity of the existing culvert, resulting in backwater that inundates a large storage area along the northern embankment of the railroad before water surface elevations reach the finish floors of adjacent buildings. In order to properly evaluate existing conditions and the proposed improvement, the available flood storage immediately upstream of the existing culvert should be considered in addition to the hydraulic capacity improvements offered by a replacement structure.

Therefore, based on the hydrologic calculations, field observations, historical flooding, and Milford map research, YRC recommends that the peak flow rates calculated utilizing the TR-55 Method be used for hydraulic analysis of existing and proposed conditions. The calculated peak flow rates for the TR-55 Method are summarized in the table below, with the recommended 100-year design flow in bold.

AVG. RECURRENCE INTERVAL (STORM)	PEAK FLOW RATE (CFS)
	RATIONAL METHOD
Avg. Day	0.2
Avg. Spring	0.4
1-year	86
2-year	111
5-year	153
10-year	188
25-year	235
50-year	271
100-year	**307**
500-year	427

APPENDIX A

PHOTOGRAPHS

282 Woodmont Road looking north

Eastern Steel Road looking northwest towards 465 Old Gate Lane

Intersection of Research Drive and Woodmont Road

Upstream Railroad Embankment at Culvert

Downstream Embankment at culvert – note sloughing

Downstream outlet – note collapsed structure

APPENDIX B

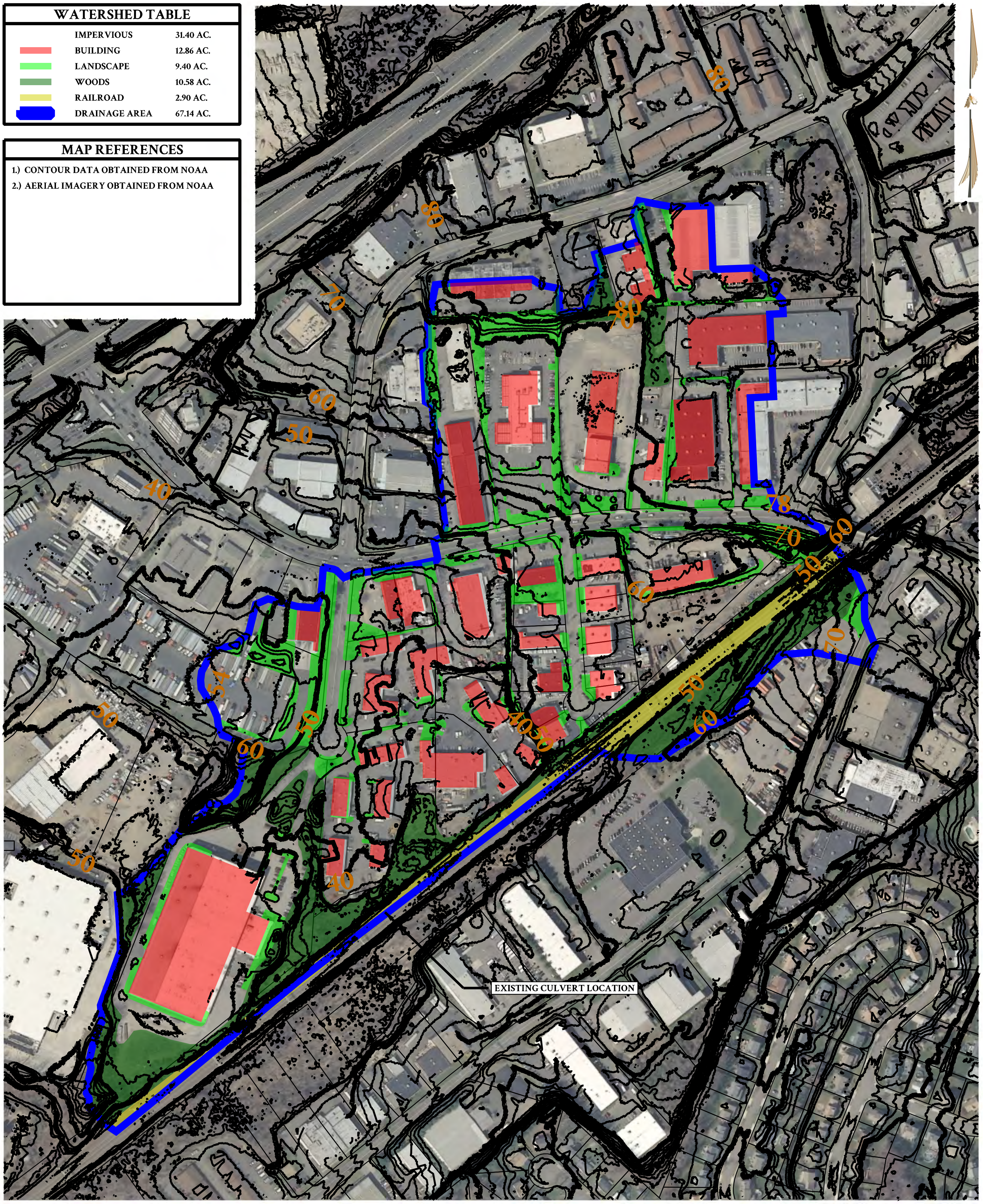
WATERSHED DATA

WATERSHED TABLE

	IMPERVIOUS	31.40 AC.
	BUILDING	12.86 AC.
	LANDSCAPE	9.40 AC.
	WOODS	10.58 AC.
	RAILROAD	2.90 AC.
	DRAINAGE AREA	67.14 AC.

MAP REFERENCES

1.) CONTOUR DATA OBTAINED FROM NOAA
2.) AERIAL IMAGERY OBTAINED FROM NOAA



SCALE: 1"= 400'

400 0 400 800

DATE
3/2/16

SHEET
1 OF 3

YRC
YANTIC RIVER CONSULTANTS LLC

CONTACT INFORMATION
YANTIC RIVER CONSULTANTS, LLC
191 NORWICH AVENUE
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Phone: (860) 367-7264
Web: www.yanticriverconsultants.com

CULVERT REPLACEMENT - MP 65.60

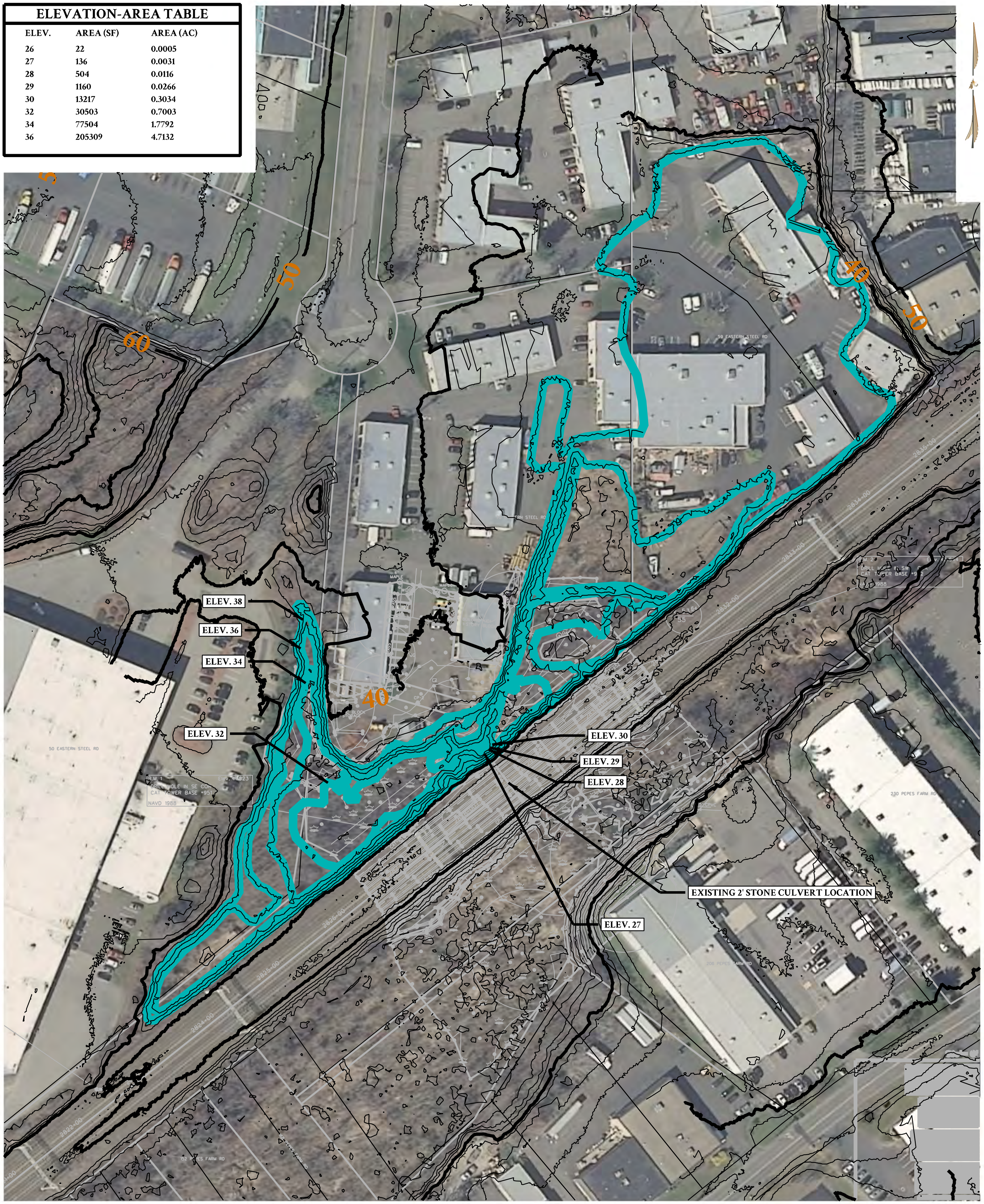
CONNECTICUT DEPARTMENT OF TRANSPORTATION

WATERSHED MAP

NEW HAVEN MAINLINE MILFORD, CT

ELEVATION-AREA TABLE

ELEV.	AREA (SF)	AREA (AC)
26	22	0.0005
27	136	0.0031
28	504	0.0116
29	1160	0.0266
30	13217	0.3034
32	30503	0.7003
34	77504	1.7792
36	205309	4.7132



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150 0 150 300

DATE 3/2/16

SHEET 2 OF 3

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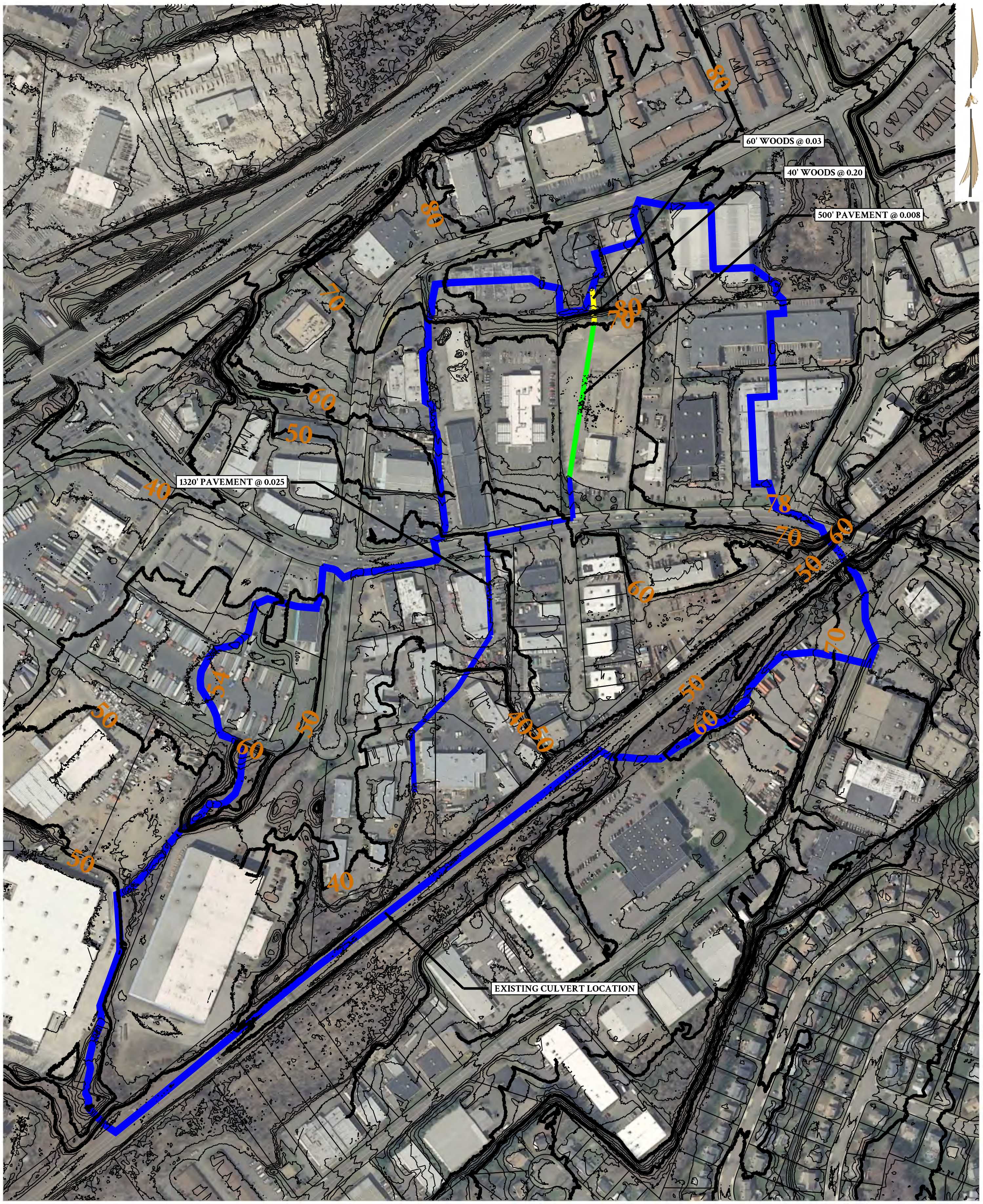
CULVERT REPLACEMENT - MP 65.60

CONNECTICUT DEPARTMENT OF TRANSPORTATION

PO-1 ELEVATION AREA MAP

NEW HAVEN MAINLINE MILFORD, CT



SCALE: 1"= 400'

400 0 400 800

DATE 3/2/16

SHEET 3 OF 3

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CULVERT REPLACEMENT - MP 65.60

CONNECTICUT DEPARTMENT OF TRANSPORTATION

Tc MAP

NEW HAVEN MAINLINE MILFORD, CT

Hydrologic Soil Group—State of Connecticut
(301-175 Hydrologic Soil Group Map)

Map Scale: 1:6,950 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0, 100, 200, 400, 600

Feet: 0, 300, 600, 1200, 1800

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: State of Connecticut
Survey Area Data: Version 14, Sep 22, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 27, 2014—Jul 22, 2014

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — State of Connecticut (CT600)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
60B	Canton and Charlton soils, 3 to 8 percent slopes	B	23.1	10.2%
73C	Charlton-Chatfield complex, 3 to 15 percent slopes, very rocky	B	0.1	0.0%
306	Udorthents-Urban land complex	B	17.6	7.8%
307	Urban land	D	186.2	82.0%
Totals for Area of Interest			**227.0**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

NOAA Atlas 14, Volume 10, Version 2
BRIDGEPORT SIKORSKY MEM A
Station ID: 06-0806
Location name: Stratford, Connecticut, US*
Latitude: 41.1583°, Longitude: -73.1289°
Elevation:
Elevation (station metadata): 5 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.345 (0.280-0.419)	0.416 (0.337-0.506)	0.533 (0.430-0.651)	0.629 (0.504-0.773)	0.762 (0.587-0.982)	0.865 (0.650-1.14)	0.968 (0.702-1.33)	1.10 (0.747-1.54)	1.26 (0.824-1.85)	1.39 (0.882-2.08)
10-min	0.488 (0.396-0.594)	0.589 (0.478-0.717)	0.754 (0.609-0.922)	0.891 (0.715-1.10)	1.08 (0.832-1.39)	1.23 (0.921-1.62)	1.37 (0.994-1.88)	1.55 (1.06-2.18)	1.79 (1.17-2.62)	1.97 (1.25-2.94)
15-min	0.574 (0.466-0.698)	0.693 (0.562-0.844)	0.888 (0.716-1.08)	1.05 (0.841-1.29)	1.27 (0.979-1.64)	1.44 (1.08-1.90)	1.61 (1.17-2.21)	1.83 (1.24-2.57)	2.11 (1.37-3.08)	2.32 (1.47-3.46)
30-min	0.802 (0.650-0.974)	0.967 (0.783-1.18)	1.24 (0.998-1.51)	1.46 (1.17-1.80)	1.77 (1.36-2.28)	2.01 (1.51-2.65)	2.25 (1.63-3.08)	2.54 (1.73-3.58)	2.94 (1.91-4.29)	3.24 (2.05-4.83)
60-min	1.03 (0.835-1.25)	1.24 (1.00-1.51)	1.59 (1.28-1.94)	1.87 (1.50-2.30)	2.27 (1.75-2.92)	2.57 (1.94-3.39)	2.88 (2.09-3.95)	3.26 (2.22-4.59)	3.77 (2.45-5.50)	4.15 (2.63-6.19)
2-hr	1.34 (1.09-1.61)	1.62 (1.32-1.96)	2.08 (1.69-2.52)	2.46 (1.98-3.00)	2.98 (2.31-3.83)	3.39 (2.57-4.45)	3.79 (2.77-5.19)	4.33 (2.96-6.04)	5.03 (3.29-7.30)	5.57 (3.53-8.24)
3-hr	1.55 (1.27-1.86)	1.87 (1.53-2.26)	2.41 (1.96-2.91)	2.85 (2.31-3.47)	3.47 (2.70-4.43)	3.94 (2.99-5.15)	4.41 (3.23-6.01)	5.04 (3.46-7.01)	5.88 (3.85-8.49)	6.51 (4.14-9.60)
6-hr	1.96 (1.61-2.33)	2.37 (1.95-2.83)	3.05 (2.50-3.66)	3.61 (2.94-4.36)	4.38 (3.44-5.57)	4.98 (3.81-6.48)	5.58 (4.12-7.57)	6.40 (4.40-8.84)	7.48 (4.91-10.7)	8.30 (5.29-12.1)
12-hr	2.41 (2.00-2.86)	2.92 (2.42-3.47)	3.76 (3.10-4.48)	4.46 (3.65-5.34)	5.41 (4.26-6.82)	6.15 (4.73-7.94)	6.88 (5.11-9.28)	7.91 (5.46-10.8)	9.26 (6.10-13.2)	10.3 (6.58-14.9)
24-hr	2.81 (2.35-3.32)	3.44 (2.87-4.06)	4.46 (3.71-5.29)	5.31 (4.38-6.33)	6.48 (5.14-8.13)	7.38 (5.72-9.50)	8.29 (6.20-11.1)	9.60 (6.65-13.1)	11.3 (7.48-16.0)	12.6 (8.12-18.2)
2-day	3.13 (2.63-3.66)	3.88 (3.26-4.55)	5.12 (4.29-6.03)	6.15 (5.11-7.28)	7.57 (6.05-9.46)	8.66 (6.76-11.1)	9.75 (7.37-13.1)	11.5 (7.96-15.5)	13.7 (9.08-19.2)	15.4 (9.93-22.1)
3-day	3.38 (2.85-3.94)	4.21 (3.55-4.91)	5.56 (4.67-6.52)	6.69 (5.57-7.88)	8.24 (6.61-10.3)	9.43 (7.39-12.1)	10.6 (8.07-14.3)	12.5 (8.73-16.9)	15.1 (9.99-21.0)	17.0 (10.9-24.2)
4-day	3.62 (3.07-4.21)	4.50 (3.80-5.23)	5.92 (4.99-6.92)	7.10 (5.94-8.35)	8.73 (7.03-10.8)	9.99 (7.85-12.7)	11.2 (8.56-15.0)	13.3 (9.25-17.8)	15.9 (10.6-22.2)	17.9 (11.6-25.5)
7-day	4.34 (3.69-5.01)	5.27 (4.48-6.10)	6.80 (5.75-7.90)	8.07 (6.78-9.43)	9.81 (7.92-12.1)	11.2 (8.79-14.1)	12.5 (9.53-16.6)	14.6 (10.2-19.5)	17.4 (11.6-24.0)	19.5 (12.6-27.5)
10-day	5.02 (4.29-5.79)	6.00 (5.12-6.91)	7.58 (6.44-8.78)	8.90 (7.50-10.4)	10.7 (8.67-13.1)	12.1 (9.55-15.2)	13.5 (10.3-17.7)	15.6 (11.0-20.7)	18.4 (12.3-25.3)	20.4 (13.3-28.7)
20-day	7.06 (6.07-8.08)	8.12 (6.98-9.30)	9.86 (8.43-11.3)	11.3 (9.58-13.1)	13.3 (10.8-16.0)	14.8 (11.7-18.3)	16.3 (12.4-21.0)	18.3 (12.9-24.1)	20.9 (14.0-28.5)	22.8 (14.9-31.8)
30-day	8.75 (7.56-9.97)	9.88 (8.52-11.3)	11.7 (10.1-13.4)	13.2 (11.3-15.3)	15.4 (12.5-18.4)	17.0 (13.4-20.8)	18.6 (14.1-23.6)	20.4 (14.5-26.8)	22.9 (15.4-31.1)	24.8 (16.1-34.3)
45-day	10.9 (9.41-12.3)	12.1 (10.4-13.7)	14.0 (12.1-16.0)	15.7 (13.4-18.0)	17.9 (14.6-21.3)	19.6 (15.5-23.8)	21.4 (16.1-26.8)	23.1 (16.5-30.1)	25.4 (17.2-34.3)	27.2 (17.8-37.6)
60-day	12.6 (11.0-14.3)	13.9 (12.1-15.7)	15.9 (13.8-18.1)	17.7 (15.1-20.2)	20.0 (16.4-23.7)	21.8 (17.3-26.4)	23.6 (17.8-29.5)	25.4 (18.1-32.9)	27.6 (18.7-37.1)	29.3 (19.2-40.4)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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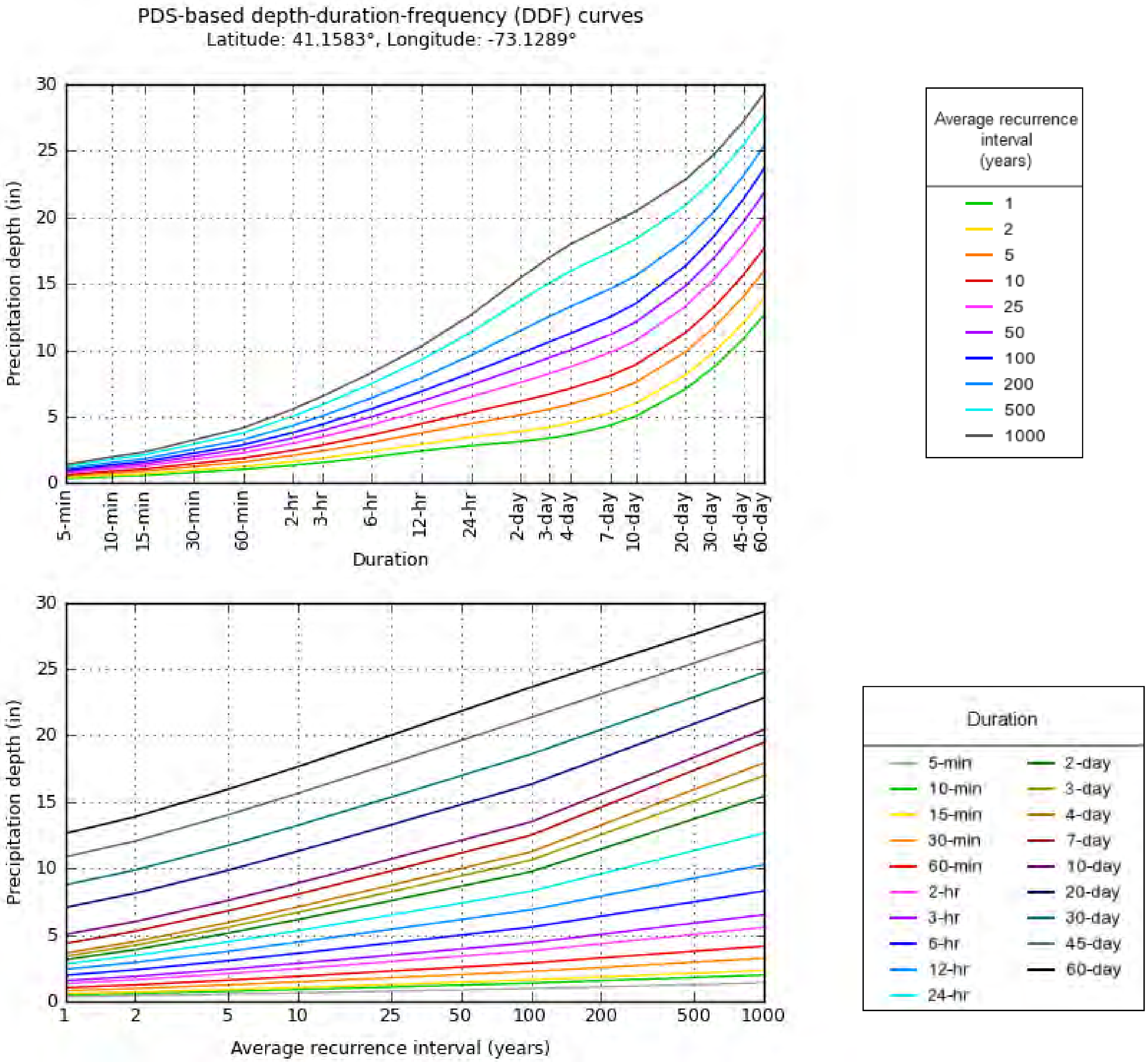
PF graphical



NOAA Atlas 14, Volume 10, Version 2 Created (GMT): Wed Nov 11 15:34:28 2015

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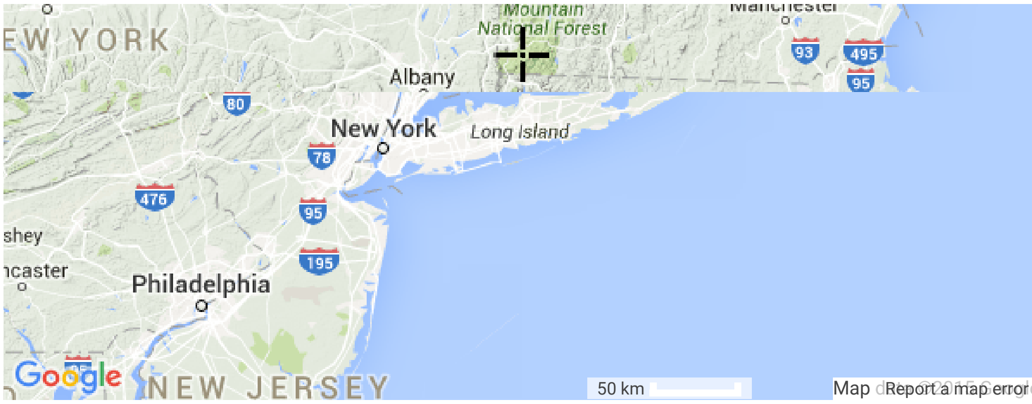
Maps & aerials

Small scale terrain



Large scale terrain

Large scale map

Large scale aerial

Back to Top

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National Oceanic and Atmospheric Administration
National Weather Service
Office of Hydrologic Development
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

NOAA Atlas 14, Volume 10, Version 2
BRIDGEPORT SIKORSKY MEM A
Station ID: 06-0806
Location name: Stratford, Connecticut, US*
Latitude: 41.1583°, Longitude: -73.1289°
Elevation:
Elevation (station metadata): 5 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

27.1 Min.

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	4.14 (3.36-5.03)	4.99 (4.04-6.07)	6.40 (5.16-7.81)	7.55 (6.05-9.28)	9.14 (7.04-11.8)	10.4 (7.80-13.7)	11.6 (8.42-15.9)	13.2 (8.96-18.5)	15.2 (9.89-22.2)	16.7 (10.6-24.9)
10-min	2.93 (2.38-3.56)	3.53 (2.87-4.30)	4.52 (3.65-5.53)	5.35 (4.29-6.58)	6.48 (4.99-8.35)	7.35 (5.53-9.70)	8.23 (5.96-11.3)	9.31 (6.35-13.1)	10.8 (7.00-15.7)	11.8 (7.49-17.7)
15-min	2.30 (1.86-2.79)	2.77 (2.25-3.38)	3.55 (2.86-4.34)	4.20 (3.36-5.16)	5.08 (3.92-6.55)	5.77 (4.34-7.60)	6.45 (4.68-8.85)	7.30 (4.98-10.3)	8.44 (5.49-12.3)	9.29 (5.88-13.9)
30-min	1.60 (1.30-1.95)	1.93 (1.57-2.35)	2.47 (2.00-3.02)	2.92 (2.34-3.59)	3.54 (2.73-4.56)	4.01 (3.02-5.29)	4.49 (3.26-6.16)	5.09 (3.47-7.15)	5.88 (3.82-8.58)	6.47 (4.10-9.66)
60-min	1.03 (0.835-1.25)	1.24 (1.00-1.51)	1.59 (1.28-1.94)	1.87 (1.50-2.30)	2.27 (1.75-2.92)	2.57 (1.94-3.39)	2.88 (2.09-3.95)	3.26 (2.22-4.59)	3.77 (2.45-5.50)	4.15 (2.63-6.19)
2-hr	0.669 (0.546-0.808)	0.810 (0.660-0.978)	1.04 (0.844-1.26)	1.23 (0.992-1.50)	1.49 (1.16-1.91)	1.70 (1.28-2.22)	1.90 (1.39-2.59)	2.16 (1.48-3.02)	2.52 (1.64-3.65)	2.78 (1.77-4.12)
3-hr	0.515 (0.422-0.619)	0.624 (0.511-0.752)	0.803 (0.654-0.970)	0.950 (0.769-1.16)	1.15 (0.898-1.48)	1.31 (0.996-1.72)	1.47 (1.08-2.00)	1.68 (1.15-2.34)	1.96 (1.28-2.83)	2.17 (1.38-3.20)
6-hr	0.326 (0.269-0.390)	0.396 (0.326-0.473)	0.509 (0.418-0.611)	0.603 (0.491-0.728)	0.732 (0.574-0.930)	0.832 (0.636-1.08)	0.932 (0.688-1.26)	1.07 (0.735-1.48)	1.25 (0.820-1.79)	1.39 (0.884-2.03)
12-hr	0.200 (0.166-0.237)	0.243 (0.201-0.288)	0.312 (0.258-0.372)	0.370 (0.303-0.444)	0.449 (0.354-0.566)	0.510 (0.392-0.659)	0.571 (0.424-0.770)	0.656 (0.453-0.900)	0.768 (0.506-1.09)	0.853 (0.546-1.24)
24-hr	0.117 (0.098-0.138)	0.143 (0.120-0.169)	0.186 (0.155-0.220)	0.221 (0.183-0.264)	0.270 (0.214-0.339)	0.308 (0.238-0.396)	0.345 (0.258-0.464)	0.400 (0.277-0.545)	0.472 (0.312-0.667)	0.527 (0.338-0.760)
2-day	0.065 (0.055-0.076)	0.081 (0.068-0.095)	0.107 (0.089-0.126)	0.128 (0.106-0.152)	0.158 (0.126-0.197)	0.180 (0.141-0.231)	0.203 (0.154-0.273)	0.239 (0.166-0.323)	0.286 (0.189-0.401)	0.321 (0.207-0.460)
3-day	0.047 (0.040-0.055)	0.058 (0.049-0.068)	0.077 (0.065-0.091)	0.093 (0.077-0.109)	0.114 (0.092-0.143)	0.131 (0.103-0.168)	0.148 (0.112-0.198)	0.174 (0.121-0.235)	0.209 (0.139-0.292)	0.236 (0.152-0.336)
4-day	0.038 (0.032-0.044)	0.047 (0.040-0.055)	0.062 (0.052-0.072)	0.074 (0.062-0.087)	0.091 (0.073-0.113)	0.104 (0.082-0.133)	0.117 (0.089-0.157)	0.138 (0.096-0.186)	0.166 (0.110-0.231)	0.187 (0.121-0.265)
7-day	0.026 (0.022-0.030)	0.031 (0.027-0.036)	0.040 (0.034-0.047)	0.048 (0.040-0.056)	0.058 (0.047-0.072)	0.066 (0.052-0.084)	0.074 (0.057-0.099)	0.087 (0.061-0.116)	0.103 (0.069-0.143)	0.116 (0.075-0.164)
10-day	0.021 (0.018-0.024)	0.025 (0.021-0.029)	0.032 (0.027-0.037)	0.037 (0.031-0.043)	0.045 (0.036-0.055)	0.050 (0.040-0.063)	0.056 (0.043-0.074)	0.065 (0.046-0.086)	0.076 (0.051-0.105)	0.085 (0.055-0.120)
20-day	0.015 (0.013-0.017)	0.017 (0.015-0.019)	0.021 (0.018-0.024)	0.024 (0.020-0.027)	0.028 (0.022-0.033)	0.031 (0.024-0.038)	0.034 (0.026-0.044)	0.038 (0.027-0.050)	0.043 (0.029-0.059)	0.048 (0.031-0.066)
30-day	0.012 (0.010-0.014)	0.014 (0.012-0.016)	0.016 (0.014-0.019)	0.018 (0.016-0.021)	0.021 (0.017-0.026)	0.024 (0.019-0.029)	0.026 (0.020-0.033)	0.028 (0.020-0.037)	0.032 (0.021-0.043)	0.034 (0.022-0.048)
45-day	0.010 (0.009-0.011)	0.011 (0.010-0.013)	0.013 (0.011-0.015)	0.014 (0.012-0.017)	0.017 (0.014-0.020)	0.018 (0.014-0.022)	0.020 (0.015-0.025)	0.021 (0.015-0.028)	0.024 (0.016-0.032)	0.025 (0.016-0.035)
60-day	0.009 (0.008-0.010)	0.010 (0.008-0.011)	0.011 (0.010-0.013)	0.012 (0.011-0.014)	0.014 (0.011-0.016)	0.015 (0.012-0.018)	0.016 (0.012-0.020)	0.018 (0.013-0.023)	0.019 (0.013-0.026)	0.020 (0.013-0.028)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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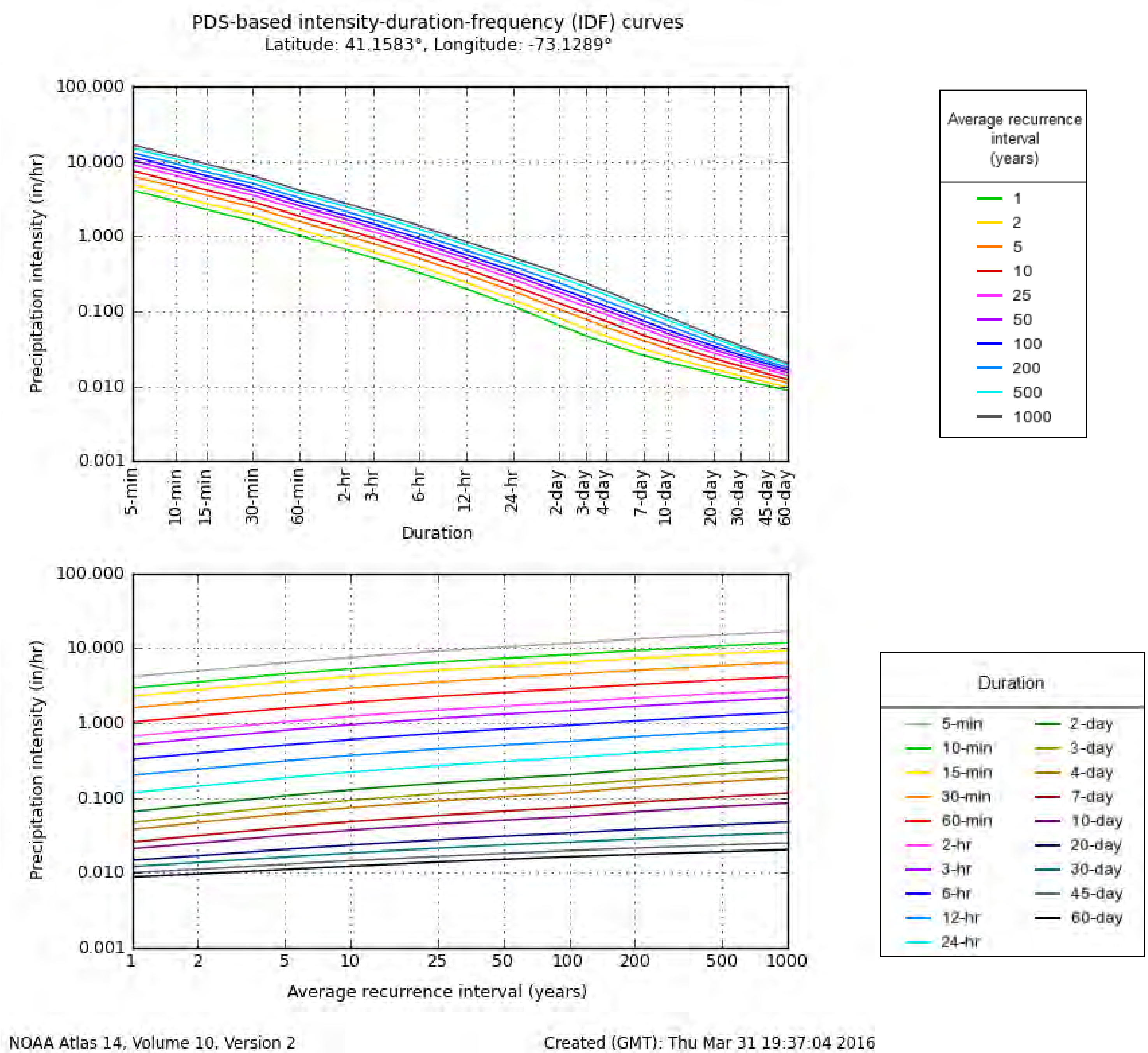
PF graphical



