Queens Lake Dam

Dam Safety Inventory #199016

Dam Break Inundation Study

Prepared for:

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COMMONWEALTH OF VIRGINIA
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I. INTRODUCTION

This engineering report is an analysis of Queens Lake Dam (Inventory Number 199016). It includes a hydrologic and hydraulic (H&H) analysis for the dam entailing four different dam breach scenarios: Sunny Day Breach, 100% Probable Maximum Flood (PMF), Spillway Design Flood (SDF) with breach and the Spillway Design Flood (SDF) with no breach

Queens Lake Dam is in Williamsburg, Virginia (York County) and owned and operated by the Queens Lake Community Association (QLCA). The dam currently impounds Queens Lake where it discharges directly into Queens Creek which eventually flows south-east into the York River. The contributing drainage area to the dam outfall is 1.54 square miles (984.73 ac) and the watershed consists primarily of forest/woods cover, managed turf areas, residential subdivisions and associated impervious cover. The upper portion of the watershed drains from across Interstate 64 starting roughly at the Penniman Road and Queens Creek Road intersection. The drainage area to Queens Lake Dam represents approximately 9.0% of the total watershed draining to Queens Creek directly east of the dam toe. That overall, total watershed is 17.6 square miles which drains more from the northwest and includes Waller Mill Reservoir drainage area. Refer to Appendix A for the Queens Lake Watershed Map.

A July 17, 2020 field survey (NAVD 1988) of Queens Lake Dam indicates the top of dam is an earthen embankment with varying upstream and downstream side slopes ranging from 2H:1V-to-3H:1V; an embankment length of approximately 645 feet and a bridge deck top elevation of 12.56 directly atop the dams spillway. Queens Drive (County Route 716) runs along the top of embankment at a road width of 15.75 feet, roughly between Prince Charles Road and Charles River Landing Road. The primary spillway is a concrete-weir approximately 28-feet wide x 31-feet long and a surveyed weir crest elevation of 8.22. An approximately 10-inch thick solid wall center pier and concrete abutments support a single lane bridge for Queens Drive which crosses the spillway. The water level in the lake measured elevation 7.95 feet at time of survey. The linear length of Queens Lake itself measures approximately 7,200 feet (1.27 miles) and varies in width from approximately 200-ft to 600-ft wide near the dam. There is an 8-foot wide x 700-foot long pier supported foot bridge spanning Queens Lake, approximately 65-feet lakeward on the upstream side of the dam. A USGS NOAA Tidal Gauge (8637689) is located approximately 14 miles south-east from the dam at the Yorktown USCG Training Center. Year 2021 NOAA tidal predictions for the gauge indicate a predicted MHW elevation of 3.3-feet for October 8-10, 2021.

II. METHODOLOGY

A series of hydrology and hydraulic models were developed to determine the Dam's Hazard Class, the Spillway Design Flood (SDF) and the resulting dam break inundation zones (DBIZ). This was achieved by modeling various breach/no breach scenarios (Sunny Day breach; PMP breach/no breach; SDF breach/no breach; 100-yr breach/no breach to determine and assess the downstream impacts.

III. HYDROLOGY

The hydrologic analysis for the Queens Lake Dam updates previous hydrology modeling prepared by others for the contributing watershed. Basin delineation was performed using USGS StreamStats program. Present land use was obtained from Virginia GIS landcover data. Soils data was obtained from NRCS Soils Report for James City and York Counties and the City of Williamsburg. Probable Maximum Precipitation (PMP) rainfall amounts were derived using the 2016 VA-DCR PMP Study and Evaluation tool for the 6-, 12- and 24-hour precipitation events.

IV. MODELING PARAMETERS

HEC-HMS (Version 4.3) and a single basin delineation for the watershed were used to determine peak discharges at the dam site. Refer to Appendix A for detailed drainage information about watershed size, land use, and soils.

The HEC-HMS program was selected because it simulates the precipitation-runoff process of dendritic watershed systems and supports the Soil Conservation Service (SCS) hydrologic methods developed by the National Resources Conservation Service (NRCS). SCS hydrologic methods, as found in the NRCS National Engineering Handbook (Kent M.K., 1972), are recommended for developing hydrographs for reservoirs and spillway systems. ArcGIS/ArcMap 10.6.1 Software was used to help develop the Geographical Information System (GIS) based inputs for the HEC-HMS model.

V. MODEL SETUP

The HEC-HMS model uses an SCS curve number (CN) loss method. The SCS CN procedures translate the total precipitation from a storm event into runoff based on an empirical relationship obtained from multiple correlation analyses (Haan et al.,1982). The data for the analyses came from gaged watersheds located across the United States and were correlated with various physical properties of those watersheds. Inputs for the model were based on a combination of desktop analysis/investigations of channel geometry and roughness, land cover, and storage areas. Table 1 summarizes the primary drainage basin data inputs.

Table 1: Basin Data

Basin	Drainage Area (ac)	CN	Lag Time (min)
Queens Lake Dam	986	70	107.1

VI. SOILS CONSERVATION SERVICE (SCS) CURVE NUMBER PARAMETERS

The development of a runoff curve number (RCN) for hydrology modeling requires hydrologic soil group (HSG), land use, and the assignment of conditions (good, fair and poor) in the

determination of a composite curve number (CN) for the contributing drainage area. The method of assignment for specific CN's for each sub-basin is based on procedures developed by the NRCS (USDA, 1986) TR-55 Urban Hydrology for Small Watersheds.

VII. HYDROLOGIC SOIL GROUP (HSG)

A detailed GIS based Soil Survey Geographic Database (SSURGO) soils layer was obtained for York County, Virginia from the NRCS web soil survey, for use in the development of area-weighted, sub-basin hydrologic soil classifications. Table 2 summarizes the resulting soils distribution within the watershed, based on the SSURGO soils data.

Table 2: Hydrologic Soil Classifications

Hydrologic Soil Group (HSG)	Area (ac)	Watershed (%)
A	38.28	3.88
B	372.67	37.84
C	201.55	20.47
D	295.38	29.99
W	76.85	7.80
Total =	984.73	100.00
Pervious Area	839.78	85.28
Impervious Area	144.95	14.72

Water (W) and split Hydrologic soil types, such as A/D or B/D were modeled as 'D' soils in the curve number calculation for the Queens Lake watershed to be conservative.

VIII. LAND USE

Land use and land cover conditions (good, fair, and poor) were determined using aerial imagery and manual delineation of each land use type. These land uses are summarized in Table 3 with forested conditions comprising approximately 55% of the contributing watershed.

Table 3: Land-Use Patterns

Land Use	Area (ac)	Watershed (%)
Forested/Woods	541.29	54.96
Impervious	144.95	14.72
Managed Turf	298.49	30.32
Total =	984.73	100.0

IX. QUEENS LAKE DATA

An elevation-area table was set up in HEC-HMS to best model the approximate size of Queens Lake. A bathymetric survey was not available for use in this area so results from the previous dam inundation study, pertaining to lake size, remain unchanged for this analysis. In addition, GIS data was referenced to estimate approximate area size of Queens Lake.

Table 4: Queens Lake Elevation-Area Table

Elevation (ft)	Area (ac)
4	27.25
*7.98	40.00
12	61.00

**Spillway Weir Elevation is 7.98' (July 07, 2020)*

X. QUEENS LAKE PMP DATA

The Virginia PMP evaluation tool provided from DCR was used to estimate PMP extreme rainfall amounts for Queens Lake watershed. The tool uses the geo-referenced drainage area GIS shapefile of the dam to estimate General, Local, and Tropical PMP rainfall events to come up with the probable maximum rainfall amounts. It provides the 6-, 12-, and 24-hour storm event precipitation amounts. The HEC-HMS (v4.3) model run indicated the 6-hour PMP event resulted in the largest peak discharge, becoming the controlling PMF (Probable Maximum Flood) storm for Queens Lake Dam. Table 5 summarizes PMP rainfall amounts and peak discharge values for respective PMP events.

Table 5: PMP Tool Results

PMP Event (hr)	Precipitation (in)	HEC-HMS Peak Discharge (cfs)
6-hour	32.8	7617.7
12-hour	37.4	6834.0
24-hour	37.4	4697.1

Results from the respective HEC-HMS Hydrology models were used as peak flow data in HEC-RAS (Version 5.07) and run at steady state and mixed flow regime to estimate the flood wave of the breach with the goal of demonstrating one foot of convergence of the water surface elevations for both (SDF) breach and non-breach events. For downstream boundary conditions the starting water surface elevation utilized the peak MHW elevation of 3.3 ft (Oct. 8-10, 2021) from NOAA's year 2021 predicted tidal high waters for USGS StationId: 8637689.

Table 6: HEC-HMS Hydrology Model Results

Model Event	Peak Discharge (cfs)	Peak Elevation (ft)
Sunny Day Breach	1476.3	8.00
PMF Breach (6-Hr)	7230.3	13.0
100-yr Breach	1476.5	8.00
100-yr No Breach	486.3	11.8

**Dam Top = 12.56'*

XI. HAZARD CLASSIFICATION DETERMINATION

Queens Lake dam and the marina/pier property directly downstream of the dam are all owned by the Queens Lake Community Association (QLCA). The VDOT 2016 AADT for Queens Drive (716) across the dam is 140, between Prince Charles Road and Charles River Landing Road and is less than the maximum allowable of 400 for Low Hazard Dams. Per VA-DCR criteria Queens Lake therefore qualifies for Special Low Hazard Classification since no properties are impacted except those owned by QLCA. The Special Low Hazard classification is summarized below:

- The 230 W Queens Drive residential property, located left of the dam embankment appears not impacted by any of the breach or non-breach flow events (FFE = 18.0').
- Queens Lake dam and the downstream marina/pier are all owned by QLCA.
- The 2016 VDOT Annual Average Daily Traffic Volume Estimates (Jurisdiction Rept. 99) for Queens Drive atop the dam is 140.
- 1' of convergence is obtained in Queen's Creek for the 100-year breach and no-breach scenarios

XII. SPILLWAY DESIGN FLOOD (SDF)

Per 4VAC50-20-51 the recommended minimum SDF for the impounding structure is the 50-year flood, although no specific spillway design flood is mandatory for an impounding structure that qualifies as Special Low Hazard Classification. For this analysis, AMT proved the 100-year event was contained within the dam making the 100-year storm the spillway design flood. Based on HEC-RAS model results, the SDF (100yr) No Breach water surface elevation does not overtop the dam top elevation, as well as, the SDF Breach and SDF No Breach water surface elevations converge to within 1-foot directly downstream of the toe of dam at the 10003.51 cross section.

XIII. INUNDATION ZONE MAPPING

Per VA-DCR 4VAC50-20-51 Special criteria for certain low hazard impounding structures "*no map is required pursuant to 4VAC50-20-54*" where in other cases inundation zone mapping would be required for development to a point downstream where the water surface elevation of a dam breach during the SDF event, and the water surface elevation from the SDF without a dam breach converge to within one foot. As a reference an inundation map is provided for the owners benefit

to illustrate downstream limits of the resulting inundation zone from the dam breach analysis to a point of 1’ convergence.

Picture 2.1 – Queens Lake Dam Spillway Outfall

Picture 2.2 – Queens Lake Spillway Inflow

XIV. CONCLUSIONS

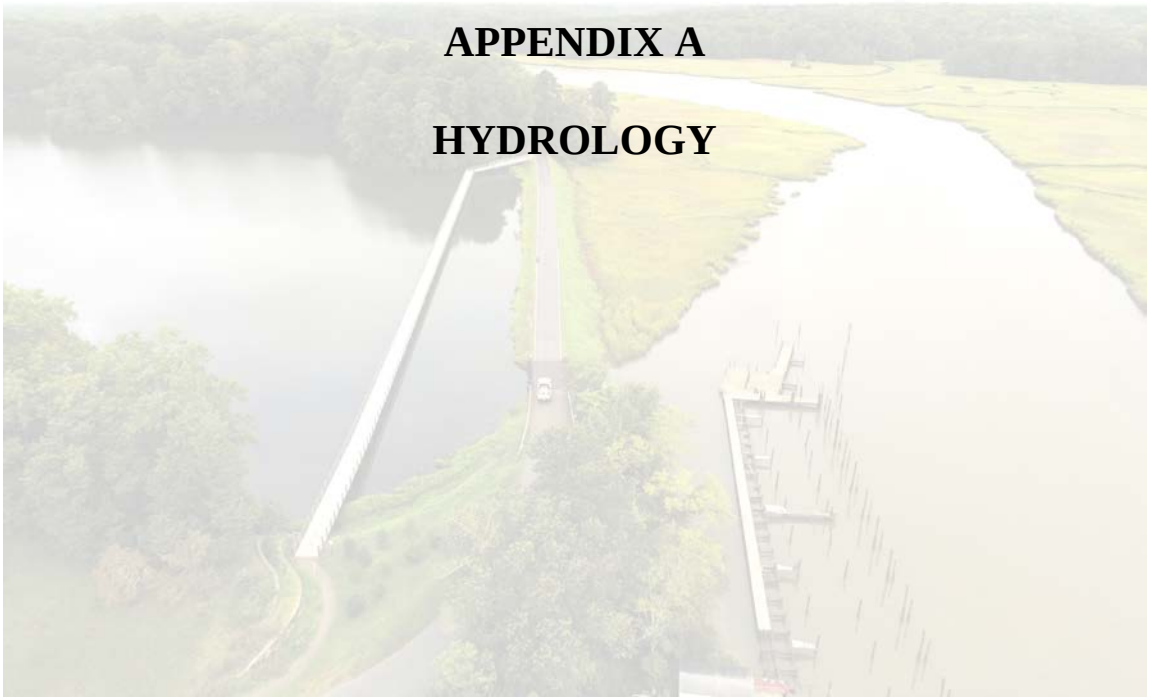
Queens Lake Dam meets criteria for Special Low Hazard class but goes above and beyond by having the ability to pass the 100-year storm based on the results of this study. Per 4VAC50-20-51. Special criteria for low hazard impounding structures - the dam owner is required to perform inspections of the impounding structure annually in accordance with the requirements of 4VAC50-20-105 and shall notify the local emergency services coordinator in the event of a dam failure or emergency condition at the impounding structure. The dam owner should notify DCR immediately of any change in circumstances that would cause the impounding structure to no longer qualify to utilize the provisions of 4VAC50-20-51.

REFERENCES

- *Structural Evaluation of the Queens Lake Spillway, February 2018:*
  TAM Consultants Project No. 17496
- *Queens Lake Dam – Hazard Classification Opinion, August 2014:*
  URS/AECOM
- AMT Topographic Survey, July 17, 2020.
- 4VAC50-20-51. Special Criteria for Certain Low Hazard Impounding Structures
- 2016 VDOT Daily Traffic Volume Estimates / Jurisdiction Report 99 / York County, City of Poquoson
- NOAA Tide Predictions (2021) – Station ID 8637689, Yorktown USCG Training Center, VA.

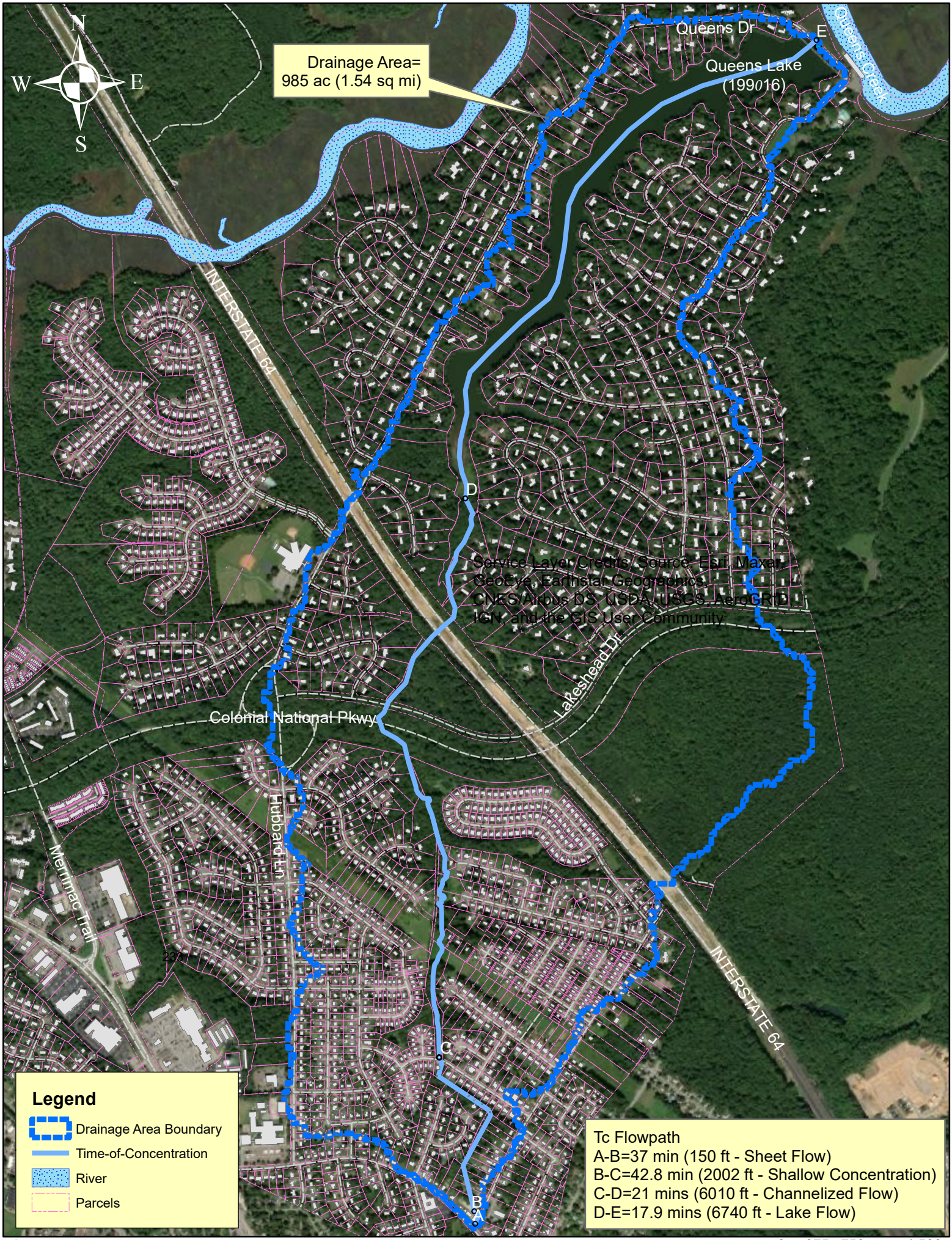
Queens Lake Dam
Inventory #199016

Inundation Study
Williamsburg, Virginia



APPENDIX A

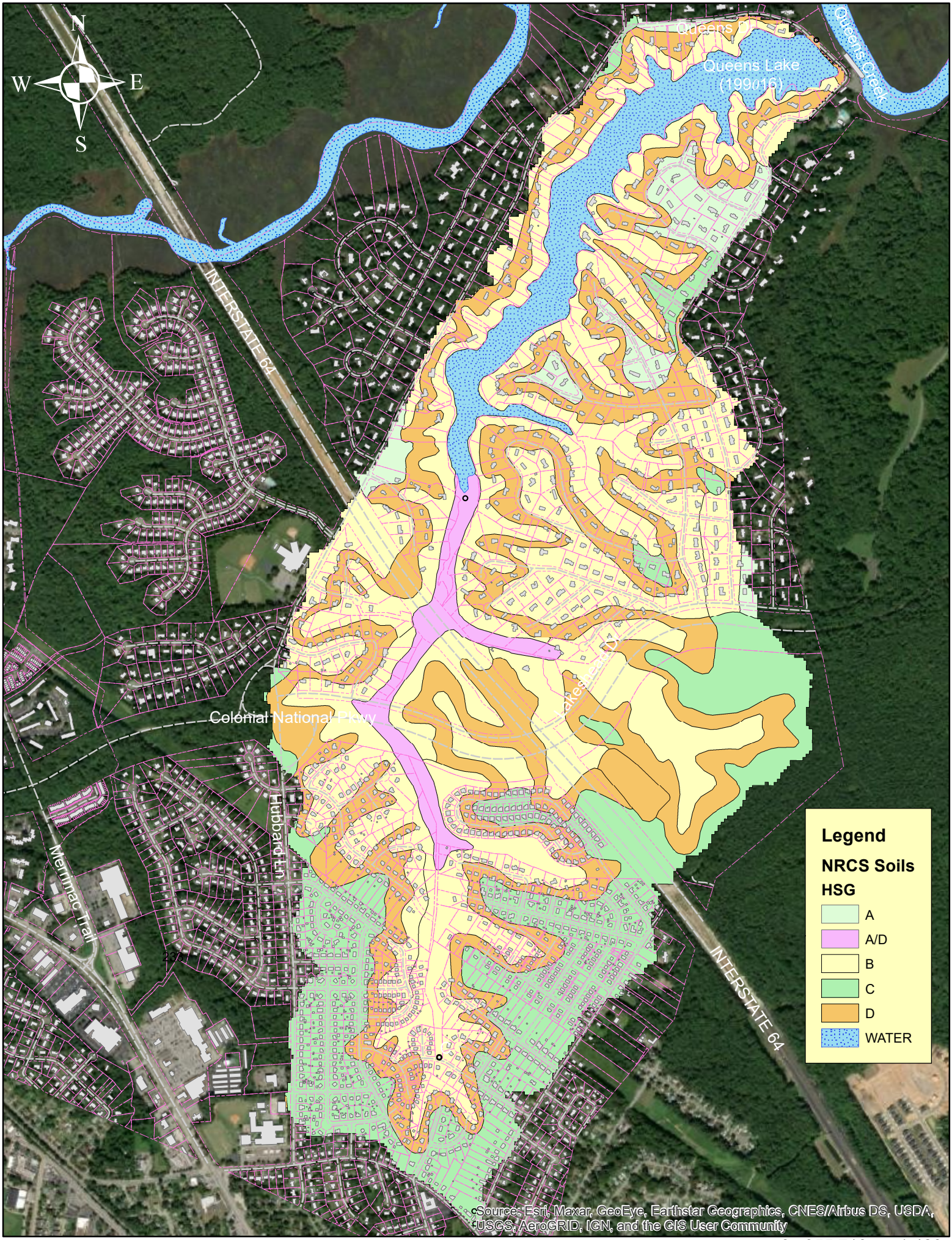
HYDROLOGY



Queens Lake Watershed Map

February 02, 2021

0 375 750 1,500 Feet



Queens Lake Soils Map

February 02, 2021

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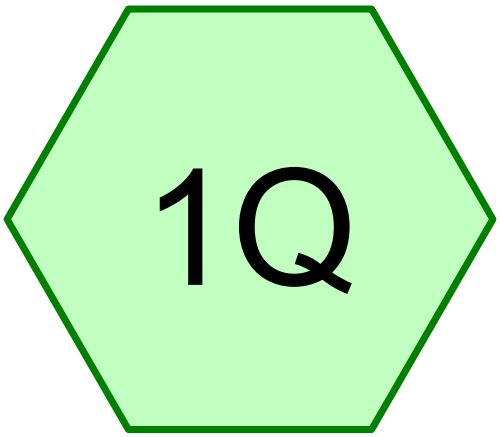