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Maps & aerials

Small scale terrain

Large scale terrain

Large scale map

Large scale aerial

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US Department of Commerce
National Oceanic and Atmospheric Administration
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APPENDIX C

HYDROLOGIC CALCULATIONS

Average Daily & Spring Flows
TR-55 Method (Pondpack)
Rational Method

APPENDIX C1

AVERAGE DAILY & SPRING FLOWS

AVERAGE DAILY AND SPRING FLOWS

SYMBOLS

Q	=	Flow (cfs)
A	=	Contributing Drainage Area (Square Miles)

EQUATIONS

AVERAGE DAILY FLOW

$$Q_{avg.\ daily} = (A^{0.98})*1.87$$

AVERAGE SPRING FLOW

$$Q_{avg.\ spring} = (A^{0.988})*3.62$$

CALCULATIONS

A = 0.105 square miles

$Q_{avg.\ daily}$ = 0.2 cfs

$Q_{avg.\ spring}$ = 0.4 cfs

PREPARED BY: BJH
DATE: 11/11/2015

APPENDIX C2

TR-55 METHOD (Pondpack)

Project Summary

Title	301-175 Existing Conditions
Engineer	Brandon Handfield, PE
Company	Yantic River Consultants, LLC
Date	11/11/2015

Notes	Existing Conditions analysis of watershed draining to 2' masonry culvert under MNRR MP 65.60 in the vicinity of Eastern Steel Road, Milford, CT.

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Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
CM-1	NOAA 1-Year	1	10.555	12.300	85.63
CM-1	NOAA 2-Year	2	13.842	12.300	111.40
CM-1	NOAA 5-Year	5	19.279	12.300	153.09
CM-1	NOAA 10-Year	10	23.874	12.300	187.65
CM-1	NOAA 25-Year	25	30.255	12.300	234.92
CM-1	NOAA 50-Year	50	35.191	12.300	271.06
CM-1	NOAA 100-Year	100	40.199	12.300	307.45
CM-1	NOAA 500-Year	500	56.836	12.300	426.95

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
O-1	NOAA 1-Year	1	9.784	12.900	26.65
O-1	NOAA 2-Year	2	13.021	12.950	30.43
O-1	NOAA 5-Year	5	18.385	13.050	34.55
O-1	NOAA 10-Year	10	23.278	12.700	36.37
O-1	NOAA 25-Year	25	29.954	12.450	36.37
O-1	NOAA 50-Year	50	34.831	12.350	36.37
O-1	NOAA 100-Year	100	38.907	12.300	36.37
O-1	NOAA 500-Year	500	43.855	12.100	36.37

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
PO-1 (IN)	NOAA 1-Year	1	10.555	12.300	85.63	(N/A)	(N/A)
PO-1 (OUT)	NOAA 1-Year	1	9.784	12.900	26.65	34.39	4.318
PO-1 (IN)	NOAA 2-Year	2	13.842	12.300	111.40	(N/A)	(N/A)
PO-1 (OUT)	NOAA 2-Year	2	13.021	12.950	30.43	34.95	5.795
PO-1 (IN)	NOAA 5-Year	5	19.279	12.300	153.09	(N/A)	(N/A)
PO-1 (OUT)	NOAA 5-Year	5	18.385	13.050	34.55	35.66	8.309
PO-1 (IN)	NOAA 10-Year	10	23.874	12.300	187.65	(N/A)	(N/A)
PO-1 (OUT)	NOAA 10-Year	10	23.278	12.700	36.37	36.00	9.797
PO-1 (IN)	NOAA 25-Year	25	30.255	12.300	234.92	(N/A)	(N/A)
PO-1 (OUT)	NOAA 25-Year	25	29.954	12.450	36.37	36.00	9.797
PO-1 (IN)	NOAA 50-Year	50	35.191	12.300	271.06	(N/A)	(N/A)
PO-1 (OUT)	NOAA 50-Year	50	34.831	12.350	36.37	36.00	9.797
PO-1 (IN)	NOAA 100-Year	100	40.199	12.300	307.45	(N/A)	(N/A)
PO-1 (OUT)	NOAA 100-Year	100	38.907	12.300	36.37	36.00	9.797

Subsection: Master Network Summary

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
PO-1 (IN)	NOAA 500-Year	500	56.836	12.300	426.95	(N/A)	(N/A)
PO-1 (OUT)	NOAA 500-Year	500	43.855	12.100	36.37	36.00	9.797

Time-Depth Curve: 100-Year	
Label	100-Year
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	100 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.1	0.1	0.1
1.000	0.1	0.1	0.1	0.1	0.1
1.500	0.1	0.1	0.1	0.1	0.2
2.000	0.2	0.2	0.2	0.2	0.2
2.500	0.2	0.2	0.2	0.2	0.2
3.000	0.3	0.3	0.3	0.3	0.3
3.500	0.3	0.3	0.3	0.3	0.3
4.000	0.4	0.4	0.4	0.4	0.4
4.500	0.4	0.4	0.4	0.4	0.5
5.000	0.5	0.5	0.5	0.5	0.5
5.500	0.5	0.5	0.6	0.6	0.6
6.000	0.6	0.6	0.6	0.6	0.7
6.500	0.7	0.7	0.7	0.7	0.7
7.000	0.8	0.8	0.8	0.8	0.8
7.500	0.8	0.9	0.9	0.9	0.9
8.000	0.9	1.0	1.0	1.0	1.0
8.500	1.1	1.1	1.1	1.1	1.2
9.000	1.2	1.2	1.3	1.3	1.3
9.500	1.4	1.4	1.4	1.5	1.5
10.000	1.6	1.6	1.7	1.7	1.7
10.500	1.8	1.8	1.9	2.0	2.0
11.000	2.1	2.1	2.2	2.3	2.4
11.500	2.5	2.6	2.8	3.1	3.4
12.000	4.1	4.8	5.2	5.5	5.7
12.500	5.8	5.9	6.0	6.1	6.2
13.000	6.2	6.3	6.3	6.4	6.4
13.500	6.5	6.5	6.6	6.6	6.7
14.000	6.7	6.8	6.8	6.8	6.9
14.500	6.9	6.9	7.0	7.0	7.1
15.000	7.1	7.1	7.1	7.2	7.2
15.500	7.2	7.3	7.3	7.3	7.3
16.000	7.3	7.4	7.4	7.4	7.4
16.500	7.4	7.5	7.5	7.5	7.5
17.000	7.5	7.6	7.6	7.6	7.6
17.500	7.6	7.6	7.7	7.7	7.7

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
18.000	7.7	7.7	7.7	7.7	7.7
18.500	7.8	7.8	7.8	7.8	7.8
19.000	7.8	7.8	7.8	7.9	7.9
19.500	7.9	7.9	7.9	7.9	7.9
20.000	7.9	7.9	8.0	8.0	8.0
20.500	8.0	8.0	8.0	8.0	8.0
21.000	8.0	8.0	8.1	8.1	8.1
21.500	8.1	8.1	8.1	8.1	8.1
22.000	8.1	8.1	8.1	8.2	8.2
22.500	8.2	8.2	8.2	8.2	8.2
23.000	8.2	8.2	8.2	8.2	8.2
23.500	8.3	8.3	8.3	8.3	8.3
24.000	8.3	(N/A)	(N/A)	(N/A)	(N/A)

Time-Depth Curve: 10-Year	
Label	10-Year
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	10 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.0
1.000	0.1	0.1	0.1	0.1	0.1
1.500	0.1	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.1
2.500	0.1	0.1	0.1	0.2	0.2
3.000	0.2	0.2	0.2	0.2	0.2
3.500	0.2	0.2	0.2	0.2	0.2
4.000	0.2	0.2	0.2	0.2	0.3
4.500	0.3	0.3	0.3	0.3	0.3
5.000	0.3	0.3	0.3	0.3	0.3
5.500	0.3	0.3	0.4	0.4	0.4
6.000	0.4	0.4	0.4	0.4	0.4
6.500	0.4	0.4	0.4	0.5	0.5
7.000	0.5	0.5	0.5	0.5	0.5
7.500	0.5	0.6	0.6	0.6	0.6
8.000	0.6	0.6	0.6	0.6	0.7
8.500	0.7	0.7	0.7	0.7	0.8
9.000	0.8	0.8	0.8	0.8	0.9
9.500	0.9	0.9	0.9	1.0	1.0
10.000	1.0	1.0	1.1	1.1	1.1
10.500	1.1	1.2	1.2	1.3	1.3
11.000	1.3	1.4	1.4	1.5	1.5
11.500	1.6	1.7	1.8	2.0	2.2
12.000	2.7	3.1	3.3	3.5	3.6
12.500	3.7	3.8	3.8	3.9	3.9
13.000	4.0	4.0	4.1	4.1	4.1
13.500	4.2	4.2	4.2	4.3	4.3
14.000	4.3	4.3	4.4	4.4	4.4
14.500	4.4	4.5	4.5	4.5	4.5
15.000	4.5	4.6	4.6	4.6	4.6
15.500	4.6	4.6	4.7	4.7	4.7
16.000	4.7	4.7	4.7	4.7	4.8
16.500	4.8	4.8	4.8	4.8	4.8
17.000	4.8	4.8	4.9	4.9	4.9
17.500	4.9	4.9	4.9	4.9	4.9

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
18.000	4.9	4.9	4.9	5.0	5.0
18.500	5.0	5.0	5.0	5.0	5.0
19.000	5.0	5.0	5.0	5.0	5.0
19.500	5.0	5.1	5.1	5.1	5.1
20.000	5.1	5.1	5.1	5.1	5.1
20.500	5.1	5.1	5.1	5.1	5.1
21.000	5.1	5.2	5.2	5.2	5.2
21.500	5.2	5.2	5.2	5.2	5.2
22.000	5.2	5.2	5.2	5.2	5.2
22.500	5.2	5.2	5.2	5.3	5.3
23.000	5.3	5.3	5.3	5.3	5.3
23.500	5.3	5.3	5.3	5.3	5.3
24.000	5.3	(N/A)	(N/A)	(N/A)	(N/A)

Time-Depth Curve: 1-Year	
Label	1-Year
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	1 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.0
1.000	0.0	0.0	0.0	0.0	0.0
1.500	0.0	0.0	0.0	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.1
2.500	0.1	0.1	0.1	0.1	0.1
3.000	0.1	0.1	0.1	0.1	0.1
3.500	0.1	0.1	0.1	0.1	0.1
4.000	0.1	0.1	0.1	0.1	0.1
4.500	0.1	0.1	0.1	0.2	0.2
5.000	0.2	0.2	0.2	0.2	0.2
5.500	0.2	0.2	0.2	0.2	0.2
6.000	0.2	0.2	0.2	0.2	0.2
6.500	0.2	0.2	0.2	0.2	0.2
7.000	0.3	0.3	0.3	0.3	0.3
7.500	0.3	0.3	0.3	0.3	0.3
8.000	0.3	0.3	0.3	0.3	0.4
8.500	0.4	0.4	0.4	0.4	0.4
9.000	0.4	0.4	0.4	0.4	0.5
9.500	0.5	0.5	0.5	0.5	0.5
10.000	0.5	0.5	0.6	0.6	0.6
10.500	0.6	0.6	0.6	0.7	0.7
11.000	0.7	0.7	0.7	0.8	0.8
11.500	0.8	0.9	1.0	1.0	1.2
12.000	1.4	1.6	1.8	1.9	1.9
12.500	2.0	2.0	2.0	2.1	2.1
13.000	2.1	2.1	2.1	2.2	2.2
13.500	2.2	2.2	2.2	2.3	2.3
14.000	2.3	2.3	2.3	2.3	2.3
14.500	2.3	2.4	2.4	2.4	2.4
15.000	2.4	2.4	2.4	2.4	2.4
15.500	2.4	2.5	2.5	2.5	2.5
16.000	2.5	2.5	2.5	2.5	2.5
16.500	2.5	2.5	2.5	2.5	2.5
17.000	2.6	2.6	2.6	2.6	2.6
17.500	2.6	2.6	2.6	2.6	2.6

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
18.000	2.6	2.6	2.6	2.6	2.6
18.500	2.6	2.6	2.6	2.6	2.6
19.000	2.7	2.7	2.7	2.7	2.7
19.500	2.7	2.7	2.7	2.7	2.7
20.000	2.7	2.7	2.7	2.7	2.7
20.500	2.7	2.7	2.7	2.7	2.7
21.000	2.7	2.7	2.7	2.7	2.7
21.500	2.7	2.7	2.7	2.7	2.8
22.000	2.8	2.8	2.8	2.8	2.8
22.500	2.8	2.8	2.8	2.8	2.8
23.000	2.8	2.8	2.8	2.8	2.8
23.500	2.8	2.8	2.8	2.8	2.8
24.000	2.8	(N/A)	(N/A)	(N/A)	(N/A)

Time-Depth Curve: 25-Year	
Label	25-Year
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	25 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.1	0.1
1.000	0.1	0.1	0.1	0.1	0.1
1.500	0.1	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.2
2.500	0.2	0.2	0.2	0.2	0.2
3.000	0.2	0.2	0.2	0.2	0.2
3.500	0.2	0.2	0.3	0.3	0.3
4.000	0.3	0.3	0.3	0.3	0.3
4.500	0.3	0.3	0.3	0.3	0.4
5.000	0.4	0.4	0.4	0.4	0.4
5.500	0.4	0.4	0.4	0.4	0.5
6.000	0.5	0.5	0.5	0.5	0.5
6.500	0.5	0.5	0.5	0.6	0.6
7.000	0.6	0.6	0.6	0.6	0.6
7.500	0.7	0.7	0.7	0.7	0.7
8.000	0.7	0.8	0.8	0.8	0.8
8.500	0.8	0.9	0.9	0.9	0.9
9.000	0.9	1.0	1.0	1.0	1.0
9.500	1.1	1.1	1.1	1.2	1.2
10.000	1.2	1.3	1.3	1.3	1.4
10.500	1.4	1.4	1.5	1.5	1.6
11.000	1.6	1.7	1.7	1.8	1.9
11.500	1.9	2.0	2.2	2.4	2.7
12.000	3.2	3.8	4.1	4.3	4.4
12.500	4.5	4.6	4.7	4.8	4.8
13.000	4.9	4.9	5.0	5.0	5.0
13.500	5.1	5.1	5.2	5.2	5.2
14.000	5.3	5.3	5.3	5.3	5.4
14.500	5.4	5.4	5.5	5.5	5.5
15.000	5.5	5.6	5.6	5.6	5.6
15.500	5.6	5.7	5.7	5.7	5.7
16.000	5.7	5.8	5.8	5.8	5.8
16.500	5.8	5.8	5.9	5.9	5.9
17.000	5.9	5.9	5.9	5.9	5.9
17.500	6.0	6.0	6.0	6.0	6.0

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
18.000	6.0	6.0	6.0	6.0	6.1
18.500	6.1	6.1	6.1	6.1	6.1
19.000	6.1	6.1	6.1	6.1	6.1
19.500	6.2	6.2	6.2	6.2	6.2
20.000	6.2	6.2	6.2	6.2	6.2
20.500	6.2	6.3	6.3	6.3	6.3
21.000	6.3	6.3	6.3	6.3	6.3
21.500	6.3	6.3	6.3	6.3	6.3
22.000	6.4	6.4	6.4	6.4	6.4
22.500	6.4	6.4	6.4	6.4	6.4
23.000	6.4	6.4	6.4	6.4	6.4
23.500	6.5	6.5	6.5	6.5	6.5
24.000	6.5	(N/A)	(N/A)	(N/A)	(N/A)

Time-Depth Curve: 2-Year	
Label	2-Year
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	2 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.0
1.000	0.0	0.0	0.0	0.0	0.0
1.500	0.1	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.1
2.500	0.1	0.1	0.1	0.1	0.1
3.000	0.1	0.1	0.1	0.1	0.1
3.500	0.1	0.1	0.1	0.1	0.1
4.000	0.1	0.2	0.2	0.2	0.2
4.500	0.2	0.2	0.2	0.2	0.2
5.000	0.2	0.2	0.2	0.2	0.2
5.500	0.2	0.2	0.2	0.2	0.2
6.000	0.2	0.3	0.3	0.3	0.3
6.500	0.3	0.3	0.3	0.3	0.3
7.000	0.3	0.3	0.3	0.3	0.3
7.500	0.3	0.4	0.4	0.4	0.4
8.000	0.4	0.4	0.4	0.4	0.4
8.500	0.4	0.5	0.5	0.5	0.5
9.000	0.5	0.5	0.5	0.5	0.6
9.500	0.6	0.6	0.6	0.6	0.6
10.000	0.7	0.7	0.7	0.7	0.7
10.500	0.7	0.8	0.8	0.8	0.8
11.000	0.9	0.9	0.9	0.9	1.0
11.500	1.0	1.1	1.2	1.3	1.4
12.000	1.7	2.0	2.2	2.3	2.4
12.500	2.4	2.5	2.5	2.5	2.6
13.000	2.6	2.6	2.6	2.7	2.7
13.500	2.7	2.7	2.7	2.8	2.8
14.000	2.8	2.8	2.8	2.8	2.9
14.500	2.9	2.9	2.9	2.9	2.9
15.000	2.9	3.0	3.0	3.0	3.0
15.500	3.0	3.0	3.0	3.0	3.0
16.000	3.0	3.1	3.1	3.1	3.1
16.500	3.1	3.1	3.1	3.1	3.1
17.000	3.1	3.1	3.1	3.1	3.2
17.500	3.2	3.2	3.2	3.2	3.2

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
18.000	3.2	3.2	3.2	3.2	3.2
18.500	3.2	3.2	3.2	3.2	3.2
19.000	3.2	3.2	3.3	3.3	3.3
19.500	3.3	3.3	3.3	3.3	3.3
20.000	3.3	3.3	3.3	3.3	3.3
20.500	3.3	3.3	3.3	3.3	3.3
21.000	3.3	3.3	3.3	3.3	3.4
21.500	3.4	3.4	3.4	3.4	3.4
22.000	3.4	3.4	3.4	3.4	3.4
22.500	3.4	3.4	3.4	3.4	3.4
23.000	3.4	3.4	3.4	3.4	3.4
23.500	3.4	3.4	3.4	3.4	3.4
24.000	3.4	(N/A)	(N/A)	(N/A)	(N/A)

Time-Depth Curve: 500-Year	
Label	500-Year
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	500 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.1	0.1	0.1	0.1	0.1
1.000	0.1	0.1	0.1	0.1	0.2
1.500	0.2	0.2	0.2	0.2	0.2
2.000	0.2	0.2	0.2	0.3	0.3
2.500	0.3	0.3	0.3	0.3	0.3
3.000	0.3	0.4	0.4	0.4	0.4
3.500	0.4	0.4	0.4	0.5	0.5
4.000	0.5	0.5	0.5	0.5	0.5
4.500	0.6	0.6	0.6	0.6	0.6
5.000	0.6	0.7	0.7	0.7	0.7
5.500	0.7	0.7	0.8	0.8	0.8
6.000	0.8	0.8	0.9	0.9	0.9
6.500	0.9	0.9	1.0	1.0	1.0
7.000	1.0	1.0	1.1	1.1	1.1
7.500	1.1	1.2	1.2	1.2	1.3
8.000	1.3	1.3	1.3	1.4	1.4
8.500	1.5	1.5	1.5	1.6	1.6
9.000	1.6	1.7	1.7	1.8	1.8
9.500	1.9	1.9	2.0	2.0	2.1
10.000	2.1	2.2	2.3	2.3	2.4
10.500	2.4	2.5	2.6	2.7	2.7
11.000	2.8	2.9	3.0	3.1	3.2
11.500	3.4	3.6	3.8	4.2	4.7
12.000	5.6	6.6	7.1	7.5	7.7
12.500	7.9	8.1	8.2	8.3	8.4
13.000	8.5	8.6	8.6	8.7	8.8
13.500	8.9	8.9	9.0	9.0	9.1
14.000	9.2	9.2	9.3	9.3	9.4
14.500	9.4	9.5	9.5	9.6	9.6
15.000	9.7	9.7	9.7	9.8	9.8
15.500	9.8	9.9	9.9	10.0	10.0
16.000	10.0	10.0	10.1	10.1	10.1
16.500	10.2	10.2	10.2	10.2	10.3
17.000	10.3	10.3	10.3	10.3	10.4
17.500	10.4	10.4	10.4	10.4	10.5

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
18.000	10.5	10.5	10.5	10.5	10.6
18.500	10.6	10.6	10.6	10.6	10.6
19.000	10.7	10.7	10.7	10.7	10.7
19.500	10.7	10.8	10.8	10.8	10.8
20.000	10.8	10.8	10.8	10.9	10.9
20.500	10.9	10.9	10.9	10.9	10.9
21.000	11.0	11.0	11.0	11.0	11.0
21.500	11.0	11.0	11.0	11.1	11.1
22.000	11.1	11.1	11.1	11.1	11.1
22.500	11.1	11.2	11.2	11.2	11.2
23.000	11.2	11.2	11.2	11.2	11.2
23.500	11.3	11.3	11.3	11.3	11.3
24.000	11.3	(N/A)	(N/A)	(N/A)	(N/A)

Time-Depth Curve: 50-Year	
Label	50-Year
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	50 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.1	0.1	0.1
1.000	0.1	0.1	0.1	0.1	0.1
1.500	0.1	0.1	0.1	0.1	0.1
2.000	0.1	0.2	0.2	0.2	0.2
2.500	0.2	0.2	0.2	0.2	0.2
3.000	0.2	0.2	0.2	0.3	0.3
3.500	0.3	0.3	0.3	0.3	0.3
4.000	0.3	0.3	0.3	0.3	0.4
4.500	0.4	0.4	0.4	0.4	0.4
5.000	0.4	0.4	0.4	0.5	0.5
5.500	0.5	0.5	0.5	0.5	0.5
6.000	0.5	0.5	0.6	0.6	0.6
6.500	0.6	0.6	0.6	0.6	0.7
7.000	0.7	0.7	0.7	0.7	0.7
7.500	0.8	0.8	0.8	0.8	0.8
8.000	0.8	0.9	0.9	0.9	0.9
8.500	0.9	1.0	1.0	1.0	1.0
9.000	1.1	1.1	1.1	1.2	1.2
9.500	1.2	1.3	1.3	1.3	1.4
10.000	1.4	1.4	1.5	1.5	1.6
10.500	1.6	1.6	1.7	1.7	1.8
11.000	1.8	1.9	2.0	2.0	2.1
11.500	2.2	2.3	2.5	2.8	3.1
12.000	3.7	4.3	4.6	4.9	5.1
12.500	5.2	5.3	5.3	5.4	5.5
13.000	5.5	5.6	5.6	5.7	5.7
13.500	5.8	5.8	5.9	5.9	5.9
14.000	6.0	6.0	6.1	6.1	6.1
14.500	6.2	6.2	6.2	6.2	6.3
15.000	6.3	6.3	6.4	6.4	6.4
15.500	6.4	6.5	6.5	6.5	6.5
16.000	6.5	6.6	6.6	6.6	6.6
16.500	6.6	6.6	6.7	6.7	6.7
17.000	6.7	6.7	6.7	6.8	6.8
17.500	6.8	6.8	6.8	6.8	6.8

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
18.000	6.8	6.9	6.9	6.9	6.9
18.500	6.9	6.9	6.9	6.9	7.0
19.000	7.0	7.0	7.0	7.0	7.0
19.500	7.0	7.0	7.0	7.0	7.1
20.000	7.1	7.1	7.1	7.1	7.1
20.500	7.1	7.1	7.1	7.1	7.1
21.000	7.2	7.2	7.2	7.2	7.2
21.500	7.2	7.2	7.2	7.2	7.2
22.000	7.2	7.2	7.3	7.3	7.3
22.500	7.3	7.3	7.3	7.3	7.3
23.000	7.3	7.3	7.3	7.3	7.3
23.500	7.3	7.4	7.4	7.4	7.4
24.000	7.4	(N/A)	(N/A)	(N/A)	(N/A)

Time-Depth Curve: 5-Year	
Label	5-Year
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	5 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.0
1.000	0.0	0.0	0.1	0.1	0.1
1.500	0.1	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.1
2.500	0.1	0.1	0.1	0.1	0.1
3.000	0.1	0.1	0.1	0.2	0.2
3.500	0.2	0.2	0.2	0.2	0.2
4.000	0.2	0.2	0.2	0.2	0.2
4.500	0.2	0.2	0.2	0.2	0.2
5.000	0.3	0.3	0.3	0.3	0.3
5.500	0.3	0.3	0.3	0.3	0.3
6.000	0.3	0.3	0.3	0.3	0.4
6.500	0.4	0.4	0.4	0.4	0.4
7.000	0.4	0.4	0.4	0.4	0.4
7.500	0.5	0.5	0.5	0.5	0.5
8.000	0.5	0.5	0.5	0.5	0.6
8.500	0.6	0.6	0.6	0.6	0.6
9.000	0.7	0.7	0.7	0.7	0.7
9.500	0.7	0.8	0.8	0.8	0.8
10.000	0.8	0.9	0.9	0.9	0.9
10.500	1.0	1.0	1.0	1.1	1.1
11.000	1.1	1.1	1.2	1.2	1.3
11.500	1.3	1.4	1.5	1.7	1.9
12.000	2.2	2.6	2.8	2.9	3.1
12.500	3.1	3.2	3.2	3.3	3.3
13.000	3.3	3.4	3.4	3.4	3.5
13.500	3.5	3.5	3.5	3.6	3.6
14.000	3.6	3.6	3.7	3.7	3.7
14.500	3.7	3.7	3.8	3.8	3.8
15.000	3.8	3.8	3.8	3.9	3.9
15.500	3.9	3.9	3.9	3.9	3.9
16.000	4.0	4.0	4.0	4.0	4.0
16.500	4.0	4.0	4.0	4.0	4.0
17.000	4.1	4.1	4.1	4.1	4.1
17.500	4.1	4.1	4.1	4.1	4.1

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
18.000	4.1	4.1	4.2	4.2	4.2
18.500	4.2	4.2	4.2	4.2	4.2
19.000	4.2	4.2	4.2	4.2	4.2
19.500	4.2	4.2	4.3	4.3	4.3
20.000	4.3	4.3	4.3	4.3	4.3
20.500	4.3	4.3	4.3	4.3	4.3
21.000	4.3	4.3	4.3	4.3	4.3
21.500	4.3	4.4	4.4	4.4	4.4
22.000	4.4	4.4	4.4	4.4	4.4
22.500	4.4	4.4	4.4	4.4	4.4
23.000	4.4	4.4	4.4	4.4	4.4
23.500	4.4	4.4	4.4	4.5	4.5
24.000	4.5	(N/A)	(N/A)	(N/A)	(N/A)

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	60.00 ft
Manning's n	0.400
Slope	0.030 ft/ft
2 Year 24 Hour Depth	3.3 in
Average Velocity	0.08 ft/s
Segment Time of Concentration	0.199 hours

Segment #2: TR-55 Sheet Flow	
Hydraulic Length	40.00 ft
Manning's n	0.400
Slope	0.200 ft/ft
2 Year 24 Hour Depth	3.3 in
Average Velocity	0.16 ft/s
Segment Time of Concentration	0.067 hours

Segment #3: TR-55 Shallow Concentrated Flow	
Hydraulic Length	500.00 ft
Is Paved?	True
Slope	0.008 ft/ft
Average Velocity	1.82 ft/s
Segment Time of Concentration	0.076 hours

Segment #4: TR-55 Shallow Concentrated Flow	
Hydraulic Length	1,320.00 ft
Is Paved?	True
Slope	0.025 ft/ft
Average Velocity	3.21 ft/s
Segment Time of Concentration	0.114 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.457 hours

==== SCS Channel Flow

Tc =	R = Qa / Wp V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n (Lf / V) / 3600
Where:	R= Hydraulic radius Aq= Flow area, square feet Wp= Wetted perimeter, feet V= Velocity, ft/sec Sf= Slope, ft/ft n= Manning's n Tc= Time of concentration, hours Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc =	Unpaved surface: V = 16.1345 * (Sf**0.5) Paved Surface: V = 20.3282 * (Sf**0.5) (Lf / V) / 3600
Where:	V= Velocity, ft/sec Sf= Slope, ft/ft Tc= Time of concentration, hours Lf= Flow length, feet

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
Impervious Areas - Paved parking lots, driveways, streets and roads - Soil D	98.000	31.400	0.0	0.0	98.000
Open space (Lawns,parks etc.) - Good condition; grass cover > 75% - Soil D	80.000	9.400	0.0	0.0	80.000
Woods - good - Soil D	77.000	10.580	0.0	0.0	77.000
Open space (Railroad Corridor) - Good condition; - Soil D	80.000	2.900	0.0	0.0	80.000
Impervious Areas - Buildings - Soil D	98.000	12.860	0.0	0.0	98.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	67.140	(N/A)	(N/A)	91.393

Storm Event	1-Year
Return Event	1 years
Duration	24.000 hours
Depth	2.8 in
Time of Concentration (Composite)	0.457 hours
Area (User Defined)	67.140 acres

Computational Time Increment	0.061 hours
Time to Peak (Computed)	12.309 hours
Flow (Peak, Computed)	86.11 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.300 hours
Flow (Peak Interpolated Output)	85.63 ft³/s

Drainage Area	
SCS CN (Composite)	91.000
Area (User Defined)	67.140 acres
Maximum Retention (Pervious)	1.0 in
Maximum Retention (Pervious, 20 percent)	0.2 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	1.9 in
Runoff Volume (Pervious)	10.601 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	10.555 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.457 hours
Computational Time Increment	0.061 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	166.45 ft³/s
Unit peak time, Tp	0.305 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	1.219 hours
Total unit time, Tb	1.523 hours

Storm Event	2-Year
Return Event	2 years
Duration	24.000 hours
Depth	3.4 in
Time of Concentration (Composite)	0.457 hours
Area (User Defined)	67.140 acres

Computational Time Increment	0.061 hours
Time to Peak (Computed)	12.309 hours
Flow (Peak, Computed)	111.97 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.300 hours
Flow (Peak Interpolated Output)	111.40 ft³/s