Queens Lake Hydrology

Subcat Reach Pond Link

Routing Diagram for Hydrology-Queens
Prepared by AMT, Printed 1/21/2021

Project Notes

Defined 10 rainfall events from CowCreek IDF

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	1-yr	Type II 24-hr		Default	24.00	1	2.90	2
2	2-yr	Type II 24-hr		Default	24.00	1	3.60	2
3	5-yr	Type II 24-hr		Default	24.00	1	4.60	2
4	10-yr	Type II 24-hr		Default	24.00	1	5.50	2
5	25-yr	Type II 24-hr		Default	24.00	1	6.80	2
6	50-yr	Type II 24-hr		Default	24.00	1	8.00	2
7	100-yr	Type II 24-hr		Default	24.00	1	9.30	2
8	PMP-12hr	Type II 12-hr		Default	12.00	1	37.40	2
9	PMP-24hr	Type II 24-hr		Default	24.00	1	37.40	2
10	PMP-6hr	Type II 6-hr		Default	6.00	1	32.80	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
9.040	61	1/4 acre lots, 38% imp, HSG A (1Q)
55.890	75	1/4 acre lots, 38% imp, HSG B (1Q)
52.770	83	1/4 acre lots, 38% imp, HSG C (1Q)
61.550	87	1/4 acre lots, 38% imp, HSG D (1Q)
7.750	30	Meadow, non-grazed, HSG A (1Q)
55.230	58	Meadow, non-grazed, HSG B (1Q)
74.460	71	Meadow, non-grazed, HSG C (1Q)
49.900	78	Meadow, non-grazed, HSG D (1Q)
4.520	98	Water Surface, HSG B (1Q)
72.330	98	Water Surface, HSG D (1Q)
21.490	30	Woods, Good, HSG A (1Q)
261.550	55	Woods, Good, HSG B (1Q)
74.320	70	Woods, Good, HSG C (1Q)
183.930	77	Woods, Good, HSG D (1Q)
984.730	**70**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
38.280	HSG A	1Q
377.190	HSG B	1Q
201.550	HSG C	1Q
367.710	HSG D	1Q
0.000	Other	
984.730		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
9.040	55.890	52.770	61.550	0.000	179.250	1/4 acre lots, 38% imp	1Q
7.750	55.230	74.460	49.900	0.000	187.340	Meadow, non-grazed	1Q
0.000	4.520	0.000	72.330	0.000	76.850	Water Surface	1Q
21.490	261.550	74.320	183.930	0.000	541.290	Woods, Good	1Q
38.280	**377.190**	**201.550**	**367.710**	**0.000**	**984.730**	**TOTAL AREA**	

Time span=0.00-20.00 hrs, dt=0.05 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1Q: Queens Lake Runoff Area=984.730 ac 14.72% Impervious Runoff Depth>0.55"
Flow Length=14,902' Tc=107.1 min CN=70 Runoff=183.36 cfs 44.957 af

Total Runoff Area = 984.730 ac Runoff Volume = 44.957 af Average Runoff Depth = 0.55"
85.28% Pervious = 839.765 ac 14.72% Impervious = 144.965 ac

Summary for Subcatchment 1Q: Queens Lake Hydrology

York County, VA.
GIS Soils - NRCS
GIS Landuse - VaGIN

[47] Hint: Peak is 154% of capacity of segment #3

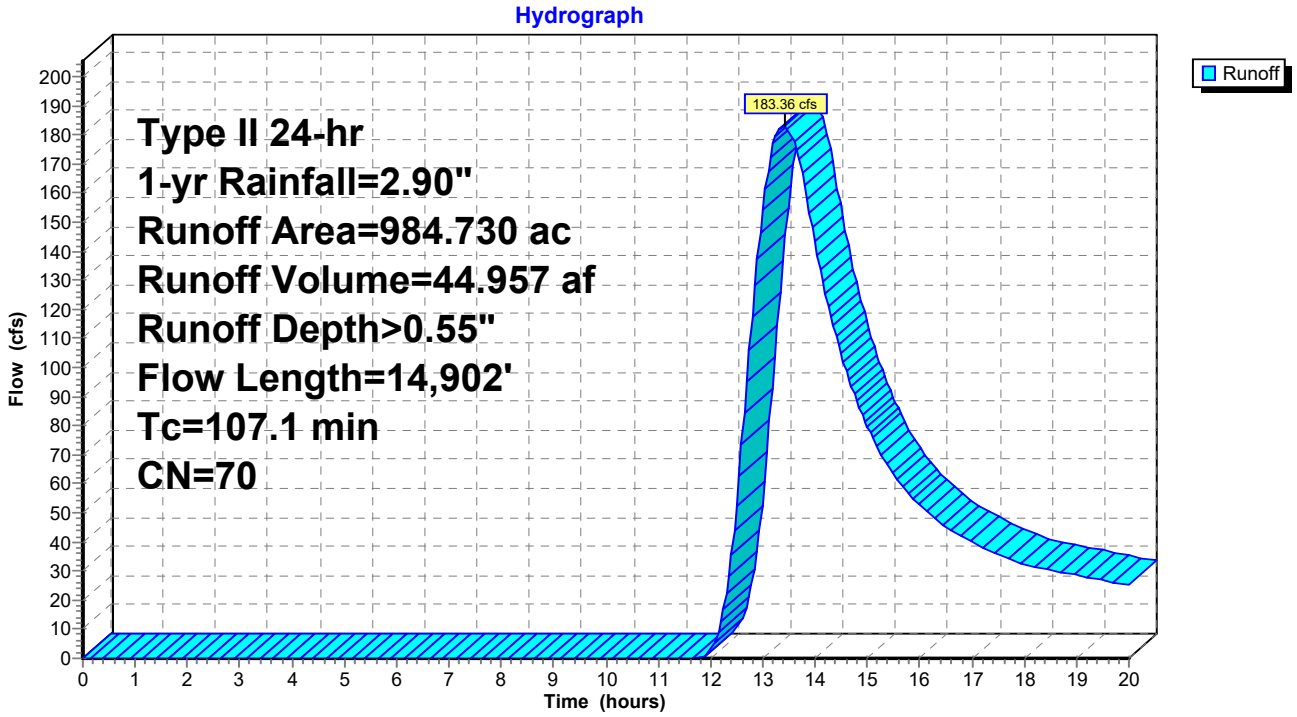
Runoff = 183.36 cfs @ 13.43 hrs, Volume= 44.957 af, Depth> 0.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-yr Rainfall=2.90"

Area (ac)	CN	Description
60.340	87	1/4 acre lots, 38% imp, HSG D
52.770	83	1/4 acre lots, 38% imp, HSG C
55.890	75	1/4 acre lots, 38% imp, HSG B
9.040	61	1/4 acre lots, 38% imp, HSG A
1.210	87	1/4 acre lots, 38% imp, HSG D
172.430	77	Woods, Good, HSG D
74.320	70	Woods, Good, HSG C
261.550	55	Woods, Good, HSG B
21.490	30	Woods, Good, HSG A
11.500	77	Woods, Good, HSG D
49.390	78	Meadow, non-grazed, HSG D
74.460	71	Meadow, non-grazed, HSG C
55.230	58	Meadow, non-grazed, HSG B
7.750	30	Meadow, non-grazed, HSG A
0.510	78	Meadow, non-grazed, HSG D
13.710	98	Water Surface, HSG D
4.520	98	Water Surface, HSG B
58.620	98	Water Surface, HSG D
984.730	70	Weighted Average
839.765		85.28% Pervious Area
144.965		14.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
37.0	150	0.0100	0.07		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.60"
42.8	2,002	0.0124	0.78		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
21.0	6,010	0.0083	4.76	119.01	**Channel Flow, C-D** Area= 25.0 sf Perim= 20.0' r= 1.25' n= 0.033 Earth, grassed & winding
6.3	6,740		17.94		**Lake or Reservoir, D-E (Queens Lake)** Mean Depth= 10.00'
107.1	14,902	Total			

Subcatchment 1Q: Queens Lake Hydrology



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Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

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Flow Length=14,902' Tc=107.1 min CN=70 Runoff=322.75 cfs 74.557 af

Total Runoff Area = 984.730 ac Runoff Volume = 74.557 af Average Runoff Depth = 0.91"
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Summary for Subcatchment 1Q: Queens Lake Hydrology

York County, VA.
GIS Soils - NRCS
GIS Landuse - VaGIN

[47] Hint: Peak is 271% of capacity of segment #3

Runoff = 322.75 cfs @ 13.35 hrs, Volume= 74.557 af, Depth> 0.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-yr Rainfall=3.60"

Area (ac)	CN	Description
60.340	87	1/4 acre lots, 38% imp, HSG D
52.770	83	1/4 acre lots, 38% imp, HSG C
55.890	75	1/4 acre lots, 38% imp, HSG B
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839.765		85.28% Pervious Area
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37.0	150	0.0100	0.07		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.60"
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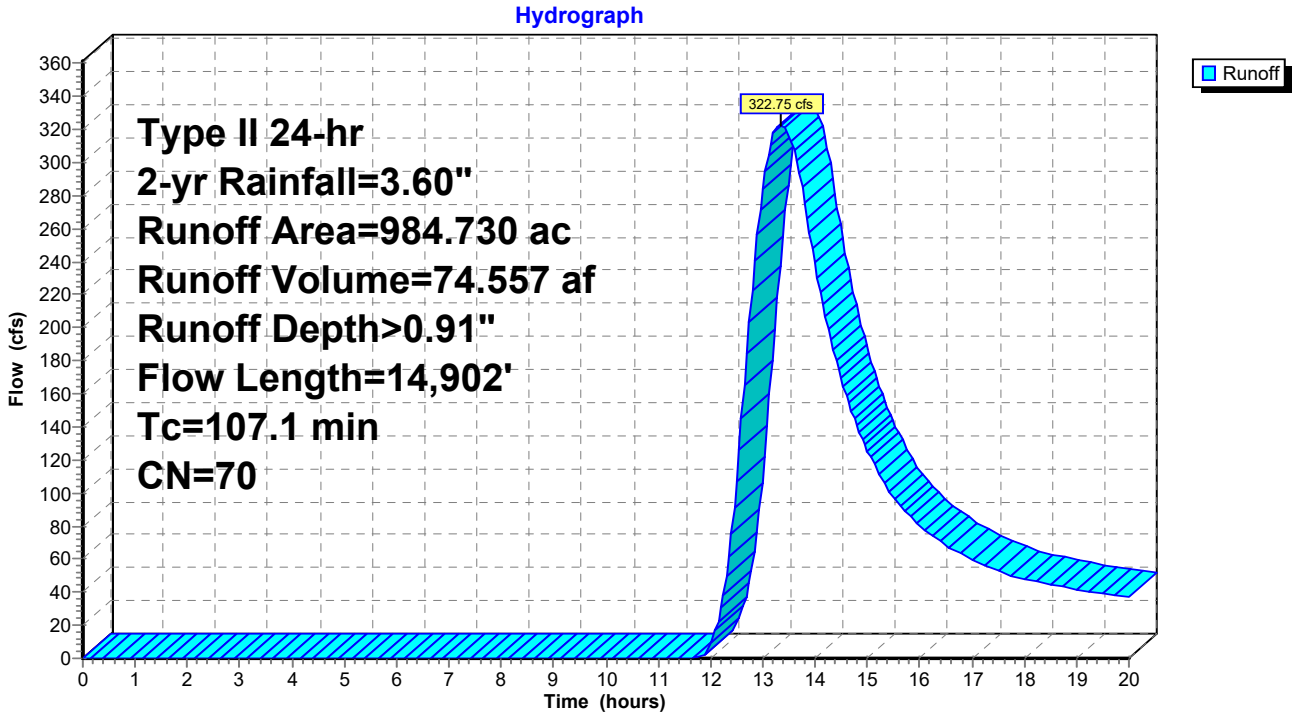
6.3	6,740		17.94		**Lake or Reservoir, D-E (Queens Lake)** Mean Depth= 10.00'
107.1	14,902	Total			

Subcatchment 1Q: Queens Lake Hydrology



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Subcatchment1Q: Queens Lake Runoff Area=984.730 ac 14.72% Impervious Runoff Depth>1.51"
Flow Length=14,902' Tc=107.1 min CN=70 Runoff=558.04 cfs 123.758 af

Total Runoff Area = 984.730 ac Runoff Volume = 123.758 af Average Runoff Depth = 1.51"
85.28% Pervious = 839.765 ac 14.72% Impervious = 144.965 ac

Summary for Subcatchment 1Q: Queens Lake Hydrology

York County, VA.
GIS Soils - NRCS
GIS Landuse - VaGIN

[47] Hint: Peak is 469% of capacity of segment #3

Runoff = 558.04 cfs @ 13.28 hrs, Volume= 123.758 af, Depth> 1.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 5-yr Rainfall=4.60"

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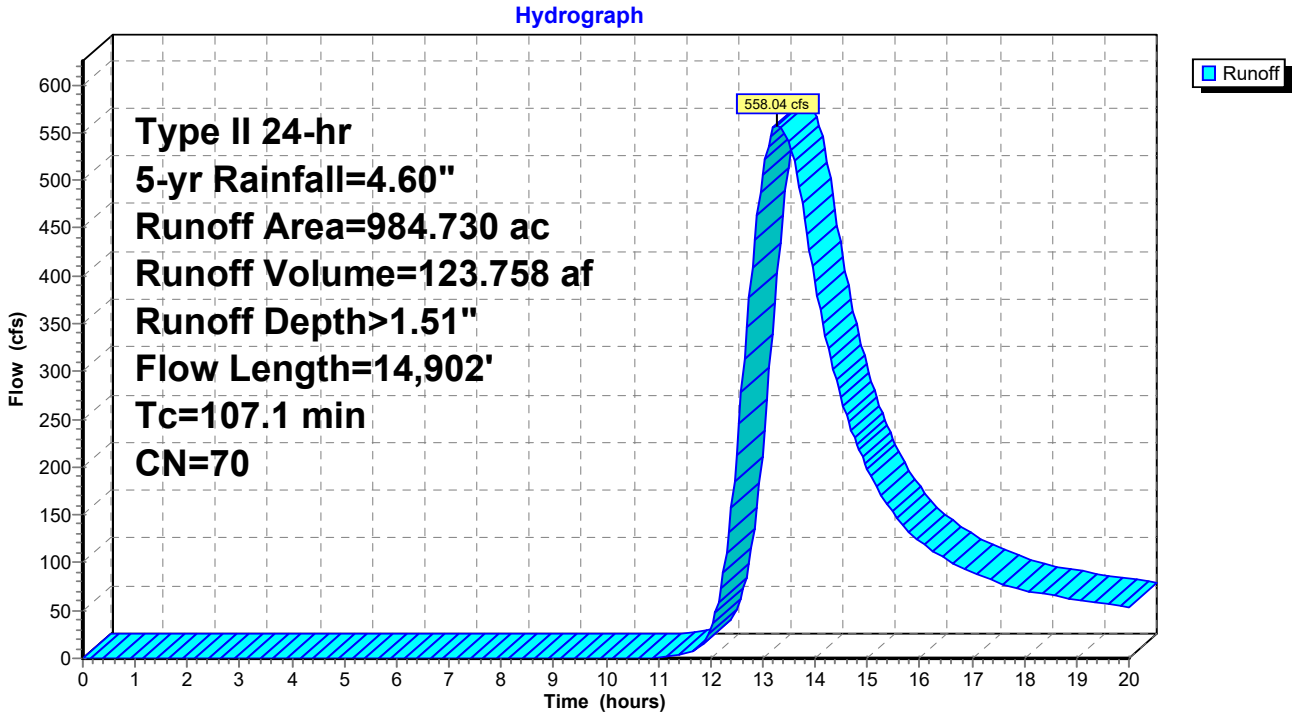
37.0	150	0.0100	0.07		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.60"
42.8	2,002	0.0124	0.78		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
21.0	6,010	0.0083	4.76	119.01	**Channel Flow, C-D** Area= 25.0 sf Perim= 20.0' r= 1.25' n= 0.033 Earth, grassed & winding
6.3	6,740		17.94		**Lake or Reservoir, D-E (Queens Lake)** Mean Depth= 10.00'
107.1	14,902	Total			

Subcatchment 1Q: Queens Lake Hydrology



Time span=0.00-20.00 hrs, dt=0.05 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1Q: Queens Lake Runoff Area=984.730 ac 14.72% Impervious Runoff Depth>2.11"
Flow Length=14,902' Tc=107.1 min CN=70 Runoff=793.41 cfs 173.027 af

Total Runoff Area = 984.730 ac Runoff Volume = 173.027 af Average Runoff Depth = 2.11"
85.28% Pervious = 839.765 ac 14.72% Impervious = 144.965 ac

Summary for Subcatchment 1Q: Queens Lake Hydrology

York County, VA.
GIS Soils - NRCS
GIS Landuse - VaGIN

[47] Hint: Peak is 667% of capacity of segment #3

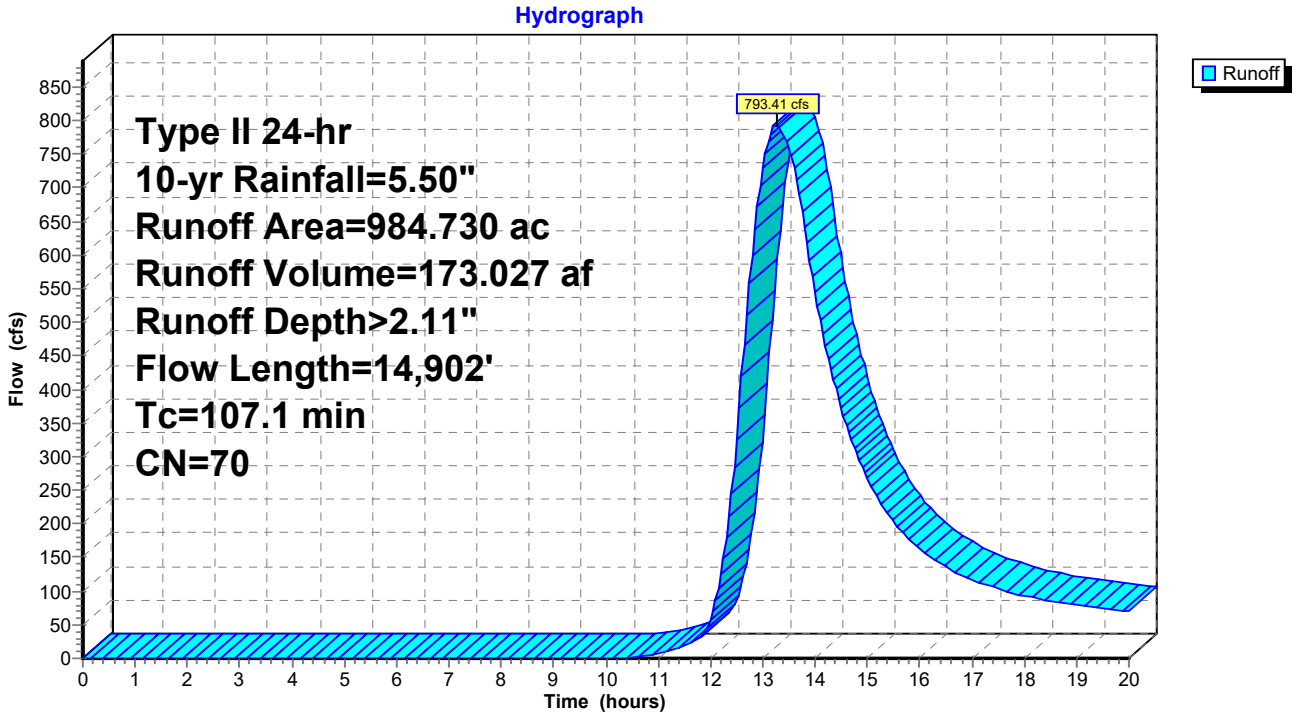
Runoff = 793.41 cfs @ 13.25 hrs, Volume= 173.027 af, Depth> 2.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-yr Rainfall=5.50"

Area (ac)	CN	Description
60.340	87	1/4 acre lots, 38% imp, HSG D
52.770	83	1/4 acre lots, 38% imp, HSG C
55.890	75	1/4 acre lots, 38% imp, HSG B
9.040	61	1/4 acre lots, 38% imp, HSG A
1.210	87	1/4 acre lots, 38% imp, HSG D
172.430	77	Woods, Good, HSG D
74.320	70	Woods, Good, HSG C
261.550	55	Woods, Good, HSG B
21.490	30	Woods, Good, HSG A
11.500	77	Woods, Good, HSG D
49.390	78	Meadow, non-grazed, HSG D
74.460	71	Meadow, non-grazed, HSG C
55.230	58	Meadow, non-grazed, HSG B
7.750	30	Meadow, non-grazed, HSG A
0.510	78	Meadow, non-grazed, HSG D
13.710	98	Water Surface, HSG D
4.520	98	Water Surface, HSG B
58.620	98	Water Surface, HSG D
984.730	70	Weighted Average
839.765		85.28% Pervious Area
144.965		14.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
37.0	150	0.0100	0.07		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.60"
42.8	2,002	0.0124	0.78		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
21.0	6,010	0.0083	4.76	119.01	**Channel Flow, C-D** Area= 25.0 sf Perim= 20.0' r= 1.25' n= 0.033 Earth, grassed & winding
6.3	6,740		17.94		**Lake or Reservoir, D-E (Queens Lake)** Mean Depth= 10.00'
107.1	14,902	Total			

Subcatchment 1Q: Queens Lake Hydrology



Time span=0.00-20.00 hrs, dt=0.05 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1Q: Queens Lake Runoff Area=984.730 ac 14.72% Impervious Runoff Depth>3.05"
Flow Length=14,902' Tc=107.1 min CN=70 Runoff=1,157.87 cfs 249.995 af

Total Runoff Area = 984.730 ac Runoff Volume = 249.995 af Average Runoff Depth = 3.05"
85.28% Pervious = 839.765 ac 14.72% Impervious = 144.965 ac

Summary for Subcatchment 1Q: Queens Lake Hydrology

York County, VA.
GIS Soils - NRCS
GIS Landuse - VaGIN

[47] Hint: Peak is 973% of capacity of segment #3

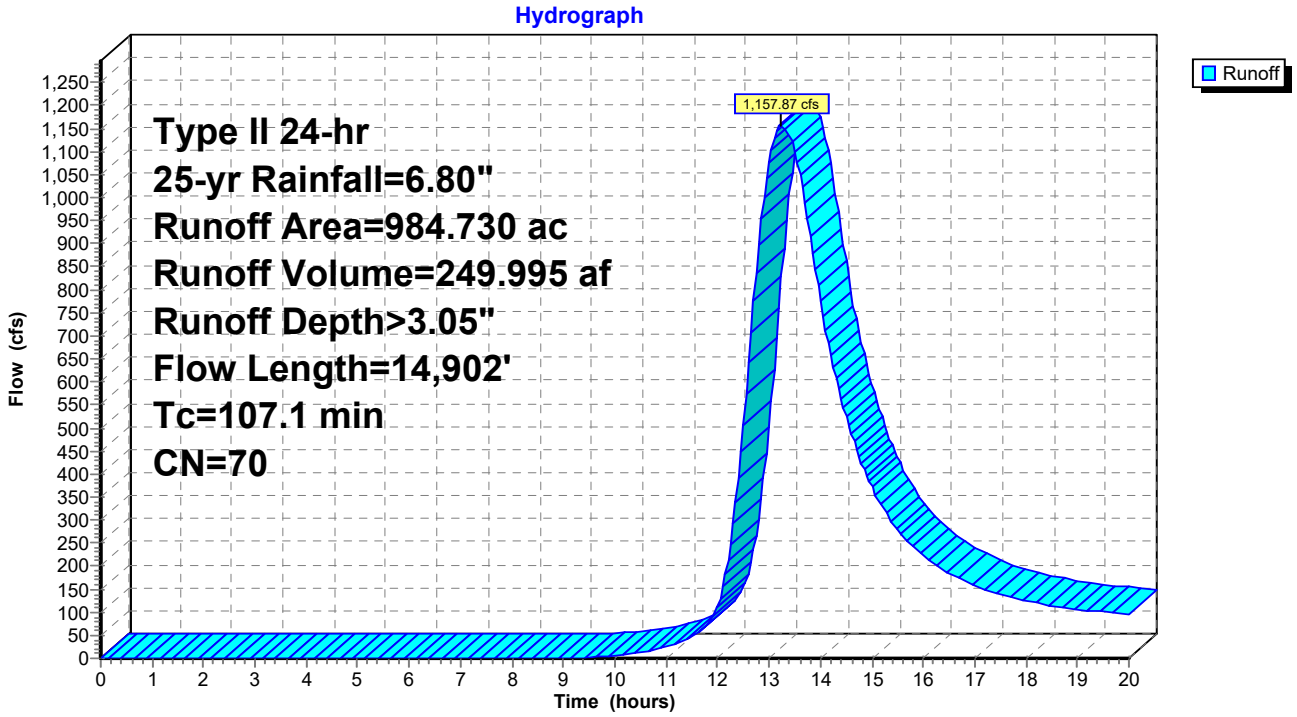
Runoff = 1,157.87 cfs @ 13.23 hrs, Volume= 249.995 af, Depth> 3.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr Rainfall=6.80"

Area (ac)	CN	Description
60.340	87	1/4 acre lots, 38% imp, HSG D
52.770	83	1/4 acre lots, 38% imp, HSG C
55.890	75	1/4 acre lots, 38% imp, HSG B
9.040	61	1/4 acre lots, 38% imp, HSG A
1.210	87	1/4 acre lots, 38% imp, HSG D
172.430	77	Woods, Good, HSG D
74.320	70	Woods, Good, HSG C
261.550	55	Woods, Good, HSG B
21.490	30	Woods, Good, HSG A
11.500	77	Woods, Good, HSG D
49.390	78	Meadow, non-grazed, HSG D
74.460	71	Meadow, non-grazed, HSG C
55.230	58	Meadow, non-grazed, HSG B
7.750	30	Meadow, non-grazed, HSG A
0.510	78	Meadow, non-grazed, HSG D
13.710	98	Water Surface, HSG D
4.520	98	Water Surface, HSG B
58.620	98	Water Surface, HSG D
984.730	70	Weighted Average
839.765		85.28% Pervious Area
144.965		14.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
37.0	150	0.0100	0.07		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.60"
42.8	2,002	0.0124	0.78		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
21.0	6,010	0.0083	4.76	119.01	**Channel Flow, C-D** Area= 25.0 sf Perim= 20.0' r= 1.25' n= 0.033 Earth, grassed & winding
6.3	6,740		17.94		**Lake or Reservoir, D-E (Queens Lake)** Mean Depth= 10.00'
107.1	14,902	Total			

Subcatchment 1Q: Queens Lake Hydrology



Time span=0.00-20.00 hrs, dt=0.05 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1Q: Queens Lake Runoff Area=984.730 ac 14.72% Impervious Runoff Depth>3.96"
Flow Length=14,902' Tc=107.1 min CN=70 Runoff=1,512.37 cfs 325.360 af

Total Runoff Area = 984.730 ac Runoff Volume = 325.360 af Average Runoff Depth = 3.96"
85.28% Pervious = 839.765 ac 14.72% Impervious = 144.965 ac

Summary for Subcatchment 1Q: Queens Lake Hydrology

York County, VA.
GIS Soils - NRCS
GIS Landuse - VaGIN

[47] Hint: Peak is 1271% of capacity of segment #3

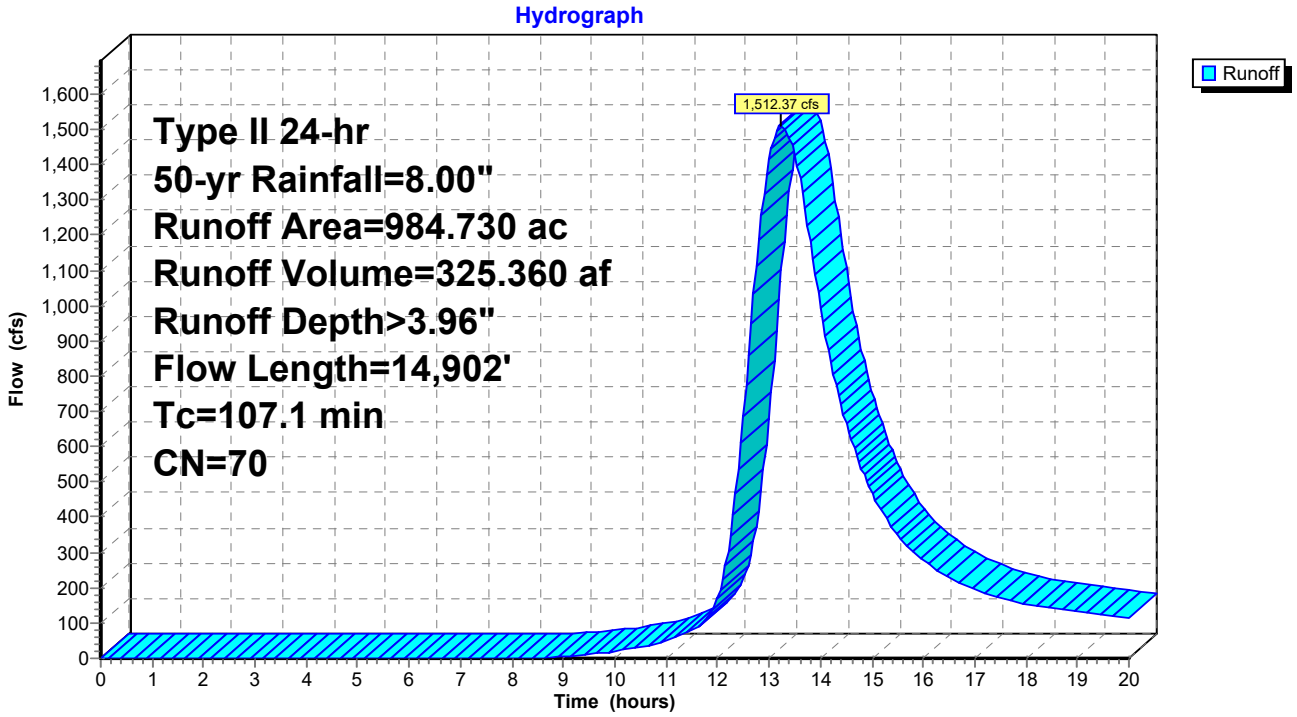
Runoff = 1,512.37 cfs @ 13.22 hrs, Volume= 325.360 af, Depth> 3.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-yr Rainfall=8.00"

Area (ac)	CN	Description
60.340	87	1/4 acre lots, 38% imp, HSG D
52.770	83	1/4 acre lots, 38% imp, HSG C
55.890	75	1/4 acre lots, 38% imp, HSG B
9.040	61	1/4 acre lots, 38% imp, HSG A
1.210	87	1/4 acre lots, 38% imp, HSG D
172.430	77	Woods, Good, HSG D
74.320	70	Woods, Good, HSG C
261.550	55	Woods, Good, HSG B
21.490	30	Woods, Good, HSG A
11.500	77	Woods, Good, HSG D
49.390	78	Meadow, non-grazed, HSG D
74.460	71	Meadow, non-grazed, HSG C
55.230	58	Meadow, non-grazed, HSG B
7.750	30	Meadow, non-grazed, HSG A
0.510	78	Meadow, non-grazed, HSG D
13.710	98	Water Surface, HSG D
4.520	98	Water Surface, HSG B
58.620	98	Water Surface, HSG D
984.730	70	Weighted Average
839.765		85.28% Pervious Area
144.965		14.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
37.0	150	0.0100	0.07		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.60"
42.8	2,002	0.0124	0.78		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
21.0	6,010	0.0083	4.76	119.01	**Channel Flow, C-D** Area= 25.0 sf Perim= 20.0' r= 1.25' n= 0.033 Earth, grassed & winding
6.3	6,740		17.94		**Lake or Reservoir, D-E (Queens Lake)** Mean Depth= 10.00'
107.1	14,902	Total			

Subcatchment 1Q: Queens Lake Hydrology



Time span=0.00-20.00 hrs, dt=0.05 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1Q: Queens Lake Runoff Area=984.730 ac 14.72% Impervious Runoff Depth>5.00"
Flow Length=14,902' Tc=107.1 min CN=70 Runoff=1,906.20 cfs 410.315 af

Total Runoff Area = 984.730 ac Runoff Volume = 410.315 af Average Runoff Depth = 5.00"
85.28% Pervious = 839.765 ac 14.72% Impervious = 144.965 ac

Summary for Subcatchment 1Q: Queens Lake Hydrology

York County, VA.
GIS Soils - NRCS
GIS Landuse - VaGIN

[47] Hint: Peak is 1602% of capacity of segment #3

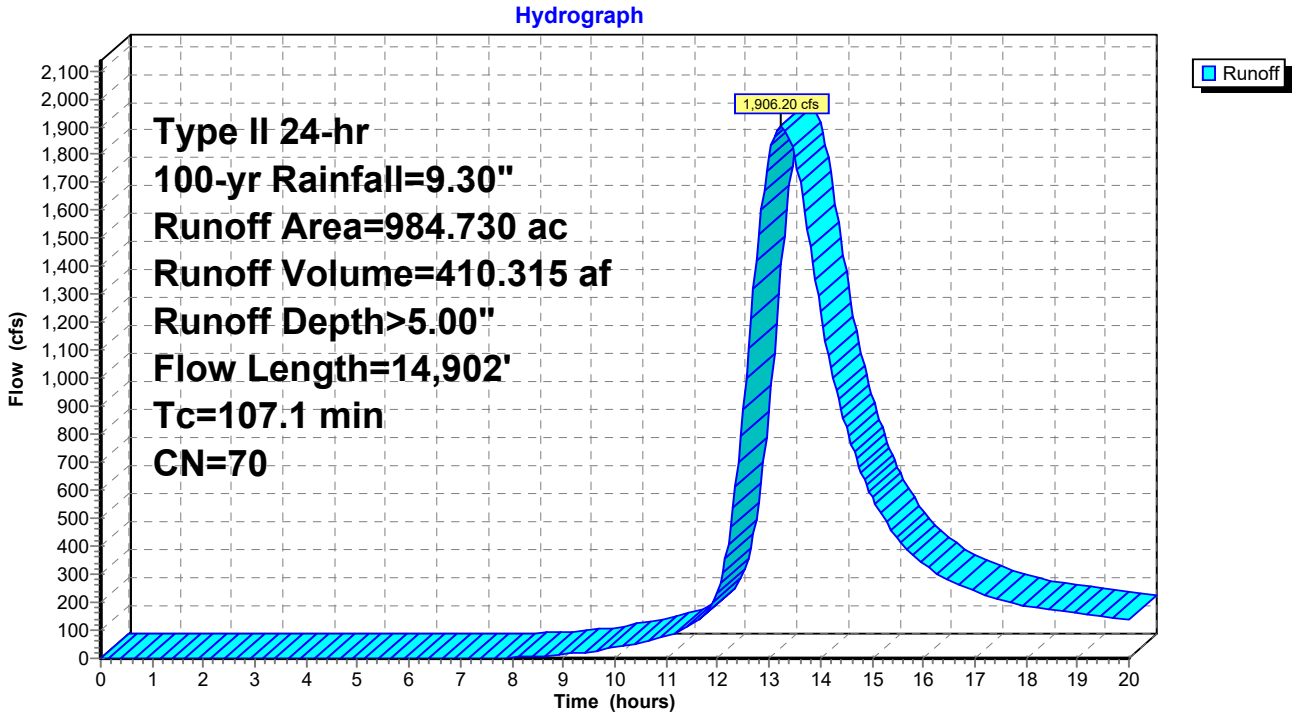
Runoff = 1,906.20 cfs @ 13.22 hrs, Volume= 410.315 af, Depth> 5.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-yr Rainfall=9.30"

Area (ac)	CN	Description
60.340	87	1/4 acre lots, 38% imp, HSG D
52.770	83	1/4 acre lots, 38% imp, HSG C
55.890	75	1/4 acre lots, 38% imp, HSG B
9.040	61	1/4 acre lots, 38% imp, HSG A
1.210	87	1/4 acre lots, 38% imp, HSG D
172.430	77	Woods, Good, HSG D
74.320	70	Woods, Good, HSG C
261.550	55	Woods, Good, HSG B
21.490	30	Woods, Good, HSG A
11.500	77	Woods, Good, HSG D
49.390	78	Meadow, non-grazed, HSG D
74.460	71	Meadow, non-grazed, HSG C
55.230	58	Meadow, non-grazed, HSG B
7.750	30	Meadow, non-grazed, HSG A
0.510	78	Meadow, non-grazed, HSG D
13.710	98	Water Surface, HSG D
4.520	98	Water Surface, HSG B
58.620	98	Water Surface, HSG D
984.730	70	Weighted Average
839.765		85.28% Pervious Area
144.965		14.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
37.0	150	0.0100	0.07		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.60"
42.8	2,002	0.0124	0.78		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
21.0	6,010	0.0083	4.76	119.01	**Channel Flow, C-D** Area= 25.0 sf Perim= 20.0' r= 1.25' n= 0.033 Earth, grassed & winding
6.3	6,740		17.94		**Lake or Reservoir, D-E (Queens Lake)** Mean Depth= 10.00'
107.1	14,902	Total			

Subcatchment 1Q: Queens Lake Hydrology



Time span=0.00-20.00 hrs, dt=0.05 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1Q: Queens Lake Runoff Area=984.730 ac 14.72% Impervious Runoff Depth=32.71"
Flow Length=14,902' Tc=107.1 min CN=70 Runoff=12,642.78 cfs 2,683.964 af

Total Runoff Area = 984.730 ac Runoff Volume = 2,683.964 af Average Runoff Depth = 32.71"
85.28% Pervious = 839.765 ac 14.72% Impervious = 144.965 ac

Summary for Subcatchment 1Q: Queens Lake Hydrology

York County, VA.
GIS Soils - NRCS
GIS Landuse - VaGIN

[47] Hint: Peak is 10623% of capacity of segment #3

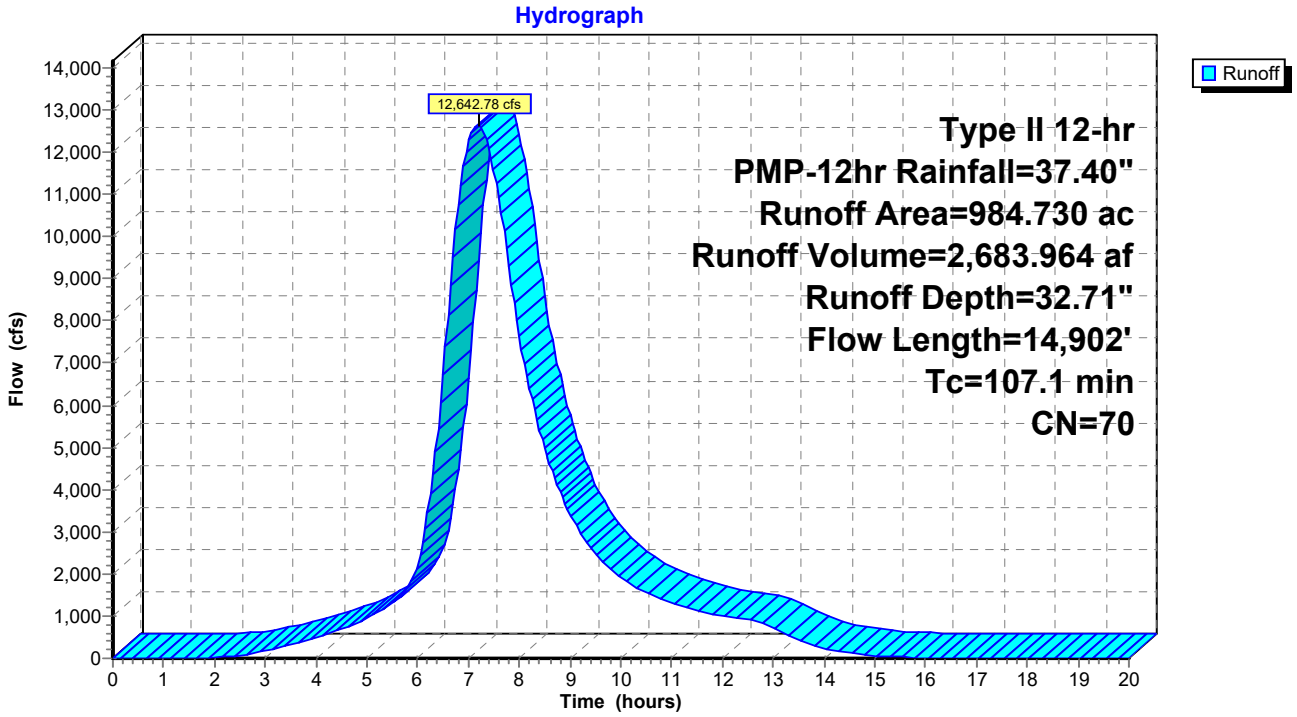
Runoff = 12,642.78 cfs @ 7.20 hrs, Volume= 2,683.964 af, Depth=32.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 12-hr PMP-12hr Rainfall=37.40"

Area (ac)	CN	Description
60.340	87	1/4 acre lots, 38% imp, HSG D
52.770	83	1/4 acre lots, 38% imp, HSG C
55.890	75	1/4 acre lots, 38% imp, HSG B
9.040	61	1/4 acre lots, 38% imp, HSG A
1.210	87	1/4 acre lots, 38% imp, HSG D
172.430	77	Woods, Good, HSG D
74.320	70	Woods, Good, HSG C
261.550	55	Woods, Good, HSG B
21.490	30	Woods, Good, HSG A
11.500	77	Woods, Good, HSG D
49.390	78	Meadow, non-grazed, HSG D
74.460	71	Meadow, non-grazed, HSG C
55.230	58	Meadow, non-grazed, HSG B
7.750	30	Meadow, non-grazed, HSG A
0.510	78	Meadow, non-grazed, HSG D
13.710	98	Water Surface, HSG D
4.520	98	Water Surface, HSG B
58.620	98	Water Surface, HSG D
984.730	70	Weighted Average
839.765		85.28% Pervious Area
144.965		14.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
37.0	150	0.0100	0.07		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.60"
42.8	2,002	0.0124	0.78		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
21.0	6,010	0.0083	4.76	119.01	**Channel Flow, C-D** Area= 25.0 sf Perim= 20.0' r= 1.25' n= 0.033 Earth, grassed & winding
6.3	6,740		17.94		**Lake or Reservoir, D-E (Queens Lake)** Mean Depth= 10.00'
107.1	14,902	Total			

Subcatchment 1Q: Queens Lake Hydrology



Time span=0.00-20.00 hrs, dt=0.05 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1Q: Queens Lake Runoff Area=984.730 ac 14.72% Impervious Runoff Depth>30.00"
Flow Length=14,902' Tc=107.1 min CN=70 Runoff=10,727.46 cfs 2,461.600 af

Total Runoff Area = 984.730 ac Runoff Volume = 2,461.600 af Average Runoff Depth = 30.00"
85.28% Pervious = 839.765 ac 14.72% Impervious = 144.965 ac