Drainage Area	
SCS CN (Composite)	91.000
Area (User Defined)	67.140 acres
Maximum Retention (Pervious)	1.0 in
Maximum Retention (Pervious, 20 percent)	0.2 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	2.5 in
Runoff Volume (Pervious)	13.900 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	13.842 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.457 hours
Computational Time Increment	0.061 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	166.45 ft³/s
Unit peak time, Tp	0.305 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	1.219 hours
Total unit time, Tb	1.523 hours

Storm Event	5-Year
Return Event	5 years
Duration	24.000 hours
Depth	4.5 in
Time of Concentration (Composite)	0.457 hours
Area (User Defined)	67.140 acres

Computational Time Increment	0.061 hours
Time to Peak (Computed)	12.309 hours
Flow (Peak, Computed)	153.79 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.300 hours
Flow (Peak Interpolated Output)	153.09 ft³/s

Drainage Area	
SCS CN (Composite)	91.000
Area (User Defined)	67.140 acres
Maximum Retention (Pervious)	1.0 in
Maximum Retention (Pervious, 20 percent)	0.2 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	3.5 in
Runoff Volume (Pervious)	19.356 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	19.279 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.457 hours
Computational Time Increment	0.061 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	166.45 ft³/s
Unit peak time, Tp	0.305 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	1.219 hours
Total unit time, Tb	1.523 hours

Storm Event	10-Year
Return Event	10 years
Duration	24.000 hours
Depth	5.3 in
Time of Concentration (Composite)	0.457 hours
Area (User Defined)	67.140 acres

Computational Time Increment	0.061 hours
Time to Peak (Computed)	12.309 hours
Flow (Peak, Computed)	188.46 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.300 hours
Flow (Peak Interpolated Output)	187.65 ft³/s

Drainage Area	
SCS CN (Composite)	91.000
Area (User Defined)	67.140 acres
Maximum Retention (Pervious)	1.0 in
Maximum Retention (Pervious, 20 percent)	0.2 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	4.3 in
Runoff Volume (Pervious)	23.966 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	23.874 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.457 hours
Computational Time Increment	0.061 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	166.45 ft³/s
Unit peak time, Tp	0.305 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	1.219 hours
Total unit time, Tb	1.523 hours

Storm Event	25-Year
Return Event	25 years
Duration	24.000 hours
Depth	6.5 in
Time of Concentration (Composite)	0.457 hours
Area (User Defined)	67.140 acres

Computational Time Increment	0.061 hours
Time to Peak (Computed)	12.309 hours
Flow (Peak, Computed)	235.87 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.300 hours
Flow (Peak Interpolated Output)	234.92 ft³/s

Drainage Area	
SCS CN (Composite)	91.000
Area (User Defined)	67.140 acres
Maximum Retention (Pervious)	1.0 in
Maximum Retention (Pervious, 20 percent)	0.2 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	5.4 in
Runoff Volume (Pervious)	30.368 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	30.255 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.457 hours
Computational Time Increment	0.061 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	166.45 ft³/s
Unit peak time, Tp	0.305 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	1.219 hours
Total unit time, Tb	1.523 hours

Storm Event	50-Year
Return Event	50 years
Duration	24.000 hours
Depth	7.4 in
Time of Concentration (Composite)	0.457 hours
Area (User Defined)	67.140 acres

Computational Time Increment	0.061 hours
Time to Peak (Computed)	12.309 hours
Flow (Peak, Computed)	272.12 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.300 hours
Flow (Peak Interpolated Output)	271.06 ft³/s

Drainage Area	
SCS CN (Composite)	91.000
Area (User Defined)	67.140 acres
Maximum Retention (Pervious)	1.0 in
Maximum Retention (Pervious, 20 percent)	0.2 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	6.3 in
Runoff Volume (Pervious)	35.321 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	35.191 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.457 hours
Computational Time Increment	0.061 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	166.45 ft³/s
Unit peak time, Tp	0.305 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	1.219 hours
Total unit time, Tb	1.523 hours

Storm Event	100-Year
Return Event	100 years
Duration	24.000 hours
Depth	8.3 in
Time of Concentration (Composite)	0.457 hours
Area (User Defined)	67.140 acres

Computational Time Increment	0.061 hours
Time to Peak (Computed)	12.309 hours
Flow (Peak, Computed)	308.62 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.300 hours
Flow (Peak Interpolated Output)	307.45 ft³/s

Drainage Area	
SCS CN (Composite)	91.000
Area (User Defined)	67.140 acres
Maximum Retention (Pervious)	1.0 in
Maximum Retention (Pervious, 20 percent)	0.2 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	7.2 in
Runoff Volume (Pervious)	40.345 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	40.199 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.457 hours
Computational Time Increment	0.061 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	166.45 ft³/s
Unit peak time, Tp	0.305 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	1.219 hours
Total unit time, Tb	1.523 hours

Storm Event	500-Year
Return Event	500 years
Duration	24.000 hours
Depth	11.3 in
Time of Concentration (Composite)	0.457 hours
Area (User Defined)	67.140 acres

Computational Time Increment	0.061 hours
Time to Peak (Computed)	12.309 hours
Flow (Peak, Computed)	428.48 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.300 hours
Flow (Peak Interpolated Output)	426.95 ft³/s

Drainage Area	
SCS CN (Composite)	91.000
Area (User Defined)	67.140 acres
Maximum Retention (Pervious)	1.0 in
Maximum Retention (Pervious, 20 percent)	0.2 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	10.2 in
Runoff Volume (Pervious)	57.036 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	56.836 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.457 hours
Computational Time Increment	0.061 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	166.45 ft³/s
Unit peak time, Tp	0.305 hours

SCS Unit Hydrograph Parameters	
Unit receding limb, Tr	1.219 hours
Total unit time, Tb	1.523 hours

Summary for Hydrograph Addition at 'O-1'

Upstream Link	Upstream Node
EX_Outlet-1	PO-1

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	EX_Outlet-1	9.784	12.900	26.65
Flow (In)	O-1	9.784	12.900	26.65

Summary for Hydrograph Addition at 'O-1'

Upstream Link	Upstream Node
EX_Outlet-1	PO-1

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft³/s)
Flow (From)	EX_Outlet-1	13.021	12.950	30.43
Flow (In)	O-1	13.021	12.950	30.43

Summary for Hydrograph Addition at 'O-1'

Upstream Link	Upstream Node
EX_Outlet-1	PO-1

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft³/s)
Flow (From)	EX_Outlet-1	18.385	13.050	34.55
Flow (In)	O-1	18.385	13.050	34.55

Summary for Hydrograph Addition at 'O-1'

Upstream Link	Upstream Node
EX_Outlet-1	PO-1

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft³/s)
Flow (From)	EX_Outlet-1	23.278	12.700	36.37
Flow (In)	O-1	23.278	12.700	36.37

Summary for Hydrograph Addition at 'O-1'

Upstream Link	Upstream Node
EX_Outlet-1	PO-1

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	EX_Outlet-1	29.954	12.450	36.37
Flow (In)	O-1	29.954	12.450	36.37

Summary for Hydrograph Addition at 'O-1'

Upstream Link	Upstream Node
EX_Outlet-1	PO-1

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	EX_Outlet-1	34.831	12.350	36.37
Flow (In)	O-1	34.831	12.350	36.37

Summary for Hydrograph Addition at 'O-1'

Upstream Link	Upstream Node
EX_Outlet-1	PO-1

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	EX_Outlet-1	38.907	12.300	36.37
Flow (In)	O-1	38.907	12.300	36.37

Summary for Hydrograph Addition at 'O-1'

Upstream Link	Upstream Node
EX_Outlet-1	PO-1

Node Inflows

Inflow Type	Element	Volume (ac-ft)	Time to Peak (hours)	Flow (Peak) (ft^3/s)
Flow (From)	EX_Outlet-1	43.855	12.100	36.37
Flow (In)	O-1	43.855	12.100	36.37

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
0.000	26.00	26.00	26.00	26.00	26.00
0.250	26.00	26.00	26.00	26.00	26.00
0.500	26.00	26.00	26.00	26.00	26.00
0.750	26.00	26.00	26.00	26.00	26.00
1.000	26.00	26.00	26.00	26.00	26.00
1.250	26.00	26.00	26.00	26.00	26.00
1.500	26.00	26.00	26.00	26.00	26.00
1.750	26.00	26.00	26.00	26.00	26.00
2.000	26.00	26.00	26.00	26.00	26.00
2.250	26.00	26.00	26.00	26.00	26.00
2.500	26.00	26.00	26.00	26.00	26.00
2.750	26.00	26.00	26.00	26.00	26.00
3.000	26.00	26.00	26.00	26.00	26.00
3.250	26.00	26.00	26.00	26.00	26.00
3.500	26.00	26.00	26.00	26.00	26.00
3.750	26.00	26.00	26.00	26.00	26.00
4.000	26.00	26.00	26.00	26.00	26.00
4.250	26.00	26.00	26.00	26.00	26.00
4.500	26.00	26.00	26.00	26.00	26.00
4.750	26.00	26.00	26.00	26.00	26.00
5.000	26.00	26.00	26.00	26.00	26.00
5.250	26.00	26.00	26.00	26.00	26.00
5.500	26.00	26.00	26.00	26.00	26.00
5.750	26.00	26.00	26.00	26.00	26.00
6.000	26.00	26.01	26.02	26.04	26.08
6.250	26.15	26.26	26.40	26.54	26.65
6.500	26.77	26.93	27.05	27.15	27.27
6.750	27.40	27.52	27.61	27.70	27.81
7.000	27.92	28.03	28.11	28.19	28.29
7.250	28.39	28.49	28.57	28.65	28.73
7.500	28.82	28.92	29.01	29.04	29.07
7.750	29.11	29.15	29.19	29.23	29.27
8.000	29.32	29.36	29.41	29.46	29.51
8.250	29.52	29.54	29.56	29.59	29.61
8.500	29.63	29.65	29.68	29.71	29.73
8.750	29.76	29.79	29.82	29.85	29.89
9.000	29.92	29.96	29.99	30.02	30.04
9.250	30.07	30.10	30.12	30.15	30.18
9.500	30.21	30.24	30.27	30.30	30.34
9.750	30.37	30.41	30.45	30.48	30.52
10.000	30.55	30.58	30.62	30.65	30.69
10.250	30.73	30.77	30.81	30.85	30.89
10.500	30.93	30.97	31.01	31.05	31.09

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
10.750	31.12	31.16	31.20	31.23	31.27
11.000	31.31	31.35	31.39	31.42	31.46
11.250	31.50	31.54	31.57	31.61	31.65
11.500	31.69	31.73	31.77	31.82	31.87
11.750	31.94	32.01	32.08	32.17	32.27
12.000	32.40	32.55	32.71	32.90	33.10
12.250	33.29	33.50	33.66	33.82	33.96
12.500	34.07	34.15	34.22	34.28	34.32
12.750	34.35	34.37	34.38	34.39	34.39
13.000	34.38	34.37	34.36	34.34	34.32
13.250	34.30	34.28	34.26	34.24	34.21
13.500	34.19	34.16	34.13	34.11	34.08
13.750	34.06	34.03	34.00	33.97	33.93
14.000	33.90	33.87	33.83	33.80	33.76
14.250	33.73	33.70	33.66	33.63	33.60
14.500	33.57	33.53	33.50	33.46	33.42
14.750	33.39	33.35	33.32	33.28	33.25
15.000	33.22	33.18	33.15	33.12	33.09
15.250	33.07	33.04	33.01	32.98	32.95
15.500	32.92	32.89	32.86	32.83	32.80
15.750	32.77	32.74	32.72	32.69	32.67
16.000	32.64	32.62	32.60	32.57	32.55
16.250	32.53	32.51	32.48	32.46	32.43
16.500	32.41	32.38	32.36	32.34	32.32
16.750	32.30	32.28	32.26	32.24	32.22
17.000	32.20	32.19	32.17	32.15	32.14
17.250	32.12	32.11	32.09	32.08	32.06
17.500	32.05	32.04	32.03	32.01	32.00
17.750	31.99	31.97	31.96	31.95	31.93
18.000	31.92	31.91	31.89	31.88	31.87
18.250	31.86	31.85	31.84	31.82	31.81
18.500	31.80	31.79	31.78	31.78	31.77
18.750	31.76	31.75	31.74	31.73	31.73
19.000	31.72	31.71	31.70	31.70	31.69
19.250	31.68	31.68	31.67	31.67	31.66
19.500	31.66	31.65	31.65	31.64	31.64
19.750	31.63	31.63	31.62	31.62	31.61
20.000	31.61	31.60	31.60	31.60	31.59
20.250	31.59	31.59	31.58	31.58	31.58
20.500	31.57	31.57	31.57	31.56	31.56
20.750	31.56	31.55	31.55	31.55	31.55
21.000	31.54	31.54	31.54	31.53	31.53
21.250	31.53	31.53	31.53	31.52	31.52

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
21.500	31.52	31.52	31.51	31.51	31.51
21.750	31.51	31.51	31.50	31.50	31.50
22.000	31.50	31.49	31.49	31.49	31.49
22.250	31.49	31.48	31.48	31.48	31.48
22.500	31.47	31.47	31.47	31.47	31.46
22.750	31.46	31.46	31.46	31.45	31.45
23.000	31.45	31.45	31.45	31.44	31.44
23.250	31.44	31.44	31.43	31.43	31.43
23.500	31.43	31.42	31.42	31.42	31.42
23.750	31.42	31.41	31.41	31.41	31.41
24.000	31.40	(N/A)	(N/A)	(N/A)	(N/A)

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
0.000	26.00	26.00	26.00	26.00	26.00
0.250	26.00	26.00	26.00	26.00	26.00
0.500	26.00	26.00	26.00	26.00	26.00
0.750	26.00	26.00	26.00	26.00	26.00
1.000	26.00	26.00	26.00	26.00	26.00
1.250	26.00	26.00	26.00	26.00	26.00
1.500	26.00	26.00	26.00	26.00	26.00
1.750	26.00	26.00	26.00	26.00	26.00
2.000	26.00	26.00	26.00	26.00	26.00
2.250	26.00	26.00	26.00	26.00	26.00
2.500	26.00	26.00	26.00	26.00	26.00
2.750	26.00	26.00	26.00	26.00	26.00
3.000	26.00	26.00	26.00	26.00	26.00
3.250	26.00	26.00	26.00	26.00	26.00
3.500	26.00	26.00	26.00	26.00	26.00
3.750	26.00	26.00	26.00	26.00	26.00
4.000	26.00	26.00	26.00	26.00	26.00
4.250	26.00	26.00	26.00	26.00	26.00
4.500	26.00	26.00	26.00	26.00	26.00
4.750	26.00	26.00	26.00	26.00	26.00
5.000	26.00	26.00	26.00	26.00	26.00
5.250	26.00	26.00	26.00	26.01	26.04
5.500	26.08	26.15	26.25	26.41	26.55
5.750	26.66	26.79	26.95	27.07	27.17
6.000	27.29	27.42	27.54	27.62	27.72
6.250	27.82	27.93	28.03	28.11	28.20
6.500	28.29	28.39	28.49	28.57	28.64
6.750	28.73	28.82	28.91	29.00	29.03
7.000	29.07	29.10	29.14	29.18	29.22
7.250	29.27	29.31	29.36	29.41	29.46
7.500	29.50	29.52	29.54	29.56	29.58
7.750	29.61	29.63	29.65	29.68	29.70
8.000	29.73	29.75	29.78	29.81	29.84
8.250	29.87	29.90	29.93	29.96	30.00
8.500	30.02	30.04	30.07	30.09	30.12
8.750	30.14	30.17	30.20	30.23	30.26
9.000	30.29	30.32	30.36	30.39	30.43
9.250	30.46	30.50	30.53	30.56	30.60
9.500	30.63	30.67	30.70	30.74	30.78
9.750	30.82	30.86	30.90	30.94	30.98
10.000	31.02	31.05	31.09	31.12	31.16
10.250	31.19	31.22	31.26	31.29	31.33
10.500	31.36	31.40	31.43	31.47	31.51

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
10.750	31.54	31.57	31.60	31.63	31.66
11.000	31.69	31.72	31.75	31.79	31.82
11.250	31.85	31.89	31.92	31.96	32.00
11.500	32.03	32.07	32.11	32.15	32.20
11.750	32.26	32.33	32.41	32.51	32.61
12.000	32.74	32.90	33.07	33.26	33.48
12.250	33.68	33.89	34.08	34.23	34.37
12.500	34.50	34.58	34.65	34.70	34.75
12.750	34.78	34.80	34.82	34.83	34.83
13.000	34.83	34.82	34.82	34.81	34.79
13.250	34.78	34.76	34.74	34.72	34.70
13.500	34.68	34.66	34.64	34.62	34.60
13.750	34.57	34.55	34.53	34.51	34.48
14.000	34.45	34.42	34.39	34.36	34.33
14.250	34.29	34.26	34.23	34.20	34.17
14.500	34.14	34.11	34.08	34.05	34.02
14.750	33.99	33.96	33.92	33.88	33.85
15.000	33.81	33.78	33.74	33.71	33.67
15.250	33.64	33.60	33.57	33.54	33.50
15.500	33.46	33.42	33.38	33.35	33.31
15.750	33.28	33.24	33.21	33.17	33.14
16.000	33.11	33.08	33.05	33.02	32.99
16.250	32.96	32.92	32.89	32.86	32.82
16.500	32.79	32.77	32.74	32.71	32.68
16.750	32.66	32.63	32.61	32.58	32.56
17.000	32.54	32.52	32.50	32.47	32.44
17.250	32.42	32.40	32.37	32.35	32.33
17.500	32.31	32.29	32.27	32.25	32.23
17.750	32.21	32.19	32.18	32.16	32.14
18.000	32.13	32.11	32.10	32.08	32.07
18.250	32.06	32.04	32.03	32.02	32.01
18.500	31.99	31.98	31.96	31.95	31.94
18.750	31.92	31.91	31.90	31.89	31.88
19.000	31.87	31.86	31.85	31.84	31.83
19.250	31.82	31.81	31.80	31.79	31.79
19.500	31.78	31.77	31.76	31.76	31.75
19.750	31.74	31.74	31.73	31.73	31.72
20.000	31.71	31.71	31.70	31.70	31.69
20.250	31.69	31.68	31.68	31.67	31.67
20.500	31.66	31.66	31.65	31.65	31.65
20.750	31.64	31.64	31.64	31.63	31.63
21.000	31.62	31.62	31.62	31.61	31.61
21.250	31.61	31.60	31.60	31.60	31.60

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
21.500	31.59	31.59	31.59	31.58	31.58
21.750	31.58	31.58	31.57	31.57	31.57
22.000	31.57	31.56	31.56	31.56	31.56
22.250	31.55	31.55	31.55	31.55	31.55
22.500	31.54	31.54	31.54	31.54	31.53
22.750	31.53	31.53	31.53	31.53	31.52
23.000	31.52	31.52	31.52	31.52	31.51
23.250	31.51	31.51	31.51	31.51	31.50
23.500	31.50	31.50	31.50	31.50	31.49
23.750	31.49	31.49	31.49	31.48	31.48
24.000	31.48	(N/A)	(N/A)	(N/A)	(N/A)

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
0.000	26.00	26.00	26.00	26.00	26.00
0.250	26.00	26.00	26.00	26.00	26.00
0.500	26.00	26.00	26.00	26.00	26.00
0.750	26.00	26.00	26.00	26.00	26.00
1.000	26.00	26.00	26.00	26.00	26.00
1.250	26.00	26.00	26.00	26.00	26.00
1.500	26.00	26.00	26.00	26.00	26.00
1.750	26.00	26.00	26.00	26.00	26.00
2.000	26.00	26.00	26.00	26.00	26.00
2.250	26.00	26.00	26.00	26.00	26.00
2.500	26.00	26.00	26.00	26.00	26.00
2.750	26.00	26.00	26.00	26.00	26.00
3.000	26.00	26.00	26.00	26.00	26.00
3.250	26.00	26.00	26.00	26.00	26.00
3.500	26.00	26.00	26.00	26.00	26.00
3.750	26.00	26.00	26.00	26.00	26.00
4.000	26.00	26.00	26.00	26.00	26.00
4.250	26.00	26.00	26.00	26.00	26.01
4.500	26.02	26.06	26.12	26.22	26.37
4.750	26.53	26.65	26.81	26.99	27.10
5.000	27.23	27.37	27.52	27.61	27.72
5.250	27.84	27.96	28.06	28.15	28.25
5.500	28.35	28.47	28.56	28.64	28.73
5.750	28.82	28.91	29.01	29.04	29.07
6.000	29.11	29.15	29.19	29.23	29.27
6.250	29.32	29.36	29.41	29.46	29.50
6.500	29.52	29.54	29.56	29.58	29.60
6.750	29.63	29.65	29.67	29.70	29.72
7.000	29.75	29.78	29.80	29.83	29.86
7.250	29.89	29.93	29.96	29.99	30.02
7.500	30.04	30.06	30.09	30.11	30.14
7.750	30.16	30.19	30.21	30.24	30.27
8.000	30.30	30.33	30.36	30.39	30.42
8.250	30.46	30.49	30.52	30.55	30.58
8.500	30.61	30.64	30.68	30.71	30.74
8.750	30.78	30.82	30.86	30.90	30.93
9.000	30.97	31.01	31.04	31.08	31.11
9.250	31.14	31.18	31.21	31.24	31.28
9.500	31.31	31.34	31.38	31.41	31.44
9.750	31.48	31.51	31.54	31.56	31.59
10.000	31.62	31.65	31.67	31.70	31.73
10.250	31.75	31.78	31.81	31.84	31.86
10.500	31.89	31.92	31.95	31.98	32.01

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
10.750	32.03	32.06	32.09	32.11	32.14
11.000	32.16	32.19	32.22	32.25	32.28
11.250	32.31	32.34	32.38	32.41	32.45
11.500	32.49	32.53	32.57	32.61	32.66
11.750	32.72	32.79	32.88	32.99	33.10
12.000	33.24	33.41	33.60	33.81	34.05
12.250	34.26	34.49	34.66	34.83	34.98
12.500	35.09	35.18	35.26	35.33	35.38
12.750	35.42	35.45	35.48	35.49	35.50
13.000	35.51	35.51	35.50	35.50	35.49
13.250	35.48	35.47	35.46	35.45	35.43
13.500	35.41	35.40	35.38	35.36	35.35
13.750	35.33	35.31	35.29	35.27	35.25
14.000	35.23	35.21	35.19	35.17	35.15
14.250	35.13	35.11	35.09	35.07	35.04
14.500	35.02	35.00	34.97	34.95	34.92
14.750	34.89	34.86	34.84	34.81	34.78
15.000	34.75	34.73	34.70	34.67	34.65
15.250	34.62	34.59	34.57	34.54	34.51
15.500	34.48	34.44	34.41	34.38	34.34
15.750	34.31	34.27	34.24	34.20	34.17
16.000	34.14	34.11	34.07	34.04	34.01
16.250	33.97	33.93	33.89	33.85	33.81
16.500	33.77	33.73	33.69	33.65	33.61
16.750	33.58	33.54	33.50	33.46	33.42
17.000	33.38	33.34	33.30	33.26	33.22
17.250	33.19	33.15	33.12	33.09	33.05
17.500	33.02	32.99	32.96	32.92	32.89
17.750	32.85	32.82	32.79	32.76	32.73
18.000	32.70	32.67	32.65	32.62	32.60
18.250	32.57	32.55	32.53	32.50	32.48
18.500	32.45	32.42	32.40	32.38	32.35
18.750	32.33	32.31	32.29	32.27	32.25
19.000	32.23	32.21	32.20	32.18	32.16
19.250	32.15	32.13	32.12	32.11	32.09
19.500	32.08	32.07	32.06	32.04	32.03
19.750	32.02	32.01	32.00	31.99	31.98
20.000	31.97	31.96	31.95	31.94	31.93
20.250	31.92	31.91	31.90	31.89	31.88
20.500	31.87	31.86	31.86	31.85	31.84
20.750	31.83	31.83	31.82	31.81	31.81
21.000	31.80	31.79	31.79	31.78	31.78
21.250	31.77	31.77	31.76	31.76	31.75

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
21.500	31.75	31.74	31.74	31.73	31.73
21.750	31.72	31.72	31.72	31.71	31.71
22.000	31.70	31.70	31.70	31.69	31.69
22.250	31.68	31.68	31.68	31.67	31.67
22.500	31.67	31.66	31.66	31.66	31.65
22.750	31.65	31.65	31.65	31.64	31.64
23.000	31.64	31.63	31.63	31.63	31.62
23.250	31.62	31.62	31.62	31.61	31.61
23.500	31.61	31.61	31.60	31.60	31.60
23.750	31.59	31.59	31.59	31.59	31.58
24.000	31.58	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Time vs. Elevation | Return Event: 10 years
Label: PO-1 (OUT) | Storm Event: 10-Year

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
0.000	26.00	26.00	26.00	26.00	26.00
0.250	26.00	26.00	26.00	26.00	26.00
0.500	26.00	26.00	26.00	26.00	26.00
0.750	26.00	26.00	26.00	26.00	26.00
1.000	26.00	26.00	26.00	26.00	26.00
1.250	26.00	26.00	26.00	26.00	26.00
1.500	26.00	26.00	26.00	26.00	26.00
1.750	26.00	26.00	26.00	26.00	26.00
2.000	26.00	26.00	26.00	26.00	26.00
2.250	26.00	26.00	26.00	26.00	26.00
2.500	26.00	26.00	26.00	26.00	26.00
2.750	26.00	26.00	26.00	26.00	26.00
3.000	26.00	26.00	26.00	26.00	26.00
3.250	26.00	26.00	26.00	26.00	26.00
3.500	26.00	26.00	26.00	26.00	26.00
3.750	26.00	26.00	26.01	26.02	26.05
4.000	26.11	26.21	26.37	26.54	26.67
4.250	26.84	27.03	27.15	27.29	27.46
4.500	27.58	27.69	27.82	27.96	28.07
4.750	28.17	28.28	28.40	28.51	28.60
5.000	28.70	28.80	28.90	29.01	29.04
5.250	29.08	29.12	29.16	29.21	29.26
5.500	29.30	29.35	29.41	29.46	29.51
5.750	29.53	29.55	29.57	29.59	29.61
6.000	29.63	29.66	29.68	29.71	29.73
6.250	29.76	29.78	29.81	29.84	29.87
6.500	29.90	29.93	29.97	30.00	30.02
6.750	30.04	30.07	30.09	30.11	30.14
7.000	30.16	30.19	30.22	30.24	30.27
7.250	30.30	30.33	30.36	30.39	30.43
7.500	30.46	30.49	30.52	30.55	30.58
7.750	30.61	30.64	30.68	30.71	30.74
8.000	30.78	30.81	30.85	30.88	30.92
8.250	30.95	30.99	31.02	31.05	31.08
8.500	31.11	31.14	31.17	31.21	31.24
8.750	31.27	31.30	31.33	31.36	31.39
9.000	31.43	31.46	31.49	31.52	31.55
9.250	31.57	31.60	31.63	31.65	31.68
9.500	31.71	31.73	31.76	31.79	31.81
9.750	31.84	31.87	31.89	31.92	31.95
10.000	31.98	32.00	32.02	32.05	32.07
10.250	32.09	32.11	32.14	32.16	32.18
10.500	32.21	32.23	32.26	32.29	32.31

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
10.750	32.34	32.37	32.40	32.43	32.46
11.000	32.49	32.52	32.54	32.57	32.60
11.250	32.62	32.65	32.69	32.72	32.76
11.500	32.80	32.84	32.89	32.94	33.00
11.750	33.06	33.13	33.22	33.33	33.47
12.000	33.61	33.79	34.01	34.22	34.46
12.250	34.68	34.90	35.09	35.25	35.40
12.500	35.53	35.63	35.71	35.78	35.83
12.750	35.88	35.92	35.94	35.96	35.98
13.000	35.99	35.99	35.99	35.99	35.99
13.250	35.99	35.98	35.97	35.96	35.95
13.500	35.94	35.93	35.91	35.90	35.89
13.750	35.87	35.86	35.84	35.83	35.81
14.000	35.80	35.78	35.76	35.75	35.73
14.250	35.71	35.70	35.68	35.66	35.64
14.500	35.62	35.61	35.59	35.57	35.55
14.750	35.53	35.51	35.49	35.47	35.45
15.000	35.42	35.40	35.37	35.35	35.33
15.250	35.30	35.28	35.26	35.23	35.21
15.500	35.18	35.16	35.14	35.11	35.09
15.750	35.06	35.04	35.01	34.99	34.96
16.000	34.92	34.89	34.86	34.83	34.80
16.250	34.77	34.74	34.71	34.68	34.65
16.500	34.62	34.59	34.56	34.53	34.50
16.750	34.46	34.42	34.38	34.34	34.31
17.000	34.27	34.23	34.20	34.16	34.13
17.250	34.09	34.06	34.02	33.99	33.94
17.500	33.90	33.86	33.82	33.78	33.74
17.750	33.70	33.66	33.62	33.58	33.54
18.000	33.50	33.46	33.41	33.37	33.33
18.250	33.29	33.25	33.21	33.17	33.14
18.500	33.10	33.07	33.04	33.01	32.97
18.750	32.93	32.90	32.86	32.83	32.80
19.000	32.77	32.74	32.71	32.68	32.66
19.250	32.63	32.60	32.58	32.56	32.54
19.500	32.51	32.49	32.47	32.44	32.42
19.750	32.39	32.37	32.35	32.33	32.31
20.000	32.29	32.27	32.25	32.24	32.22
20.250	32.20	32.19	32.17	32.16	32.15
20.500	32.13	32.12	32.11	32.10	32.08
20.750	32.07	32.06	32.05	32.04	32.03
21.000	32.02	32.01	32.00	31.99	31.98
21.250	31.97	31.96	31.95	31.95	31.94

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
21.500	31.93	31.92	31.91	31.90	31.90
21.750	31.89	31.88	31.87	31.87	31.86
22.000	31.85	31.85	31.84	31.84	31.83
22.250	31.82	31.82	31.81	31.81	31.80
22.500	31.80	31.79	31.79	31.78	31.78
22.750	31.77	31.77	31.76	31.76	31.75
23.000	31.75	31.75	31.74	31.74	31.73
23.250	31.73	31.73	31.72	31.72	31.71
23.500	31.71	31.71	31.70	31.70	31.70
23.750	31.69	31.69	31.68	31.68	31.68
24.000	31.67	(N/A)	(N/A)	(N/A)	(N/A)

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
0.000	26.00	26.00	26.00	26.00	26.00
0.250	26.00	26.00	26.00	26.00	26.00
0.500	26.00	26.00	26.00	26.00	26.00
0.750	26.00	26.00	26.00	26.00	26.00
1.000	26.00	26.00	26.00	26.00	26.00
1.250	26.00	26.00	26.00	26.00	26.00
1.500	26.00	26.00	26.00	26.00	26.00
1.750	26.00	26.00	26.00	26.00	26.00
2.000	26.00	26.00	26.00	26.00	26.00
2.250	26.00	26.00	26.00	26.00	26.00
2.500	26.00	26.00	26.00	26.00	26.00
2.750	26.00	26.00	26.00	26.00	26.00
3.000	26.00	26.00	26.00	26.00	26.00
3.250	26.00	26.00	26.00	26.00	26.00
3.500	26.01	26.02	26.05	26.11	26.22
3.750	26.40	26.56	26.71	26.90	27.07
4.000	27.20	27.37	27.53	27.64	27.77
4.250	27.92	28.05	28.15	28.27	28.39
4.500	28.52	28.61	28.71	28.82	28.94
4.750	29.02	29.06	29.10	29.15	29.19
5.000	29.24	29.29	29.35	29.40	29.46
5.250	29.51	29.53	29.55	29.57	29.59
5.500	29.62	29.64	29.67	29.70	29.72
5.750	29.75	29.78	29.81	29.84	29.87
6.000	29.90	29.93	29.97	30.00	30.02
6.250	30.04	30.06	30.09	30.11	30.14
6.500	30.16	30.19	30.21	30.24	30.27
6.750	30.30	30.33	30.36	30.39	30.42
7.000	30.45	30.49	30.52	30.55	30.58
7.250	30.61	30.64	30.67	30.70	30.74
7.500	30.77	30.81	30.84	30.88	30.91
7.750	30.95	30.98	31.02	31.05	31.08
8.000	31.11	31.14	31.17	31.20	31.22
8.250	31.25	31.28	31.31	31.34	31.37
8.500	31.40	31.43	31.46	31.49	31.52
8.750	31.54	31.57	31.59	31.62	31.64
9.000	31.67	31.69	31.72	31.75	31.77
9.250	31.80	31.83	31.85	31.88	31.91
9.500	31.93	31.96	31.99	32.01	32.03
9.750	32.06	32.08	32.10	32.12	32.15
10.000	32.17	32.19	32.22	32.24	32.26
10.250	32.29	32.31	32.34	32.36	32.39
10.500	32.42	32.44	32.47	32.50	32.52

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
10.750	32.55	32.57	32.60	32.62	32.65
11.000	32.68	32.71	32.74	32.77	32.80
11.250	32.83	32.86	32.90	32.94	32.98
11.500	33.02	33.06	33.10	33.15	33.21
11.750	33.28	33.36	33.46	33.57	33.70
12.000	33.86	34.05	34.26	34.50	34.71
12.250	34.95	35.16	35.36	35.54	35.68
12.500	35.81	35.92	36.00	36.00	36.00
12.750	36.00	36.00	36.00	36.00	36.00
13.000	36.00	36.00	36.00	36.00	36.00
13.250	36.00	36.00	36.00	36.00	36.00
13.500	36.00	36.00	36.00	36.00	36.00
13.750	36.00	36.00	36.00	36.00	36.00
14.000	36.00	36.00	36.00	36.00	36.00
14.250	36.00	36.00	36.00	36.00	36.00
14.500	36.00	36.00	36.00	36.00	36.00
14.750	36.00	36.00	36.00	36.00	36.00
15.000	35.99	35.97	35.95	35.93	35.91
15.250	35.88	35.86	35.84	35.82	35.80
15.500	35.78	35.76	35.74	35.72	35.69
15.750	35.67	35.65	35.63	35.61	35.58
16.000	35.56	35.54	35.52	35.49	35.47
16.250	35.44	35.41	35.38	35.36	35.33
16.500	35.30	35.27	35.25	35.22	35.19
16.750	35.16	35.14	35.11	35.08	35.05
17.000	35.03	35.00	34.97	34.93	34.90
17.250	34.87	34.83	34.80	34.77	34.73
17.500	34.70	34.67	34.64	34.61	34.57
17.750	34.54	34.51	34.47	34.43	34.39
18.000	34.35	34.31	34.27	34.24	34.20
18.250	34.16	34.12	34.09	34.05	34.01
18.500	33.97	33.93	33.88	33.84	33.79
18.750	33.75	33.71	33.67	33.63	33.59
19.000	33.55	33.51	33.47	33.42	33.38
19.250	33.33	33.29	33.25	33.22	33.18
19.500	33.14	33.11	33.07	33.04	33.01
19.750	32.98	32.94	32.90	32.87	32.84
20.000	32.80	32.77	32.74	32.71	32.69
20.250	32.66	32.63	32.61	32.59	32.56
20.500	32.54	32.52	32.50	32.47	32.45
20.750	32.42	32.40	32.38	32.36	32.34
21.000	32.32	32.30	32.28	32.26	32.24
21.250	32.23	32.21	32.20	32.18	32.17