Summary for Subcatchment 1Q: Queens Lake Hydrology

York County, VA.
GIS Soils - NRCS
GIS Landuse - VaGIN

[47] Hint: Peak is 9014% of capacity of segment #3

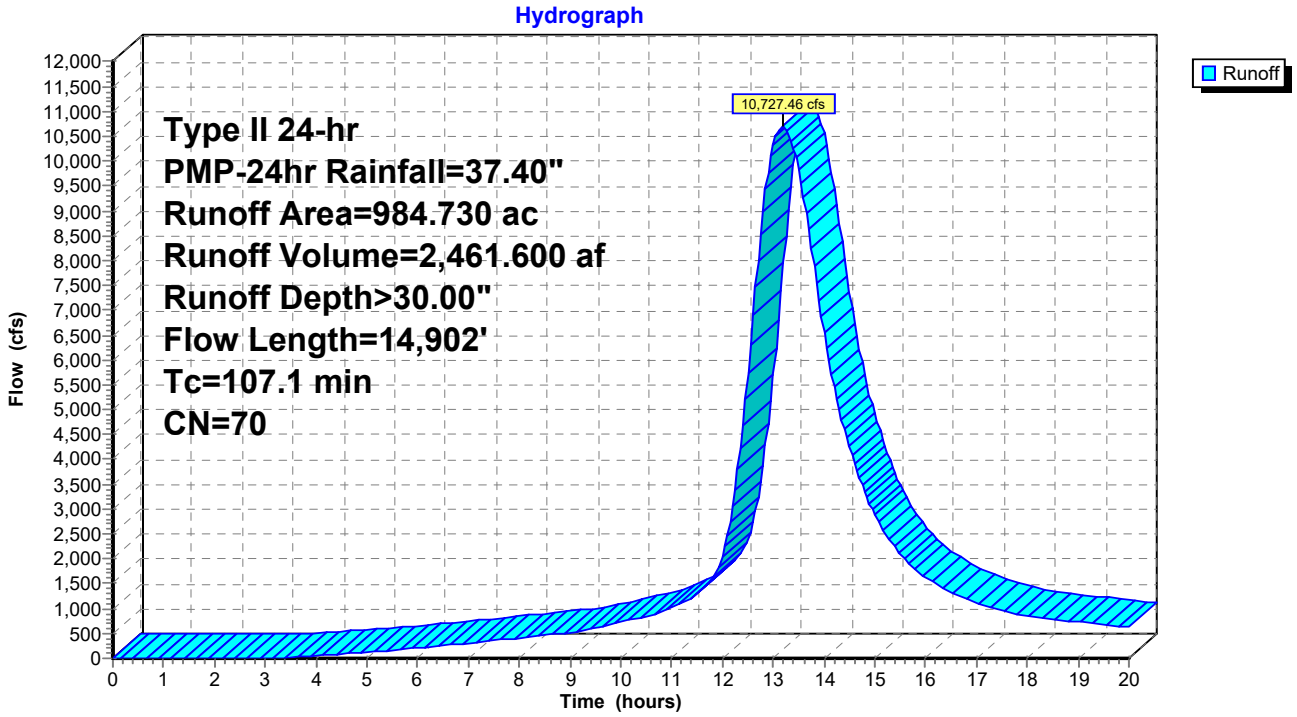
Runoff = 10,727.46 cfs @ 13.20 hrs, Volume= 2,461.600 af, Depth>30.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr PMP-24hr Rainfall=37.40"

Area (ac)	CN	Description
60.340	87	1/4 acre lots, 38% imp, HSG D
52.770	83	1/4 acre lots, 38% imp, HSG C
55.890	75	1/4 acre lots, 38% imp, HSG B
9.040	61	1/4 acre lots, 38% imp, HSG A
1.210	87	1/4 acre lots, 38% imp, HSG D
172.430	77	Woods, Good, HSG D
74.320	70	Woods, Good, HSG C
261.550	55	Woods, Good, HSG B
21.490	30	Woods, Good, HSG A
11.500	77	Woods, Good, HSG D
49.390	78	Meadow, non-grazed, HSG D
74.460	71	Meadow, non-grazed, HSG C
55.230	58	Meadow, non-grazed, HSG B
7.750	30	Meadow, non-grazed, HSG A
0.510	78	Meadow, non-grazed, HSG D
13.710	98	Water Surface, HSG D
4.520	98	Water Surface, HSG B
58.620	98	Water Surface, HSG D
984.730	70	Weighted Average
839.765		85.28% Pervious Area
144.965		14.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
37.0	150	0.0100	0.07		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.60"
42.8	2,002	0.0124	0.78		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
21.0	6,010	0.0083	4.76	119.01	**Channel Flow, C-D** Area= 25.0 sf Perim= 20.0' r= 1.25' n= 0.033 Earth, grassed & winding
6.3	6,740		17.94		**Lake or Reservoir, D-E (Queens Lake)** Mean Depth= 10.00'
107.1	14,902	Total			

Subcatchment 1Q: Queens Lake Hydrology



Time span=0.00-20.00 hrs, dt=0.05 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1Q: Queens Lake Runoff Area=984.730 ac 14.72% Impervious Runoff Depth=28.16"
Flow Length=14,902' Tc=107.1 min CN=70 Runoff=12,766.25 cfs 2,311.172 af

Total Runoff Area = 984.730 ac Runoff Volume = 2,311.172 af Average Runoff Depth = 28.16"
85.28% Pervious = 839.765 ac 14.72% Impervious = 144.965 ac

Summary for Subcatchment 1Q: Queens Lake Hydrology

York County, VA.
GIS Soils - NRCS
GIS Landuse - VaGIN

[47] Hint: Peak is 10727% of capacity of segment #3

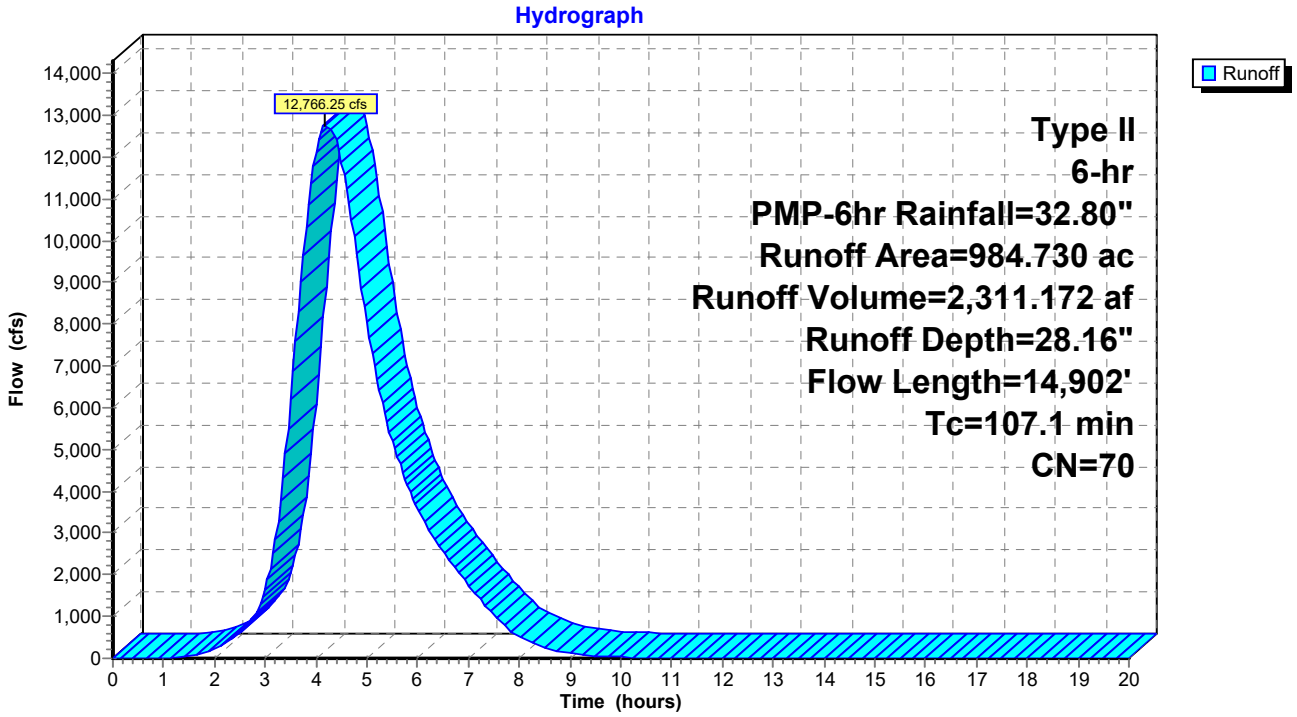
Runoff = 12,766.25 cfs @ 4.19 hrs, Volume= 2,311.172 af, Depth=28.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 6-hr PMP-6hr Rainfall=32.80"

Area (ac)	CN	Description
60.340	87	1/4 acre lots, 38% imp, HSG D
52.770	83	1/4 acre lots, 38% imp, HSG C
55.890	75	1/4 acre lots, 38% imp, HSG B
9.040	61	1/4 acre lots, 38% imp, HSG A
1.210	87	1/4 acre lots, 38% imp, HSG D
172.430	77	Woods, Good, HSG D
74.320	70	Woods, Good, HSG C
261.550	55	Woods, Good, HSG B
21.490	30	Woods, Good, HSG A
11.500	77	Woods, Good, HSG D
49.390	78	Meadow, non-grazed, HSG D
74.460	71	Meadow, non-grazed, HSG C
55.230	58	Meadow, non-grazed, HSG B
7.750	30	Meadow, non-grazed, HSG A
0.510	78	Meadow, non-grazed, HSG D
13.710	98	Water Surface, HSG D
4.520	98	Water Surface, HSG B
58.620	98	Water Surface, HSG D
984.730	70	Weighted Average
839.765		85.28% Pervious Area
144.965		14.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
37.0	150	0.0100	0.07		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.60"
42.8	2,002	0.0124	0.78		**Shallow Concentrated Flow, B-C** Short Grass Pasture Kv= 7.0 fps
21.0	6,010	0.0083	4.76	119.01	**Channel Flow, C-D** Area= 25.0 sf Perim= 20.0' r= 1.25' n= 0.033 Earth, grassed & winding
6.3	6,740		17.94		**Lake or Reservoir, D-E (Queens Lake)** Mean Depth= 10.00'
107.1	14,902	Total			

Subcatchment 1Q: Queens Lake Hydrology



United States Department of Agriculture

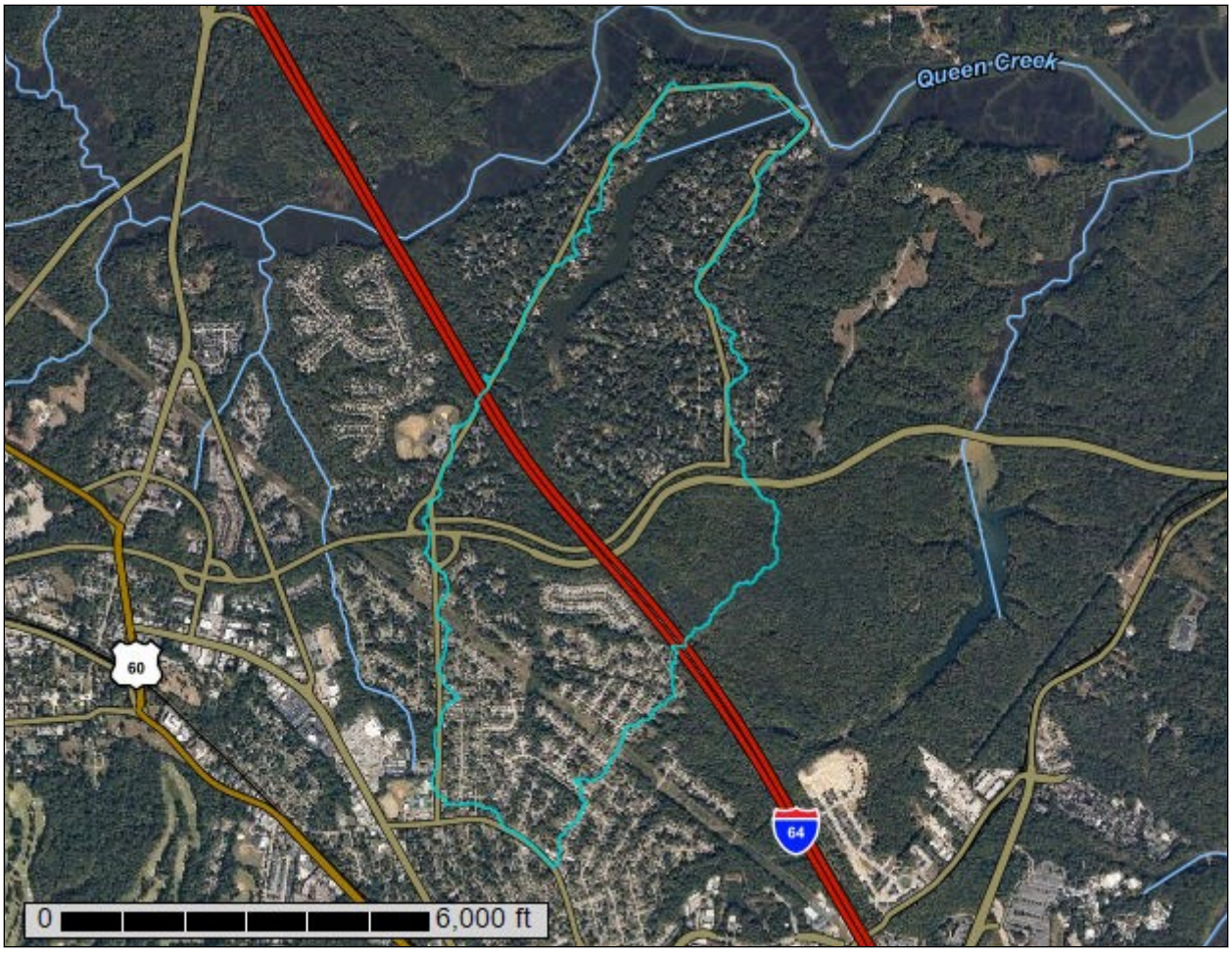
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

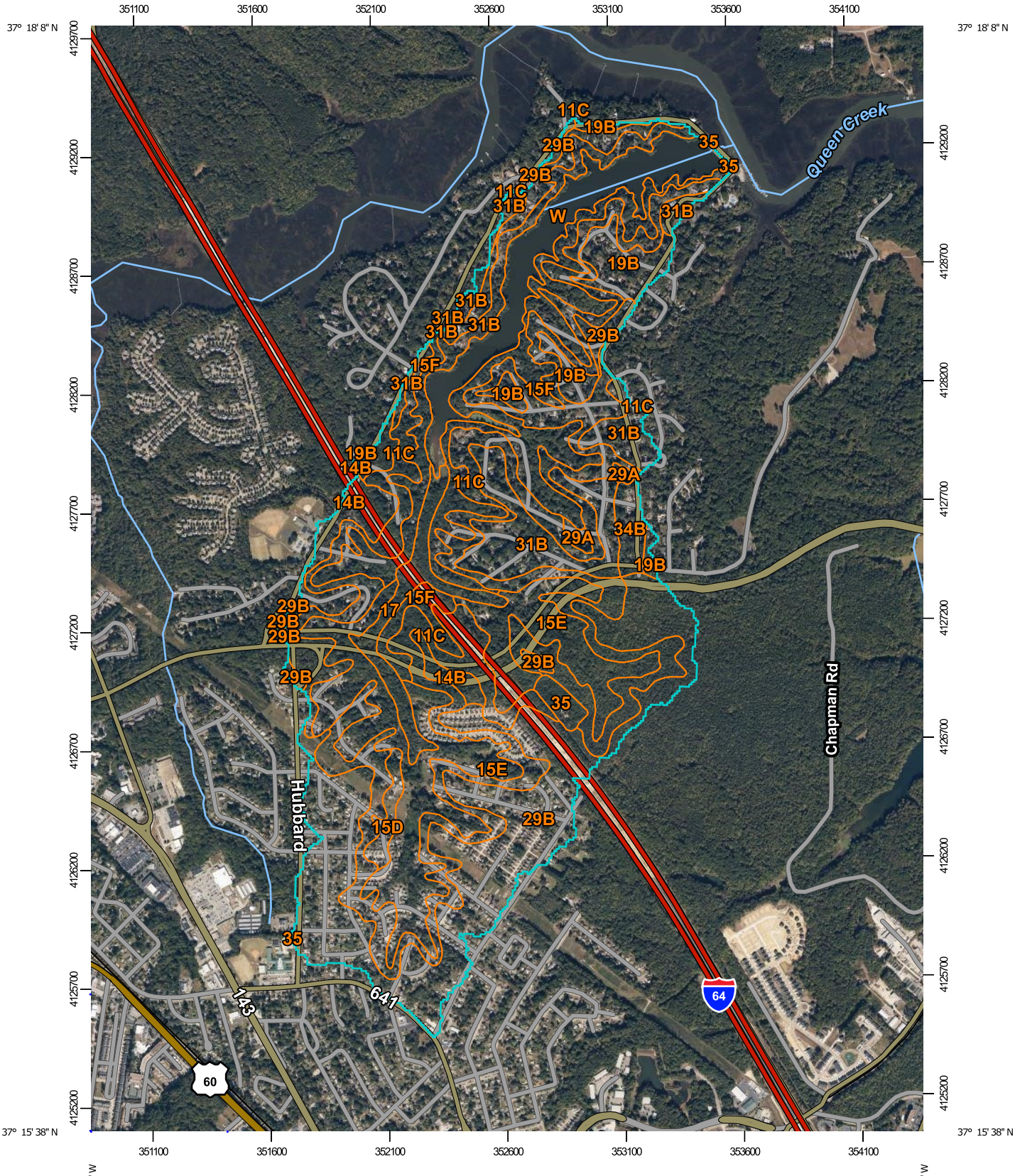
Custom Soil Resource Report for James City and York Counties and the City of Williamsburg, Virginia

QUEENS LAKE - SOILS



January 11, 2021

Custom Soil Resource Report
Soil Map



Map Scale: 1:22,700 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 300 600 1200 1800

Feet: 0 1000 2000 4000 6000

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 Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

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 1:15,800.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
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: James City and York Counties and the City of Williamsburg, Virginia
Survey Area Data: Version 18, Jun 15, 2020

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

Date(s) aerial images were photographed: Oct 11, 2019—Oct 15, 2019

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.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
11C	Craven-Uchee complex, 6 to 10 percent slopes	267.2	27.1%
14B	Emporia fine sandy loam, 2 to 6 percent slopes	26.5	2.7%
15D	Emporia complex, 10 to 15 percent slopes	8.1	0.8%
15E	Emporia complex, 15 to 25 percent slopes	134.4	13.7%
15F	Emporia complex, 25 to 50 percent slopes	129.3	13.1%
17	Johnston complex	26.9	2.7%
19B	Kempsville-Emporia fine sandy loams, 2 to 6 percent slopes	38.3	3.9%
29A	Slagle fine sandy loam, 0 to 2 percent slopes	3.6	0.4%
29B	Slagle fine sandy loam, 2 to 6 percent slopes	198.0	20.1%
31B	Suffolk fine sandy loam, 2 to 6 percent slopes	68.4	6.9%
34B	Uchee loamy fine sand, 2 to 6 percent slopes	10.5	1.1%
35	Udorthents, loamy	7.0	0.7%
W	Water	66.6	6.8%
Totals for Area of Interest		**984.8**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

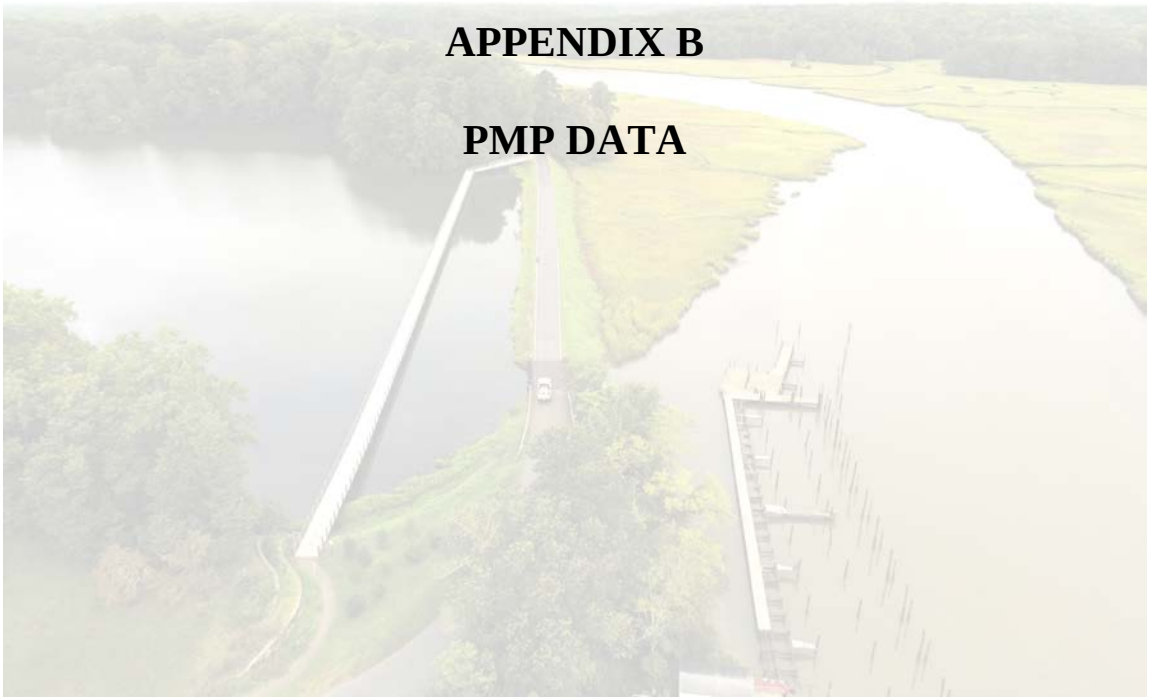
An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion

of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Queens Lake Dam
Inventory #199016

Inundation Study
Williamsburg, Virginia



APPENDIX B

PMP DATA

Note : This sheet should be used in consultation with the *Guidance Document on New Probable Maximum Precipitation (PMP) Implementation* (March 23, 2016) and the *Certification Form: Review of New Probable Maximum Precipitation Values (Effective March 23, 2016) Using the PMP Evaluation Tool* .

Virginia 2015 PMP Watershed Calculation Worksheet (SEPTEMBER 2016 version)

Dam: Queens Lake Dam (Inventory 199016)
Company: AMT, Inc.
Engineer:

Date: 1/20/2021

NOTES

A. PLEASE ENSURE ALL RELEVANT SECTIONS ARE FILLED OUT (PLEASE SCROLL DOWN THROUGH ENTIRE WORKSHEET)
B. PLEASE ENSURE CELLS WITH EMBEDDED CALCULATIONS (CELLS WITH NO BLUE COLOR) ARE REFERENCING THE CORRECT NUMBERS. WHEN ADDING OR DELETING ROWS FOR GRID POINTS, CELLS WITH EMBEDDED CALCULATIONS MAY BE REFERENCING THE WRONG INFORMATION. PLEASE CHECK CALCULATION CELLS!
C. PLEASE ENSURE THAT ALL SUPPORTING DOCUMENTATION AND CALCULATIONS REQUIRED FOR THIS SUMMARY SHEET ARE INCLUDED IN SUBMITTAL (ESPECIALLY INFORMATION FOR SDF CALCULATIONS IN SECTIONS E AND F).