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
21.500	32.15	32.14	32.13	32.12	32.10
21.750	32.09	32.08	32.07	32.06	32.05
22.000	32.04	32.03	32.02	32.01	32.00
22.250	32.00	31.99	31.98	31.97	31.96
22.500	31.95	31.94	31.93	31.92	31.91
22.750	31.91	31.90	31.89	31.88	31.88
23.000	31.87	31.86	31.86	31.85	31.84
23.250	31.84	31.83	31.83	31.82	31.81
23.500	31.81	31.80	31.80	31.79	31.79
23.750	31.78	31.78	31.77	31.77	31.76
24.000	31.76	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Time vs. Elevation | Return Event: 50 years
Label: PO-1 (OUT) | Storm Event: 50-Year

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
0.000	26.00	26.00	26.00	26.00	26.00
0.250	26.00	26.00	26.00	26.00	26.00
0.500	26.00	26.00	26.00	26.00	26.00
0.750	26.00	26.00	26.00	26.00	26.00
1.000	26.00	26.00	26.00	26.00	26.00
1.250	26.00	26.00	26.00	26.00	26.00
1.500	26.00	26.00	26.00	26.00	26.00
1.750	26.00	26.00	26.00	26.00	26.00
2.000	26.00	26.00	26.00	26.00	26.00
2.250	26.00	26.00	26.00	26.00	26.00
2.500	26.00	26.00	26.00	26.00	26.00
2.750	26.00	26.00	26.00	26.00	26.00
3.000	26.00	26.00	26.00	26.00	26.01
3.250	26.04	26.10	26.20	26.38	26.56
3.500	26.71	26.92	27.08	27.23	27.41
3.750	27.56	27.69	27.83	27.99	28.11
4.000	28.22	28.35	28.50	28.60	28.71
4.250	28.82	28.95	29.02	29.07	29.11
4.500	29.16	29.21	29.27	29.32	29.38
4.750	29.44	29.50	29.52	29.55	29.57
5.000	29.60	29.62	29.65	29.68	29.70
5.250	29.73	29.76	29.79	29.83	29.86
5.500	29.89	29.93	29.96	30.00	30.02
5.750	30.05	30.07	30.09	30.12	30.14
6.000	30.17	30.20	30.22	30.25	30.28
6.250	30.31	30.34	30.37	30.40	30.43
6.500	30.46	30.50	30.52	30.55	30.58
6.750	30.61	30.64	30.68	30.71	30.74
7.000	30.78	30.81	30.85	30.88	30.92
7.250	30.95	30.99	31.02	31.05	31.08
7.500	31.11	31.14	31.17	31.20	31.23
7.750	31.26	31.29	31.32	31.35	31.38
8.000	31.40	31.43	31.46	31.49	31.51
8.250	31.54	31.56	31.58	31.61	31.63
8.500	31.65	31.68	31.70	31.72	31.75
8.750	31.77	31.80	31.82	31.85	31.87
9.000	31.90	31.92	31.95	31.98	32.00
9.250	32.03	32.05	32.07	32.09	32.11
9.500	32.14	32.16	32.18	32.21	32.23
9.750	32.25	32.28	32.30	32.33	32.35
10.000	32.38	32.40	32.43	32.45	32.48
10.250	32.51	32.53	32.55	32.57	32.59
10.500	32.62	32.64	32.67	32.69	32.72

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
10.750	32.75	32.78	32.80	32.83	32.87
11.000	32.90	32.93	32.96	33.00	33.03
11.250	33.05	33.09	33.12	33.16	33.19
11.500	33.24	33.28	33.33	33.39	33.45
11.750	33.53	33.61	33.70	33.83	33.98
12.000	34.14	34.32	34.54	34.76	35.01
12.250	35.23	35.46	35.65	35.83	35.99
12.500	36.00	36.00	36.00	36.00	36.00
12.750	36.00	36.00	36.00	36.00	36.00
13.000	36.00	36.00	36.00	36.00	36.00
13.250	36.00	36.00	36.00	36.00	36.00
13.500	36.00	36.00	36.00	36.00	36.00
13.750	36.00	36.00	36.00	36.00	36.00
14.000	36.00	36.00	36.00	36.00	36.00
14.250	36.00	36.00	36.00	36.00	36.00
14.500	36.00	36.00	36.00	36.00	36.00
14.750	36.00	36.00	36.00	36.00	36.00
15.000	36.00	36.00	36.00	36.00	36.00
15.250	36.00	36.00	36.00	36.00	36.00
15.500	36.00	36.00	36.00	36.00	36.00
15.750	36.00	36.00	36.00	36.00	36.00
16.000	36.00	36.00	36.00	36.00	36.00
16.250	36.00	36.00	36.00	36.00	35.98
16.500	35.96	35.93	35.91	35.88	35.86
16.750	35.84	35.81	35.79	35.76	35.74
17.000	35.71	35.69	35.66	35.64	35.61
17.250	35.59	35.57	35.54	35.52	35.49
17.500	35.46	35.43	35.40	35.37	35.34
17.750	35.31	35.28	35.25	35.23	35.20
18.000	35.17	35.14	35.11	35.08	35.05
18.250	35.02	34.99	34.96	34.92	34.88
18.500	34.85	34.81	34.78	34.75	34.71
18.750	34.68	34.64	34.61	34.58	34.54
19.000	34.51	34.47	34.43	34.39	34.35
19.250	34.31	34.27	34.23	34.19	34.16
19.500	34.12	34.08	34.04	34.01	33.96
19.750	33.92	33.88	33.83	33.79	33.75
20.000	33.70	33.66	33.62	33.58	33.54
20.250	33.50	33.46	33.41	33.37	33.33
20.500	33.29	33.25	33.21	33.17	33.14
20.750	33.10	33.07	33.04	33.01	32.97
21.000	32.93	32.90	32.86	32.83	32.80
21.250	32.77	32.74	32.71	32.68	32.66

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
21.500	32.63	32.61	32.58	32.56	32.54
21.750	32.52	32.50	32.47	32.45	32.42
22.000	32.40	32.38	32.36	32.34	32.32
22.250	32.30	32.28	32.26	32.24	32.23
22.500	32.21	32.20	32.18	32.17	32.15
22.750	32.14	32.13	32.12	32.10	32.09
23.000	32.08	32.07	32.06	32.05	32.04
23.250	32.03	32.02	32.01	32.00	31.99
23.500	31.98	31.97	31.96	31.95	31.95
23.750	31.94	31.93	31.92	31.91	31.90
24.000	31.89	(N/A)	(N/A)	(N/A)	(N/A)

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
0.000	26.00	26.00	26.00	26.00	26.00
0.250	26.00	26.00	26.00	26.00	26.00
0.500	26.00	26.00	26.00	26.00	26.00
0.750	26.00	26.00	26.00	26.00	26.00
1.000	26.00	26.00	26.00	26.00	26.00
1.250	26.00	26.00	26.00	26.00	26.00
1.500	26.00	26.00	26.00	26.00	26.00
1.750	26.00	26.00	26.00	26.00	26.00
2.000	26.00	26.00	26.00	26.00	26.00
2.250	26.00	26.00	26.00	26.00	26.00
2.500	26.00	26.00	26.00	26.00	26.00
2.750	26.00	26.00	26.01	26.02	26.06
3.000	26.14	26.28	26.50	26.64	26.83
3.250	27.04	27.19	27.37	27.55	27.68
3.500	27.83	28.00	28.12	28.25	28.39
3.750	28.53	28.64	28.76	28.89	29.01
4.000	29.06	29.10	29.16	29.21	29.27
4.250	29.33	29.39	29.46	29.51	29.53
4.500	29.56	29.58	29.61	29.64	29.67
4.750	29.70	29.73	29.76	29.80	29.83
5.000	29.87	29.90	29.94	29.98	30.01
5.250	30.04	30.06	30.09	30.11	30.14
5.500	30.17	30.20	30.22	30.25	30.28
5.750	30.32	30.35	30.38	30.41	30.44
6.000	30.48	30.51	30.54	30.57	30.60
6.250	30.63	30.66	30.69	30.72	30.76
6.500	30.79	30.83	30.86	30.90	30.93
6.750	30.97	31.00	31.03	31.06	31.09
7.000	31.12	31.15	31.18	31.21	31.24
7.250	31.27	31.30	31.33	31.36	31.38
7.500	31.41	31.44	31.47	31.50	31.52
7.750	31.55	31.57	31.59	31.62	31.64
8.000	31.66	31.68	31.70	31.73	31.75
8.250	31.77	31.79	31.81	31.84	31.86
8.500	31.88	31.91	31.93	31.95	31.98
8.750	32.00	32.02	32.04	32.06	32.09
9.000	32.11	32.13	32.15	32.17	32.20
9.250	32.22	32.24	32.27	32.29	32.32
9.500	32.34	32.37	32.39	32.42	32.45
9.750	32.47	32.50	32.52	32.54	32.56
10.000	32.59	32.61	32.63	32.65	32.68
10.250	32.70	32.72	32.75	32.77	32.80
10.500	32.83	32.86	32.88	32.91	32.94

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
10.750	32.98	33.01	33.03	33.06	33.09
11.000	33.12	33.15	33.18	33.21	33.24
11.250	33.28	33.32	33.35	33.40	33.44
11.500	33.49	33.54	33.58	33.64	33.70
11.750	33.78	33.88	33.99	34.11	34.25
12.000	34.43	34.61	34.82	35.05	35.28
12.250	35.53	35.74	35.96	36.00	36.00
12.500	36.00	36.00	36.00	36.00	36.00
12.750	36.00	36.00	36.00	36.00	36.00
13.000	36.00	36.00	36.00	36.00	36.00
13.250	36.00	36.00	36.00	36.00	36.00
13.500	36.00	36.00	36.00	36.00	36.00
13.750	36.00	36.00	36.00	36.00	36.00
14.000	36.00	36.00	36.00	36.00	36.00
14.250	36.00	36.00	36.00	36.00	36.00
14.500	36.00	36.00	36.00	36.00	36.00
14.750	36.00	36.00	36.00	36.00	36.00
15.000	36.00	36.00	36.00	36.00	36.00
15.250	36.00	36.00	36.00	36.00	36.00
15.500	36.00	36.00	36.00	36.00	36.00
15.750	36.00	36.00	36.00	36.00	36.00
16.000	36.00	36.00	36.00	36.00	36.00
16.250	36.00	36.00	36.00	36.00	36.00
16.500	36.00	36.00	36.00	36.00	36.00
16.750	36.00	36.00	36.00	36.00	36.00
17.000	36.00	36.00	36.00	36.00	36.00
17.250	36.00	36.00	36.00	36.00	36.00
17.500	36.00	36.00	36.00	36.00	36.00
17.750	36.00	36.00	36.00	36.00	36.00
18.000	35.98	35.95	35.93	35.90	35.87
18.250	35.85	35.82	35.79	35.77	35.74
18.500	35.71	35.69	35.66	35.64	35.61
18.750	35.58	35.56	35.53	35.51	35.48
19.000	35.44	35.41	35.38	35.35	35.32
19.250	35.29	35.26	35.23	35.20	35.17
19.500	35.14	35.11	35.08	35.05	35.02
19.750	34.99	34.95	34.92	34.88	34.85
20.000	34.81	34.78	34.74	34.71	34.67
20.250	34.64	34.61	34.57	34.54	34.51
20.500	34.47	34.42	34.38	34.34	34.30
20.750	34.26	34.22	34.18	34.15	34.11
21.000	34.07	34.03	34.00	33.95	33.91
21.250	33.86	33.82	33.78	33.73	33.69

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
21.500	33.65	33.61	33.57	33.53	33.49
21.750	33.44	33.40	33.36	33.31	33.27
22.000	33.23	33.20	33.16	33.12	33.09
22.250	33.06	33.03	32.99	32.95	32.92
22.500	32.88	32.85	32.82	32.79	32.76
22.750	32.73	32.70	32.67	32.64	32.62
23.000	32.59	32.57	32.55	32.53	32.50
23.250	32.48	32.45	32.43	32.41	32.38
23.500	32.36	32.34	32.32	32.30	32.28
23.750	32.26	32.24	32.23	32.21	32.19
24.000	32.18	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Time vs. Elevation | Return Event: 500 years
Label: PO-1 (OUT) | Storm Event: 500-Year

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
0.000	26.00	26.00	26.00	26.00	26.00
0.250	26.00	26.00	26.00	26.00	26.00
0.500	26.00	26.00	26.00	26.00	26.00
0.750	26.00	26.00	26.00	26.00	26.00
1.000	26.00	26.00	26.00	26.00	26.00
1.250	26.00	26.00	26.00	26.00	26.00
1.500	26.00	26.00	26.00	26.00	26.00
1.750	26.00	26.00	26.01	26.04	26.11
2.000	26.25	26.50	26.68	26.94	27.15
2.250	27.37	27.58	27.76	27.98	28.14
2.500	28.31	28.51	28.65	28.81	28.99
2.750	29.06	29.12	29.19	29.27	29.35
3.000	29.44	29.51	29.54	29.58	29.61
3.250	29.65	29.69	29.73	29.77	29.82
3.500	29.87	29.92	29.97	30.01	30.04
3.750	30.08	30.11	30.15	30.19	30.22
4.000	30.26	30.30	30.34	30.39	30.43
4.250	30.48	30.52	30.56	30.59	30.63
4.500	30.67	30.72	30.76	30.80	30.85
4.750	30.89	30.93	30.98	31.02	31.05
5.000	31.09	31.12	31.16	31.19	31.23
5.250	31.26	31.29	31.33	31.36	31.39
5.500	31.42	31.46	31.49	31.52	31.54
5.750	31.57	31.59	31.61	31.64	31.66
6.000	31.68	31.70	31.73	31.75	31.77
6.250	31.79	31.81	31.83	31.85	31.87
6.500	31.89	31.91	31.93	31.95	31.98
6.750	32.00	32.01	32.03	32.05	32.07
7.000	32.09	32.10	32.12	32.14	32.16
7.250	32.18	32.20	32.22	32.23	32.25
7.500	32.27	32.29	32.31	32.33	32.35
7.750	32.37	32.39	32.42	32.44	32.46
8.000	32.48	32.50	32.52	32.53	32.55
8.250	32.57	32.59	32.60	32.62	32.64
8.500	32.66	32.68	32.70	32.73	32.75
8.750	32.77	32.80	32.82	32.85	32.87
9.000	32.90	32.93	32.95	32.98	33.01
9.250	33.03	33.06	33.08	33.11	33.13
9.500	33.16	33.19	33.22	33.24	33.27
9.750	33.30	33.33	33.36	33.39	33.42
10.000	33.45	33.48	33.51	33.54	33.56
10.250	33.59	33.62	33.65	33.68	33.72
10.500	33.75	33.79	33.82	33.86	33.90

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
10.750	33.95	33.99	34.03	34.06	34.10
11.000	34.14	34.18	34.22	34.27	34.31
11.250	34.36	34.41	34.47	34.52	34.56
11.500	34.61	34.67	34.73	34.80	34.87
11.750	34.96	35.06	35.16	35.29	35.44
12.000	35.60	35.79	36.00	36.00	36.00
12.250	36.00	36.00	36.00	36.00	36.00
12.500	36.00	36.00	36.00	36.00	36.00
12.750	36.00	36.00	36.00	36.00	36.00
13.000	36.00	36.00	36.00	36.00	36.00
13.250	36.00	36.00	36.00	36.00	36.00
13.500	36.00	36.00	36.00	36.00	36.00
13.750	36.00	36.00	36.00	36.00	36.00
14.000	36.00	36.00	36.00	36.00	36.00
14.250	36.00	36.00	36.00	36.00	36.00
14.500	36.00	36.00	36.00	36.00	36.00
14.750	36.00	36.00	36.00	36.00	36.00
15.000	36.00	36.00	36.00	36.00	36.00
15.250	36.00	36.00	36.00	36.00	36.00
15.500	36.00	36.00	36.00	36.00	36.00
15.750	36.00	36.00	36.00	36.00	36.00
16.000	36.00	36.00	36.00	36.00	36.00
16.250	36.00	36.00	36.00	36.00	36.00
16.500	36.00	36.00	36.00	36.00	36.00
16.750	36.00	36.00	36.00	36.00	36.00
17.000	36.00	36.00	36.00	36.00	36.00
17.250	36.00	36.00	36.00	36.00	36.00
17.500	36.00	36.00	36.00	36.00	36.00
17.750	36.00	36.00	36.00	36.00	36.00
18.000	36.00	36.00	36.00	36.00	36.00
18.250	36.00	36.00	36.00	36.00	36.00
18.500	36.00	36.00	36.00	36.00	36.00
18.750	36.00	36.00	36.00	36.00	36.00
19.000	36.00	36.00	36.00	36.00	36.00
19.250	36.00	36.00	36.00	36.00	36.00
19.500	36.00	36.00	36.00	36.00	36.00
19.750	36.00	36.00	36.00	36.00	36.00
20.000	36.00	36.00	36.00	36.00	36.00
20.250	36.00	36.00	36.00	36.00	36.00
20.500	36.00	36.00	36.00	36.00	36.00
20.750	36.00	36.00	36.00	36.00	36.00
21.000	36.00	36.00	36.00	36.00	36.00
21.250	36.00	36.00	36.00	36.00	36.00

Subsection: Time vs. Elevation
Label: PO-1 (OUT)

Return Event: 500 years
Storm Event: 500-Year

Time vs. Elevation (ft)

Output Time increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)	Elevation (ft)
21.500	36.00	36.00	36.00	36.00	36.00
21.750	36.00	36.00	36.00	36.00	36.00
22.000	36.00	36.00	36.00	36.00	36.00
22.250	36.00	36.00	36.00	36.00	36.00
22.500	36.00	36.00	36.00	36.00	36.00
22.750	36.00	36.00	36.00	36.00	36.00
23.000	36.00	36.00	36.00	36.00	36.00
23.250	36.00	36.00	36.00	36.00	36.00
23.500	36.00	36.00	36.00	36.00	36.00
23.750	36.00	36.00	36.00	36.00	36.00
24.000	36.00	(N/A)	(N/A)	(N/A)	(N/A)

Requested Pond Water Surface Elevations	
Minimum (Headwater)	26.00 ft
Increment (Headwater)	0.50 ft
Maximum (Headwater)	36.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Culvert-Box	EX_CV1	Forward	TW	30.90	36.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Structure ID: EX_CV1 Structure Type: Culvert-Box	
Number of Barrels	1
Width	2.00 ft
Height	2.00 ft
Length	90.00 ft
Length (Computed Barrel)	90.06 ft
Slope (Computed)	0.037 ft/ft

Outlet Control Data	
Manning's n	0.013
Ke	0.500
Kb	0.012
Kr	0.000
Convergence Tolerance	0.00 ft

Inlet Control Data	
Equation Form	Form 1
K	0.0610
M	0.7500
C	0.0423
Y	0.8200
T1 ratio (HW/D)	1.225
T2 ratio (HW/D)	1.478
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	33.35 ft	T1 Flow	19.80 ft³/s
T2 Elevation	33.86 ft	T2 Flow	22.63 ft³/s

Structure ID: TW Structure Type: TW Setup, DS Channel	
Tailwater Type	Free Outfall

Convergence Tolerances	
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.01 ft
Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft
Headwater Tolerance (Maximum)	0.50 ft
Flow Tolerance (Minimum)	0.001 ft³/s
Flow Tolerance (Maximum)	10.000 ft³/s

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = EX_CV1 (Culvert-Box)

Mannings open channel maximum capacity: 66.81 ft^3/s
Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
26.00	0.00	(N/A)	0.00
26.50	0.00	(N/A)	0.00
27.00	0.00	(N/A)	0.00
27.50	0.00	(N/A)	0.00
28.00	0.00	(N/A)	0.00
28.50	0.00	(N/A)	0.00
29.00	0.00	(N/A)	0.00
29.50	0.00	(N/A)	0.00
30.00	0.00	(N/A)	0.00
30.50	0.00	(N/A)	0.00
30.90	0.00	(N/A)	0.00
31.00	0.16	(N/A)	0.00
31.50	2.27	(N/A)	0.00
32.00	5.65	(N/A)	0.00
32.50	9.91	(N/A)	0.00
33.00	14.90	(N/A)	0.00
33.50	20.56	(N/A)	0.00
34.00	23.79	(N/A)	0.00
34.50	27.48	(N/A)	0.00
35.00	30.73	(N/A)	0.00
35.50	33.66	(N/A)	0.00
36.00	36.37	(N/A)	0.00

Computation Messages
Upstream HW & DNstream TW < Inv.El
Upstream HW & DNstream TW < Inv.El
Upstream HW & DNstream TW < Inv.El
Upstream HW & DNstream TW < Inv.El
Upstream HW & DNstream TW < Inv.El
Upstream HW & DNstream TW < Inv.El
Upstream HW & DNstream TW < Inv.El
Upstream HW & DNstream TW < Inv.El
Upstream HW & DNstream TW < Inv.El
Upstream HW & DNstream TW < Inv.El
Upstream HW & DNstream TW < Inv.El
CRIT.DEPTH CONTROL Vh= .029ft Dcr= .057ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .171ft Dcr= .343ft CRIT.DEPTH Hev= .00ft

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = EX_CV1 (Culvert-Box)

Mannings open channel maximum capacity: 66.81 ft³/s
Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Computation Messages
CRIT.DEPTH CONTROL Vh= .314ft Dcr= .628ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .457ft Dcr= .914ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .600ft Dcr= 1.200ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .743ft Dcr= 1.486ft CRIT.DEPTH Hev= .00ft
INLET CONTROL... Submerged: HW =3.10
INLET CONTROL... Submerged: HW =3.60
INLET CONTROL... Submerged: HW =4.10
INLET CONTROL... Submerged: HW =4.60
INLET CONTROL... Submerged: HW =5.10

Subsection: Composite Rating Curve
Label: EX_MNRR Culvert

Return Event: 100 years
Storm Event: 2-Year

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
26.00	0.00	(N/A)	0.00
26.50	0.00	(N/A)	0.00
27.00	0.00	(N/A)	0.00
27.50	0.00	(N/A)	0.00
28.00	0.00	(N/A)	0.00
28.50	0.00	(N/A)	0.00
29.00	0.00	(N/A)	0.00
29.50	0.00	(N/A)	0.00
30.00	0.00	(N/A)	0.00
30.50	0.00	(N/A)	0.00
30.90	0.00	(N/A)	0.00
31.00	0.16	(N/A)	0.00
31.50	2.27	(N/A)	0.00
32.00	5.65	(N/A)	0.00
32.50	9.91	(N/A)	0.00
33.00	14.90	(N/A)	0.00
33.50	20.56	(N/A)	0.00
34.00	23.79	(N/A)	0.00
34.50	27.48	(N/A)	0.00
35.00	30.73	(N/A)	0.00
35.50	33.66	(N/A)	0.00
36.00	36.37	(N/A)	0.00

Contributing Structures
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
None Contributing
EX_CV1
EX_CV1
EX_CV1
EX_CV1
EX_CV1
EX_CV1
EX_CV1
EX_CV1
EX_CV1
EX_CV1

Composite Outflow Summary

Contributing Structures
EX_CV1

Index

APPENDIX C3

RATIONAL METHOD

YRC YANTIC RIVER CONSULTANTS, LLC

STATE PROJECT NO. 301-175
CULVERT REPLACEMENT
MNRR NEW HAVEN MAINLINE
M.P. 65.60, MILFORD, CONN.

HYDROLOGIC CALCULATIONS - RATIONAL METHOD

DETERMINE RUNOFF COEFFICIENT (C)

Surface	Area	Roughness Range		C	Comp. C
		C (low)	C (high)		
Streets / Walks	31.40	0.70	0.95	0.90	0.42
Buildings	12.86	0.75	0.95	0.95	0.18
Landscape	9.40	0.10	0.30	0.30	0.04
Woods / Undisturbed	10.58	0.10	0.30	0.20	0.03
Railroad Corridor	2.90	0.20	0.40	0.30	0.01
Total Area (A) =	67.14	Composite Roughness (C) =			0.69

DETERMINE TIME OF CONCENTRATION (Tc)

Sheet Flow						
Surface	Length	Slope	n	2-Yr 24 Hr	Tt	Unit
Woods	60	0.03	0.4	3.44	0.195	Hours
Woods	40	0.2	0.4	3.44	0.066	Hours
Shallow Concentrated Flow						
Surface	Length	Slope	Paved		Tt	Unit
Paved Driveway	500	0.008	yes		0.076	Hours
Paved Roads	1320	0.025	yes		0.114	Hours
				Time of Concentration	0.452	Hours
				Time of Concentration	27.1	Minutes

DETERMINE RAINFALL INTENSITY (I)

Storm	1	2	5	10	25	50	100
NOAA (Duration Low)	15	15	15	15	15	15	15
NOAA (Intensity Low)	2.3	2.77	3.55	4.2	5.08	5.77	6.45
Tc (Duration)	**27.1**	**27.1**	**27.1**	**27.1**	**27.1**	**27.1**	**27.1**
Interpolated Intensity (I)	**1.74**	**2.09**	**2.68**	**3.17**	**3.84**	**4.35**	**4.87**
NOAA (Duration High)	30	30	30	30	30	30	30
NOAA (Intensity High)	1.6	1.93	2.47	2.92	3.54	4.01	4.49

FREQUENCY FACTORS (Cf)

Storm	1	2	5	10	25	50	100
Cf	1	1	1	1	1.1	1.2	1.25

CALCULATE PEAK DISCHARGE (Q = C x Cf x I x A)

Storm	1	2	5	10	25	50	100
Q	80.3	96.9	124.0	146.6	195.4	241.7	281.7

PREPARED BY: BJH
DATE: 3/2/2016

The final element to be factored into the determination of runoff coefficients is the land slope. As the slope of the drainage basin increases, the selected C value should also increase. This is caused by the fact that as the slope of the drainage area increases, the velocity of overland and channel flow will increase allowing less opportunity for water to infiltrate the ground surface. Thus, more of the rainfall will become runoff from the drainage area.

In summary, it should be reiterated that in assigning a value to the runoff coefficient for use in the rational method, the engineer must rely heavily on experience and judgement.

Table 6-3 Recommended Coefficient Of Runoff For Pervious Surfaces By Selected Hydrologic Soil Groupings And Slope Ranges

Slope	A	B	C	D
Flat (0 - 1%)	0.04-0.09	0.07-0.12	0.11-0.16	0.15-0.20
Average (2 - 6%)	0.09-0.14	0.12-0.17	0.16-0.21	0.20-0.25
Steep (Over 6%)	0.13-0.18	0.18-0.24	0.23-0.31	0.28-0.38

Source: Storm Drainage Design Manual, Erie and Niagara Counties Regional Planning Board.

Table 6-4 Recommended Coefficient Of Runoff Values For Various Selected Land Uses

Description of Area		Runoff Coefficients
Business: Downtown areas		0.70-0.95
Neighborhood areas		0.50-0.70
Residential:	Single-family areas	0.30-0.50
	Multi units, detached	0.40-0.60
	Multi units, attached	0.60-0.75
	Suburban	0.25-0.40
Residential (0.5 ha (1.2 ac) lots or more)		0.30-0.45
Apartment dwelling areas		0.50-0.70
Industrial:	Light areas	0.50-0.80
	Heavy areas	0.60-0.90
Parks, cemeteries		0.10-0.25
Playgrounds		0.20-0.40
Railroad yard areas		0.20-0.40
Unimproved areas		0.10-0.30

Table 6-5 Coefficients For Composite Runoff Analysis

Surface		Runoff Coefficients
Street:	Asphalt	0.70-0.95
	Concrete	0.80-0.95
Drives and walks		0.75-0.85
Roofs		0.75-0.95

YRC

YANTIC RIVER
CONSULTANTS, LLC

APPENDIX B

PHOTOGRAPHS

282 Woodmont Road looking north

Eastern Steel Road looking northwest towards 465 Old Gate Lane

Intersection of Research Drive and Woodmont Road

Upstream Railroad Embankment at Culvert


Downstream Embankment at culvert – note sloughing


Downstream outlet – note collapsed structure

Channel section within downstream wetland area

Channel section within downstream wetland area

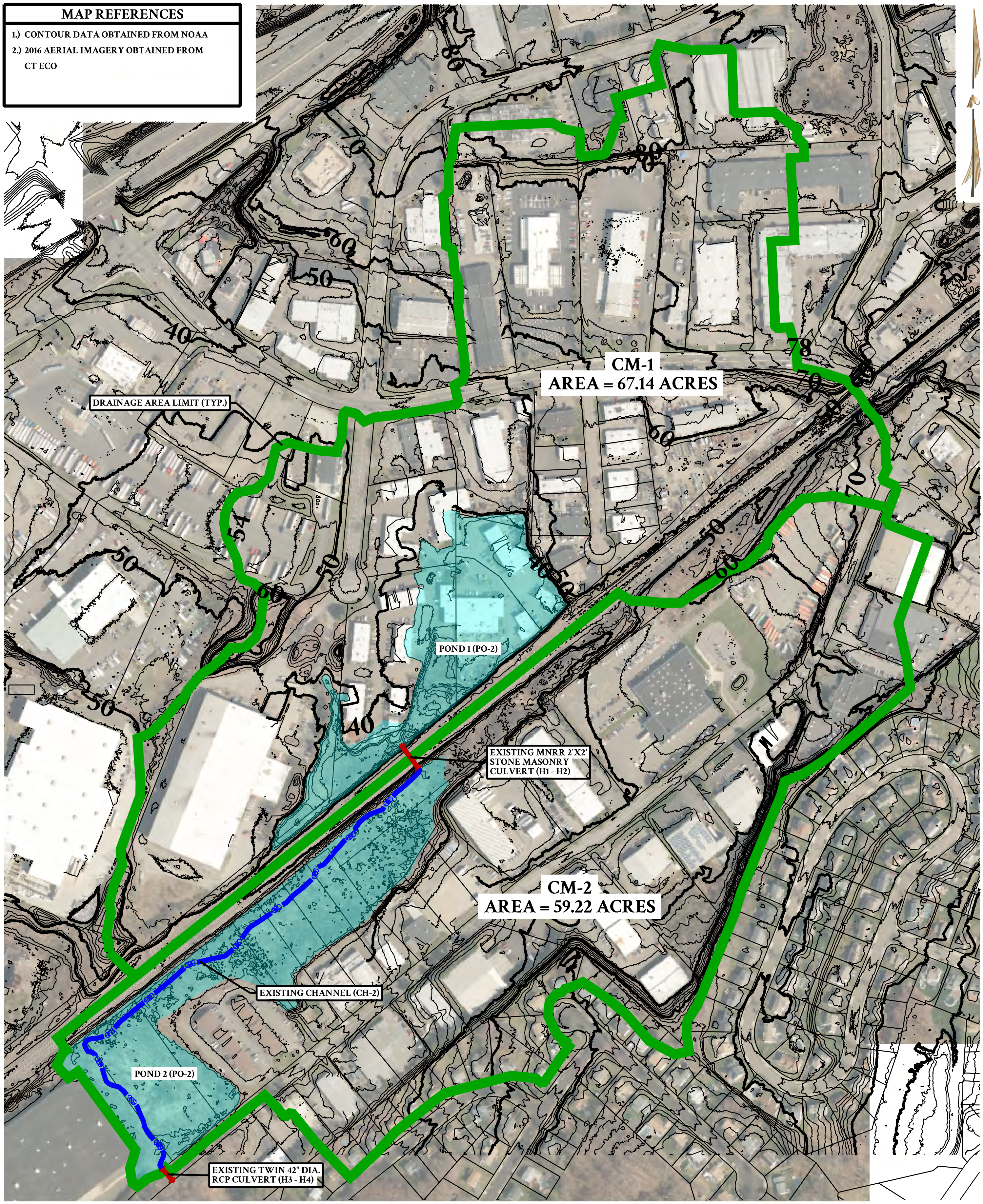
Wetland & storage area immediately upstream of Pepes Farm Road

Twin 42" RCP culvert at Pepes Farm Road

APPENDIX C

MAPS

Catchment Area Map
CN Area Map
Storage Volume Map
Inundation Area Map



SCALE: 1"= 400'

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DATE 3/22/17

SHEET 1 OF 4

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CULVERT REPLACEMENT - MP 65.60

CONNECTICUT DEPARTMENT OF TRANSPORTATION

WATERSHED MAP

NEW HAVEN MAINLINE

MILFORD, CT

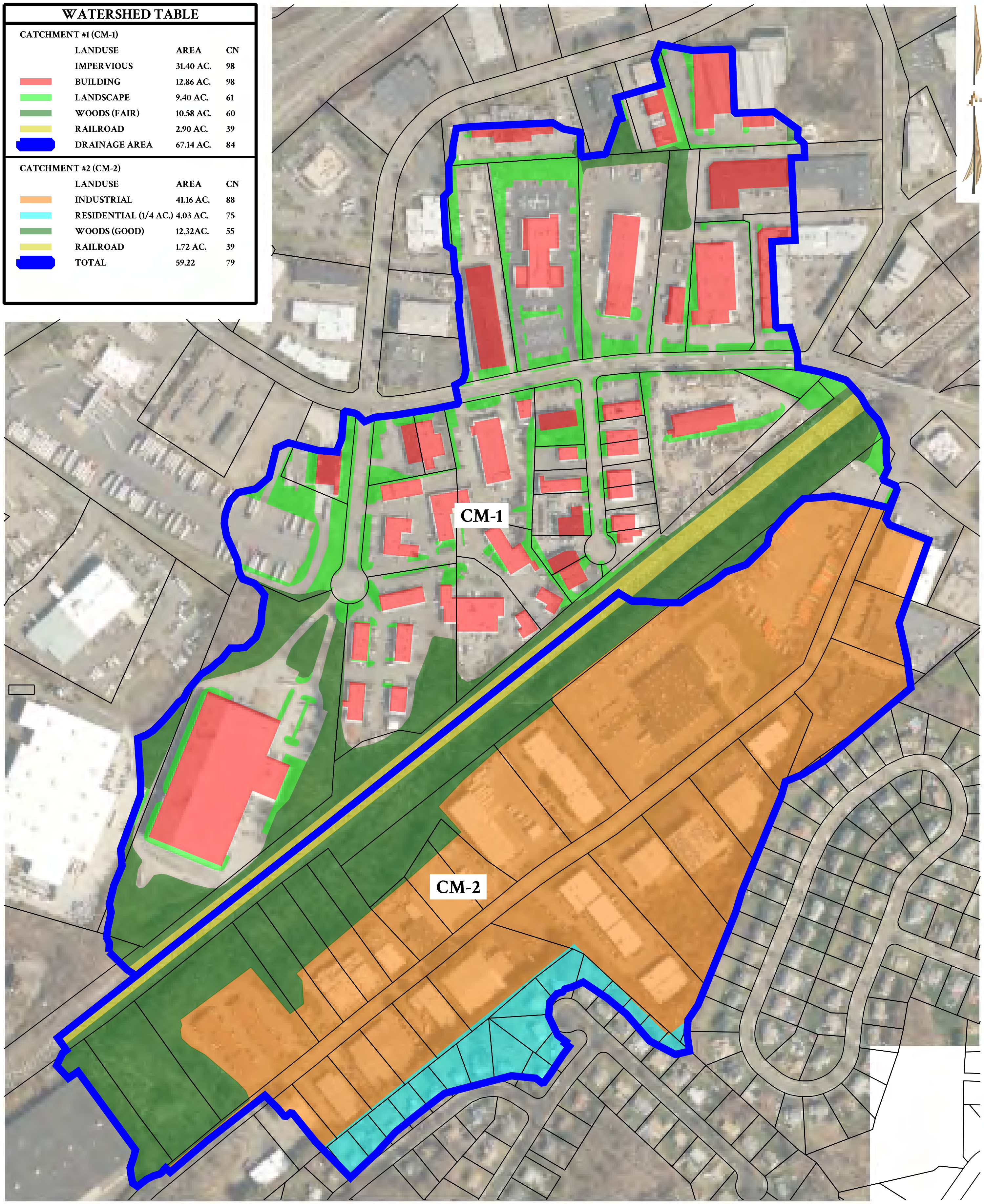
WATERSHED TABLE

CATCHMENT #1 (CM-1)

	LANDUSE	AREA	CN
	IMPERVIOUS	31.40 AC.	98
(red)	BUILDING	12.86 AC.	98
(light green)	LANDSCAPE	9.40 AC.	61
(dark green)	WOODS (FAIR)	10.58 AC.	60
(yellow)	RAILROAD	2.90 AC.	39
(blue)	DRAINAGE AREA	67.14 AC.	84

CATCHMENT #2 (CM-2)

	LANDUSE	AREA	CN
(orange)	INDUSTRIAL	41.16 AC.	88
(cyan)	RESIDENTIAL (1/4 AC.)	4.03 AC.	75
(dark green)	WOODS (GOOD)	12.32AC.	55
(yellow)	RAILROAD	1.72 AC.	39
(blue)	TOTAL	59.22	79



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DATE 3/22/17

SHEET 2 OF 4

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CONNECTICUT DEPARTMENT OF TRANSPORTATION

LANDUSE / CN MAP

NEW HAVEN MAINLINE MILFORD, CT

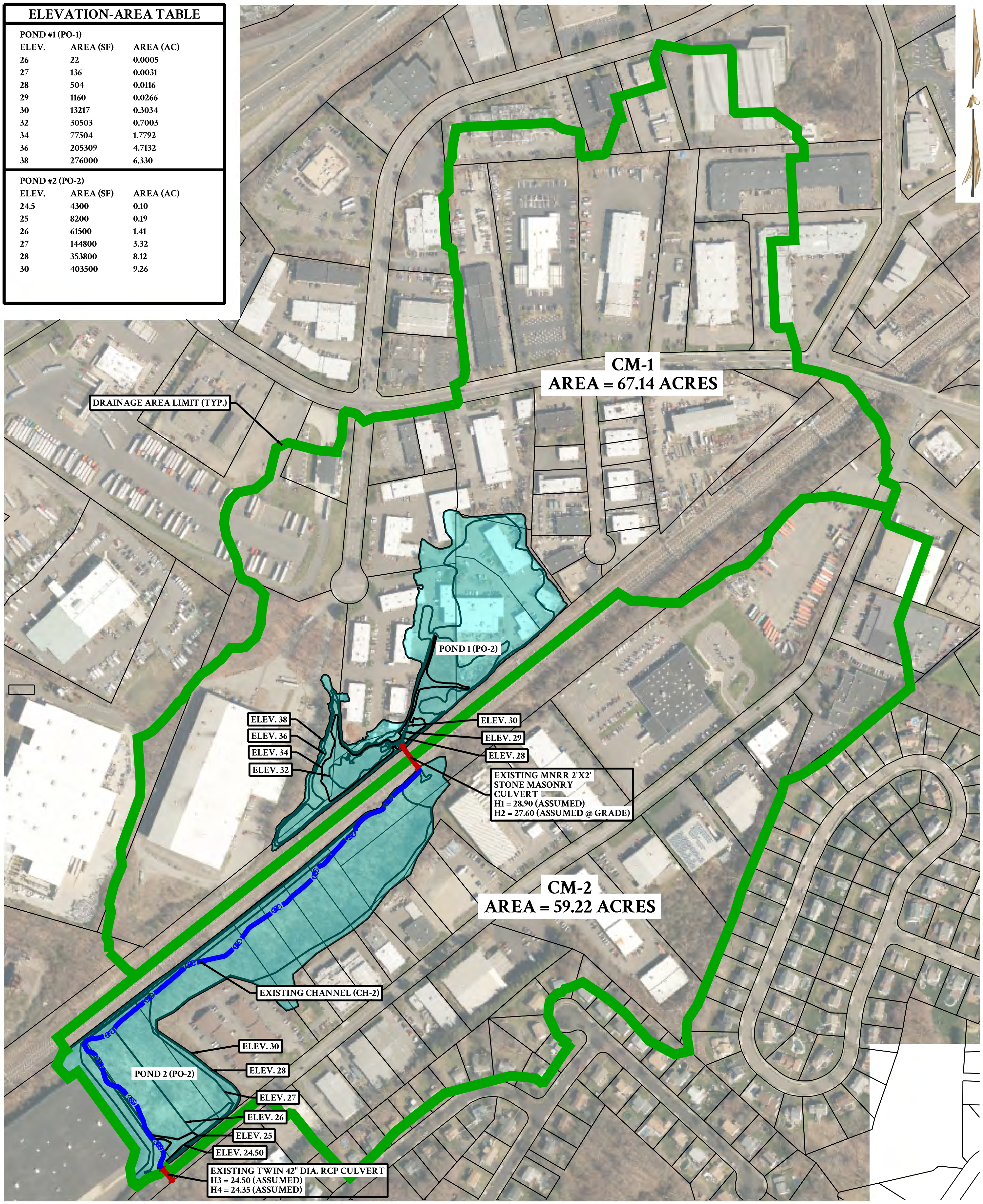
ELEVATION-AREA TABLE

POND #1 (PO-1)

ELEV.	AREA (SF)	AREA (AC)
26	22	0.0005
27	136	0.0031
28	504	0.0116
29	1160	0.0266
30	13217	0.3034
32	30503	0.7003
34	77504	1.7792
36	205309	4.7132
38	276000	6.330

POND #2 (PO-2)

ELEV.	AREA (SF)	AREA (AC)
24.5	4300	0.10
25	8200	0.19
26	61500	1.41
27	144800	3.32
28	353800	8.12
30	403500	9.26



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DATE 3/22/17

SHEET 3 OF 4

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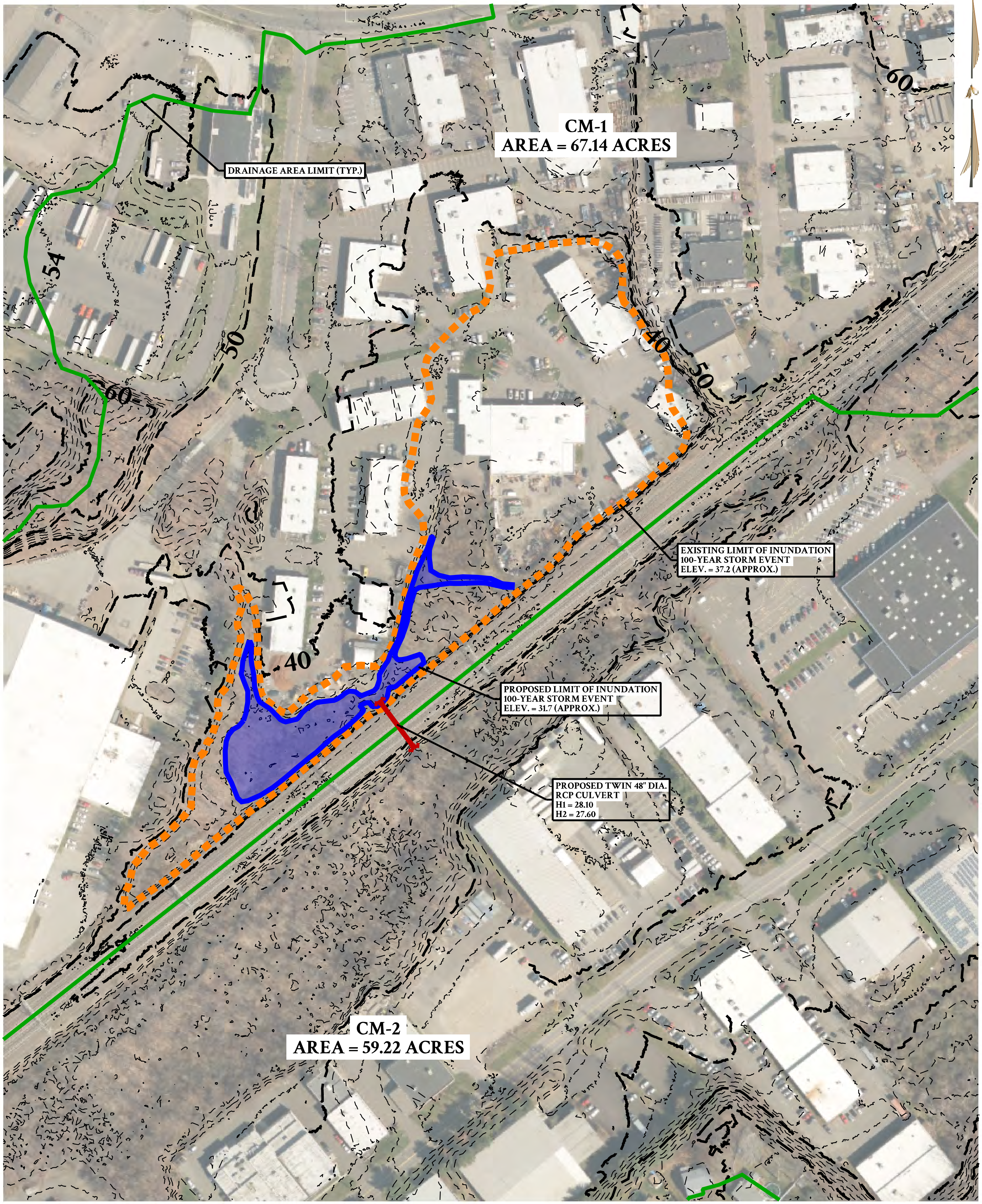
CONNECTICUT DEPARTMENT OF TRANSPORTATION

STORAGE (POND) VOLUME MAP

NEW HAVEN MAINLINE MILFORD, CT



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DATE
3/22/17

SHEET
4 OF 4

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CONNECTICUT DEPARTMENT OF TRANSPORTATION

INUNDATION AREA MAP

NEW HAVEN MAINLINE

MILFORD, CT

APPENDIX D

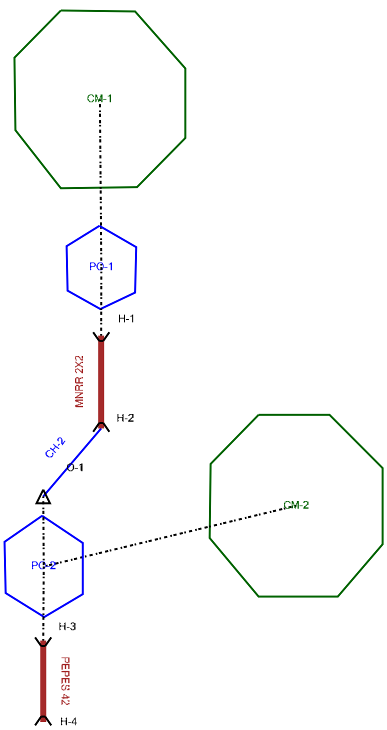
ROUTING COMPUTATIONS

Existing Conditions
Alternate 1: Twin 48" RCP Culvert
Alternate 2: Twin 48" RCP Culvert with Restrictions

APPENDIX D1

Existing Conditions (CivilStorm)

Scenario: NOAA Base



Calculation Executive Summary

Scenario

Label	NOAA 1-Year

Storm Event

Label	NOAA 1-Year - Rainfall Runoff Alternative - 1	Return Event	1 years
Global Storm Event	NOAA Bridgeport (1 -Year) - 1 Year		

Calculation Executive Summary

Total Inflow Volume	732,755.4 ft³	Total System Volume Change	11,187.0 ft³
Total System Outflow Volume	681,077.7 ft³	Continuity Error	5.5 %
Total System Overflow Volume	0.0 ft³	Total Pond Infiltration Volume	0.0 ft³
Total Gutter Volume Change	(N/A) ft³	Total N-R Iterations	2028

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.050 hours
Calculation Time Step	0.025 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft^3)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	2.8	67.140	457,543.0	85.22	12.300
CM-2	Unit Hydrograph	SCS CN	2.8	59.220	275,080.0	49.28	12.400

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR 2X2	Conduit	1	12.750	34.28	8.57	33.33
PEPES 42	Conduit	1	13.950	54.23	6.20	26.49
CH-2	Channel	1	12.850	34.26	2.42	29.08
PO-1	Pond	1	---	---	---	33.33

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-2	Pond	1	---	---	---	26.49

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	84.83	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.400	77.59	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.800 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR 2X2	Box - 2.0 x 2.0 ft	Stone masonry	0.019	90.0		2.0	2.0	34.28
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			54.23

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
12.800	33.33	33.33	30.22	8.57	8.57
12.800	26.49	26.49	25.89	4.25	5.92

Calculation Executive Summary

Scenario

Label	NOAA 2-Year

Storm Event

Label	NOAA 2-Year - Rainfall Runoff Alternative - 1	Return Event	2 years
Global Storm Event	NOAA Bridgeport (2 -Year) - 2 Year		

Calculation Executive Summary

Total Inflow Volume	932,645.3 ft³	Total System Volume Change	12,504.2 ft³
Total System Outflow Volume	859,398.1 ft³	Continuity Error	6.5 %
Total System Overflow Volume	0.0 ft³	Total Pond Infiltration Volume	0.0 ft³
Total Gutter Volume Change	(N/A) ft³	Total N-R Iterations	2601

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.050 hours
Calculation Time Step	0.025 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft^3)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	3.3	67.140	570,887.0	105.67	12.300
CM-2	Unit Hydrograph	SCS CN	3.3	59.220	361,597.0	65.21	12.350

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR 2X2	Conduit	1	12.850	36.58	9.15	33.96
PEPES 42	Conduit	1	12.800	59.33	4.99	26.69
CH-2	Channel	1	12.900	36.57	2.45	29.13
PO-1	Pond	1	---	---	---	33.96

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-2	Pond	1	---	---	---	26.69

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	105.07	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.350	94.93	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.850 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR 2X2	Box - 2.0 x 2.0 ft	Stone masonry	0.019	90.0		2.0	2.0	36.58
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			59.33

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
12.850	33.96	33.96	30.42	9.15	9.15
12.800	26.69	26.68	26.05	4.67	6.43

Calculation Executive Summary

Scenario

Label	NOAA 5-Year

Storm Event

Label	NOAA 5-Year - Rainfall Runoff Alternative - 1	Return Event	5 years
Global Storm Event	NOAA Bridgeport (5 -Year) - 5 Year		

Calculation Executive Summary

Total Inflow Volume	1,432,320.3 ft³	Total System Volume Change	16,484.5 ft³
Total System Outflow Volume	1,347,459.3 ft³	Continuity Error	4.8 %
Total System Overflow Volume	0.0 ft³	Total Pond Infiltration Volume	0.0 ft³
Total Gutter Volume Change	(N/A) ft³	Total N-R Iterations	3361

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.050 hours
Calculation Time Step	0.025 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft^3)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	4.5	67.140	849,177.0	154.72	12.300
CM-2	Unit Hydrograph	SCS CN	4.5	59.220	582,912.0	105.26	12.350

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR 2X2	Conduit	1	12.950	40.19	10.05	35.03
PEPES 42	Conduit	1	12.800	88.78	6.11	27.10
CH-2	Channel	1	13.050	40.21	2.48	29.22
PO-1	Pond	1	---	---	---	35.03

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-2	Pond	1	---	---	---	27.10

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	153.59	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.350	137.61	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.950 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR 2X2	Box - 2.0 x 2.0 ft	Stone masonry	0.019	90.0		2.0	2.0	40.19
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			88.78

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
12.950	35.03	35.03	30.77	10.05	10.05
12.750	27.10	27.07	26.41	5.76	7.42

Calculation Executive Summary

Scenario

Label	NOAA 10-Year

Storm Event

Label	NOAA 10-Year - Rainfall Runoff Alternative - 1	Return Event	10 years
Global Storm Event	NOAA Bridgeport (10-Year) - 10 Year		

Calculation Executive Summary

Total Inflow Volume	1,775,199.4 ft³	Total System Volume Change	14,423.6 ft³
Total System Outflow Volume	1,780,045.6 ft³	Continuity Error	1.1 %
Total System Overflow Volume	0.0 ft³	Total Pond Infiltration Volume	0.0 ft³
Total Gutter Volume Change	(N/A) ft³	Total N-R Iterations	2957

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.050 hours
Calculation Time Step	0.025 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft³)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	5.3	67.140	1,037,602.0	187.25	12.300
CM-2	Unit Hydrograph	SCS CN	5.3	59.220	737,319.0	132.64	12.350

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR 2X2	Conduit	1	13.050	41.86	10.46	35.56
PEPES 42	Conduit	1	12.700	105.42	6.67	27.32
CH-2	Channel	1	13.100	41.90	2.48	29.26
PO-1	Pond	1	---	---	---	35.56

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-2	Pond	1	---	---	---	27.32

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	185.75	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.350	163.50	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 13.050 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR 2X2	Box - 2.0 x 2.0 ft	Stone masonry	0.019	90.0		2.0	2.0	41.86
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			105.42

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
13.050	35.56	35.56	30.94	10.46	10.46
12.750	27.32	27.26	26.57	6.19	7.80

Calculation Executive Summary

Scenario

Label	NOAA 25-Year

Storm Event

Label	NOAA 25-Year - Rainfall Runoff Alternative - 1	Return Event	25 years
Global Storm Event	NOAA Bridgeport (25-Year) - 25 Year		

Calculation Executive Summary

Total Inflow Volume	2,298,204.3 ft³	Total System Volume Change	23,974.5 ft³
Total System Outflow Volume	2,276,292.0 ft³	Continuity Error	0.1 %
Total System Overflow Volume	0.0 ft³	Total Pond Infiltration Volume	0.0 ft³
Total Gutter Volume Change	(N/A) ft³	Total N-R Iterations	3276

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.050 hours
Calculation Time Step	0.025 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft³)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	6.5	67.140	1,322,678.0	235.72	12.300
CM-2	Unit Hydrograph	SCS CN	6.5	59.220	975,179.0	174.05	12.350

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR 2X2	Conduit	1	13.150	43.92	10.98	36.24
PEPES 42	Conduit	1	12.750	120.65	7.03	27.59
CH-2	Channel	1	13.200	43.98	2.47	29.31
PO-1	Pond	1	---	---	---	36.24

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-2	Pond	1	---	---	---	27.59

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	233.69	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.300	200.26	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 13.150 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR 2X2	Box - 2.0 x 2.0 ft	Stone masonry	0.019	90.0		2.0	2.0	43.92
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			120.65

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
13.150	36.24	36.24	31.16	10.98	10.98
12.800	27.59	27.50	26.73	6.52	8.22

Calculation Executive Summary

Scenario

Label	NOAA 50-Year

Storm Event

Label	NOAA 50-Year - Rainfall Runoff Alternative - 1	Return Event	50 years
Global Storm Event	NOAA Bridgeport (50-Year) - 50 Year		

Calculation Executive Summary

Total Inflow Volume	2,695,044.0 ft³	Total System Volume Change	27,619.7 ft³
Total System Outflow Volume	2,651,631.8 ft³	Continuity Error	0.6 %
Total System Overflow Volume	0.0 ft³	Total Pond Infiltration Volume	0.0 ft³
Total Gutter Volume Change	(N/A) ft³	Total N-R Iterations	3248

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.050 hours
Calculation Time Step	0.025 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft³)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	7.4	67.140	1,537,726.0	271.86	12.300
CM-2	Unit Hydrograph	SCS CN	7.4	59.220	1,156,918.0	205.18	12.350

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR 2X2	Conduit	1	13.250	45.30	11.32	36.72
PEPES 42	Conduit	1	12.850	130.41	7.27	27.77
CH-2	Channel	1	13.300	45.38	2.41	29.34
PO-1	Pond	1	---	---	---	36.72

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-2	Pond	1	---	---	---	27.77

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	269.43	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.300	227.80	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 13.250 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR 2X2	Box - 2.0 x 2.0 ft	Stone masonry	0.019	90.0		2.0	2.0	45.30
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			130.41

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
13.250	36.72	36.72	31.31	11.32	11.32
12.800	27.77	27.65	26.84	6.79	8.49

Calculation Executive Summary

Scenario

Label	NOAA 100-Year

Storm Event

Label	NOAA 100-Year - Rainfall Runoff Alternative - 1	Return Event	100 years
Global Storm Event	NOAA Bridgeport (100-Year) - 100 Year		

Calculation Executive Summary

Total Inflow Volume	3,094,598.0 ft^3	Total System Volume Change	23,500.6 ft^3
Total System Outflow Volume	3,096,972.5 ft^3	Continuity Error	0.8 %
Total System Overflow Volume	0.0 ft^3	Total Pond Infiltration Volume	0.0 ft^3
Total Gutter Volume Change	(N/A) ft^3	Total N-R Iterations	3508

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.050 hours
Calculation Time Step	0.025 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft^3)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	8.3	67.140	1,753,487.0	307.85	12.300
CM-2	Unit Hydrograph	SCS CN	8.3	59.220	1,340,658.0	236.28	12.350

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR 2X2	Conduit	1	13.300	46.59	11.65	37.18
PEPES 42	Conduit	1	12.850	139.69	7.53	27.94
CH-2	Channel	1	13.350	46.70	2.21	29.37
PO-1	Pond	1	---	---	---	37.18

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-2	Pond	1	---	---	---	27.94

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	305.01	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.300	255.23	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 13.300 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR 2X2	Box - 2.0 x 2.0 ft	Stone masonry	0.019	90.0		2.0	2.0	46.59
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			139.69

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
13.300	37.18	37.18	31.46	11.65	11.65
12.850	27.94	27.81	26.94	7.06	8.72

Calculation Executive Summary

Scenario

Label	NOAA 500-Year

Storm Event

Label	NOAA 500-Year - Rainfall Runoff Alternative - 1	Return Event	500 years
Global Storm Event	NOAA Bridgeport (500-Year) - 500 Year		

Calculation Executive Summary

Total Inflow Volume	4,438,639.5 ft³	Total System Volume Change	116,701.4 ft³
Total System Outflow Volume	4,213,922.0 ft³	Continuity Error	2.4 %
Total System Overflow Volume	1,223.4 ft³	Total Pond Infiltration Volume	0.0 ft³
Total Gutter Volume Change	(N/A) ft³	Total N-R Iterations	3962

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.050 hours
Calculation Time Step	0.025 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft^3)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	11.3	67.140	2,475,795.0	426.95	12.300
CM-2	Unit Hydrograph	SCS CN	11.3	59.220	1,962,221.0	339.41	12.350

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR 2X2	Conduit	1	13.250	50.42	12.61	38.00
PEPES 42	Conduit	1	12.900	163.80	8.51	28.47
CH-2	Channel	1	13.250	51.02	0.70	29.46
PO-1	Pond	1	---	---	---	38.00

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-2	Pond	1	---	---	---	28.47

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	422.80	---	---	---	---	12.650	0.12
PO-2	Pond	1	12.300	370.43	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.650 hours

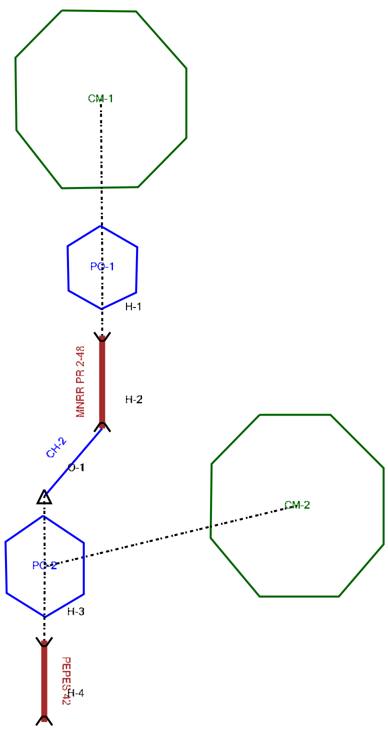
Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR 2X2	Box - 2.0 x 2.0 ft	Stone masonry	0.019	90.0		2.0	2.0	50.42
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			163.80

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
12.650	38.00	38.00	31.75	12.25	12.25
12.900	28.47	28.40	27.25	8.33	9.40

APPENDIX D2

Alternate 1: Twin 48" RCP Culvert (CivilStorm)

Scenario: NOAA Base



Calculation Executive Summary

Scenario

Label	NOAA 1-Year

Storm Event

Label	NOAA 1-Year - Rainfall Runoff Alternative - 1	Return Event	1 years
Global Storm Event	NOAA Bridgeport (1 -Year) - 1 Year		

Calculation Executive Summary

Total Inflow Volume	732,818.9 ft³	Total System Volume Change	9,731.4 ft³
Total System Outflow Volume	657,771.6 ft³	Continuity Error	8.9 %
Total System Overflow Volume	0.0 ft³	Total Pond Infiltration Volume	0.0 ft³
Total Gutter Volume Change	(N/A) ft³	Total N-R Iterations	2680

Calculation Detailed Summary

<General>

Label	Base1 Calculation Options	Output Increment	0.100 hours
Calculation Time Step	0.050 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft^3)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	2.8	67.140	457,492.0	85.22	12.300
CM-2	Unit Hydrograph	SCS CN	2.8	59.220	275,081.0	49.28	12.400

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR PR 2-48	Conduit	1	12.400	82.26	6.71	30.05
PEPES 42	Conduit	1	12.700	74.01	5.55	26.92
CH-2	Channel	1	12.400	82.35	3.30	29.77
PO-1	Pond	1	---	---	---	30.05

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-2	Pond	1	---	---	---	26.92

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	85.22	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.400	128.21	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.400 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR PR 2-48	Circle - 48.0 in	Concrete	0.013	101.0	48.0			82.26
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			74.01

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
12.400	30.05	30.05	29.78	6.75	5.87
12.700	26.92	26.57	25.97	4.74	6.41

Calculation Executive Summary

Scenario

Label	NOAA 2-Year

Storm Event

Label	NOAA 2-Year - Rainfall Runoff Alternative - 1	Return Event	2 years
Global Storm Event	NOAA Bridgeport (2 -Year) - 2 Year		

Calculation Executive Summary

Total Inflow Volume	932,410.6 ft³	Total System Volume Change	7,078.0 ft³
Total System Outflow Volume	936,629.2 ft³	Continuity Error	1.2 %
Total System Overflow Volume	0.0 ft³	Total Pond Infiltration Volume	0.0 ft³
Total Gutter Volume Change	(N/A) ft³	Total N-R Iterations	8390

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.025 hours
Calculation Time Step	0.013 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft³)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	3.3	67.140	570,882.0	105.67	12.300
CM-2	Unit Hydrograph	SCS CN	3.3	59.220	361,597.0	65.21	12.350

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR PR 2-48	Conduit	1	12.325	104.58	8.14	30.13
PEPES 42	Conduit	1	12.700	99.70	6.54	27.22
CH-2	Channel	1	12.375	104.40	3.61	29.85
PO-1	Pond	1	---	---	---	30.13

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-2	Pond	1	---	---	---	27.22

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	105.60	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.375	168.24	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.325 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR PR 2-48	Circle - 48.0 in	Concrete	0.013	101.0	48.0			104.58
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			99.70

Label	Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
MNRR PR 2-48	12.325	30.13	30.13	29.86	8.18	7.16
PEPES 42	12.725	27.22	26.69	26.25	6.16	7.17

Calculation Executive Summary

Scenario

Label	NOAA 5-Year

Storm Event

Label	NOAA 5-Year - Rainfall Runoff Alternative - 1	Return Event	5 years
Global Storm Event	NOAA Bridgeport (5 -Year) - 5 Year		

Calculation Executive Summary

Total Inflow Volume	1,431,944.5 ft³	Total System Volume Change	3,159.7 ft³
Total System Outflow Volume	1,427,455.4 ft³	Continuity Error	0.1 %
Total System Overflow Volume	0.0 ft³	Total Pond Infiltration Volume	0.0 ft³
Total Gutter Volume Change	(N/A) ft³	Total N-R Iterations	10302

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.025 hours
Calculation Time Step	0.013 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft³)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	4.5	67.140	849,171.0	154.72	12.300
CM-2	Unit Hydrograph	SCS CN	4.5	59.220	582,912.0	105.26	12.350

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR PR 2-48	Conduit	1	12.350	151.52	9.66	30.78
PEPES 42	Conduit	1	12.800	127.63	7.20	27.72
CH-2	Channel	1	12.375	151.15	4.16	29.95
PO-1	Pond	1	---	---	---	30.78

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-2	Pond	1	---	---	---	27.72

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	154.50	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.375	245.19	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.350 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR PR 2-48	Circle - 48.0 in	Concrete	0.013	101.0	48.0			151.52
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			127.63

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
12.350	30.78	30.78	30.02	8.47	9.55
12.775	27.72	27.24	26.52	6.00	7.75

Calculation Executive Summary

Scenario

Label	NOAA 10-Year

Storm Event

Label	NOAA 10-Year - Rainfall Runoff Alternative - 1	Return Event	10 years
Global Storm Event	NOAA Bridgeport (10-Year) - 10 Year		

Calculation Executive Summary

Total Inflow Volume	1,774,790.3 ft^3	Total System Volume Change	17,415.9 ft^3
Total System Outflow Volume	1,737,010.9 ft^3	Continuity Error	1.1 %
Total System Overflow Volume	0.0 ft^3	Total Pond Infiltration Volume	0.0 ft^3
Total Gutter Volume Change	(N/A) ft^3	Total N-R Iterations	9450

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.025 hours
Calculation Time Step	0.013 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft^3)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	5.3	67.140	1,037,595.0	187.25	12.300
CM-2	Unit Hydrograph	SCS CN	5.3	59.220	737,318.0	132.64	12.350

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR PR 2-48	Conduit	1	12.350	182.97	10.73	31.05
PEPES 42	Conduit	1	12.825	142.94	7.63	28.00
CH-2	Channel	1	12.375	182.50	4.47	30.00
PO-1	Pond	1	---	---	---	31.05

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-2	Pond	1	---	---	---	28.00

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	186.91	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.375	295.96	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.350 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR PR 2-48	Circle - 48.0 in	Concrete	0.013	101.0	48.0			182.97
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			142.94

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
12.350	31.05	31.05	30.11	9.22	11.00
12.825	28.00	27.48	26.69	6.40	8.18

Calculation Executive Summary

Scenario

Label	NOAA 25-Year

Storm Event

Label	NOAA 25-Year - Rainfall Runoff Alternative - 1	Return Event	25 years
Global Storm Event	NOAA Bridgeport (25-Year) - 25 Year		

Calculation Executive Summary

Total Inflow Volume	2,297,702.8 ft³	Total System Volume Change	15,323.9 ft³
Total System Outflow Volume	2,284,816.0 ft³	Continuity Error	0.1 %
Total System Overflow Volume	0.0 ft³	Total Pond Infiltration Volume	0.0 ft³
Total Gutter Volume Change	(N/A) ft³	Total N-R Iterations	8356

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.025 hours
Calculation Time Step	0.013 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft^3)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	6.5	67.140	1,322,669.0	235.72	12.300
CM-2	Unit Hydrograph	SCS CN	6.5	59.220	975,179.0	174.05	12.325

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR PR 2-48	Conduit	1	12.350	231.14	12.48	31.15
PEPES 42	Conduit	1	12.850	161.43	8.39	28.42
CH-2	Channel	1	12.375	230.86	4.89	30.07
PO-1	Pond	1	---	---	---	31.15

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-2	Pond	1	---	---	---	28.42

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	235.22	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.350	374.45	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.350 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR PR 2-48	Circle - 48.0 in	Concrete	0.013	101.0	48.0			231.14
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			161.43