Example Cell	**Cells Requiring User Input are Highlighted in Blue**

Calculation Section A - Drainage Area to Dam

Information obtained from GIS shapefile / watershed boundary analysis or previously completed Dam Failure Analysis

Drainage Area	985.60	1.540
	Acres	Sq. Miles

Calculation Section B - Original HMR 51/52 Values

Information obtained from previously computed HMR 51/52 program (previously completed Dam Failure Analysis)

6-hr HMR 51/52 PMP Value	25	in / 6-hr
12-hr HMR 51/52 PMP Value	30	in / 12-hr
24-hr HMR 51/52 PMP Value	35	in / 24-hr

Calculation Section C - New 2015 PMP Values

Information obtained from new 2015 PMP GIS Evaluation Tool (see the PMP section of the DCR Dam Safety website for more details)

General Storm Events

Grid Pts	Point X	Point Y	Zone	6 Hr. PMP	12 Hr. PMP	24 Hr. PMP	Controlling 6 Hr. Storm	Controlling 12 Hr. Storm	Controlling 24 Hr. Storm
1	-76.675	37.275	7	8.4	15	22.7	SPAS_1201_1	SPAS_1201_1	SPAS_1201_1
2	-76.65	37.275	7	8.4	15	22.7	SPAS_1201_1	SPAS_1201_1	SPAS_1201_1
3	-76.675	37.3	7	8.4	15	22.7	SPAS_1201_1	SPAS_1201_1	SPAS_1201_1
4	-76.65	37.3	7	8.4	15	22.7	SPAS_1201_1	SPAS_1201_1	SPAS_1201_1

Average PMP Values:	8.4	15.0	22.7

Local Storm Events

Grid Pts	Point X	Point Y	Zone	6 Hr. PMP	12 Hr. PMP	24 Hr. PMP	Controlling 6 Hr. Storm	Controlling 12 Hr. Storm	Controlling 24 Hr. Storm
1	-76.675	37.275	7	32.8	37.4	37.4	SPAS_1534_1	SPAS_1534_1	SPAS_1534_1
2	-76.65	37.275	7	32.8	37.4	37.4	SPAS_1534_1	SPAS_1534_1	SPAS_1534_1
3	-76.675	37.3	7	32.8	37.4	37.4	SPAS_1534_1	SPAS_1534_1	SPAS_1534_1
4	-76.65	37.3	7	32.8	37.3	37.3	SPAS_1534_1	SPAS_1534_1	SPAS_1534_1

Average PMP Values:	32.8	37.4	37.4

Tropical Storm Events

Grid Pts	Point X	Point Y	Zone	6 Hr. PMP	12 Hr. PMP	24 Hr. PMP	Controlling 6 Hr. Storm	Controlling 12 Hr. Storm	Controlling 24 Hr. Storm
1	-76.675	37.275	7	23.4	35.8	35.8	SPAS_1491_1	SPAS_1491_1	SPAS_1491_1
2	-76.65	37.275	7	23.5	35.9	35.9	SPAS_1491_1	SPAS_1491_1	SPAS_1491_1
3	-76.675	37.3	7	23.4	35.8	35.8	SPAS_1491_1	SPAS_1491_1	SPAS_1491_1
4	-76.65	37.3	7	23.5	35.9	35.9	SPAS_1491_1	SPAS_1491_1	SPAS_1491_1

Average PMP Values:	23.4	35.8	35.8

Governing PMP Values from Storm Events

	6 Hr. PMP	12 Hr. PMP	24 Hr. PMP
Governing PMP Values for Watershed	**32.8**	**37.4**	**37.4**

Calculation Section D - Comparison Calculations - Original HMR 51/52 Values vs. New 2015 PMP Values

Information for these calculations obtained from data provided in this spreadsheet. Section provides comparison between HMR 51/52 rainfall values and new 2015 PMP rainfall values. Please review options presented below and DCR Dam Safety PMP Guidance Documentation to determine if SDF calculations are required (next section).

Storm Duration, hrs.	HMR 51/52 Value, in/hr	Governing 2015 PMP Value, in/hr	Comparison	Percent Difference, %
6	25	32.8	**7.80**	31.20%
12	30	37.4	**7.37**	24.58%
24	35	37.4	**2.37**	6.79%

Section Completion Options

Option A - The Dam in question has no previously completed (or approved) Inundation Study and will only be utilizing the Governing 2015 PMP values for the new Dam Failure Analysis. Calculation Section E and Calculation Section F are not required as the SDF for the Dam in question will be calculated from the new Dam Failure Analysis. This option only applies to Dams with no previously completed (or approved) Inundation Study on file with DCR Dam Safety.

Option B - All three of the new Governing 2015 PMP values decreased when compared to the previously completed HMR 51/52 values (negative values for all three storm durations in the comparison column above). At this time, revisions to the existing Inundation Maps / EAPs for the Dam in question are optional and not generally required [Please refer to the *Guidance Document on New Probable Maximum Precipitation (PMP) Implementation* for further details, restrictions, and exceptions]. Please fill out information below in Calculation Section E Only. Calculation Section F is not required for this option.

Option C - One or two of the new Governing 2015 PMP values increased when compared to the previously completed HMR 51/52 values (positive values for one or two storm durations in the comparison column above). At this time, revisions to the existing Inundation Maps / EAPs for the Dam in question may be required depending on further analysis of the Dam in question [Please refer to the *Guidance Document on New Probable Maximum Precipitation (PMP) Implementation* for further details, restrictions, and exceptions]. Please fill out information below in Calculation Section E and Calculation Section F as both are required. It must be determined if either of these new increased PMP values have become the controlling storm for the basin in question.

Option D - All of the new Governing 2015 PMP values increased when compared to the previously completed HMR 51/52 values (positive values for all three storm durations in the comparison column above). At this time revisions to the existing Inundation Maps / EAP's for the Dam in question will be required for the Dam in question [Please refer to the *Guidance Document on New Probable Maximum Precipitation (PMP) Implementation* for further details, restrictions, and exceptions]. Please fill out information below in Calculation Section E and Calculation Section F as both are required.

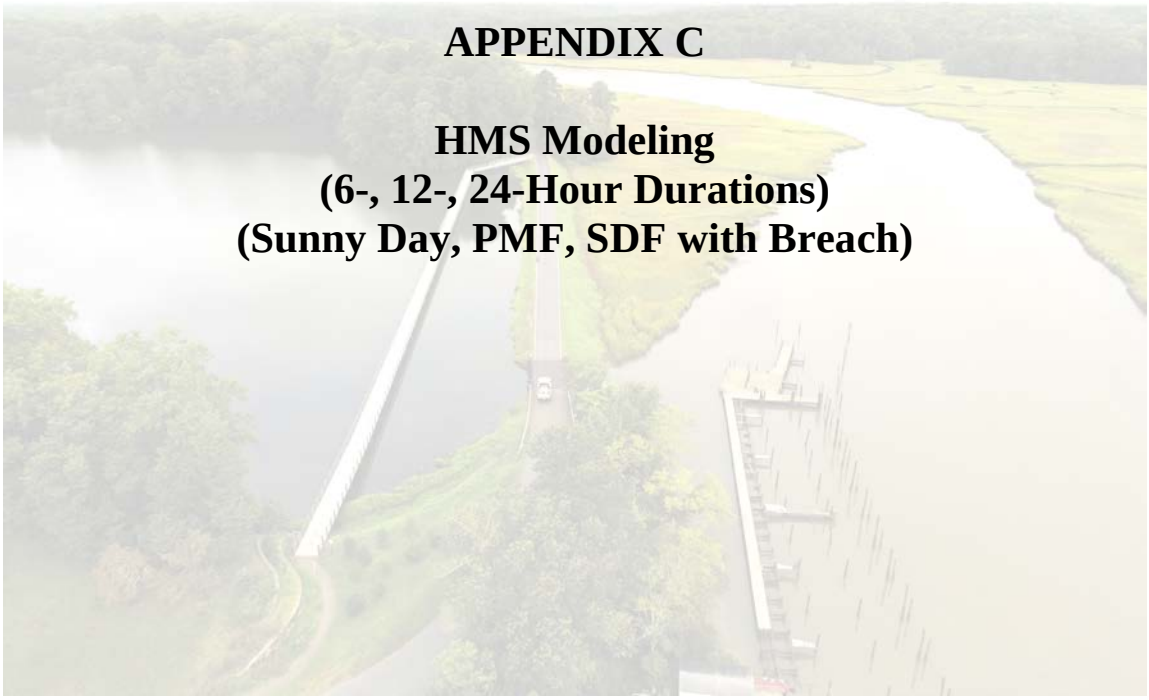
Calculation Section E - Current Flow and SDF for Dam in Question

Information for this calculation section obtained from previously completed Dam Failure Analysis hydrology calculations (HEC-1 or HEC-HMS). Section provides existing controlling storm for Dam in question, existing controlling flow (flow to Dam) from controlling storm for Dam in question, flow existing Dam in question can pass without overtopping, storm event (SDF) existing Dam in question can pass without overtopping, and storm event (SDF) existing Dam in question must pass per Regulations.

Current controlling storm duration for Dam (6, 12, or 24):	6	hour
PMF Flow TO existing Dam during controlling storm duration	7617.7	cfs
Flow existing Dam can pass without overtopping		cfs
Storm event (SDF) existing Dam can pass without overtopping (calc)		PMF storm
Storm event (SDF) existing Dam must pass per State DS Regulations		storm

Queens Lake Dam
Inventory #199016

Inundation Study
Williamsburg, Virginia

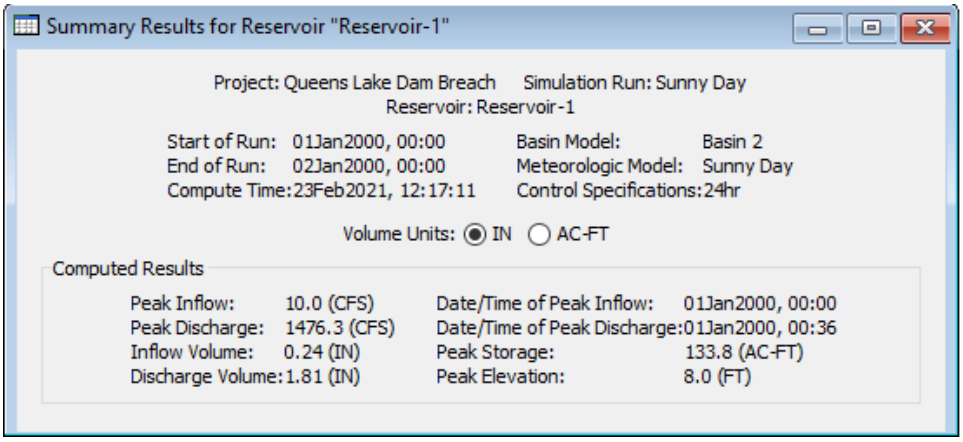


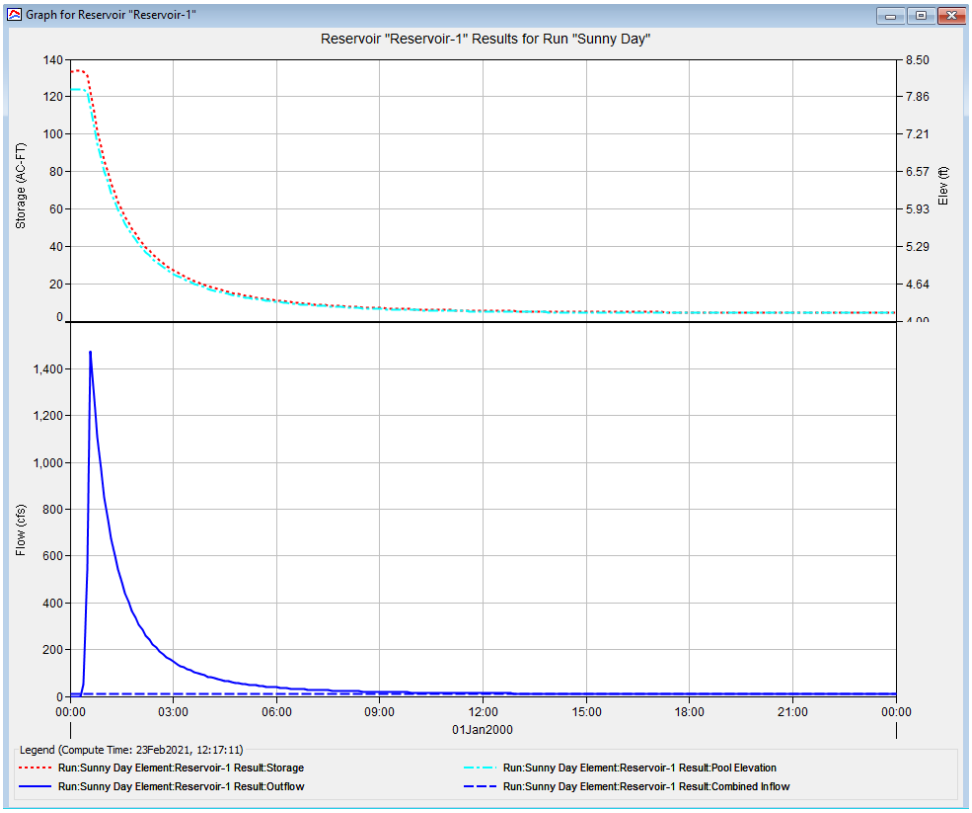
APPENDIX C

HMS Modeling
(6-, 12-, 24-Hour Durations)
(Sunny Day, PMF, SDF with Breach)

HEC-HMS RESULTS

Sunny Day Breach Results





HEC-HMS RESULTS

PMF Breach Results

Summary Results for Reservoir "Reservoir-1"

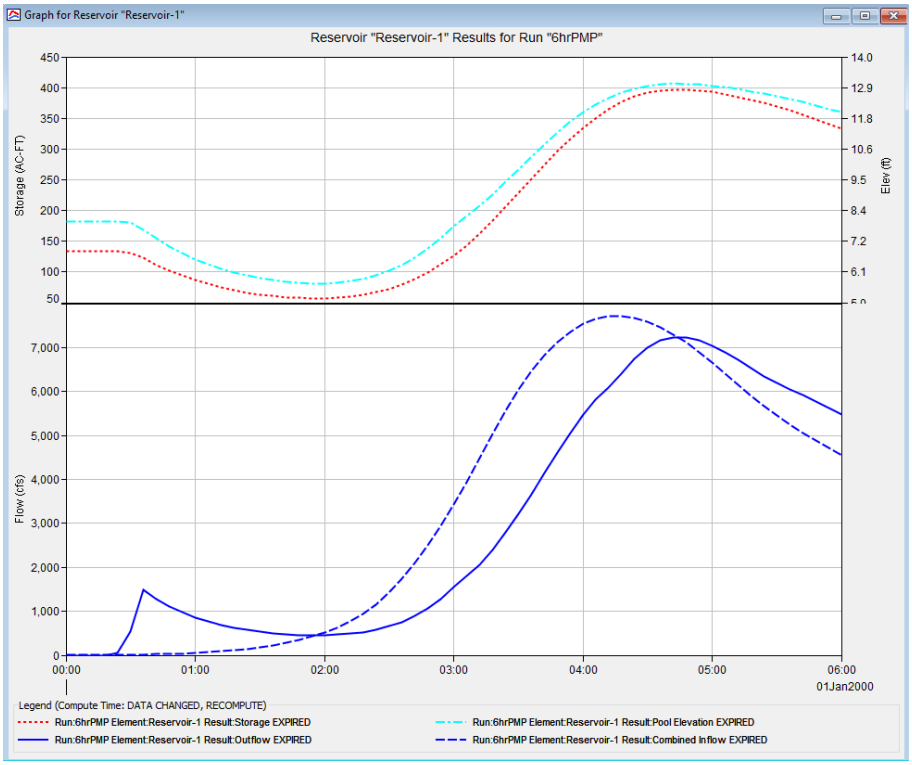
Project: Queens Lake Dam Breach Simulation Run: 6hrPMP
Reservoir: Reservoir-1

Start of Run:	01Jan2000, 00:00	Basin Model:	Basin 2
End of Run:	01Jan2000, 06:00	Meteorologic Model:	6hrPMP
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	6hr

Volume Units: (•) IN ( ) AC-FT

Computed Results

Peak Inflow:	7710.0 (CFS)	Date/Time of Peak Inflow:	01Jan2000, 04:12
Peak Discharge:	7230.3 (CFS)	Date/Time of Peak Discharge:	01Jan2000, 04:42
Inflow Volume:	20.75 (IN)	Peak Storage:	397.0 (AC-FT)
Discharge Volume:	18.31 (IN)	Peak Elevation:	13.0 (FT)



HEC-HMS RESULTS

100-Year Breach Results

Summary Results for Reservoir "Reservoir-1"

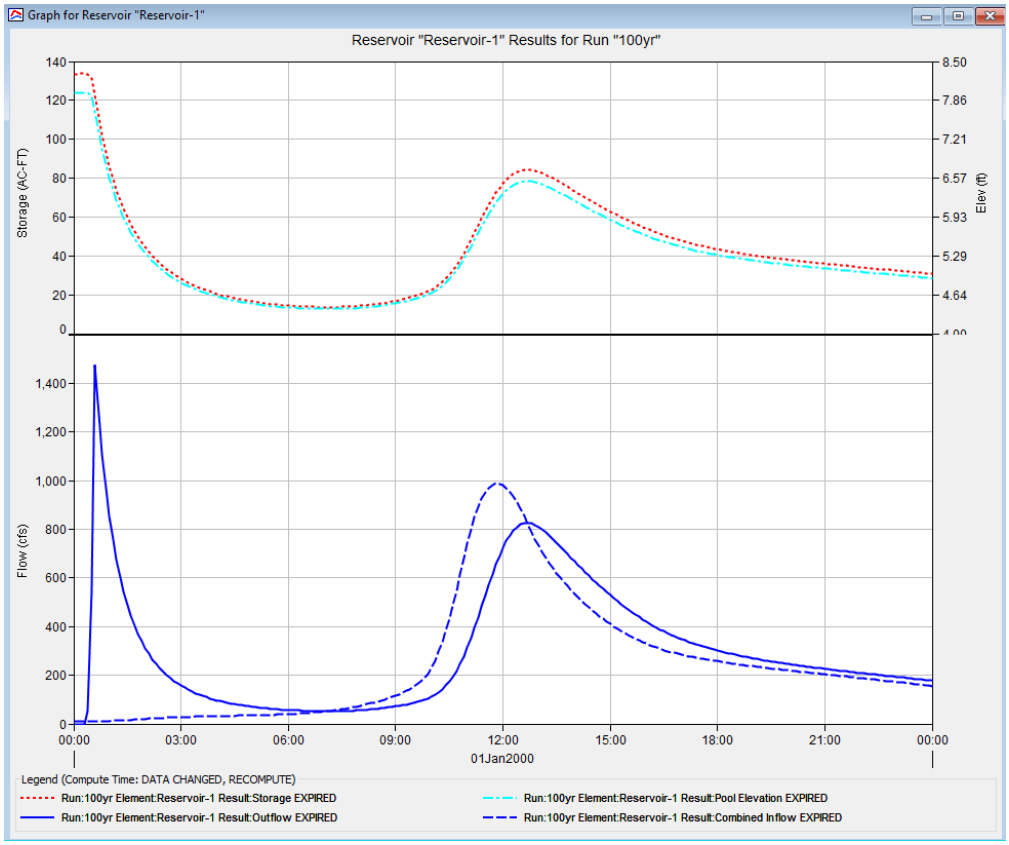
Project: Queens Lake Dam Breach Simulation Run: 100yr
Reservoir: Reservoir-1

Start of Run:	01Jan2000, 00:00	Basin Model:	Basin 2
End of Run:	02Jan2000, 00:00	Meteorologic Model:	100yr
Compute Time:	DATA CHANGED, RECOMPUTE	Control Specifications:	24hr

Volume Units: (•) IN ( ) AC-FT

Computed Results

Peak Inflow:	989.0 (CFS)	Date/Time of Peak Inflow:	01Jan2000, 11:42
Peak Discharge:	1476.5 (CFS)	Date/Time of Peak Discharge:	01Jan2000, 00:36
Inflow Volume:	6.05 (IN)	Peak Storage:	133.8 (AC-FT)
Discharge Volume:	7.31 (IN)	Peak Elevation:	8.0 (FT)



HEC-HMS RESULTS

100-Year No Breach Results

Summary Results for Reservoir "Reservoir-1"

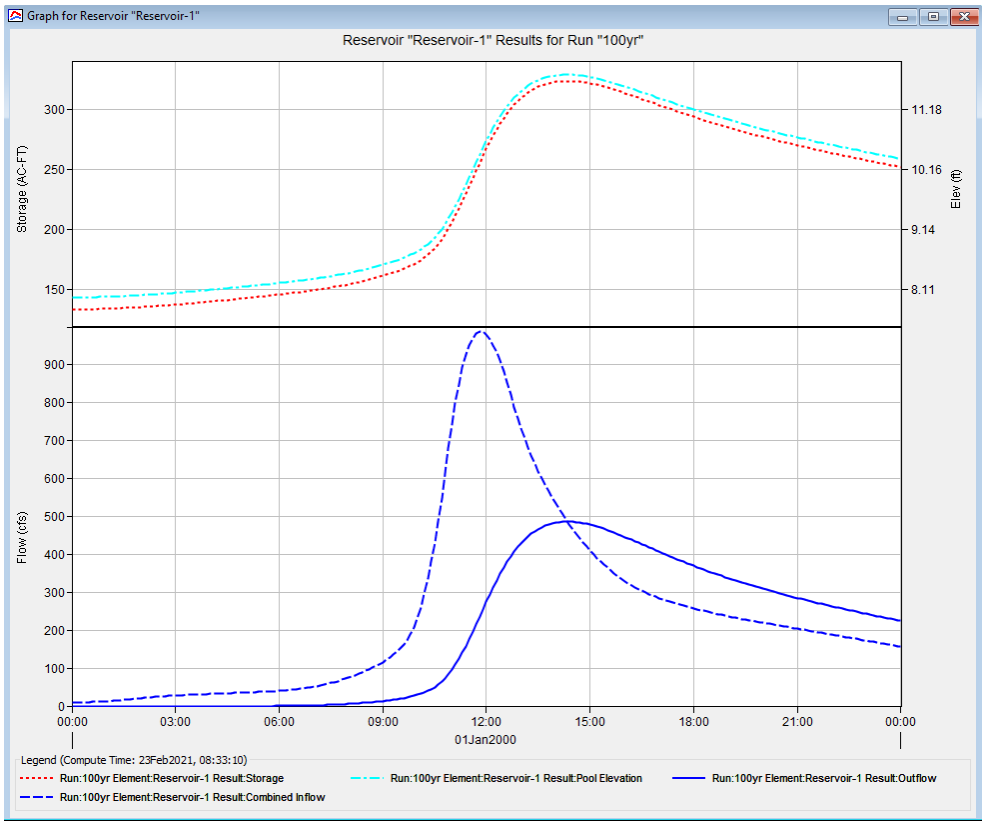
Project: Project 1 Simulation Run: 100yr
Reservoir: Reservoir-1

Start of Run:	01Jan2000, 00:00	Basin Model:	Basin 2
End of Run:	02Jan2000, 00:00	Meteorologic Model:	100yr
Compute Time:	23Feb2021, 08:33:10	Control Specifications:	24hr

Volume Units: (•) IN ( ) AC-FT

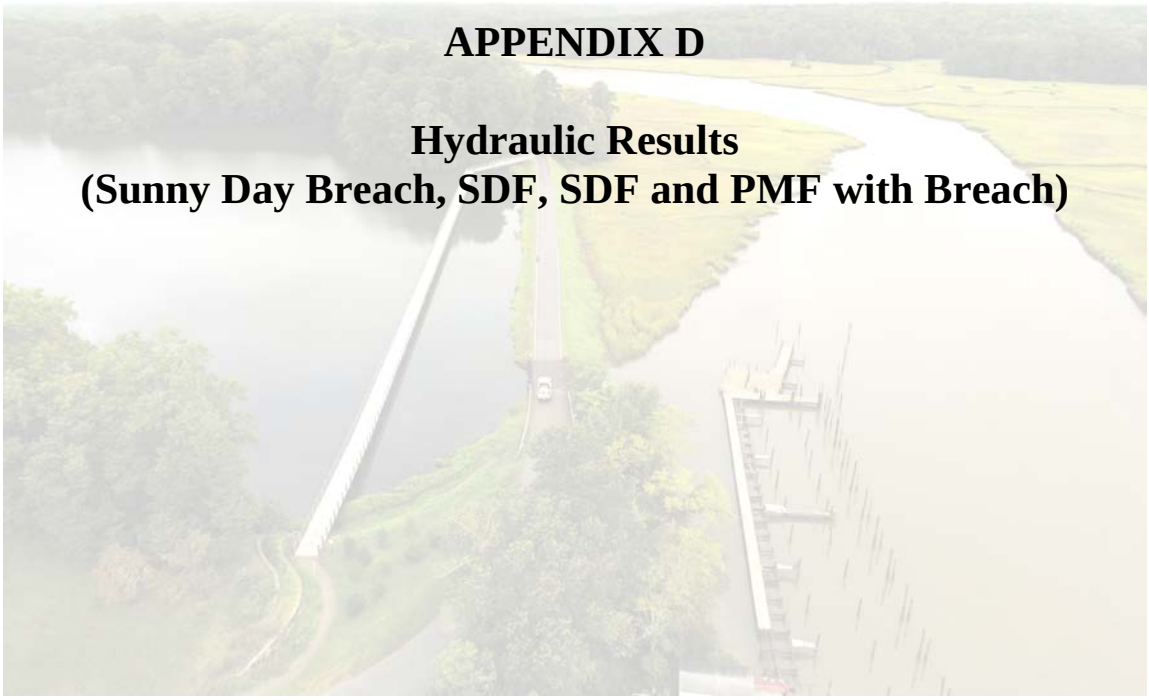
Computed Results

Peak Inflow:	989.0 (CFS)	Date/Time of Peak Inflow:	01Jan2000, 11:42
Peak Discharge:	486.3 (CFS)	Date/Time of Peak Discharge:	01Jan2000, 14:18
Inflow Volume:	6.05 (IN)	Peak Storage:	323.4 (AC-FT)
Discharge Volume:	4.61 (IN)	Peak Elevation:	11.8 (FT)



Queens Lake Dam
Inventory #199016

Inundation Study
Williamsburg, Virginia



APPENDIX D

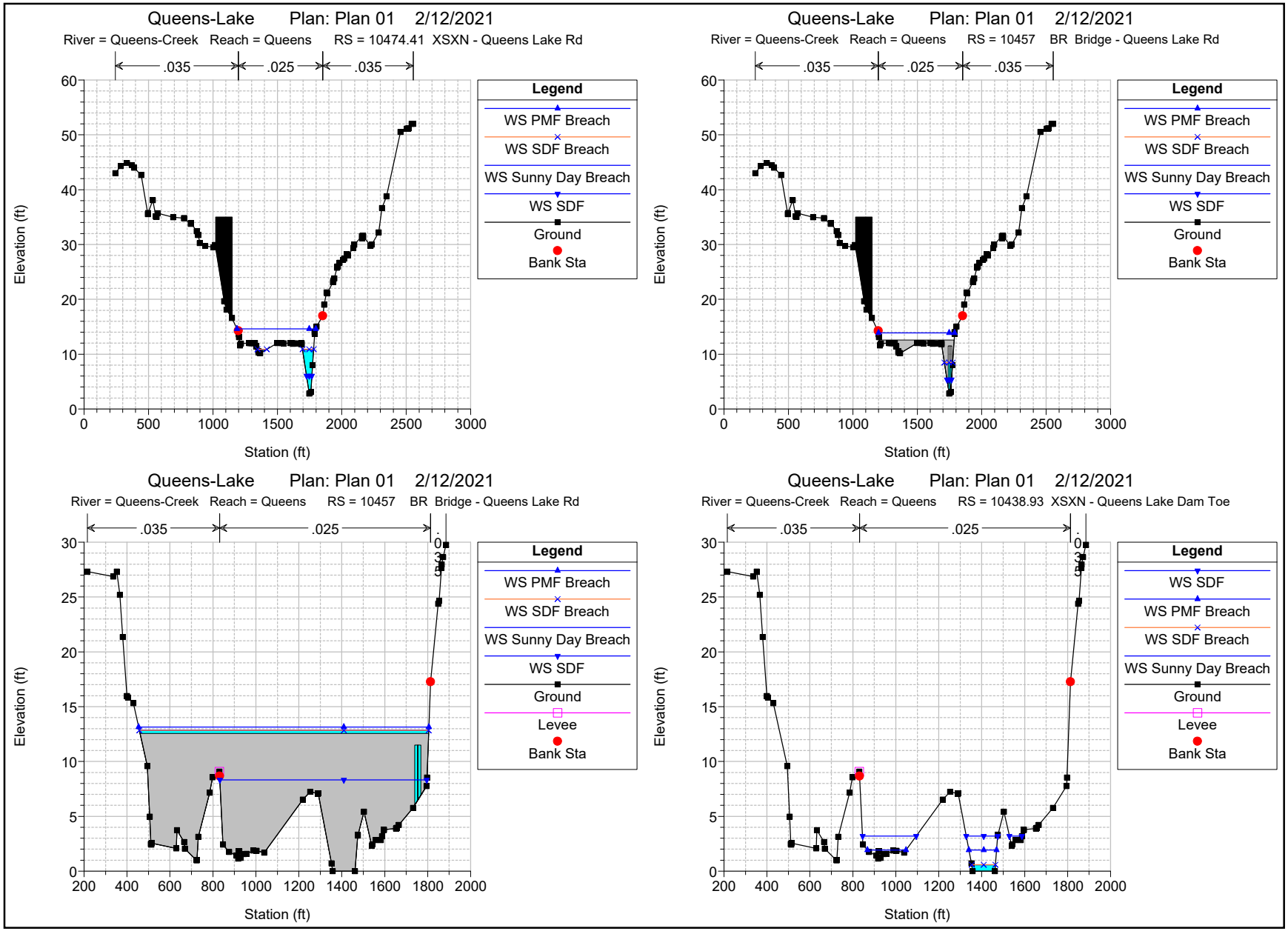
Hydraulic Results
(Sunny Day Breach, SDF, SDF and PMF with Breach)

HEC-RAS Plan: QL-Dam Breach River: Queens-Creek Reach: Queens

Reach	River Sta	Profile	Q Total	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Queens	10474.41	Sunny Day Breach	1476.30	12.28	9.18	12.34	0.000896	2.05	719.33	578.87	0.32
Queens	10474.41	PMF Breach	7230.30	14.68	12.67	14.86	0.000601	3.38	2140.57	613.93	0.32
Queens	10474.41	100-Year	486.30	8.41	7.44	8.68	0.001875	4.17	116.56	55.86	0.51
Queens	10474.41	100-Yr Breach	1476.50	12.28	9.18	12.34	0.000894	2.05	719.76	578.88	0.32
Queens	10457		Bridge								
Queens	10438.93	Sunny Day Breach	1476.30	0.51	1.94	11.82	0.519866	26.97	54.74	109.57	6.73
Queens	10438.93	PMF Breach	7230.30	1.92	3.57	13.12	0.244134	26.85	269.32	307.69	5.06
Queens	10438.93	100-Year	486.30	3.21	0.87	3.21	0.000060	0.64	754.06	454.32	0.09
Queens	10438.93	100-Yr Breach	1476.50	0.51	1.95	11.82	0.519769	26.97	54.75	109.57	6.73
Queens	10003.51	Sunny Day Breach	1476.30	3.29	0.29	3.29	0.000002	0.17	8518.69	2882.84	0.02
Queens	10003.51	PMF Breach	7230.30	4.38	0.75	4.38	0.000017	0.62	11736.30	2995.07	0.05
Queens	10003.51	100-Year	486.30	3.21		3.21	0.000000	0.06	8283.60	2862.57	0.01
Queens	10003.51	100-Yr Breach	1476.50	3.29	0.29	3.29	0.000002	0.17	8518.76	2882.85	0.02
Queens	9715.345	Sunny Day Breach	1476.30	3.29		3.29	0.000006	0.30	4994.61	1651.30	0.03
Queens	9715.345	PMF Breach	7230.30	4.35		4.37	0.000050	1.07	6756.05	1659.50	0.09
Queens	9715.345	100-Year	486.30	3.21		3.21	0.000001	0.10	4862.25	1650.68	0.01
Queens	9715.345	100-Yr Breach	1476.50	3.29		3.29	0.000006	0.30	4994.64	1651.30	0.03
Queens	8218.719	Sunny Day Breach	1476.30	3.26		3.27	0.000093	0.85	1731.08	953.50	0.11
Queens	8218.719	PMF Breach	7230.30	4.04		4.18	0.000676	2.91	2483.39	959.23	0.32
Queens	8218.719	100-Year	486.30	3.21		3.21	0.000011	0.29	1682.25	953.13	0.04
Queens	8218.719	100-Yr Breach	1476.50	3.26		3.27	0.000093	0.85	1731.10	953.50	0.11
Queens	7208.689	Sunny Day Breach	1476.30	3.24		3.25	0.000008	0.34	4358.91	1583.82	0.04
Queens	7208.689	PMF Breach	7230.30	3.91		3.94	0.000099	1.34	5411.79	1585.66	0.13
Queens	7208.689	100-Year	486.30	3.20		3.21	0.000001	0.11	4296.66	1583.71	0.01
Queens	7208.689	100-Yr Breach	1476.50	3.24		3.25	0.000008	0.34	4358.93	1583.82	0.04
Queens	6282.566	Sunny Day Breach	1476.30	3.23		3.24	0.000015	0.40	3696.53	1639.72	0.05
Queens	6282.566	PMF Breach	7230.30	3.78		3.81	0.000179	1.57	4591.53	1650.79	0.17
Queens	6282.566	100-Year	486.30	3.20		3.20	0.000002	0.13	3648.19	1637.20	0.02
Queens	6282.566	100-Yr Breach	1476.50	3.23		3.24	0.000015	0.40	3696.54	1639.72	0.05
Queens	4791.195	Sunny Day Breach	1476.30	3.22		3.22	0.000008	0.33	4434.66	1624.31	0.04

HEC-RAS Plan: QL-Dam Breach River: Queens-Creek Reach: Queens (Continued)

Reach	River Sta	Profile	Q Total	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Queens	4791.195	PMF Breach	7230.30	3.55		3.58	0.000135	1.45	4974.85	1626.28	0.15
Queens	4791.195	100-Year	486.30	3.20		3.20	0.000001	0.11	4409.67	1624.22	0.01
Queens	4791.195	100-Yr Breach	1476.50	3.22		3.22	0.000008	0.33	4434.67	1624.31	0.04
Queens	2869.535	Sunny Day Breach	1476.30	3.21		3.21	0.000002	0.20	7468.52	2385.45	0.02
Queens	2869.535	PMF Breach	7230.30	3.42		3.43	0.000047	0.91	7971.96	2386.83	0.09
Queens	2869.535	100-Year	486.30	3.20		3.20	0.000000	0.07	7446.76	2385.39	0.01
Queens	2869.535	100-Yr Breach	1476.50	3.21		3.21	0.000002	0.20	7468.53	2385.45	0.02
Queens	1549.037	Sunny Day Breach	1476.30	3.21		3.21	0.000003	0.23	6558.76	2087.81	0.02
Queens	1549.037	PMF Breach	7230.30	3.34		3.36	0.000065	1.06	6846.19	2090.03	0.10
Queens	1549.037	100-Year	486.30	3.20		3.20	0.000000	0.07	6546.78	2087.72	0.01
Queens	1549.037	100-Yr Breach	1476.50	3.21		3.21	0.000003	0.23	6558.76	2087.81	0.02
Queens	166.0642	Sunny Day Breach	1476.30	3.20	0.64	3.20	0.000007	0.27	5510.75	2379.27	0.03
Queens	166.0642	PMF Breach	7230.30	3.20	1.50	3.23	0.000159	1.31	5510.75	2379.27	0.15
Queens	166.0642	100-Year	486.30	3.20	0.30	3.20	0.000001	0.09	5510.75	2379.27	0.01
Queens	166.0642	100-Yr Breach	1476.50	3.20	0.64	3.20	0.000007	0.27	5510.75	2379.27	0.03


Queens-Lake Plan: Plan 01 2/12/2021
River = Queens-Creek Reach = Queens RS = 10474.41 XSXN - Queens Lake Rd
.035
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PMF Breach
WS SDF Breach
WS Sunny Day Breach
WS SDF
Ground
Bank Sta
Queens-Lake Plan: Plan 01 2/12/2021
River = Queens-Creek Reach = Queens RS = 10457 BR Bridge - Queens Lake Rd
.035
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PMF Breach
WS SDF Breach
WS Sunny Day Breach
WS SDF
Ground
Bank Sta
Queens-Lake Plan: Plan 01 2/12/2021
River = Queens-Creek Reach = Queens RS = 10457 BR Bridge - Queens Lake Rd
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.025
Elevation (ft)
Station (ft)
Legend
WS PMF Breach
WS SDF Breach
WS Sunny Day Breach
WS SDF
Ground
Levee
Bank Sta
Queens-Lake Plan: Plan 01 2/12/2021
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Elevation (ft)
Station (ft)
Legend
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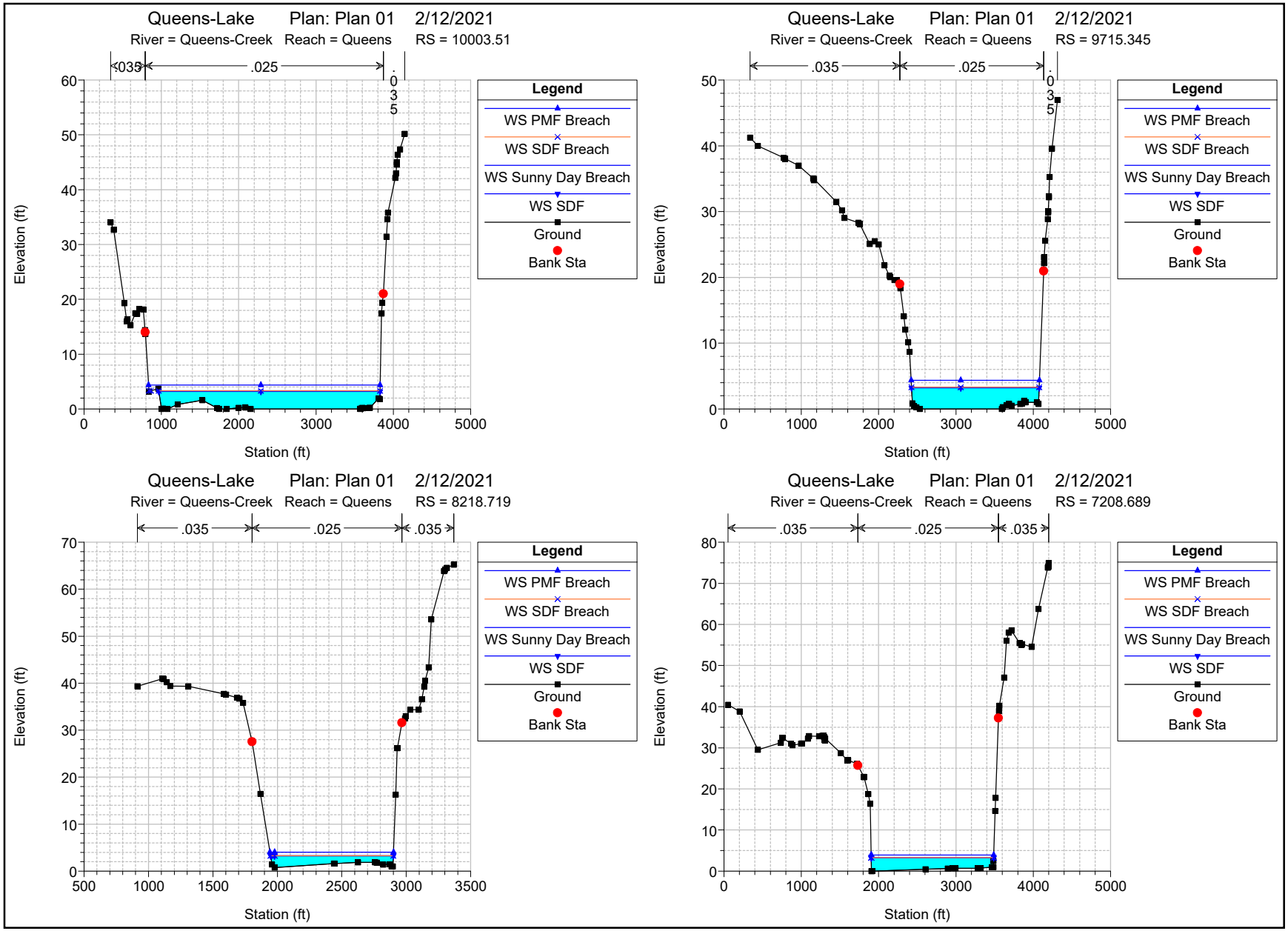
WS SDF Breach
WS Sunny Day Breach
Ground
Levee
Bank Sta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Station (ft)
Legend
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WS SDF Breach
WS Sunny Day Breach
WS SDF
Ground
Bank Sta
Queens-Lake Plan: Plan 01 2/12/2021
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.035
Elevation (ft)
Station (ft)
Legend
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WS SDF Breach
WS Sunny Day Breach
WS SDF
Ground
Bank Sta
Queens-Lake Plan: Plan 01 2/12/2021
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Elevation (ft)
Station (ft)
Legend
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WS SDF Breach
WS Sunny Day Breach
WS SDF
Ground
Bank Sta
Queens-Lake Plan: Plan 01 2/12/2021
River = Queens-Creek Reach = Queens RS = 7208.689
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Elevation (ft)
Station (ft)
Legend
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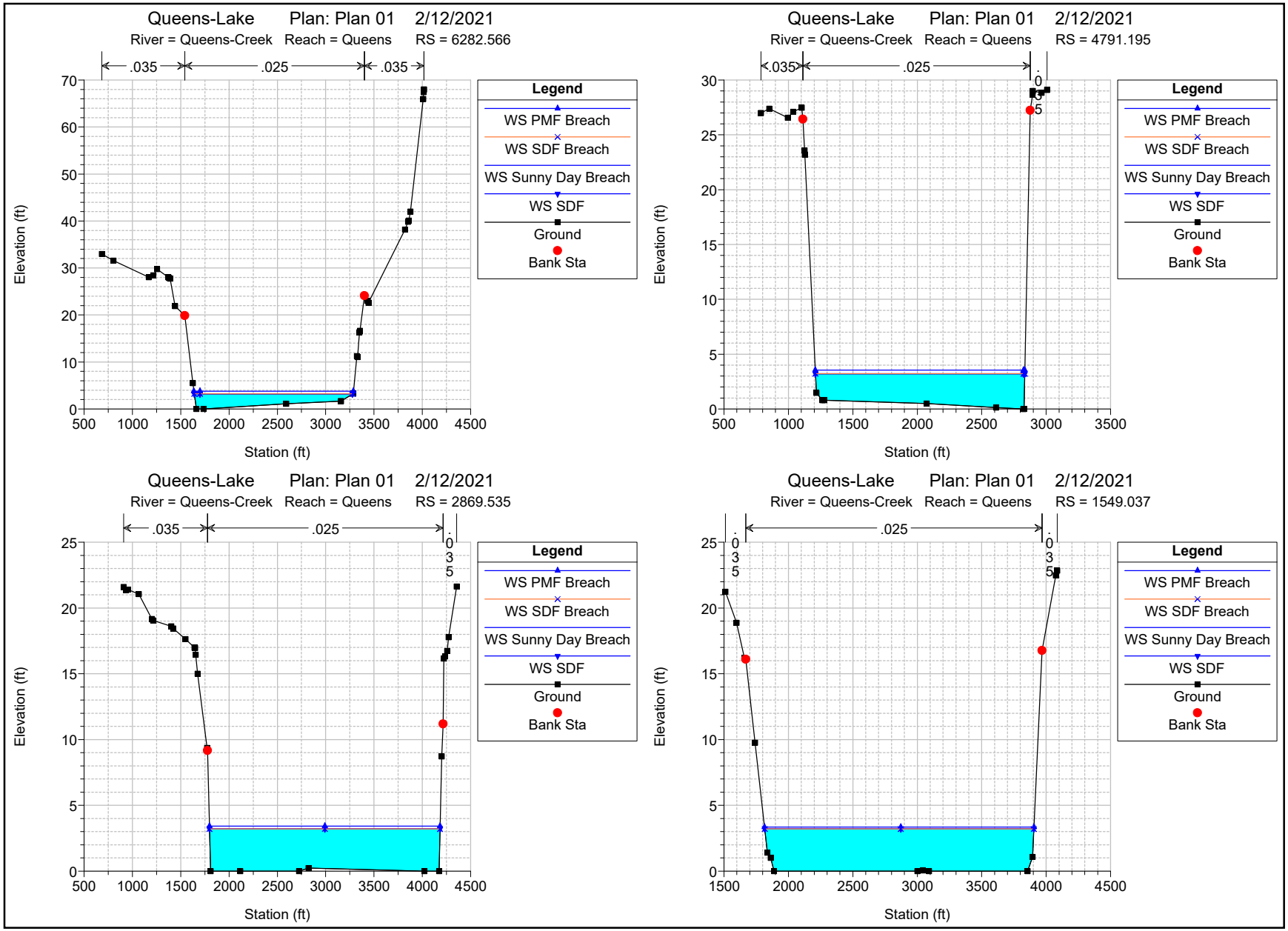
WS SDF Breach
WS Sunny Day Breach
WS SDF
Ground
Bank Sta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.035
Elevation (ft)
Station (ft)
Legend
WS PMF Breach
WS SDF Breach
WS Sunny Day Breach
WS SDF
Ground
Bank Sta
Queens-Lake Plan: Plan 01 2/12/2021
River = Queens-Creek Reach = Queens RS = 4791.195
.035
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PMF Breach
WS SDF Breach
WS Sunny Day Breach
WS SDF
Ground
Bank Sta
Queens-Lake Plan: Plan 01 2/12/2021
River = Queens-Creek Reach = Queens RS = 2869.535
.035
.025
.035
Elevation (ft)
Station (ft)
Legend
WS PMF Breach
WS SDF Breach
WS Sunny Day Breach
WS SDF
Ground
Bank Sta
Queens-Lake Plan: Plan 01 2/12/2021
River = Queens-Creek Reach = Queens RS = 1549.037
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.025
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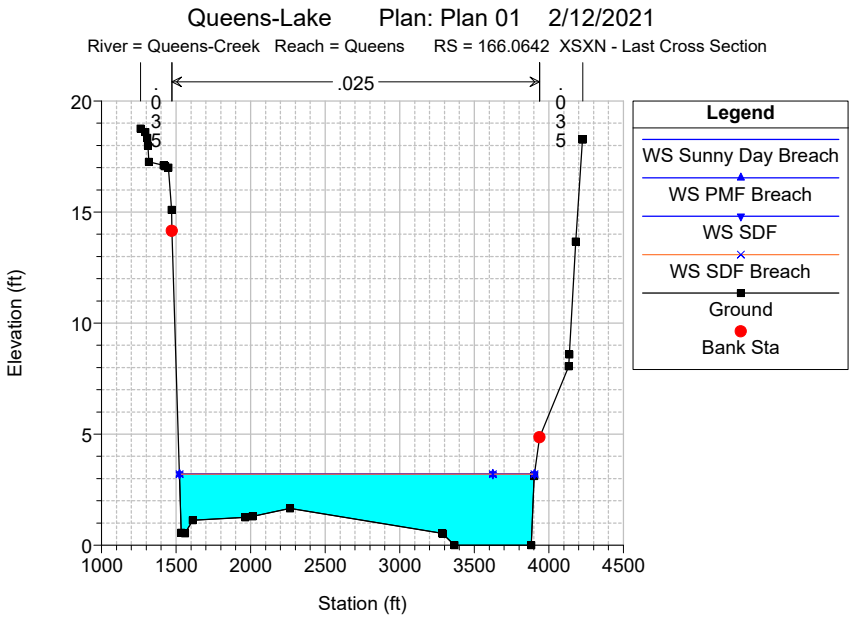
Elevation (ft)
Station (ft)
Legend
WS PMF Breach
WS SDF Breach
WS Sunny Day Breach
WS SDF
Ground
Bank Sta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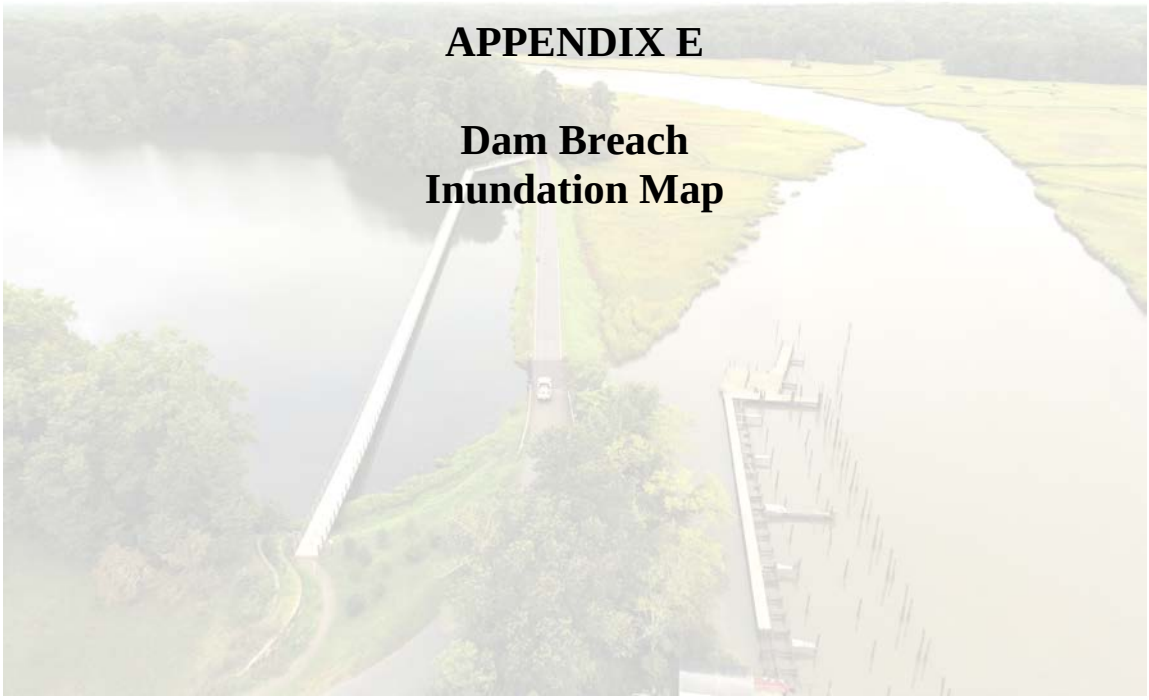
.035
.035
Legend
WS Sunny Day Breach
WS PMF Breach
WS SDF
WS SDF Breach
Ground
Bank Sta
Elevation (ft)
Station (ft)
0
5
10
15
20
1000
1500
2000
2500
3000
3500
4000
4500