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
12.350	31.15	31.15	30.21	11.24	13.29
12.850	28.42	27.81	26.94	7.08	8.70

Calculation Executive Summary

Scenario

Label	NOAA 50-Year

Storm Event

Label	NOAA 50-Year - Rainfall Runoff Alternative - 1	Return Event	50 years
Global Storm Event	NOAA Bridgeport (50-Year) - 50 Year		

Calculation Executive Summary

Total Inflow Volume	2,694,471.0 ft^3	Total System Volume Change	8,119.7 ft^3
Total System Outflow Volume	2,684,752.8 ft^3	Continuity Error	0.1 %
Total System Overflow Volume	0.0 ft^3	Total Pond Infiltration Volume	0.0 ft^3
Total Gutter Volume Change	(N/A) ft^3	Total N-R Iterations	5864

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.025 hours
Calculation Time Step	0.013 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft^3)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	7.4	67.140	1,537,716.0	271.86	12.300
CM-2	Unit Hydrograph	SCS CN	7.4	59.220	1,156,918.0	205.34	12.325

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR PR 2-48	Conduit	1	12.325	267.04	12.95	31.48
PEPES 42	Conduit	1	12.875	177.12	9.20	28.72
CH-2	Channel	1	12.375	266.58	5.16	30.11
PO-1	Pond	1	---	---	---	31.48

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-2	Pond	1	---	---	---	28.72

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	271.24	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.350	433.36	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.325 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR PR 2-48	Circle - 48.0 in	Concrete	0.013	101.0	48.0			267.04
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			177.12

Label	Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
MNRR PR 2-48	12.325	31.48	31.48	30.38	11.79	14.33
PEPES 42	12.875	28.72	27.93	27.02	7.32	8.87

Calculation Executive Summary

Scenario

Label	NOAA 100-Year

Storm Event

Label	NOAA 100-Year - Rainfall Runoff Alternative - 1	Return Event	100 years
Global Storm Event	NOAA Bridgeport (100-Year) - 100 Year		

Calculation Executive Summary

Total Inflow Volume	3,093,946.0 ft^3	Total System Volume Change	10,079.8 ft^3
Total System Outflow Volume	3,082,230.0 ft^3	Continuity Error	0.1 %
Total System Overflow Volume	0.0 ft^3	Total Pond Infiltration Volume	0.0 ft^3
Total Gutter Volume Change	(N/A) ft^3	Total N-R Iterations	9275

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.025 hours
Calculation Time Step	0.013 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft³)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	8.3	67.140	1,753,476.0	307.85	12.300
CM-2	Unit Hydrograph	SCS CN	8.3	59.220	1,340,658.0	236.61	12.325

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR PR 2-48	Conduit	1	12.350	300.10	14.23	31.66
PEPES 42	Conduit	1	12.875	191.53	9.95	29.02
CH-2	Channel	1	12.375	299.66	4.91	30.15
PO-1	Pond	1	---	---	---	31.66

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-2	Pond	1	---	---	---	29.02

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	307.10	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.325	483.78	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.350 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR PR 2-48	Circle - 48.0 in	Concrete	0.013	101.0	48.0			300.10
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			191.53

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
12.350	31.66	31.66	30.40	12.70	15.95
12.875	29.02	28.20	27.17	7.94	9.21

Calculation Executive Summary

Scenario

Label	NOAA 500-Year

Storm Event

Label	NOAA 500-Year - Rainfall Runoff Alternative - 1	Return Event	500 years
Global Storm Event	NOAA Bridgeport (500-Year) - 500 Year		

Calculation Executive Summary

Total Inflow Volume	4,437,748.0 ft^3	Total System Volume Change	26,097.8 ft^3
Total System Outflow Volume	4,478,719.0 ft^3	Continuity Error	1.5 %
Total System Overflow Volume	0.0 ft^3	Total Pond Infiltration Volume	0.0 ft^3
Total Gutter Volume Change	(N/A) ft^3	Total N-R Iterations	12209

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.025 hours
Calculation Time Step	0.013 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft³)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	11.3	67.140	2,475,782.0	426.95	12.300
CM-2	Unit Hydrograph	SCS CN	11.3	59.220	1,962,220.0	340.31	12.325

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR PR 2-48	Conduit	1	12.400	394.53	16.01	32.76
PEPES 42	Conduit	1	12.825	316.39	16.44	29.82
CH-2	Channel	1	12.375	386.48	2.91	30.46
PO-1	Pond	1	---	---	---	32.76

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-2	Pond	1	---	---	---	29.82

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	425.80	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.325	626.88	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.400 hours

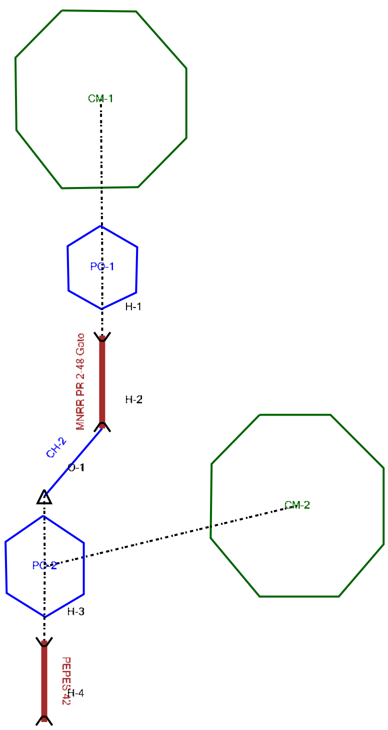
Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR PR 2-48	Circle - 48.0 in	Concrete	0.013	101.0	48.0			394.53
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			316.39

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
12.400	32.76	32.76	30.74	15.70	18.66
12.800	29.82	29.03	27.65	10.00	10.22

APPENDIX D3

Alternate 2: Twin 48" RCP Culvert with Restrictions (CivilStorm)

Scenario: NOAA Base



Calculation Executive Summary

Scenario

Label	NOAA 1-Year

Storm Event

Label	NOAA 1-Year - Rainfall Runoff Alternative - 1	Return Event	1 years
Global Storm Event	NOAA Bridgeport (1 -Year) - 1 Year		

Calculation Executive Summary

Total Inflow Volume	732,562.1 ft³	Total System Volume Change	10,553.9 ft³
Total System Outflow Volume	689,277.6 ft³	Continuity Error	4.5 %
Total System Overflow Volume	0.0 ft³	Total Pond Infiltration Volume	0.0 ft³
Total Gutter Volume Change	(N/A) ft³	Total N-R Iterations	3565

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.025 hours
Calculation Time Step	0.013 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft³)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	2.8	67.140	457,539.0	85.22	12.300
CM-2	Unit Hydrograph	SCS CN	2.8	59.220	275,080.0	49.28	12.400

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR PR 2-48 Gate	Conduit	1	12.600	53.08	9.91	32.72
PEPES 42	Conduit	1	12.925	61.43	5.13	26.70
CH-2	Channel	1	12.675	52.91	2.81	29.50

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-1	Pond	1	---	---	---	32.72
PO-2	Pond	1	---	---	---	26.70

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	85.21	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.475	92.88	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.625 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR PR 2-48 Gate	Rectangular-Round - 3.8 x 2 ft	Concrete	0.013	101.0		1.4	3.8	53.08
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			61.43

Label	Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
MNRR PR 2-48 Gate	12.625	32.72	32.72	30.33	9.54	13.92
PEPES 42	12.925	26.70	26.59	25.96	4.41	6.24

Calculation Executive Summary

Scenario

Label	NOAA 2-Year

Storm Event

Label	NOAA 2-Year - Rainfall Runoff Alternative - 1	Return Event	2 years
Global Storm Event	NOAA Bridgeport (2 -Year) - 2 Year		

Calculation Executive Summary

Total Inflow Volume	932,410.6 ft³	Total System Volume Change	7,554.6 ft³
Total System Outflow Volume	962,939.5 ft³	Continuity Error	4.0 %
Total System Overflow Volume	0.0 ft³	Total Pond Infiltration Volume	0.0 ft³
Total Gutter Volume Change	(N/A) ft³	Total N-R Iterations	3643

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.025 hours
Calculation Time Step	0.013 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft^3)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	3.3	67.140	570,882.0	105.67	12.300
CM-2	Unit Hydrograph	SCS CN	3.3	59.220	361,597.0	65.21	12.350

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR PR 2-48 Gate	Conduit	1	12.650	59.52	10.94	33.26
PEPES 42	Conduit	1	12.825	85.10	6.28	26.93
CH-2	Channel	1	12.700	59.44	2.92	29.62

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-1	Pond	1	---	---	---	33.26
PO-2	Pond	1	---	---	---	26.93

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	105.60	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.425	114.10	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.650 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR PR 2-48 Gate	Rectangular-Round - 3.8 x 2 ft	Concrete	0.013	101.0		1.4	3.8	59.52
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			85.10

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
12.650	33.26	33.26	30.49	10.70	14.70
12.950	26.93	26.84	26.34	6.08	7.29

Calculation Executive Summary

Scenario

Label	NOAA 5-Year

Storm Event

Label	NOAA 5-Year - Rainfall Runoff Alternative - 1	Return Event	5 years
Global Storm Event	NOAA Bridgeport (5 -Year) - 5 Year		

Calculation Executive Summary

Total Inflow Volume	1,431,987.0 ft^3	Total System Volume Change	14,942.7 ft^3
Total System Outflow Volume	1,412,675.0 ft^3	Continuity Error	0.3 %
Total System Overflow Volume	0.0 ft^3	Total Pond Infiltration Volume	0.0 ft^3
Total Gutter Volume Change	(N/A) ft^3	Total N-R Iterations	3293

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.025 hours
Calculation Time Step	0.013 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft³)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	4.5	67.140	849,171.0	154.72	12.300
CM-2	Unit Hydrograph	SCS CN	4.5	59.220	582,912.0	105.26	12.350

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR PR 2-48 Gate	Conduit	1	12.725	69.23	12.73	34.39
PEPES 42	Conduit	1	12.925	104.88	6.61	27.33
CH-2	Channel	1	12.775	69.21	3.09	29.70

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-1	Pond	1	---	---	---	34.39
PO-2	Pond	1	---	---	---	27.33

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	154.50	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.375	162.35	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.725 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR PR 2-48 Gate	Rectangular-Round - 3.8 x 2 ft	Concrete	0.013	101.0		1.4	3.8	69.23
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			104.88

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
12.725	34.39	34.39	30.78	12.45	15.53
12.925	27.33	27.30	26.59	6.18	7.87

Calculation Executive Summary

Scenario

Label	NOAA 10-Year

Storm Event

Label	NOAA 10-Year - Rainfall Runoff Alternative - 1	Return Event	10 years
Global Storm Event	NOAA Bridgeport (10-Year) - 10 Year		

Calculation Executive Summary

Total Inflow Volume	1,774,797.0 ft³	Total System Volume Change	7,277.0 ft³
Total System Outflow Volume	1,766,937.6 ft³	Continuity Error	0.0 %
Total System Overflow Volume	0.0 ft³	Total Pond Infiltration Volume	0.0 ft³
Total Gutter Volume Change	(N/A) ft³	Total N-R Iterations	4755

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.025 hours
Calculation Time Step	0.013 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft^3)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	5.3	67.140	1,037,595.0	187.25	12.300
CM-2	Unit Hydrograph	SCS CN	5.3	59.220	737,318.0	132.64	12.350

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR PR 2-48 Gate	Conduit	1	12.775	72.66	13.36	34.95
PEPES 42	Conduit	1	12.900	116.93	6.91	27.54
CH-2	Channel	1	12.825	72.65	3.15	29.72

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-1	Pond	1	---	---	---	34.95
PO-2	Pond	1	---	---	---	27.54

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	186.91	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.350	189.80	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.775 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR PR 2-48 Gate	Rectangular-Round - 3.8 x 2 ft	Concrete	0.013	101.0		1.4	3.8	72.66
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			116.93

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
12.775	34.95	34.95	30.94	13.06	15.51
12.925	27.54	27.52	26.75	6.56	8.25

Calculation Executive Summary

Scenario

Label	NOAA 25-Year

Storm Event

Label	NOAA 25-Year - Rainfall Runoff Alternative - 1	Return Event	25 years
Global Storm Event	NOAA Bridgeport (25-Year) - 25 Year		

Calculation Executive Summary

Total Inflow Volume	2,297,702.8 ft³	Total System Volume Change	3,609.9 ft³
Total System Outflow Volume	2,291,387.0 ft³	Continuity Error	0.1 %
Total System Overflow Volume	0.0 ft³	Total Pond Infiltration Volume	0.0 ft³
Total Gutter Volume Change	(N/A) ft³	Total N-R Iterations	4004

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.025 hours
Calculation Time Step	0.013 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft^3)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	6.5	67.140	1,322,669.0	235.72	12.300
CM-2	Unit Hydrograph	SCS CN	6.5	59.220	975,179.0	174.05	12.325

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR PR 2-48 Gate	Conduit	1	12.850	76.66	14.10	35.63
PEPES 42	Conduit	1	12.975	132.54	7.33	27.81
CH-2	Channel	1	12.900	76.66	3.21	29.74

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-1	Pond	1	---	---	---	35.63
PO-2	Pond	1	---	---	---	27.81

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	235.22	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.325	228.72	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.850 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR PR 2-48 Gate	Rectangular-Round - 3.8 x 2 ft	Concrete	0.013	101.0		1.4	3.8	76.66
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			132.54

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
12.850	35.63	35.63	31.14	13.78	15.46
12.950	27.81	27.80	26.93	7.02	8.68

Calculation Executive Summary

Scenario

Label	NOAA 50-Year

Storm Event

Label	NOAA 50-Year - Rainfall Runoff Alternative - 1	Return Event	50 years
Global Storm Event	NOAA Bridgeport (50-Year) - 50 Year		

Calculation Executive Summary

Total Inflow Volume	2,694,471.0 ft³	Total System Volume Change	19,281.3 ft³
Total System Outflow Volume	2,678,231.5 ft³	Continuity Error	0.1 %
Total System Overflow Volume	0.0 ft³	Total Pond Infiltration Volume	0.0 ft³
Total Gutter Volume Change	(N/A) ft³	Total N-R Iterations	4270

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.025 hours
Calculation Time Step	0.013 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft^3)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	7.4	67.140	1,537,716.0	271.86	12.300
CM-2	Unit Hydrograph	SCS CN	7.4	59.220	1,156,918.0	205.34	12.325

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR PR 2-48 Gate	Conduit	1	12.900	79.16	14.55	36.08
PEPES 42	Conduit	1	13.000	142.29	7.61	27.99
CH-2	Channel	1	12.950	79.15	2.55	29.75

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-1	Pond	1	---	---	---	36.08
PO-2	Pond	1	---	---	---	27.99

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	271.24	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.325	257.42	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.900 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR PR 2-48 Gate	Rectangular-Round - 3.8 x 2 ft	Concrete	0.013	101.0		1.4	3.8	79.16
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			142.29

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
12.900	36.08	36.08	31.26	14.23	15.41
12.950	27.99	27.99	27.04	7.39	8.94

Calculation Executive Summary

Scenario

Label	NOAA 100-Year

Storm Event

Label	NOAA 100-Year - Rainfall Runoff Alternative - 1	Return Event	100 years
Global Storm Event	NOAA Bridgeport (100-Year) - 100 Year		

Calculation Executive Summary

Total Inflow Volume	3,093,946.0 ft³	Total System Volume Change	13,961.4 ft³
Total System Outflow Volume	3,079,679.5 ft³	Continuity Error	0.0 %
Total System Overflow Volume	0.0 ft³	Total Pond Infiltration Volume	0.0 ft³
Total Gutter Volume Change	(N/A) ft³	Total N-R Iterations	4546

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.025 hours
Calculation Time Step	0.013 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft^3)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	8.3	67.140	1,753,476.0	307.85	12.300
CM-2	Unit Hydrograph	SCS CN	8.3	59.220	1,340,658.0	236.61	12.325

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR PR 2-48 Gate	Conduit	1	12.950	81.44	14.97	36.50
PEPES 42	Conduit	1	12.925	150.81	7.89	28.16
CH-2	Channel	1	13.000	81.43	1.71	29.76

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-1	Pond	1	---	---	---	36.50
PO-2	Pond	1	---	---	---	28.16

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	307.10	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.325	285.66	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.950 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR PR 2-48 Gate	Rectangular-Round - 3.8 x 2 ft	Concrete	0.013	101.0		1.4	3.8	81.44
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			150.81

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
12.950	36.50	36.50	31.38	14.64	15.36
12.975	28.16	28.16	27.14	7.84	9.16

Calculation Executive Summary

Scenario

Label	NOAA 500-Year

Storm Event

Label	NOAA 500-Year - Rainfall Runoff Alternative - 1	Return Event	500 years
Global Storm Event	NOAA Bridgeport (500-Year) - 500 Year		

Calculation Executive Summary

Total Inflow Volume	4,437,751.0 ft³	Total System Volume Change	937,287.1 ft³
Total System Outflow Volume	2,026,214.4 ft³	Continuity Error	33.1 %
Total System Overflow Volume	4,559.0 ft³	Total Pond Infiltration Volume	0.0 ft³
Total Gutter Volume Change	(N/A) ft³	Total N-R Iterations	17197

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.025 hours
Calculation Time Step	0.013 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft^3)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1	Unit Hydrograph	SCS CN	11.3	67.140	2,475,782.0	426.95	12.300
CM-2	Unit Hydrograph	SCS CN	11.3	59.220	1,962,220.0	340.31	12.325

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR PR 2-48 Gate	Conduit	1	2.775	1.84	1.82	38.00
PEPES 42	Conduit	1	12.775	148.12	7.80	28.10
CH-2	Channel	1	13.650	5.96	0.35	28.22

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
PO-1	Pond	1	---	---	---	38.00
PO-2	Pond	1	---	---	---	28.10

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	427.44	---	---	---	---	12.175	0.11
PO-2	Pond	1	12.325	308.58	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.175 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR PR 2-48 Gate	Rectangular-Round - 3.8 x 2 ft	Concrete	0.013	101.0		1.4	3.8	1.84
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			148.12

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
12.175	38.00	38.00	38.06	-0.30	-0.30
12.775	28.10	27.23	26.57	6.07	7.65

APPENDIX E

TEMPORARY FACILITIES & FLOOD CONTINGENCY

TEMPORARY FACILITIES

TEMPORARY FACILITIES

The 48" pipes will be jacked through the existing railroad embankment to minimize impact to the railroad service above. Work will be completed in two (2) stages. Design Plans, provided under separate cover, detail the method of construction to accomplish the work, provide protection of the work during construction and minimize impacts to the natural resources.

STAGE 1

Stage 1 consists of the installation of access roads, jacking of both 48" RCP culvert cells, construction of new headwall and endwall structures, installation of interim structure modifications, and installation of precast concrete block revetment. This stage is anticipated to be completed in 4-6 weeks, with the critical pipe jacking phase to be completed in less than 2 weeks.

Upstream of the railroad corridor, flows will be diverted through the construction site using 24" bypass pipes and cofferdams and will discharge to the existing 2' stone culvert. Cofferdams will be set at elevation 31.50 to divert flows into the bypass pipe and contain water surface elevations within the surrounding stream channel and wetland areas. Higher flows will be allowed to overtop the cofferdams to minimize any increase in upstream flooding.

The existing 2' stone culvert will discharge to a 24" bypass pipe and cofferdam system to direct flow through the construction site. At the upstream side, the water diversion barrier top elevation will be set to 31.50. At the outlet of the 24" bypass pipe, a water diversion barrier will be set to a top elevation of 29.4.

STAGE 2

Stage 2 consists relocating cofferdams and rerouting bypass piping through the newly installed 48" culvert pipes to allow for placement of streambed material, abandoning the existing 2' stone culvert and regrading railroad embankment slopes.

The same 24" diameter HDPE bypass piping and cofferdam heights will be used as Stage 1.

HYDRAULIC MODELING

As temporary facilities will utilize the existing culvert, a modified existing conditions model was created to analyze the temporary conditions. The watershed was divided into 2 subareas, CM-1A, which consists of the western portion of the watershed draining to the 24" bypass pipe through the pipe jacking area, and CM-1B, which consists of the eastern portion of the watershed draining to the existing 2' stone culvert.

In accordance with the Chapter 6, Appendix F of the Drainage Manual, "Hydrology for Temporary Facilities," the temporary design frequency for in-stream work (10 weeks) was estimated to be slightly less than a 2-year design frequency. For this location, discharge through the existing 2' stone culvert is the only feasible option for water handing and use of a 2-year design frequency for temporary conditions would result in unreasonable backwater elevations and the potential for flooding of private property upstream.

Further analysis was performed to determine the water handling needs for the duration of critical work items, such as pipe jacking and installation of the headwall and endwall, and the associated design risk. The estimated duration to complete the critical work items included under Stage 1 is 4 – 6 weeks. These critical items can be further broken down into specific items that will need to be completed in sequence with minimal risk of flooding. These items include:

- Installation of pipe jacking pit – 1 week max.
- Pipe jacking – 2 week max.
- Installation of headwall and endwall – 3 week max.
- Installation of interm structure modifications – 1 week max.
- Installation of concrete block revetment – 1 week max.

Each of the above items can be scheduled by the contractor to accommodate seasonal flows and projected storm events to ensure minimal disruption to operations.

Therefore, the water handling plan has been designed to accommodate flows less than a 2-year design storm. Consideration was given to a flow ten times the Average Spring Flow of 4.0 CFS (0.4 CFS x 10). However, as precipitation rates are not published for storm events <1-year, a storm event with a precipitation depth of 1.50" over a 24-hour period was used as a conservative measure.

Under the resulting temporary storm event, the 24" bypass pipe will accommodate a flow of 10.33 cfs with an upstream water surface elevation of 31.12 and the existing 2' stone culvert will accommodate a flow of 24.12 cfs at a water surface elevation of 31.03. Temporary cofferdams, such as sand bags, will be set at elevation 31.50 and will allow for overtopping under larger events.

WATER HANDLING

Proper sediment and erosion control measures will be installed and maintained until the project site is completely stabilized. Dewatering activities from the jacking pits will be discharged into a sedimentation basin. The sedimentation basin will be located outside of the channel and wetlands.

Water handling will be administered during construction under the Best Management Practices outlined in CTDOT Form 817.

FLOOD CONTINGENCY

GENERAL

During construction of the twin 48” RCP pipe culvert, the hydraulic capacity of the existing structure and bypass piping will not provide for large storm events at times. This flood contingency plan has been developed for general safety.

Construction Flood Contingency Operation Plan

All construction activities will be in accordance with CTDOT Form 817 section 1.10.03 Environmental Compliance “Required Best Management Practices” including but not limited to Item No. 9 which states:

“Whenever possible, work within or adjacent to watercourses shall be conducted during periods of low flow. The Engineer shall remain aware of flow conditions during the conduct of such work, and shall order such work stopped if flow conditions threaten to cause excessive erosion, siltation or turbidity. Before predicted major storms (i.e., a storm predicted by NOAA Weather Service, with warnings of flooding, severe thunderstorms, or similarly severe weather conditions or effects), the Contractor shall make every effort to secure the Site to the satisfaction of the Engineer. Unless allowed by a DEEP permit, the Contractor shall store no materials and place no staging areas below the 100-year elevation. The Contractor shall not store below the 500-year flood level any materials which are buoyant, hazardous, flammable, explosive, soluble, expansive, radioactive, and any other materials that could be injurious to human, animal or plant life in the event of a flood.”

The following Operation Plan shall be implemented:

a. The Office of Rail or Representative Engineer shall monitor weather conditions when a storm is forecasted.
b. The Contractor shall be immediately notified of the possibility of flooding conditions at the project site.
c. The Contractor shall make every effort to secure the work site prior to the onset of flooding.

Post Construction Flood Contingency Operation Plan

The proposed culvert is designed to pass the 100-year storm without overtopping the railroad. In the situation that a storm event greater than the 100-year frequency storm should occur, appropriate measures should be taken to ensure the safety of daily trains, surrounding properties, and downstream roadway crossings. During such a storm event, the channel and the subject crossing should be monitored. In the instance that the River should present a direct hazard to residents, travelers by or the railroad, notification should be made and the line temporarily shut down until water recedes.

Appendix F – Hydrology for Temporary Facilities

Step 1: Determine Impact Ratings

The following selection factors are rated considering their severity as 1, 2, or 3 for low, medium or high conditions.

Potential Loss of Life - If inhabited structures, permanent or temporary, can be inundated or are in the path of a flood wave caused by an embankment failure, then this item will have a multiple of 15 applied. If no possibility of the above exists, then loss of life will be the same as the severity used for the A.D.T.

Property Damages - Private and public structures (houses, commercial, or manufacturing); appurtenances such as sewage treatment and water supply; utility structures either above or below ground, are to have a multiple of 10 applied. Active cropland, parking lots, recreational areas are to have a multiple of 5 applied. All other areas shall use the severity determined by site conditions.

Traffic Interruption - Includes consideration for emergency supplies and rescue; delays; alternate routes; busses; etc. Short duration flooding of a low volume roadway might be acceptable. If the duration of flooding is long (more than a day), and there is a nearby good quality alternate route, then the flooding of a higher volume highway might also be acceptable. The severity of this component is determined by the detour length multiplied by the average daily traffic projected for bi-directional travel.

Detour Length - The length in kilometers (miles) of an emergency detour by other roads should the temporary facility fail.

Height Above Streambed - The difference in elevation in meters (feet) between the traveled roadway and the bed of the waterway.

Drainage Area - The total area contributing runoff to the temporary facility, in km^2 (mi^2).

Average Daily Traffic - The average amount of vehicles traveling bi-directional through the area in a 24-h period.

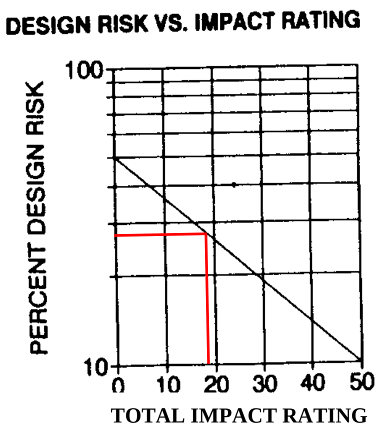
RATING SELECTION

Factor	Rating		
	1	2	3
Loss of Life	See Instructions		
Property Damage	See Instructions		
Traffic Interruptions	< 2000	2000-4000	> 4000
Detour Length, km (mi)	< 8 (< 5)	8-16 (5-10)	> 16 (> 10)
Height Above Streambed, m (ft)	< 3 (< 10)	3-6 (10-20)	> 6 (> 20)
Drainage Area, km^2 (mi^2)	< 2.6 (< 1)	2.6-26.0 (1-10)	> 26.0 (> 10)
Rural ADT	< 400	400-1500	> 1500
Suburban ADT	< 750	750-1500	> 1500
Urban ADT	< 1500	1500-3000	> 3000

IMPACT RATING TABLE

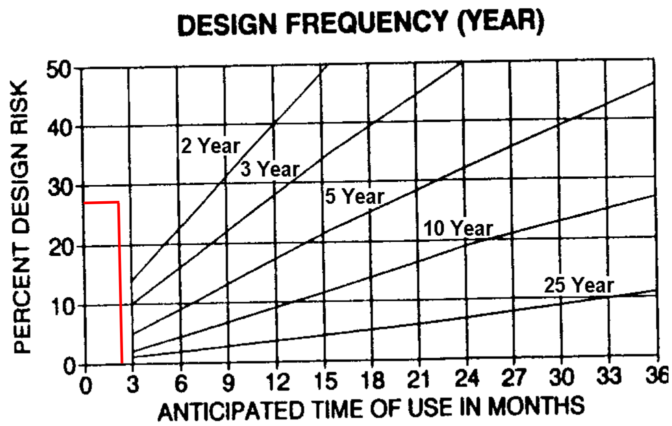
Loss of Life Rating (See Instructions)=	3
Property Damage Rating (See Instructions) =	3
Traffic Interruption Rating =	3
Detour Length Rating =	3
Height Above Streambed Rating =	2
Drainage Area Rating =	1
Average Daily Traffic Rating =	3
Total Impact Rating = (sum of the above) =	18

Step 2: Determine risk percentage



Percent Design Risk = 27

Step 3: Determine Temporary Design Frequency



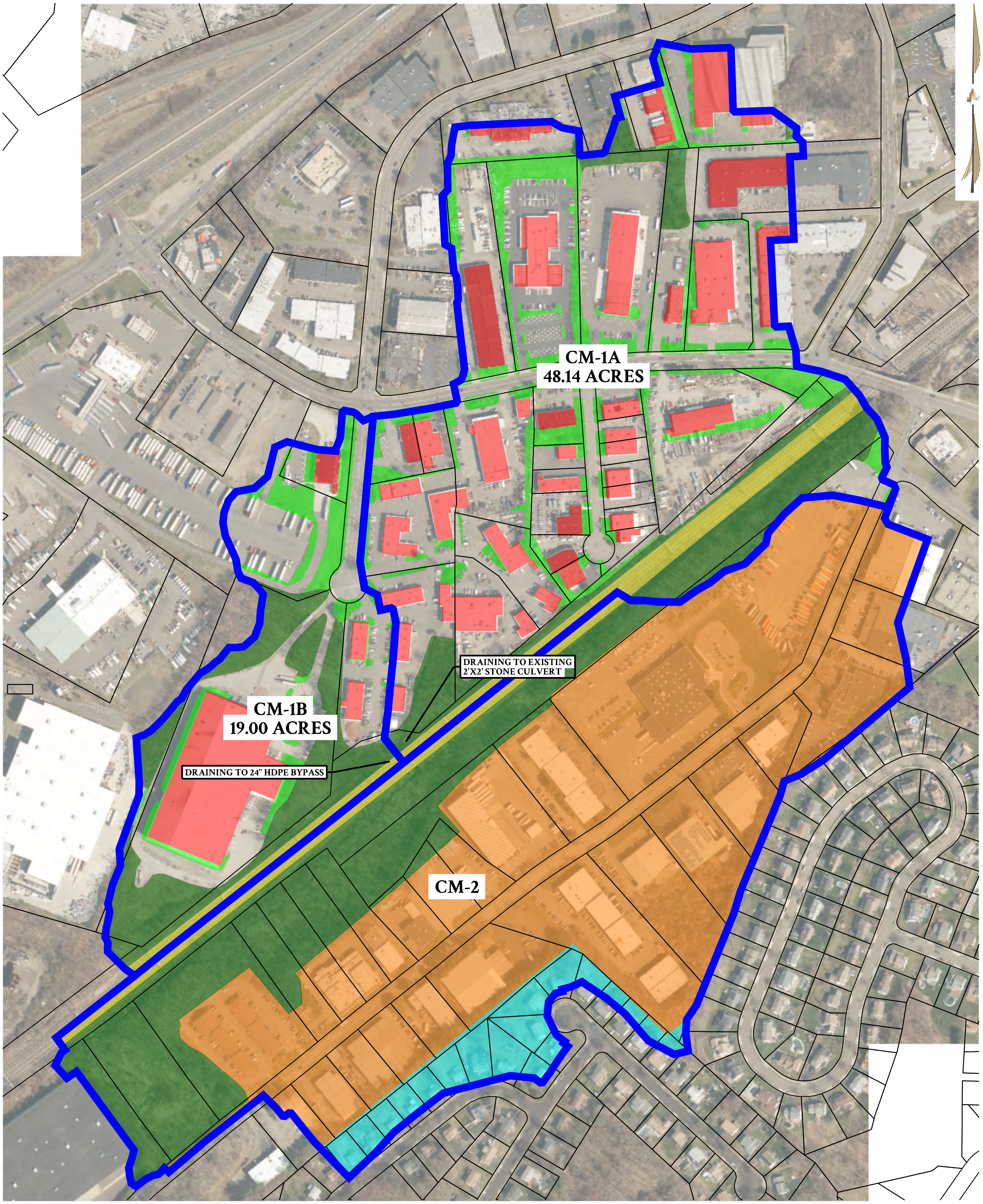
(for temporary facility)

Design Frequency = 10x Avg. Spng **years**

Step 4: Determine Temporary Design Discharge

A. If sufficient discharges have been developed either by the designer or a Flood Insurance Study, then the Temporary Design Discharge should be taken either directly or from a frequency curve plot of the data, based on the design frequency determined in Step 3. Enter the Temporary Design Discharge below. *If Discharge – Frequency information is unavailable, proceed to Step 4 B.*

Temporary Design Discharge = 0.11 **m^3/s (** 10 x 0.4 = 4 **cfs)**



SCALE: 1"= 400'
400 0 400

DATE
11/8/17

SHEET
1 OF 1

YRC

CONTACT INFORMATION

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CULVERT REPLACEMENT - MP 65.60

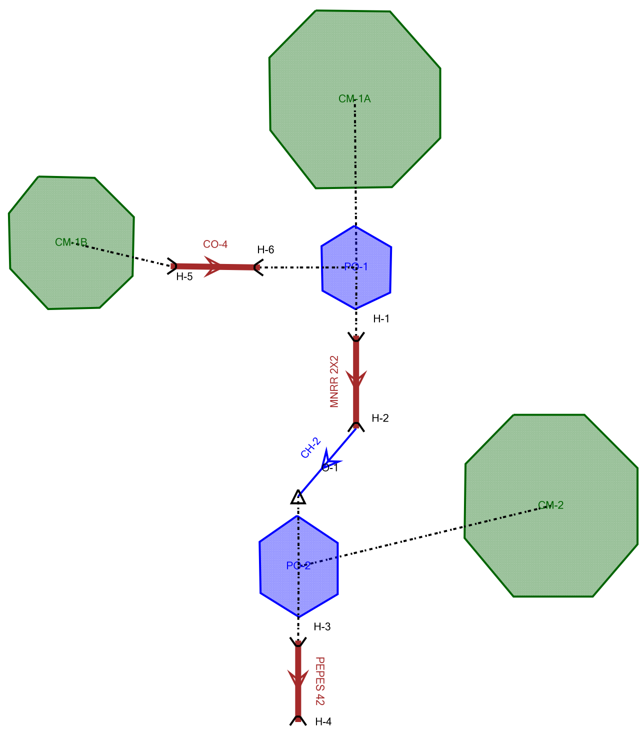
CONNECTICUT DEPARTMENT OF TRANSPORTATION

AREA MAP - TEMP CCONDITIONS

NEW HAVEN MAINLINE

MILFORD, CT

Scenario: NOAA Temp1.5



Calculation Executive Summary

Scenario

Label	NOAA Temp1.5

Storm Event

Label	NOAA Temp1.5 - Rainfall Runoff Alternative - 1	Return Event	0 years
Global Storm Event	NOAA Bridgeport (Temporary 1.5in) - 0 Year		

Calculation Executive Summary

Total Inflow Volume	260,262.1 ft³	Total System Volume Change	5,173.8 ft³
Total System Outflow Volume	255,317.5 ft³	Continuity Error	0.1 %
Total System Overflow Volume	0.0 ft³	Total Pond Infiltration Volume	0.0 ft³
Total Gutter Volume Change	(N/A) ft³	Total N-R Iterations	2683

Calculation Detailed Summary

<General>

Label	Base Calculation Options	Output Increment	0.025 hours
Calculation Time Step	0.013 hours	Duration	24.000 hours

Implicit Engine

Virtual Flow Depth	0.040 ft	NR Weighting Coefficient	0.700
Y Iteration Tolerance	0.03 ft	Relaxation Weighting Coefficient	0.600
LPI Coefficient	1.000	Computation Distance	50.00 ft

Inlets

Neglect Side Flow?	False	Active Components for Combination Inlets In Sag	Grate and Curb
Neglect Gutter Cross Slope For Side Flow?	False	Active Components for Combination Inlets on Grade	Grate and Curb

Catchment Calculation Summary

Label	Runoff Method	Loss Method	Total Rainfall Depth (in)	Area (User Defined) (acres)	Volume (Total Runoff) (ft^3)	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)
CM-1A	Unit Hydrograph	SCS CN	1.5	48.140	128,653.0	24.07	12.325
CM-2	Unit Hydrograph	SCS CN	1.5	59.220	80,785.0	13.12	12.400
CM-1B	Unit Hydrograph	SCS CN	1.5	19.000	50,850.0	10.77	12.225

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
MNRR 2X2	Conduit	1	12.550	24.12	6.05	31.03
PEPES 42	Conduit	1	12.825	28.24	4.36	25.84
CO-4	Conduit	1	12.225	10.33	3.77	31.12

General Calculation Summary

Label	Element Type	Branch	Time (Maximum Flow) (hours)	Flow (Maximum) (cfs)	Velocity (Maximum Calculated) (ft/s)	Hydraulic Grade (Maximum) (ft)
CH-2	Channel	1	12.625	24.02	2.20	28.79
PO-1	Pond	1	---	---	---	31.03
PO-2	Pond	1	---	---	---	25.84

Node Calculation Summary

Label	Element Type	Branch	Time to Maximum Inflow (hours)	Flow (Total In Maximum) (cfs)	Time To Maximum Inlet Flow (hours)	Flow (Surface Maximum) (cfs)	Time To Maximum Captured Flow (hours)	Flow (Captured Maximum) (cfs)	Time to Maximum Overflow (hours)	Flow (Overflow Maximum) (cfs)
O-1	Outfall	0	(N/A)	(N/A)	---	---	---	---	(N/A)	(N/A)
PO-1	Pond	1	12.300	33.58	---	---	---	---	0.000	0.00
PO-2	Pond	1	12.550	34.66	---	---	---	---	0.000	0.00

Gutter Calculation Summary

Label	Gutter Shape	Flow (Maximum) (cfs)	Time (Maximum Flow) (hours)	Velocity (Maximum Calculated) (ft/s)

FlexTable: Conduit Report

Current Time: 12.300 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR 2X2	Box - 2.0 x 2.0 ft	Stone masonry	0.019	90.0		2.0	2.0	24.12
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			28.24
CO-4	Circle - 24.0 in	Corrugated HDPE (Smooth Interior)	0.012	50.0	24.0			10.33

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
12.550	31.03	30.72	29.22	5.51	6.17
12.900	25.84	25.39	25.10	2.99	3.74
12.300	31.12	31.12	30.73	3.51	3.18

FlexTable: Conduit Report

Current Time: 12.550 hours

Label	Conduit Description	Material	Manning's n	Length (User Defined) (ft)	Diameter (in)	Rise (ft)	Span (ft)	Flow (Maximum) (cfs)
MNRR 2X2	Box - 2.0 x 2.0 ft	Stone masonry	0.019	90.0		2.0	2.0	24.12
PEPES 42	Circle - 42.0 in	Concrete	0.013	50.0	42.0			28.24
CO-4	Circle - 24.0 in	Corrugated HDPE (Smooth Interior)	0.012	50.0	24.0			10.33

Time to Maximum Hydraulic Grade (hours)	Hydraulic Grade (Maximum) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Velocity (In) (ft/s)	Velocity (Out) (ft/s)
12.550	31.03	31.03	29.40	6.03	6.70
12.900	25.84	25.71	25.32	2.96	3.98
12.300	31.12	31.08	31.04	2.12	1.91

APPENDIX F

CHANNEL DESIGN

CHANNEL DESIGN

STORM EVENT	VELOCITY[1] (FT/S) UPSTREAM OF MNRR			VELOCITY[1] (FT/S) DOWNSTREAM OF MNRR		
	EXISTING	ALT 1: (2) 48”	ALT 2: GATE	EXISTING	ALT 1: (2) 48”	ALT 2: GATE
1-year	8.57	6.75	9.54	8.57	5.87	13.92
2-year	9.15	8.18	10.70	9.15	7.16	14.70
5-year	10.05	8.47	12.45	10.05	9.55	15.53
10-year	10.46	9.22	13.06	10.46	11.00	15.51
25-year	10.98	11.24	13.78	10.98	13.29	15.46
50-year	11.32	11.79	14.23	11.32	14.33	15.41
100-year	**11.65**	**12.70**	**14.64**	**11.65**	**15.95**	**15.36**
500-year	- [2]	15.70	- [2]	- [2]	18.66	- [2]

[1] Velocity obtained from MNRR Conduit Report In & Out
[2] No velocity reported at full capacity

To address increases in velocity resulting from improved roughness coefficients, increased hydraulic capacity, and reduction of backwater conditions at MNRR, revetment is required at the inlet and outlet. Design considerations in selecting the revetment included material sizing, maintenance and channel disturbance/wetland impact.

Articulating concrete blocks (ACB) with an open-cell block are proposed to meet the project needs. The blocks significantly reduce the required thickness of revetment and resulting disturbance as compared to rip rap and open-cell construction will promote growth of natural vegetation in the overbank conditions. The ACB system will be placed on a geotextile and granular fill to match the existing channel grade, extend up the side slopes of the channel and natural floodplain, and terminated at the ends to minimize the potential for erosion or scour to undermine the ends.

The proposed precast concrete block revetment system will consist of Armorflex Class 50 Large ACB’s tied with a revetment cable to create a continuous mat. Calculations, installation guide and Armorflex ACB System Specifications follow. Plans and details are provided under separate cover.

Factor of Safety
Hydraulic Analysis

These calculations are an application of the Moment Stability Analysis technique presented in Julien (2010) and as illustrated in the NCMA Manual (2010), listed in the References.
The factor of safety method is used in the selection of block sizes for ACB's for revetments or bed armor.
The following assumes that hydraulic testing has been performed for the block system to quantify a critical shear stress; the use of Manning's equation conservatively assumes normal depth and critical velocity.

References

1. Julien, Pierre Y. (2010) "Erosion and Sedimentation", 2nd Edition, Cambridge University Press

2. National Concrete Masonry Association (2010), "Design Manual for Articulating Concrete Block (ACB) Revetment Systems", NCMA Publication TR220A.

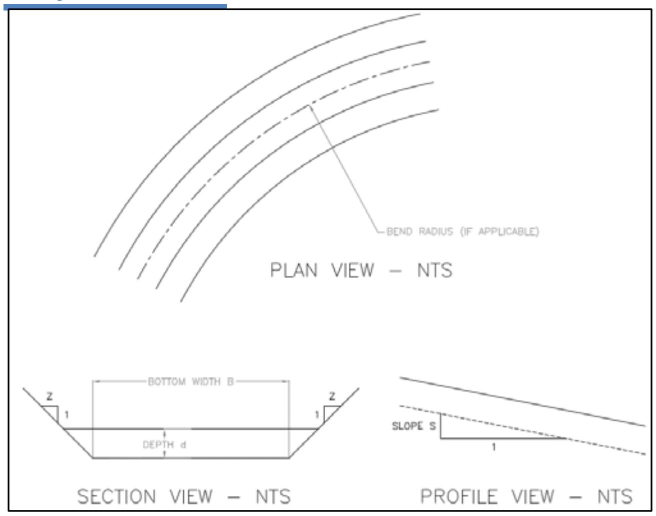
3. USDOT Federal Highway Administration Hydraulic Engineering Circular No. 15, Third Edition (2005) "Design of Roadside Channels with Flexible Linings", National Highway Institute.

4. FHWA Hydraulic Engineering Circular No. 23: Bridge Scour and Stream Instability Countermeasures: Experience, Selection and Design Guidance - Third Edition, Volume II, Design Guideline 8.

5. ASTM D 7276 & D7277 Testing and Analysis Compliant

Factor of Safety
Hydraulic Analysis

Project Data



Channel Bottom Width, B	8	ft
Bed Slope, S_o	0.006	ft/ft
Friction Slope, S	0.006	ft/ft
Left Side Slope, Z_L	2	(_H:1V)
Right Side Slope, Z_R	2	(_H:1V)
Bend Radius, r	0	ft
Depth of Flow d	3.42	ft

The Depth of Flow is varied iteratively to obtain a given volumetric flow rate.

Top Surface Width ,T	21.68	ft

Other Constants

Unit Weight of Water, γ	62.4	pcf
Unit Wt. of Concrete, Dry-Cast	130	pcf
Sp. Gr. Of Concrete, S_c	2.083	--
Gravitational Constant, g	32.2	ft/s^2

Calculated Channel Geometry Factors

Flow Area, A	50.78	ft^2
Wetted Perimeter, P	23.30	ft
Hydraulic Radius = R_H = A/P =	2.18	ft
Bend Coefficient, K_b	1	--
Froude Number, Fr	1.52	--
Flow Type	Supercritical	
Largest Side Slope Angle, θ_1	26.565	°
Bed Slope Angle, θ_0	0.344	°

Volumetric Flow Rate, Q	307.00	cfs

The Volumetric Flow Rate is determined using Manning's equation:

$Q = 1.486 / (n * A * R^{2/3} * S^{1/2})$

Velocity, V	15.95	ft/sec

ArmorFlex Block parameters

Class	50-L
SF	1.83

ϑ_1	0.250	ft
ϑ_2	1.222	ft
ϑ_3	0.400	ft
ϑ_4	1.222	ft

Weight	116.0	lbs
Width	1.967	ft
τ_c	22.1	psf
ΔZ	0.5	in
n	0.032	--

ARMORTEC
Erosion Control Solutions

Factor of Safety
Hydraulic Analysis

Detailed Calculations — REFERENCE

Flow Area, $A = A_L + A_B + A_R$

$A_L = ½ * d^2 * Z_L =$	11.70	ft^2	
$A_B = B * d =$	27.37	ft^2	
$A_R = ½ * d^2 * Z_R =$	11.70	ft^2	
$A =$	50.78	ft^2	

Wetted Perimeter, $P = P_L + P_B + P_R$

$P_L = d * (Z_L^2 +1)^{0.5} =$	7.65	ft	
$P_B = B =$	8	ft	
$P_R = d * (Z_R^2 +1)^{0.5} =$	7.65	ft	
$P =$	23.30	ft	

Volumetric Flow Rate, Q

$Q = 1.486 / n * A * R_H^{2/3} * S^{1/2} =$	307.00	cfs	(Ref. 3 Eqn. 2.1)

Compute Factor of Safety Parameters

Submerged Weight, W_s	$W_s = W * ((S_c – 1) / S_c) =$	60.3	lb	(Ref. 2 Eqn 4.13a)
Applied Shear Stress, τ_o	$\tau_o = \gamma * d * S_o =$	1.28	psf	(Ref. 3 Eqn. 2.4)

Bend Coefficient Calculation

X = r/B = (Constrained to between 1.984 and 10)	1.984	--	
Calculated $K_b = 2.38-0.206(X)+0.0073(X)^2 =$	2.00	--	(Ref. 3 Eqn. 3.7)
Constrained K_b: $1.05 \le K_b \le 2$ →	1.00		

(If no bend radius is present, $K_b = 1$)

Step 1: Compute Factor of Safety Parameters

(Design Shear Stress)	$\tau_o = K_b \gamma y \sin(\tan^{-1} S_o) =$	1.28	lbs/ft^2	(Ref. 3 Eqn 3.1 & 3.6)
(Stability Number for Horizontal Surface)	$\eta_o = \tau_0 / \tau_c =$	0.06	--	(Ref. 2 Eqn 4.12a)
	$a_\theta = (\cos^2\theta_1 – \sin^2\theta_0)^{1/2} =$	0.89	°	(Ref. 2 Eqn 4.10a)
	$\theta = \arctan((\sin\theta_0 * \cos\theta_1) / (\sin\theta_1 * \cos\theta_0) =$	0.7	°	(Ref. 2 Eqn 4.9a)
	$\beta = \arctan((\cos(\theta_0 + \theta) / ((\vartheta_4 / \vartheta_3 +1) * (1 - a_\theta^2)^{1/2} / (\eta_o * \vartheta_2/\vartheta_1) + \sin(\theta_0 + \theta)) =$	8.87	°	(Ref. 2 Eqn 4.8a)
(Stability Number for Slope Surface)				
	$\eta_1 = ((\vartheta_4 / \vartheta_3 + \sin(\theta_0 + \theta + \beta)) / (\vartheta_4 / \vartheta_3 + 1)) * \eta_o =$	0.05	--	(Ref. 2 Eqn 4.7a)
	$\delta = 90^o - \beta - \theta =$	80.44	°	(Ref. 2 Eqn 4.6a)

Step 2: Consider Effects for Specified Projection (Assumes lift and drag forces are equal)

$F_L' = F_D' = 0.5\Delta Zb\rho V_{des}^2 =$	20.22	lbs	(Ref. 2 Eqn. 2.2)

Step 3: Compute Factor of Safety

$SF = (\vartheta_2/\vartheta_1 * a_\theta) / ((1 - a_\theta^2)^{1/2} * \cos\beta + \eta_1 * (\vartheta_2/\vartheta_1) + (\vartheta_3 * F_D' * \cos\delta + \vartheta_4 * F_L') / (\vartheta_1 * W_s)) =$

1.83	--	(Ref. 2 Eqn 4.5a)

Detailed Calculations

If H = horizontal component of side slope, then $\theta_1 = \tan^{-1}(1/H)$
If S = bed slope, then $\theta_0 = \tan^{-1}(S)$

For τ_o:

$\tan^{-1} S_o =$	0.34	$\sin(\tan^{-1} S_o) =$	0.006

For a_θ:

$\cos\theta_1 =$	0.894	$\cos^2\theta_1 =$	0.800
$\sin\theta_0 =$	0.006	$\sin^2\theta_0 =$	0.000

For θ:

$\sin\theta_0 * \cos\theta_1 =$	0.005	$(\sin\theta_0 * \cos\theta_1) / (\sin\theta_1 * \cos\theta_0) =$	0.012
$\sin\theta_1 =$	0.447		
$\cos\theta_0 =$	1.000		
$\sin\theta_1 * \cos\theta_0 =$	0.447		

For β:

$\cos(\theta_0 + \theta) =$	1.000	$(\vartheta_4 / \vartheta_3 + 1) * (1 - a_\theta^2)^{1/2} / (\eta_o * \vartheta_2 / \vartheta_1) =$	6.3876
$\vartheta_4 / \vartheta_3 + 1 =$	4.055	$(\vartheta_4 / \vartheta_3 + 1) * (1 - a_\theta^2)^{1/2} / (\eta_o * \vartheta_2 / \vartheta_1) + \sin(\theta_0 + \theta) =$	6.406
$(1 - a_\theta^2)^{1/2} =$	0.447	$\cos(\theta_0 + \theta) / ((\vartheta_4 / \vartheta_3 + 1) * (1 - a_\theta^2)^{1/2} / (\eta_o * \vartheta_2 / \vartheta_1) + \sin(\theta_0 + \theta)) =$	0.1561
$\eta_o * \vartheta_2 / \vartheta_1 =$	0.284		
$\sin(\theta_0 + \theta) =$	0.018		

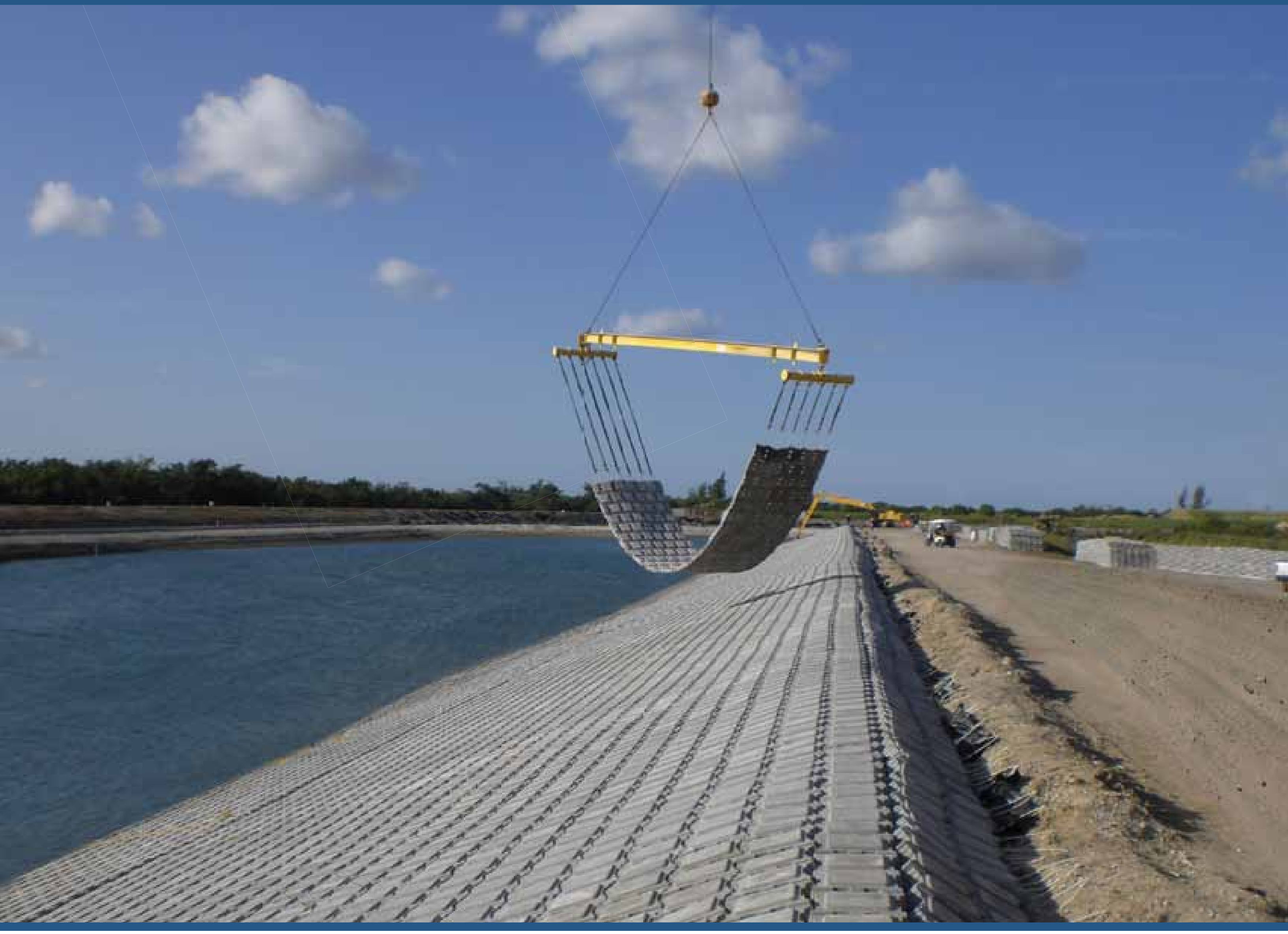
For η_1:

$\vartheta_4 / \vartheta_3 =$	3.055	$\vartheta_4 / \vartheta_3 + \sin(\theta_0 + \theta + \beta) =$	3.227
$\sin(\theta_0 + \theta + \beta) =$	0.172	$(\vartheta_4 / \vartheta_3 + \sin(\theta_0 + \theta + \beta)) / (\vartheta_4 / \vartheta_3 + 1) =$	0.7958
$\vartheta_4 / \vartheta_3 + 1 =$	4.055		
$\eta_o =$	0.058		

For SF:

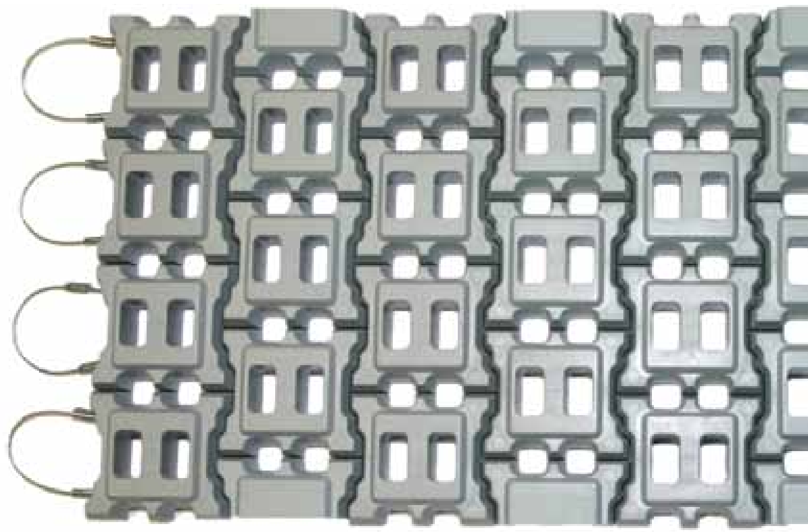
$\vartheta_2/\vartheta_1 * a_\theta =$	4.372	$(\vartheta_3 * F_D' * \cos\delta + \vartheta_4 * F_L') / (\vartheta_1 * W_s) =$	1.727
$(1 - a_\theta^2)^{1/2} * \cos\beta =$	0.442	$(1 - a_\theta^2)^{1/2} * \cos\beta + \eta_1 * (\vartheta_2/\vartheta_1) + (\vartheta_3 * F_D' * \cos\delta + \vartheta_4 * F_L') / (\vartheta_1 * W_s) =$	2.3953
$\eta_1 * (\vartheta_2/\vartheta_1) =$	0.226		
$\cos\delta =$	0.166		
$\vartheta_3 * F_D' * \cos\delta + \vartheta_4 * F_L' =$	26.054		
$\vartheta_1 * W_s =$	15.082		

ArmorFlex® Installation Guide



Erosion Control Solutions

ArmorFlex® Installation Guide



The purpose of the ArmorFlex Installation Guide is to provide recommendations for the proper installation of Articulating Concrete Block (ACB) revetment systems. While this guide offers a set of instructions for performing those operations that are critical for the proper functioning of ACB revetment systems, final preparation and installation is the responsibility of the end user. Additional information is contained in ASTM D6884 Standard Practice for Installation of Articulating Concrete Block (ACB) Revetment Systems.

The proper installation of ACB revetment systems is important to achieving the intended hydraulic performance and maintaining stability against the erosive forces of flowing water. An ACB revetment system consists of a suitably prepared and compacted subgrade, a suitable site-specific filter fabric and properly sized ACB block mattresses placed in "intimate contact" with the filter fabric and subgrade. Each individual site will vary so it is important to follow the engineering project drawings as designed and sealed by a registered Professional Engineer; particularly as they relate to standard termination details. All illustrations and photographs used in this guide are examples of typical situations.

It is the Contractor's responsibility to maintain safe work practices consistent with OSHA (Occupational Safety and Health Administration) regulations and other prevailing safe work practices. This guide is intended to be used in conjunction with all applicable safety regulations and safe work practices and is in no way a replacement thereof.

Site Planning & Preparation

Foundation Preparation

Areas on which filter fabric and ACB units are to be placed shall be constructed to the lines and grades shown on the contract drawings to the tolerances specified in the contract documents and approved by the engineer. All areas to receive the ACB shall be compacted and graded smooth to facilitate the installation of the articulated concrete block system and ensure that intimate contact (between the slope face, the filter fabric and the entire bottom surface of the ACB units) is maintained throughout the system.

Unsatisfactory soils (soils having excessive in-place moisture content, soils containing clods, roots, or other organic material that impair the local slope face) must be removed, replaced with approved material and compacted to a minimum 90% of Standard Proctor density (Test Method D698).

Holes, "pockmarks", slope board teeth marks, footprints or other voids greater than 1 inch in depth normal to the local slope face shall not be permitted. No grooves or depressions greater than 0.5 inches in depth normal to the local slope face with a dimension exceeding 1 foot in any direction shall be permitted. Where such areas are evident, they shall be brought to grade by placing compacted homogeneous material. The slope and slope face shall be uniformly compacted, and the Engineer shall determine the depth of layers, homogeneity of soil, and amount of compaction required. If differing block heights are used — the slope is to be prepared so that the tops of the blocks are flush.

Care shall be exercised so as not to excavate below the grades shown on the Engineer's Contract Drawings, unless directed by the Engineer to remove unsatisfactory materials. Excavation of subgrade shall not be more than 2 inches (50 mm) below specified grade. In such areas, placing and compacting approved material, in order to get up to specified grade, in layers not exceeding 6 inches (150 mm) is required. In such areas where subgrade is above specified grade, they shall be brought to grade by removing material or reworking existing material and compacting.

Proper excavation, grading and compaction is critical to the performance of the ACB system.

Fabric shall have the proper overlap and be free of any holes or tears.

When working in an underwater application, it is the contractor's responsibility to assess the jobsite conditions and the means of achieving proper subgrade preparation, per the Engineer's Contract drawings, specifications, and tolerances.

Placement of Filter Fabric

The subgrade shall be inspected immediately prior to filter fabric and ACB placement for proper preparation. The filter fabric shall be placed directly on the prepared subgrade, in intimate contact with the subgrade and free of folds, wrinkles or excess tension. The filter fabric shall not be walked on or disturbed in a manner resulting in the loss of intimate contact between the filter frabric, the ArmorFlex block and subgrade soils.

The filter fabric shall be placed so that upstream sections overlap downstream sections and so that upslope sections overlap downslope sections ("shingle effect"). Overlaps shall be in the direction of flow wherever possible. The longitudinal and transverse joints shall be overlapped at least 3 feet (91 cm) for below-water installations and at least 2 feet (60 cm) for dry installations. The filter fabric shall extend at least 1 foot beyond the top, bottom, and flanking revetment termination points.

Product Delivery and Handling

Deliveries are typically scheduled to accommodate the overall installation sequence requested though the stacking of mats on an individual load is limited to larger mats towards the bottom and smaller mats toward the top of the trailer.

Deliveries are typically made on 48' flat beds with over-the-road tractors, so adequate truck access and turnaround room at the jobsite must be provided by the Contractor. The trucks and drivers are typically contract carriers (not CONTECH trucks).

The drivers are not expected to have any special certifications, jobsite training or equipment. In the case special requirements are needed, the terms and conditions will need to be negotiated and established at the time of the order. Drivers will untie their loads but are not qualified to help with any rigging, unloading or installation.

CONTECH requires at least a full 4 day notice to schedule trucks (Example: notification on Monday for Friday delivery).

For staging mats (offloading for installation later) allow approximately 30-45 minutes to offload each truck. Staging of mats on-site is highly recommended, especially if your company has never installed ArmorFlex in the past.

Timing is everything. Be prepared to unload the mats when the trucks arrive. If applicable, the first load will have the Spreader Bar and filter fabric, along with the first sequence of mats.
For installation off the truck, allow 45-60 minutes for direct installation off the truck. Additional time between loads should be considered for inexperienced crews.

CONTECH loads typically allow 2 hours for unloading time. Detention may apply after this 2 hour period and will be charged to the contractor. Loads are typically pre-loaded the day before in order to arrive first thing in the morning.

Each load will have a Bill of Lading (BOL) that has the load number with unloading dates and times.

All mats will be marked on the side of each mat with one of the following descriptions:

1. Rectangle mats will be marked with the size (Example: 8' W x 20' L).
2. Angle/Pie shape mats will be marked with the mat number per the Mat Layout Spreadsheet.

CONTECH requires notification of any changes or cancellation of scheduled deliveries during normal business hours the day prior to loading in order to avoid any cancellation charges.

The use of a crane is optimal for fast and safe unloading and installation of the mats.

Spreader Bar Overview

This instruction content is for informational purposes and should not be considered to be used in lieu of consultation with a professional rigger. Distribute this guide as a procedure for rigging and handling CONTECH supplied Spreader Bars (See Detail A). Notwithstanding the instructions contained in this guide, it is the responsibility of the customer or customer's agent to handle CONTECH products in a safe and efficient manner. For additional information, refer to safety standard ASME B30.20, *Below-the-Hook Lifting Devices*.

Inspection

The operator or other designated personnel should visually inspect the unit before every lift, as well as during operation in the event that damage occurs during a lift. Connector Links, Eye Hooks with Snap Lock and Screw Pin Shackles should engage properly and be free of damage (see Detail B).

The unit shall be free of structural deformation, cracks or excessive wear of any part of the Main Lifting Beam and the Hook Tube Assemblies. The operator should check for loose or missing fasteners, including Connector Links (12), Eye Hooks with Snap Lock (12) and Screw Pin Shackles (2). Welds should also be inspected for signs of obvious cracking.

Maintenance

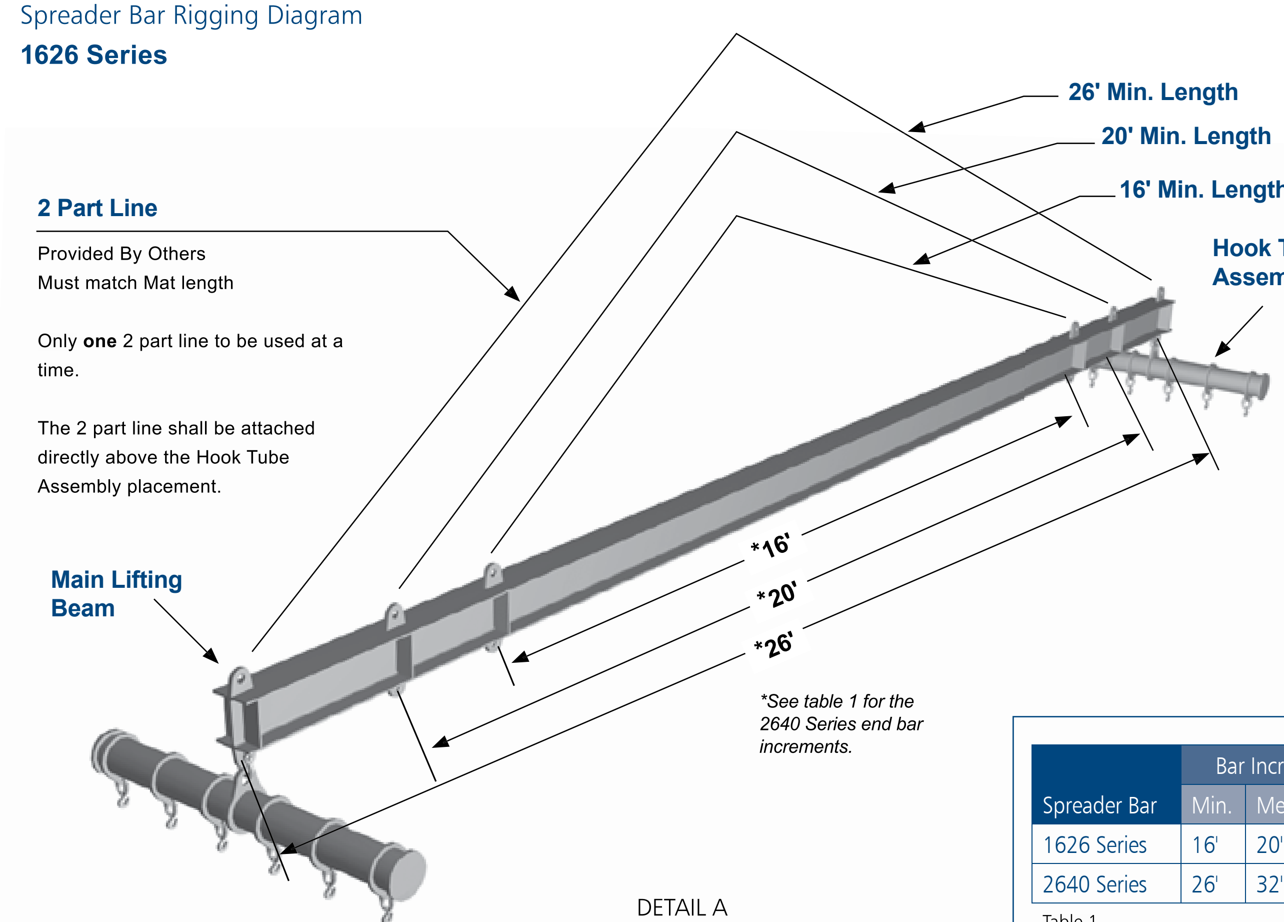
Any observed damage to the Connector Links, Eye Hooks with Snap Lock and Screw Pin Shackles or hazardous conditions found during an inspection shall be corrected before the Spreader Bar is put back into service. Adjustments and repairs shall only be done by a qualified person, and the following process shall be followed by the contractor or their designee:

1. Contact a CONTECH Project Manager before any repair work is performed.
2. The Spreader Bar shall be tagged "OUT OF SERVICE."
3. Replacement parts shall be equal and/or exceed the original manufacturer's specifications (see "Spreader Bar Parts List").
4. Personnel working on the device must be qualified to make the given repair.