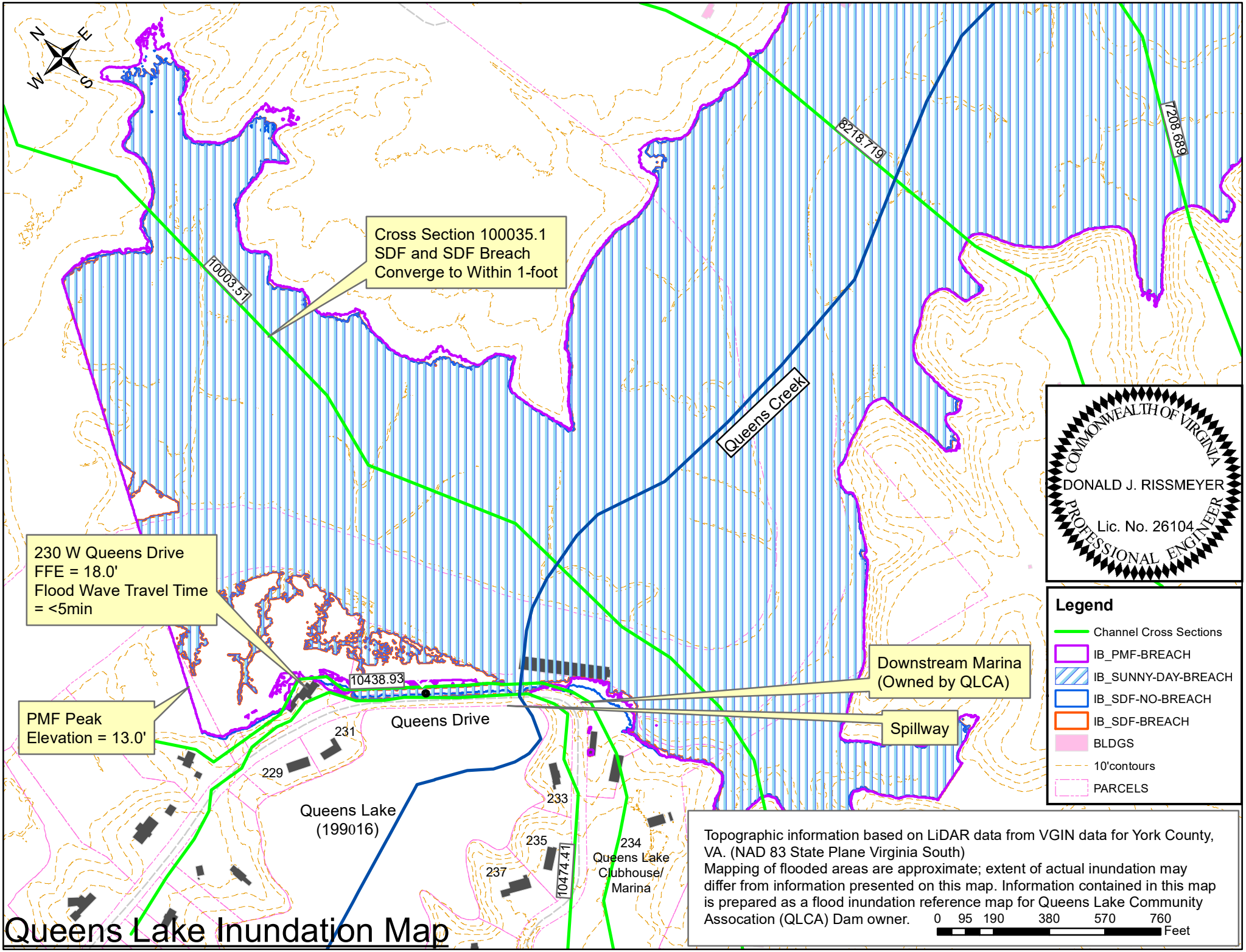
Queens Lake Dam
Inventory #199016

Inundation Study
Williamsburg, Virginia



APPENDIX E

Dam Breach
Inundation Map



Queens Lake Inundation Map

Queens Lake Dam
Inventory #199016

Inundation Study
Williamsburg, Virginia

APPENDIX F

Site Photos

Queens Lake Dam – JUNE & SEPTEMBER 2020

01 – Aerial Drone View at Spillway

02 – Looking NE Across Embankment

03 – Looking SE Across Embankment

04 – Looking at Spillway Outfall

Queens Lake Dam – JUNE & SEPTEMBER 2020

05 – Spillway Outfall

06 – Looking NW Outfall & Embankment

07 – Looking SE Downstream Embankment

08 – Looking SE at Spillway Inflow

Queens Lake Dam – Google Street View

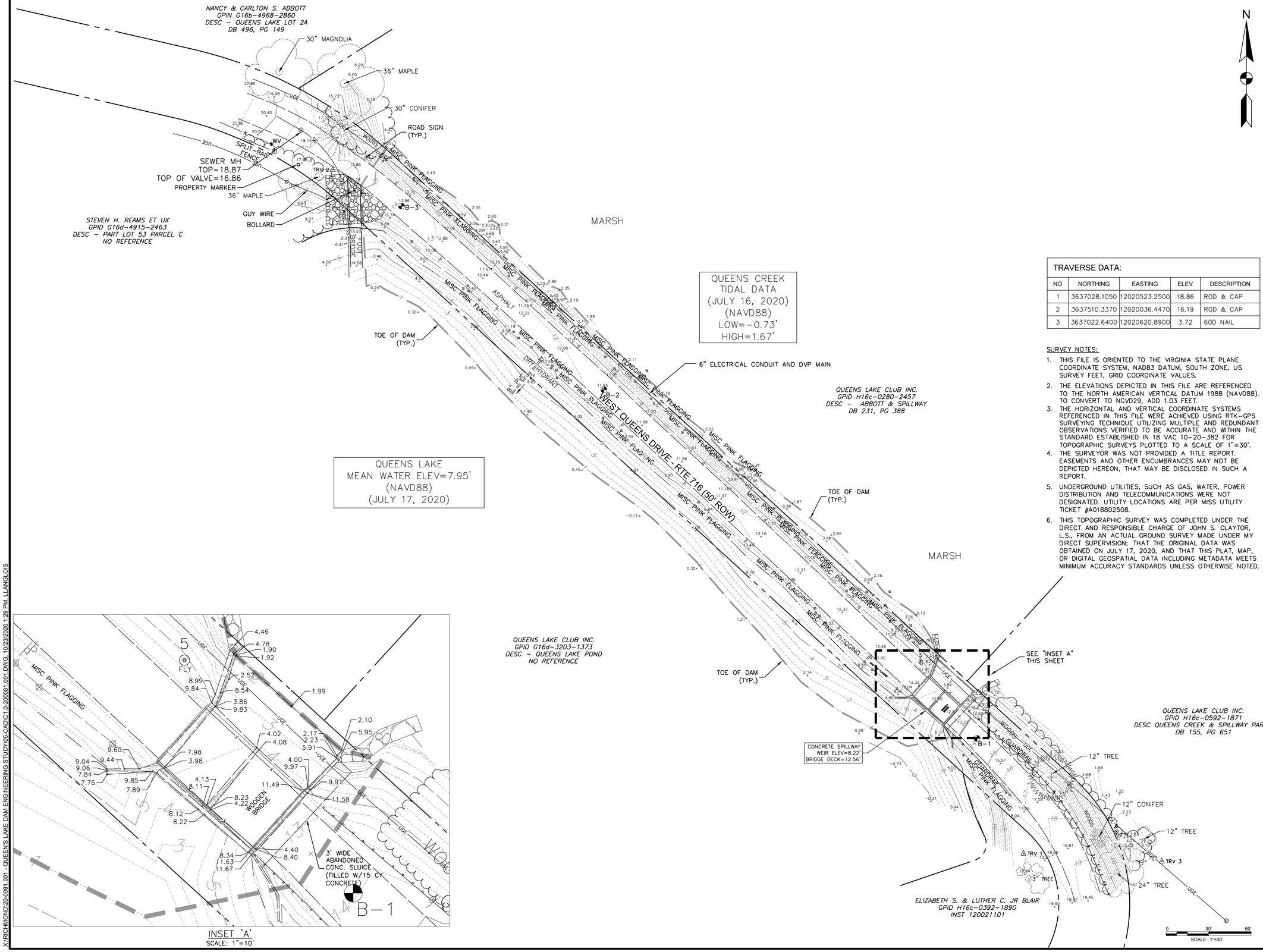
09 – Spillway Inflow & Outfall Looking Downstream of Queens Creek
(May 2019)

Queens Lake Dam
Inventory #199016

Inundation Study
Williamsburg, Virginia

APPENDIX F

Site Visit Photos



INSET 'A'
SCALE: 1"=10'

TRAVERSE DATA:				
NO	NORTHING	EASTING	ELEV	DESCRIPTION
1	3637028.1050	12020523.2500	18.86	ROD & CAP
2	3637510.3370	12020036.4470	16.19	ROD & CAP
3	3637022.6400	12020620.8900	3.72	60D NAIL

SURVEY NOTES:

1. THIS FILE IS ORIENTED TO THE VIRGINIA STATE PLANE COORDINATE SYSTEM, NAD83 DATUM, SOUTH ZONE, US SURVEY FEET, GRID COORDINATE VALUES.
2. THE ELEVATIONS DEPICTED IN THIS FILE ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM 1988 (NAVD88). TO CONVERT TO NGVD29, ADD 1.03 FEET.
3. THE HORIZONTAL AND VERTICAL COORDINATE SYSTEMS REFERENCED IN THIS FILE WERE ACHIEVED USING RTK-GPS SURVEYING TECHNIQUE UTILIZING MULTIPLE AND REDUNDANT OBSERVATIONS VERIFIED TO BE ACCURATE AND WITHIN THE STANDARD ESTABLISHED IN 18 VAC 10-20-382 FOR TOPOGRAPHIC SURVEYS PLOTTED TO A SCALE OF 1"=30'.
4. THE SURVEYOR WAS NOT PROVIDED A TITLE REPORT. EASEMENTS AND OTHER ENCUMBRANCES MAY NOT BE DEPICTED HEREON, THAT MAY BE DISCLOSED IN SUCH A REPORT.
5. UNDERGROUND UTILITIES, SUCH AS GAS, WATER, POWER DISTRIBUTION AND TELECOMMUNICATIONS WERE NOT DESIGNATED. UTILITY LOCATIONS ARE PER MISS UTILITY TICKET #A018802508.
6. THIS TOPOGRAPHIC SURVEY WAS COMPLETED UNDER THE DIRECT AND RESPONSIBLE CHARGE OF JOHN S. CLAYTOR, L.S., FROM AN ACTUAL GROUND SURVEY MADE UNDER MY DIRECT SUPERVISION; THAT THE ORIGINAL DATA WAS OBTAINED ON JULY 17, 2020, AND THAT THIS PLAT, MAP, OR DIGITAL GEOSPATIAL DATA INCLUDING METADATA MEETS MINIMUM ACCURACY STANDARDS UNLESS OTHERWISE NOTED.

A. MORTON THOMAS AND ASSOCIATES, INC.
CONSULTING ENGINEERS
100 GATEWAY CENTRE PARKWAY, SUITE 200
RICHMOND, VA 23235
PHONE (804) 276-6231
EMAIL: AMT1@AMTENGINEERING.COM

COMMONWEALTH OF VIRGINIA
DONALD J. SISSMEYER
REG. No. 26104
PROFESSIONAL ENGINEER
NOT FOR CONSTRUCTION

QUEENS LAKE DAM
DAM INVENTORY #199016
WILLIAMSBURG, VIRGINIA

QUEENS LAKE COMMUNITY ASSOCIATION, INC.
234 EAST QUEENS DRIVE
WILLIAMSBURG, VA 23185
(757) 229-0973 / FAX (757) 229-2652

MARK	DATE	DESCRIPTION

PROJECT NO:	20-0081.001
SCALE:	1"=30'
DESIGNED BY:	DJR
DRAWN BY:	LAL
CHECKED BY:	DJR

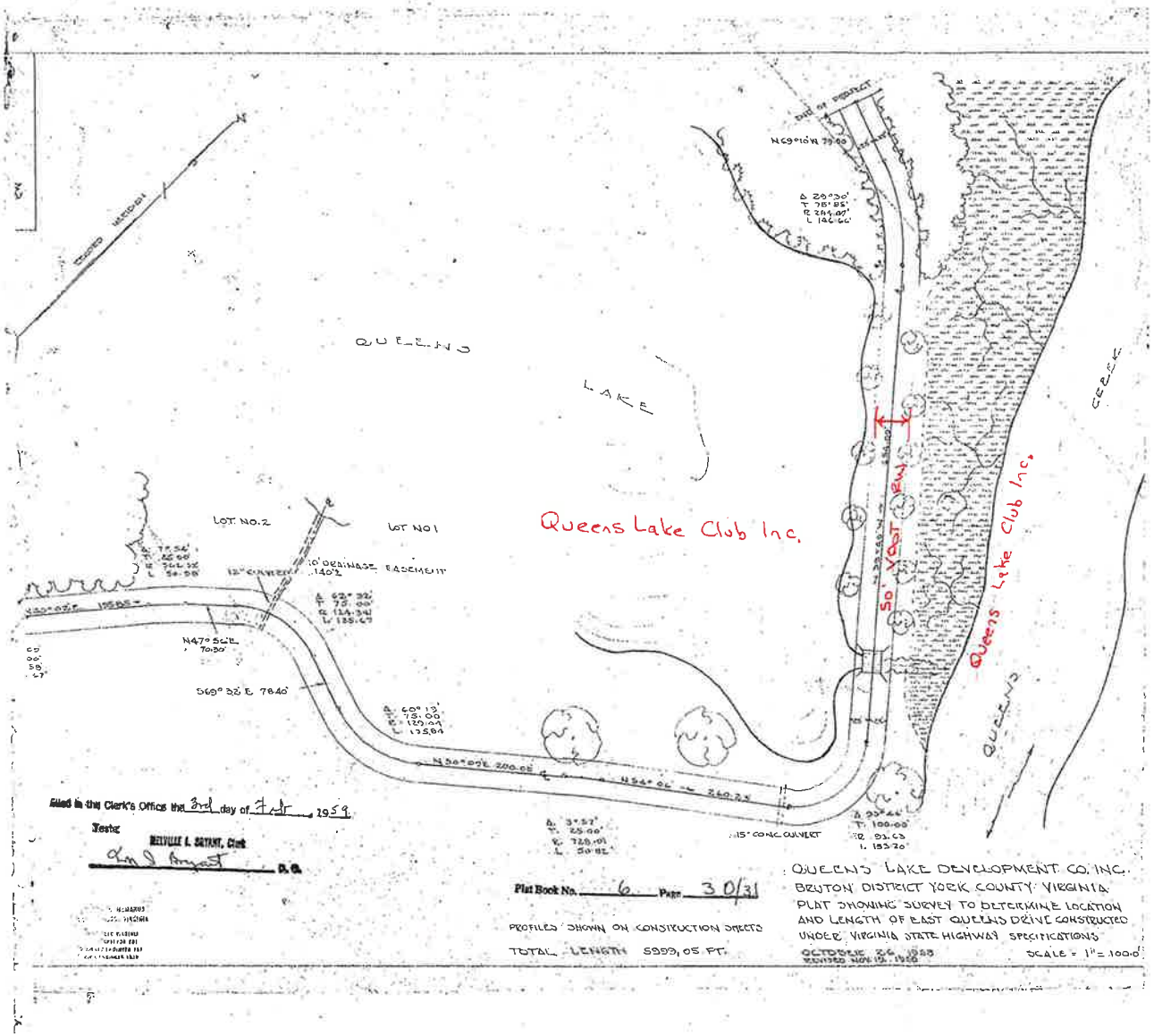
SHEET TITLE

EXISTING CONDITIONS PLAN

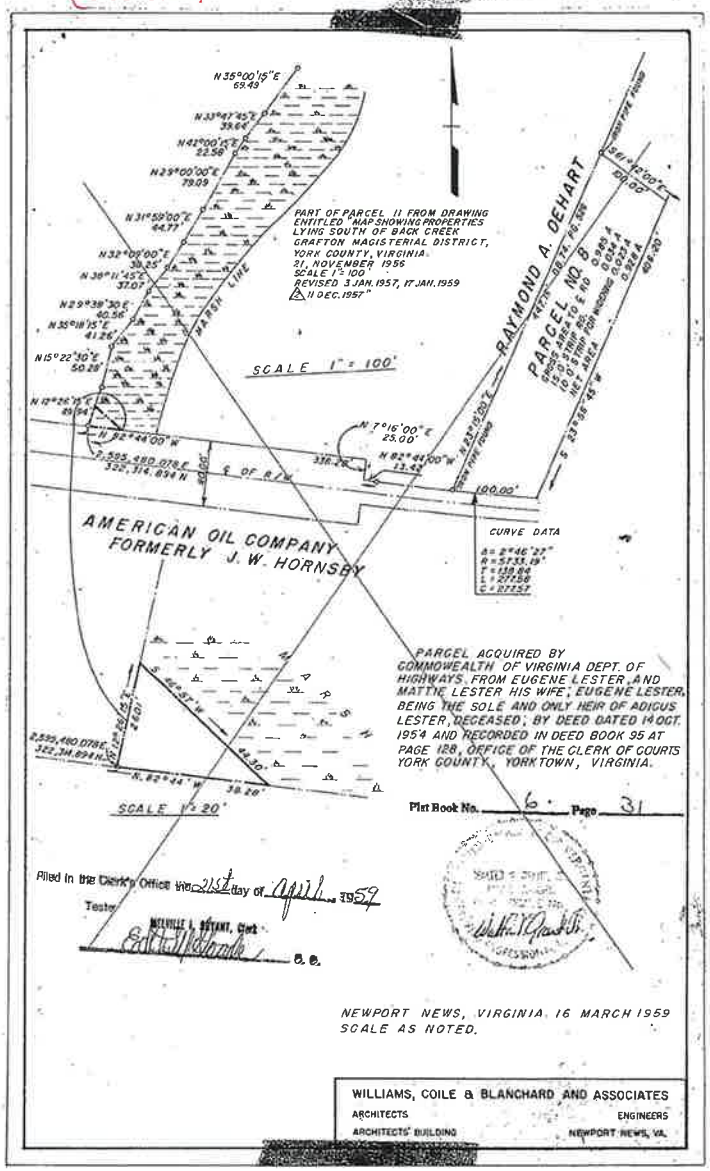
C1.0

SHEET 1 OF 3

X:\RICHMOND\20-0081.001 - QUEEN'S LAKE DAM ENGINEERING STUDY\05-CADC\1.0-20081.001.DWG, 10/23/2020 1:29 PM, LLANGLOIS



PROPERTY OWNERSHIP ON DAM
(800' L ±)



STRUCTURAL EVALUATION
OF THE
QUEENS LAKE SPILLWAY
FEBRUARY 2018

TAM Consultants Project No. 17496-W

Prepared for:

AES CONSULTING ENGINEERS
5248 Olde Towne Road, Suite 1
Williamsburg, VA 23188

By:

TAM Consultants
4350 New Town Avenue
Williamsburg, VA 23188
757-564-4434

TAM
CONSULTANTS

ATTACHMENT 26 MARCH 2018

TAM
CONSULTANTS
ENGINEERED SOLUTIONS
FOR OUR BUILT WORLD

February 5, 2018

AES Consulting Engineers
5248 Olde Towne Road, Suite 1
Williamsburg, VA 23188

Att: Howard Price

Re: Structural Evaluation of the
Queens Lake Spillway
York County, Virginia
TAM Project # 17496-W

Dear Howard:

Upon your authorization, TAM Consultants has performed a structural evaluation of the existing Queens Lake Dam and Spillway in York County, Virginia.