When structural damage of the unit is noted or repairs are needed (except for Connector Link, Eye Hooks with Snap Lock, Screw Pin Shackle), the contractor shall halt use of the Spreader Bar, tag the bar "OUT OF SERVICE" and contact the CONTECH Project Manager for further instruction. No welding whatsoever shall be performed on the Spreader Bar unit.

Spreader Bar Rigging Diagram

1626 Series



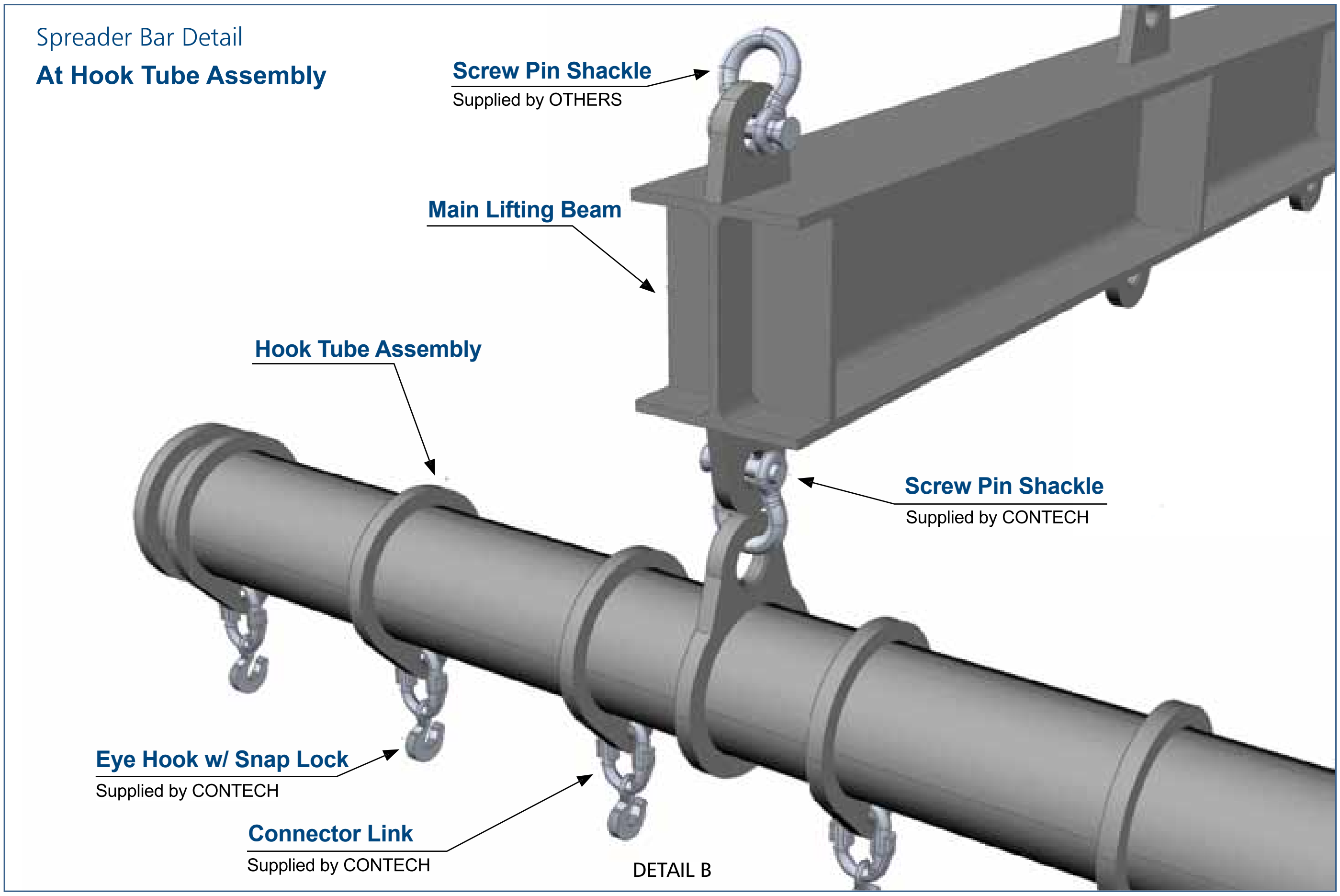
DETAIL A

Spreader Bar	Bar Increments		
	Min.	Med.	Max.
1626 Series	16'	20'	26'
2640 Series	26'	32'	40'

Table 1

Spreader Bar Detail

At Hook Tube Assembly



SPREADER BAR PARTS LIST	
Qty.	Description
1	Main Lifting Beam
2	Hook Tube Assembly
12	Connector Link, Lok-A-Loy 6-5/8", 16,500 lb Crosby #1014459
12	Eye Hook w/ Snap Lock - 2 ton S-320C Crosby #1022233
2	1" Screw Pin Shcackle 20,000 lb Columbus McKinnon #600-02515
	Replacement Latch Kit - Crosby #1096468

Equipment Needs

Prior to delivery, review the heaviest lift and highest pick in order to properly size the equipment used for the offload and the installation of the mats.

Total pick weight will include the weight of each mat AND Spreader Bar. Estimated Spreader Bar weight is 2,600 lbs for 26’ bars and 3,500 lbs for 40’ bars.

Total vertical lift height typically ranges between 30’ - 65’ and is determined by the following variables:

Setting Mats with a Crane or Excavator

1. “Walking” mats with an excavator or using more than one piece of equipment to pick is not recommended and can result in unsafe working conditions and/or damage to the ACB mattresses.
2. Proper lifting with the Spreader Bar ensures the 5:1 working load factor of the cable is preserved.
3. Single end picks (picking up the mat from one end) are not allowed.
4. Identify and avoid obstructions that may hinder reach height (Example: Power lines).

EQUIPMENT	*PICK HEIGHT IMPACT*
Flatbed Trailer	5'
Sag of Mat	5'-20'
2-Part Line	15'-35'
Height of Spreader Bar	4'
Total Vertical Lift Range	30'-65'

Is the reach of your crane or excavator sufficient to set the mats?

CAUTION: Consult the load chart for the machine to verify its load rating is not exceeded.

WARNING NOTES & SAFETY INSTRUCTIONS

Only trained and authorized equipment operators are to be permitted to use CONTECH supplied Spreader Bars. Failure to follow these instructions can result in serious injury or death and/or damage to the product.

DO NOT: Exceed the rated load or lift loads not specified in this guide.

DO NOT: Operate a damaged or malfunctioning unit or a unit with missing parts.

DO NOT: Lift people.

DO NOT: Leave suspended loads unattended.

DO NOT: Remove or obscure warning labels.

DO NOT: Operate without having read and understood the operating guide.

DO NOT: Stand under or near suspended load.

DO NOT: Lift loads higher than necessary.

DO NOT: Make alterations or modifications to a Spreader Bar.

Installation Instructions

Placement of ArmorFlex Units

Care shall be taken while installing the system in order to avoid damage to the filter fabric or the underlying subgrade. The ArmorFlex units shall be placed on the filter fabric in such a manner as to produce a smooth plane surface in intimate contact with the filter fabric.

The preferred method is to start installation of the ACB system at the downstream end and proceed upstream, taking care to protect the leading edge against erosive forces. These erosive forces could potentially undermine the system if proper installation procedures are not followed.

No individual unit within the plane of the system shall exceed a 0.5 inch protrusion or greater protrusion than is specified in the contract drawings. The units shall be placed side by side so that the blocks abut. Termination trenches typically consist of a 2-block toe-in, including the top of slope, the toe of slope and flanks unless otherwise directed by the EOR. This design is typical of an ACB system to protect all sides from erosive factors.

Subgrade preparation, placement of filter fabric, placement of the ArmorFlex concrete units and the final completed project shall be inspected and approved by the Contractor and EOR.

To assist in aligning the unit being placed, use of a pry bar may be necessary.

Earth Anchors (if required):

1. Anchors shall be installed per the manufacturer's instructions.
2. Anchor penetrations through the filter fabric shall be grouted with approved material to prevent migration of subsoil through the penetration point.

FINISHING

Grouting

4,000 psi non-shrinking grout or 4,000 psi concrete shall be placed where the loop ends of the mats meet, or wherever there is greater than a 2-inch gap between adjacent mats or structures. Grout to the top of the block or slightly lower (not above). Grouting of seams is meant to provide a hydraulic connection, not necessarily a structural connection between mats.

Backfill

Backfill of the block shall be specified by the Engineer of Record (EOR). Typical backfill is either suitable soil for revegatation or .375 to .750 inch (10 to 20 mm) diameter crushed stone. Backfilling should occur as early as possible to protect the filter fabric from UV damage. The exposed edges shall be backfilled until flush, ensuring the integrity of a soil backfill is maintained.

Termination trenches shall be backfilled as shown on the approved contract drawings. This backfill material shall be approved by the EOR. It is Armortec's recommendation that this non-erodible backfill be 4,000 psi non-shrinking grout or concrete.

Repair of Damaged Units

In the event that a damaged concrete unit exists prior to the placement or after the mat has been installed, the concrete unit can be repaired in one of the following acceptable manners; unit to be completely removed and then backfilled with 4,000 psi grout/concrete or, replaced with a new block unit.

Depending on the size of the crack or chip, the perimeter and void areas of the block can be filled with grout up to or just below the top grade of the block.

Chipping resulting in a weight loss exceeding 10% of the average weight of a concrete unit shall be repaired. Surface chipping (i.e. weight loss of less than 10%) resulting from customary handling methods generally do not require repair.

Grout to the top of the block or slightly lower — not above.

Backfilling should occur as early as possible to protect the filter fabric from UV damage.

Tool and Material Checklist	
Two-part line for attachment to the Spreader Bar's Main Lifting Beam. Each leg of the two-part line needs to be equal to or greater than the longest mat to be picked to achieve an angle no less than 60 degrees between the bar and line. (See Detail A).	**Supplied by others**
Chokers or Straps for ease of Spreader Bar adjustment, recommend: 6 chokers each 2', 5', 8' or 1-2 nylon straps each 2', 5', 8'.	**Supplied by others**
Swivel Clevis for picking point of equipment	**Supplied by others**
Three heavy duty rock bar or pry bars (5 feet length is optimal).	**Supplied by others**
Upside down marking paint (for alignment markings on the mats or ground during installation).	**Supplied by others**
100' measuring tape.	**Supplied by others**
Amortec's Mat Layout Plan Drawings and Mat Layout Spreadsheet with mat numbers and sizes. Have these documents on-site at ALL times for reference.	**Supplied by CONTECH**

Notes:

Support

If you need guidance please, call your local sales representative or our corporate headquarters at 1.800.338.1122 and ask for a representative.

- Drawings and specifications are available at www.contech-cpi.com.
- Site-specific design support is available from CONTECH representatives.

CONTECH Construction Products Inc. provides site solutions for the civil engineering industry. CONTECH's portfolio includes bridges, drainage, sanitary sewer, stormwater and earth stabilization products.

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CONTECH® CONSTRUCTION PRODUCTS INC.

ARMORTEC™ Erosion Control Solutions

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ARTICULATING CONCRETE BLOCK (ACB)
SYSTEM SPECIFICATIONS – ARMORFLEX®

GENERAL

Scope of Work

The contractor shall furnish all labor, materials, equipment, and incidentals required for, and perform all operations in connection with, the installation of the ArmorFlex® Articulating Concrete Block (ACB) system in accordance with the lines, grades, design and dimensions shown on the Contract Drawings and as specified herein.

Submittal

The Contractor shall submit to the Engineer of Record (EOR) evidence of full-scale hydraulic testing in accordance with ASTM D-7277, and if necessary, Factor of Safety (FoS) calculations in support of the proposed ACB system stamped and signed by a Professional Engineer licensed to practice in the state where the project is located. The Contractor shall also submit to the EOR an appropriate geotextile, selected for the site being protected on the basis of the gradation and permeability of the surface soils, which information shall have been provided by the EOR or the designated geotechnical engineer.

The Contractor shall furnish manufacturer's certificates of compliance for ACB/mats, revetment cable, geotextile, and any revetment cable fittings and connectors. The Contractor shall also furnish the manufacturer's specifications, literature, preliminary shop drawings for the layout of the mats, installation and safety instructions, and any recommendations, if applicable, that are specifically related to the project. If a color has been specified for the block, the Contractor shall submit a color chart indicating the specified standard color.

Alternative materials from qualified suppliers may be considered; to qualify, proposed alternative suppliers must own and operate their own manufacturing facility, and shall directly employ a minimum of five (5) registered Professional Engineers. Full documentation consistent with the foregoing must be submitted in writing to the EOR a minimum of twenty (20) business days prior to bid date, and must be pre-approved in writing as an addendum to the bid documents and drawings by the EOR at least ten (10) business days prior to bid date. Submittal packages must also include, as a minimum, the following:

1. Evidence of satisfactory full-scale laboratory testing in accordance with *ASTM D 7277, Standard Test Method for Performance Testing of Articulating Concrete Block (ACB) Revetment Systems for Hydraulic Stability in Open Channel Flow*, performed on behalf the submitting manufacturer on a qualifying test flume of sufficient length for the test flows to achieve normal depth in all cases, and associated engineered calculations quantifying the FoS of the proposed ACB system under the design conditions of the specific project, stamped and signed by a registered Professional Engineer residing in and licensed to practice in the state where the project is located;

2. A list of 5 comparable projects, in terms of size and applications, in the United States, where the satisfactory performance of the specific alternate ACB system can be verified after a minimum of five (5) years of service life;

3. Information about, or certifications of, all materials associated with the ACB system as detailed above, including (but not limited to) cable, fittings, geotextile, and any other materials required for satisfactory installation in accordance with *ASTM D 6884, Standard Practice for Installation of Articulating Concrete Block (ACB) Revetment Systems*;

4. The names and contact information (phone numbers and e-mail addresses, at a minimum) for the suppliers' representatives, for technical, production or logistics questions, at least one of whom must reside in the state where the project is located.

PRODUCT

General

All ACB mats shall be prefabricated as an assembly of concrete blocks having specific hydraulic capacities, and laced with revetment cables. The ACB system may also be assembled on-site by hand-placing the individual units either with or without subsequent insertion of cables.

Individual units in the system shall be staggered and interlocked for enhanced stability. The mats shall be constructed of open and/or closed cell units as shown on the contract drawings. The open cell units have two (2) vertical openings of rectangular cross section with sufficient wall thickness to resist cracking during shipping and installation. Parallel strands of cable shall extend through two (2) cable ducts in each block allowing for longitudinal binding of the units within a mat. Each row of units shall be laterally offset by one-half of a block width from the adjacent row so that any given block is cabled to four other blocks (two in the row above and two in the row below). Half-blocks, if used, are always closed-cell units and need not be specified separately as such.

Each block shall incorporate interlocking surfaces that minimize lateral displacement of the blocks within the mats when they are lifted by the longitudinal revetment cables. The interlocking surfaces must not protrude beyond the perimeter of the blocks to such an extent that they reduce the flexibility or articulation capability of the ACB mats or become damaged or broken when the mats are lifted during shipment or placement. Once the mats are in place, the interlocking surfaces shall minimize the lateral displacement of the blocks even if the cables should become damaged or removed. The mats must be able to flex a minimum of 18° between any given row or column of blocks in the uplift direction and 45° in the downward direction.

The cables inserted into the mats shall form lifting loops at one end of the mat with the corresponding cable ends spliced together to form a lifting loop at the other end of the mat. The EOR shall approve appropriate sleeves for use in order to splice the lifting loop. The cables shall be inserted after sufficient time has been allowed for the concrete to complete the curing process.

The ACB mats shall be placed on a filter fabric as specified herein. Under no circumstances shall the filter fabric be permanently affixed or otherwise adhered to the blocks or mats; i.e., the filter fabric shall be independent of the block system.

Certification (Open-Channel Flow): ACB mats will only be accepted when accompanied by documented hydraulic performance characteristics that are derived from tests under controlled flow conditions. Testing shall conform to *ASTM D 7277, Standard Test Method for Performance Testing* *of Articulating Concrete Block (ACB) Revetment Systems for Hydraulic Stability in Open Channel Flow*, as amended and updated. Note that all hydraulic performance testing shall be performed in a 2H:1V flume, and that the tested length be long enough that the test flows achieve normal depth in all cases. Analysis and interpretation of the test data shall conform to the guidance contained in *ASTM D 7276, Standard Guide for Analysis and Interpretation of Test Data for Articulating Concrete Block (ACB) Revetment Systems in Open Channel Flow*, as amended and updated.

Performance (Open-Channel Flow): The design of the ACB mats shall be in accordance with the Factor-of-Safety design methodology as described in "Erosion and Sedimentation" by Pierre Julien, Cambridge University Press, Second Ed. 2010. The minimum designed safety factor shall be 1.5 by utilizing the following equation.

$$SF = ((\vartheta_2 / \vartheta_1)\, \alpha_\theta) / ((1 - \alpha_\theta^2)^{0.5} \cos \beta + \eta\, (\vartheta_2 / \vartheta_1) + (\vartheta_3 F_d' \cos \delta + \vartheta_4 F_l') / \vartheta_1 W_s) \geq 1.5$$

where ϑ_1, ϑ_2, ϑ_3, & ϑ_4 are geometric properties of the block, α_θ, β, & δ are angles characteristic of the site and application, η is the stability number for a sloped surface, F_d & F_l are the drag and lift forces, respectively, and W_s is the submerged weight of the block. ArmorFlex block geometric parameters are available upon request.

The analysis shall be performed based upon the stability of the ACBs due to gravity forces alone, neglecting conservative forces added by cabling, mechanical anchorage, contact with adjacent blocks, or other restraints not attributable to gravity based forces. The analysis must account for a 0.5-inch block projection, in accordance with *ASTM D 6884, Standard Practice for Installation of Articulating Concrete Block (ACB) Revetment Systems,* Section 6.3.3. **Site grading requirements may not be used to omit this requirement for standard (non-tapered) block.**

In order to analyze the performance of the unit, the hydraulic information listed below is required:

ACB HYDRAULIC INFORMATION

Design Volumetric Flow Rate (ft^3/sec)	307
Minimum Shear Stress (lb/ft^2)	15.95
Channel Friction or Bed Slope (ft/ft)	0.006
Channel Side Slopes (_H:1V)	2:1
Channel Bottom Width (ft)	8
Allowable Unit Protrusion (in)	0.5

Articulating Concrete Blocks

Scope: This specification covers ACB mats used for general erosion control, slope stabilization, channel armoring and channel protection. Installations may be exposed to infrequent and/or light-duty vehicular loading, such as for low-water crossings or boat ramps, by specifying a minimum thickness of 6”. Concrete units covered by this specification are made from lightweight or normal weight aggregates, or both. The values stated in U.S. customary units are to be regarded as the standard.

Materials: Cementitious Materials - Materials shall conform to the following applicable ASTM specifications:

1. Portland Cements - Specification C 150, for Portland Cement.
2. Blended Cements - Specification C 595, for Blended Hydraulic Cements.
3. Hydrated Lime Types - Specification C 207, for Hydrated Lime Types.
4. Pozzolans - Specification C 618, for Fly Ash and Raw or Calcined Natural Pozzolans for use in Portland Cement Concrete.
5. Aggregates – Specification C 33, for Concrete Aggregates, except that grading requirements shall not necessarily apply.

Casting: The ACB units shall be produced using a dry cast method. Dry cast units obtain strength more quickly than wet cast blocks, and will also achieve a greater uniformity of quality and greater durability.

Physical Requirements: At the time of delivery to the work site, the ACB units shall conform to the physical requirements prescribed in Table 2 listed below.

PHYSICAL REQUIREMENTS

Compressive Strength Net Area Min. p.s.i (mPa)		**Water Absorption Max. lb/ft^3 (kg/m^3)**	
Avg. of 3 units	Individual Unit	Avg. of 3 units	Individual Unit
4,000 (27.6)	3,500 (24.1)	9.1 (160)	11.7 (192)

Units will be sampled and tested in accordance with *ASTM D 6684, Standard Specification for Materials and Manufacture of Articulating Concrete Block (ACB) Revetment Systems.*

Visual Inspection: All units shall be sound and free of defects which would interfere with the proper placement of the unit, or which would impair the performance of the system. Surface cracks incidental to the usual methods of manufacture, or surface chipping resulting from customary methods of handling in shipment and delivery, shall not be deemed grounds for rejection.

Cracks exceeding 0.25 inches (.635 cm) in width and/or 1.0 inch (2.54 cm) in depth shall be deemed grounds for rejection. Chipping resulting in a weight loss exceeding 10% of the average weight of a concrete unit shall be deemed grounds for rejection.

Blocks rejected prior to delivery from the point of manufacture shall be replaced at the manufacturer's expense. Blocks rejected at the job site shall be repaired with structural grout or replaced upon request at the expense of the contractor.

Sampling and Testing: The purchaser (or their authorized representative) shall be accorded access to the relevant manufacturing facility or facilities, if desired, in order to inspect and/or sample the ACB units from lots ready for delivery prior to release for delivery to the job site. Such inspections are at the sole expense of the requesting entity.

Field installation shall be consistent with the way the system was installed in preparation for hydraulic testing pursuant to *ASTM D 7277, Standard Test Method for Performance Testing of Articulating Concrete Block (ACB) Revetment Systems for Hydraulic Stability in Open Channel Flow*.

Any external restraints, anchors, or other ancillary components (such as synthetic drainage mediums) shall be employed as they were during testing; e.g., if the hydraulic testing installation utilized a drainage layer, then the field installation must also utilize a drainage layer. This does not preclude the use of other section components for other purposes, e.g., a geogrid for strengthening the subgrade for vehicular loading, or an intermediate filter layer of sand to protect very fine-grained native soils.

Hydraulic testing shall be conducted on the thinnest block in a "family" of similar blocks (i.e., same footprint but different thicknesses), with the tested critical shear value then converted to a critical shear at 0° before extrapolation to thicker blocks within the same family. Such extrapolation may not be made from a thicker block to a thinner block. The extrapolation method is detailed in the National Concrete Masonry Association (NCMA) "Design Manual for Articulated Concrete Block (ACB) Revetment Systems", section 4.2.

Purchaser may request additional testing other than that provided by the manufacturer as needed. Such requested testing will extend any stated lead times for manufacturing and delivery, if the results of such testing are a prerequisite to approval (i.e., approval for release to manufacturing). Costs associated with such testing shall be borne by the purchaser.

Manufacturer: Articulating concrete blocks (ACB's) shall be **ArmorFlex®** as manufactured and sold by:

ARMORTEC, A Contech Company
9025 Centre Pointe Dr., Suite 400
West Chester, OH 45269
Phone: 1-800-645-7000
Fax: 1-513-645-7993
URL: http://www.conteches.com/Products/Erosion-Control/Hard-Armor/ArmorFlex

The selected ARMORFLEX® blocks shall have the following nominal characteristics:

STANDARD SIZES OF ARMORFLEX® BLOCKS

CLASS	TYPE	MIN. WEIGHT (lbs)	BLOCK SIZE Length (in)	Width (in)	Height* (in)	OPEN AREA %
50L	Open	115	17.4	23.6	6.0	20
**Block height may vary based on local manufacture's capabilities.*						

Revetment Cable and Fittings

Option 1. Polyester Revetment Cable and Fittings: Revetment cable shall be constructed of high tenacity, low elongating, and continuous filament polyester fibers. Cable shall consist of a core construction comprised of parallel fibers contained within an outer jacket or cover. The size of the revetment cable shall be selected such that the minimum acceptable strength is at least five (5) times that required for lifting of the mats, in accordance with ASTM D-6684 paragraph 5.5.2.

Elongation requirements specified below are based upon stabilized new, dry cable. Stabilization refers to a process in which the cable is cycled fifty (50) times between a load corresponding to $200D^2$ and a load equal to 10%, 20% or 30% of the cable's approximate average breaking strength. Relevant elongation values are as shown in the table below. The tolerance on these values is ± 5%.

ELASTIC ELONGATION		
at Percentage of Break Strength		
10%	20%	30%
0.6	1.4	2.2

The revetment cable shall exhibit resistance to most concentrated acids, alkalis and solvents. Cable shall be impervious to rot, mildew and degradation associated with marine organisms. The materials used in the construction of the cable shall not be affected by continuous immersion in fresh or salt water.

Selection of cable and fittings shall be made in a manner that insures a safe design factor for mats being lifted from both ends, thereby forming a catenary. Consideration shall be taken for the bending of the cables around hooks or pins during lifting. Fittings such as sleeves and stops shall be aluminum and washers shall be plastic unless otherwise shown on the Contract Drawings.

Option 2. Galvanized Steel Revetment Cable and Fittings: Revetment cable shall be constructed of preformed galvanized aircraft cable (GAC). The cables shall be made from individual wires and strands that have been formed during the manufacture into the shape they have in finished cable.

Cable shall consist of a core construction comprised of seven (7) wires wrapped within seven (7) or nineteen (19) wire strands. The size of the revetment cable shall be selected such that the minimum acceptable strength is at least five (5) times that required for lifting of the mats.

The revetment cable shall exhibit resistance to mild concentrations of acids, alkalis, and solvents. Fittings such as sleeves and stops shall be aluminum, and the washers shall be galvanized steel or plastic. Furthermore, depending on material availability, the cable type (7x7 or 7x19) can be interchanged while always ensuring the required factor of safety for the cable.

Selection of cable and fittings shall be made in a manner that insures a safe design factor for mats being lifted from both ends, thereby forming a catenary. Consideration shall be taken for the bending of the cables around hooks or pins during lifting. Revetment cable splicing fittings shall be selected so that the resultant splice shall provide a minimum of 75% of the minimum rated cable strength.

Anchors

The specifying EOR *may* require, at his/her discretion, permanent anchoring of the mats, e.g., by the use of ancillary earth anchors or attachment to other structures using the lifting cable loops, or through the open cells of an open-cell block. The design of the ArmorFlex system is intended to provide hydraulic stability without the use of such anchors; consequently, any such anchor design shall be by others as approved by the EOR.

Filter Fabric

The geotextile filter shall meet the minimum physical requirements listed in Table No. 3 of these Specifications. Consultation with the manufacturer is recommended; the standard for sizing geotextile for these applications is AASHTO M-288, Permanent Erosion Control. Either woven or non-woven geotextile are acceptable, as long as they meet the other project requirements.

The geotextile fiber shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of propylene, ethylene, ester, or amide, and shall contain stabilizers and/or inhibitors added to the base plastic, if necessary, to make the filaments resistant to deterioration due to ultraviolet and heat exposure. The edges of the geotextile shall be finished to prevent the outer fiber from pulling away from the geotextile.

The Contractor shall furnish manufacturer's certified test results to the EOR, showing actual test values obtained when the physical properties are tested for compliance with the specifications.

During all periods of shipment and storage, the filter fabric shall be protected from direct sunlight, UV radiation, and temperatures greater than 140°F. To the extent possible, the fabric shall be maintained wrapped in its protective covering. The geotextile shall not be exposed to sunlight or UV radiation until the installation process begins.

PHYSICAL REQUIREMENTS

Physical Property	Test Procedure	Minimum Value
Grab Tensile Strength (Unaged Geotextile)	ASTM D4632	*IAW AASHTO M288 Class 2*
Breaking Elongation (Unaged Geotextile)	ASTM D4632	50% max. (in any principal direction)
Burst Strength	ASTM D3786	*IAW AASHTO M288 Class 2*
Puncture Strength	ASTM D4833	*IAW AASHTO M288 Class 2*
A.O.S., U.S. Std. Sieve	ASTM D4751	
Permittivity	ASTM D4491	

Specified by EOR

<u>Final acceptance of the filtration geotextile must be made by the EOR based on project specific soil information.</u> Soil characteristics such as grain size distribution, permeability, and plasticity shall be determined for every 200,000 square feet of geotextile installed or for each source of borrow material used during construction. Significant differences in soil characteristics may require the performance of further sieve and possible hydrometer testing at the discretion of the EOR. The locations for which the material to be tested is extracted shall be approved by the EOR. The Contractor shall provide the site-specific soil and modified proctor curves for the site soil, at his own expense, to the manufacturer. Also, the contractor shall be responsible for the performance of the test by a certified independent laboratory experienced in performing such test. The test shall be performed under the actual field soil conditions or as otherwise required by the EOR.

At the time of installation, the filter fabric shall be rejected if it has been removed from its protective cover for over 72 hours or has defects, tears, punctures, flow deterioration, or damage incurred during manufacture, transportation or storage. With the acceptance of the EOR, placing a filter fabric patch over the damaged area prior to placing the mats shall repair a torn or punctured section of fabric. The patch shall be large enough to overlap a minimum of three (3) feet in all directions.

<u>Size of ACB Mats</u>

General: The concrete blocks, cables and fittings shall be fabricated at the manufacturer or another approved location into mats with a width of up to eight (8) feet and a length up to forty (40) feet, which is approved by the EOR. The maximum mat length may be shorter for heavier blocks.

Mat Length: The ACB mats shall have the ability for fabrication in various lengths, widths, and in combinations of length and/or widths. Special mats are a combination of two opposing dimensions either in the longitudinal or transverse direction of the mats. The special mats are available in various dimensions that allow for a custom fit to a site-specific project. Obstructions, such as manholes, pipe outfalls, or other fixed structures, will be accommodated to the extent that accurate information is provided about them prior to the preparation of mat layout drawings.

FOUNDATION PREPARATION, GEOTEXTILE AND MAT PLACEMENT

Subgrade Preparation

General: All subgrade preparation shall be performed in accordance with *ASTM D 6884, Standard Practice for Installation of Articulating Concrete Block (ACB) Revetment Systems*, as updated and amended.

Grading: The slope shall be graded to a smooth plane surface to ensure that intimate contact is achieved between the slope face and the geotextile (filter fabric), and between the geotextile and the entire bottom surface of the individual ACBs. All slope deformities, roots, grade stakes, and stones which project normal to the local slope face must be re-graded or removed. No holes, "pockmarks", slope board teeth marks, footprints, or other voids greater than 0.5 inch in depth normal to the local slope face shall be permitted. No grooves or depressions greater than 0.5 inches in depth normal to the local slope face with a dimension exceeding 1.0 foot in any direction shall be permitted. Where such areas are evident, they shall be brought to grade by placing compacted homogeneous material. The slope and slope face shall be uniformly compacted, and the depth of layers, homogeneity of soil, and amount of compaction shall be as required by the EOR.

Excavation and preparation for all termination trenches or aprons shall be done in accordance to the lines, grades and dimensions shown in the Contract Drawings. The termination trench hinge-point at the top of the slope shall be uniformly graded so that no dips or bumps greater than 0.5 inches over or under the local grade occur. The width of the termination trench hinge-point shall also be graded uniformly to assure intimate contact between all ACBs and the underlying grade at the hinge-point.

Inspection: Immediately prior to placing the filter fabric and ACB mats, the prepared subgrade shall be inspected by the EOR as well as the owner's representative. No fabric or blocks shall be placed thereon until that area has been approved by each of these parties.

Placement of Geotextile Filter Fabric

General: All placement and preparation should be performed in accordance with *ASTM D 6884, Standard Practice for Installation of Articulating Concrete Block (ACB) Revetment Systems*, as updated and amended. Filter Fabric, or filtration geotextile, as specified elsewhere, will be placed within the limits of ACBs shown on the Contract Drawings.

Placement: The filtration geotextile will be placed directly on the prepared area, in intimate contact with the subgrade, and free of folds or wrinkles. The geotextile will not be walked on or disturbed when the result is a loss of intimate contact between the ACB and the geotextile or between the geotextile and the subgrade. The geotextile filter fabric will be placed so that the upstream strip of fabric overlaps the downstream strip. The longitudinal and transverse joints will be overlapped at least one and a half (1.5) feet for dry installations and at least three (3) feet for below-water installations. The geotextile will extend at least one (1) foot beyond the top and bottom revetment termination points, or as required by the EOR. If ACBs are assembled and placed as large mattresses, the top lap edge of the geotextile should not occur in the same location as a space between ACB mats unless the space is concrete filled.

Placement of ACBs/Mats

General: ACB placement and preparation should be performed in accordance with *ASTM D 6884, Standard Practice for Installation of Articulating Concrete Block (ACB) Revetment Systems*, as amended and updated. ACB block/mats, as specified in Part 2:A of these Specifications, will be constructed within the specified lines and grades shown on the Contract Drawings.

Placement: The subgrade shall be prepared in such a manner as to produce a smooth plane surface prior to placement of the ACBs or mats. No individual block within the plane of placed ACBs will protrude more than one-half inch or as otherwise specified by the EOR. ACBs should be flush and develop intimate contact with the subgrade section, as approved by the EOR. Proposed hand placing is only to be used in limited areas, specifically identified by the EOR or manufacturers' mat layout drawings, as approved by the EOR.

If assembled and placed as large mattresses, the ACB mats will be attached to a spreader bar or other approved device to aid in the lifting and placing of the mats in their proper position by the use of a crane or other approved equipment. The equipment used should have adequate capacity to place the mats without bumping, dragging, tearing or otherwise damaging the underlying fabric. The mats will be placed side-by-side, so that the mats abut each other, and/or end-to-end. Mat seams or openings between mats greater than two (2) inches will be backfilled with 4000 p.s.i. non-shrink grout, concrete or other material approved by the EOR. Whether placed by hand or in large mattresses, distinct changes in grade that results in a discontinuous revetment surface in the direction of flow will require backfill at the grade change location so as to produce a continuous surface.

Termination trenches will be backfilled and compacted flush with the top of the blocks. The integrity of the trench backfill must be maintained so as to ensure a surface that is flush with the top surface of the ACBs for its entire service life. Termination trenches will be backfilled as shown on the Contract Drawings. Backfilling and compaction of trenches will be completed in a timely fashion. No more than 500 linear feet of placed ACBs with non-completed termination trenches will be permitted at any time.

Finishing: The cells or openings in the ACBs will be backfilled and compacted with suitable material, as specified by the EOR. Backfilling and compaction will be completed in a timely manner so that no more than 500 feet of exposed mats exist at any time. Finishing requirements are explicitly at the discretion of the EOR.

Consultation: The manufacturer of the ACBs/mats shall provide design and construction advice during the design and initial installation phases of the project when required or as necessary, at the discretion of the EOR. The ACB supplier shall provide, at a minimum, one full day or two half-days of on-site project support upon request.

YRC

YANTIC RIVER
CONSULTANTS, LLC