PROJECT DESCRIPTION

The Queens Lake Spillway is a poured in place concrete structure approximately 31'-9" wide, with a flow length of about 30 feet. On the lake side, the dam is approximately 5'-6" tall above the flow line. On each side of the spillway there are concrete abutment walls approximately 8'-5" tall, with an 8" wide divider wall in the center. The abutment walls, and the divider wall, provide support for a structural steel and heavy timber vehicular bridge carrying West Queens Drive over the spillway. The bridge is maintained by the Virginia Department of Transportation. No plans for the dam and spillway were available. The primary components of the spillway appear to have been constructed at different times, or perhaps major modifications were made from time to time. The Queens Lake residential development was begun in the 1950's. There are two thicknesses of concrete on the vertical dam wall. There are vertical cold joints between the abutment walls and the flared wing walls on the outfall. There appear to have been some patches and repair work done at some time.

OBSERVATIONS

In general, the dam and spillway are in Fair Condition. There are some areas that would benefit from repairs, but there is no obvious movement or signs of distress that would indicate structural failure. Areas that can be repaired:

1. There is a cold joint between the West abutment and wing wall (see photos 01.10 and 01.11). There are roots growing in the joint that have reached a size so that they are applying pressure that is causing a separation of the joint. This root, and all vegetation, should be removed. Once the vegetation is removed, the joint can be patched.

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'ewport News, VA 23606
Phone (757) 873-8858

www.tamconsultants.com

2. At the top of the slope on the outfall slab there is a crack that begins at the East abutment wall and runs approximately 3/4 of the distance across the slab (see photos 01.12, 01.13 and 01.14). The crack varies in width from almost 1/4 inch down to a hairline, then disappears. This crack could be patched, but we do not feel patching is necessary at the present time. We might watch the crack over a period of time to see if it is continuing to move.

3. There is a crack and spall in the East abutment wall, that also appears to be a cold joint (see photos 01.15 and 01.16). The spall appears to have been patched previously, but the patch has failed. This could be patched as preventative maintenance. The wing wall at this location also needs to have vegetation removed.

4. At the outfall of the spillway there is a vertical concrete bulkhead. From a distance it appears the face is spalled and rough. Up close it is obvious the rough surface is from barnacles that have attached themselves to the face of the wall below the water line. The face of the wall above the water line is clean and smooth. Timber planks that are visible on the face of the bulkhead appear to be form boards used when the wall was first poured. These boards do not appear to have a structural function.

There was some concern expressed about water that possibly might be leaking through vertical joints at the dam intersection with the abutments. Water was flowing over the dam at the time of the field inspection and no noticeable flow through the joint was observed. This might be re-checked during drier weather. If water is flowing through the joint, that can be corrected by an expanding foam injected into the joint.

We hope these comments will be useful in planning for maintenance efforts for the spillway. We saw nothing that we feel required immediate corrective action. The items listed can be scheduled as weather and available funding might permit.

We appreciate this opportunity to serve AES and the Queens Lake Association. Please let us know if you have questions.

Very truly yours,

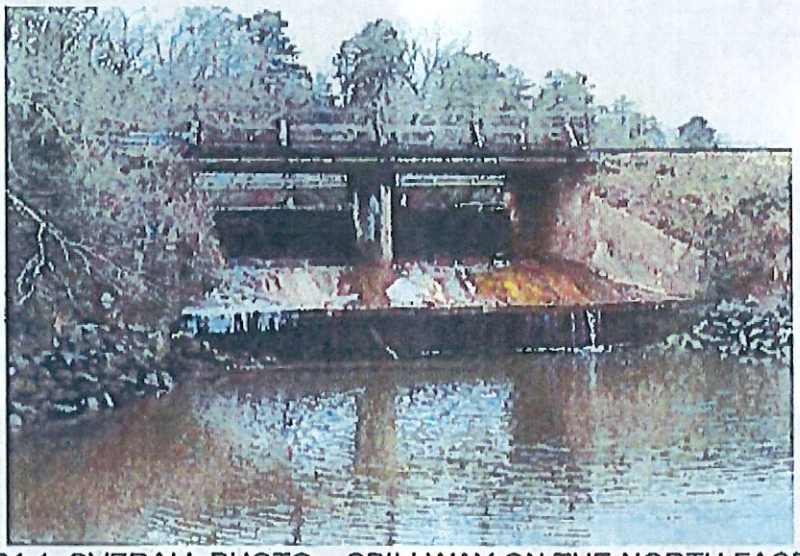
TAM CONSULTANTS

William D. Johnson, Jr., P.E.
Senior Project Manager

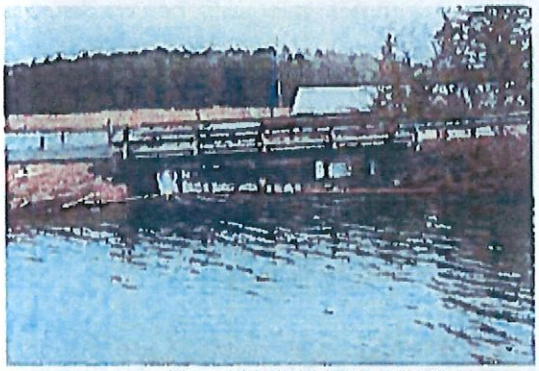
COMMONWEALTH OF VIRGINIA
WILLIAM D. JOHNSON, JR.
Lic. No. 7427
2/5/2018
PROFESSIONAL ENGINEER

TAM Consultants is a certified small/micro business,SWaM, a member of American Council of Engineering Companies, ACEC, the National Institute of Building Science, NIBS, the Building Enclosure Council, BEC, and Licensed American Air Barrier Association third party auditors, ABAA.

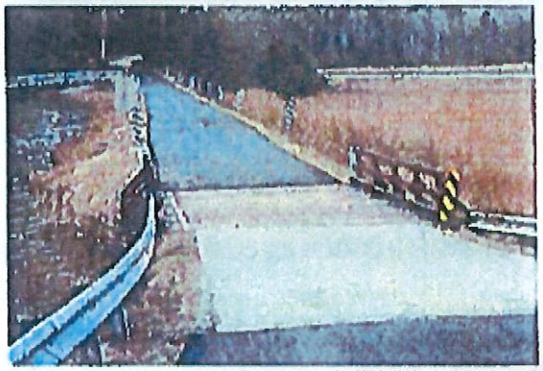
01.0 STRUCTURAL EVALUATION OF THE QUEENS LAKE SPILLWAY



01.1: OVERALL PHOTO – SPILLWAY ON THE NORTH FACE

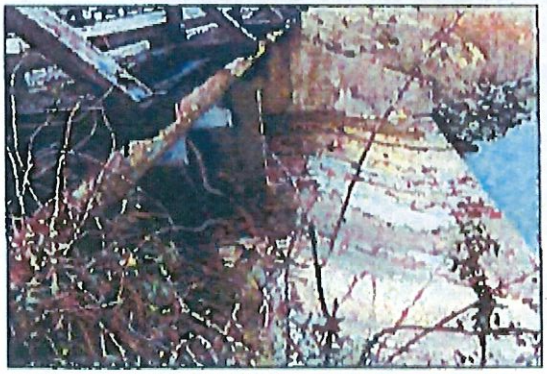


01.2: QUEENS LAKE DAM ON UPSTREAM SIDE



01.3: QUEENS LAKE DRIVE BRIDGE CROSSES THE SPILLWAY

01.4: SPILLWAY LOOKING TO THE EAST

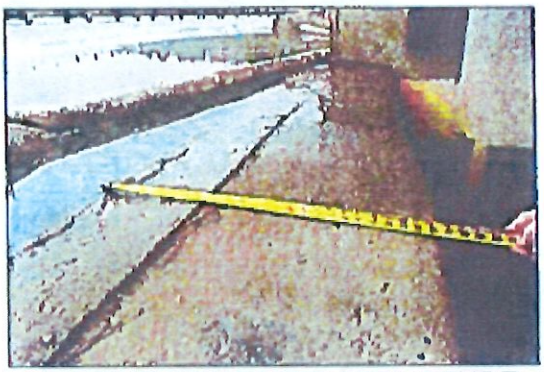


01.5: SPILLWAY LOOKING TO THE WEST

01.6: WEST ABUTMENT LOOKING TOWARDS THE DAM

01.7: WEST ABUTMENT LOOKING AT THE WINGWALL AT THE OUTFALL

01.8: HEAVY TIMBERS CAP THE CONCRETE ABUTMENTS TO SUPPORT BRIDGE STRUCTURE



01.9: THE CONCRETE STRUCTURE APPEARS TO HAVE BEEN CONSTRUCTED IN VARIOUS SECTIONS

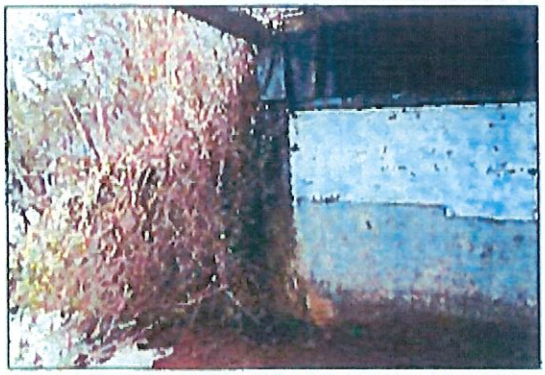
01.10: THERE IS A COLD JOINT BETWEEN THE WINGWALL AND THE ABUTMENT, AND ALSO AT THE BASE OF THE WINGWALL

01.11: LARGE ROOTS ARE FORCING THE COLD JOINT TO SEPARATE

01.12: CRACK ACROSS SPILLWAY

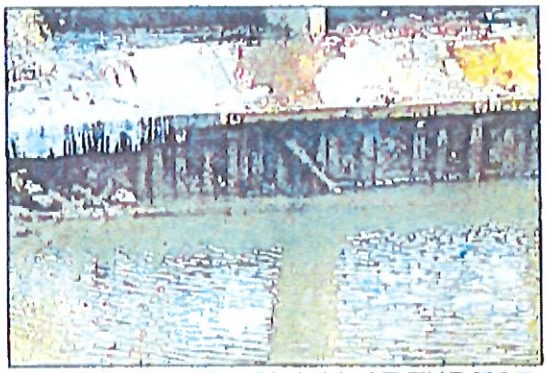
01.13: SPILLWAY CRACK VARIES FROM ABOUT ¼" TO HAIRLINE

01.14: SPILLWAY CRACK LOOKING TOWARDS THE EAST ABUTMENT



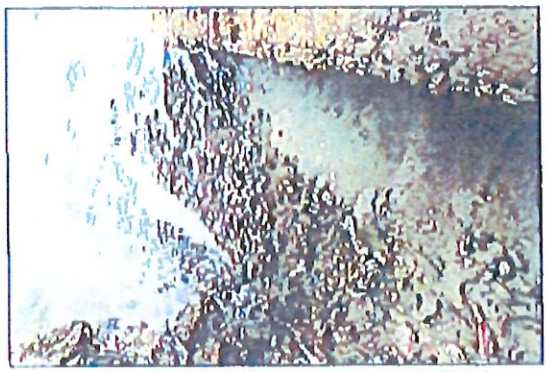
01.15: CRACK AND SPALL IN EAST ABUTMENT AT WING WALL

01.16: CRACK AND SPALL IN THE EAST ABUTMENT AT WING WALL



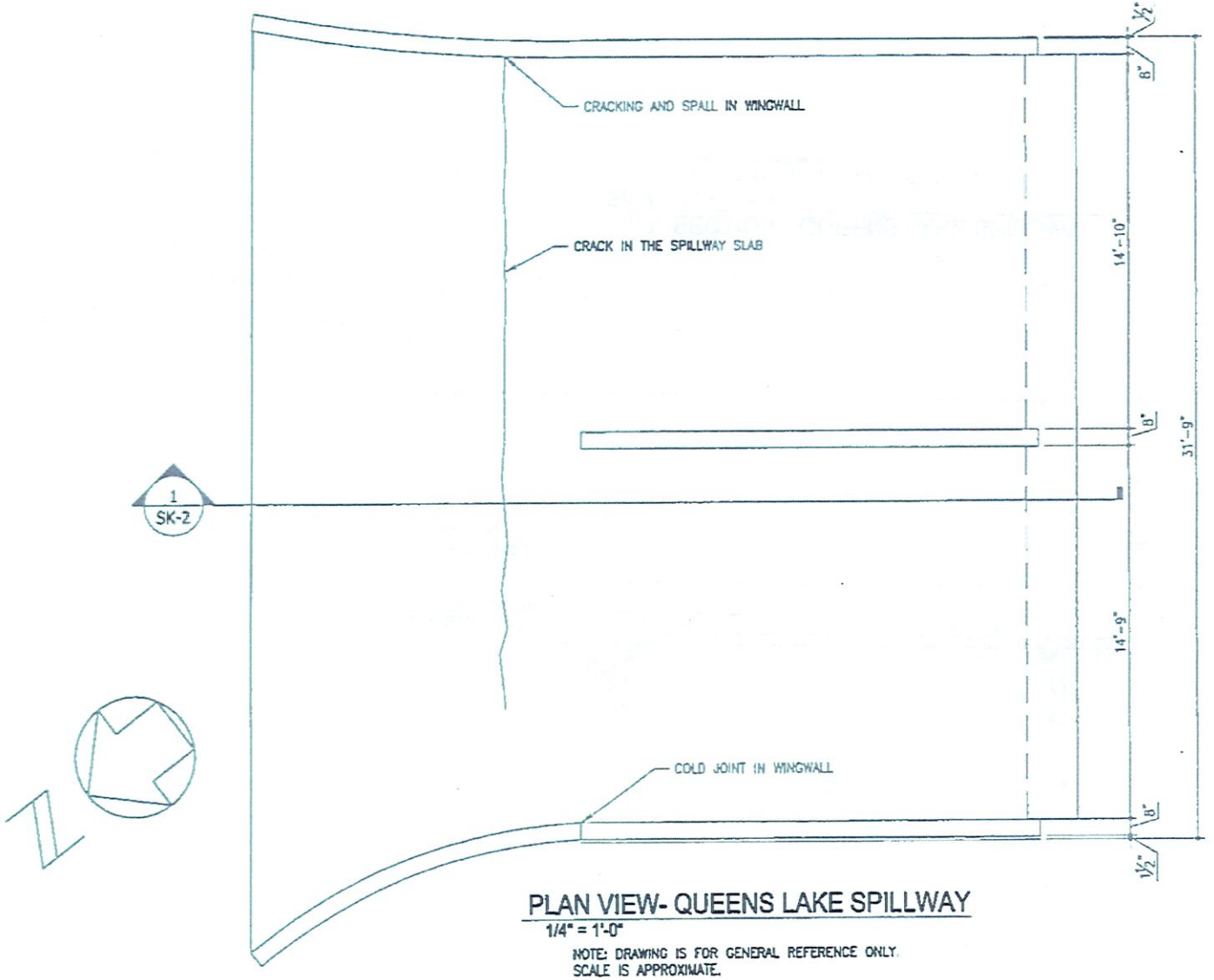
01.17: CONCRETE WALL AT THE TOE OF THE SPILLWAY

01.18: EXPOSED TIMBERS APPEAR TO BE PART OF FORMING FOR TOE



01.19: CONCRETE BELOW THE WATER LINE IS COVERED WITH BARNACLES

01.20: ABOVE THE WATER LINE THE CONCRETE IS CLEAN AND SMOOTH



PLAN VIEW- QUEENS LAKE SPILLWAY

1/4" = 1'-0"

NOTE: DRAWING IS FOR GENERAL REFERENCE ONLY.
SCALE IS APPROXIMATE.

TAM CONSULTANTS

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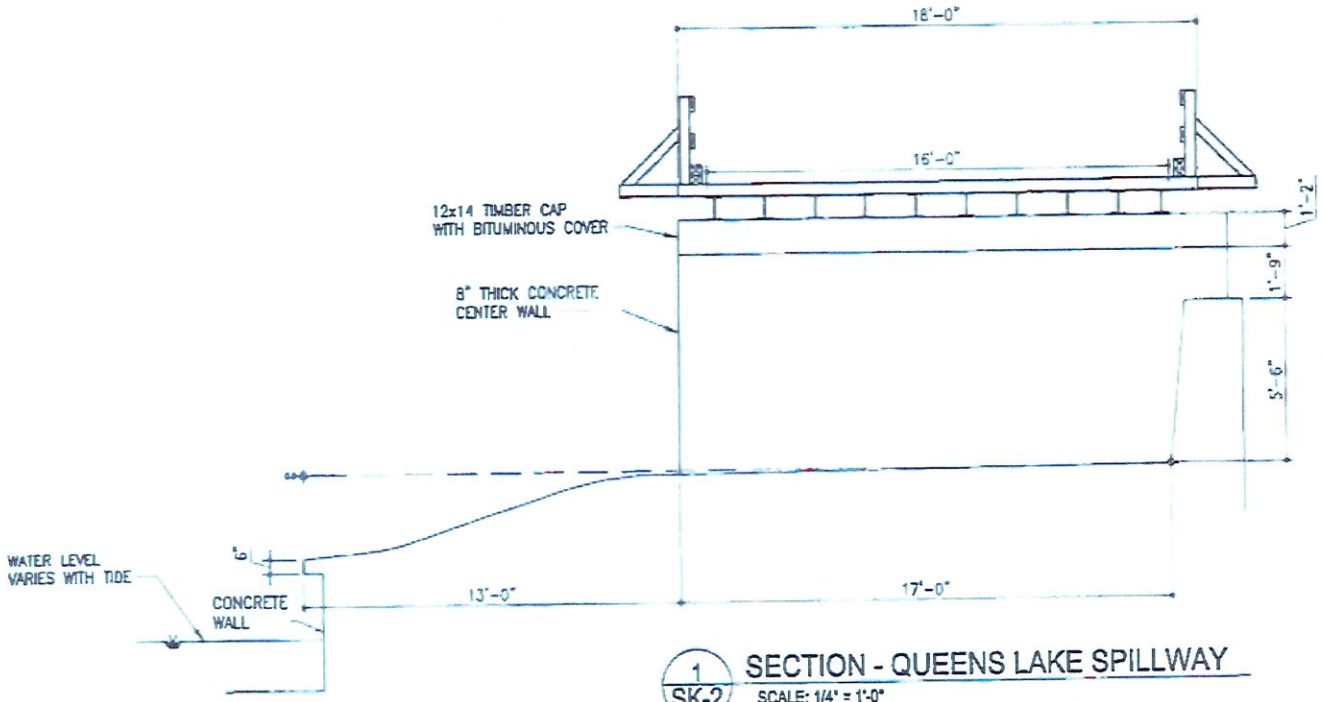
(757) 564-4434
FAX: (757) 564-1666

PROJECT MANAGER: WDJ
DESIGNED: BJ
DRAWN: GL
CHECKED: WDJ
DATE: 02/05/2018

STRUCTURAL EVALUATION
QUEENS LAKE SPILLWAY
AES CONSULTING ENGINEERS
YORK COUNTY, VIRGINIA

SHEET SK-1

CAD NO. 17496S1
JOB NO. 17496-W



1 / SK-2 SECTION - QUEENS LAKE SPILLWAY

SCALE: 1/4" = 1'-0"

NOTE: DRAWING IS FOR GENERAL REFERENCE ONLY. SCALE IS APPROXIMATE.

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PROJECT MANAGER: WDJ
DESIGNED: BJ
DRAWN: GL
CHECKED: WDJ
DATE: 02/05/2018

STRUCTURAL EVALUATION
QUEENS LAKE SPILLWAY
AES CONSULTING ENGINEERS
YORK COUNTY, VIRGINIA

SHEET SK-2

CAD NO. 17496S1
JOB NO. 17496-W